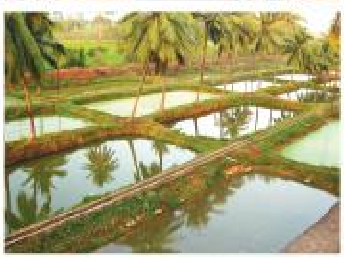


STATE SPECIFIC STRATEGIES FOR DOUBLING FARMERS INCOME - 2022






Indian Council of Agricultural Research
(Department of Agricultural Research and Education)
New Delhi-110001

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सत्यमेव जयते

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भाकृअनुप
ICAR

My dream is to see farmers double their income by 2022 when the country completes 75 years of its Independence.

Shri Narendra Modi, Hon'ble Prime Minister of India
while addressing a farmers' rally in Bareilly, UP on 28th Feb, 2016

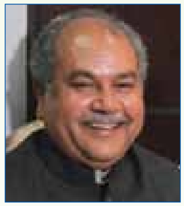
नरेन्द्र सिंह तोमर
NARENDRA SINGH TOMAR
D.O. No. ....462....... /AM

कृषि एवं किसान कल्याण,
ग्रामीण विकास तथा पंचायती राज मंत्री
भारत सरकार
कृषि भवन, नई दिल्ली

सत्यमेव जयते

MINISTER OF AGRICULTURE & FARMER WELFARE,
RURAL DEVELOPMENT AND PANCHAYATI RAJ
GOVERNMENT OF INDIA
KRISHI BHAWAN, NEW DELHI

13 DEC 2019



संदेश

स्वतन्त्रता पश्चात अवधि के दौरान हुई प्रौद्योगिकीय प्रगति के कारण भारतीय कृषि ने शानदार प्रगति की है। खाद्यान्नों की कमी से आत्मनिर्भरता और शुद्ध आयातक से कृषि–जिंसों के शुद्ध निर्यातक तक हुआ देश का रूपान्तरण हम सभी भारतीयों के लिए गर्व का विषय है। अपने प्रौद्योगिकीय विकास और प्रचार–प्रसार के प्रयासों के माध्यम से भाकृअप ने हरित क्रांति, श्वेत क्रांति, नीली क्रांति लाने तथा हमारे कृषि क्षेत्र के परवर्ती विकास में अग्रणी भूमिका निभाई है, जिससे वर्ष 1951 से अब तक देश के खाद्य अनाज उत्पादन में 5.4 गुणा से अधिक, बागवानी फसलों में 10.1 गुणा से अधिक, मात्स्यिकी उत्पादन में 15.5 गुणाए दुग्ध उत्पादन में 10.00 गुणा से अधिक और अंडों के उत्पादन में 48.1 गुणा वृद्धि हुई है और इसका राष्ट्रीय खाद्य एवं पौषणिक सुरक्षा पर प्रत्यक्ष प्रभाव पड़ा है। इस दिशा में भाकृअप, कृषि, सहकारिता और किसान कल्याण विभाग तथा देश और विदेश में कृषि क्षेत्र में अनुसंधान और/ अथवा विकास कार्य में लगे अन्य विभागों और संस्थानों के साथ निकट सहयोग करते हुए कार्य कर रहा है। इन सभी उपलब्धियों के बावजूद कृषि के विभिन्न क्षेत्रों में उत्पादन और उत्पादकता वृद्धि के अनुरूप किसानों की आय में बढ़ोतरी नहीं हुई है। देश की खाद्य सुरक्षा और अर्थव्यवस्था के लिए महत्वपूर्ण होने के कारण यह सुनिश्चित करना हमारा दायित्व है कि किसानों की आय में वृद्धि हो और उन्हें व्यापक वित्तीय सुरक्षा प्राप्त हो। इस तथ्य को ध्यान में रखते हुए माननीय प्रधानमंत्री ने वर्ष 2022 तक किसानों की आय को दुगुना करने के लिए सभी संबंधितों का राष्ट्रीय आह्वान किया है जो पूर्व के उत्पादन केन्द्रित दृष्टिकोण से नए आय केन्द्रित दृष्टिकोण में हुए आदर्श परिवर्तन में प्रदर्शित होता है।

इस संबंध में मुझे यह जान कर बहुत प्रसन्नता हुई है कि डेयर/भाकृअप ने वर्ष 2022 तक किसानों की आय को दुगुना करने पर राज्य विशिष्ट कार्यनीति दस्तावेज तैयार किए हैं जो आवश्यक कार्रवाई करने हेतु राज्य सरकारों को उपलब्ध कराए गए हैं। इस खंड में राज्यों के कार्यन्वयन हेतु संस्तुत कृषि प्रौद्योगिकियों और कृषि क्रियाओं के पैकेज पर मुख्य रूप से फोकस करते हुए भाकृअप/डेयर

द्वारा संस्तुत कार्य–योजना का सार प्रस्तुत किया गया है। इस दस्तावेज का विशेष महत्व है क्योंकि इसमें विभिन्न राज्यों की विद्यमान कृषि–पारिस्थितिकियों को ध्यान में रखकर परिषद द्वारा प्रोत्साहित की जा रही उन्नत प्रौद्योगिकियों और मूल्य श्रृंखला के उपयुक्त संयोजनों का विवरण है। यह समेकित ढंग से महत्वपूर्ण अंतरालों को भरने और उपयुक्त फसल/पशुधन/मत्स्य संयोजन और अन्य कार्यनीतियों पर संतुलित ध्यान केन्द्रित करने सहित राज्य कृषि क्षेत्र की बाधाओं को दूर करने के लिए कार्यान्वित की जा रही कार्य–योजना प्रदान करेगा।

मुझे विश्वास है कि यह दस्तावेज सभी हितधारकों के लिए एक संदर्भ–पुस्तिका के रूप में कार्य करेगा और वर्ष 2022 तक किसानों की आय को दुगुना करने के लक्ष्य को प्राप्त करने के लिए राज्य की ऐजेंसियों और कृषक समुदाय का मार्ग प्रशस्त करने के साथ–साथ एक सुदृढ़ और समृद्ध भारत बनाने की दिशा में भी योगदान करेगा।

मैं इस अवसर पर भाकृअप/डेयर द्वारा इस दिशा में किए गए महत्वपूर्ण प्रयासों की सफलता की कामना करता हूँ और उन्हें बधाई देता हूँ।

(नरेन्द्र सिंह तोमर)

परशोत्तम रूपाला
PARSHOTTAM RUPALA

कृषि एवं किसान कल्याण
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MINISTER OF STATE FOR AGRICULTURE
& FARMERS WELFARE
GOVERNMENT OF INDIA

संदेश

भारत सरकार ने, माननीय प्रधानमंत्री के विजन द्वारा मार्गदर्शित, किसानों की आय को वर्ष 2022 तक दोगुना करने का एक महत्वाकांक्षी लक्ष्य निर्धारित किया है जिसके लिए क्षेत्र–विशिष्ट की नवोन्मेषण कार्य–नीति को अपनाने की आवश्यकता है। इस उच्च लक्ष्य को केवल विभिन्न राज्यों के निकट समन्वयन से ही प्राप्त किया जा सकता है, चूंकि वे न केवल विचारों को कार्य रूप में रूपांतरित करने में प्रमुख भूमिका निभाएंगे, बल्कि सम्पूर्ण प्रक्रिया को उसके तार्किक निष्कर्ष तक पहुंचाने में भी मार्गदर्शन करेंगे।

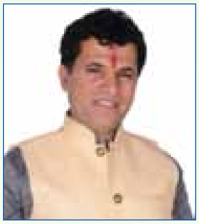
यह बड़े हर्ष का विषय है कि भाकृअप/डेयर नेए राज्य–विशेष की प्रौद्योगिकीय युक्तियों पर फोकस करते हुए, किसानों की आय को दोगुना करने के इस लक्ष्य की प्राप्ति में सहायता करने के लिए राज्य विशेष के कार्य–नीतिपरक दस्तावेज तैयार किए हैं और उसे संबंधित राज्य सरकार के साथ साझा भी किया है और अब वे 2022 तक सभी राज्यों के किसानों की आय को दोगुना करने की प्रस्तावित प्रमुख कार्य–नीतियों पर प्रकाश डालते हुए इसका एक समेकित दस्तावेज प्रकाशित करना चाहते हैं। इस सार–संग्रह में, मुख्य रूप से किसानों के कल्याण एवं विकास को ध्यान में रखते हुए लक्ष्य–प्राप्ति हेतु भाकृअप द्वारा किए गए प्रयासों का उल्लेख किया गया है।

इस दस्तावेज में भारत के कृषि क्षेत्र के सभी महत्वपूर्ण पहलुओं को लिया गया है और किसानों की आय को बढ़ाने के लिए पैदावार में बढ़ोतरी करनेए उत्पादन की लागत कम करने ताकि उन बचतों के कारण किसानों की अतिरिक्त आय हो सके, और पर्यावरण को ध्यान में रखते हुए नई–नई कार्य–विधियों को अपनाने में किसानों की सहायता करने के नवोन्मेषी सुझाव दिए गए हैं।

मुझे विश्वास है कि यह सार–संग्रह देश की खाद्य सुरक्षा को सुनिश्चित करने के लिए महत्वपूर्ण कार्य–नीतियों को अपनाने में प्रत्येक राज्य की सहायता करने के लिए एक बहुत बड़े संसाधन के रूप में कार्य करेगा। यह उत्पादन को नियंत्रित करने और उनके निवेशों को सुरक्षित रखने में भी किसानों की सहायता करेगा तथा इस प्रकार से एक समृद्ध और सुदृढ़ भारत बनाने का मार्ग प्रशस्त करेगा।

(परषोत्तम रूपाला)

कैलाश चौधरी
KAILASH CHOUDHARY



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संदेश

भारत ने कृषि क्षेत्र को सक्षम बनाने तथा इसकी विकास में तेजी लाने के लिए व्यावहारिक कृषि योजनाओं के निर्माण तथा मूल्य श्रृंखला में अद्यतन प्रौद्योगिकीय नवोन्मेषणों के कार्यान्वयन द्वारा अपने देशवासियों के लिए खाद्य सुरक्षा को सुनिश्चित करने के लिए कृषि के सभी क्षेत्रों में उल्लेखनीय प्रगति की है। तथापि, भारतीय अर्थ–व्यवस्था के विकास में महत्वपूर्ण भूमिका निभाने तथा रोजगार–सृजन करने के बावजूद, अन्य कारणों के अलावा कृषि निवेशों (इनपुट) की बढ़ती कीमतों तथा सिकुड़ रही जोतभूमि के करण कृषि एक बहुत चुनौतिपूर्ण विषय रहा है। इसलिए, हमें अपनी कार्यनीतियों पर पुनर्विचार करने की आवश्यकता है क्योंकि जो कुछ विगत वर्षों में सफल रहा है, यह आवश्यक नहीं कि वह अब भी हमारी अपेक्षाओं के अनुरूप प्रभावी हो। इसके लिए एक कार्य योजना की आवश्यकता है जिसमें एक सामूहिक लक्ष्य प्राप्त करने के लिए सभी हितधारक एक साथ मिलकर कार्य करें।

बदलते आर्थिक परिदृश्य में हमारे किसानों के समक्ष आ रही चुनौतियों को समझते हुए, वर्ष 2016 में माननीय प्रधानमंत्री नरेन्द्र मोदी जी ने वर्ष 2020–22 तक किसानों की आय को दुगना करने का आह्वान किया है। मुझे यह जानकर खुशी है कि डेयर/भाकृअप ने इस लक्ष्य को प्राप्त करने के लिएए राज्य–विशिष्ट प्रौद्योगिकीय युक्तियों पर फोकस करते हुए राज्य–विशिष्ट कार्यनीति दस्तावेज तैयार किए हैं जो संबंधित राज्य सरकारों को उपलब्ध कराए गए हैं। डेयर/भाकृअप अब यह विशेष प्रकाशन निकाल रहा है, जो कि सभी राज्यों के लिए विकसित किए गए अलग–अलग विस्तृत दस्तावेजों से बनाया गया सारांश दस्तावेज है। इस दस्तावेज के माध्यम से उन सभी कार्रवाई बिन्दुओं के बारे में उपयोगी जानकारी दी गई है जिस पर परिषद द्वारा विभिन्न राज्यों में कार्यान्वित करने के लिए कार्य किया जा रहा है और जिससे राष्ट्र को विकास के उच्चतर पथ पर ले जाया जा सके।

मुझे विश्वास है इस सार–संग्रह में सुझाई गई कार्यनीतियों का किसानों के बीच परेशानी उत्पन्न करने वाले जटिल मुद्दों के समाधान के साथ–साथ, देश के कृषि क्षेत्र में त्वरित विकास को सुनिश्चित करते हुए किसानों की आय को दोगुना करने का लक्ष्य प्राप्त करने के लिए सभी हितधारकों द्वारा कार्यान्वयन किया जाएगा।

इस महत्वपूर्ण प्रकाशन को तैयार करने के लिए मैं एक बार पुनरू डेयर/भाकृअप को धन्यवाद देता हूं।

(कैलाश चौधरी)

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TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

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PREFACE

"If farmers give up farming, even the Rishis (Sages) cannot afford to survive."- Thirukkural (300 BC)

The above sacred verse from an ancient Indian literary text opines that no living person, however minimal his worldly needs be, could think of leading their lives without farming and the statement remains true even today.

The Prime Minister's call to double farmers' income by 2022 has brought a major change in the focus of agricultural sector from the traditional production orientation to income orientation and created renewed interest among all major stakeholders in the country, ranging from the agricultural research community, policy makers, state authorities, extension agencies, private players, and more importantly the farming community. Several reformative steps have been taken by the Government in this regard which target; re-orientation of focus from intensification to diversification, from sustenance to commercialization, and turning the agricultural units to enterprises. A series of programs/initiatives have been floated by the Govt. to execute and monitor the outreach of technologies, soil health card scheme, simplification of agriculture credit, PM Krishi Sinchayee Yojana, Paramparagat Krishi Vikas Yojana. Price supports are now provided to include several new crops and price stabilisation funds have been created, agriculture credit facilities strengthened. APMC act has been modified and National Agricultural Market (eNAM) platform created to provide direct market access to producers/farmers by linking them to all the major mandis of the country to ensure better returns. To minimise the distress among farming community, innovative agri-insurance scheme besides PM Kisan Samman Nidhi and PM Kisan Pension Yojana have also been started. Entrepreneurship is being promoted for increased income and employment security.

In pursuance of the clarion call given by the Hon'ble Prime Minister and the policy initiative taken by the Government of India in this regard, ICAR took efforts to develop state specific strategy documents with major focus on the key agricultural technologies and their combinations along with effective technology delivery mechanism and market linkage. In this connection ICAR requested Prof. Ramesh Chand, Member, Agriculture, NITI Aayog to make presentation in the ICAR Directors Conference on 14th February, 2017. Subsequently, ICAR constituted State-wise Coordination Committees (SCCs) with the Vice Chancellor of one of the Agricultural Universities in the state as the Chairman and one of the Directors of ICAR Institutes/ ATARIs as the convener of the Committee. All the other Vice Chancellors and the ICAR Directors, Director, ATARI of the concerned region, one nominee each of DAC&FW, DAHDF, Ministry of Food Processing Industries and Ministry of Water Resources as well as the senior representatives of the concerned State Departments as the members of the Committee. Senior representatives from CGIAR system and Commodity Boards and the Farmers Organizations were co-opted as additional members in some of the Committees as per requirement.

The Committees were assigned the task of developing the comprehensive strategy documents on doubling farmers' income by 2022 for their respective states indicating existing productivity and income levels in the states, interventions to double the income of farmers by the year 2022, proposed action plan, mechanism for monitoring and midcourse correction etc. NITI Aayog Documents and the presentation made by Prof. M. S. Swaminathan before the Hon'ble Prime Minister on the subject and other relevant documents were also shared with the Chairmen and the Conveners of SCCs to develop the state specific proposals accordingly. While developing the strategies the committee were asked to take into consideration, the, agro-ecologies of the State, land use and cropping pattern, natural resource endowments, important development indicators, infrastructure for agriculture and Government programmes, productivity gaps and major constraints keeping into mind the scope and potential for development of Horticulture, Livestock, Fisheries, Agro-forestry and Post-harvest processing etc. in the states. Besides, the plans have given special focus on the role of technology and developing the strategy and action plan for enhancing production, cost reduction, quality improvement and generating additional income. Potential contribution to farmers' income and strategy for scaling out these technologies (Technology information/packages validated/successfully demonstrated) have also been included. Focus is also given on Value Chain Development, Market Linkages and Trade Potential, Policy and Investment Requirements and Role of the Government besides giving implementation plan along with the institutional responsibilities.

The documents developed by various SCCs were presented by them in the states as well as at the level of Council. The final round of presentations was made by all the SCCs in the joint meeting chaired by Professor (Dr.) M. S. Swaminathan, at NASC Complex, New Delhi on 3rd November, 2017. Based on the suggestions received, the documents were further refined by bridging critical gaps and identifying the actionable points and the points of convergence between various Departments and stakeholders. The final documents submitted by the SCCs were released by the Hon'ble Agriculture and Farmers Welfare Minister, Government of India in the Vice Chancellors and ICAR.

Directors Annual Conference on 8th March, 2018. The finally developed documents received from all SCCs were shared with respective state governments through the Minister of Agriculture

& the Director General, ICAR who sent these documents to the respective Chief Ministers and Chief Secretaries concerned for implementation. In all, twenty-nine States and the UT of Delhi were covered in this exercise.

While the States were being requested to implement and scale-up the strategies in their states in different agro-ecologies in their respective states, ICAR has taken initiatives to implement the recommended package of practices through KVKs by adopting two villages each and demonstrating the technologies at farm level through farm level demonstrations. ICAR Institutes notably Indian Institute of Sugarcane Research, Lucknow took initiatives for doubling farmers' income in Public Private Partnership Model to harness the potential of sugarcane sector towards doubling farmers' income, and initiated a joint venture with DCM Shriram Limited (DSL), New Delhi in command areas of four sugar mills in 2017 to double income of all 2028 farm families in eight villages of two districts by introducing technological, human resource and developmental interventions. Blue print of required interventions (sugarcane based and in allied agri-enterprises) were developed and implemented with logistic and financial support of DSL group with impressive results. Similar models are being developed & promoted in other ICAR Institutes.

The strategies in the document focus on increased emphasis on agri-business through transforming farming into agri-enterprises performing multiple functions at one point of time. Encouraging processing and building value chains would help create non-farm jobs in rural areas. Neither the productivity centric nor the marketing and price centric approach are going to work in isolation. Every commodity has to be dealt in a holistic value chain approach where suitable interventions are required at all the critical stages. The implementation of DFI strategies by the states needs formulation of strategic plans for all sub-sectors and effective linkages among the high-powered think tanks and implementing bodies. Indian Council of Agricultural Research through its Research Institutes and State Agricultural Universities is advising states to implement these strategies'. Centre-State linkages would be extremely important in mainstreaming and channelizing the policies and investment to the targeted goals for development. A crucial role will have to be played by the state and state development agencies in implementing state plans and working on strategic framework the implementation & mid-course correction involving all stakeholders for fulfilling the objective.

(T. Mohapatra)

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ACKNOWLEDGEMENT

Doubling of farmers' income by 2022 in pursuance of the clarion call given by the Hon'ble Prime Minister, remains the most important agenda of the government. Towards this cause ICAR has focused efforts towards farmers' participatory research to develop and scale up location specific, cost effective, eco-friendly and climate resilient technologies and promotion of grass-root farm innovations to enhance agricultural production, productivity and profitability in the agriculture sector and increase farmers' income. To realise this, Indian Council of Agricultural Research constituted State Level Coordination Committees (SLCCs) headed by a Senior Vice Chancellor of an Agricultural University in each state. These documents have already been provided to the state governments from the levels of Hon'ble Minister and DG, ICAR for implementing in all agro-ecologies of their respective states. ICAR, is now focusing on the implementation of the action plan at the ground level in selected villages by ensuring involvement of the ICAR Research Institutes, ATARIs & KVKs along with Agricultural Universities and the state Govt. departments. This document is a summary document developed from the detailed state specific documents and includes in brief the approaches, major strategies and technology interventions included to be implemented in different states at times supported by few case studies/ success stories.

I put on record my immense gratefulness to our Hon'ble Agriculture & Farmers Welfare Minister Shri Narendra Singh Tomar ji and the Hon'ble Ministers of State for Agriculture & Farmers Welfare Shri Parshottam Rupala ji and Shri Kailash Chaudhary ji for their visionary leadership and the micro vision for agriculture sector and interest to work dedicatedly for the cause of the farmers and farming community. I am also grateful to the former Minister of Agriculture &Farmers Welfare Hon'ble Shri Radha Mohan Singh ji and former Minister of State for Agriculture & Farmers Welfare Shri Gajendra Singh Shekhawat ji for their motivation and keen interest in these efforts.

A lot of efforts from a large number of persons have gone into developing and refining these strategies. I place on record my deep sense of gratitude to Dr. T. Mohapatra, Secretary, DARE & DG, ICAR for spearheading the efforts at all levels beginning from conceptualising the idea of developing state wise DFI documents, constituting the state wise coordination committees, steering a series of review meetings to discuss and revise the strategies, consistently guiding and motivating all teams involved in the development and implementation of the strategy as also inviting eminent authorities including Prof. M.S. Swaminathan, Prof. Ramesh Chand, Secretaries of various line departments and other stakeholders including NGOs to the stakeholder meetings to add additional dimensions, bring in holistic vision and wide ranging expertise to fine-tune the strategies as also sharing these documents with the respective chief secretaries and maintaining constant liaison for the implementation of these strategies at the ground level.

The motivation and guidance received from the farther of Indian green revolution and a father figure to the entire agricultural community of the country, Professor M.S. Swaminathan himself who very kindly agreed to chair the review meeting organised to finalise the state wise DFI documents. The guidance and motivational support received from Prof. Ramesh Chand, Member, Agriculture, NITI Aayog to Chair the review meetings and share his vision as also to make presentations on this aspect during ICAR Directors Conference is gratefully acknowledged.

The motivational guidance received from the Former and present secretaries of ICAR namely, Shri Chhabilendra Raul ji, Shri Sushil Kumar ji and Shri Sanjay Singh Ji and the Financial Advisor DARE/ICAR Shri B. Pradhan ji are gratefully acknowledged. The inputs and the suggestions provided by all the senior officers of the Council including DDGs and ADGs are also gratefully acknowledged.

The enormous efforts put in by the chairmen, conveners and the members of all the 30 state level coordination committees (Annexure-1) for developing and implementing the DFI documents are gratefully acknowledged. I am particularly grateful to DDG, Extension & Agricultural Extension Division of ICAR including ATARI Directors & KVKs for adopting villages for scaling up the recommended interventions involving different stakeholders. Support received from the Scientists and staff of the Technical Coordination Division is thankfully acknowledged. Cooperation and support extended by the Directors & staff of all ICAR research institutes and the officers from the State Governments is also duly acknowledged.

(S.P. Kimothi)

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INTRODUCTION

Doubling of farmers' income by 2022 is the most important agenda of government of India. With this in view, ICAR has intensified efforts towards farmers' participatory research to develop and scale up location specific, cost effective and climate resilient technologies to enhance agricultural production, productivity and profitability in the agriculture sector and increase farmers' income. To realise this, Indian Council of Agricultural Research constituted State Level Coordination Committees (SLCCs) headed by a Senior Vice Chancellor of an Agricultural University in each state. All the other Vice Chancellors and the ICAR Directors, Director, ATARI of the concerned region, one nominee each of the related central ministries as well as the senior representatives of the concerned State Departments as the members of the Committee. During the process of the development of the state specific documents, a series of review meetings at the level of the Council were held to discuss and revise the strategies during which eminent authorities including Prof. M.S. Swaminathan, Prof. Ramesh Chand, Secretaries of line departments and other stakeholders including NGOs were also invited to bring in wide ranging expertise to fine-tune the strategies. The documents provide strategies for all the agro-ecologies of the States keeping into mind the scope and potential for development of Horticulture, Livestock, Fisheries, Agro-forestry and Post-harvest processing in the states. The documents focus on enhanced production, reduction of cost, improvement in quality besides providing strategy for scaling out these technologies.

The state wise documents were subsequently provided to the state governments from the levels of Hon'ble Minister and DG, ICAR for implementing in all agro-ecologies of their respective states. The state level coordination committees have been asked to oversee and implementation in close coordination with the respective state Governments to provide necessary technical help and guidance to implement these strategies. Indian Council of Agricultural Research through its Research Institutes and State Agricultural Universities is advising states to implement these strategies. ICAR, on its part is implementing the action plan in selected villages through KVKs and ICAR Research Institutes by involving other stakeholders including NGOs and the state agencies. ICAR Institutes notably Indian Institute of Sugarcane Research, Lucknow took initiatives for doubling farmers' income in Public Private Partnership Model to harness the potential of sugarcane sector towards doubling farmers' income, and initiated a joint venture with DCM Shriram Limited (DSL), New Delhi in command areas of four sugar mills in 2017 to double income of all 2028 farm families in eight villages of two districts by introducing technological, human resource and developmental interventions. Similar models are being developed & promoted in other ICAR Institutes.

The present volume is a summary document developed from the detailed state specific documents and includes in brief the approaches, major strategies and technology interventions included to be implemented in different states at times supported by few case studies/ success stories. The strategies in the document focus on increased emphasis on agri-business through transforming farming into agri-enterprises performing multiple functions at one point of time. Encouraging processing and building value chains would help create non-farm jobs in rural areas. We sincerely hope that the document will be found useful by various development agencies and departments besides policy planners, farmers, field extension workers and concerned scientists alike, and will play a meaningful role towards realising this very important dream of our Hon'ble Prime Minister.

1

ANDHRA PRADESH

The composite state of Andhra Pradesh came into existence on November 1, 1956 in accordance with the recommendations of the State Reorganisation Commission. The state is constituted of 23 districts.

The total geographical area of the state is 162.97 lakh hectares. 38.09% is under net area sown (62.08 lakh hectares), 22.63% under forest (36.88 lakh hectares), 8.65% under current fallow lands (14.10 lakh hectares), 12.47% under land put non-agricultural uses (20.32 lakh hectares), 8.27% under barren and uncultivable land (13.47 lakh hectares), 7.63% (12.43 lakh hectares) is under other fallow, cultivable waste lands like permanent pastures and other grazing lands and the remaining land under miscellaneous tree crops and groves are counted for 2.26% (3.69 lakh hectares).

In Andhra Pradesh 62% of the population is dependent on agriculture. Cropped areas in Andhra Pradesh fall into six zones based on agro-climatic conditions viz.,

i. High altitude and tribal areas, ii. North coastal zone, iii. Godavari zone,

iv. Krishna zone, v. Southern zone and vi. Scarce rainfall zone.

The average size of land holdings in Andhra Pradesh has marginally declined to 1.06 ha while number of holdings has increased to 76.21 lakhs.

Agriculture is diversified with 28 crops in the state under cultivation with rice, maize, pulses, groundnut, cotton, chillies, tobacco and sugarcane as major crops. The cropping intensity is about 124%. The state receives an average normal rainfall of 556 mm of south-west monsoon and 296 mm from north-east monsoon. The groundwater potential is estimated at 16.43 lakh ha with 15.09 lakh borewells. Andhra Pradesh is known as river state with canal irrigation of 10.81 lakh ha. The gross irrigated area in the state is 35.47 lakh ha and net irrigated area is about 27.43 lakh ha.

Fisheries, occupies an important place in the socio-economic development of sunrise Andhra Pradesh State. It is one of the vibrant sub-sectors of the Primary Sector, and identified as one of the growth engines. It is a significant employment generator and a source of proteinous food and foreign exchange earner for the State. The state ranks 1st in total fish and shrimp production and contributes more than 70% of cultured shrimp produced in the country. AP ranks 3rd in Global shrimp production. The state of Andhra Pradesh has 190 Agricultural

Market Committees including 10 for commercial crops, 19 for fruit markets, 22 for vegetable markets and 29 for cattle markets.

Gross state domestic product (GSDP) of Andhra Pradesh registered a growth rate of 11% in 2015-16 and is higher than the growth of GDP of the country during the last three years. The share of agriculture sector in Gross value added (GVA) in 2016-17 at current prices was 31.8%. Agriculture sub sector registered a growth rate of 2.03% in 2016-17. Horticulture grew at impressive rate of 16.79%. Livestock sector emerged as an alternative and dependable source of income generation during drought and registered a growth rate of 12.18%. Fisheries sector registered a phenomenal growth rate of 30.09%. The Per-capita income of Andhra Pradesh at constant prices (2011-12) registered a growth rate of 10.97%. The literacy rate stands at 67.35%.

A well established infrastructure is available for agriculture sector in the state of Andhra Pradesh. The state has established 2127 Fruit/Vegetables waste, compost production units, 1551 Custom Hiring Centres for Agricultural Equipment, 700 Seed Treatment drums & chemicals and 441 Bio-fertilizer Production Units are available in the state along with ATMA Infrastructure, Seed Storage Godowns including Dehumidifies Refrigerated Seed Storage Godowns, Kisan Call Centres, and Seed Processing Facilities etc.

In terms of marketing infrastructure in agriculture, 22 regulated markets have been linked to e-NAM. The state government initiated the primary sector mission and prepared action plans for achieving double digit growth. Soil testing and soil health card mission is given prime importance with distribution of 42.38 lakh soil health cards to farmers with a target of covering 76 lakhs farm holdings in the state. The state government is a pioneer in deployment of ICT initiatives in agriculture for the benefit of farmers. Crop insurance, organic/ natural farming, supports for tenant farmers, credit support and seed production is other important initiatives in recent times. Similarly several initiatives have been launched in horticulture, animal husbandry and fisheries sector.

Major Productivity Gaps and Constraints:

Several gaps and constraints were observed while framing the strategies to achieve the goal of doubling of farmers' income by 2022. A comparative study of productivity of major crops was done in all the districts of the state in order to develop a clear insight of the major gap lying between them and a detailed study was done to know the reasons behind them.

The average yield of major crops of the state along with highest and lowest yield along with the districts are given in Table 1.1. It is clear from the data that a big gap lies between highest and lowest yield and needs an eagle eye approach to bridge them.

Table 1.1: Productivity of major crops across various districts in the state

Crop	State average (kg/ha)	Highest (Kg/ha)	Lowest (Kg/ha)
Rice	**3532**	3969 (West Godavari)	1687 (Visakhapatnam)
Jowar	2435	6884 (Guntur)	304 (Anantapur)
Bajra	1366	2674 (SPS Nellore)	587 (Anantapur)
Maize	6390	7691 (Prakasam)	2731(Visakhapatnam)
Red gram	503	1558 (Guntur)	129 (Anantapur)
Bengal gram	1144	2303 (Guntur)	568 (Anantapur)
Groundnut	564	4538 (Guntur)	306 (Anantapur)
Sunflower	803	1125 (SPS Nellore)	334 (Anantapur)
Castor	575	1432 (Guntur)	440 (Prakasam)
Sugarcane	71847	116794 (Kurnool)	48330 (Visakhapatnam)
Cotton	570	886 (Guntur)	239 (Anantapur)
Tobacco	2565	6245 (Krishna)	1904 (Anantapur)

From the above information it is evident that a wide gap in productivity lies in various crops and after an exhaustive study to evaluate the cause for these lapses has helped in identifying the major notable constraints. Given below are the most notable constraints of major crops like rice, jowar, maize, oilseeds, pulses, livestock and fisheries.

Major constraints in achieving the demonstrated yield in Rice

- Major biotic stresses like Brown Plant Hopper, Stem borer, Bacterial Leaf Blight, Stem Rot, Sheath Blight, Red Stripe and Leaf & Neck Blast.
- Abiotic stresses like frequent floods during vegetative to flowering stage, increased salinity levels in the soil and stress due to heat and cold.
- Damage due to natural calamities like cyclones and heavy rains coinciding with harvest and prolonged cloudy weather during Kharif season.
- Lack of small scale farm machinery for various operations including post harvest handling suitable for small and marginal farmers.
- Lack of efficient or proper spraying equipment.
- Acute shortage of labour during peak operations leading to delay in timely operation and escalation of cost of production.
- Wide spread cultivation of non climate resilient rice varieties
- Deterioration of soil fertility and productivity.
- Indiscriminate / imbalanced use of fertilizers and pesticides
- Improper drainage in low lying areas of rice cultivation.

- Lack of assured irrigation for timely sowing in certain areas.
- Lack of proper threshing, drying and storage facilities.

Major constraints in achieving the demonstrated yield in Jowar

i. Non adoption of recommended high yielding varieties/hybrids to realize the potential yield in place of local varieties which are poor yielding types especially under rainfed conditions.

ii. Lack of awareness on application of recommended doses of fertilizers both under rainfed as well as irrigated conditions.

iii. Lack of need based plant protection for important pests and diseases.

iv. Most of the crop is grown under rainfed and residual moisture conditions. Periodical drought of varying intensities and lack of irrigation facilities reduces the productivity levels.

v. Variation in soil types.

vi. Lack of timely and adequate seed supply.

vii. Shoot fly and grain moulds in kharif season and shoot fly and charcoal rot in rabi season are the major limiting factors.

Major constraints in achieving the demonstrated yield in Maize

i. High incidence of biotic and abiotic stresses during the two growing seasons is influencing yields of maize.

ii. Non availability of climate resilient maize cultivars.

iii. Lower price compared to cereals.

iv. Institutional and economic constraints.

v. Lack of proper storage facilities in market yards.

vi. Lack of infrastructure for post harvest processing and value addition.

vii. Fading organic carbon in the soil is declining crop productivity and profitability is being reduced besides escalating costs of inputs and cost of cultivation.

viii. Lack of varieties suitable for late sown condition.

Major constraints in achieving the demonstrated yield in Oilseeds:

i. Non-availability of quality seed

ii. The non-availability of water at different intervals was also a major constraint in getting the adequate production from oilseed crops

iii. Incidence of pest and diseases

iv. Inadequate knowledge about disease and pest management

v. The economic constraints relate to high input costs, shortage of human labour, low and fluctuating prices etc

vi. Inadequate storage
vii. Lack of Processing Facilities
viii. Poor Marketing System and Access to Markets
ix. Lack of Information about the price and Markets

Major constraints in achieving the demonstrated yield in Pulses:

Blackgram

i. Pre- harvest sprouting during *kharif* season lowers the quality of seeds.
ii. Plant establishment in Rice-fallows
iii. In Rice-fallow system there is serious menace of weeds & *cuscuta*.
iv. Terminal moisture stress reduces the final yield.
v. Diseases that seriously affect the blackgram are leaf curl, MYMV, leaf crinkle, PM, *Corynespora*, rust, wilt and *Macrophomina*.
vi. Insect pests affecting the crop are Thrips, whitefly, Maruca pod borer, stem-fly and Spodoptera.

Greengram

i. Pre harvest sprouting during *kharif* season
ii. Intermittent moisture stress
iii. Plant establishment in Rice-fallows
iv. Weed menace & cuscuta in Rice-fallows
v. The greengram plants are susceptible to
vi. Diseases: Leaf curl, leaf crinkle, MYMV, powdery mildew, ABLS
vii. Insect pests: Thrips, whitefly, maruca pod borer, spodoptera litura

Redgram

i. Terminal moistures stress
ii. Cultivation as an intercrop under neglected management.
iii. Indeterminate, tall habit of the present day cultivars making plant protection operations difficult.
iv. Incidence of following is very prominent
v. Diseases: Wilt and Sterility mosaic diseases
vi. Insect pests: Maruca, Heliothis and pod fly

Bengal gram

i. Short and warm winters
ii. Drought

iii. Incidence of

iv. Diseases: Dry root rot, collar rot and wilt

v. Insect pests: Helicoverpa pod borer, Spodoptera exigua

Major constraints observed for low productivity in Livestock

i. Local breeds are being reared which have low productivity.

ii. Cross bred animals poorly adapt to the local conditions.

iii. The farmers are not having adequate knowledge about feeding.

iv. Fodder is not available round the year

v. High costs on feeding & Storage of feed

vi. Lack of Grazing land

vii. Low availability of dry fodder

Major constraints observed for low productivity in Fisheries:

i. Availability of quality fish seed in required quantity and time is always limited.

ii. Farmers depends on single type of culture practices (Inland sector: carp culture, Brackish water : Vennami culture)

iii. Non availability of sufficient seed and artificial feed in Sea bass culture, crab culture

iv. Low productivity due to poor growth rate.

v. Traditional methods of fish cultivation in community and panchayat tanks resulting less yields (Average fish production 500kg/ha)

vi. Lack of awareness about maintenance of pond environment and water quality management.

Strategy and interventions for doubling of farmers' income

The above mentioned points give a clear insight about the gaps and accordingly the following strategy and interventions were developed

Strategies for different zones

The cropped areas in Andhra Pradesh are divided into six zones based on the agro-climatic conditions. The classification mainly concentrates on the range of rainfall received, type and topography of the soil. Here the strategies and interventions are given for different zones characterized into following groups:

A. North Coastal Zone & High Altitude and Tribal areas (Srikakulam, Vizianagaram, Visakhapatnam districts)

B. Godavari Zone (East Godavari, West Godavari)

C. Krishna Zone (Krishna, Guntur, Prakasam)

D. Southern Zone (Chittoor, Kadapa, Nellore)

E. Scarce Rainfall Zone (Anantapur, Kurnool)

A. North Coastal Zone & High Altitude and Tribal areas (Srikakulam, Vizianagaram, Visakhapatnam districts)

The North Coastal Zone & High altitude tribal areas is spread over 1.19 M ha comprising of three districts i.e., Srikakulam, Vizianagaram and Visakhapatnam covering 6592 villages in 101 mandals of 11 revenue divisions. In general the productivity is low in north coastal districts due to low fertility status of soils in adequate irrigation and poor facilities, adoption of improved varieties and management practices. This zone receives a rainfall from 1100 to 1400 mm. Horticultural crops, millets, pulses, chillies, turmeric and pepper are the important crops grown.

Strategy and Interventions for North Coastal Zone & High Altitude and Tribal areas

Strategy 1: Productivity Enhancement	❖ Introduction of flood tolerant MTU & RGL paddy varieties ❖ Reviving rice fallow pulses with introduction of Yellow Mosaic Virus disease tolerant varieties in black gram and green gram. ❖ Establishment of seed hub for pulses in Srikakulam for production of 1000q/year. ❖ Promotion of sugarcane clones for rainfed situations in Visakhapatnam district with productivity of >75 tonnes/ha ❖ Introduction of high yielding varieties of sesame with a productivity of >1 ton/ha e.g., YLM-136 ❖ Replacement of seedling orchards with grafts in Cashew & rejuvenation of aged orchards of mango, cashew, guava
Strategy 2: Cost reduction	❖ Paddy + Fish IFS model ❖ Direct sowing of paddy using drum seeder in uplands to reduce costs ❖ Zero till cultivation of rabi maize ❖ Green manuring and organic production of paddy ❖ Soil test based nutrient application in paddy, maize, sugarcane ❖ Integrated pest management practices in paddy, pulses, sugarcane and oilseeds ❖ Establishment of nurseries for pro- tray production and supply of vegetable seedlings ❖ Farm mechanization - Power tillers, Power weeders, Paddy threshers, Maize Sheller, power operated paddy reapers and harvesters

Strategy 3: Quality Improvement / Processing/ value addition/ niche markets	❖ Millets – primary processing & value addition. ❖ Good agricultural practice of trellising in vegetable crops (tomato, brinjal, cucumber, capsicum) for increasing good quality marketable produce yield upto 80% and quality by 20% ❖ Cultivation of open pollinated chilli varieties (LCA-625) to reduce costs and increase profitability ❖ Organic jaggery production ❖ Organic coffee in high altitude tribal areas ❖ Value added products from Palmyrah
Strategy 4: Generation of additional income	❖ Mother units / small hatchery units for backyard Poultry improved breeds of Srinidhi, Rajeshwari, Gramapriya etc. ❖ Efficient feed management utilizing crop residues like maize stover, straws of legume crops etc for dairy ❖ Cluster farming @500-1000 broiler birds by 8-10 youth in low cost housing ❖ Year round fodder production with hybrid napier and guinea grass ❖ Semi-intensive sheep production in Horti-pastoral system (mango) ❖ Intercropping/ multi-storied cropping in coconut and oilpalm with banana, pineapple, black pepper, turmeric, yam, colocasia, cocoa, long pepper, heliconia, red ginger with a cost benefit ratio ranging between 2.18 to 2.67 ❖ Adoption of casuarina & eucalyptus clones for paper industry ❖ Skill training in bee-keeping for income generation ❖ Mushroom production

B. Godavari Zone (East and West Godavari)

The Godavari Zone comprises of two districts i.e., East Godavari and West Godavari. Red soils with clay base, pockets of acidic soils, alluvial soils, soils with pH 4-5. The normal rainfall of the zone is about 1050-1100 mm.

Strategy and Interventions for Godavari Zone: Strategy and Interventions

Strategy 1: Productivity Enhancement	❖ Adoption of multiple stress tolerant high yielding paddy cultivars ❖ Reviving rice fallow pulses with introduction of disease tolerant varieties in blackgram and greengram. ❖ Intercropping in oil palm with Cocoa, pepper, heliconia, red ginger ❖ Replacement of seedling orchards with cashew grafts in tribal areas ❖ High density planting of guava ❖ Pro-tray vegetable seedling production and supply

Strategy 2: Cost reduction	❖ Direct seeding of paddy along with weed management ❖ Disease free tissue culture banana plants for planting ❖ Establishment of pro-tray nursery under insect proof nets to get uniform, healthy seedlings to ensure better establishment and to reduce seed rate (20%). ❖ Adopt drip & fertigation to save water and fertilizers (20- 30%) with increased water and nutrient use efficiency. ❖ Soil health based nutrient recommendations ❖ Adopt mulching (preferably silver and black) to get early and healthy crop along with weed control there by reducing the cost for weeding. ❖ Agri-biomass briquettes for tobacco curing and use of ❖ solar energy to reduce dependency on wood fuel for increasing fuel efficiency in tobacco curing ❖ Solar dryer technology - time taken for drying of fish reduced by 60-70% & post harvest wastage reduced by 20%
Strategy 3: Quality Improvement / Processing/ value addition/ niche markets	❖ Palmyrah value added products ❖ Jaggery powder production at village level ❖ Rubber extraction & processing ❖ Processing & value added fisheries products ❖ Millets – primary processing & value addition through establishment of minimal processing units and skill training, ❖ product development, branding, certification and market linkage ❖ Promotion of Farmers clubs/ FPOs/FPCs for value chains and market linkages
Strategy 4: Generation of additional income	❖ Multi-storied cropping in coconut (banana, pineapple, black pepper, turmeric, yam & colocasia) ❖ Protected cultivation high value vegetables ❖ Fodder production+ Mini dairy+Composting+ Protected cultivation ❖ Good agricultural practices in aquaculture ❖ Promotion of apiculture for small and landless farmers ❖ Sericulture (mulberry) production ❖ Open field/ Protected floriculture ❖ Cage culture of fisheries in reservoirs

C. Krishna Zone (Krishna, Guntur, Prakasam)

The Krishna Zone comprising of three districts i.e., Krishna, Guntur and Prakasam. The soil is red with clay, red loams, costal sands and saline soils and deltaic alluvium soils with good moisture retentive capacity. The normal rainfall of the zone is about 800-1100 mm.

Strategy and Interventions for Krishna Zone – strategies and interventions

Strategy 1: Productivity Enhancement	❖ Seed production of Paddy, Redgram, Korra (Foxtail millet), Castor ❖ Pulses, maize and jowar as alternative irrigated dry crops ❖ Disease free tissue culture banana ❖ Rice fallow pulses - YMV tolerant Blackgram (TBG104 and GBG1) ❖ Cotton Intercrop in redgram, millets etc. ❖ Groundnut intercrop with redgram ❖ Double cropping in Kharif fallow- chickpea cropping areas. ❖ Preceding catch crop of pulse/ millet followed by chickpea/ tobacco in southern light soils of Prakasam district
Strategy 2: Cost reduction	❖ Drum seeding of paddy ❖ Soil test based micro nutrient application in paddy, pulses, oilseeds and millets ❖ Seed to Seed mechanization in chickpea ❖ Custom hiring of farm machinery ❖ Promotion of use of Power tillers, Power weeders, Paddy threshers, Maize sheller, Wheel Hand hoe, Manual/ power operated Paddy reapers.
Strategy 3: Quality Improvement / Processing/ value addition/ niche markets	❖ Promotion of apiculture for small and landless farmers ❖ Grading, processing and branding of eggs & meat ❖ Organic eggs / fortified egg production ❖ Processing & value added fisheries products ❖ Millets – primary processing & value addition through establishment of minimal processing units and skill training, product development, branding, certification and market linkage ❖ Training of rural youth and women to convert the surplus milk to milk products and run small scale cottage industries when availability of milk is more in flush season. ❖ Installation of mini grading machines at village level. ❖ Establishment of mandal level cold storage facilities. ❖ Promotion of Farmers clubs/ FPOs/FPCs for value chains and market linkages

Strategy 4: Generation of additional income	❖ Protected cultivation+ Composting+Goatry/backyard poultry ❖ Fodder production+ Mini dairy+Composting+ Protected cultivation ❖ Alternate land use systems such as Agro-forests like Subabul and eucalyptus. ❖ Mother units / local hatchery units of Backyard Poultry for improved breeds of Rajsri, Grampriya ❖ Cluster farming @500-1000 broiler birds by 8-10 youth in low cost housing ❖ Mushroom production ❖ Sericulture(mulberry) production

D. Southern Zone (Chittoor, Kadapa, Nellore)

The Southern Zone comprising of three districts i.e., Chittoor, Kadapa and Nellore. Soil in this zone is Red loams, shallow to moderately deep. The normal rainfall of the zone is about 700-1000 mm.

Strategy and Interventions for Southern Zone- strategies and interventions

Strategy 1: Productivity Enhancement	❖ Adoption of improved tobacco varieties/hybrids (Siri and Hema for Black Soils and N-98 for red soils) ❖ Pro-tray vegetable seedling production (tomato, chillies) ❖ High density planting of mango & guava ❖ Virus free budlings of sweet orange & acid lime ❖ Micronutrients & soil test based INM –In Groundnut, Yield improvements of 28% during 2015-16 in Chittoor ❖ Seed production of Rice, Redgram, Korra, Castor, Mungari Cotton through farmers groups. ❖ Open / Protected cultivation - Marigold, Jasmine, Crossandra, Lilly, Chrysanthemum ❖ Rainwater harvesting in farm ponds for supplemental irrigation through micro irrigation ❖ Rain guns for life saving irrigation in groundnut and high value crops ❖ Production and supply of quality groundnut seed through Mana vitana Kendras (Our Seed Centers) involving farmers clubs for village level seed production and certification

Strategy 2: Cost reduction	❖ Intercropping systems redgram + foxtail millet/ pearl millet/ groundnut ❖ Promotion of micro irrigation in high value crops like sweet orange and vegetables. ❖ In situ rainwater harvesting ❖ Virus free citrus (lemon) planting material ❖ Use of bio mulches in sweet orange ❖ Soil test based nutrient application ❖ Foliar application of micronutrients Zn, Bo, Mg & Fe ❖ Use of Aqua seed drill for timely sowing without wasting of available soil moisture.
Strategy 3: Quality Improvement/ Processing/ value addition/ niche markets	❖ Processing varieties of mango, tomato ❖ Value addition of millets. Establishment of minimal processing units for seed grading and cleaning units for millets and grains ❖ Bulk milk coolers and value addition of milk and milk products ❖ Establishment of mandal level cold storage facilities ❖ Promotion of Farmers clubs/ FPOs/FPCs for value chains and market linkages
Strategy 4: Generation of additional income	❖ Ram lamb rearing in horti-pasture systems ❖ Dairy + Goatery+ BYP + Horticulture ❖ Mushroom cultivation ❖ Sericulture ❖ Cottage enterprises – jam, jelly, pickle, juice, banana chips, milk products ❖ Apiculture for small farmers and landless ❖ Mini-dairy with year round fodder production, mineral supplementation, silage making ❖ Mother units / local hatchery units for BY Poultry ❖ Cluster farming @500-1000 broiler birds by 8-10 youth in low cost housing

E. Scarce Rainfall Zone (Anantapur, Kurnool)

The Scarce rainfall zone comprises of two districts i.e., Anantapur and Kurnool. This zone has red with loamy soils, sandy soils and black cotton soils in pockets. The normal rainfall of the zone is about 500-750 mm.

Strategy and Interventions for Scarce Rainfall Zone

Strategy 1: Productivity Enhancement	❖ Drought tolerant groundnut (Dharani) sown with seed cum fertilizer drill. ❖ Improved varieties of Redgram (PRG 158), Mungari Cotton (Srinandi, Yaganti). ❖ Millets, blackgram, greengram, sesamum as preceding crops preceding chickpea in kharif fallows ❖ Micro irrigation system in mango, pomegranate, drumstick, papaya ❖ Foliar application of micronutrients ❖ Production and supply of quality groundnut seed through Mana vitana Kendras (Our Seed Centers) involving farmers clubs for village level seed production and certification ❖ Double cropping in Kharif fallow- chickpea cropping areas. ❖ Preceding catch crop of pulse/ millet followed by chickpea/tobacco in southern light soils of Prakasam district
Strategy 2: Cost reduction	❖ Intercropping systems with Redgram + Foxtail millet, Red- gram + Pearl Millet, Redgram + groundnut in black soils ❖ Promotion of zero tillage chickpea under double cropping sequence & promotion of mechanical harvest genotypes (NBeG 47) ❖ Seed to seed mechanization in chickpea ❖ Farm mechanization through custom hiring centres
Strategy 3: Quality Improvement / Processing/ value addition/ niche markets	❖ Processing varieties of mango, tomato ❖ Organic farming/ natural farming ❖ Processing & value addition to millets, supply chains, linking to markets ❖ Shade net house for nursery and vegetable production ❖ Promotion of Farmers clubs/ FPOs/ FPCs for value chains and market linkages
Strategy 4: Generation of additional income	❖ Mini diary-goatery-BYP-high value floriculture, ram lamb rearing ❖ Semi-intensive & intensive sheep production with feed making units ❖ Apiculture for small farmers and landless ❖ Free range poultry farming (hatchery / mother units / feed making units)

Technological interventions matrix for districts of Andhra Pradesh

Area	Major Intervention	Objective contribution
North Coastal Zone: District Srikakulam (paddy, maize, cashew nut, coconut, chillies)		
Productivity enhancement and Cost reduction	Direct seeding of paddy with Drum seeder	Direct seeding of paddy with drum seeder in puddled soil is the technology that is very much effective because it saves time, labour and cost of cultivation due to skipping of nursery raising, nursery pulling and transplanting. In this method the yield increase is by 4.1% and cost of cultivation is reduced by an amount of Rs 4000-5500 per/ acre.

Area	Major Intervention	Objective contribution
Climate resilient	Promotion of flood tolerant paddy varieties in flood prone areas of Andhra Pradesh	About 1.39 m ha area is flood prone in Andhra Pradesh. Among various varieties tested MTU-1061 gave a yield advantage of 28.6 to 59.1% over check (MTU-7029) and 40 to 65% in increase net income.
Livelihood Zone cashew nut, coconut, chillies diversification and stability of income	Paddy cum fish culture	The low lying unproductive land can be converted to productive units through proper land shaping and integration of paddy with fish culture. Pond dykes can be utilized for growing horticulture crops like banana, papaya, vegetable crops and the retained water in reserve pond and trenches can be utilized for life saving irrigation to rabi crops after harvesting of fish. The intervention IFS paddy cum fish (0.7 ac paddy, 0.3 ac fish culture) gave yield (Paddy :11.34 q, Fish :4.20 q) With net returns of Rs. 28760/ha, whereas sole paddy crop in flood prone area gave yield of 13.77 q with net returns of Rs.10480/ha.
Productivity enhancement and cost reduction	Zero tillage Maize cultivation in rice fallow situations – A Cost reduction and resource conservation technology	Maize is the second major crop after paddy in the district. As per the field condition 3 - 4 irrigations are required, two irrigations will be saved compared to normal method of maize cultivation. The yield obtained was about 7 per cent higher than conventionally cultivated maize. After the successful demonstration of technology in farmers field, 1850 farmers and presently around 2500 acres of area is under zero tillage maize.
North Coastal Zone: District: Vizianagarm (paddy, banana, cashew nut, mango, oil palm and chillies, bajra, ragi, jowar and cash crops sugarcane, groundnut, sesame, niger)		
Productivity enhancement	Reviving cultivation of rice fallow pluses with the introduction of disease tolerant varieties	Demonstration of YMV tolerant cultivar LBG-752 in participatory cluster frontline demonstrations by KVK Vizianagaram indicated a bridgeable yield gap of 6.16 q/ha and additional net returns of Rs. 46200/ha
Productivity enhancement	Intercropping in Sugarcane enhances profitability in Vizianagaram district of North Coastal Zone.	Sugarcane + bhindi (Sugarcane equivalent yield:118.2 t/ha; net returns of Rs.128,940/ha), sugarcane+ cluster bean (Sugarcane equivalent yield: 119.1 t/ha; net returns of Rs. 129,919/ha), sugarcane + spinach (Sugarcane equivalent yield: 105.1 t/ha; net returns of Rs. 102,420/ha) Sugarcane sole (Sugarcane equivalent yield: 98.2 t/ha; net returns of Rs. 95,913/ha)

Area	Major Intervention	Objective contribution
Generation of additional income	Mushroom cultivation as livelihood option in tribal villages of Visakhapatnam	Training on Mushroom cultivation during 2015- 2016 under Tribal Sub Plan (TSP) programme was given to 60 farmers and youth from 6 tribal mandals on chemical treatment of paddy straw, preparation of beds, spawning and casing of mushroom beds etc. On completion of training mushroom cultivation was taken up by one SHG with the technical support by the staff KVK. Each member of the group is earning additional income of Rs. 2750.00 per month and the total family income per month rose to Rs. 11,950.00 per month.
Cost reduction	Pro-tray nursery for Ginger cultivation	With the intervention of Pro-tray nursery for Ginger cultivation, the cost on seed was brought down by Rs. 44000 per acre (earlier Rs.45000/acre) because of which an addition net income of Rs. 54,400 could be obtained with B:C ratio of 4.0 compared to 1.92 in the conventional method.
Godavari zone: District: West Godavari (paddy, banana, sugarcane, chillies, coconut, maize, tobacco and Oil palm)		
Productivity Enhancement and cost reduction	Direct sowing in paddy with drum seeder	Paddy is the predominant crop grown in Matsyapuri village during kharif and rabi seasons. The preferred varieties of paddy were MTU- 7029 (Swarna) and MTU-1010. Due to poor release of canal water at critical stages i.e during panicle initiation stage to flowering stage, grain shattering due to low temperatures at the time of harvesting and heavy rains during threshing affected the paddy yield to an extent of 50 percent. Further the rabi sowings were also delayed forcing the farmers to forego the summer pulse cultivation which is the common practice in this area in the earlier times. During Rabi 2011-12 under NICRA, demonstrations on paddy direct sowing with drum seeder was taken up. The direct sown paddy matured 15 days earlier compared to manual transplanted crop facilitating to escape from the rains at the time of threshing. The yield was 15.4 percent more than transplanted paddy and the cost of cultivation was reduced by 6250 Rs/ha.

Area	Major Intervention	Objective contribution
Crop diversification	Tobacco farmer switches to horticulture	Sri. Muppena Ramana Reddy, a tobacco farmer switched to cashew in his 4 acres of land located in Gopalapuram area of West Godavari district due to fluctuation in market prices and delays in payment. Cashew grafts of BPP-8 and BPP-9 were planted along with adoption of irrigation, fertilizer application, and pest and disease management and pruning. Income from tobacco in Godavari area is about Rs. 1 lakh /ha/year (@2000 kg/ha yield) whereas the income from Cashew was 2.5 lakhs (3rd to 5th year) and additional income was obtained from intercrop of Maize during 1st two years. M. Ramana Reddy's 4 ac garden motivated other farmers to switch to cashew in 500 ha area in surrounding villages.
Value addition	Millet processing – a group approach for livelihood Enhancement of tribal woman in West Godavari	Training programmes on millet processing were conducted by KVK, Venkataramannagudem, Andhra Pradesh to tribal Self Help Groups (SHGs) under TSP. Two Self Help Groups viz., Girivanitha and Giriposhana were formed which established their own millet processing units with the financial assistance of ITDA. Both the groups supply approximately800kg (400 kg each) of millet products to schools every week and each group is earning an amount of Rs.2,00,000 per month.. After deducting the expenses, net profit is shared among the members of the group. The millet products are also supplied to nearby super markets in Eluru, Koyyalagudem, Rajahmundry and local shandies in the villages. Recently an outlet in Eluru Rythu Bazar was also started and the sales are encouraging with a turnover of about Rs. 30,000/- to 50,000/- per month.
Productivity enhancement	Integrated Management of cashew orchards in West Godavari	Cashew is the main horticultural crop and provides livelihood to tribal adivasi families. The training programmes and demonstrations given on the INM and IPM of cashew and on canopy management by KVK brought down injudicious use of fertilizers and pesticides and encouraged the tribal farmers to take up ecologically safe plant protection measures like spray of neem oil and neem and pongamia soap when the pest load is low in the beginning of the flowering season. A total of 57.8 (12% increase over previous year) tonnes of cashew nuts were marketed by these 223 farmers with an average price of Rs. 123.5 per kg of nuts. Each farmer on an average got an amount of Rs. 31,251 per acre at the end of the season.

Area	Major Intervention	Objective contribution
Livelihood Diversification and stability of income	Apiculture – A successful skill based intervention for improved livelihood of rural and tribal families of West Godavari	Collection of honey from wild bee colonies is one of the income sources for rural/tribal families during lean periods of employment i.e. during November to February in tribal areas of west Godavari district. Sixteen tribal farmers from Kamaiahkunta, Pandugudem and Bandarlagudem villages of Buttaigudemmandal were identified to support with bee hive boxes under Tribal sub plan activity of KVK, Venkataramannagudem. Regular follow up visits and advisory was also provided for effective maintenance of the bee hives. Honey can be extracted @ 2-3 Kg from each box by October and can be continued up to June. Honey extracted from these colonies was sold @ Rs. 300/- to 500/- per Kg. depending on the season and demand.
Productivity enhancement	Grow with Profitable Oilpalm	Andhra Pradesh is first in oilpalm area (1.35 lakh ha) & Production (9.3 lakh t fresh fruit bunches (FFB), 1.6 lakh t crude palm oil. About 75000 farmers cultivate oilpalm in 1 lakh ha area of Godavari zone and realize monthly income round the year. The technology revolves around **3 M's** i.e., Manure, Mulching & Micro-irrigation. Adoption of better management practices has resulted in nearly doubling productivity.
Godavari zone: District: East Godavari (paddy, coconut, cotton, cashewnuts, sugarcane, mangoes, plantation crops.)		

Area	Major Intervention	Objective contribution
Livelihood diversification and stability of income	Enhancing income of tribal fishermen through reservoir fisheries in East Godavari.	The agency area of East Godavari district has vast potential for development of fisheries as there are many perennial hill streams and rivers like Godavari and Sileru flowing through the area. To improve the socio – economic condition and livelihood of the affected tribal families, Krishi Vigyan Kendra Pandirimamidi has taken initiative to create awareness among tribal farmers on reservoir management and were able to motivate 147 tribal families to take up fisheries activity. During December, 2012 two lakhs fish fingerlings were released in Bhupathipalem Reservoir and the tribal fisher men started harvesting fish with the grill nets and teppas since October, 2014. The average size of the harvested fish ranged from 3 to 5 kg., and the fish were sold at Rs.100/kg at the reservoir site. The members of the society harvested 5 to 6 quintals of fish per day which was marketed through Primary Tribal Fishermen Co-operative Society (PTFCS). The profit thus obtained was distributed equally among the tribal fishermen families after completion of the fish harvesting. Tribal families were ensured an income of Rs. 20,000 to 25,000 per family over a period of eight months.
Productivity enhancement	Reviving cultivation of rice fallow pluses with the introduction of Disease tolerant varieties	A significant decline in rice fallow pulse area was witnessed in Andhra Pradesh due to severe incidence of Yellow Mosaic Virus (YMV) disease in short duration pulse crops (blackgram and greengram). Demonstration of YMV tolerant cultivar MASH-338 in participatory cluster frontline demonstrations by KVK East Godavari indicated a bridgeable yield gap of 5.60 q/ha and additional net returns of Rs. 28000/ha.

Area	Major Intervention	Objective contribution
Productivity enhancement	Enhanced yields due to improved variety and best management practices in Sorghum cultivation	Farming in agency areas of East Godavari district of A.P has been characterized as a subsistence activity with farmers producing a wide array of crops (including multiple cultivars of the same crop) for their own consumption, using few purchased inputs.. The productivity level of these crops is very low resulting in poor economic status of these tribal farmers. Sorghum seed (improved variety CSV-15) along with package of improved practices and timely plant protection measures resulted in higher productivity of 7-8q/acre compared to 1-2 q/acre by their traditional practices. An average net income of Rs.10,000/- was achieved by the tribal farmers who followed the improved practices and realized an average benefit cost ratio of 5.99. Superior quality traits of the newly introduced CSV-15variety fetched premium price of Rs. 1500/q in the local market compared to the Rs.1100/- per quintal of local varieties.
Livelihood diversification and stability of income	Goatery breed for higher income in East Godavari.	Black Bengal breed of goat which is found in West Bengal, Bihar, Odisha and Bangladesh, are prolific. These breeds gave high net returns due to kidding at least twice in a year with low mortality and these breeds are easy for rearing as this doesn't have any feed preference. Krishi Vigyan Kendra, Kalvacharla, East Godavari, first conducted one farm trial with Black Bengal breed of goat with 3 farmers as well as on campus at KVK. The rearing of black Bengal goat there was an additional income of about Rs.13,0000/- per goat. With the successful demonstration at present there are around 700 beneficiaries (250 through ATMA and 350 through state animal husbandry and dairy department and progressive farmers) have started backyard rearing of goat in about 32 villages.

Area	Major Intervention	Objective contribution
Farmer Producer Organisation	Coconut FPO	Noveeal coconut Producer Company was registered under companies act during the year 2013. The support farmers is provided by extending assistance for planting, production, marketing and export of coconut and its products and their vision is to encourage the coconut industry and to bring confidence among coconut farmers by producing value added products. So far 247 societies, where land holding size per member is 0.97 ha and number of trees per member is 144. The company in consortium with other developing agencies and produces few value added products which are having good potential and demand in both national and international markets. The major benefits derived by small and marginal farmers' are: The per capita income of the farmer ha increased to Rs 37050/ha from coconut cultivation. The producer share in consumer price has improved to 40-50% from earlier 25-30.
Krishna Zone: District: Krishna (paddy, maize, greengram, blackgram, cotton, sugarcane)		
Cost reduction and productivity enhancement	Direct sown Paddy with seed drill	Sri. J. Picheswara Rao, farmer in Raavivaripalem village of Mopidevi mandal has adopted seed drill cultivation for the past 5 years, he has been benefitting high net income with less cost of cultivation especially savings in respect to nursery management. The yield increase oven conventional method was about 17.37 % with net income of Rs. 32080/ha.
Cost reduction	Shift from Chemical Agriculture to Zero-Budget Natural Farming in Krishna	Sri Seetha Rami Reddy of Kaaza village of Movva mandal has shifted from chemical intensive agriculture to Zero-Budget Natural Farming in 6 acres. From one cow, daily 10-12 kg of dung and 8-10 L of urine collected was used in the preparation of *ghana* and *drava jeevamrutha*. This is applied in the field which act as an excellent tonic to the field and tones the soil in terms of supply of the nutrients and also substrate (organic C compounds) for the earth worms and microbes. For pest control, the natural farmer uses various *asthras* viz., *agniastrha*, *neemasthra*, *brahmasthra* and *dashaparnikasthra* apart from using fermented buttermilk and coconut milk for disease management. The farmer is also practicing mulching and crop residue management for improved soil health. The yield decline due to adopting natural farming is only 2 to 3 bags per acre in case of rice, but the grains fetch bonus price.

Area	Major Intervention	Objective contribution
Farmer Producer Organisation	Marine Fisheries FPO	Samyuktha fisheries Producer Company, Etimandipallepallu village, Kruttivennu mandal, Krishna district has 425 member farmers from 30 villages, which was registered in September, 2015, through NABARD's support and SNEHA, local NGO as facilitator. The FPO established 3 collection centers, an ice factory and also placed cooling boxes with a weighing machine in each of the collection centre. They deal with a wide range of marine products like fish, prawn and crabs. The NGO organized awareness and exposure visits to most of the member farmer's to fish markets at Narsapur, Chennai and Bhimavaram. This has enabled farmers to realize the advantages of coming together collectively to bargain higher prices in the markets as they were cheated by the intermediaries in their villages who gave only 40-50% of prices that they in turn earned in these markets.
Farmer Producer Organisation	Banana FPO	Sri Vigneshwara Banana FPO formally registered as a company in July 2015 with 190 active members. Farmers from 30 surrounding villages encompassing 5 *mandal*s converge to sell their banana fruit bunches on every Monday and Thursday during the week. The turnover of the FPO was 9.6 million last year earning a profit of Rs 0.55 million by charging 6% levy on banana sales. A member farmer, Shri S Nagireddy says, "If I sell banana bunch to local trader at the farm gate, I used to get Rs 150 per bunch, here in FPO, I get Rs 325 per bunch and is more than double the previous amount. Also, being a part of the FPO fetched me 100% more". The abuse of intermediaries in differential pricing has dramatically reduced for farmers participating in this FPO where grading and pricing were held with transparency. This is attracting new banana farmers from other places.
Krishna Zone: District: Guntur (paddy, maize, sorghum, black gram, green gram, pigeon pea, ground nut, chickpea, and sesame)		

Area	Major Intervention	Objective contribution
Livelihood Diversification stability of income	Vermicomposting	Srinivasa Rao resident of Gorantla village, Guntur Rural, Andhra Pradesh started vermicompost unit with an annual production capacity of 300 T. The production cost incurred by him was Rs. 2.25/ kg and sells at Rs. 3.75/ kg with a margin of Rs. 1.5/kg. He approached KVK, Guntur for technical support, with timely advises of KVK, Guntur scientists he could able to increase Vermicompost production (700 T) by reducing production cost Rs. 1.20/ kg and sells at Rs. 4/kg with a margin of Rs. 2.80/kg.
Farmer Producer Organisation	Turmeric FPO	Mangalagiri Agricultural Producers' Company Limited, is promoted by Nilgiri Foundation, NGO. This FPO was registered in July, 2015 with 350 turmeric producing small farmers from 21 villages. These farmers collectively hold about 380 ha of land and are producing 950 tons of turmeric annually. A novel turmeric processing system, which brings down the processing time from 20 days to 10 days was introduced to the farmers' groups. Turmeric is a commercial crop with high input costs to the tune of Rs 123,500 to148,200 per ha and FPO farmers benefit directly by reducing their seed and fertilizer costs by up to15%. Further farmers benefit to the extent of 10% by their collective marketing in Duggirala market. The FPOs initiative to reduce input costs, processing times and market linkage appears to impact the livelihoods of small farmers' with increased profit from turmeric cultivation.
Krishna Zone: District: Prakasam (paddy, pulses, cotton, oilseeds, maize, chillies and horticulture crops)		
Productivity Enhancement and cost reduction	Liquid bio fertilizers in Paddy reduces cost of cultivation	Farmers of Prakasam district are using high doses of N and P fertilizers, which will lead to increased cost of cultivation and deterioration of soil heath. Demonstrations with liquid bio-fertilizers reduced usage of chemical fertilizers by 50% in paddy and reduced cost of fertilizers by Rs. 3800/ha.
Productivity enhancement	Reviving cultivation of pluses in rice fallow with the introduction of disease Tolerant varieties	A significant decline of area under pulse in rice fallows was witnessed in Andhra Pradesh due to severe incidence of Yellow Mosaic Virus (YMV) disease in short duration pulse crops (blackgram and greengram). Demonstration of YMV tolerant cultivar TBG-104 in participatory cluster frontline demonstrations by KVK East Godavari indicated a bridgeable yield gap of 10.05 q/ha and additional net returns of Rs. 45457/ha.

Area	Major Intervention	Objective contribution
Southern Zone: Chittoor (paddy, ragi, groundnut, sugarcane and mangoes)		
Value addition	Enhanced Income through Value addition to Millets	Mrs. M.Frida from Kalikiri, Chittoor came forward to take up processing and value addition to millet as an entrepreneur activity after attending the training programme conducted by KVK Kalikiri. Under technical guidance of KVK and with financial support of DWCRA they established three small scale processing and value addition unit. They registered value added millet products under Food Safety and Standards Authority of India 2006 (FSSAI Reg. No. 20116020000285) with a brand name "AROGYA MILLET FOODS", and "STAR HEALTHY SNACKS". Selling their products in Krishi Vigyan Kendra outlet, super markets in Tirupati, Chittoor and Nandyala. The monthly production is around 350 kg with a net profit of Rs. 20,000-30,000/-.
Southern Zone: Kadapa (groundnut, paddy, cotton, pigeonpea, sunflower, bengalgram, sesamum, mango, banana, papaya, orange, lemon, chillies, onion, tomato)		
Sustainability intensification for stability of income	Foxtail millet *(Korra)* – Bengalgram Cropping sequence for resource Conservation under rainfed medium black soils of YSR Kadapa district.	Bengalgram was predominant crop in black soils under rainfed conditions during *Rabi.* Due to moisture stress because of breaks in North East Monsoon and severity of Helicoverpa and wilt resulted in low yields of Bengalgram in the district. KVK Scientists demonstrated the technology by introducing short duration korra variety Suryanandi (75 days) released from RARS, Nandyal as preceding crop to Bengalgram. By doing so, weed population was being suppressed by korra resulted reducing the cost for weeding during rainy season. Higher net returns of Rs.24, 625/- per ha was recorded in successive cropping of Korra-Bengalgram than sole Bengal gram cropping system (net returns of Rs. 9,325/). The area of Korra-Bengal gram cropping sequence in rainfed black soils increased from the normal area of 250 ha to actual area of 2000 ha in the KVK operated villages. Rainfed farmers got valuable fodder for their milch animals.

Area	Major Intervention	Objective contribution
Productivity enhancement	Enhanced yields due to use of *Trichoderma viride* in managing *Phytophthora* wilt in Betelvine	Betelvine is predominant crop in Kullumullapalli village of C.K.Dinnemandal. But due to incidence of *Phytophthora* wilt resulted in reduced yields and incurring huge loss to the farmers. Farmers used to soil drench with Copper oxy chloride to manage the problem. KVK Scientists demonstrated soil application of *Trichoderma viride* keeping in view of this problem. There was about 70% decrease in disease infestation and 12.35 % increase in yield. The yield in farmers method was 44.5 Q/ha with an net profit 54,125 rupees per ha with a B:C ratio of 1:1.82. The yield when soil application of *Trichoderma viride* was done 50 Q/ha with an net profit 75,000 rupees per ha with a B:C ratio of 1:3.0.
Crop diversification	Introduction of Safflower as alternate crop for Rabi Bengalgram	Introduced Safflower variety Manjeera in area of 200 hectares as alternate crop to Rabi Bengalgram where wild deers and wild boars were more problematic. Farmers got net returns of Rs.16150/- per ha from Safflower cultivation compared to Bengalgram (Rs.8812/- per ha) besides avoiding damage to crops caused by wild deers and boars. Additional returns of Rs.7338/- per hectare from Safflower cultivation.
Southern Zone: Nellore (paddy, bajra, jowar and ragi crop, tobacco, groundnut, chillies, sesame, sugarcane)		
Livelihood diversification and stability of income	Mushroom production	Nellore climatic conditions demand cultivation of Milky Mushrooms & Oyster Mushrooms and there is heavy demand for the mushrooms in urban areas. Farmers are engaged in the mushroom production in lean periods of the day (After farm work) as it is less laborious and able to utilise their time and labour for additional income. In terms of income, the farmer is earning an additional income of Rs. 2000-3000 per 10 kgs of mushrooms per cycle (45 days) in addition to their farm income with B:C ratio of 3:1 to 4:1.

Area	Major Intervention	Objective contribution
Livelihood diversification and stability of income	Rural Feed Processing Unit at Nellore	National Research Centre on Meat (NRCM), Hyderabad has taken up rearing of ram lambs under stall feeding with 'Complete Feeds' under world bank funded National Agricultural Innovation Project. For this purpose a Rural Feed Processing Unit has been established at Chennur village of Gudurmandal in Nellore dist. of A.P. Under this, farmers are made to rear weaned ram lambs of 3-4 months age under complete confinement in their stall and the animals were never allowed to go out for grazing till they attain market weight. In the stalls, ram lambs were offered with complete feed in the feeders which can meet all the nutrient requirements in dry mash farm as seen in the case of broiler poultry rearing. The ram lambs attained market weight in 120 days of feeding. The profit earned within 4 months is about Rs.2670-2070 per animal.
Scarce Rainfall: District: Kurnool (rice, sorghum, groundnut, cotton, Bengal gram, sunflower, castor, red gram, mango, sweet, orange, tomato, onion, coriander, brinjal)		
Productivity enhancement	Reviving cultivation of rice fallow pluses with the introduction of disease tolerant varieties	A significant decline in rice fallow pulse area was witnessed in Andhra Pradesh due to severe incidence of Yellow Mosaic Virus (YMV) disease in short duration pulse crops (blackgram and greengram). Demonstration of YMV tolerant cultivar TBG-104 in participatory cluster frontline demonstrations by KVK Kurnool indicated a bridgeable yield gap of 9.84 q/ha and additional net returns of Rs. 57124/ha
	Crop diversification with Foxtail millet (*Setaria italica*)	Cotton and pigeon pea were the main crops grown in Yagantipalle village during kharif season. Most of the crops got affected with late onset of monsoon, followed by dry spells during critical stages of crop growth, which in turn severely affected the crop yields. The short duration millets viz., Foxtail millet (SIA 3085, Suryanandi) varieties with 70-75 days duration and tolerance to drought and downy mildew were introduced in place of jowar and cotton in 25 acres in 2011 Kharif. These varieties of foxtail millet could escape drought due to its shorter duration and could yield net income of about Rs. 36,879/- where as the net income for cotton farmers was only Rs. 6594/- during Kharif 2015.
Scarce Rainfall: District: Anantapur(groundnut, sweet lime, mango, pomegranate, vegetables.)		

Area	Major Intervention	Objective contribution
Productivity enhancement	Increased milk yields with CSH 24 MF sorghum fodder benefits farmer in Anantapur district	Adikeshava Naidu from Bandlapalle village in Penukonda mandal in Anantapur district has been having great success with CSH 24 MF sorghum green fodder. He has 2 milch buffaloes and before the RythuKosam project, he was obtaining only 4 litre milk/buffalo/day with fat content of 7%. As a part of the RythuKosam project in 2015, the farmer received the new variety of sorghum and has been reaping rewards ever since. After feeding the new variety mixed with other varieties of green fodder, he received 6 litre milk/buffalo/day with fat content 7.5%. The net income increase was Rs 2,400/buffalo and almost Rs 5,000/month from the two milch animals. The overall milk yield has now increased by 120 litre/month from the two milch animals. With increased fat content, he sells the milk at ` 40/litre.
North Coastal Zone, Godavari Zone, Krishna Zone, Southern Zone and Scarce Rainfall Zone: Applicable to all districts of Andhra Pradesh		
Livelihood diversification and stability of income	Mother Units in villages-Potential model for 1000 birds (Up to 6 weeks of age)	Setting up of mother units can be taken up by unemployed youth/ women farmers. The aim is to produce grown up chicks (6 weeks of age) of desi chicken breeds (Vanaraja, Gramapriya, Srinidhi, Rajasree) for free range poultry. The cost/ bird, Rs. 64 and sale price, Rs.8/ bird. The net returns/year (6cycles) is Rs. 126000. The litter can be sold @ Rs 1000/ton. Birds in the mother unit can be reared up to 10-15 weeks to produce coloured birds for meat purpose.
Livelihood diversification and stability of income poultry	Rural Hatchery Units for Backyard Poultry	Rural hatchery unit can be set up by rural youth and women farmers. The aim of the unit is to hatch out baby chicks from fertile eggs produced from rural / free range poultry farming. It provides work opportunity all through the year (12 cycles in a year). The profit obtained by this potential model (24,000 eggs hatcher at 28d interval) in 5 years is Rs.1848000.
Livelihood diversificatio n and stability of income	Poultry litter to Organic Fertilizer	The stakeholders for this technological intervention are intensive broiler and layer poultry farmers. The main aim is to produce organic fertilizer rich in nitrogen and available phosphorus for agricultural purpose utilizing poultry litter composting technology. The Cost of litter, 1500 kg is Rs.1000, composting cost is Rs.500, and miscellaneous cost is Rs 200 with total cost per kg is Rs 1.7/- only

Area	Major Intervention	Objective contribution
North Coastal Zone, Godavari Zone, Krishna Zone, Southern Zone and Scarce Rainfall Zone: Vijayawada, Vishakapatnam, Tirupati, Guntur, Kurnool,		
Livelihood diversificatio n and stability of income	Cluster Broiler Farming by rural youth- Potential model for 2000 broilers	Cluster broiler farming can be taken up by unemployed rural youth/women farmers. The aim is to rear commercial broiler varieties for meat production The economics for the potential model is cost per bird is Rs. 150 and sale price is Rs. 160/ bird. The net returns /year (6cycles) of 2000 units/batch is Rs.120000 and litter can be sold @Rs 1000, 2t/ batch. They can even establish hygienic chicken processing centres to cater the production from their own farming which will ensure higher returns.
North Coastal Zone, Godavari Zone, Krishna Zone, Southern Zone and Scarce Rainfall Zone: Chittoor, East Godavari, Visakhapatnam, Anantapur		
Crop diversification	Switching to Floriculture with rainwater harvesting and micro irrigation	In many districts across zones scope exists for floriculture under irrigation to fetch remunerative prices. Examples include cultivation of marigold, tuberose and crossandra. The demonstrations were conducted by KVKs on Marigold in Chittoor and Visakhapatnam where the yield gap w.r.t farmer's field ranged from 16-18 q/ha. The demonstrations on tuberose gave yield increase of 40% in East Godavari. Crossandra demonstrations in Visakhapatnam district showed a yield increase of 32.2% over farmers plot.

Summary

In Andhra Pradesh 62% of the population is dependent on agriculture. Agriculture is diversified with 28 crops under cultivation with rice, maize, pulses, groundnut, cotton, chillies, tobacco and sugarcane as major crops. Yield gaps in major crops such as paddy, sugarcane, cotton, pulses and oilseeds are bridgeable with the use of high yielding varieties, stress (biotic and abiotic) tolerant varieties as demonstrated in farmers' fields. Micro irrigation through drip and sprinkler has proved effective both in terms of cost and output. Potential for development of livestock depends on addressing shortages in feed (42%) and fodder (41% green fodder and 21% dry fodder). A comprehensive fodder policy is necessary to boost growth of livestock sector. Fisheries occupy an important place in the socio-economic development of Andhra Pradesh. The potential of agro forestry revolves around popularization of clonal technology in Eucalpytus and Leucaena based systems in the state. Promotion of Farmers clubs/ FPOs/FPCs for value chains and market linkages needs to be addressed. There is considerable scope for boosting post harvest processing by setting up of food parks on PPP basis or private investment in the state.

SUCCESS STORIES

1. Reviving cultivation of rice fallow pulses with the introduction of disease tolerant varieties

A significant decline in rice fallow pulse area was witnessed in Andhra Pradesh due to severe incidence of Yellow Mosaic Virus (YMV) disease in short duration pulse crops (blackgram and greengram). In 2012-13 area under blackgram stood at 3.7 lakh ha during rabi. The area came down by about 1.2 lakh ha due to reluctance of farmers to cultivate pulses because of YMV disease. Under National Food Security Mission (NFSM), KVKs in Andhra Pradesh demonstrated YMV tolerant blackgram and greengram varieties in rice fallows during rabi 2015-16 and 2016-17. The area under rice fallow blackgram in 2016-17 increased to 4.4 lakh ha. Demonstration of YMV tolerant cultivars such as TBG-104, PU-31,MASH-338 and LBG-752 in participatory cluster frontline demonstrations indicated a bridgeable yield gap of 2-10 q/ha and additional net returns of Rs. 17,000 - 58,000/ha.

Black gram- TBG-104 at KVK-Darsi

Black gram TBG-104 at KVK -RASS

Results of rice fallow blackgram– YMV tolerant variety + technology

Zone	District	Variety	Bridgeable Yield gap		Additional Net Returns (Rs./ha)
			Yield gap (q/ha)	Yield gap (%)	
North Coastal	Vizianagaram	LBG-752	6.16	49.04	46200
Godavari	East Godavari	MASH-338	5.60	51.38	28000
	West Godavari	TBG-104	4.67	46.84	21312
Krishna	Krishna	TBG-104	1.99	13.64	17008
	Guntur	TBG-104	0.25	1.95	1550
	Prakasam	TBG-104	10.05	61.85	45457
Southern	Chittoor	TBG-104	6.90	46.62	58137
	Nellore	TBG-104	2.95	41.26	17707
Scarce Rainfall	Kurnool	LBG-752	0.90	9.09	7454
	Kurnool	TBG-104	9.84	45.18	57124

2. Intercropping in Sugarcane enhances profitability in Vizianagaram district of North Coastal Zone

Sugarcane is cultivated as a rainfed crop in North coastal zone especially in Vizianagaram district in an area of 1.3 lakh ha. However, the productivity of sugarcane is very low at 58.9 t/ha against the state average of 76.2 t/ha. The reasons for low productivity are several which include its cultivation under rainfed conditions in poor soils by resource poor farmers in marginal and sub-marginal land holdings. Non adaption of improved sugarcane production technologies, poor ratoon cane management, water logging and lodging of cane during north east monsoon season, moisture stress during formative phase (March to June) and incidence of major pests like borers and diseases like red rot.

The major strategies for increasing the productivity of sugarcane include: Use of quality planting material of suitable varieties, promoting single node seedling technology with recommended package of practices to reduce seed and planting cost, adoption of drip irrigation for judicious use of irrigation water, soil health management through liberal application of organic manures, growing green manures crops, mechanization to overcome labour problem, adoption of integrated pest and disease management practices for management of pests and diseases. Promotion of intercropping with short duration legumes/vegetables has the potential of generating additional income leading to investments in sugarcane cultivation for productivity enhancement and increased profitability. A number of intercrops in sugarcane were evaluated by RARS, Anakapalle by adopting paired row planting method (120 x 60 cm). Few intercrops that showed promise and potential for up scaling are given in table below along with net returns and BC ratio.

Additional income through intercropping in sugarcane

Intervention	Cane yield (t/ha)	Sucrose %	Yield of intercrops (q/ha)	Sugarcane equivalent yields (t/ha)	Gross Returns (Rs/ha)	Net Returns (Rs/ha)	BC ratio
Sugarcane + Bhendi	91.4	16.5	29.7	118.2	243,887	128,940	2.12
S'cane + Cluster bean	91.0	16.4	41.7	119.1	245,217	129,919	2.14
Sugarcane + Spinach	94.9	16.4	24.7	105.1	215,887	102,420	1.90
Sugarcane (Sole)	98.2	17.3	-	98.2	202,147	95,913	1.89

2

ARUNACHAL PRADESH

Arunachal Pradesh being essentially hilly with deep valley and high mountain peaks traversed by number of rivers and rivulets, has varying agro-climatic zones. There are 20 districts in Arunachal Pradesh which can be classified into four agro-ecological zones namely, Alpine, Temperate, Sub-Tropical and Tropical zones. Tropical Zone with high rain-fall and humidity, warm temperature ranges from 22-36 degree C in summer and 10-25 degree in winter and elevation range of up to 900 m above MSL. Sub-Tropical Zone with moderate rainfall and humidity, cool temperature is ranges from 15-30 degree C in summer and 14-21 in winter and elevation range 900-1800 m above MSL. Temperate Zone with less rainfall, cool temperature ranges from 0-22 degree Centigrade and elevation ranging from 1801 m to 3500 m MSL. Alpine Zone essentially cool temperature from 0-20 degree Centigrade with snow-fall and elevation above 3500 m above MSL.

The total population of the state is 1.38 million (Census 2011) with population density of 17 persons $km^{2.}$ The main occupation of the people is agriculture and livestock rearing. Therefore, agriculture and allied sectors primarily drives the economy of the state and nearly 75% of the state's total workforce is engaged in agriculture and allied services.

Main crops which are grown in the state are rice, maize, millets, wheat, pulses, sugarcane, oilseeds, fruits, vegetables and spices. Rice is the staple food for the state and grown as major crop under rainfed as well as irrigated system of agriculture. In general, food crops (rice, maize, millets, and pulses) production is predominant over the cash or commercial crops (potato, oil seed, ginger, chilli, sugarcane, turmeric and vegetables). In the past decade, it has been observed that the farmers of Arunachal Pradesh are taking more interest in the crops other than food crops viz. horticulture, floriculture and plantation.

2.1 Productivity Gaps and Major Constraints:

State level coordination committee conducted comparative analysis of productivity of different states and found that the productivity (kg/ ha) of total food grains in Arunachal Pradesh during 2011-12 to 2014-15 was lower than the national average (Fig-1). Even if, the productivity of total food grains in this state was lower than that of Himachal Pradesh, having similar agro-ecology. The gap was seen as lower in 2014-15 as compared to 2011-12. The productivity of kharif rice, main staple food in Arunachal Pradesh, is similar to national average (Fig-2), however, higher than that of Himachal Pradesh. This could be due to more plain area in Arunachal Pradesh.

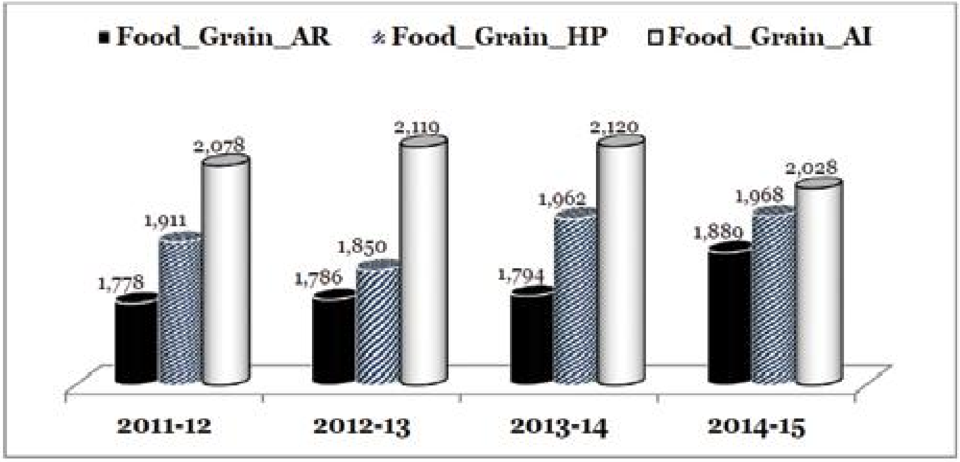

Fig-1: Total Grain Production in Arunachal Pradesh(AR), Himachal Pradesh (HP) and All India(AI) *[Agricultural Statistics at a glance 2016, DAC].*

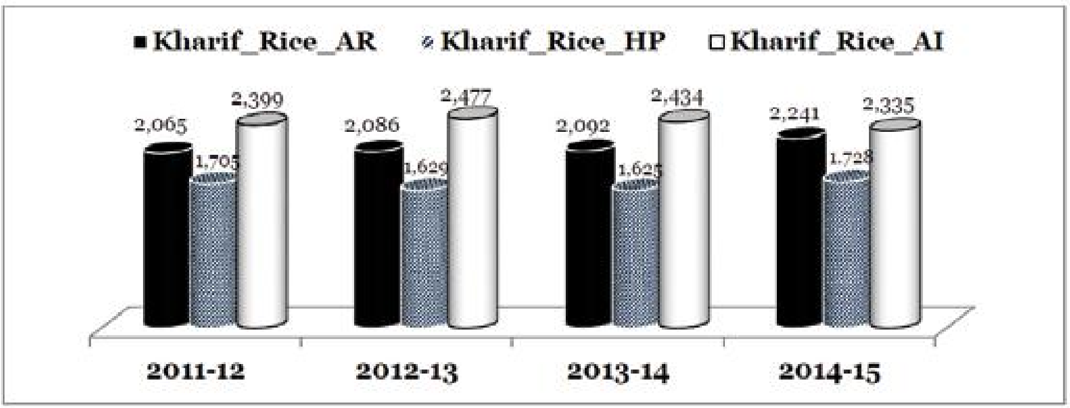

Fig 2: Total Rice Production in Arunachal Pradesh, Himachal Pradesh and All India *[Agricultural Statistics at a glance 2016, DAC].*

The wheat and maize productivity in Arunachal Pradesh is far lower than the national average (Fig-3 & Fig-4). However, wheat productivity in the state is similar that of Himachal Pradesh. The maize is the second major cereal in Arunachal Pradesh, productivity of which is lower than that in Himachal Pradesh (Fig-4), indicating scope of improvement.

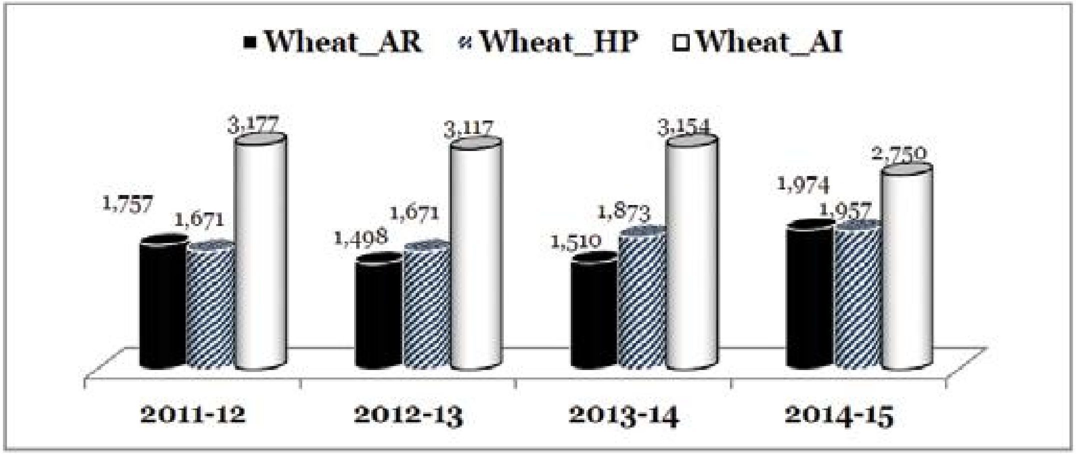

Fig-3: Total Wheat Production in Arunachal Pradesh, Himachal Pradesh and All India *[Agricultural Statistics at a glance 2016, DAC].*

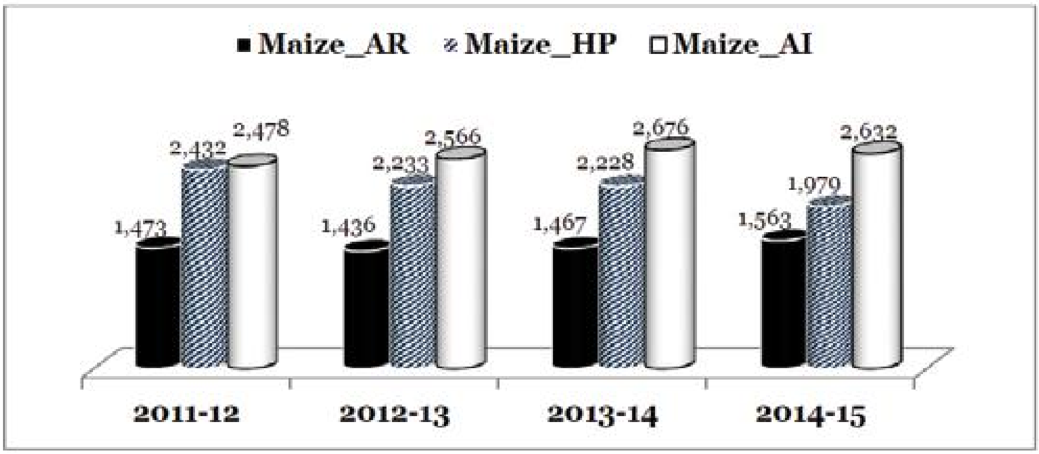

Fig-4: Total Maize Production in Arunachal Pradesh, Himachal Pradesh and All India *[Agricultural Statistics at a glance 2016, DAC].*

The productivity of pulses in Arunachal is higher than the national average and same is for Himachal Pradesh (Fig-5) which may be linked with favorable agro-ecological conditions in these hill states. The oilseed productivity in Arunachal Pradesh is comparable to that of national average (Fig-6), however, quite higher than of Himachal Pradesh.

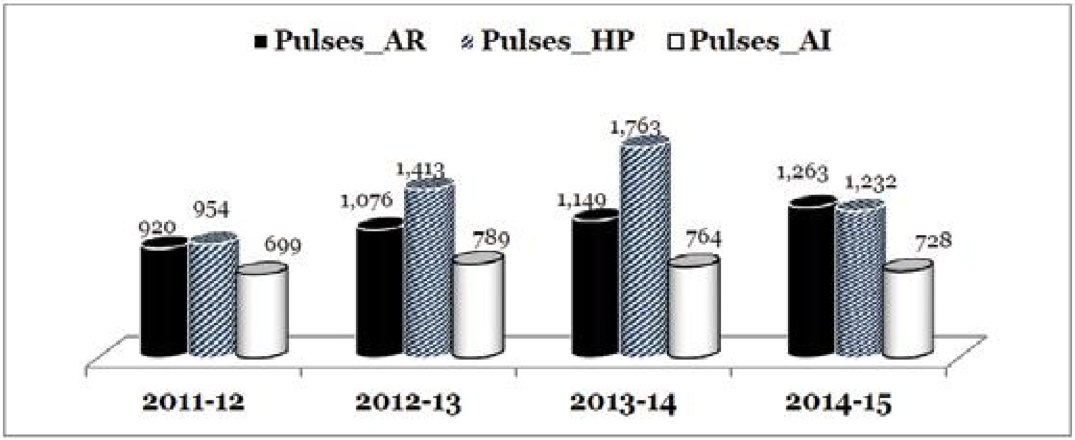

Fig-5: Total Pulses Production in Arunachal Pradesh, Himachal Pradesh and All India *[Agricultural Statistics at a glance 2016, DAC].*

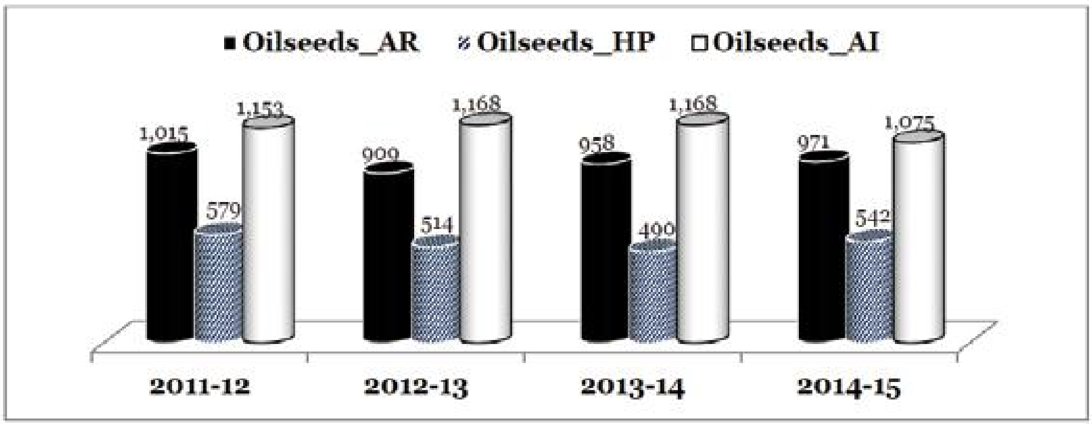

Fig-6: Total Oilseeds Production in Arunachal Pradesh, Himachal Pradesh and All India *[Agricultural Statistics at a glance 2016, DAC].*

2.2 Strategy and interventions for doubling of farmers' income

The rich resource base in Arunachal Pradesh such as mega bio-diversity, fertile soil, varied agro-ecological situations of plains as well as valleys, hills, immense water resources, human resources of ethnic diversity and cultural groups, could be potential sources of agricultural development of the state. However, due to lack of appropriate strategies for development of natural resources, absence of coordination in programme implementation, weak geographical links and poor infrastructure facilities, the region is handicapped in catching up with the agricultural developmental pathways in tune with the national ethos. Thus, agricultural sector needs prioritization of development perspectives for enhancing the adoption of recommended technologies through extension programme, input supply, support of financial institutions and marketing functionaries. The thrust should be on the development of agricultural system, which does not damage the fragile ecological balance in the region, but help in conserving and strengthening the sustainability of natural resources.

The strategies to improve the agriculture productivity in Arunachal Pradesh includes Soil Health Enhancement, Irrigation Water Supply Augmentation and Management, Technology Back-up for new high yielding varieties along with a farming system orientation involving crop-livestock integrated production systems post-harvest value addition to biomass, Input delivery systems supported by adequate credit and extension facilities. Market reform should begin with production planning, so that every link in the cultivation- consumption- commerce chain receives adequate and timely attention.

The strategies to reduce production costs while maintaining yield should include Diversification of crop, Proper Pest and Weed Management, Lower Seed Cost, Boost Fertilizer Efficiency Based on Soil Test Results, Change Crop Rotation, and Better Agronomic Practices.

The strategies towards generating additional income should include more dependency on livestock rearing having multifaceted impact as household livelihood structure shows. Management of agro-biodiversity through organic agriculture may be a viable option for the state to achieve the twin objectives of biodiversity conservation and promotion of different organic production. Floriculture and orchid farming as a cottage industry, ornamental fisheries could be an eco-friendly lucrative business. Ecotourism or agro-tourism in Arunachal can be a sustainable industry with a potential to return benefits to the local people. The rich cultural heritage, folklore, handicrafts, and ethnic diversity, as well as the rich and exotic flora and fauna, may be promoted as the attractive assets of the region. It also offers an opportunity for local communities to earn additional income, as the industry can accommodate skilled and unskilled people. Tourism can help to create employment, either as a primary or as a secondary source of income, check migration from the villages, revive the arts and crafts, traditional customs, and cultural identities, and promote greater social contact and exchange.

- In view of the rapid technology turn over, appropriate strategy for capacity building of farmers in Arunachal Pradesh is required to maximize farm income through adoption of cutting-edge modern technology. The farmers usually stick to old practices and the younger generation distracts, which makes agriculture an occupation of elderly people living in rural areas. To attract enterprising youths to take up farming as profitable occupation and to reverse the out-migration, innovative strategy such as commercialization of agriculture and adoption of improved methods must be promoted. The action plan, therefore, should include:
- Development of irrigation facilities and promotion of water-harvesting methods for assured water supply particularly in the *Rabi* season
- Creation of Single *Window* input delivery system in the rural areas to ensure timely supply.
- Surveillance of major pests and diseases and adoption of timely control measures
- Programme for user-friendly information delivery system through on-farm trials,

demonstration, training, farmer-participatory interaction programme

- Programme to promote the development of fruit crops (kiwi, orange, persimmon, apple, walnut, pears, and pomegranate) and vegetables (on and off-season like (cabbage, cauliflower, tomatoes, squash, beans, pumpkin, chilies and brinjal).
- Creating sufficient storage facilities particularly cold storage for perishable commodities and food processing units.
- Financial support for creation of agricultural infrastructure such as strengthening irrigation facilities, farm machineries, processing and storage facilities, rural roads and communication.
- Marketing infrastructure to be created at the primary markets in rural areas and regulated markets in district level to reduce distress sale by the farmers.

Potential contribution to farmers' income and strategy for scaling out these technologies:

ICAR Institutes in North Eastern region have developed good number of technologies for augmenting production and value addition, validated and demonstrated in the region along with estimation of net income of the participating farmers. Adoption of these zone specific technologies and their expansion in horizontal manner can be instrumental in achieving the target of doubling farmers' income in the region.

There are 20 districts in Arunachal Pradesh which can be classified into four agro-ecological zones namely, Alpine, Temperate, Sub-Tropical and Tropical zones. Some of the districts may fall in different zones have specific production systems and commodities.

2.3 Technological interventions for the specific zones:

A. Alpine zone:

Alpine zone consists of four districts namely *Tawang*, *Kurung Kumey*, *Dibang Valley* and *Anjaw*. This zone consists of approximately 25% geographical area of the state. High altitude livestock is the primary component of agricultural production in this agro-climatic zone. Yaks and sheep are reared in alpine pasture with nearly zero input systems and is the only livelihood and nutritional security of the highlanders.

i. **Complete Feed Block to combat winter feed crisis in high altitude livestock:** This helps in recovering in loss of 25% body weight during winter. Under field condition yak farmers gains a net profit of Rs. 1730/- per growing yak and Rs. 3390/- per lactating yak in winter season (November to March). 22000 CFB has been distributed to farmers under TSP and appreciated by the farmers [Validated by ICAR-NRCY].

ii. **Establishment and rejuvenation of highland pastures:** Pasture biomass enhanced from 100.14 q/ha (2 cuts) to 519.90 q/ha (3 cuts) by establishing and rejuvenation of alpine pasture with suitable grasses. Traditional pasture can support 10 yak units per hectare for three months whereas this technology supports 50 yak units. The B:C ratio is 5.12 and the net annual income for this intervention is Rs. 4,10,000/- [Validated by ICAR-NRCY].

iii. **Value addition of livestock fibres:** Presently the yak/sheep fibres are underutilised, value addition of which through blending with other natural fibres gives a B:C ratio of 6.1 and net annual income is Rs.4,00,320/-. Additionally, the products are eco-friendly, new venture and has better market potential [Validated by ICAR-NRCY].

B. Temperate Zone:

Temperate zone consists of four districts namely *West Kameng*, *East Kameng*, *Upper Subansari* and *Upper Siang*. Livestock, horticulture, crop and cold water fisheries are primary component of agricultural production.

i. **Cultivation of off-season vegetables:** Adoption of protected cultivation using low cost plastic tunnels and rain shelter helped to grow vegetables successfully year around with higher productivity. The B:C ratio ranged from 2.84 to 5.19 was recorded in different combination of broccoli, spinach, coriander, cabbage, radish, tomato, pea, bitter gourd, bottle gourd, sponge gourd, capsicum, cucumber, carrot, cauliflower, beetroot and fenugreek. [Validated by ICAR-RC NEH, Sikkim].

Low cost rain water harvesting structure (*Jalkund* with storing capacity 30,000 L using HDPE pond line of 5 x 4 x 1.5 m size) for harvesting of rain water during the rainy season and its subsequent use during dry periods to cultivate off-season vegetables like cauliflower, broccoli, cabbage, radish, leafy vegetables and tomato could give B:C of 2.62 to farmers. A Meghalaya farmer earned Rs.1,07,500/- by raising nursery of vegetable and selling her crops [Validated by ICAR-RC NEH, Umiam].

ii. **Bee Keeping:** A farmer in Arunachal Pradesh started bee keeping with 3 boxes of *Apis cerana* colonies increased the number of honey boxes to 36, harvest honey five time a year and earned Rs. 1,80,000/- per year. He is further aiming to have 100 boxes to yield 1000 Kg honey worth Rs 5,00,000/- per year [Validated by ICAR-RC NEH, Arunachal Pradesh].

iii. **Low cost production of Oyster Mushroom:** A farmer in East Khasi hill established a low-cost production unit of Oyster mushroom in 200m2 area, which yield 200Kg per month and received annual net income of Rs 2,25,840/- with a B:C of 4.04 [Validated by KVK East Khasi Hill, Meghalaya].

iv. **IFS (crop-livestock-fish-bee-vermicomposting):** A farmer constructed four ponds in 0.75 hectares of land for fish fingerling production and composite fish culture, constructed *Jalkund* of 75000 L capacity, adopted paddy cum fish culture. In addition to field crops (paddy, ground), he integrated his farming practises with horticulture crops, bee keeping (10 boxes), livestock (5 Assam goats), 520 Vanaraja poultry birds, one vermicomposting unit and one mushroom production unit. The farmer with his different IFS components is earning more than Rs. 4,00,000/-annually [Validated by ICAR-RC NEH, Manipur].

v. **Eco-friendly management of Cabbage butterfly:** A farmer in Tawang adopted the eco-friendly technologies viz., Physical control by summer ploughing and hand picking, blue & yellow stickers, and application of neem pesticides at 30,45,60 days after transplanting for controlling the cabbage butterfly. He produced 125 qtl/ha cabbages without use chemical pesticides and earned the net return of Rs. 38,000/- from a plot of 0.2 ha size during the season [Validated by KVK, Tawang, Arunachal Pradesh].

C. Subtropical zone:

Sub-tropical zone consists of six districts namely *Kra Daadi*, *Lower Subansari*, *West Siang*, *Siang*, *Lower Dibang Valley* and *Changlang*. Horticulture, livestock, crop and fisheries are primary component of agricultural production.

i. **IFS (SALT):** Mr. Peter, recipient of *Jagjivan Ram Abhinav Kisan Purskar 2016* by ICAR adopted Sloping Agricultural Land Technology (SALT) for 10 ha agroforestry (tree bean, wild apple, gooseberry) plantation on hill top, followed by horticultural (kiwi, broccoli, leek, grapes, king chilli, tomato, papaya, Chow-chow), and agricultural (paddy) crops, livestock (poultry and piggery units) and fisheries with 8 polythene lining ponds in 3ha of land in descending order of elevation. He was using solar unit for maintaining inside temperature of poultry house, maintained 2 boxes for bee keeping, vermicomposting of crop residue and animal waste and also obtained FSSAI licence for small fruit processing unit. Presently he is earning more than Rs. 5,00,000/- annually with a B:C ratio of 7.78 [Validated by ICAR-RC NEH, Manipur].

ii. **Oyster mushroom cultivation**: A farmer is profitably running a mushroom unit in West Siang district, Arunachal Pradesh. He has been successful in producing 18Kg fresh Oyster mushroom from 20 paddy straws with a biological efficiency of 90%. On an average he earns an additional income of Rs. 4,80,000/- annually from mushroom cultivation [Validated by ICAR-RC NEH, Arunachal Pradesh].

iii. **Backyard poultry** (*Vanaraja*): A farmer of West Siang, Arunachal Pradesh, reared Vanaraja poultry under semi-scavenging system (birds allowed to scavenge and housed at night in low cost shed). Due to limited resources, he could not increase birds number beyond 50 but generated an income of Rs. 71,000/- after investing a sum of Rs. 20,000/- with B:C ratio of 2.5 [Validated by ICAR-RC NEH, Arunachal Pradesh].

iv. Three progressive farmers of Lower Dibang Valley, Arunachal Pradesh, started backyard Vanaraja poultry. They could produce 6000 fertile eggs and distributed among 25 fellow farmers. Now, 50 farmers are practicing this less capital intensive and sustainable economic returns and livelihood oriented enterprise in the district. The venture has generated average annual income of Rs. 1,12,500/- [Validated by KVK, *Lower Dibang Valley*, Arunachal Pradesh].

v. **System of Rice Intensification (SRI) for Paddy Cultivation** (Rice *var. Shahsarang*): This technology involves single seedling transplantation of young seedlings of 10-14 days old instead of the conventional method of transplanting with multiple (3-4 seedlings/hill) and mature seedlings (40-45 days old) from the nursery. Adoption of SRI technology for cultivation of Shahsarang paddy variety in 0.5 ha area has resulted in better productivity with B:C of 2.69 as compared to traditional method paddy cultivation (B:C ratio of 1.57) [Validated by KVK, *Ri Bhoi*, Meghalaya].

vi. Crop diversification with Pea cultivation in rice fallow raised and sunken beds (*Var. Prakash*): Adoption of diversification of crops by increasing the cropping intensity with cultivation of pea in raised and sunken beds in rice fallows provides substantial benefits to subsequent paddy crop. The main advantage of cultivating pea crop is the increase soil fertility through nitrogen fixation. The technology was adopted by the farmers of *Ri Bhoi*, Meghalaya, to generate additional income from uncultivated fallow paddy field through pea cultivated during lean season with B:C of 2.9 [Validated by KVK, *Ri Bhoi*, Meghalaya].

vii. Banana and Pineapple leaf fibre products: Banana fibre extraction from pseudo stem and pineapple fibre from leaf is a new and an innovative technology, which has provided a platform for entrepreneurs. With the increasing environmental awareness and growing importance of eco-friendly fabrics, products made of banana and pineapple leaf fibre has been recognized for all its good qualities and now its application is increasing in other fields too such as apparel garments and Home furnishings. A woman SHG at *Jharnapani*, Nagaland, has adopted this technology of fibre extraction and are earning annually Rs. 20,000/-from the preparation of fibre products [Validated by KVK, *Dimapu*r, Nagaland].

D. Tropical Zone:

The Tropical zone also consists of six districts, bordering Assam, namely Papum Pare, East Siang, Lohit, Namsai, Tirap and Longding. Crops, livestock, horticulture and fish are primarily produced in the region.

i. Mushroom: Oyster mushroom cultivated on paddy straw, has giving the yield of 8.5-8.9 kg/10 spawn bags in three plucking and assisted the farm women in generating her alternative income with B:C ratio of 8.9 [Validated by KVK, *Lohi*t, Arunachal Pradesh].

ii. IFS (Rice-Maize-Groundnut-Pea-vegetable-livestock-fish): A farmer adopted IFS with seven components comprising crop component (paddy *var. RCM-9*, maize *var. Pusa composite-3*, groundnut *var. ICGS-76*, pea *var. Azad pea-1*, Cabbage *var. rare ball*, cauliflower *var. Early Hemlata*, fruits (tree beans, Kachai lemon and orange), livestock (6 crossbred piglet and 125 *Grampriya* poultry) and fish farming (carps). A Jalkund and vermicomposting unit were developed. The farmer earned a total net return of Rs. 3,63,500/- per annum from 4.0 ha [Validated by KVK , *Churachandpu*r, Manipur].

iii. IFS (Rice-Fish-Duck): This technology has advantage over the traditional indigenous type of paddy cum fish culture; here fish are introduced in the pond 0.01 -0.03 ha before sowing of rice rather than fish fingerlings. Canals (2-3 feet wide and 1.5-2 feet depth) are dug in two sides of rice field and connected to the pond. When the water level goes up the fishes migrate to the rice field automatically and the culture area of fish increases up to 80 - 100 times. The net income of Rs. 1, 93,000/- from 1.0 hectare of land [Validated by KVK, *Lohit*, Arunachal Pradesh].

iv. **Piggery**: Crossbreed pig (Hampshire x Assam local) rearing for pork: Crossbred pig are more prolific and grow faster than the indigenous pigs. A farm woman of Namsai, Arunachal Pradesh, reared crossbred piglets, which matured at 9 months of age and given 13 numbers of piglets at first farrowing. Based on local price of piglet, the farmer got return of Rs. 3000/- per piglet [Validated by KVK, *Lohit* Arunachal Pradesh].

v. **HYV Rice:** Improved rice variety Tamphaphou (CAU R-1) is high yielding, tolerant to Rice blast and Bacterial blight, the variety withstands rice gall midge and stem borer infestations to a considerable extent. High performance under low applied fertilizer level of NPK (60:40:20) per ha. Suitable for late sowing up to July end. Net return is Rs. 37, 500/- [Validated by KVK, *East Siang*, Arunachal Pradesh].

vi. **Poly culture of Fish:** Poly culture of Indian Major Carps (Rohu, Catla and Mrigel) with Exotic carp (Grass carp, Silver carp and Common carp) for better utilization of food and ecological niches is adopted by the farmers of East Siang district of Arunachal Pradesh. The technology has benefited the farmers with B:C ratio of 2.29 [Validated by KVK, *East Siang*, Arunachal Pradesh].

vii. **Mixed cultivation of fruit crops** (orange, pineapple, banana): A farmer of adopted intensive cropping system, high density system and inter cropping system for mixed cultivation of fruit crops and established a *Khasi mandarin* orchard in 1 ha area of land, intercropping with high density pineapple and banana. He is marketing 1500 – 2000 pineapple fruits @ Rs. 20 per fruit, 30-50 banana bunch @ Rs. 200 – 300 per bunch every year from this orchard besides the earning from the mandarin trees. His annual earning annually Rs. 1,50,000/- from 2.0 ha. He has expanded his farm size and cultivating pineapple in 2.0 ha and large cardamom in 2.0 ha area [Validated by KVK, *Papum Pare*, Arunachal Pradesh].

viii. **Dairy based entrepreneurship:** A farmer from Tura, started a diary unit with 3 cows after taking loan from the bank. After initial success, he upgraded his dairy unit with 18 milking cows, 6 heifers, 10 calves and one bull and one-hectare fodder production farm. Additionally, he constructed a vermicomposting pit for preparation of vermicomposting from animal excreta and farmyard refusal. His annual net income is Rs. 8,51,250/- from his dairy unit. [Validated by KVK, *Tura*, Meghalaya].

2.4 Summary Recommendations:

Aiming to double the farmers' income for Arunachal Pradesh by 2022, the state has the potential because of its diverse geo-climatic conditions and biodiversity. A transformation from the traditional *jhuming* with mono-cropping towards diversified multi-cropping agriculture using high yielding varieties is the required to enhance the agri-production.

The livestock rearing is the strength of the state, but the milk production is deficient as per the requirement. Dairying has high profit potential; hence, low yielding local livestock need to be upgraded with the introduction of elite milch breeds.

The piggery and poultry need to be promoted for enhancing the production to meet the meat requirements of the inhabitants. Lack of post-harvest storage and processing along with the poor infra-structure facilities in the state is directly affecting the agri-value chain development and marketing.

Therefore, the only government intervention will not be sufficient to ensure better production and market access. In fact, the Agricultural Produce Marketing Committee has failed to fulfill the aspirations of the rural economy of Arunachal Pradesh. The respective wing of the Government needs to assume a greater role to free the cultivators from exploitations and make the economy more dynamic and vibrant. Following are the recommendations to overcome such shortcomings:

- Agricultural and farm production could be enhanced by developing suitable value chains supported by the technological inputs.
- Enhanced production should be linked to various organised markets, retailers, agro-processors and trades for better profits.
- Organic production potential of state should be nurtured with establishing linkages with specific markets through FPOs and private players.
- Creation of postharvest processing, value addition and storage (cold and dry) facilities are necessary requirements to minimize damage and wastage of farm produce to tap the potential profits.
- State should focus on market related infra-structure development.
- Private players and FPOs should be attracted for investment on farm produce processing and marketing through establishing fair trade contract and environment.
- Farmers should be connected to eNAM through the efforts of APMC. Besides, APMC should possess perfect knowledge of the existing demand and prices of the crops in the markets and for that it must have a sound market intelligence network. This network will communicate the information on the prices to the cultivators and also generate awareness among the cultivators to adopt more market-oriented cultivation.
- APMC should keep a strict vigil on the traders so that they cannot dupe the farmers of their dues.

SUCCESS STORIES

Dairy based entrepreneurship:

A farmer from Tura, started a diary unit with 3 cows after taking loan from the bank. After initial success, he upgraded his dairy unit with 18 milking cows, 6 heifers, 10 calves and one bull and one-hectare fodder production farm. Additionally, he constructed a vermicomposting pit for preparation of vermicomposting from animal excreta and farmyard refusal. His annual net income is Rs. 8,51,250/- from his dairy unit.

Backyard poultry (*Vanaraja*):

A farmer of West Siang, Arunachal Pradesh, reared Vanaraja poultry under semi-scavenging system (birds allowed to scavenge and housed at night in low cost shed). Due to limited resources, he could not increase birds number beyond 50 but generated an income of Rs. 71,000/- after investing a sum of Rs. 20,000/- with B:C ratio of 2.5.

Three progressive farmers of Lower Dibang Valley, Arunachal Pradesh, started backyard Vanaraja poultry. They could produce 6000 fertile eggs and distributed among 25 fellow farmers. Now, 50 farmers are practicing this less capital intensive and sustainable economic returns and livelihood oriented enterprise in the district. The venture has generated average annual income of Rs. 1,12,500/-

3

ASSAM

Assam is a state in North East India, situated south of the eastern Himalayas along the Brahmaputra and Barak River valleys. The land of blue hills and red river is a darling of nature. She has lavished upon her abundant natural bounties unseen elsewhere in the country.

Assam covers an area of 78,438 km^2 (30,285 sqm). The state provides shelter to 2.6 percent population of the country. The total geographical area is 78.44 lakh ha, total population 2,66,38,407; grossed cropped area 36.37 lakh ha, net cropped area 23.86 lakh ha, area under horticultural crop 5.46 lakh ha, area under tea cultivation 3.15 lakh ha, cultivable wasteland 80 thousand ha, irrigated area 17.47% of net cropped area, average operational holding 1.27 ha.

Cropping intensity: 152.43% Small farmers: 26% of total population, Marginal farmers: 36% of total population, chronically flood prone area: 4,75,060 ha, chronically drought prone area: 93,817 ha, Per capita annual income: Rs. 24,660.00, Literacy: 73.18%, Male: 78.81%, Female: 67.27% and Average monthly household income: Rs. 6695.00 (Rs. 80340.00/yr).

Based on agro-ecological situations such as topography, soil characteristics, rainfall and other climatic conditions the state is divided into six agro-climatic zones. The climate of Assam is humid, with a sub-tropical nature, having warm humid summers and cool dry winters. Assam is situated in the high rainfall zone with annual average rainfall of 2297.4 mm. The scope of industrialisation, agricultural prosperity and all round economic development are high, if the state's natural resources are fully tapped and utilised. Assam is rich in mineral resources. Petroleum, natural gas, coal, and limestone are the state's principal mineral resources. Among these petroleum is the most important.

Fragmented land holding in the state is one of the major problems in mechanization. Moreover, low Farm Power provision in the state also hampers the achievement of coveted schemes of double or multiple cropping. The State Agriculture Department, has taken up initiatives to procure farm equipment like Tractors, Power Tillers and other farm machineries under various Externally Aided, Centrally Sponsored and State Plan Schemes for the benefit of farmers mainly for Small and Marginal farmers.

3.1 Productivity gaps and major constraints

Agriculture:

Yield levels of all the major crops in Assam are very low and below their corresponding national average. The reasons for the yield gap are -

1. Vagaries of monsoon with weather aberrations.
2. Frequent flooding and water inundation in plains.
3. Periodic droughts in between showers in critical growth stages.
4. High incidence of insect pest due to high humidity.
5. Non adherence of recommended package and practices.
6. Inadequate availability of quality seeds.
7. Low light intensity during the Kharif season.
8. Lack of awareness about the new varieties/technologies

Animal husbandry

The reasons for the yield gap are -

1. Less availability of superior germplam
2. Low availability of quality feed and fodder
3. Lack of awareness about scientific farming
4. Poor health care and biosecurity
5. Non adherence of recommended package and practices.
6. Low access to extension.
7. Low access to credit.
8. Free grazing system.

Fisheries

The state has vast potential fisheries resources which are yet to be explored. There is a gap of 0.63 lakh tonnes. However, the Department of Fisheries, Govt. of Assam claims that ultimate potential is 400,000 tonnes fish annually.

The reasons for the yield gap are -

1. Low water pH.
2. Low temperature during September to March (below $28^{0\ C)}$
3. Improper pond management.
4. High stocking.
5. Low feeding.

6. Siltation and eutrophication in beels.
7. Indiscriminate fishing
8. Damage of breeding grounds.

Horticulture

It is estimated that there is an average post harvest crop loss of 30% in case of fruits. A large share of these surplus quantities can be easily explored for exports in fresh and processed forms

The reasons for the yield gap are -

- Insufficiency of quality planting materials particularly in case of vegetatively propagated fruits crops like khasi mandarin, guava, mango etc.
- Absence of standard scion bank in case of khasi mandarin as well as root stock most of the citrus orchard suffering from the problem of citrus die-back due to occurrence of Triestza virus.
- Shortage of micro-propagation and plant disease diagnostic facility like TC lab, Diagnostic lab i.e. Plant health clinic etc.
- Lack of sufficient accredited nursery in the state for generation of quality planting materials due to absence of proper mother as well as rootstock blocks.
- Scattered nature of cultivation due to fragmented land holding by small and marginal farmers hindering the way of commercial horticulture.
- Unfavorable climatic condition for most of the horticultural crops characterized by excess and uneven rainfall.
- Poor socio-economic condition of the farmers for availing hi tech options like micro irrigation, protected cultivation etc.
- Huge post harvest loss to the tune of 40% due to poor cold chain infrastructure.
- Unorganized marketing system hampering coverage of cultivation cost by farmers.

Strategy for Doubling Farmers' Income by 2022

A strategy for agricultural development in Assam should be built around two elements, namely, (a) promoting the rabi season as the engine for agricultural growth and (b) aggressively pushing for commercialization of agriculture.

To double farmers' income by 2022 by bridging productivity gaps, employing latest production technologies, processing technologies and marketing is prepared keeping the following points in mind.

Stable, safe, affordable food supplies

- Enhance availability and utilization of selected locally produced foods;
- Engage and support youth involvement in agriculture;

Sustainable and resilient farming systems

- Reduce vulnerability to production risk & climate change impacts;
- Engender a culture of sustainable farming & resource use;
- Raise producer productivity and profitability levels;

Innovative, profitable agri-business

- Integrate the supply chain to build critical mass
- Forge farm to market linkages
- Foster development of value adding to local farm produce

Zone wise technology intervention

S. No.	Agroclimatic Zone with Districts	Crop/enterprise	Technology Intervention
1	**Lower Brahmaputra Valley Zone (Dhubri, Bongaigaon, Goalpara, Barpeta Nalbari, Kamrup Baksa Chirang Kokrajhar)**	Agriculture (Rice and Maize)	Rice: Replacement of variety, INM, IPM, Application of lime and micronutrients specially Zinc phosphate
		Horticulture (Vegetable)	Use of high quality seeds and planting materials, IPM and INM, post harvest management
		Animal husbandry (Pig, Dairy, Poultry)	Pig: Rearing of improved pig varieties (RANI, HDK-75, ASHA) through scientific management, proper feeding and health care practices
			Dairy: Rearing of up graded breed, proper feeding, proper health care and AI.
			Poultry: Quality cheeks, proper feeding and health care
		Fisheries (Carps and Koi)	Fisheries: Composite carp culture Koi culture Use of aerators Proper feeding Regular application of lime

S. No.	Agroclimatic Zone with Districts	Crop/enterprise	Technology Intervention
2	**Upper Brahmaputra Valley (Dibrugarh, Tinsukia, Sibsagar, Jorhat and Golaghat)**	Agriculture (Rice)	Rice: Replacement of variety, INM, IPM, Application of lime and micronutrients specially Zinc phosphate
		Animal husbandry (Pig, Dairy, Poultry)	Pig: Rearing of improved pig varieties (RANI, HDK-75, ASHA) through scientific management, proper feeding and health care practices
			Dairy: Rearing of up graded breed, proper feeding, proper health care and AI.
			Poultry: Quality cheeks, proper feeding and health care
		Fisheries (Carps and Koi)	Fisheries: Composite carp culture Koi culture Use of aerators Proper feeding Regular application of lime
3	**Barak Valley (Cachar, Karimganj and Hilakandi)**	Agriculture (Rice)	Rice: Replacement of variety, INM, IPM, Application of lime and micronutrients specially Zinc phosphate
		Animal husbandry (Pig, Dairy, Poultry)	Pig: Rearing of improved pig varieties (RANI, HDK-75, ASHA) through scientific management, proper feeding and health care practices
			Dairy: Rearing of up graded breed, proper feeding, proper health care and AI.
			Poultry: Quality cheeks, proper feeding and health care
		Fisheries (Carps and Koi)	Fisheries: Composite carp culture Koi culture Use of aerators Proper feeding Regular application of lime

S. No.	Agroclimatic Zone with Districts	Crop/enterprise	Technology Intervention
4	**Central Brahmaputra Valley (Morigaon and Nagaon)**	Agriculture (Rice and Maize)	Rice: Replacement of variety, INM, IPM, Application of lime and micronutrients specially Zinc phosphate
		Animal husbandry (Pig, Dairy and Poultry)	Pig: Rearing of improved pig varieties (RANI, HDK-75, ASHA) through scientific management, proper feeding and health care practices
			Dairy: Rearing of up graded breed, proper feeding, proper health care and AI.
			Poultry: Quality cheeks, proper feeding and health care
		Fisheries (Carps and Koi)	Fisheries: Composite carp culture Koi culture Use of aerators Proper feeding Regular application of lime
5	**North Bank Plain (Lakhimpur, Dhemaji, Sonitpur, Darrang, Udalguri)**	Agriculture (Rice and Maize)	Rice: Replacement of variety, INM, IPM, Application of lime and micronutrients specially Zinc phosphate
		Animal husbandry (Pig, Dairy and Poultry)	Pig: Rearing of up graded pig, proper feeding, proper health care and AI.
			Dairy: Rearing of up graded breed, proper feeding, proper health care and AI.
			Poultry: Quality cheeks, proper feeding and health care
		Fisheries (Carps and Koi)	Fisheries: Composite carp culture Koi culture Use of aerators Proper feeding Regular application of lime

S. No.	Agroclimatic Zone with Districts	Crop/enterprise	Technology Intervention
6	**Hills zone (NC Hills, Karbi Anglong)**	Agriculture (Rice and Maize)	Rice: Replacement of variety, INM, IPM, Application of lime and micronutrients specially Zinc phosphate
		Animal husbandry (Pig, Dairy and Poultry)	Pig: Rearing of improved pig varieties (RANI, HDK-75, ASHA) through scientific management, proper feeding and health care practices
			Dairy: Rearing of up graded breed, proper feeding, proper health care and AI.
			Poultry: Quality cheeks, proper feeding and health care
		Fisheries (Carps and Koi)	Fisheries: Composite carp culture Koi culture Use of aerators Proper feeding Regular application of lime

3.3 Technology intervention:

A. Rice:

A. Cultivation of rice in 14 lakh ha relatively risk free area in kharif season.

B. Cultivation of modern mega varieties and hybrids rice in 12 lakh ha and Joha and bora in 2 lakh ha.

C. Cultivation of Boro rice in 6 lakh ha during rabi season.

D. INM and IPM will be practised.

E. Application of micronutrients and lime.

F. This is expected to produce 120 lakh tonnes rice from 20 lakh ha area.

B. Pulse and Oilseed

A. Cultivation of pulses in 4 lakh ha in place of present 1.3 lakh ha.

B. Targeting a production of 4 lakh tonnes with productivity target of 3.2 lakh tonnes in place of present level of 0.8 lakh tonnes (1 tonne per ha).

C. In case of oil seed area shall be increased from 2.8 lakh ha to 5 lakh ha to produce 5 lakh tonnes (1.0 t t/ha), 3.4 lakh tonnes in place of present level of 1.6 lakh tonnes.

D. Introduction of high yielding varieties of various *rabi* pulses and oilseeds (particularly, rape & mustard) with better adaptation to acidic soil, moisture stress and suitability for late sowing.

E. Develop and promote situation specific agronomic practices with emphasis on moisture stress management and INM, IPM and cropping systems.

F. Improve farmers' access to irrigation for rapid increase in productivity.

G. Application of micronutrients and lime

C. Fisheries

A. Disilting and re designing of 1 lakh ha beels.

B. Introduction of capture cum culture fisheries in beels.

C. Maintenance of natural breeding ground

D. Establishment of mini hatcheries for stock replenishment. Induced breeding will be done for production of fish seed which will be released in the beel.

E. Maintenance of water pH. Lime will be applied @ 400 kg per ha per year.

F. Capturing gravid fish will be stopped during breeding season as per the Assam Fisheres Rules, 1953.

G. Culture of Koi fish (Thailand strain) in small ponds below 0.1 ha which are not suitable for carp culture. It takes only four months to attain marketable size.

H. Introduction of aerators in semi-intensive carp culture ponds

I. Proper feeding

J. Regular fertilization

K. Integrated pig fish farming: Pig dung will be recycled in the fish pond.

L. Integrated rice fish farming: Fish rearing will be integrated with rice farming.

D. Horticulture

A. An area of 0.80 lakh ha of fallow lands will be brought under horticulture.

B. Inter cropping of fruit trees will be introduced in tea gardens. Citrus, orange and arecanut will be planted.

C. Total area under horticulture shall be expanded from 1,36,000 ha to 1,50,000 with primary emphasis on banana, citrus, pineapple, papaya, litchi, guava, coconut with on garden approach.

D. Increase productivity of potato and other vegetable crops and conversion of low yielding vegetable growing areas into floriculture covering the foothills and mid-hill areas of the state.

E. Utilization of foot hill areas/tilla lands and the bunds around the wastelands, beels etc.

F. V type nurseries will be established.

G. Green house technology will be used for floriculture and high value crops

H. Tissue culture facility will be created for citrus, banana and other crops

I. Protected cultivation will be introduced for vegetables covering 0.1 lakh ha

J. Conservation facilities will be created for, maintenance and production of indigenous fruits.

K. Integrated potato seed production programme for totally replacing the farmers' non-descript varieties with improved varieties

E. Floriculture

A. General improvement of market infrastructure, technology support to growers, integrated post-harvest management, development of collection and auction centers, infrastructure development etc. Development of a floriculture park in Assam is also recommended, which would showcase the technology and production aspects for commercial floriculture, for the entire region.

B. It is recommended to set up collection centres with integrated post-harvest management facilities in Guwahati, Jorhat, Silchar and Tezpur. Provide good quality flower planting material at 50% subsidy and low cost poly house free of cost.

C. Potential areas of export are flowers and cultivation of tuberose, marigold and gladiolus are being taken up for development of floriculture on a commercial basis. A commercial venture for the cultivation of hybrid orchids is running successfully in the State and all the cut flowers are being specially packed and sent to cities like Delhi, Kolkata and Bangalore etc.The aim is to increase in the commercial floriculture activities to at least 2000Ha from the present 650Ha.

F. Animal husbandry

A. Pig rearing: Improved pig breed/variety, proper health care, proper feeding

B. Poultry: Quality chicks, proper feeding, proper health care

C. Dairy cattle: Selected cows, proper feeding and proper health care

D. Cultivation of fodder crops for cattle and pig. Especially, cultivation of HQPM is recommended for at least 1 lakh ha area during rabi and 0.5 lakh ha during kharif season.

G. Promoting agriculture centric employment avenues

A. Facilitating agri-service centers for custom-hiring of farm implements and micro-irrigation facilities together with maintenance and repairing facilities.

B. Agri-service centres for seed, fertilizers, pesticides and farm operation packages in each district.

C. Facilitating establishment of agri-clinics in each district.

D. Facilitating establishment of fruit/vegetable processing facilities like pineapple, orange, tomato, potato, chilli, ginger etc

E. Apiary (bee keeping) and processing units for honey 100 in each district.

F. Facilitation agency for Agricultural Insurance Services

G. Livestock health service centres including AI facilities in each district.

H. Information technology kiosks in rural areas for access to various agriculture related information (100 centrers).

I. Setting up of metallic/non-metallic storage structure

J. Vegetable/fruit *mandis*

H. Processing plants

A. Pack-house facilities in production sites:

i. For *Khasi* mandarin: One unit each in Tinsukia, Nagajanka and Sonapur

ii. For Banana: One unit each in Dudhnoi, Nalbari, Nagaon, Jorhat, Sivasagar, Dibrugarh and Silchar.

iii. For pineapple: One unit each in Golaghat, Karbi-Anglong, Jorhat and Silchar.

iv. For pineapple: One unit each in Golaghat, Karbi-Anglong, Jorhat and Silchar.

v. For ginger and turmeric: One unit each in Tinsukia, Golaghat, Karbi-Anglong, Dima Hasao, Sivasagar.

vi. For vegetables: One unit each in Dibrugarh, Sivasagar, Jorhat, Golaghat. Nagaon, Borpeta, Nalbari, Goalpara, Silchar.

vii. For cut-flowers: Jorhat, Hajo, Kamrup.

B. Pack-house facilities in production sites:

i. Cereal processing units: For production of rice flakes, puffed rice etc. at Dibrugarh, Jorhat, Golaghat, Barpeta, Nalbari and Silchar.

ii. Cereal Processing units for fruits and vegetables: These units need to be established in the following areas to process fruits and vegetables into products like jam, jelly, beverages, pickles, dehydrated vegetables etc. at Dibrugarh, Diphu, Nagaon, Borpeta, Silchar and Goalpara.

iii. Milk collection and packaging facilities: Considering the need for hygienically produced safe milk for human consumption there is a need to establish milk collection and packaging centres in districts like Barpeta, Nalbari, Marigaon, Sibsagar, Lakhimpur and Tinsukia.

iv. Modern abattoirs and Meat processing unit: To scientifically slaughter meat animals like pigs, goat and sheep and poultry and to provide safe meat for human consumption there should be certified abattoirs species wise preferably in each district. To avoid post harvest losses and for processing of meat to value added products due to increasing demand there is a necessity to establish atleast four meat processing units in each agro climatic zone.

v. Marketing linkage: An effective marketing linkage from the producer to the consumers needs to be established.

vi. Retail chain: Retails shops to be constructed at urban places

Summary Recommendations

- Cultivation of rice in relatively risk free area in kharif season. Cultivation of modern mega varieties and hybrids rice in 12 lakh ha and Joha and bora in 2 lakh ha and Boro rice in 6 lakh ha during rabi season. Practise integrated nutrient and pest management.

- Increase cultivation area under pulses and oilseeds. Introduction of high yielding varieties of various *rabi* pulses and oilseeds (particularly, rape & mustard) with better adaptation to acidic soil, moisture stress and suitability for late sowing.
- Improve farmers' access to irrigation for rapid increase in productivity and application of micronutrients and lime
- Disilting and re-designing of beels. Introduction of capture cum culture fisheries in beels.
- Maintenance of natural breeding ground for fishes, establishment of mini hatcheries for stock replenishment. Proper feeding, regular fertilization. Integrated pig fish farming and integrated rice fish farming.
- Fallow lands to be brought under horticulture. Inter cropping of fruit trees with tea gardens. Planting of Citrus, orange and arecanut.
- Increase productivity of potato and other vegetable crops and conversion of low yielding vegetable growing areas into floriculture covering the foothills and mid-hill areas of the state.
- Use of new technologies (V type nurseries, Green house technology, Tissue culture) for high value crops. Creation of conservation facilities for maintenance and production of indigenous fruits.
- Integrated potato seed production programme for totally replacing the farmers' non-descript varieties with improved varieties
- Use of improved animal breed/variety, introducing proper health care, proper feeding
- Cultivation of fodder crops for cattle and pig. Especially, cultivation of HQPM is recommended for at least 1 lakh ha area during rabi and 0.5 lakh ha during kharif season.
- Facilitating agri-service centers for custom-hiring of farm implements and micro-irrigation facilities together with maintenance and repairing facilities. Agri-service centres for seed, fertilizers, pesticides and farm operation packages in each district.
- Establishment of agri-clinics and Livestock health service centres in each district.
- Facilitation agency for Agricultural Insurance Services
- Information technology kiosks in rural areas for access to various agriculture related information (100 centres).
- Setting up of metallic/non-metallic storage structure and vegetable/fruit *mandis*
- Establishing pack-house facilities and processing facilities in production sites for *Khasi* mandarin, Banana, pineapple, ginger, turmeric, vegetables and cut-flowers along with meat and milk.
- Establishment of an effective marketing linkage from the producer to the consumers. Construction of retails shops at urban places.

A comprehensive and collaborative approach from all stakeholders involved to deal with the above key factors could bring a change to agricultural sector in the state. It is expected that there will be minimum 5% growth in the existing areas and it will be double when included in expanded areas. Farmers' income will be more than double if post harvest lost is prevented and market intelligence based production planning is done.

SUCCESS STORIES

1. Pig farming opens a new window for economic empowerment of tribal youths

'Mising', a tribal community of Assam had been rearing pig in almost every household from time immemorial as a part of their traditional culture. Pork constitutes an integral part of offering in social functions like marriage, death ceremony and other religious & social functions. Rearing pigs by the Mising community is practiced not only to meet the requirement of meat but also to generate additional income from the sale of surplus pigs as meat and piglets. However, the Mising community had been rearing pigs of indigenous breed with low productivity and follow traditional management practice which is unscientific. Though many farmers are interested to rear improve breeds but their availability is limited in the rural areas. Through extensive survey in the tribal villages KVK Jorhat realized that integration of improved breeds of pig and scientific management practice alone could solve the problem of low productivity of rural piggery sector. At the same time the availability of improve piglets locally need to be assured.

Plan, Implement and Support:

Krishi Vigyan Kendra, Jorhat under a Tribal Sub Plan (TSP) funded project introduced improved pig breed in 10 selected tribal villages under Dhakargarah Development Block of Jorhat to replace the existing low productive indigenous breed and to increase the availability of improve piglets locally. KVK, Jorhat had selected Hampshire, an improved breed as a need based intervention for solving the problem with indigenous low productive breed. To meet the requirement of improve piglets of the new improved breed, one breeding unit was established in each of the 10 selected villages with 10 female pigs and two boars. Further, KVK, Jorhat introduced the technology of improved housing and feed management in the villages of the Allengmora area.

KVK scientists regularly monitored the performance of the breed, besides providing health care and technical support. Vaccination against infectious disease was also done on a regular basis. Extensive trainings on piggery management were also provided to the farmers.

Output:

Among the beneficiary farmers, Mrs. Mahilarani Misong w/o Mr. Atul Misong, a progressive farmer from Neolgaon of Allengmora area has emerged as most successful in rearing and production of piglets of the new breed for horizontal spread. During the year 2015-16 they sold 140 piglets of Hampshire breed to the nearby villages and earned Rs. 4,05,000.00 from the sale of piglets. In addition to the spread of new breed, local female pigs were also crossed with Hampshire boar for improvement of the local breed for which the beneficiary farmer charges Rs 300.00 per service. More than 120 female pigs were crossed at Mrs Misong's farm from which she has earned additional Rs 36,000.00 during 2015-16. Mrs Misong has extended her farm with 3 new sheds with new piglets for which she has invested from her own.

Outcome:

The beneficiaries were very happy with the new Hampshire breed for its adaptability to the local conditions and overall high productivity. Almost all the beneficiaries of the selected villages under the programme are maintaining their farm very scientifically and earning a substantial amount from the sale of pig for meat as well as piglets.

Marketing:

Due to high demand of good quality piglets and meat, the farmers did not have any problem in selling the piglets and pork. In fact, there is advance booking for the Hampshire piglets in most of the farms. The piglets are also sold even to nearby district like Sivasagar & Golaghat. The present rate of piglets is Rs 3000.00 per piglet and Rs 200.00 per kg of meat.

Impact:

Due to instant good result and return from new Hampshire breed, the farmers of the nearby villages are either purchasing the piglets from the breeding units or crossing the local female with the Hampshire boar at the farms of the beneficiary farmers and thereby improving the local breeds of the locality.

2. Integrated Farming System opens a new window for economic empowerment of rural Farmers in Boloma area

Sri Phoni Bora is the eldest son of Late Sunaram Bora, Burakuri Gaon, Boloma, Teok of Jorhat district. He has passed High School Leaving Certificate during the year 1974 with 58 percent marks and taken admission into Pre Degree (Science) in J. B. College, Jorhat. He has successfully completed Pre Degree (Science) in the year 1976 but could not proceed for higher studies due to very poor financial status of his father. He therefore, strongly decided to be self employed by taking farming as a means of livelihood and help his brothers & sister to continue their higher studies. Initially he has started vegetable farming by taking advantage of his high land situation and winter paddy in the low lands. He has expanded his farming into other sectors like fishery, dairy, piggery in an integrated farming mode.

At present Sri Bora is cultivating summer & winter vegetables, winter paddy and other cash crops like sugarcane, banana, coconut, arecanut, betel vine, black pepper & indigenous fruit crops. He is very successful in three tier faming system i. e. poultry, piggery & fishery. He is also producing vegetable seedlings of HYV & hybrids in polyhouse at large scale and selling to the local vegetable growers and neighboring villages. He is marketing his farm produces in the nearby daily & weekly markets by engaging local unemployed youth of his village. Sri Phoni Bora is one of the successful farmer in Integrated Farming System (IFS) in Teok Area and more than 40 educated unemployed youth of the locality are following him and adopting Integrated Farming System by utilizing the available resources for their livelihood security.

One of the important innovations of Sri Phoni Bora is the development of raised & sunken bed system in medium land for vegetable cultivation where vegetables cannot be grown in normal situation. By adopting this technique, he has bought another 0.50 ha under vegetable cultivation during rainy season.

Plan, Implement and Support:

From the interest and feedback received from farmers of the Boloma area, Krishi Vigyan Kendra, Jorhat has planned to introduce new high value vegetable crops in the area and accordingly trainings was organized for the farmers of the locality. After taking the training from KVK, Jorhat on scientific production technology, Sri Borah and the other farmers of the area has initially started cultivating new crops like Broccoli in the area. They have harvested a bumper crop in the first year itself and due to high demand of this vegetable in the Jorhat & Mariani market, they have received a premium price and were very happy. At present Boloma area is one of the major vegetable producing areas of the district and Sri Phoni Bora is the torch bearer and ideal farmer of the locality.

KVK, Jorhat also helped the farmers to introduce new improved breeds of cattle, piggery and poultry for integrating with crop components. KVK provided all kinds of technological interventions and necessary skill up-gradation trainings to the farmers of the area.

Output:

Sri Phoni Bora, among the farmers of Boloma area has emerged as most successful farmer in implementing the Integrated Farming System. During the year 2015-16 Sri Phoni Bora has cultivated summer & winter vegetables in an area of 1.50 hectare and earned Rs. 5, 66,000.00 from sale of vegetables, Rs 54,000.00 from Sale of fishes, Rs 69,000.00 from sale of Pig & piglet, Rs. 1,12,800.00 from sale of milk, 14,000.00 from sale of egg and Rs 19,200.00 from sale of fruits. In addition to his self employment, Sri Bora is also providing full time appointment to 6 unemployed youth of his village in his farm and 2 workers for marketing his farm produce with his own conveyance.

 

Outcome:

The pig breeding unit of Sri Bora is producing high quality piglets of Hampshire breed and serving as a source of good quality piglet in the locality. He has developed a traditional bari with an area of 0.80 ha which includes various indigenous fruits viz., Ponial (*Flacourtia gangomos*), *Dilienia indica, Naga tenga* (*Rhus semialata*), various types of Jamun, Ber, Citrus, Carrabolla, Jack fruit, Tamarind, Aonla, Olive, Plum, Peach, Custard apple and medicinal plants viz., Alovera, Sarpagondha, Pachauli, *Paederia foetida*, Murrayakoenigii, Cinnamon, Bay leaf etc. His typical bari represents the image of biodiversity conservation. Apart from his involvement in farming activities he is also associated as an active member in different social organizations for the welfare of the farming community.

Impact:

Due to good result and return from new integrated farming, the farmers of the nearby villages are both purchasing the production of the farms of the beneficiary farmer and thereby improving the financial status of the farmer. During the year the cultivation of crop has spread to several villages of the Burakuri Gaon, Boloma, Teok area and in the next season many more farmers are expected to follow his farming system. Mr. Bora has emerged as an example of successful vegetable grower among the vegetable growers of the locality.

4

BIHAR

The state of new Bihar came into existence in the year 2000 after creation of a new state of Jharkhand from old Bihar. Bihar, comprising 2.9 per cent of the total geographical area of India and about 9 per cent of its total population, also has the distinction of being the most densely populated state of the country. Agriculture is the mainstay of economy in Bihar and contributing nearly 24.84% to the State Gross Domestic Product (2011-12) and about 19% to State Net Domestic Product, respectively. It provides employment to 67 per cent of rural work force.

Annual precipitation in the state varies between 990 and 1,200 mm, with major precipitation during the months of July to September. Bihar is the only state in the country which has to experience drought and floods simultaneously on a recurring basis.

The state is divided into four agro-ecological subzones. These are: Zone I: North–West Gangatic Plains, Zone II: North Eastern Gangatic Plain, Zone IIIA and IIIB: South Bihar Plains. The topography of Bihar can be easily described as a fertile alluvial plain occupying the Gangetic Valley. Paddy, wheat, maize, lentils, chickpea, sugarcane, jute, etc. are the major field crops. The principal fruits are: mangoes, banana, guava, jack fruit and litchi.

The proportion of total land put to agricultural use is high, compared to other states of India. Cropping pattern of Bihar reveals that the agricultural economy of the state is very much tilted in favour of the subsistence sector, since the acreage under food grains has been more than 92 percent in all the years. Bihar predominantly cultivates cereals. It devotes around 79 per cent of its gross cropped area for cereal production as compared to the national average of 51 per cent.

4.1 Productivity Gap and Major Constraints

A. Agri-Horti Crops

A. Smaller farm holdings are the greatest challenge for the development of agriculture sector in Bihar. The average size of land holding is less than 0.40 ha. More than 91 percent of all holdings fall in the category of marginal holdings with farm size less than 1 hectare.

B. Large section of the population in the state has remained unskilled and poorly educated.

C. Bihar is primarily an agricultural state and large landlords still control vast expanses of land. Private investment to increase agricultural productivity remain suboptimal.

D. Slow adoption of modern technologies by the farmers. Dominance of cereals in cropping pattern reflects on the subsistence nature of state agriculture. Although all the 38 districts have a functional Krishi Vigyan Kendras (KVKs), still the institutional extension system faces the challenge to take latest technologies to the farmers' field.

E. The state is flood and drought prone, nearly 41 per cent of cropped area (2.2 million ha) is flood-prone. Canal Irrigation is scanty. Irrigation is majorly (70 percent) dependent on diesel based tube wells as the share of consumption of electricity for Agricultural purpose is very low (6%).

F. Seed replacement rate (SRR) is very low, especially in pulses (11-20%).

G. The average post-harvest losses are very high in horticultural crops.

H. Road connectivity, storage structures and power availability to agriculture sector is inadequate to usher accelerated agriculture development in the state.

I. Credit and insurance sector in the state is weak, though the credit flow is rising over time.

J. Marketing and processing infrastructure are not adequate, affecting farmer's income. Markets are underdeveloped in the state and are thinly spread.

Agro-Climatic Zone specific constraints for agricultural crops

Zone	Districts	Major issues
Zone I	West Champaran, East Champaran, Gopal ganj, Saran, Siwan, Sitamarhi, Muzaffarpur, Darbhanga, Vaishali, Samastipur, Sheohar, Madhubani, Begusarai	❖ Water logging in Saran, Vaishali and Samastipur districts due to floods of Gandak, Burhi Gandak and Ghaghra rivers. ❖ Salinity/alkalinity problems in Siwan, Gopalganj, East & West Champaran and Muzaffarpur districts. ❖ Poor drainage in low lying areas due to high water table. ❖ Low productivity of old traditional and senile orchards. ❖ Alternate or irregular bearing in litchi ❖ High post-harvest losses in litchi and mango. ❖ High percentage of non-descript animals and infertility. ❖ Lack of fodder banks. ❖ Low level of mechanization.
Zone II	Purnea, Katihar Madhepura, Saharsa Araria, Kishanganj Supaul, Khagaria	❖ Utilization of wet land and water logged areas ❖ Provision of market chain, agricultural market and storage structures ❖ Installation of agro-based processing industries especially for maize, banana, potato, jute etc. ❖ Management of weeds, diseases and other pests in major crops ❖ Scientific cultivation of makhana with special reference to marketing

Zone	Districts	Major issues
Zone IIIA	Banka, Munger, Jamui Lakhisarai, Shekhpura Bhagalpur	❖ Water management (Irrigation, Drainage and Flood) ❖ Land consolidation to promote Farm mechanization ❖ Lack of crop diversification with high value crops ❖ Lack of ware houses to manage post harvest losses ❖ Poor market infrastructure to ensure proper price of produce ❖ Lack of agro-industries *viz*. maize processing plant, rice/ flour/ dal mill/food industry etc. ❖ Poor supply of quality agricultural inputs at reasonable price ❖ Paucity of improved breed of cow, buffaloes, poultry, goat, fish and seed of fodder crops and concentrate feed.
Zone IIIB	Patna, Gaya, Jahanabad Nawada, Nalanda, Rohatas, Bhojpur, Aurangabad, Buxar, Kaimur, Arwal	❖ Lack of Irrigation for major crops ❖ Scientific cultivation in ***Tal*** areas ❖ Farm mechanization in Tal areas ❖ Improved variety of pulses (Lentil) for Tal land ❖ Management of weeds in Tal areas ❖ Marketing of vegetables like bottle gourd, ash gourd, pointed gourd, pumpkin should be address in ***diara*** areas ❖ Scientific cultivation of vegetables in *diara* lands ❖ Early maturing variety of cauliflower for better profitability ❖ Varieties of potato resistance to early and late blight ❖ Late sown variety of wheat with high yields ❖ High yielding variety of tomato for early and late sown condition ❖ Suitable varieties of vegetables for organic cultivation ❖ Introduction of high value crops ❖ Cultivation of fodder trees ❖ Development of fodder bank ❖ Cultivation of maize, jowar, oat and hybrid Napier for fodder

Major constraints in horticultural crops

Commodities	Major constraints
Fruit crops	
Mango (All Zones)	❖ Prevalence of old, senile and unproductive orchards ❖ Long pre-bearing stage of mango orchards under traditional varieties ❖ High rate of fruit drop ❖ High incidence of insect pests and diseases in bearing orchards ❖ Unavailability of true-to-type quality planting material ❖ Poor fruit quality due to high incidence of anthracnose on fruits ❖ High rate of post harvest loss of fruits ❖ Alternate bearing in traditional cultivars
Banana (All Zones)	❖ Unavailability of quality planting material of improved varieties ❖ Low productivity of traditional plantations ❖ Destruction of plants due to high wind ❖ Deterioration of fruit quality due to high incidence scaring beetle
Litchi (Zone I, II & IIIA)	❖ Prevalence of old, senile and unproductive orchards ❖ High incidence of fruit cracking ❖ Biotic stresses like incidence of seed borer and litchi mite ❖ Long pre bearing age of the orchards ❖ Alternate bearing in litchi cv. China ❖ Poor post harvest life of litchi fruits ❖ Unavailability of quality planting material
Guava (All Zones)	❖ Low productivity of traditional orchards ❖ Prevalence of old, senile and unproductive orchards ❖ Incidence of guava wilt ❖ Unavailability of quality planting material of improved varieties
Papaya (All Zones)	❖ Unavailability of seeds of gynoedioecious varieties ❖ Low productivity of traditional orchards ❖ High incidence of ring spot virus
Pineapple (Zone II)	❖ Low productivity of traditional plantation ❖ Staggered maturity of the fruits ❖ Unavailability of quality planting material

Commodities	Major constraints
Vegetable crops	
Potato	❖ High input cost including of planting material and fertilizer ❖ Unavailability of seeds of varieties suitable for processing purpose ❖ Heavy incidence of late blight ❖ High post harvest loss
Onion	❖ Unavailability of seeds of improved varieties for cultivation during different season ❖ High post harvest loss
Cauliflower	❖ Unavailability of quality seeds
Brinjal	❖ Unavailability of seeds of bacterial wilt resistant high yielding varieties
Tomato	❖ Unavailability of seeds of bacterial wilt resistant high yielding varieties ❖ Unavailability of suitable varieties for processing purposes
Field peas	❖ Unavailability of seeds of powdery mildew resistant early season varieties

B. Zone wise Issues and strategies in Livestock sector

Sector	Zone 1	Zone II	Zone IIA	Zone IIB
Dairy animals	Large numbers of non-descript animal	Large numbers of non-descript animal	Large numbers of non-descript animal	Nil
	Undernutrition of dairy animals	Undernutrition of dairy animals	Undernutrition of dairy animals	High input cost for milk production
	High incidence of diseases and infertility	High incidence of diseases and infertility	High incidence of diseases and infertility	High incidence of diseases and infertility
	Deficiency of green fodder	Deficiency of green fodder	Deficiency of green fodder	Moderate deficiency of green fodder
Goat	High mortality of kid and low body weight growth	High mortality of kid and low body weight growth	High mortality of kid and low body weight growth	High mortality of kid and low body weight growth
Pig			Large no. of desi pigs, low body weight, low fecundity	Large no. of desi pigs, low body weight, low fecundity

Sector	Zone 1	Zone II	Zone IIA	Zone IIB
Poultry	Large no. of indigenous backyard poultry with low yield potential and high mortality	Large no. of indigenous backyard poultry with low yield potential and high mortality	Large no. of indigenous backyard poultry with low yield potential and high mortality	Large no. of indigenous backyard poultry with low yield potential and high mortality
Fodder	Less area under fodder production	Less area under fodder production	Less area under fodder production	Local varieties having low green fodder yield, burning of straw
Health care	Lack of infrastructure for disease diagnosis and vaccination	Lack of infrastructure for disease diagnosis and vaccination	Lack of infrastructure for disease diagnosis and vaccination	
Marketing	Lack of market linkage of livestock products except milk	Lack of market linkage of livestock products except milk	Lack of market linkage of livestock products except milk	Lack of market linkage of livestock products except milk

C. Fisheries sector

In fisheries sector, the major constraints across the agro-climatic zones are as follows:

- Quality brood management
- High cost of feed
- Lack of integrated fish farming models/units
- Lack of quality seed and fish fingerlings, particularly of IMC
- Unorganized marketing sector
- Lack of cold chain and cold storage
- Inadequate number of trained extension functionaries

D. Constraints of Beekeeping Industry in Bihar

- Bihar is enriched with highly diversified, abundant bee-flora and favourable ecological conditions. The honey production potential is about three times (60-65 kg) higher than the national average (20 kg) and very high than any state of India, viz., Punjab (30 kg) H.P. (35 kg) and Haryana (20 kg) per hive per year.
- Beekeepers are not alert to build up their colonies to full strength before honey flow season resulting in poor honey yield.
- Extraction of unripe honey and honey from brood cell reduces quality of honey.
- Queen excluder are not properly used which also affect quality of honey.

- Old and blackish frames are used in super chamber and exchange of brood frame and super frames decline honey yield with dark colour.
- At the time of extraction of honey, proper care is not taken to clean the equipments, container and filter. Extraction is not done in bee proof chamber.
- Beekeepers generally place dark colour old frames in super chamber resulting the production of poor quality honey.
- Processing of raw honey is not done by beekeepers to prevent fermentation and granulation.
- The level of HMF (Hydoxy-Methyl-Furfuraldehyde) should be below permissible level in honey and care is not taken by beekeepers.
- Uncontrolled heating of honey during processing by beekeepers causes loss of flavour, aroma, enzyme, taste and colour.
- Honey is stored poorly during storage by beekeepers in metallic container which rust and darken the stored honey.
- There is no agency to issue quarantine or migration certificate of bee colonies.
- Delay in official formalities, particularly at check gates results in mortality of the honeybees.
- Lack of established marketing channel
- Lack of storage facilties
- Lack of legislation to use safer pesticides to honeybees. The application of pesticides during flowering period without information cause severe damage to bee colonies.
- Lack of initiatives for promoting bee flora during afforestation.

E. Mushroom Production

Nutrition levels of poor farmers can be improved by increasing mushroom production. There is considerable demand for medicinal mushrooms in addition to edible mushroom species. Straw is being better utilized by promoting mushroom production. For this, the availability of mushroom seeds and quality compost is important. So far, 7 Mushroom span units have been established in the state to overcome the shortage of Mushroom Span (seed). The production is being encouraged by setting up a group of mushroom producing farmers, especially the women farmers. Training is being organized to give information to women farmers about this technique. The production is being linked to the market. The Government has also targeted to setup 20 mushroom production units and 10 mushroom span units by 2022.

4.2 Strategy and interventions for Doubling Farmers' income by 2022

Strategy 1. Improving wheat productivity through zero tillage in rice-wheat system (in all the zones of Bihar)

- Zero tillage (ZT) with and without residue retention ('conservation agriculture' implies ZT with residue retention) has demonstrated considerable agronomic and economic benefits, while improving the environmental footprint of agriculture by reducing energy costs and improving soil and water quality.

- Zero tillage proves better for direct-seeded rice, maize, soybean, cotton, pigeonpea, mungbean, clusterbean, pearlmillet during *kharif* season and wheat, barley, chickpea, mustard and lentil during *rabi* season.
- Wheat sowing after rice can be advanced by 10-12 days by adopting this technique compared to conventionally tilled wheat, and wheat yield reduction caused by late sowing can be avoided.
- In ZT wheat, agronomic factors leading to productivity advantages are related to (i) time savings in crop establishment, allowing earlier sowing and, hence, reducing risks of terminal heat stress during the grain-filling phase; (ii) better control of weeds, such as *Phalaris minor*; (iii) better nutrient management; and (iv) water savings.
- In Bihar ZT to facilitate an advancement of wheat sowing can be exploited in well-drained areas.

Strategy 2. Integrated Farming System Approach

Two integrated farming system (IFS models) have been developed by the ICAR RCER Patna.

One acre model (for irrigated midland situation): Crops(3500 m^2) + Goat(20+1 nos.) + Poultry(200 birds/cycle of 35-40 days) **(for all the zones)**

Two acre model (lowland situation): Crops(6500 m2) + livestock (2 cows + 2 calves) + fish/ duck (1000 m2) **(for all the zones)**

Makhana-based Integrated Farming System (Zone I & Zone II)

- The different practices followed for Makhana + Fish + water chestnut system are:
- Timely cleaning of pond,
- Removal of carnivorous fishes and application of *mahua* oil cake (@ 2.5 t/ ha),
- Transplanting and gap filling for optimization of crop density (@ 10,000 plants/ha),
- Delineation of 10 % of the total water body area as refuge area, and
- Integration of different carp species seed (@ 5000 numbers/ha as fingerlings of 10-18 g.
- Half of the seeds of different carp species of Rohu, Catla, Common carp, Mrigal introduced in fixed ratio of 40:20:20:20 in March-April and rest half quantity of fish seed are introduced in the month of September after harvest of Makhana. The fishes are harvested twice: first in the month of September after the harvest of Makhana, and second in the month of December – January before the emergence of Makhana. Water chestnut is taken as third crop during the months of October – November.

Strategy 3. Enhancing Pulse Production

Utilization of rice fallows (Zone-II & Zone- III A&B)

- For productive utilization of rice fallows, a farming/cropping system approach should be followed.
- Construction of water harvesting reservoirs and farm ponds to provide come-up / life-saving irrigation would ensure success of *rabi* crops and improve their productivity.
- Cultivation of early maturing paddy varieties like Swarna Shreya, Naveen, Rajendra Bhagwati, Sabaur Ardhjal, Sahbhagi Dhan, etc. followed by early maturing varieties of chickpea (JSC 55, JSC 56, JG 14,Vijay, JG 315, and SAKI 9516), lentil (WBL 77, KLS 218, NM1, and DPL 15) and lathyrus (Ratan, Parteek, Mahateora). Introduction of short duration varieties of pulses can escape terminal moisture and heat stress.
- Seed priming (Overnight soaking of seeds) and seed treatment with *Rhizobium* culture hastens seed germination and establishment under relay cropping, and 20-25% higher seed rate ensures desired plant stand.
- Foliar application of 2% urea and micronutrients like Zn and Mo at flowering and pod formation.
- Zero-till sowing with anchored crop residue of previous crop, to make the best use of available soil moisture, and also the nutrient placement.

Impact

Covering even 50% of rice-fallow area (say 1.10 million ha) under pulses in the next five years with a minimum productivity level of 500 kg/ha will result in an additional production of 550 tonnes of pulses in the State, besides improving soil health.

Improving Pulse Productivity of Mokama Tal (Zone III A&B)

Issue

Mokama group of *Tals* consisting of 7 Tals in series (Patna, Nalanda and Lakhisarai districts) covering an area of around 1,18,000 ha. This is known as 'Pulse bowl' of the State. Wilt disease, blue bulls and parasitic weed *Cuscuta* spp. are the major problems in the *Tal* area.

The Technology

- Popularization of HYV of lentil (HUL 57, KLS 218, Pant Lentil 8) and Chickpea (Pusa 547, Pusa 1103).
- Promotion of seed treatment with technologies like *Rhizobium* inoculation, *Trichoderma*, PSB & VAM.
- Foliar spray of 2% urea and micronutrients like Zn and Mo.
- Popularization of IPM modules for wilt/rust in lentil and chickpea, and powdery mildew in field pea.

Impact

Covering even 50% of area (say 59,000 ha) under improved technologies in the next five years with an increase in present productivity by 500 kg/ha will result in an additional production of 29,500 tonnes pulses in the State.

Area expansion in Pulses

Besides rice-fallow there is further scope of increasing pulse area by cropping system manipulation, like mungbean and urdbean as catch crop during summer/spring under cereal-based cropping systems of Bihar, intercropping of short-duration pulses like mungbean, urdbean, cowpea in sugarcane etc. Mungbean with ratooned sugarcane (Zone I) during spring/summer (irrigated), chickpea or lentil with autumn planted sugarcane and advocating new cropping systems like rice–lentil/chickpea. Intercropping of pigeonpea with maize, raising bund height and planting of pigeonpea on raised bunds during *kharif* season is other options to raise the pigeonpea production in Zone I, Zone IIIA&B.

Strategy 4. Enhancing productivity of Sugarcane-based cropping system (Zone I)

Sugarcane in Bihar is highly income generating and a boon for small and marginal farmers. Sugar industry is the largest agro-based industry in Bihar. However, the productivity of the crop in the state is very low (46.0 t/ha).

Issues

- Cultivation of rejected cane varieties.
- Non-availability of quality seed of new varieties.
- Low soil organic carbon content.
- Non adoption of agronomic and plant protection measures.
- Lower mechanization of sugarcane cultivation.

Interventions

- Promotion of improved sugarcane varieties ‘CoLK 94184’ (Birendra), which has early maturity, high sugar recovery, better rationing, and ability to withstand water logging & drought.
- Identification and development of seed villages, cane seed farmers and seed multiplication at sugar mill farms.
- Intercropping with remunerative crops like Sugarcane+garlic (1:2), Sugarcane+ potato (1:2), Sugarcane + rajmash (1:2), Sugarcane+ coriander (1:2), Sugarcane+lentil (1:2), Sugarcane + *toria* (1:2) in autumn planting cane, and Sugarcane+greengram/blackgram in spring planted cane. This system not only provide additional income to the farmers but also improves soil health by improving soil organic carbon.
- **Mechanization**: Sugarcane cultivation is highly labour intensive. Popularization of

mechanizations like modified method of planting viz., spaced transplanting technique, ring-pit, trench and FIRB methods.

- ***Ratoon management***: Ratooning covers almost 50% of cane acreage in the State and is an integral component of the sugarcane production system. However, despite higher sugar content in ratoon, its productivity is 30-40% less as compared to that of plant crop owing to negligence from the farmers for management point of view. Popularization of ratoon management techniques like deep planting (25 cm), trash mulching, gap filling, intercropping, etc. is required to increase sugarcane productivity and profitability.

Widespread dissemination of water saving technologies like trench planting, , micro-irrigation techniques like drip irrigation results in water saving and raising the sugarcane yield by 30-40 %.

Strategy 5. Crop Diversification (in all Zones)

In order to mitigate the adverse effect of climate change on agricultural crops, improve soil health and to increase the farmer's income, following crop diversification models need to be promoted.

- Inclusion of summer greengram in rice-wheat system.
- Diversification of rice-wheat system with inclusion of vegetables for higher income in peri-urban areas, as well as in drought prone upland areas where rice productivity is very less due to low rainfall (e.g. Jamui, Banka, Nawada districts).
- Inclusion of climate resilient, drought-tolerant nutri-cereals like sorghum, pearl millets, finger millets, foxtail millets etc. in drought affected regions of Zone III A and Zone IIIB.
- Inclusion of Soybean and Groundnut (in Koshi region) in place of upland rice.
- Inclusion of pulses like lentil and lathyrus, and oilseeds like linseed and safflower in rice-fallow areas of Zone 3A&B.
- Intercropping of pulses like lentil, chickpea, greengram etc. oilseeds like linseed and mustard, vegetables like onion, garlic, coriander, etc in sugarcane based production system in Zone I; and pigeonpea with maize in Zone I and Zone IIIA&B.
- Inclusion of floriculture in peri-urban areas.

Strategy 6. Water Resources Management (Zone IIIA)

- Construction of various beneficial structures under the Run off management program.
- Promotion of agro forestry/social forestry and arid horticulture in rainfed and other areas for environmental protection and increase in rainfall through plantation of forestry and fruit trees.
- Development of required water conservation structures for soil moisture protection / recharge of ground water. Construction of check dam in rain-fed areas and construction of irrigation-wells in sub-plateau.
- Restoration of traditional water sources and water storage structures.

Strategy 6. Horticultural Crops

i. The technological options suggested for various zones of the state for promotion of horticulture and thereby income of the farmers is depicted below:

ii. Rejuvenation of unproductive mango orchard

iii. Mango based multitier system

iv. Canopy management including Centre opening using Tractor drawn hydraulic platform

v. Pheromone trap for management of fruit fly

vi. Hot water treatment of fruits

vii. High density orcharding with drip irrigation in banana

viii. Ultra high density orcharding in guava

ix. Rejuvenation of old and unproductive guava plants

x. Rejuvenation of unproductive litchi orchard

xi. Girdling in litchi cv China

xii. Intercropping in pre-bearing litchi orchards

xiii. Bagging of litchi fruit bunches

xiv. Post harvest handling of litchi fruits including Harvesting, packaging and Dip treatment for enhancing shelflife of litchi fruits

xv. High density orcharding in papaya

xvi. High density planting in pineapple

xvii. Cultivation of improved varieties of potato viz. Kufri Pukhraj, Kufri Chipsona-1, Kufri Chipsona-2, Kufri Anand

xviii. Onion storage structure

xix. Cultivation of Bacterial wilt resistant varieties of brinjal: Swarna Shyamli and Swarna Pratibha

xx. Cultivation of Bacterial wilt resistant varieties of tomato: Swarna Lalima and Swarna Sampada

xxi. Cultivation of Powdery mildew resistant early season garden pea varieties Kashi Mukti and Kashi Nandini

xxii. Cultivation of broccoli under fertigation

xxiii. Cultivation of pointed gourd variety Swarna Alaukik

xxiv. Cultivation of Merigold variety Pusa Narangi and Pusa Basanti

xxv. Cultivation of turmeric variety Rajendra Sonia

Strategy 7. Livestock

Technologies to be adopted for improving household income through Livestock

Commodity	Technological options
Milk	❖ Bringing more animal in production through balanced feeding, area specific mineral mixture, feeding of green fodder, management of reproductive cycles. ❖ Improving genetic potential through use of superior quality semen, selective breeding. ❖ Improving nutritional status through balanced feed and green fodder, area specific mineral mixture. ❖ Reduce input cost through homemade feed and green fodder, use of chaff cutter for reduction of feed waste and increase efficiency of feed utilization, reduce mortality. ❖ Management of reproductive diseases, reproductive cycle and health care vaccination, timely disease diagnosis and control. ❖ Scientific management (proper technique of milking, milking interval, time of feeding, cleanliness, ventilation), regular deworming, management of climatic stress. ❖ Value addition and market linkage, risk management (insurance).
Meat (Small ruminants)	❖ Selective breeding of small ruminants through distribution of superior bucks ❖ Nutritional supplementation to small ruminants ❖ Reduce mortality of kids/ adult through vaccination of PPR, health care, deworming and hygienic management ❖ Slaughter of goat at proper age of at least one year ❖ Encouraging farming of goat and distribution of goats to farmers
Meat (Pig)	❖ Replacement of deshi unproductive pig with improved Yorkshire, Tamworth or T & D pigs. ❖ Nutritional supplementation to pig
Meat (Poultry)	❖ Encouraging farming of broiler and layers ❖ Replacement of indigenous chicken with improved breed in backyard ❖ Distribution of fowl and ducks through SHGs ❖ Nutritional supplementation to backyard poultry, vaccination and health care
Egg	❖ Encouraging farming of layers ❖ Replacement of indigenous chicken with improved breed in backyard ❖ Distribution of fowl and ducks through SHGs ❖ Nutritional supplementation to backyard poultry, vaccination and health care

Interventions required

The technologies are suggested hereunder for improving milk, meat and egg production in the state so as to make the farming more remunerative. Adoption of these interventions would also help to a great extent to landless farmers who rely heavily on livestock farming for their subsistence.

A. Increase in milk production

Objectives	Activities	Technologies
Increase per animal productivity	Genetic upgradation of cattle and buffalo	❖ Supply of superior quality semen of cattle and buffalo ❖ Selective breeding
	Improving nutritional status of dairy animals	❖ Feeding of balanced ration and/ or total mixed ration ❖ Regular deworming ❖ Feeding of area specific mineral mixture
Bringing more cow in to milk	Improving nutritional status of dairy animals	❖ Feeding of balanced ration and/ or total mixed ration ❖ Feeding of area specific mineral mixture ❖ Feeding of green fodder ❖ Azolla production to meet up the fodder requirement
	Management of reproductive diseases/ disorders	❖ Management of anoestrous and repeat breeding ❖ Regular deworming and vaccination
Reducing cost of production and increasing profitability	Preparation of low cost balanced feed with locally available ingredients	❖ Preparation and feeding of homemade concentrate mixture ❖ Distribution of chaff cutter machine
	Small scale mechanization	❖ Small scale mechanization in milking, washing, manure lifting & cleaning
	Feeding of quality green fodder	❖ Round the year fodder production ❖ Feeding of green fodder in combination of leguminous and non-leguminous (at 1:3 ratio) ❖ Silage making of surplus fodder ❖ Azolla production and feeding ❖ Replacement of fodder seed with high yielding varieties, establishing fodder seed bank ❖ Increasing fodder production on bunds, canal and river sides on community basis

Objectives	Activities	Technologies
	Reduce mortality of livestock	❖ Timely vaccination ❖ Timely disease diagnosis and treatment ❖ Regular deworming ❖ Cleanliness of farm ❖ Control of mastitis ❖ Control of ecto parasites
	Adoption of scientific management practices	❖ Reduce Age at 1st Oestrous ❖ Reduce Dry period ❖ Reduce Calving interval
	Value addition of milk and manure	❖ Preparation of Paneer, Ghee etc ❖ Preparation and marketing of compost and verni-compost
	Marketing and credit	❖ Fixation of minimum support price of milk ❖ Formation of Milk Society at every village ❖ Promotion of private dairy ❖ Subsidy on purchase of high yielding dairy animals ❖ Insurance ❖ Easy credit by financial institution even to landless farmers

B. Increase in meat production

Objectives	Activities	Technologies
Improving body weight gain of goat	Selective breeding	❖ Distribution of improved bucks to each village ❖ Change of bucks at every three years
	Improving nutrition to goat	❖ Supplementation of grain and crop by-products and oilcakes
Reducing mortality of kids	Health care and hygienic management	❖ Regular vaccination against PPR and deworming ❖ Hygienic management to reduce the incidence of diarrhoea and pneumonia
Slaughter of goat at proper age and body weight	Slaughter at proper age and body weight	❖ Slaughter of goat at minimum one year of age
Replacement of low productive pigs	Crossing of indigenous pigs with improved pigs	❖ Crossing of indigenous pigs with Tamworth or Yorkshire pigs

Objectives	Activities	Technologies
Better Nutrition to crossbred pigs	Feeing of low cost balanced feed	❖ Feeding of low cost feed
Promotion of commercial pig farming	Establishment of improved pig farms like Yorkshire and T & D breeds	❖ Crossing of deshi pigs with improved breeds like Large White Yorkshire and T & D pigs ❖ Balanced feeding
Increase in chicken production	Establishment of poultry farm with improved backyard breed of chicken Establishment of poultry hatcheries	❖ Replacement of indigenous chicken with improved breed for backyard production ❖ Distribution of backyard poultry 1 lakh nos per year ❖ Supplementation of probiotic/ prebiotic
Increase in duck meat production	Establishment of duck farm with improved breed like Khaki Campbell	❖ Replacement of deshi ducks with Khaki Campbell ducks ❖ Distribution of Khaki Campbell ducks to SHGs (30000 nos/ year)

C. Increase in egg production

Objectives	Activities	Technologies
Increase in poultry production	Establishment of poultry farm with improved backyard breed of chicken Establishment of poultry hatcheries	❖ Replacement of indigenous chicken with improved breed for backyard production ❖ Distribution of improved backyard poultry
	Establishment of duck farm with improved breed like Khaki Campbell	❖ Replacement of deshi ducks with Khaki Campbell ducks
		❖ Distribution of improved ducks

Total contribution of livestock and poultry sector to state through Milk + Meat + Egg = Rs 10232.75 million.

4.4 Summary Recommendations

Doubling Farmers' income of the state of Bihar by 2022 is quite challenging, but it is needed and is attainable. In terms of the way forward the following points are worth considering:

- Nearly seventy-three per cent of North Bihar is affected by floods and 33 per cent of South Bihar receives less than 750 mm of rainfall, making the southern part of the state drought prone. There is need to increase investment in flood management in North Bihar and watershed management and rain water harvesting in south Bihar.
- Irrigation is an extremely important input for bringing 2nd Green Revolution in the state

alongwith quality seeds of High Yielding Varieties. The government needs to increase investment in both surface water and ground water irrigation. The state needs to expand agricultural production substantially in order to provide livelihood to the rural population. In order to achieve higher agricultural production, the state needs more irrigation. A higher irrigation ratio will facilitate higher crop intensity and will increase production.

- The water productivity in the state may be further improved by efficient use of irrigation water through micro irrigations systems like drips & sprinklers.
- Therefore major emphasis needs to be given on balanced use of fertilizers based on soil health card and use of bio-fertilizers.
- For efficient movement of inputs and products to and from rural areas the government needs to increase the length of all-weather surfaced roads in Bihar. The state government has also included *'GharTakPakkiGali-Naliyan'* in its seven commitments (*SaatNischaya*).
- There is need to expedite the construction of marketing infrastructure at designated locations to ensure that farmers benefit from the government's price policies. Besides, farmers in Bihar need to integrate with the National Agriculture Markets e-NAM under which agricultural producers can fully participate in agricultural markets nationwide for better price discovery without intermediaries.
- There is considerable scope for expansion of dairy co-operative societies to increase collection, processing and marketing of the milk produced in the state. Health and reproduction management is crucial for increasing productivity. Bihar needs to increase the proportion of cross-bred bovines and to use germplasm from superior breeds in cross-breeding.
- The degraded and wasteland should be utilising for quality fodder production, short duration fodder crops in the periods between main crops and efficient utilisation of available resources such as crop residue should be encouraged.
- Bihar seems to have a large scope for contract farming in poultry. Winter maize should be utilized by establishment of maize processing units, which is currently insignificant to reap the benefit of vertical integration in the maize value chain, and give a fillip to the poultry industry in Bihar.
- Agricultural research in Bihar needs to be greatly strengthened, both financially and institutionally. In fact, a comprehensive view will need to be taken of the entire agricultural research system existing in the state to ensure that the system functions effectively. Accountability and responsibility of the State Agricultural Universities and the Krishi Vigyan Kendras (KVKs) need to be clearly established and the relevance of their research reviewed.
- There is need for co-operative research activities with the private sector and institutionalisation of public-private partnerships. Several areas in which opportunities exist to partner include extension of production practices, delivery of inputs, seed production, skill enhancement, etc.

- The availability of a large number of fresh water bodies in the state provides a good basis for the development of fishery and the state government has taken a number of promotional measures to accelerate it. But the water bodies (sairats) are auctioned every year to private players including fishermen's co-operatives. Yearly leases do not allow the lessees to invest in the water body and work for the long-term development of fisheries. If the water bodies are leased out for longer periods, say three to five years, this shortcoming can be overcome.
- To facilitate the advancement of agricultural credit by commercial banks to farmers, it is critical that land surveys are completed quickly to revise and update land records to reflect current ownership.

SUCCESS STORIES

1. Poultry based Integrated Farming System

Ranjan Paswan a young hard working and innovative farmer from village Budhwa Parri (Block – Alouli, Distt- Khagaria) was having a land holding size of 0.25 acre. After dropping out from school, he went to Bangalore to earn money but after working for a few years his internal consciousness compelled him to return home to his village to do some innovative work and to set example for the others to emulate. In earliar days Mr. Paswan was struggling hard to earn livelihood due to his very small land holding (0.25 acre,) lack of capital and technical knowhow. Through Kisan Choupal he came to know about the Krishi Vigyan Kendra, Khagaria and took training on goat as well as backyard poultry farming from the KVK. He started goatary as well as milch cattle rearing to earn livelihood and support his family. The goatery farm was established with 10 local goats and 1 Sirohi male goat reared under stall –fed intensive system and milch cattle farm with 2 animals. He also adopted innovative low cost semi intensive backyard poultry farming as advocated by the KVK with 200 Vanraja poultry. He used to earn Rs. 1.06 Lakh yearly from the poultry farming. He used Sirohi male goat for cross breeding with local goat varieties and is earning net profit of Rs. 0.30 Lakh annually by cross breeding activity and 0.60 Lakh by selling cross bred goat kids. From dairy farming he is earning Rs. 0.40 Lakh annually. In this way now he is able to earn handsomely from his small land holding. With the integration of different animal components Mr. Ranjay Paswan has become a well-recognized Integrated Farming System farmer with very small land holding size.

Till date about 500 farmers have visited his farm. Now he is developing and strengthening linkage with small farmers of his area for establishing low cost semi-intensive backyard poultry farming as well as breed improvement of local goat with Sirohi . At present about 30 farmers have established low cost Semi-intensive backyard poultry farming unit under his leadership. A great numbers of farmers are in the line to adopt the farming.

Economic of the farm

S. No.	Enterprise	No.	Cost of Production (Rs.)	Grass returns (Rs.)	Net Income (Rs.)
1.	Backward poultry farming (two cycles annually)	400	0.64 lakh	1.70 lakh	1.06 lakh
2.	Goatry	10	0.40 lakh	1.00 lakh	0.60 lakh
3.	Cow	2	0.40 lakh	0.80 lakh	0.40 lakh
Total			1.44 lakh	3.50 lakh	1.06 lakh

2. Apiary based Integrated Farming System

Anil Kumar Sinha a innovative farmers from Madhopur having 4ha area of land under beekeeping, pounds, poultry farm, fisheries mushroom cultivation and organic vegetables cultivation. Under vegetables, he grew brinjal, cucumber, tomato and pumpkin etc. After interaction and training through KVK Nalanda he developed IFS model. Under IFS model he adopted organic vegetable, fisheries Bee Keeping, Poultry, mushroom production. He is also a member of FPO madhopur.

Economics of the farm:

Crop/ Livestock/Fish/ Enterprise	Area (acre)/No.	Cost of Production (Rs. Per unit)	Returns (Rs. Per Unit)	Net income (Rs. Per unit)
Organic farming (vegetables)	0.2 ha	30,000/ acre	75,000	45,000
Fisheries	0.1 ha	15,000	80,000	65,000
Poultry	-	1,50,000	2,00,000	50,000
Mushroom	2000 bag	Rs. 20/Bag	3,00,000	2,60,000
Bee keeping	60 boxes	1,00,000	3,60,000	2,60,000

Before adoption of IFS model, he was growing only vegetables, and earning annually Rs. 1,15,000/-

5

CHHATTISGARH

Chhattisgarh is one of the youngest states of the Indian Union created on November 1, 2000. It was carved out of erstwhile Madhya Pradesh. It is the ninth largest state of the country with total geographical area of about 138 lakh hectare. Rich in natural and mineral resources, Chhattisgarh has 44% of its area under forest cover and 43% arable land under cultivation. Being a new state and with limited legacies of the past, there are enormous opportunity for Chhattisgarh to plan and execute developmental activities and to undertake reforms and frame policies to aid rapid social and economic development.

Chhattisgarh state is divided into three Agro-climatic zones *viz.* Chhattisgarh Plains, Bastar Plateau and Northern Hills zone covering 51.0%, 28.0% and 21.0% of the geographical area, respectively. The cropping intensity of the state is about 135 percent.

Chhattisgarh plains:

This agro-climatic zone covers 50% of total geographical area of the state with districts of Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kabirdham, Bilaspur, Korba, Janjgir, and part of Kanker (Narharpur and Kanker blocks) along with part of Raigarh district. The cropped area in this zone covers 32,91,000 ha which is the highest among all the three agro climatic zones.

Bastar Plateau:

It accounts for 29% of total geographical area with districts of Jagdalpur, Dantewada, Beejapur, Narayanpur and remaining part of Kanker with a cropped area of 6,37,000 ha.

Northern Hills:

The area of this agro-climatic zone accounts for 21% of total geographical area that covers districts of Sarguja, Korba, Jashpur and Dharamjaigarh Tehsil of Raigarh districts having cropped area of 8,34,000 ha.

Rice is the major crop of the state grown in every district and it is perhaps because of this reason that Chhattisgarh is known as “Rice Bowl of India”. The three agro-climatic zones in Chhattisgarh is having a different type of soil. However, generally the common types like black and red soils, sandy loam and loamy sands are found in all the districts.

5.1 Productivity Gaps and Major Constraints

There are critical gaps or constraints that are hindering the growth and productivity on sustainable basis in agriculture and allied sectors in the state. Some of the factors identified are as follows:

- Insufficient investment in the primary sector (other than mining).
- Insufficient infrastructure for meeting various needs of agriculture and allied sectors creating hindrance in adequate and timely delivery of critical inputs.
- Low Seed Replacement Rate (SRR) for various crops and non availability of quality planting material.
- Lack of crop diversification, horizontal as well as vertical.
- Low soil pH, high erodibility, low soil fertility and predominance of light soils with low water retention capacity.
- Incidence of insects, pests and diseases crops.
- Lack of effective and responsive extension services.
- Limited irrigation facilities; lack of assured irrigation as well as of systems and methods for higher water use efficiency.
- Erratic and uneven distribution of rainfall and wide fluctuations in other climatic parameters such as temperature, humidity, wind velocity etc.
- Non-availability of human power (Agricultural labour) during the peak period of agricultural operations.
- Prevalence of non-descript/ desi type of livestock including poultry with poor management practices in rural area.
- Open grazing by livestock.
- Deficit green and dry fodder as well as feed for livestock, poultry and fisheries.
- Unmanaged and depleting community pasturelands.
- Inadequate diagnostic facilities at field level especially in Veterinary and Fisheries.
- Poor veterinary health coverage.
- Deficit supply of fishing equipments especially modern ones.
- Lack of value addition/processing centres especially in rural areas.
- Absence of certification for organic produce.
- Lack of proper facilities at market places as well as lack of marketing net-work (backward and forward linkages) for the produce from agriculture and allied sectors.
- Mismatch between technology generated through research and that required by farmers.
- Lack of quality extension services as reflected by poor adoption rate of new technology.
- Inadequate / ineffective quality control mechanism for agriculture and allied sector inputs.
- Non availability of critical inputs in time due to various reasons.

- Insufficient and untrained extension personnels.
- Under utilization of bio-resources for crop and animal improvement with desirable characters for tolerance to various stresses and suitable for alleviating malnourishment.
- Weak linkages and poor convergence with line departments.
- Lack of appropriate farming system models for landless, resource poor and resource rich farmers under various agro-ecological situations of the state.

5.2 Strategy and Technological action plan for enhancing production, cost reduction, quality improvement and generating income

A. Chhattisgarh Plain

Module A: Marginal & Small-Rainfed

S. No.	Crops/ Enter prises	Technology
1.	**Paddy**	Popularization of short duration and drought resistant varieties i.e. Indira Barani Dhan – 1, Sahabhagi SRI Method of cultivation Use of quality seed Life saving Irrigation during critical stages Low water requiring crops/varieties Balance application of plant nutrients Life saving Irrigation during critical stages STCR Based Nutrient Management in Rice
2.	**Maize**	Introduction of hybrid varieties Integrated Nutrient management Planting in ridge furrow method
3.	**Minor millets**	Popularization of disease resistant and high variety i.e. Indira Ragi 1, Indira Kodo – 1, GPU – 28 etc. Community farming, organic practices, processing and value addition, packaging
4.	**Pigeonpea**	Popularization of improved varieties, Promotion of SPI Broad bed and furrow method for Pigeon pea cultivation
5.	**Lathyrus**	Improved Utera Cultivation
6.	**Blackgram**	Popularization of improved varieties processing (Dal making)
7.	**Chickpea**	Line Sowing, Seed treatment
8.	**Wheat**	Popularization of Improved high yielding varieties Life saving Irrigation during critical stages
9.	**Goatry**	Popularization of high meat and milk yielding breed
10.	**Dairy**	Popularization of high meat and milk yielding breed

S. No.	Crops/ Enter prises	Technology
11.	**Poultry**	Popularization of improved breeds (Kadaknath) Introduction of backyard poultry
12.	**NTFPs**	Collection of NTFPs i.e. Mahua, Tamarind,Chironji,Lac & Tendu leaves etc. Collection, processing and value addition of of NTFPs.

Medium & Large-Rainfed

S. No.	Crops/ Enter prises	Technology
1.	**Paddy**	❖ Popularization of Improved high yielding varieties ❖ Life saving ❖ SRI Method ofcultivation ❖ Popularization of short duration varieties like Indira barani,Samleshwari, IR 64 Life saving Irrigation during critical stages Production of Poha/ Scented quality rice ❖ Demonstration of Direct Seeded Rice by the use of seed cum fertilizer drill ❖ STCR Based Nutrient Management in Rice
2.	**Maize**	❖ Introduction of hybridvarieties ❖ Integrated Nutrient management
3.	**Minor millets**	❖ Popularization of disease resistant and high variety ❖ i.e. Indira Ragi 1, Indira Kodo – 1, GPU – 28 etc. ❖ Community farming, organic practices, processing and value addition, packaging
4.	**Pigeonpea**	❖ Popularization of improved varieties ❖ Broad bed and furrow method for Pigeonpea cultivation ❖ Promotion of SPI
5.	**Blackgram**	❖ Popularization of improved varieties
6.	**Lathyrus**	❖ Popularization of improved low ODAP content varieties ❖ Improved Utera Cultivation
7.	**Chickpea**	❖ Line Sowing ❖ Seed treatment
8.	**Wheat**	❖ Popularization of Improved high yielding varieties ❖ Life saving Irrigation during critical stages ❖ Promotion of Pusa hydrogel

S. No.	Crops/ Enter prises	Technology
9.	**Vegetable**	❖ Popularization of High Yielding and Triple Resistant variety of Tomato ❖ Drip and Sprinkler irrigation technique ❖ Protected cultivation ❖ Life saving Irrigation during critical stages ❖ Processing/value addition
10.	**Fruits**	❖ Plantation of Mango, Guava, Banana, Drumstick, coconut, cashew nut and Papaya
11.	**Goatary**	❖ Popularization of high meat and milk yielding breed ❖ Proper Deworming and Vaccination
12.	**Dairy**	❖ Popularization of high meat and milk yielding breed
13.	**Poultry**	❖ Popularization of improved breeds ❖ Introduction ofbackyard poultry
14.	**Fisheries**	❖ Improvement of survival rate nursery pond through control of aquatic insects ❖ Distribution of ice box and supplementary feed ❖ Use of composite fish culture ❖ Promotion of community village ponds
15.	**NTFPs**	❖ Collection of NTFPs i.e. Mahua, Tamarind,Chironji,Lac & Tendu leaves etc., Collection, processing and value addition of of NTFPs. ❖ Collection, processing and value addition of of NTFPs.

Module B: Marginal & Small-Irrigated

S. No.	Crops/ Enter prises	Technology
1.	**Paddy**	❖ Popularization of Hybrid varieties SRI Method of cultivation ❖ Popularization of Rice transplanter for cost saving ❖ Chemiacl weed control ❖ INM & IPM practices ❖ STCR Based Nutrient Management in Rice ❖ Dry Seeded Rice Technology with Pre & Post Emergence Application of Herbicide ❖ Dry Seeded Rice Technology with Pre & Post Emergence Application of Herbicide
2.	**Maize**	❖ Introduction of hybrid varieties Integrated Nutrient management ❖ Intercropping of Maize with Cow Pea

S. No.	Crops/ Enter prises	Technology
3.	**Minor millets**	❖ Popularization of disease resistant and high variety ❖ i.e. Indira Ragi 1, Indira Kodo – 1, GPU – 28 etc. ❖ Community farming, organic practices, processing and value addition, packaging
4.	**Pigeonpea**	❖ Popularization of improved varieties ❖ Promotion of SPI
5.	**Blackgram**	❖ Popularization of improved varieties ❖ Line sowing with Chemical weed Management ❖ INM in Black Gram (Bio-fertilizer + Chemical Fertilizer)
6.	**Greengram**	❖ Growing in summer greengram get additional income
7.	**Chickpea**	❖ Line Sowing Seed treatment ❖ IPM Tools for Pest Management ❖ Enhancing Cropping Intensity in Rice-Fallow Area by improved Utera Cultivation of Pulses
8.	**Wheat**	❖ Popularization of Improved high yielding varieties ❖ SWI
9.	**Vegetable**	❖ Mulching, staking, grading, ❖ Drip irrigation
10.	**Goatary**	❖ Popularization of high meat and milk yielding breed, Proper Deworming and Vaccination
11.	**Dairy**	❖ Popularization of high milk-yielding breeds ❖ Efficient utilization of animal power Ensuring green fodder round the year
12.	**Poultry**	❖ Popularization of improved breeds & Introduction of backyard poultry
13.	**Fisheries**	❖ Integrated Fish Farming
14.	**IFS**	❖ 1.0 ha IFS Model for Small & Marginal Farmers
15.	**Flower**	❖ Entrepreneurship Dev. through Flower Cultivation

Medium & Large-Irrigated

S. No.	Crops/ Enter prises	Technology
1.	**Paddy**	❖ Popularization of Improved high yielding varieties SRI Method of cultivation ❖ Dry Seeded Rice Technology with Pre & Post Emergence Application of Herbicide

S. No.	Crops/ Enter prises	Technology
2.	**Maize**	❖ Introduction of hybrid varieties Integrated Nutrient management ❖ Intercropping of Maize with Cow Pea
3.	**Minor millets**	❖ Popularization of disease resistant and high variety ❖ i.e. Indira Ragi 1, Indira Kodo – 1, GPU – 28 etc. ❖ Community farming, organic practices, processing and value addition, packaging
4.	**Pigeonpea**	❖ Popularization of improved varieties
5.	**Blackgram**	❖ Popularization of improved varieties
6.	**Chickpea**	❖ Line Sowing , Seed treatment ❖ IPM Tools for Pest Management ❖ Enhancing Cropping Intensity in Rice-Fallow Area by improved Utera Cultivation of Pulses
7.	**Wheat**	❖ Popularization of Improved high yielding varieties ❖ Life saving Irrigation during critical stages
8.	**Goatary**	❖ Popularization of high meat and milk yielding breed, ❖ Proper Deworming and Vaccination
9.	**Dairy**	❖ Popularization of high meat and milk yielding breed ❖ Availability of Green Fodder round the year
10.	**Poultry**	❖ Back Yard Rearing of Kadaknath Poultry Birds
11.	**Fisheries**	❖ Spawn to Fry/Fingerling Production in Seasonal Ponds ❖ Fish cum Duck Cultivation
12.	**IFS**	❖ 1.0 ha IFS Model
13.	**Lac Cultivation**	❖ Lac Cultivation in Alternate Host Semialata
14.	**Crop Diversification**	❖ Introduction of Kharif Onion

B. Bastar Plateau

Module A: Rainfed (Marginal and Small farmers)-

Crop	Technology
Paddy	❖ Line sowing /Drum seeder. ❖ Selection HYV Transplanting/line transplanting ❖ Selection HYV Line sowing/ HYV line transplanting+IWM+INM+IPM ❖ Selection HYV Transplanting/line transplanting ❖ Selection HYV Line sowing/ HYV line transplanting+IWM+INM+IPM ❖ Broad casting/Linesowing ❖ Line sowing/linetransplanting +IWM+INM+IPM ❖ STCR Based Nutrient Managementin Rice ❖ Replacement of upland rice with Maize pulses/oilseed ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties.
Blackgram	❖ Linesowing+INM+IPM ❖ Linesowing+INM+IPM ❖ INM+IWM+IPM+ line sowing+ Irrigation+ micro nutrient foliarspray ❖ Line sowing + INM+IPM ❖ INM+IWM+IPM+ line sowing+ Irrigation+ micro nutrient foliarspray ❖ Line sowing with Chemical ❖ INM in BlackGram (Bio fertilizer+ChemicalFertilizer)
Dairy	❖ Local breed/ Improved breed +management
Fisheries	❖ Improved fish breed / finger lings ❖ Improved fingerlings/+management ❖ Improved fish breed / finger lings ❖ Spawn to Fry/Fingerling Production in Seasonal Ponds
Goatary	❖ Local breed/ Improved breed+management ❖ BreedImprovementwithSirohiGoat
Greengram	❖ Line sowing+INM ❖ INM+IWM+IPM+linesowing+Irrigation+ micro nutrient foliar spray ❖ INM+IWM+IPM+linesowing+Irrigation+ micro nutrient foliar spray
Maize	❖ Line sowing/INM ❖ Selection HYV+Management ❖ Selection HYV/linesowing+seed treatment+foliarsprayofnutrient+IPM+INM

Crop	Technology
Poultry	❖ Local poultry/Karaknath120nos)+managem ent. ❖ Local poultry/Asil/Karaknath(40-50 nos)+management ❖ Local breed poultry ❖ Local poultry ❖ BackyardRearingofKadaknath poultry birds
Ragi	❖ Line sowing/ ICM ❖ Selection HYV /line sowing+ seed treatment +INM+IPM
Vegetable-Brinjal, Tomato, bitter guard, Cauliflower	❖ INM, +Improved package of practice+ ❖ INM,+Improvedpackageofpractice+ HYV+ drip irrigation system
Chickpea/ Fieldpea	❖ Broad casting ❖ Broadcasting/linesowing+seed treatment +foliar spray of nutrient+IPM ❖ IPM Tools for Pest Management
Finger Millets	❖ ImprovedProductionTechwith HYV and Line Sowing
Horse Gram	❖ Introductionof Highyielding Varietieswith Chemicalweed Management
Lac Cultivation	❖ ImprovedLaccultivationin Existing ❖ Hosts
IFS	❖ 1.0haIFSModelforsmall&Marginal ❖ Farmers
Onion	❖ Introduction of kharif Onion

Module B: Rainfed (Medium and Large farmers)-

Crop	Technology
Paddy	❖ Line sowing /Drum seeded/SRI ❖ Selection HYV Line sowing/ HYV line transplanting+IWM+INM+IPM ❖ Broad casting/Linesowing ❖ STCRBasedNutrientManagementinRice ❖ Replacement of upland rice with Maize pulses/ oilseed ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties.
Maize	❖ Line sowing/INM ❖ Selection HYV /line sowing+ seed treatment+foliarsprayofnutrient ❖ +IPM+INM

Crop	Technology
Ragi	❖ Line sowing/HYV/ICM ❖ Selection HYV /line sowing+seed treatment +INM+IPM
Green gram	❖ Line sowing+INM ❖ INM+IWM+IPM+line sowing+Irrigation+ micro nutrient foliar spray ❖ INM+IWM+IPM+line sowing+Irrigation+ micro nutrient foliar ❖ spray
Black gram	❖ Line sowing + INM+IPM ❖ INM+IWM+IPM+line sowing+Irrigation+ micro nutrient foliar spray ❖ INM+IWM+IPM+line sowing+Irrigation+ micro nutrient foliar spray ❖ INM in Black Gram (Bio fertilizer+Chemical Fertilizer)
Dairy	❖ Local breed/ Improved breed+management
Goatary	❖ Local breed/ Improved breed+management ❖ Breed Improvement with Sirohi Goat
Fisheries	❖ Improved fish breed / finger lings. ❖ Improved fingerlings/+management ❖ Fisheries pond (July-March) ❖ Spawn to Fry/Fingerling Production in Seasonal Ponds
Poultry	❖ Local poultry/Asil/Karaknath120nos)+manage ment. ❖ Local poultry/Karaknath(40-50 nos)+management ❖ Local poultry/Asil/Karaknath(100-150 nos)+management ❖ Back yard Rearing of Kadaknath poultry birds
Vegetable-Brinjal, Tomato, bitter guard, Cauliflower	❖ INM, +Improved package of practice+ HYV+ drip irrigation system
Chickpea/Fieldpea	❖ Broad casting ❖ Broad casting/line sowing+ seed treatment +foliar spray of nutrient+IPM ❖ IPM Tools for Pest Management
Finger Millets	❖ Improved Production Tech with HYV and Line Sowing
Horse Gram	❖ Introduction of High yielding Varieties with Chemical weed Management
Lac Cultivation	❖ Improved Lac cultivation in Existing Hosts
IFS	❖ 1.0 ha IFS Model for small & Marginal Farmers
Onion	❖ Introduction of kharif Onion

Module C: Irrigated (Marginal and Small farmers)-

Crop	Technology
Paddy	❖ Line sowing /Drum seede ❖ Selection HYV Line sowing/ HYV line transplanting+IWM+INM+IPM ❖ HYV+line transplanting/SRI+IWM+INM+IPM ❖ LineSowingbyPaddydrumSeeder withPOE-Herbicide ❖ Transplanting of Rice with Self Pro pelled Paddy Transplanter ❖ STCR Based Nutrient Managementin Rice ❖ Replacement of upland rice with Maize pulses/ oilseed. ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties.
Blackgram	❖ Seed treatment , Line sowing + INM+IPM ❖ INM+IWM+IPM+linesowing+Irrigation+ micro nutrient foliarspray
Vegetable-Brinjal, Tomato, bitter guard, Cauliflower	❖ INM,+Improvedpackageofpractice+ Drip irrigation ❖ INM,+Improvedpackageofpractice+ HYV+ drip irrigation system ❖ Production and Income Enhancement of Brinjal Based intensive Cropping under Drip Irrigation
Dairy	❖ Local breed/ Improved breed +management
Fisheries	❖ Improved fish breed / finger lings ❖ Small pond ❖ Fish Cum Duck Cultivation ❖ IFS Modal
Goatary	❖ Local breed/ Improved breed + feed management
Greengram	❖ Seed treatment with fungicide -Line sowing +INM ❖ INM+IWM+IPM+linesowing+Irrigation+ micro nutrient foliarspray ❖ Line sowing+INM
Tomato	❖ HYV(Arka rakshak/laxmi-5005 ❖ HYV(Arka rakshak/laxmi 5005)+management
Maize	❖ Line sowing/INM ❖ Selection HYV/linesowing+seed treatment+foliarsprayofnutrient ❖ +IPM+INM ❖ HYV+ Management ❖ Weed Management ❖ Selection HYV/linesowing+seed treatment+foliarsprayofnutrient ❖ +IPM+INM

Crop	Technology
Chickpea/Fieldpea	❖ IPM Tools for Pest Management
	❖ Introduction of HYV
Lac Cultivation	❖ Lac Cultivation in AlternateHost Semlata
IFS	❖ 1.0 ha IFS Model for small& Marginal ❖ Farmers
Poultry	❖ Local poultry/Karaknath130nos)+management. ❖ Local poultry/Asil/Karaknath(40-50 nos)+management ❖ Local poultry/Asil/Karaknath120nos)+manage ment ❖ Back yard Rearing of Kadaknath poultry birds
Onion	❖ HYV (Nasik red) +management ❖ Introduction of kharif Onion
Wheat	❖ HYV+INM

Module D: Irrigated (Medium and Large farmers)-

Crop	Technology
Paddy	❖ Line sowing /Drum seeder ❖ Selection HYV Line sowing/ HYV line transplanting+IWM+INM+IPM ❖ Transplanting/line transplanting ❖ HYV+linetransplanting/SRI+IWM+INM+IPM ❖ STCRBasedNutrientManagementinRice ❖ Replacement of upland rice with Maize pulses/ oilseed. ❖ Demonstration on Productivity and profitability enhancement throughhigh yielding Rice Varieties.
Maize	❖ Line sowing/INM. ❖ SelectionHYV/linesowing+seedtreatment ❖ +foliar spray of nutrient +IPM+INM ❖ STCRBasedNutrientManagementinRice
Green gram	❖ Line sowing+INM ❖ INM+IWM+IPM+linesowing+Irrigation+ micro nutrient foliarspray
Black gram	❖ Line sowing + INM+IPM ❖ INM+IWM+IPM+linesowing+Irrigation+ micro nutrient foliarspray

Crop	Technology
Vegetable- Brinjal, Tomato, bitter guard, Cauliflo wer,potato	❖ INM,+Improved package of practice+ Drip irrigation
Chickpea/Fiel dpea	❖ IPM Tools for Pest Management ❖ Introduction of HYV
Dairy	❖ Local breed/ Improved breed + feed management ❖ Improved breed 4nos.
Goatary	❖ Local breed/ Improved breed + feed management
Fisheries	❖ Improved fish breed / finger lings ❖ Improved fingerlings/+management ❖ Fishery pond ❖ Fish Cum Duck Cultivation
	❖ Mixed Fish Farming
Poultry	❖ Local poultry/Karaknath20-25 nos)+management ❖ Localpoultry/Asil/Karaknath120nos)+manage ment ❖ Local poultry/Karaknath (140-150 nos) + management ❖ Local poultry/Asil/Karaknath(80- 100)+management ❖ Local poultry/Asil/Karaknath(30- 40nos)+management ❖ Local poultry/Asil/Karaknath(40-50 nos)+management ❖ Back yard Rearing of Kadaknath poultry birds ❖ Local poultry/Asil/Karaknath(80-100)+management
Wheat	❖ HYV+Line sowing ❖ INM and chemical weed control
Onion	❖ HYV (Nasik red) +management ❖ Introduction of kharif Onion
Lac Cultivation	❖ Lac Cultivation in AlternateHost Semlata
IFS	❖ 1.0 ha IFS Model

Northern Hills of Chhattisgarh

Module A: Rainfed (Marginal and Small farmers)-

Crop	Technology
Paddy	❖ 1.Broad casting 2. *Lehi* ❖ 1.Line sowing of Improved variety 2.Seed treatment 3. INM and foliar application of MN ❖ Popularization of short duration varieties like Indira barani, Samleshwari,IR64 Life saving Irrigation during critical stages ❖ Popularization of rice transplanter, harvesters threshers and graders Use of seed saving technology like SRI, SWI, SPI, Dibbling, Line sowing etc Mulching ❖ yieldMaximization ofRiceUnderDSRwithICM ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties. ❖ Demonstration on Enhancement of Income through organic production of scented rice FPO at village level ❖ STCR based INM in Rice ❖ Use of Pusa hydrogel
	❖ Improved variety + seed treatment through bio fertilizers ❖ fertilizer+ soil application of bio fertilizer+folliar application in NPK+IPM ❖ Popularization of improved varieties ❖ Processing (Dalmaking) ❖ Chemical weedManagement ❖ INM in Black Gram (Bio-fertilizer+Chemical Fertilizer)
Dairy	❖ Demonstration on Annual, Kharif & Rabi fodder for minimizing feedcost
Goatary	❖ round the year forage production through combination of perennial grasses with annual legume forage ❖ Black Bengal breed ❖ Local breed/ Improved breed +management ❖ Local breed/ Improved breed (35- 40)+management ❖ Popularizationofhigh meat and milk yielding breeds ❖ Breed improvement with Sirohi Goat
Groundnut	❖ Line sowing+ improved variety + seed treatment+ soil application of bio fertilizer+ foliar application of NPK+INM

Crop	Technology
Poultry	❖ Kadaknath /vanraja ❖ Local poultry/Asil/Karaknath(40-50 nos)+management ❖ Local poultry/Asil/Karaknath(50-60
	❖ nos)+management ❖ Popularization of improved breeds Introduction of backyard poultry ❖ Promotion of community culture ❖ Back Yard Rearing of Kadaknath Poultry Bird
Tomato	❖ 1.Hybrid+FYM+Earthing ❖ 1.Hybrid+Root treatment+INM and Lime application +foliar application of MN
Wheat	❖ Use of FYM ❖ 1 Broadcasting+FYM ❖ 1.HYV+Seed treatment+ INM and Foliar application of MN ❖ 1.Line sowing of Improved variety 2.Seed treatment 3. INM and foliar application of MN
Maize	❖ Introduction of hybrid varieties Integrated Nutrient management ❖ STCR based INM in Maize
IFS	❖ 1.0 ha IFS Model for Small & Marginal Farmers
Ginger	❖ Productivity and Income Enhancement of ❖ Ginger through IDM
Mushroom	❖ Income Enhancement through Value addition of Oyester Mushroom. ❖ Demonstration on mushroom production for income generation of SHGs under Skill Development Programme and subsequent Vermicompost production from wastage of Mushroom.
Mahua	❖ Assessment of value addition of Mahua for ❖ making Mahua Candy.
Mustard	❖ Varietal demonstration on Yield and income enhancement through high yielding Mustard variety ❖ STCR based NM in Mustard
Pigeonpea	❖ Demonstration of Yield and Income Maximization of Pigeonpea through MCP with ❖ Integrated nutriment management.
Chickpea/fie ldpea	❖ Improved Package of practices with MCP. ❖ IPM Tools for Pest Management
Linseed	❖ Improved Package of practices & Zero Seed Drilling

Crop	Technology
Niger	❖ Improved Package of practices
Horse Gram	❖ Improved Package of practices . ❖ Introduction of High Yielding Varieties with Chemical weedManagement
Finger Millets	❖ Improved Production Tech with HYV and Line Sowing
Fisheries	❖ Spawn to Fry/Fingerling Production in Seasonal ❖ Ponds
Lac Cultivation	❖ Improved Lac Cultivation in Existing Hosts
Onion	❖ Introduction of Kharif Onion
Vegetables	❖ Nursery Management. ❖ management of Shoot & Fruit borer in Brinjal ❖ Foliar application of Ethrel PGR at 2 & 4 True leaf stages in Bitter gourd ❖ weed management in Rabi Onion ❖ Improved Production Tech of Colocasia
ICT Application	❖ Visual based technical information ❖ dissemination through Whatsapp to Agricultural Farmers
Animal Husbandary	❖ Availability of Round the year Green Fodder
Okra	❖ IPM modules against management of shoot and fruit borer in Okra

Module B: Rainfed (Medium and Large farmers)-

Crop	Technology
Paddy	❖ Broad casting+FYM ❖ SRI+STCR+MN ❖ Useofqualityseed Lifesaving Irrigationduring criticalstages Lowwater requiring crops/varieties SRItechnique Balance applicationof plantnutrients ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties. ❖ Demonstration on Enhancement of Income through organic production of scented rice FPO at villagelevel ❖ Replacement of Upland Rice with Pulses/Oilseed/Vegetables ❖ N- saving by use of urea briquettes in transplanted Rice ❖ Group Processing and Marketing of

Crop	Technology
Black Gram	❖ 1.Broad casting +FYM ❖ Improved variety 2.seed treatment 3. Soil application of Biofertilizer + foliar application in NPK+MN+IPM ❖ Popularizationof improvedvarieties ❖ Line sowing with Chemical weed Management ❖ INM in Black Gram (Bio-fertilizer + Chemical Fertilizer)
Dairy	❖ Sahiwal breed
Goatary	❖ Barbari/ Jamunapari(per goat) ❖ Local breed/ Improved breed (40- 50)+management ❖ Popularizationofhighmeatandmilkyielding varieties ❖ Breed improvement with Sirohi Goat
Groundnut	❖ Line sowing +FYM ❖ Line sowing+improved variety+seed treatment+foliar application in NPK+ MN+IPM
Onion	❖ 1. HYV 2.FYM ❖ Introduction of Kharif Onion
Poultry	❖ Vanraja/kadaknath in deep litter system(per bird) ❖ Local poultry/Asil/Karaknath(100-150 nos)+management ❖ Popularizationof improvedvarities ❖ Back Yard Rearing of Kadaknath Poultry Bird
Tomato	❖ HYV 2. FYM
Wheat	❖ 1.Broad casting+FYM ❖ Improvedvariety+seedtreatment+STCR+MN
Fisheries	❖ Fisheries pond(July-March ❖ Spawn to Fry/Fingerling Production in Seasonal Ponds
Maize	❖ Introductionof hybridvarieties IntegratedNutrient management ❖ STCR based INM in Maize
Vegetables	❖ Popularizationof HighYieldingand TripleResistant var ietyofTomato DripandSprinkler irrigation technique. ❖ Nursery Management ❖ Foliar application of Ethrel PGR at 2 & 4 True leaf stages in Bitter gourd ❖ weed management in Rabi Onion ❖ Improved Production Tech of Colocasia

Crop	Technology
Mustard	❖ Varietal demonstration on Yield and income enhancement through high yielding Mustard ❖ variety.
	❖ STCR based NM in Mustard
Pigeonpea	❖ Demonstration of Yield and Income ❖ Maximization of Pigeon pea through MCP with Integrated nutriment management.
Mushroom	❖ Demonstration on mushroom production for income generation of SHGs under Skill Development Programme and subsequent Vermicompost production from wastage of ❖ Mushroom.
Green Fodder	❖ Demonstration on Annual, Kharif & Rabi fodder for minimizing feed cost
Chickpea/fie ldpea	❖ Improved Package of practices with MCP. ❖ IPM Tools for Pest Management
Linseed	❖ Improved Package of practices & Zero Seed ❖ Drilling
Niger	❖ Improved Package of practices
Horse Gram	❖ Improved Package of practices . ❖ Introduction of High Yielding Varieties with Chemical weed Management
Finger Millets	❖ Improved Production Tech with HYV and Line Sowing
Lac Cultivation	❖ Improved Lac Cultivation in Existing Hosts
IFS	❖ 1.0 ha IFS Model for Small & Marginal Farmers
ICT Application	❖ Visual based technical information dissemination through Whatsapp to Agricultural Farmers. ❖ Effectiveness of visual based technical information dissemination through Whatsapp to the farmers of Balrampur District
Animal Husbandary	❖ Availability of Round the year Green Fodder

Module C: Irrigated (Marginal and Small farmers)-

Crop	Technology
Paddy	❖ 1.Broad casting /.Lehi 2.FYM. ❖ Line sowing+Seed treatment+ Biofertilizer+Foliar application of NPK and MN ❖ Transplamting+INM+Foliar application of MN. ❖ Popularizationofshort durationvarietieslike Indirabarani, Samleshwari,IR64 LifesavingIrrigation duringcriticalstages ❖ Popularizationof harvesters,threshers andgraders Useofseedsaving technologylikeSRI, SWI,SPI,Dibbling, Linesowingetc Mulching ❖ Promotionof communityculture ❖ High yielding Transplanted Rice Varieties Under ICM. ❖ Yield Maximization in Fine/ Scented Rice under organic farming ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties ❖ Demonstration on Enhancement of Income through organic production of scented rice FPO at village level ❖ Group Processing and Marketing of
Blackgram	❖ Broadcasting+ FYM ❖ Improver variety + line sowing + seed treatment+ NPK + MN+IPM ❖ Popularizationof improvedvarieties ❖ Integratedcrop management, processing (Dal making)
Dairy	❖ Gir breed + nepier + barseem ❖ Popularizationofhigh milk-yieldingbreeds Efficientutilizationof animalpower Ensuringgreenfodder roundtheyear ❖ Processingof milk Products
Goatery	❖ Black begal / jamunapari(per goat) ❖ Feeding of leguminous straw with green grass + deworming ❖ Local breed/ Improved breed +management ❖ Local breed/ Improved breed (35-40 nos) +management
Groundnut	❖ Line sowing+ local variety. ❖ Line sowing+ seed treatment+ soil application in bio fertilizer+ foliar application in NPK + MN+IPM ❖ Improved variety + line sowing+ FYM+ inter cropping between ground nut + Pigeon pea 4:1+ NPK+ MN+IPM

Crop	Technology
Onion	❖ 1.Hybrid+FYM+Earthing ❖ HYV+FYM+Earthing+ Biofertilier+Foliar application of NPK and MN. ❖ HYV+FYM+Earthing+ ❖ Biofertilier+Foliar application of NPK and MN. ❖ Introduction of Kharif Onion
Poultry	❖ Vanraja/ Kadaknath(per bird). ❖ Kadaknath / coloured breed(per bird) ❖ Local poultry/Asil/Karaknath(40-50 nos)+management ❖ Local poultry/Asil/Karaknath(30- 40)+management ❖ Popularizationof improvedbreeds Introductionofbackyard poultry ❖ Promotionof communityculture ❖ Back Yard Rearing of Kadaknath Poultry Bird
Tomato	❖ Hybrid+FYM+Earthing ❖ HYV+FYM+Earthing+ Biofertilier+Foliar application of NPK and MN
Wheat	❖ 1. Line sowing +FYM ❖ Line sowing +FYM+ Seed treatment +Foliar application of NPK and MN ❖ STCR based Nutrient Management in Rice- Wheat Cropping System (Yield Target Rice 55 q/ha and Wheat 35 q/ha)
Fisheries	❖ Improvementofsurvival ratenurserypondthrough controlofaquaticinsects Distributionoficebox and supplementaryfeed. ❖ Useofcompositefish culturePromotionofcommunity village ponds. ❖ Fish cum Duck Cultivation. ❖ Mixed Fish Farming
IFS	❖ Animalbasedforming system. ❖ IFS
Maize	❖ Introductionofhybrid varieties IntegratedNutrient management. ❖ Introductionofhybrid varietieswithINM Plantinginridge furrowmethod Processingof maize grains(feed,ethanol) ❖ STCR based Integrated Nutrient Management under Maize –Mustard Cropping System(Yield Target Maize 50 q/ha and Mustard 15q/ha) ❖ INM. ❖ Weed management.

Crop	Technology
Vegetables	❖ PopularizationofHigh YieldingResistantvariety
	❖ Useofqualityseed Lowwaterrequiring varieties. ❖ Utilisationofdryland area Useofintegrated
	❖ Nutrientmanagement. ❖ LifesavingIrrigation duringcriticalstages
	❖ Processing/value addition
	❖ Chemical Control of shoot and fruit borer in
	❖ Brinjal.
	❖ Varietal Demonstration of Kharif & Rabi potato
	❖ to Enhance the income and Profitability of
	❖ farmers of hilly & Plain region.
	❖ Nursery Management
	❖ Foliar application of Ethrel PGR at 2 & 4 True
	❖ leaf stages in Bitter gourd.
	❖ weed management in Rabi Onion.
	❖ IPM modules against management of Diamond
	❖ back moth in Cauliflower.
	❖ integrated disease management of wilt complex
	❖ in brinjal
Mustard	❖ Yield Maximization of Mustard under ICM Practices. ❖ (Targeted yield 14 q/ha). ❖ Varietal demonstration on Yield and income ❖ enhancement through high yielding Mustard variety
Mushroom	❖ Income Enhancement through Value addition of Oyester Mushroom. ❖ Demonstration on mushroom production for income generation of SHGs under Skill Development Programme and subsequent Vermicompost production from wastage of Mushroom
Mahua	❖ Assessment of value addition of Mahua for making Mahua Candy.
Potato	❖ Varietal Demonstration of Kharif & Rabi potato to Enhance the income and Profitability of farmers of hilly & Plain region.
Pigeonpea	❖ Demonstration of Yield and Income Maximization of Pigeon pea through MCP with ❖ Integrated nutriment management.

Crop	Technology
Gren Fodder	❖ Demonstration on Annual, Kharif & Rabi fodder for minimizing feed cost. ❖ round the year forage production through combination of perennial grasses with annual legume forage.
Chickpea/ fieldpea	❖ Improved Package of practices with MCP. ❖ Improved Package of practices & Zero Seed Drilling ❖ IPM Tools for Pest Management. ❖ Introduction of HYV ❖ IPM modules against management of pod borer in chickpea ❖ IPM modules against management of pod borer in chickpea
Lac Cultivation	❖ Lac Cultivation in Alternate Host Semialata
Flower	❖ Entrepreneurship Dev. Through Flower ❖ Cultivation
Animal Husbandary	❖ Availability of Round the year Green Fodder
ICT	❖ effectiveness of visual based technical information dissemination through Whatsapp to the farmers of Balrampur District

Module D: Irrigated (Medium and Large farmers)-

Crop	Technology
ddy	❖ 1.Transplanting +Biofertilizer +Foliar application of NPK. ❖ SRI of HYV+INM+Foliar application of MN ❖ Useofqualityseed LifesavingIrrigation duringcriticalstages LifesavingIrrigation duringcriticalstages Lowwaterrequiring crops/varieties ❖ SRItechnique ❖ Balanceapplicationof plantnutrients ❖ Demonstration on Productivity and profitability enhancement through high yielding Rice Varieties. ❖ Demonstration on Enhancement of Income through organic production of scented rice FPO at village level ❖ Replacement of Upland Rice with Pulses/Oilseed/Vegetables ❖ Yield Maximization in Fine/ Scented Rice under organic farming
Blackgram	❖ Local variety + broadcasting. ❖ Improved variety + line sowing + seed treatment+ soil application of bio fertilizer +NPK+ foliar application of micro nutrient +IPM. ❖ Popularizationof improvedvarieties

Ground nut	❖ ❖	Line sowing + local variety. Improved variety + inter cropping groundnut & pegion pea 4:1 + NPK + seed treatment + soil application of bio fertilizer & sulphur +foliar application of micro nutrient+IPM
Tomato	❖ ❖	1.Hybrid+FYM+Earthing. 1.HYV+FYM+Earthing+ Biofertilier+Foliar application of NPK and MN
Onion	❖ ❖ ❖	1. HYBRID 1.HYV+FYM+Earthing+ Biofertilier+Foliar application of NPK and MN Introduction of Kharif Onion
Dairy	❖ ❖ ❖	Sahiwal breed / nepierbarseem/ azolla. Sahiwal breed / nepierbarseem/ azolla+feed supplements Popularizationofhigh milk-yielding breeds Efficientutilizationof animal power Ensuring green fodder round the year
Goatary	❖ ❖	Barbari/ Jamunapari. Barbari/ Jamunapari+ mineral by soil analysis + concentrate
Poultry	❖ ❖ ❖	Vanraja/kadaknath in deep litter system. Popularizationof improvedbreeds Introductionofbackyard poultry Back Yard Rearing of Kadaknath Poultry Bird
Wheat	❖ ❖	1.Hybrid+FYM+Earthing. Line sowing +FYM+ Seed treatment +Foliar application of NPK and MN
Maize	❖ ❖ ❖	Introductionofhybrid varieties IntegratedNutrient management Lowwaterrequiring varieties. STCR based Integrated Nutrient Management under Maize –Mustard Cropping System(Yield Target Maize 50 q/ha and Mustard 15q/ha) INM
Vegetables	❖ ❖ ❖ ❖	PopularizationofHigh YieldingResistant variety Useofqualityseed. Nursery Management Foliar application of Ethrel PGR at 2 & 4 True leaf stages in Bitter gourd weed management in Rabi Onion. integrated disease management of wilt complex in brinjal
Fisheries	❖ ❖ ❖	Improvement ofsurvival ratenurserypond throughcontrolof aquaticinsects Distributionoficebox andsupplimentryfeed. Fish cum Duck Cultivation. Mixed Fish Farming.

IFS	❖	Animalbasedforming system.
	❖	1.0 ha IFS Model for Small & Marginal Farmer
Potato	❖	Varietal Demonstration of Kharif & Rabi potato to Enhance the income and Profitability of farmers of hilly & Plain region
Mustard	❖	Varietal demonstration on Yield and income enhancement through high yielding Mustard variety
Pigeonpea	❖	Demonstration of Yield and Income Maximization of Pigeon pea through MCP with Integrated nutriment management.
Mushroom	❖	Demonstration on mushroom production for income generation of SHGs under Skill
	❖	Development Programme and subsequent
	❖	Vermicompost production from wastage of Mushroom.
Green Fodder	❖	Demonstration on Annual, Kharif & Rabi fodder for minimizing feed cost
Chickpea/fie ldpea	❖	Improved Package of practices with MCP.
	❖	Improved Package of practices & Zero Seed
	❖	Drilling
	❖	IPM Tools for Pest Management.
	❖	Introduction of HYV
Lac Cultivation	❖	Lac Cultivation in Alternate Host Semialata
Flower	❖	Entrepreneurship Dev. Through Flower Cultivation
Animal Husbandry	❖	Availability of Round the year Green Fodder

5.3 Summary recommendations:

A road map of Chhattisgarh has been prepared in order to double the farmers' income by 2022. Proper utilization of enormous resources available in the state, exploring biodiversity and making the small & marginal farmers more resourceful are the major basis of this road map. While practicing modern agriculture in the farmers' field along with agro-forestry/agri-horticulture, animal husbandry and fish rearing, the state has adopted "Integrated Farming". Some of the strategies to be followed are as under:

A. Irrigation resources in the state would be developed in a campaign mode in order to increase the cropping intensity.

B. All possible efforts will be made to make water available in small canals & rivers during the period of drought.

C. Efforts will also be made to encourage the use of suitable implements for crop diversification, intercropping and conservation agriculture.

D. Farmers will be motivated to make seed production as profitable venture and as an additional source of income, providing assistance in establishment of seed processing units to "Seed Producer Cooperative Societies" along with hybrid seed production of maize & rice. It will reduce the cost of cultivation to great extent.

E. Subsidies shall be provided for the construction of compost/NADEP pits for the production of agri-inputs at village level itself in addition to intensive action which shall be taken towards the improvement of village manure pits.

F. For increasing the "Lift Irrigation Acreage", extension of electric lines along the sides of all anicuts/stop dams shall be ensured in coming five years.

G. Bastar & Surguja divisions shall be developed as "Organic Farming Hub" and through certification of all the organic products, their sale and value addition will be enhanced. This will provide the appropriate and prime price of agricultural products to the farmers.

H. All the State Mandies shall be linked with the E-platform of National Agriculture Market.

I. To encourage the agricultural mechanization in the remote areas, 1000 "Agriculture Implement Custom Hiring Centres" will be established.

J. In the situation of uncertainty of weather & natural calamities, at least 50% farmers would be brought under the cover of insurance for providing the security to farmers.

K. Short-term loans being provided to farmers at zero per cent interest rate will be further expanded so as to promote the modernization of agriculture by providing the medium & long-term loans.

L. Patta of more than 3 lacs ha area has been provided by the government to over 3.5 lacs forest inhabitants (Banvasis) of the state. For doubling the income of these forest inhabitants, they will be linked with improved agriculture along with horticulture, agro-forestry, animal husbandry and poultry farming so as to uplift the socio-economic status of the farmers.

M. Forest-based industries would be established in addition to other sources of income. More than 54000 farmers will be benefited following lac cultivation and a target for doubling the production of lac will be achieved by the year, 2022.

N. "Changi Rearing System" of tusur production will be promoted so as to raise the income of silk worm rearers.

O. "Fruit & vegetable Route" will be developed keeping in view of horticulture development including green house/shade net, cold storage and pack house on cluster basis. In next five years, an additional area of 4.5 lac ha will be brought under horticultural crops.

P. Required trainings & tools would be provided to farmers practicing "apiculture".

Q. "Cage Culture" will be developed in the water bodies/reservoirs for increasing the production and productivity of fisheries. For this, fishermen would be trained and subsidies shall also be made available to them. Small farmers will be sensitized for fish rearing in a part of their field by making farm ponds.

R. Animal breed improvement work will be taken-up in campaign mode and new milk route shall be established.

S. Animal shade & poultry shade will be constructed under MNREGA. The interest of cattle producer will be protected by extending the "Livestock Insurance Scheme".

T. While providing all possible helps and best of resources to its hardworking farmers in integrated manner from central & state governments, Chhattisgarh Government is committed in fulfilling the resolution of Hon'ble Prime Minister.

SUCCESS STORIES

1. Establishment of Integrated Farming System (IFS) in farmers field:

The farmers at present concentrate mainly on crop production which is subjected to a high degree of uncertainty in income and employment to the farmers. In this contest, it is imperative to evolve suitable strategy for augmenting the income of a farm. IFS is the integration of various agricultural enterprises viz., cropping, animal husbandry, fishery, forestry etc. have great potentialities in the agricultural economy. These enterprises not only supplement the income of the farmers but also help in increasing the family labour employment. IFS is established in several farmers field by KVK, Kanker (Bastar Plateau) in different size of land holding where which agriculture, horticulture and allied enterprises were combined to increase working hours, provide employment opportunities for maximum period, minimise the risk and double/triple the farm profit from existing Rs. 55,100/- to 1,65,670/- in 0.60 ha, Rs. 45,980/- to 1,45,130/- from one ha. of land (Table 1), Rs. 89,100/- to Rs. 2,77,950/- from 2 ha., Rs.3,13,250/- to 4,51,500/- from 3 ha and 87,000/- to 3,92,900/- from 4 ha of land before and after implementation of IFS models (Table 2). Ramrao et al. (2006) also reported IFS with two bullocks + one cow + one buffalo + 10 goats along with poultry and duck was the most beneficial system for the marginal farmers in rainfed regions of Chhattisgarh in Central India. It was observed that crop + dairy + goat farming followed by crop + goat farming had the maximum potential (Singh and Sharma, 1987).

Economic of IFS model at farmers field (0.50-1.00 ha.)

Name of farmers	Components of IFS	Land holding	Income per annum (Rs.)	
			Before	After
Santosh Kawde	Rice - vegetable + backyard poultry + piggery + goatry + vermi compost	0.6	55100	165670
Chait ram	Rice + Vegetable + vermi composting + Poultry + Goatery + Piggery + Azola	1.0	45980	145130

Economic of IFS model at farmers field (2.00-4.00 ha.)

Name of farmers	Components of IFS	Land holding (ha.)	Income per annum (Rs.)	
			Before	After
Ghasiya ram	Rice + vegetable + fish + backyard poultry + goat + vermi compost + azolla	2.00	81,000	1,95,400
Suresh salam	Rice + vegetable + Poultry + Fishery + Goatery + Azola	2.00	89,100	2,77,950
Manku ram Kange	Rice + vegetable + backyard poultry + goat + piggery + vermi compost + azolla	2.00	1,41,000	2,57,250
Suklal	Rice-chickpea + backyard poultry + fish + piggery + goatry + azolla	2.00	91,600	1,56,600
Vijay Mandavi	Rice - vegetable + fruit orchard + fish + poultry + vermi compost	3.00	313250	4,51,500
Jagdish Shori	Rice - vegetable + fruit orchard + lac cultivation + animal husbandry + vermi compost	4.00	87000	3,92,900

Promotion of Kadaknath poultry breed through backyard rearing for livelihood security of tribal farmers:

Backyard poultry rearing of Kadaknath bird is an ancillary activity which have tremendous potential to raise the farm income. It is a indigenous disease resistant breed and having much medicinal values such as low fat percentage, low cholesterol, high protein content and wide adoptability. Farmers preferred this breed for rearing in their backyard. With an objective of providing quality breed of poultry bird Kadaknath, this breed was brought from KVK, Jhabua (M.P.) in 2012- 2013 and a hatchery unit (500 egg capacity) was established in 2013-14 at KVK, Kanker. The hatchery unit was further expanded during 2015-16 with 5000 egg capacity to produce 12,702 chicks and 30,761 chicks in 2015-2016 totalling 50,463 chicks in the period of three years and provided to the farmers in 19 districts of Chhattisgarh covering 32 blocks 256 villages and 463 beneficiaries for backyard rearing during 2015-16. Twenty five poultry units of 100 birds each have been established by farmers in the district and 25 units in other districts for rearing Kadaknath chicks. From 25 poultry units, 1866 mandays/year employment is generated and receipt of Rs. 5,60,000/- is obtained. Kadaknath poultry birds have now been spread from Jhabua of M.P. to several states of the country. Tribal farmers generally rear Desi poultry breed in their backyard system resulting in low selling price, but farmers are now attracting towards rearing of Kadaknath poultry bird which is resistant to disease and very much liked by them. Sale of eggs and male bird for meat purpose is the main source of income. These birds lay 90 to 120 eggs in a year and average annual income is Rs. 1200.00 per year per birds by rearing Kadaknath breed. Integration of non-crop enterprises like poultry + mushroom production + vermicomposting was sustainable system giving maximum net return and additional employment under rainfed conditions.

Number of chicks of Kadaknath poultry birds supplied by KVK, Kanker to different of Chhattisgarh and Jammu & Kashmir.

Year	No. of district covered	No. of block covered	No. of villages covered	No. of chicks supplied by KVK	No. of benefited
2014-15	7	12	25	7000	70
2015-16	17	25	75	12702	127
2016-17	19	32	156	30761	296
TOTAL			256	50,463	493
2016-17	1	-	One	50	75

Spread of Kadaknath poultry birds from Jhabua to several states of the country

Production Year	No. of chicks	States receiving chicks from Jhabua
2014-15	32,665	M.P.: Jhabua, Alirajpur, Dhar, Indore, Ujjain, Badwani, Gwalior, Shivpuri, Sivani, Sagar, Sehore, Chhindwara, Devash, Jabalpur, Khargone, Betul
2015-16	29,582	Chhattisgarh: Kanker, Rajasthan: Udaipur, Jaipur, Banswara, Churu, Sikar, Sri Ganganagar

Production Year	No. of chicks	States receiving chicks from Jhabua
2016-17	23,657	Maharastra: Pune, Nagpur, Dhule, Usmanabad, Wardha U.P. , Gujarat, Haryana, Kerala

6

DELHI

NCT of Delhi is the capital of India. It stands in a triangle formed by the Yamuna River in the east and spurs from the Aravalli range of mountain in the west and south. It is surrounded by Haryana and Uttar Pradesh. The National Capital Territory of Delhi covers an area of 1,483 km^2 (573mile2), of which 1,114 km2 is designated as urban, and 369 km2 as rural. According to the Indian geography the state is located at the north of the Indian subcontinent, amidst the ranges of Himalaya and the Aravalli. Delhi geography encompasses the location, climatic conditions, vegetation similar to Haryana and Rajasthan.

Haryana and Uttar Pradesh are the other states, which share their borders with Delhi in the west and east, respectively. Delhi geography divides the state into three parts- the Delhi ridge, the Yamuna flood plain and the plains. The Yamuna river plains are very fertile as they are flooded by the river and are rich in alluvial soil

The land utilization pattern of Delhi has a heavy tilt towards urban and industrial sector. Being the fastest growing urban area of India and the capital of emerging economy like India, it carries its own justification. The state needs to expand agricultural production substantially in order to provide livelihood to the rural population. The green area belongs to the forest and agriculture. There also the share of farm land with essential facilities is receding. The gross area irrigated reduced from 31107 hectares during 2008-09 to 29429 hectare during2015-16, indicating a decline of 5.39 per cent during the last eight years. The area irrigated through wells, which was the main source of irrigation, has also declined from 21492 hectare during 2008-09 to 19,561 hectare during 2015-16, recording a decrease of 8.00 per cent. Irrigation is an extremely important input for agricultural growth along with quality seeds of High Yielding Varieties.

There is no scope for increasing the farm size. Yet steady increase in population with shrinkage of cultivated land as a result of industrialization and urbanization would pose serious hurdle for agricultural development. Only vertical expansion is possible by integrating appropriate farming components requiring lesser space and time ensuring continuous income to the farmers.

The Vegetation of Delhi varies with its varied topography and comprises of small and medium sized plants and shrubs. One important aspect about the vegetation of Delhi is that it is widely scattered and do not form any shade as such over any part in the city. To study the nature of vegetation that grows in the different parts of the city, it is first important to know about the topographical variations of Delhi. The entire topography of Delhi is divided into a ridge, the Yamuna Flood Plain and the Plain. It is interesting to note here that each of these regions is marked by distinct type of vegetation. The ridge area of the city offers the right factors that favour the growth of acacias and some cacti. During the monsoon, herbaceous plants grow in abundance in the ridge. The plain region of Delhi is characterized by Shisham, Neem, Mulberry, Peepal and Acacia trees. The riverine type of vegetation grows along the plains of Yamuna. Vegetation of Delhi mainly comprise of medium size trees and herbs. However Delhi is known for its varied flowering plants. Weeds and grass grow on the banks of the Yamuna river.

Diversified agriculture ensures efficient utilization of natural resources and channelization of by-products of one farming enterprise to the other. The integrated farming systems, protected cultivation of horticultural crops, seed production, vegetable cultivation, improved fruit production techniques, effective utilization of water, integrated pest management, use of bio-fertilizers, use of biogas, post-harvest technique and value addition of agricultural produce, apiculture, commercialized mushroom cultivation, dairy farming, vermi-compost production, watershed management, agroforestry, handicrafts industry by rural youth and women, agro-tourism or Agricultural tourism etc. therefore, assume prime place for sound management of farm resources to enhance the farm productivity, reduce environmental degradation, improve the quality of life of farmers and to maintain the sustainability to meet the challenges of food and financial security. In order to meet the soaring demand for food –especially quality food and to keep the sanctity of farming sector as a lucrative option for income to young generation, and to enhance the income of farmers multi fold, there is a need to go for these potential technological options. These approaches facilitates in strengthening the socio-economic status of Indian farmers besides strengthening ecological balance. Integration of farming enterprises on a single small land holding or under a single ownership of holdings is well known to Indian farmers simply because of the preponderance of small farm systems which form the backbone of traditional agriculture. For small farmers, these systems enable a means of adopting diverse agro enterprises through the use of meager resources in the context of a rational means of reducing risk. Additionally, it also enables increased use efficiency of these scarce resources to ensure livelihood security and stability to farming systems.

Wheat has the biggest share among food crops in Delhi. During 2015-16, area and production of wheat were recorded as 19,050 hectare and 83,419 MT, respectively. However, vegetable crops can play immensely important role in income enhancement in the fragmented and receding agricultural landscape of Delhi. Vegetables grown in and around Delhi include cauliflower, cabbage, carrot, spinach, mustard (leaves), okra and tomato. In addition, a range of culinary herbs such as fenugreek and coriander are cultivated. The increase in the share of vegetables is partly extended by proximity to the markets. By adopting space and resource saving technologies of agriculture like vertical farming, hydroponics, aeroponics, protected cultivation etc, good quality vegetable production round the year can be increased.

6.1 Productivity Gaps and Major Constraints

According to Census of 2011, India's population rose to 1.21 billion people over the last 10 years — an increase by 181 million. According to a survey by UN State of the World Population report in 2007, 40.76 per cent of country's population is expected to reside in urban areas by 2030. The traditional pattern of poverty incidence is rapidly shifting from rural to urban areas. Every day an estimated one thousand people come to live in Delhi alone. These include migrants from poorer states such as Uttar Pradesh and Bihar (National Capital Region Planning Board, 1996). State agriculture faces multiple challenges that emanate both from within the system and from outside. Agriculture around cities improves the access of urban consumers to cheap and healthy food. The food produced in Urban and Peri- Urban Agricultural areas contribute to fulfill annual or seasonal demand in Delhi. For instance, the bulk of city dwellers' staple food requirements cannot be met by the urban and peri- urban agricultural areas. In contrast, a majority (in terms of both volume and number) of selected vegetables in the major wholesale markets were found to originate from the urban and peri-urban agricultural areas. Availability of such locally produced fruits and vegetables can contribute to solving highly prevalent urban nutritional problems stemming from insufficient intake of vitamins and minerals.

The most striking feature of urban agriculture, which distinguishes it from rural agriculture, is that it is integrated into the urban economic and ecological system: urban agriculture is embedded in -and interacting with- the urban ecosystem. Such linkages include the use of urban residents as laborers, use of typical urban resources (like organic waste as compost and urban wastewater for irrigation), direct links with urban consumers, direct impacts on urban ecology (positive and negative), being part of the urban food system, competing for land with other urban functions, being influenced by urban policies and plans, etc. Urban Agriculture plays an important role for making a city more resilient and safe in term of not only food and economy but also improving standard of living of urban poor by increasing mean of livelihood.

There are certain advantages of farmers of Delhi due to the megacity and its infrastructure. The road and railway networks are well developed, facilitating access to nearby urban markets. The additional availability of cheap migrant labour forces as well as highly qualified urban professionals makes peri-urban areas valuable locations for national and international industries. Urbanization and industrialization affect agriculture in the peri-urban areas, as population pressure from the city results in changes in land use - from agricultural to urban land use, be it for housing, commercial, industrial or other purposes. Where the land use remains agricultural, cultivation practices change. Access to urban ready markets for agricultural produce and for seasonal labour open up the possibility of cultivating on a commercial basis -high-value, highly perishable crops such as leafy vegetables, replacing storable crops such as cereals and pulses.

However if one look critically, the very proximity to this overtly industrial city raise some issues which renders the very existence of agricultural activity less justified compared to other parts of the nearby states. Natural resources are under increased pressure in the peri-urban areas because of the use of land for, inter alia, clay pits, quarries, sewage disposal tanks and garbage dumps, and as a result of air and water pollution from local industrial and urban sources. The livelihoods of the poorest inhabitants of the rural-urban fringes of many cities in developing countries are adversely affected by problems of land and water degradation and natural resource degradation in general, including air pollution stresses.

The villages inside the megacity have already been thoroughly urbanized and merged seamlessly with the surrounding urban localities. The polluting industries inside Delhi were shifted to the rural fringes of the city as a policy initiative and these have also occupied rural land areas. Once there were five rural blocks on the periphery of Delhi viz. Najafgarh, Kanjhawla, Alipur, Shahdara and Mehrauli. Among these, Shahdara and Mehrauli are practically devoid of any agricultural activity and in the other three blocks farmlands are being rapidly converted for other uses like farmhouses, venues for social functions and other commercial activities. The Government's attention to agriculture is also diminishing year after year. There is no recruitment for last several years and the old existing staff is given secondary works, other than agriculture related ones. Even banks and financial institutions are not extending loan facilities to this priority sector. Thus whatever agricultural land is available; the nature of agricultural interventions would be different from the past and surrounding rural areas.

The Agriculture Department of Delhi State is busy in redefining its role in maintaining the remaining agricultural activity of the State in the face of mounting pressure of encroachment by residential and industrial sector in the high value land, performing other administrative works onone hand and in preparing farmers to cater the need of fresh and healthy food items for the city population on the other. There is no government scheme accessible to farmers of Delhi and ATMA scheme is also not being implemented. Unlike rest of the country, there is no subsidy on electricity rates and electricity connections to the farm sector. In fact farmers could not get electricity from the private producers due to non-lucrative profit the farming sector offers. Inadequacy in land law regarding land leasing has led to reduced interest among farmers in long term investment in land that could have positive effect on production and productivity. Private players with vested interest are the only source of agri-inputs because no government shop is there for them. For assessing the farmers' needs and requirements for doubling farmers' income in coming five years, a farmer-scientist meet was convened on July 25, 2017. The outcomes of the meet are as follows:

Issues and opinions raised by the farmers:

- The share of agriculture in the economy of Delhi is small and that is not allowing the Government to consider Delhi as an agricultural state, as per definition, which in turn is not allowing the Delhi farmers to take benefits of various agricultural schemes.
- No government schemes are available to the farmers related to agriculture especially crop insurance scheme, micro-irrigation, protected agriculture etc.
- No subsidy in electricity rate is available to the farmers. Electricity rates for allied activities e.g. mushroom cultivation, fisheries production and nursery raising etc. are very high. As such enterprises are considered as a commercial activity.
- Farmers are not eligible to get bank loans for agricultural expenses.

- Problems of blue bull that destroys pulse crop thoroughly could not be tackled as there is no permission at least to erect fences or boundary walls.
- ATMA is not functioning in Delhi. Hence, farmers are not getting opportunities to participate in capacity building activities.
- The linkage between farmers and agriculture department is deficient.
- Farmers are interested in organic farming of vegetables but the certification procedure (which is essential for getting the premium price of organic produces) is painfully lengthy and very costly.
- Soil and water testing facilities are not readily available to the farmers for past several decades. They are not getting gypsum for soil amendment either.
- Lots of farmers are maintaining apiary but the price of honey is not remunerative. Farmers suggested MSP to be fixed for honey.

The farmers suggested the following remedial measures for their professional hardships:

- Delhi state need to be declared as agricultural state.
- Dedicated outlets for sale of farmers produces should be there in different localities of urban areas of Delhi.
- Timely delivery of information related to agricultural schemes, organic certification and new technologies should be provided as least block-wise.
- IARI seeds may be made available through KVK.
- Organic farming, dairy, nursery raising etc. are very profitable enterprises in Delhi, and thus farmers may be given opportunity through capacity building and other facilitation to practice them.

Agriculture in Delhi is pre-dominated by the characteristics of urban and peri-urban agriculture. Produce from urban and peri urban areas enhances the remuneration of poor farmers and access of poor urban consumers to food, the structure and conduct of marketing system and its functionaries affect both considerably. Field studies have been carried out in the main vegetable markets to identify the major stakeholders in the trading systems of urban and peri urban agricultural produce, the marketing strategies and channels and the value and price addition taking place. It was found that different prices are charged for products with similar characteristics, and in the same location different market functionaries charge varied prices to consumers in the same location. In addition, in the same location prices fluctuate during the course of a day, with lower prices later in the day. The farmer may take advantage of such variations and SMS service in real time can be initiated.

Issues Emerging in urban and peri-urban agriculture

- The low availability and high cost of land in urban / peri-urban areas may not encourage urban and peri-urban agriculture (UPA).

- Large water requirement for crop production is another major hurdle for urban agriculture. Cities in India are struggling to meet the fresh water requirements of its residents for human needs.
- The use of waste water for irrigation without careful treatment and monitoring can result in the spread of diseases.
- Use of untreated animal or human wastes in aquaculture ponds to increase fish production also puts both human and animal at risk.
- Improper and excessive use of pesticides and fertilizers in farming can pollute the soil and water in urban areas.
- Levels of pollution in cities are higher than in rural areas in the soil, water and air. Emissions from factories and automobiles lead to the presence of heavy metals and other toxic chemicals in water, soil and air while untreated and partially treated sewage lead to the presence of pathogens. This exposes the people who work in the urban farms and to a lesser extent the consumers of the produce to health risks. Suitable checks and precautions need to be exercised to prevent diseases triggered or produced by these pollutants. Besides, cultivation on contaminated land also represents a health hazard for the consumers. Pesticide residue in the urban and peri-urban horticulture may become high, besides polluted water with heavy metals and cleaning vegetables in water contaminated with bacteria and viruses after harvesting is also an issue.

Constraints to production system

- Urban and peri-urban agriculture is subject to a wide range of constraints to production. Some, for example pest attacks, adverse weather conditions and timely access to inputs such as seeds and pesticides, are common to all agricultural areas, but there are also issues that are specific to this environment. An important emerging constraint is the effect of environmental pollution of the air, soil and water, which potentially compromises the quantity, quality and safety of food produced in urban and peri urban agricultural areas. Ambient air pollution levels have been measured and their impact on crop yields assessed in the areas. The results raised serious concern. Additional research is being undertaken to assess the effects of air pollution on important crops, investigating the impact of gaseous pollutants on nutritional quality and the effects of heavy metal depositions on food safety.
- The service sector of the city is a more lucrative and less tedious alternative for income. Absentee landlords, farmers engaged in side business, employed in the city or where farmer has lesser family hands to manage the farming affairs employ labourers or give responsibility of farming to some interested person. Such persons are mostly ignorant of right stage of harvesting, proper cleaning, grading and packing of the produce, which results in low price for their produce. Sometimes, improper labeling of different grades also results in confused marketing and poor sale price. Though a good network of wholesale markets exists, Market information system is also either non-existent or not available in big mandis resulting in irregular production, uncertain availability of the produce and unorganized market prices.

6.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

To meet the multiple objectives of poverty reduction, food security, competitiveness and sustainability, several researchers have suggested farming systems approach to research and development. A farming system is the result of complex interactions among number of interdependent components where an individual farmer allocates certain quantities and qualities of four factors of production, viz. land, labour, capital and management to which he has access. As the food supply from its own land is stagnant, there is ever increasing demand of food items to feed the growing population of the city. Agricultural commodities from all over the country are being supplied in the city market. The city population is conscious of food quality and has high purchasing power. Also, with passage of time, the fragmentation in land holding became inevitable. Therefore, there is need to re-orient the nature of agriculture from rice-wheat based one to diversified agri-preneurship with olericulture, floriculture, mushroom cultivation, apiculture, poultry, dairy etc. –aspects of agriculture which have high demand among city population. Peri-urban agriculture is squeezed between paucity of land, less access to unpolluted water resources and high energy cost at one side and high demand and lure of ready market round the year on the other. Therefore, there is a need of resource conservation practices like water conservation technologies, energy-saving agriculture, recycling of bio-waste, short duration varieties, integrated practices for input and stress management, better land utilization. Improved post-harvest processing and value addition to raw farm produces will not only reduce loss but also will also increase marketability in upmarket city areas.

Brief descriptions of some of the components of agriculture to be augmented under the proposed strategy have been given below:

Improvement in overall water use efficiency of agriculture:

Irrigation is the life savior for the crops especially in the irrigated crop growing belt. For better productivity of the crops, high water use efficiency should be ensured though adopting suitable technologies e.g. drip and sprinkler irrigation, selection of suitable varieties, landscape engineering like LASER leveling, contour bund preparation and adoption of water saving crop husbandry practices, building of check dams and channelization of run-off etc. The Government of India has implemented centrally sponsored scheme on Micro Irrigation, the Pradhan Mantri Krishi Sinchai Yojana with the aim of per drop more crop and is also encouraging farmers to use water saving technologies.

Provision of quality seeds, planting materials and nutrients

One of the major factors influencing production is the use of high quality seeds and planting materials, on which the performance and efficacy of other inputs depends. It is estimated that quality seeds contribute to around a quarter of the overall increase in productivity. Sustained increase in agriculture production and increased farmers income necessarily requires continuous development of new and improved varieties of crops and efficient system of supply of the seed to farmers. ICAR-Indian Agricultural Research Institute has remained steadfast in improving as well as providing location specific, high performance varieties of wheat, rice and vegetables to the farmers of Delhi like other parts of India. Participatory seed production and incubation of FPOs alongwith training of interested rural youth are part and parcel of the Institute's regular activities. The seed programme in India tries to provide adequate safeguards for quality assurance in the seed multiplication chain to maintain the end to end purity of different varieties of crops. Another important dimension to boost productivity and bring about increased prosperity is to nurture the soil with quality nutrients and inputs. Under the Soil Health Card Scheme, the government is issuing soil cards to farmers with crop-wise recommendations of nutrients and fertilizers required for the individual farms to help farmers to improve productivity through judicious use of inputs. IARI PUSA STFR meter is also very helpful for soil test based nutrient recommendation.

Promotion of value addition through food processing

Agricultural crops are predominantly perishable in nature and after harvest, need to be cleaned, sorted, stored, processed, packed and transported. Cold storage facilities available are to be dedicated for the local farmers and affordable machineries for cleaning, sorting and processing crops should be available right at the farm. The scheme for Mega Food Parks aims to provide modern Infrastructure for food processing Units in the country on pre-identified cluster basis. Under the scheme, grant-in-aid is provided @50 per cent of the eligible project cost, subject to a maximum of Rs.50 crores per project.

Providing efficient marketing mechanism

e-National Agriculture Market (e-NAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. It provides information on commodity arrivals and prices, buy and sell trade offers, provision to respond to trade offers, among other services. Online market reduces transaction costs and information asymmetry. Aggregation of the farmers in form of Farmer Organizations, Farmer producer Companies, etc. will help them achieve economies of scale and benefits of direct marketing, thereby increasing the producer's share in consumer rupee.

Mitigating the risk in crop production

Government scheme Pradhan Mantri Fasal Bima Yojana (PMFBY) provides insurance to cover yield losses occurring due to deficit rainfall or adverse seasonal conditions, non- preventable risks, viz. drought, dry spells, flood, inundation, pests and diseases, landslides, natural fire and lightening, storm, hailstorm, cyclone, etc. The rate of insurance charges payable by the farmers will be 2 per cent for *Kharif* crops, 1.5per cent for Rabi crops, 5 percent for annual commercial and horticultural crops. In addition, the farmers can adopt various climate smart varieties and technologies (e.g. Pusa Basmati 1509, Pusa Basmati 1121, Pusa Gautami, Pusa Amulya, Pusa Basant etc.) to deal with various biotic and abiotic stresses.

Diversification and commercialization of agriculture

The farmers should shift attention from conventional cropping towards other allied enterprises like flower cultivation, honey bee cultivation, fisheries, mushroom cultivation, protected cultivation of exotic vegetables etc. It will increase the family labor employment and provide steady income and nutritious food.

Integrated Farming System

Farming system research (FSR) is considered as a powerful tool for the management of natural and human resource in developing countries like India. FSR is a multi-disciplinary whole-farm approach for solving the problems of small and marginal farmers. This approach aims at increasing income and employment from smallholdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself. Under the gradual shrinking of land holding, it is required to integrate the land-based enterprises like dairy, fishery, poultry, duck-rearing, apiary, field and horticultural crops etc. within the bio-physical and socioeconomic environment of the farmers to make farming more profitable and dependable. Currently, doubling the farm incomes has become a major focus of Government of India and specifically the vision of our honorable Prime Minister. Besides, attracting and retaining rural youth to agriculture has been a major challenge for the nation. Farmers are leaving agriculture, since it is becoming unprofitable under present scenario due to numerous resource- and production-vulnerabilities apart from unpredictability of nature due to climate change. Under such scenario, integrated farming systems (IFS) seems to be a ray of hope which has great potential in raising the farmers' incomes and employment generation, minimizing the risks in farming and enhancing the resource use efficiency, thus, leading to sustainable agriculture growth. IFS also prove as a potential approach for retaining the rural youth in agriculture through ample farm employment under different farm enterprises and better livelihood options in small and marginal farms. In view of the decline in per capita availability of land from 0.5 ha in 1950-51 to 0.15 ha by the turn of the century and a projected further decline to less than 0.1 ha by 2020, it is imperative to develop strategies and agricultural technologies that enable adequate employment and income generation, especially for small and marginal farmers who constitute more than 80 percent of the farming community. An integrated farming system represents multiple crops (cereals, legumes, tree crops, vegetables, flowers, medicinal plants etc.) and multiple enterprises (animal farming, bee keeping, fish farming, mushroom etc) in a single farm. Integration of allied activities will result in the availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins. Integrated farming will help in environmental protection through effective recycling of waste from animal activities like piggery, poultry, goat-rearing and dairy. Animals play key and multiple roles in the functioning of the farm, and not only because they provide livestock products (meat, milk, eggs, wool, and hides) but can also be converted into prompt cash in times of need. It is widely accepted as a means of achieving sustainable agriculture. Farming system approach is a multi-disciplinary whole-farm approach for solving the problems of small and marginal farmers besides management of natural and human resource at farm. A farmer can earn Rs. 3.7 lakhs per year by adopting Integrated Farming System in 1 ha, by integrating poultry, duckery, fishery, dairy, orchard, vegetables, vines, medicinal plants, along with field crops and bio-gas unit (IARI developed model).

System of Rice Intensification (SRI):

The increasing water need for agriculture poses a potential threat to natural water resources and climatic change scenarios in the near future. The great challenge will be to increase food production with less water, particularly with limited water and land resources, by promoting techniques and cropping systems of higher water-use efficiency (WUE). The System of Rice Intensification has been gaining acceptance around the world because of the remarkable increase in factor productivity method of crop production. Irrigated rice yields are being raised by 20-25 per cent,and often more, without requiring the use of purchased inputs and without changing varieties. The higher yields with SRI practices are achieved with any and all rice using less water and with little use of mineral fertilizers. Because the resulting plant phenotypes are more resistant to damage by pests and diseases, there is usually little or no need for chemical crop protection. All this has been quite unexpected. While the mechanisms that make these benefits attainable are not yet fully understood, it appears that SRI effects are the result of greater root growth and of increases in soil biological activity that are induced by different cultural practices.

Protected Cultivation of Horticultural Crops:

Protected cultivation of horticultural crops offers superior choice for diversification to traditional agriculture production system for a number of reasons. Production of crops under protected conditions has great potential in augmenting production and quality of vegetables, flowers and in some fruit crops in main and off season and maximizing water and nutrient use efficiency under varied agro climatic conditions. This technology has great potential especially in peri urban agriculture in near future, since it can be profitably used for growing high value vegetable crops like, tomato, cherry tomato, colouredbell peppers, parthenocarpic cucumbers, flowers like cut flowers, chrysanthemum, Lilium, fruits like strawberry, grapes etc. and for off season cultivation of vegetables and their healthy and virus free seedlings production. Farmers, who are living in Delhi state, can successfully diversify their traditional agriculture by adopting or using various levels of protected cultivation technologies for production of horticultural crops looking to their resources, availability of emerging markets of usual and unusual off season horticultural produce, year round demand of high value vegetables like standard tomatoes, coloured peppers and parthenocarpic cucumbers etc. High quality nursery raising in vegetables is the other area, where improvement over the traditional system of nursery raising is required. All kind of protected technologies may not be economical and useful to the farmers in Delhi, because of their very high initial running and maintenance cost, but some protected technologies are simple and highly profitable under Indian conditions and more specifically for Delhi areas, which can be adopted by farmers for production of different horticultural crops in the different manners viz. plug tray seedling production under protected conditions; Off-season cultivation of vegetable crops under plastic low tunnels; Off season vegetable cultivation under walk-in tunnels; Nursery raising for advancing vegetables ahead to their normal season; Insect proof net houses for virus free vegetable cultivation; Vegetable cultivation under Shade net houses during summer season; Low cost poly-houses for vegetable cultivation; Naturally ventilated greenhouses for high value vegetable cultivation.

Seed Production:

Seed is the most important input to harvest a good crop. The potential yield of crop depends on the quality of the seed used for cultivation of crop. Use of quality seeds alone can enhance the crop productivity by 15-25 per cent. One of the main reasons for low productivity of crops is unavailability of high quality seeds in the local markets. To enhance productivity, seed should be of high quality, which will express full potential yield of the genotype under favourable cultivation environments. Seed cultivation requires special skill and after care.

Vegetable Cultivation:

India has emerged as the second largest producer of vegetables in the world after China and is gradually striding towards achieving food and nutritional security at national level. The impact of the use of hybrids in improving the crop productivity especially cabbage, tomato, brinjal and onion has been realized in many vegetable crops. This steady increase in productivity has been achieved mainly by the use of quality seeds with built in inbred and hybrid vigor, coupled with the application of scientific production and protection technology, supported by government policies. The population of Delhi is around 1.4 crores which is causing phenomenal pressure on land, infrastructure and civic amenities. Availability of rail, road and air transport, cold storage, processing units, export houses and well established market network, will be helpful for taking up vegetable cultivation in peri-urban areas of Delhi in an organized way. Also, a huge quantity of solid waste generated during handling and marketing of fresh vegetable produce in NCR, Delhi, which is creating health and environmental hazards, can be used or recycled to produce vermicompost etc., for use in organic vegetable production or can be used as feed for anaerobic digester producing renewable energy and high quality manure. Peri-urban vegetable cultivation can provide farmers the possibility to cultivate a small piece of land, and obtain an income to meet their essential and basic needs. In recent years, around big cities, green belts are being developed which can provide a very intensive and profitable network of small farms specialized in production of perishable vegetables for consumption by the urban consumers. This is likely to result in a social symbiosis between farmers and city dwellers with mutual benefits and advantages. This will require involvement of a large number of institutions to address many issues related to the peri-urban vegetable cultivation in a viable participatory approach to make an impact and deliver anticipated results to the peri-urban population Delhi, having ever-increasing consumer population, requires extra procurement of horticultural produce, particularly vegetables from neighbouring states of Uttar Pradesh, Haryana and Rajasthan. The present day production of around seven lakh tonnes of vegetables is not sufficient and, as such, intensive vegetable cultivation on available land, on scientific lines, using latest technologies, should be adopted/promoted. Further, additional land, including diara land, has to be reclaimed and brought under vegetable cultivation. Efforts have to be made on reducing post-harvest losses and utilizing/avoiding market gluts, improvement in produce management and utilization strategy, including processing and systematic marketing. Improved marketing information system has also to be developed. Important vegetable crops which hold promise in cultivation are palak, coriander, fenugreek, lettuce, parsley, Brussel's sprouts, onion, bhindi, chilli, bitter gourd, tomato, potato, brinjal, cauliflower, peas, bottle gourd and cucumber. The thrusts have to be decided for programmes on long term and short-term basis. In addition, some medicinal and aromatic plants also need promotion in cultivation for use in therapeutic and pharmaceutical industry.

Fruit Production Techniques for Higher Yield and Better Income

In recent past, several innovations and new initiatives have been made both in research and development for improving production, productivity, quality and marketing and to identify critical gaps in various emerging areas in fruits & horticulture technology. High yielding superior fruit varieties for commercial cultivation are *Amrapali; Mallika; Pusa Arunima ; Pusa Surya; Pusa Pratibha; Pusa Shreshth ; Pusa Lalima* for Mango; *Pusa Sharad and Pusa Round* for sweet orange; and*, KagziKalan for lemon* etc. Along with the varietal change, improved fruit production technologies as High density orchard can also be option for doubling the farmers income for example high density orchard for Amrapali Mango. Mango is generally being cultivated at wider spacing (10-15 m) wherein only 80-100 trees could be planted in a hectare of area. Under this system lot of available area/land could not be utilized efficiently which causes a loss of revenue from the available land and results in low productivity. High density orchard accommodates more than 375- 450 trees per hectare. High density plantations are the consequences of continuous decline in the availability of cultivated land, rising energy and land cost together with the mounting demand for horticultural produce. Besides an increased number of trees per ha, a high density orchard must come into bearing within 2-3 years after planting, through using precocious rootstocks. As tree density is increased, profitability is increased up to approximately 2,500 trees per hectare. The result of medium density plantation is most encouraging in mango. Dwarf and compact trees in high density orchards, not only provide high yield and net economic returns per unit area in the initial years but also facilitate more efficient use of fertilizers, water, plant protection measures, weed control, and easy efficient harvest management practices.

Effective Utilization of Water

The vulnerability of Indian agriculture is bound to be severe if the present trend of water use and management efficiency is not changed. The International Water Management Institute forecasts that by 2025, 33% of India's population will live under absolute water scarcity condition. Rainfed lands are not only low in productivity and sustainability, but also more prone to risks, as compared to irrigated areas. Rainfed areas are also the location where, proportionately a greater concentration of poor and hungry persons lives. This can be obviated to some extent by expanding irrigated areas through improving water management and water use patterns.

Presently, the problem facing the country is not the development of water resources but the management of the developed water resources in a sustainable manner. The bulk of Delhi agricultural lands could be brought under irrigation by adopting efficient water management practices. Micro irrigation is one such practice.

Drip irrigation can be used for most crops, such as:

Orchard crops	Grapes, Banana, Pomegranate, Orange, Citrus, Mango, Lemon, Sapota, Guava, Papaya, Aonla, etc.
Vegetables	Tomato, Chilly, Capsicum, Cabbage, Cauliflower, Onion, Okra, Brinjal, Bitter gourd, Bottle gourd, Ridge gourd, Cucumber, Peas, Spinach, Pumpkin etc.
Flowers	Rose, Carnation, Gerbera, Anthurium, Orchids, Jasmine, Lily, Mogra, Tulip, Dahlia, Marigold etc.
Spices	Turmeric, Mint etc.
Oil seed	Sunflower

Micro irrigation system was found to result in 30 to 70 percent water savings in various orchard crops and vegetables along with 10 to 60 percent increases in yield as compared to conventional methods of irrigation. Mulching with drip further enhanced the crop yield to the tune of 10-20 per cent and controlled weeds up to 30-90 per cent.

Integrated Pest Management

Insect pests, diseases and weeds are major biotic bottlenecks in the production of crops inflicting on an average 30 percent yield loss. Monetary value of these losses has been estimated to be exceeding Rs.1,00,000 crores. There is thus ample scope to enhance our food production by curtailing losses due to pests to certain extent. Only option to boost our production remains in growing improved crop cultivars with better pest management practices. Mainly synthetic pesticides have been used to combat pest menace in agriculture and public health. Pesticides have of course played a commendable role in increasing our food production and protecting us against disease vectors. However sole reliance on pesticides has created several problems such as development of resistant pests, pest outbreaks, mortality of beneficial organisms, adverse effect on human health and environmental degradation. Adverse effects of pesticides prompted scientists to look for safer and environment friendly methods of pest control and consequently concept of integrated pest management came in to being. Integrated Pest management is known as an ecological approach to tackle pest problems, because here emphasis is on containing pests in such a way that other biotic components of the system such as natural enemies, human beings and wild life etc. are not harmed and environment is preserved in general. Pest management works on the premise that all pest population levels are not injurious to crops and crops can always compensate for certain injury due to pests. Moreover some pest population is always required for the survival of natural enemies of the pests. This has given rise to the concept of economic injury level (EIL), which helps to avoid unwarranted application of control measures. The EIL based application of control measures ensures favourable cost-benefit ratio to farmers.

Pest management also underlines that pest control tactics should be socially acceptable and within the reach of farmers. It is a holistic approach to pest problems in which we aim to protect our commodities against all the pests and ensure production of healthy crops.

Use of Bio-fertilizers

Bio-fertilizers are ready to use live formulates of such beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity in particular, and help build up the micro-flora and in turn the soil health in general. With the introduction of green revolution technologies the modern agriculture is getting more and more dependent upon the steady supply of synthetic inputs (mainly fertilizers), which are products of fossil fuel (coal+ petroleum). Adverse effects are being noticed due to the excessive and imbalanced use of these synthetic inputs. This situation has led to identifying harmless inputs like bio-fertilizers. Use of such natural products like bio-fertilizers in crop cultivation will help in safeguarding the soil health and also the quality of crop products.

Biogas

Biogas slurry has proved to be high quality organic manure compared to FYM. Digested slurry has more nutrients, because in FYM, the nutrients are lost by volatilization (especially nitrogen) due to exposure to sun (heat) as well as by leaching. When fresh cow dung dries, approximately 30 to 50 per cent of the nitrogen escapes within 10 days. While nitrogen escaping from digested slurry within the same period amounts to only 10 to 15 per cent Therefore, the value of slurry as fertilizer, if used directly in the field as it comes out of the plant, is higher than when it is used after being stored and dried. Cattle dung contains about 1 percent total nitrogen. Ammonia is less likely to leach away and hence more apt to become fixed to exchange particles like clay and humus. Experiments have shown that compared to fresh dung, nitrogen in form of ammonia in the digested slurry increases by 260 per cent whereas it decreases by 17.5 per cent in FYM. Slurry thus has more available free ammonia than that in compost or manure. As a result of anaerobic fermentation, about 30 to 40 per cent of organic carbon present in the dung is decomposed as carbon dioxide and methane. Animal waste causes environmental pollution when applied to land without appropriate controls and management, whereas agronomic utilization of biogas slurry represents the best solution for its reuse. It is obvious that biogas generation is technically feasible through the anaerobic digestion of a variety of organic materials. In developing countries animal and human waste matter are dominant inputs for the production of biogas.

Post-Harvest Technique and Value Addition of Agricultural Produce

India is the second largest producer of fruits and vegetable in the world and Delhi produce a wide range of horticultural crops. They are major sources of important valuable vitamins and minerals. Being highly perishable, fruits and vegetables can be preserved and processed either at farm level or at cottage scale/home scale during market glut season or extra seasonal produce from kitchen garden for later use. Farmers and entrepreneurs can set up their own processing units by adopting simple, low cost innovative processing technologies which will save post-harvest losses of these perishable crops and also give good returns to grower and better earning to processor / entrepreneurs. The Value Addition activities where the fruits and vegetables are processed, fetches higher remunerative prices of the produce. Such opportunities are presently not available in rural areas but could be created through selective mechanization of agriculture and appropriate postharvest management and value addition to the harvested biomass in the production catchments. The agricultural produce involves operations like cleaning, grading, drying, storage, milling, packaging, transport, marketing and utilization.

At the end of each operation, value is added to the product. The lowest and the highest monetary values of a food commodity are respectively, when it is in raw and fresh form and when it is in processed and ready to consume/eat form. Postharvest and food processing technology are commodity and location specific. It prevents avoidable postharvest losses and add value to the fresh agro-produces. It also creates opportunities for employment and income generation. Integration of production agriculture with on-farm primary processing is needed to have sustainable production, higher productivity and better quality end products for domestic and export markets. It would help in reducing rural- urban disparity and ensuring household food and nutritional security for all at an affordable cost.

Apiculture

Beekeeping has emerged an important employment generation vocation, especially for landless youth because for this dedicated land is not required. The bee hives can be kept at the side of road, canal, bare lands and bunds of fields. It can be started with 20 bee colony at a cost of Rs. 5,000 per colony. The equipment honey extractor, hive tool, uncapping tray and knife are easily available and are cheaper. Beekeeping is a decentralized, forest and rural agriculture based industry, which requires very less raw material. The raw material needed is in the form of nectar and pollen, which is freely available from flowers in nature. Bee hives neither demand additional land space nor do they compete with agriculture or animal husbandry for any input. The beekeeper only needs to spare a few hours in a week to look after his bee colonies. Beekeeping is therefore ideally suited to him as a part time occupation. Beekeeping constitutes a resource of sustainable income generation to the rural and tribal farmers. It also provides them valuable nutrition in the form of honey. However, in addition to honey, production of bees wax, propolis, pollen, royal jelly, pedigree queen bees, package bees and renting out honey bee colonies for crop pollination are some of the potential areas of apicultural diversification in India. Beekeeping, with large bees as well as meliponiculture – the rearing of small/lesser bees, has tremendous scope for development of ancillary industries and its untapped potential remains to be explored for increasing opportunities for gainful employment and income in rural areas. Each insect species has its own role in the ecosystem and its loss could affect the complexities and abundance of other organisms. All these are possible only with a proper management of bees, utilization of the local plant resources and adapting to the local climatic conditions. Honey bees, apart from yielding honey and wax, and acting as pollinators, also yield valuable products like, royal jelly, bee pollen, propolis and bee venom having nutritional

/ medicinal values.

The training facilities are available and Krishi Vigyan Kendra, Ujwa free of charges. Along a good crop of honey, other bee products like bee wax, bee venom, pollen and royal jelly can be prepared and sold. With very little expenditure from 20 colony unit one can secure about 2 lakh rupees per year. By bee keeping it has also been observed be that crop yield is increased by 15 to 20 percent through cross pollination by honey bees. Honey is easily sold in the market, fairs, exhibitions and also at road side. The processing of honey is not a very complicated job and processed honey fetches a very good price.

Commercialized Mushroom Cultivation

Mushrooms are fleshy fungi constituting a purely vegetarian diet, which is very tasty and nutritious. Some mushrooms are edible whereas others are poisonous. So far more than 1600 types of mushrooms are known of which, nearly 100 have been accepted as food worldwide. Diversification in any farming system imparts sustainability. Mushrooms are one such component that not only impart diversification but also help in addressing the problems of quality food, health and environment related issues. One of the major areas that can contribute towards goal of conservation of natural resources as well as increased productivity by recycling of agro-wastes including agro-industrial waste. Utilizing these wastes for growing mushrooms can enhance income and impart higher level of sustainability. Mushroom cultivation activities can play an important role in supporting the local economy by contributing to subsistence food security, nutrition, and medicine; generating additional employment and income through local, regional and national trade; and offering opportunities for processing enterprises. It can be taken up by small and marginal farmers as land requirement is very less.

Dairy Farming

Amongst agricultural commodities milk is the single largest contributor to gross value of output followed by paddy, wheat, oilseeds, pulse and sugar. It is not only that, milk is also least contributor to inflation. Thus it can be said that milk is the lifeline of Indian economy. Dairy farming has always been a sub-system of agriculture in such household units which entirely depends on the recyclable crop residues. Moreover the milk production system has been mainly confined to landless labourers, small and marginal farmers. Their poor socio-economic condition, religious sentiments for cattle and utilitarian attitude towards dairy farming coupled with poor milk production potential of dairy animals has remained a major impediment in the overall development of the system. Livestock is an important source of supplementary income. Mixed farming has been serving as an insurance against natural calamities, while supporting food security and nutrient recycling. Profitability of a dairy enterprise can significantly be increased if a dairy farmer knows the art of combining ideas, facilities, processes, materials and labour for optimum production from dairy animals and proper marketing of the produce. A successful dairy farmer should plan, organize, coordinate, direct and control all his resources by deciding what to do, how to do it and when. For correct decision-making he should be well informed about all kinds of information affecting his dairy business. Dairy farming therefore, could be an important vocation for rural youth.

Delhi had around 1,62,000 buffaloes and around 86,000 cattle as per 19th Livestock census of 2012 (see Table 13). Generally, farmers in Delhi are rearing 2-3 animals particularly buffaloes for milk for their home consumption. It can be upscaled on commercial basis to increase their income. The training facility for dairy farming is available at KVK Ujwa of Nazafgarh block. A dairy unit of 20 animals (buffaloes /Cows or both) is viable. A farmer can earn about 5-6 lakhs per year from the unit. For establishment the dairy unit of 20 animals a shed measuring 20x 100 square feet will be required along with a store for straw and concentrate. Source of clean drinking water is must. The Murrah buffaloes are available at Rohtak, Jind and Hissar while crossbred cows are available at Karnal, Patiala and Jaipur area. Generally, one buffalo or cow is costing about Rs. 70,000 to1.00 Lakh. The Government of Delhi should support the farmers by providing subsidy on the loan. Different banks may provide loans to the rural youth in starting the Dairy unit as different locations. It is recommended that animals should get balanced feed having dry, green fodder and concentrate along with essential minerals to produce milk at full capacity. Animal should be dewormed and vaccinated against important diseases. A good dairy management is always required. A farmer should utilize animal dung for Vermicomposting and Biogas production by establishment of both units near dairy farm. By selling milk directly to the consumer he can get good prices or he can process the milk and milk products by utilizing the biogas he gets from his biogas plants.

Piggery

It is one of the potential enterprises for rural unemployed youth of Delhi due to availability of the market. Delhi has 76000 pigs as per 19th Livestock census of 2012. A youth can rear 20 females and 2 male pigs of Large White Yorkshire breed. By maintaining the unit, he can earn 2.5 lakhs rupees per year. It is also suggested that Govt. may help the rural youth by providing bank loan on low interest rate and subsidy on the loan as per policy. The training facility is available at Krishi Vigyan Kendra, Ujwa.

To establish piggery unit of 22 pigs, a shed is to be constructed with facility of source of clean water. The animals are available in Ambala and Karnal area. One Large White Yorkshire breed animal costs around Rs. 30,000.00. For feeding the pigs, food wastes from either hotel or hostel is very economical. The pigs must be dewormed and vaccinated regularly against Swine Fever, F.M.D. & H.S. Good management practice, particularly cleaning of sheds is must. The animals should the cared well during inclement weather and farrowing (birth of piglets) of sow must be done carefully.

Poultry

Poultry farming, especially broiler farming is another profitable enterprise through which the farmers can get regular income by selling birds at the age of 6 weeks. It has been observed that if 5000 birds are reared an income of rupees 1.5 lakh to 2 lakhs per annum could be secured. Delhi has 44,000 total poultry as per 19th Livestock census of 2012. In CY 2016, demand is up and average egg prices in Delhi markets from January-October were $ 5.53 per 100 unit (Rs.366.42 as per the exchange rate of 31st March, 2016), an increase of about 19 per cent in comparison to the same period last year. The vocation may be done by farmers also as subsidiary enterprise. The farmer should start poultry farming, especially broiler poultry farming is another profitable enterprise through which the farming after proper training which is available at KVK, Ujwa free of charges. There is a market at Gazipur for selling the birds. The Government of Delhi may help the rural youth by giving subsidy on the bank loan for starting the poultry unit. For maintaining a poultry unit of 5000 birds, a poultry shed having floor space of 1 square feet per bird is required. The birds are reared on deep liter system. The bird should get sufficient number of feeder and water dispenser. All equipment should be washed and cleaned regularly. The diet should be provided as per recommendation having yellow maize, wheat bran, cakes, marble chips, bone meal, mineral mixture and vitamins for proper growth. The birds are vaccinated against Ranikhet disease at hatchery.

Fisheries

Fisheries can be a boon to the rural youth were natural ponds are available. In these ponds different species of fishes like common carps along with indigenous breeds e.g. Mrigal, Catla, Kalabasu and Rohu can be easily reared. Some farmers can also rear prawn. The fishery can also be started by digging fish ponds for which the Government can help these farmers by providing financial help through bank. The training of fish farming is available at Krishi Vigyan Kendra, Ujwa. Delhi has its past record of fish production of 0.61 thousand MT in 2008 to 0.68-0.71 thousand MT in 2015 with ups and downs like 0.82 thousand MT and 0.69 thousand MT in the years in between. Projection of fish production in 2017 was 0.71 thousand MT.

Delhi has 150 km of river and canal front. The Delhi government has identified 24 water bodies for auction, suitable for fish farming. The Fisheries Unit has consistently been encouraging fish culture in the water bodies and village ponds of the national capital to overcome the problem of encroachment on such water bodies situated on gram sabha land. Under the provision of Delhi Land Reforms Act, 1954, Gram Panchayat has to develop activities such as poultry farming and fishery. The Fisheries Unit has produced 18.25 lakh fish seeds and 680 metric tonnes of fish this year, according to Delhi government data. It has 15 nursery ponds covering a total water area of about two acres, wherein the unit produces and procures fish seed, rears them to fry and fingerling size and stocks in public and private waters. The unit also leases out specific water portions for fishing every year under rules and regulations laid down in Indian Fisheries Act 1897 and Fisheries Act 1914.

Domestic waste water could be used for fish culture as initially done in East Kolkata wetlands. According to Central Institute of Freshwater Aquaculture, the east Kolkata wetlands provide a living for some 50,000 cultivators and fish traders, most of them small-time private entrepreneurs who earn an income rearing 10,000 tonnes of wastewater-fed fish a year. The method is followed in many Indian cities as well as many countries. Preliminary treatment done or not, insolation breaks down the pollutants and subsequent heavy plankton growth leads to ample food supply for fishes leading to exponential growth of fish.

Vermicompost production:

Vermicompost is an organic manure (bio-fertilizer) produced as the vermicompost by earth worm feeding on biological waste material; plant residues. This compost is an odourless, clean, organic material containing adequate quantities of N, P, K and several micronutrients essential for plant growth. Vermicompost is a preferred nutrient source for organic farming. It is eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product. It is an environment friendly technology.

a) Small-scale or home systems

Such systems usually use kitchen and garden waste, using "earthworms and other microorganisms to digest organic wastes, such as kitchen scraps". This includes:

- All fruits and vegetables (excluding citrus and other "high acid" foods)
- Vegetable and fruit peels and ends
- Grains such as bread, cracker and cereal (including mouldy and stale)
- Eggshells (rinsed off)
- Leaves and grass clippings (not sprayed with pesticides)
- Newspapers (most inks used in newspapers are not toxic)

b) Large-scale or commercial composting

Such vermicomposting systems need reliable sources of large quantities of food. Systems presently operating use: Dairy cow or pig manure; Sewage sludge; Agricultural waste; Food processing and grocery waste; Grass clippings and wood chips

Watershed Management:

The watershed management implies, the judicious use of all the resources i.e. land, water, vegetation in an area for providing an answer to alleviate drought, absorbs the effect of flood, prevent soil erosion, improve water availability and increase food, fodder, fuel and fibre on sustained basis. The task of watershed management includes the treatment of land by using most suitable biological and engineering measures in such a manner that, the management work must be economic and socially acceptable. Rainwater harvesting means collection and storage of rainwater by some mechanism to make water available for future use. An appreciable amount of precipitation, which is generally lost as surface flow, can be harvested and stored for useful purposes like drinking and providing supplemental irrigation to the crops.

In many areas, the brief monsoon season brings with it an abundance of water. However, this water is wasted and there is an acute shortage of water during the rest of the year when it is conducive to cultivate high-value vegetable crops and horticulture, especially when these crops fetch a remunerative price.

Agroforestry:

Agroforestry is an effective land use system which contributes to food, nutritional and environmental security. Beside its multifarious use as food, fuel, fodder, fiber, medicine and timber, it enables smallholder farmers to optimize their land use. Also agroforestry has significant potential to provide employment and additional income to farmers.

In the context of climate change, agroforestry helps in mitigating the same through microclimatic modification and carbon sequestration. Towards landscape management, agroforestry plays an important role in reducing greenhouse gas (GHS) emissions and acts as an effective means of environmental services. In fact, agroforestry can help in achieving resilience in agriculture while addressing effectively the threat of climate change.

Given the fact that land-holding size is shrinking, tree farming combined with agriculture is perhaps the only way forward to optimize farm productivity and thus, enhance livelihood opportunities of smallholder farmers, landless laborers and the women farmers by creating employment opportunities and additional income.

Handicrafts industry

Delhi is a city full of skilled artisans, who are proficient in handicrafts of the city. Shahjanabad, which we today know as Old Delhi, possesses a rich heritage of handicrafts. Rural youth may empower with the handicraft items from the agricultural sources as furnishing as well as for industrial purposes. Sculpture is a very popular craft since ancient times. It is the craft of shaping figures out of materials such as clay and wood. Pottery can be taken as enterprise. India Handmade Bazaar is a direct marketing portal for handicrafts and handlooms products.

Agri-tourism or Agricultural tourism

Agri-tourism is defined as “travel which combines agricultural or rural settings with products of agricultural operations, all within a tourism experience or a range of activities, services and amenities provided by farmers” or “innovative income generating activity for enterprising farmers”. Agro-tourism is an innovative agricultural activity related to tourism and agriculture both. Agri-tourism is the form of rural tourism which involves a combination of education and recreation of the tourists at a working farm by engaging them in to observation, demonstration and participation in farm activities and various allied activities offered in the farm setup. There is a huge scope and potential for agri-tourism in Delhi and increasing number of foreign and domestic tourists create an opportunity for this new farm diversification or additional source of income for farmers and other participants. Any individual farmer can start agro-tourism who has minimum two hectares land, farm house, water resource and is interested to entertain the tourists. Apart from the individual farmer, agricultural co-operatives society, Non-government organizations, may start. Even Gram Panchayats can start such centers in their operational areas with the help of villagers and farmers. Criteria those are considered during location identification-near to water source, away from polluted environment, better connectivity, natural site, historical importance, agricultural prosperity, etc.

Aeroponics

It is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium (known as geoponics). Plants are grown in such a medium where roots penetrate and hang in a mist chamber. Regular sprays of water and nutrients go on in mist form on the basis of reports of sensors fitted inside the chamber. It is a fine example of precision farming which saves space and resources. The method requires no substrate and entails growing plants with their roots suspended in a deep air or growth chamber with the roots periodically wetted with a fine mist of atomized nutrients. Excellent aeration is the main advantage of aeroponics. Aeroponic techniques have proven to be commercially successful for propagation, seed germination, seed potato production, tomato production, leaf crops, and micro-greens. Primarily, it was used in dry regions of the world, now becoming popular in urban areas. It is now popular in India, and chance of success is high in populated city like Delhi.

Hydroponics

Hydroponics is the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Terrestrial plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite or gravel. The nutrients in hydroponics can come from an array of different sources; these can include but are not limited to byproduct from fish waste, duck manure, or normal nutrients. It is the modern technology farming in which plant growth and productivity is controlled by water and its nutrients level in the water. In this technique, water is enriched with well-balanced nutrients which are essential for plant growth and better yield. Water level pH will be maintained within the specific range which results in better growth and produce.

Vertical farming

Vertical farming is the practice of producing food and medicine in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures (such as in a skyscraper, used warehouse, or shipping container). The modern ideas of vertical farming use indoor farming techniques and controlled-environment agriculture (CEA) technology, where all environmental factors can be controlled. These facilities utilize artificial control of light, environmental control (humidity, temperature, gases) and fertigation. A vertical farm grows plants and produce in a vertical orientation, maximizing the use of the location's square footage. Most often this is achieved through the use of growing shelves suspended on a wall or fence. Because vertical farming uses so little space, it is a popular and preferred method for roof-top and other urban forms of agriculture.

6.3 Summary and Recommendations

Trade and commerce have played a pivotal role in promoting the growth of Delhi's economy by making a significant contribution in terms of tax revenues and providing gainful employment to a large section of the society. Delhi is the biggest trade and consumption centre in North India. Agricultural produce has a formidable share in this market with the biggest mandi of

Asia is in Delhi. Appropriate steps therefore are to be taken to enable Delhi farmers to take full advantage of the trade.

The following recommendations are proposed to double the income and farmers by increasing the profitability of agricultural and allied activities in Delhi:

- To increase agricultural production, the state needs more irrigation facility. A higher irrigation ratio will facilitate higher crop intensity and will increase production. With the changes in the climatic condition with every passing year, more and more land in the country needs to be covered under irrigation.
- To enhance water use efficiency in the agriculture sector, promotion of appropriate water saving and conservation technologies like drip & sprinkler irrigation technologies and encouragement of farmers to adopt these technologies is essential. There is a need to focus on end-to-end solution in problems of irrigation encompassing water resources, distribution network, efficient farm level applications, extension services on new technologies & information, subsidy and government support to encourage adoption etc. based on comprehensive planning process at district/State level.
- One of the major factors playing a pivotal role in doubling farmers income is the use of high quality seeds and planting materials as these are the critical determinants of agricultural production on which the performance and efficacy of other inputs depends. Sustained increase in agriculture production and increased farmers income necessarily requires continuous development of new and improved varieties of crops and efficient system of supply to farmers.
- There is a need of resource conservation practices like water conservation technologies, energy-saving agriculture, recycling of bio-waste, short duration varieties, integrated practices for input and stress management, etc.
- To facilitate irrigation and running of processing plants, etc., the government needs to effectively and expeditiously implement plans to increase investment to bolster the infrastructure for transmission and distribution of power. In order to ensure an assured supply of electricity for agriculture, high priority needs to be given to feeder separation to supply power to agricultural consumers and to non-agricultural consumers separately. The use of solar technology in power generation also needs to be popularized as an alternative to dependence on power supply from the grid. IARI has developed various solar powered technologies to boost up agriculture and reduce the dependence of electric power.
- There is no government scheme accessible to farmers of Delhi and ATMA scheme is also not being implemented. There is a need to start the ATMA at Delhi State.
- Due to the high perishability and seasonality of the commodities in agriculture and horticulture, proper cold storage is needed for the efficient use of the products. A total of 29 cold storage centers with a capacity of more than 76000 MT is available in Delhi for traders and farmers. Farmers need to be made aware of the post-harvest management techniques to prevent the surplus losses which occur after harvest, during storage, transit

and in other stages of the supply chain. Infrastructure facilities like precooling units, cold stores, refrigerated transportation system, packinghouses, modernized market places needs to be strengthened.

- Capacity building of the farmers on how to access and use the facilities of e- NAM should be done, so that farmers can have ready access to a standardized and regulated Market information system.
- Convergence of Line department with different governmental and nongovernmental organizations situated at Delhi state is of utmost importance.
- The existing infrastructure in the market yards can be strengthened utilizing the subsidy under the scheme for development/strengthening of agricultural marketing infrastructure, grading and standardization. Public and private sector participation is highly solicited for creating structural reforms in agricultural marketing for development of an effective marketing system.
- The farmers of the proposed green belt should be provided with subsidized manure, electricity and all other agro-inputs needed. State of the art agricultural technologies e.g. hydroponics, aeoroponics, green house etc. and requisite trainings are to be given to the farmers.
- Space saving agriculture is to be made mandatory in residential areas near the proposed green belt and farmhouses inside it. The residents of farm houses and nearby housing societies will have a symbiotic relation with the farmers. Raw material as far as possible could be sponsored by the residents and farmers of green belts are to supply seedlings, seed and saplings to those urbanites and housing societies for terrace farming, vertical farming etc. Company or farmers group could be initiated to manage such marketing process.
- All residential colonies and apartments of Delhi, especially those situated near the farmlands should have at least one dedicated Kisan stall operated by farmers.
- No organic manure that is required by various agencies of Delhi should be imported or purchased from other states. Manures from gaushalas, dairy colonies, all sorts of Mandis dealing with edible material and producing mounds of green waste of Delhi are to be produced largely through biogas plants and vermicomposting. The gas from those plants could be used for electricity generation, and could be supplied to the farmers at a subsidized rate. Fish and meat market waste could be fed to duck and duck meat and egg could be a niche market item for many entrepreneurs.
- Segregation of domestic and hotel wastes should be made mandatory for all residential and commercial areas. Green waste material could be converted to manure and power through digesters and manures from gaushalas and waste material could be used in all parks of Delhi and should be supplied to the farmers at a subsidized rate.
- Village youth and unemployed urban youth could be motivated and trained in the waste management process as mentioned and entrepreneurship development will be a part of the plan.

- Empowerment of women to be done through training in handicraft, value addition to vegetables and other farm produces, bakery units operated by women. Complete training for production and marketing to individuals and women SHG members is to be imparted.
- Farmers are to be trained for grading and sorting, value addition and processing, packaging, tricks of good and attractive packaging needed for smart marketing.
- Allied enterprises like bee keeping, cultivation of baby corn, sweet corn, mushroom, medicinal plants, sericulture could be practiced by interested farmers. Training for profitable farming of the above items are to be imparted to the farmers.
- Custom hiring center to be opened with the help of young entrepreneur or wealthy farmer for all farmers. Various agricultural implements, machineries etc. will be available at these centers. More than one entrepreneur, possibly SHGs/FIGs/Farmers' club will take the initiative to set up the centers.
- Domestic waste water generated by Delhi, the grey water *per se* could be channelized for treatment and that can be utilized for irrigation and fishery as it has been done successfully in east Kolkata wetlands and in many other cities of India.
- Rainwater harvesting could be made mandatory, at least at pilot scale near farmlands of Delhi to supply fresh water in this area of saline water.
- The farmers should take up integrated farming system including various components of crops, apiculture, pisiculture, mushroom cultivation, poultry, dairy, piggery etc. for enhanced returns and reduced cost of cultivation. In addition it will generate steady income and employment for the family round the year along with access to nutritious food.

SUCCESS STORIES

1. Value Addition In Horticulture

Mr. Narendra Tatesar a 42 years old graduate from Tatesar, Delhi is differently abled due to polio myelitis from childhood. He owns 4ha land. After completing his education, he tried his hand in scrap business and faced heavy loss. Disappointed and frustrated, he got a chance to visit a pickle factory of a progressive entrepreneur Mrs. Krishna Yadav and was highly inspired by her success. He got guidance from IARI scientist and acquired pickle making training from KrishiVigyan Kendra, Ujwa. Initially he faced loss of Rs. 2 Lakh when he started pickle making, but after visiting various pickle factories he learnt scientific method of pickle making and established his own brand "Purti Food Vision" and produced pickles of all types), murabba (carrot, aonla), sauce, jam, spices etc. He used Ayurvedic formulations and made medicated pickles, which he sold in premium price. He is participating in various Krishi Melas to popularize his brand. Now-a-days he is also producing pickles on demand for various other companies as per their specifications. He is very much concern about quality of his pickles. The mustard oil he uses is produced on his own field or fields of his relatives. Similarly, he produces most of the spices in his own field to ensure quality. He engaged his all family members, including two sons, son-in-law in pickle making and marketing. He has established pickle factory in Rohtak, Haryana where he has employed 15-16 female labour.

Currently his turn over is approx. Rs. 60 lakhs per annum. His labourers get handsome pay and his view of life is not purely commercial, but for welfare of the society.

2. Value Added Agro Based Product For Ensuring Human Health And Nutritional Security

Mr. Kundan Kumar has established a brand "Tradifo" with product range of 25. The motto of Mr. Kundan Kumar was to create win situation for farmers as well as customers. He is providing good quality healthy food product directly from farmer to customer keeping seed quality, diversity and nutritional facts of the products in mind. His concern has developed technologies to minimize nutritive value during processing. The idea of **Tradifo** (shortened from 'Traditional Food') was conceived to provide healthy, natural and tasty assortment of food products in market while procuring the top quality of non-GMO raw materials sourced from - PGS Organic Council of India certified farms.

Tradifo's parent company KAD Bioresources Pvt. Ltd. was born under India's Premier Agricultural Research Institute commonly known as PUSA Institute under business Incubation program promoting the use of innovative agricultural technology for agriculture based entrepreneurial ventures. Tradifo has also been awarded with seed funds from the Ministry of MSME, Government of India under the scheme of "Support for Entrepreneurial and Managerial Development of SMEs through incubators".

The Company's objective is to add value to agricultural produce through innovation, quality control and technology management in farmers' product. The brand Tradifo is synonymous with highest standards of food processing with procurement of chemical and pesticide free raw materials and no addition of preservatives or artificial flavoring. The mission is to give our farmers a fair share of their hard work and to promote sustainable farming as a social responsibility. Since the Company believes in conservation of nature, a sustainable supply chain for procurement of the raw materials has been adopted. This is aligned with the ideal of providing fresh and essential nutrients to consumers through a sustainable production, procurement and processing system. The products are available at more than 500 counter in Delhi and NCR as well as online platform like Amazon, Tradifo etc. The Company has established its own factory at B-259, Sector 4, Bawana Industrial Area, New Delhi-39 costing more than 40 lakhs.

7

GOA

The state of Goa comprises of two districts with a total geographical area of 3.61 lakh ha. Out of the total area, 35% is under forest and 44% is gross cropped area. The economy of Goa is primarily driven by tourism and mining followed by agriculture, animal husbandry and fisheries activities. Agriculture contributes to 3.74% of state GDP while secondary and tertiary sectors comprising of industries and services contribute to 80% of the GDP.

The two districts of Goa fall under agro-ecological region 19. Western Ghats and Coastal Plain, hot humid-perhumid eco-region (E2BA5). Further, there are two agro-ecological sub regions - 19.2. Goa, being in the tropical zone and near the Arabian Sea, has a hot and humid climate for most of the year with moderate temperature variation between 17 to 35°C. The month of May is the hottest, seeing day temperatures of over 35°C coupled with high humidity. The monsoon rains arrive by early June and provide a much-needed respite from the heat. Goa receives heavy precipitation (2500 to 3200 mm) and most of its annual rainfall is received through the South West monsoon which last till late September. Soils of Goa are mostly laterite (red coloured) with acidic soil reaction. The soils are rice soil organic carbon, deficient in soil available nitrogen, potassium, calcium, magnesium, zinc and boron and medium to sufficient in soil available potassium, iron, manganese, copper. The soils often have poor water holding capacity. Typical agricultural areas in the State are upland and lowland. The coastal saline soils (locally called Khazan) is spread over about 18000 ha area.

The major food crops grown in the state are paddy, cereals, pulses, oilseeds, sugarcane and vegetables. The important horticultural crops of the state are cashewnut, coconut, arecanut, mango, banana, pineapple and spices. Fishing is another important activity covering mainly marine fisheries. Inland fisheries are becoming popular considering the growing demand. The milk production is not sufficient to cater to the demand and is imported from neighbouring states. As such, there is good scope for animal husbandry activities. Community dairy scheme introduced by the State Govt. for large scale integrated dairy development is expected to give a big boost for the dairy sector.

The marginal or small farmers of the region have very limited land which is getting further fragmented with each generation and therefore farm enterprises requiring less land but higher productivity and employment opportunities, needed to be integrated with crop production. A judicious mix of one or more intercrops along with the main crop has a complimentary effect through effective recycling of wastes and crop residues and encompasses additional source of income to the farmers. These systems are often less risky, if managed efficiently, they benefit from synergisms among the crops, diversity in produce, and environmental soundness. Further, integration of allied enterprises in the system adds profitability and stability with intermittent returns through better recycling of resources.

7.1 Productivity Gaps and Major Constraints

- Unavailability of quality seed and planting material of paddy, cashew, coconut and other important crops
- High labour cost and unavailability of harvesters in coconut and other areas of agriculture
- Wild animal menace in agriculture is important and major problem in Goa
- Lack of cold storage and warehouses, small scale paddy processing units
- There is a wide gap between demand and production of milk, meat and eggs in Goa which is currently depends on neighbouring states.
- Unavailability of quality feed and fodder for dairy sector
- Lack of ccapacity building of farmers, youth, field veterinarians about improved animal husbandry practices
- Presently, there is an acute shortage of Field Veterinarians and Veterinary Assistants at all field establishments which limit better veterinary services to the farmers.
- Unavailability of labour in poultry, dairy and other animal husbandry sectors
- Lack of slaughter houses/meat processing units for small animals (goats, pigs and poultry) for meat production and value addition.
- Unavailability of quality seeds in fisheries sector is a major concern. Besides, storage facilities, lack of awareness about advanced technologies, lack of proper marketing chain and facilities are also matter of concern.
- Establishment of coastal zone coordination agriculture committee minimum support price
- Lack of coordination among different government departments.
- Facility /data of *kisan card* should be made valid for availing all the schemes of development departments to get support in terms of subsidy/support price etc.
- Farmers also expressed issues like capacity building of weaker sections, attracting youths to agriculture, and publications of success stories, providing agriculture inputs and providing facilities for by products processing.

7.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

Strategies:

i. Productivity improvement in crops

ii. Crop Diversification, Intensification and Integrated Farming System (IFS) approaches

(Integration of potential crops, animal and fishery) and advanced management practices like nutrient management and plant protection measures

iii. Production improvement in animal and fishery sector

iv. Mechanization in agriculture and allied activities

v. Creating value chain-supply network by Post-Harvest management and Value addition

1. Productivity improvement in crops

Crops	Strategies	Action plan				
		2017-18	2018-19	2019-20	2020-21	2021-22
Paddy	Introduction of High Yielding Varieties (HYV): Area coverage in %	10	20	30	40	50
	Increasing the Seed Replacement of Ratio (SRR) of existing popular varieties-SRR rate in %	20	40	60	80	100
	System of Rice Intensification (SRI)- Area expansion in %	5	10	15	20	25
	Certified seed production of HYV as an enterprise-Quantity in quintal (q)	20	50	100	200	500

Crops	Strategies	Action plan				
		2017-18	2018-19	2019-20	2020-21	2021-22
Cashew	Replacement of senile plantation with HYV (% area to be covered)	5	10	20	30	40
	Nutrient management (INM and IPM) in cashew. (% area to be covered)	5	10	20	30	50
	High density planting of HYV (Area in hectares)	5	10	20	30	40
Mango	Creation of new orchards of improved local verities by high density planting (Area in hectares)	5	10	20	30	40
Coconut	Introduction of Dwarf – HYV in coconut (Area in hectares)	10	20	30	40	50
	Inter cropping management – Forage / Spices / Fruits / Floriculture (Area in hectares)	10	20	30	40	50

2. Crop Diversification, Intensification and Integrated Farming System (IFS) approaches (Integration of potential crops, animal and fishery) and advanced management practices like nutrient management and plant protection measures

Crops	Strategies	Action plan				
		2017-18	2018-19	2019-20	2020-21	2021-22
Utilization of rice fallow lands for pulses like cowpea, green gram (Mung) & Ground nut (Area in hectares)	Area expansion under paddy fallow lands	2000	5000	8000	10000	12000
Vegetables	Introduction of varieties along with production and protection technologies (area in hectares)	50	100	150	200	250
High value Horticultural crops and spices	Introduction of varieties along with production and protection technologies (area in hectares)	50	100	200	300	500
Creating models of IFS in farmer filed with different components (in numbers)	IFS models in South and North Goa with best components	10	15	20	25	30

3. Production improvement in animal and fishery sector

(I) Dairy sector

A. Area expansion under green fodder production.

Green fodder production

Area expansion of green fodder cultivation through extension activities and schemes

Advance technology like Hydroponic fodder for landless farmers

Demonstration and establishing models in field

B. Breeding policy.

i. Introduction of exotic germplasm through AI not exceeding 50% genetic makeup

ii. For high yielding, crossbred dairy cattle may be promoted but not exceeding exotic blood level more than 50%. Replacement of stock at least 10 % with units can improve the production.

iii. Introduction and conservation of Indigenous breeds: In the scenario of climate change it is very much essential to identify and conserve local germplasm of cattle suited for local coastal climate. Through selective breeding and purifying local breed development is essential. The indigenous high yielding breeds of Indian continent also needs to be introduced as per requirement of farmers.

iv. Community Dairy Farming: For creating self-employment and to engage youth in dairy farming community dairy farming concept will be useful.

v. Organization of cattle markets for facilitating sale/purchase of high quality breeding animals of farmers among themselves.

Dairy cattle

Introduction of exotic germplasm through AI not exceeding 50% genetic makeup (number of crossbreeds)

Introduction of indigenous breeds: Gir, Sahiwal and Red Sindhi (Number of cows)

Community dairy farming (numbers)

Cattle markets (each in district)

C. Meat

vi. Introduction of improved breeds in Goats, Pig, Poultry.

vii. Slaughter house and meat processing units for small animals.

viii. Strengthening the veterinary services.

Goat

Introduction of coastal goat breeds (Konkan Kanyal) under stall feeding (number of breeding units in farmer’s field and govt.\units)

Pig

Introduction and conservation of indigenous and cross breed pigs (number of pigs)

Poultry

Improvement in backyard poultry and coloured broilers for meat and egg production (Number of poultry)

4. Mechanization in agriculture and allied activities

Mechanisation of Land preparation, planting and harvesting (Area covered in %)

Mechanization in coconut harvesting (Area covered in %)

5. Creating value chain-supply network by Post-Harvest management and Value addition

Paddy

Establishment of community agro- processing centres (in numbers)

Establishment and promotion of storage structures

Coconut

Establishment of processing units for virgin coconut oil and other products (in numbers)

Cashew

Cashew apple value addition including feni

Cashewnut value addition

Other fruits/crops

Establishment of community multi product processing plants for value addition of Kokum, Jackfruit, Breadfruit, Jagoma, Wax Apple, Jamun Karonda, star fruits, etc. (in numbers)

Dairy and meat products

Establishment of units for value addition in Dairy milk products and pork and mutton products(in numbers)

Fisheries sector:

- There is a wide scope to improve the income and livelihood of fishermen through diversification of fish species to increase stock density, better availability of the fish seeds, promotion of mussel farming, capacity building and awareness creation, etc.
- Improved storage facilities – cold ice plants, insulate vehicles, etc can also play an important role for marketing of the fish catch.
- Development of integrated farming systems with fishery as an important enterprise can ensure regular income and improved production.
- Post-harvest handling, value addition, allied activities like ornamental fish farming also have potential to contribute to improvement in income.
- Iimproved technologies like cage culture technology, satellite hatcheries for raising cultures can help farmers to increase their fish catch.
- Providing subsidized cages and ensuring timely and adequate supply of fish seeds to the farmers are essential to boost farmer's income.
- Fish production strategies like diversification of inland fish production through new finfish species and methodologies and promotion of ornamental fish culture through self-help groups

Potential contribution to farmers income and strategy for scaling out these technology (Technology information/packages validated/successfully demonstrated be included as examples to be replicated in different agro ecologies)

Technologies/packages validated by ICAR-CCARI, Goa

S. No.	Technology Title	Brief Description
1.	Soil and Water Conservation technologies on Sloping Land for fruit and plantation crops	In cashew, Continuous contour trenches with *Stylosanthes scabra* and *Vetiveria zizanioides* reduced runoff by 44.5% under 4 m × 4 m spacing.
2	Biological control for plant health management in Coastal regions.	❖ Application of talc formulation of bacterial antagonists in nursery (50g/m^2) and while planting (1.25g/plant) reduced the incidence of bacterial wilt in brinjal. ❖ Application of talc formulation of *Trichoderma* to the seedlings (1.25g/plant) reduced the incidence of Fusarial wilt in watermelon. ❖ Application of talc formulation of bacterial antagonists and *Trichoderma* during planting (50g/plant/year) reduced the incidence of foot rot in black pepper. ❖ Application of talc formulation of bacterial antagonists in nursery (50g/m^2) and while planting (1.25g/plant) reduced the incidence of soil borne diseases in chilli. ❖ Application of bio agents improved the growth and increased the yield in the above crops.
3	Heliconia as intercrop in coconut makes coconut farming more profitable in Goa	Heliconia- an exotic introduced flower crop performed extremely well under coconut plantation for three years. The study included 45 varieties of heliconia under coconut garden for various vegetative and floral characters. The flowers were supplied to the market and the feedback from the market is documented to short list the most promising heliconia types with high floral value.
4	Turmeric production Technology for Goa	Improved turmeric varieties were introduced, evaluated and standardized commercial production under Agro-climatic conditions of Goa which eventually resulted in recommendation of improved varieties like Prabha, Pratibha, Kedaram, Alleppey and Megha turmeric -1 for commercial production. Production technology is standardized. This technology is now taking off in the state of Goa both as pure crop and also as intercrop in cashew and coconut plantations.

S. No.	Technology Title	Brief Description
5	STFR Goa – Soil test based fertilizer recommendations Goa: An online web portal to prescribe fertilizer recommendations to major crops of Goa (Online use) Fertilizer calculator Goa: An android app to prescribe fertilizer recommendations to major crops of Goa (Offline use)	❖ Information on the economic use of the costly agricultural input i.e. fertilizers and balanced fertilization to the crops. ❖ Improved productivity of crops, higher net income to the farmer and maintenance of the soil fertility in a long run.
6	Cross breed pig production technology	❖ Crossbred pigs known for better adoptability, faster growth, early maturity and better returns for the pig grower. ❖ Accordingly, crossbred pig was produced by crossing Agonda Goan female with Large White Yorkshire male. ❖ These crossbred pigs have better growth rate and feed conversion efficiency. They do not require intensive care like pure exotic breed like Large white Yorkshire. ❖ This pig has better growth well adoptability for coastal climate. It can achieve up to 85kg body weight by 10 months age.
7	Artificial Insemination in pigs	Artificial Insemination in pigs boosted pig production in farmers' field with conception rate of 55% with higher number of births per elite boar. Crossbred pig population was increased by 15% as farmers have adopted the technology with the production of 12,000 piglets gaining 40 kg extra body weight resulted in 480 tons of additional pork production, which generated of Rs. 9.6 crores covering Goa and adjoining coastal areas of Maharashtra and Karnataka
8	Introduction of konkan kanyal goats for goat production	❖ KonkanKanyal goat is a meat type breed adapted to high rainfall, hot and humid climatic conditions of Goa ❖ The twinning percentage up to 90% ❖ Birth weight of male kids ranged from 2.8-3.2 kg and female kids from 2.4 to 2.8 kg. ❖ At 8-month age, the female goats weighed 32.36 kg and females weighs 36.43 kg.

S. No.	Technology Title	Brief Description
9	Hydroponic fodder production	Hydroponics green fodder - Green fodders produced by growing seeds without soil. Hydroponics green fodder is mostly produced in commercial unit. Concept of Low cost Hydroponics Green Fodder Production Unit was attempted and popularized among farmers and inbuilt with a greenhouse (for growth of fodder) and a control unit, (for regulation of light, temperature, humidity and water) for optimum growth of fodder. It was also tried in farmers field KVK North Goa.
10	Bypass fat technology	❖ Bypass fat (Ca-LCFA) is prepared by treating vegetable (palm/ rice bran) fatty acid oil, the by-product of the oil refinery industry and technical grade calcium hydroxide/calcium oxide under specific conditions. ❖ The indigenously prepared bypassfat contains about 70-75% fat and7-8% calcium. The indigenously prepared bypass fat is kept in air tight container in cool place after mixing with butylatedhydroxy toluene @ 0.05% asan antioxidant. ❖ Supplementation of the indigenously prepared bypass fat @ 15-20 g/ kg milk production increases the milk yield up to 20% giving an additional profit of approximately Rs 10-30/ animal/ day.

Technologies from ICAR-DCR, Puttur (Karnataka) for the state of Goa

S. No.	Technology Title	Brief description
1.	Ultra high density planting	Planting of cashew under ultra density planting technique (3 m x 3 m or 2.5 m x 2.5 m) 400 to 600 plants per by super imposing regular productive pruning using selected cashew varieties such as VRI-3, Ullal-1, NRCC Sel-2 and hybrid H-130 has been successfully demonstrated in farmers field. About 3-4 tones of nut yield per ha can be harvested in the early stage of orchard life from ultra high density orchards. These technologies are package intensive and are more successful in hilly terrains of coastal and malnad tracts.
2.	Intercropping in cashew	In the high rainfall zones and also in the regions of availability of irrigation facilities, intercrops such as locally important marketable vegetables, pulses and medicinal plants can be grown as intercrops in widely spaced cashew plantations in the initial years of cashew crop. The suitability of season and type of intercrops is a most critical factor.
3.	High yielding varieties/ hybrids	Till date, 43 high yielding cashew varieties have been released and recommended for cultivation. Of these, regionally suitable varieties can be grown successfully in different zones. A few hybrids viz., H-130, H-126, H-32/4 and NRC 493, NRC 301 with big apple and bold nut are under evaluation and in pipeline for release. Most of these are very high yielding (20-30%) and with premium kernel grade recovery (W 110 to W 180).

S. No.	Technology Title	Brief description
4.	Value added products	Protocols for the products from cashew apple such as cashew apple juice (RTS), jelly, jam, halwa and cider (low alcoholic beverage) have been standardized and market acceptability is being evaluated. This activity ensures effective utilization of cashew apple which is presently going waste, and will enhance the total income from cashew orchards.
5.	Homestead cashew processing units	Presently, the cashew farmers sell their produce to major processors at a lower price. In case they themselves adopt small scale processing the overall returns will be much higher. Further the retail rural economy will get a boost.
5.	Converting wastelands into cashew orchards.	The existing wastelands can be converted into cashew plantations through appropriate soil management practices. By this effective land utilization can be achieved and additional quantity of raw nut targeted can be obtained to meet the local processing needs of the nation.

Technologies from ICAR-CPCRI, Kasaragod, Kerala for the state of Goa

S. No.	Technology Title	Brief Description (not more than 200 words)
1.	Kalparasa (neera) tapping and its processing into value addition	Tapping of phloem sap from the coconut spadix with the use of 'coco-sap chiller' developed by ICAR-CPCRI not only collects the sap unfermented but also hygienic. It is a sweet, delicious and nutritive sap and as such can be sold as health drink. Further it can be processed into various value added products like coconut sugar, jaggery, syrup or concentrate which are in great demand both domestically and internationally.
2.	Virgin coconut oil – Hot and fermentation process	VCO is obtained from fresh and mature coconut by mechanical or natural means, with or without use of heat, no chemical refining, bleaching or de odorizing and maintains the natural aroma and nutrients. Fully matured 11-12 months old coconut is selected for VCO production. The VCO production process involves dehusking, deshelling, testa removing, blanching, pulverizing, milk expelling, cooking / fermentation, filtering and packaging. ICAR-CPCRI has standardized the process technology and developed the machineries for the production of both hot and fermentation process VCO. It has also developed the technology for the value addition of by-products such as mature coconut water (converted into vinegar, jelly, RTE squash etc.), testa (bakery and confectionary products), coconut milk residue and VCO cake (used in bakery, confectionary and extrudate products). About 35 entrepreneurs had adopted CPCRI VCO technology till now.
3.	Coconut chips	Coconut chips are crunchy, crispy and healthy snack food in place of present day junk food. It is rich in protein, fibre and anti oxidant compounds. 8-9 months old coconut is selected for chips production. The process involves dehusking, deshelling, testa removing, slicing, blanching, osmotic dehydration, drying and packaging. ICAR-CPCRI has standardized the process technology for the production of different varieties of coconut chips.

S. No.	Technology Title	Brief Description (not more than 200 words)
4.	Tender coconut processing machineries (Tender coconut punch and cutter & Snowball tender nut machine)	ICAR-CPCRI has developed a simple tender nut punch and cutter to make hole in the tender nut and cut open the nut after drinking water. This will avoid the present day drudgery practice. ICAR-CPCRI has also developed snow ball tender nut machine to serve the tender nut in the form of ball with water intact after removing the shell.

Technologies from ICAR-IISR, Kozhikode for the state of Goa

S. No.	Technology Title	Brief Description (not more than 200 words)
1.	Black pepper variety – IISR Shakthi	An open pollinated progeny of cultivar Perambramundi. Tolerant to quick wilt disease caused by *Phyophthora.* Mean yield (dry) (kg/ha): 2253 with a dry recovery 43.0%. Piperine 3.3%, oleoresin 10.2%, essential oil 3.7%.
2.	Black pepper variety – IISR Thevam	A selection from the germplam. Mean yield (dry) (kg/ha): 2481, with dry recovery 32.5%. Field tolerant to Quick wilt disease caused by *Phytophthora*. Piperine 1.6%, oleoresin 8.15%, essential oil 3.1%.
3.	Ginger variety – IISR Varada	A good quality and high yielding ginger variety with bold rhizomes. Average yield of 22.6 t/ha. Dry recovery of 20.7%. The variety has 3.9-4.5% crude fibre, 6.7% oleoresin and 1.8% oil. The variety is ideally suited for fresh ginger, dry ginger and ginger candy. Crop duration 200 days.
4.	Turmeric variety – IISR Pragathi	High yield potential variety of turmeric, short duration (180 days), tolerant to root-knot nematodes, high yield (35 t/ha) and curcumin content of 5%
5.	Turmeric variety – IISR Prathiba	A high yielding turmeric variety is developed through open pollinated progeny selection. It is a high yielding (39.12 t/ha fresh rhizomes) with reddish yellow coloured rhizome and dry recovery of 18.5%. This variety has curcumin 6.2%, oleoresin 16.2% and essential oil 6.2%. Crop duration 225 days. A stable yielder across India for high dry yield and high curcumin content.
6.	Nutmeg variety – IISR Keralashree	A high yielding nutmeg variety developed through farmer's participatory breeding programme. This variety has bold nuts with entire and thick reddish mace. Economic yield starts from 5 years and yields 7500 kg nuts and 1512 kg mace /ha at 10th year with 35% and 70% mace and nut recovery. It has a nut oil 5.9%, mace oil 7.5%, oleoresin in nut 9.1% & mace 7.5%, nut butter 24.9%, myristicin in nut 1.6%, mace 9.4%.
7.	Nutmeg variety – Konkan Sugandha	Bisexual variety of nutmeg which reduces the requirement of planting male and female trees for pollination. High yielding tree (526 fruits/ tree) adapted to Konkan region.
8.	Cinnamon variety - PPI (C)-1	High oil recovery from the bark (2.9%) and leaf oil recovery of 3.3%, bark oil 2.9%, leaf oil 3.3%, and bark recovery 34.22%. Suitable for an altitude range of 100-500 m MSL.

S. No.	Technology Title	Brief Description (not more than 200 words)
9.	Ginger and turmeric pro tray technology	Rapid multiplication of ginger & turmeric using single bud rhizome saves one third of the required seed material.
10	Plant growth promoting rhizobacteria (PGPR) for black pepper and ginger	There are eco-friendly PGPR formulations specific to black pepper and ginger available in biocapsule formulations. It reduces chemical fertilizer application rate by 25% and enhances tolerance to diseases. Recommended as soil drenching or mixing with organic base (FYM) and application to spices.
11.	*Trichoderma harzianum* IISR-P26, a promising biocontrol agent for spice crops	The *Trichoderma harzianum* can be used successfully to manage *Phytophthora*in spice crops. The formulation is recommended for use in Integrated Pest Management as well as under Organic farming system, ensures socio economic and environmental sustainability and compatible with most of the chemical at prescribed dosage.
12.	Crop specific micronutrient mixtures for spices (Black pepper, Ginger, Turmeric)	Recommended @ 5g/L water and applied as foliar spray at 60 days after planting and 90 days after planting for ginger and turmeric; spraying twice in a year at April – May and August – September for black pepper. Increased use efficiency of applied nutrients based on the crop requirement

7.3 Summary Recommendations

i. Productivity improvement in crops through introduction of High Yielding Varieties (HYV). Increasing the Seed Replacement of Ratio (SRR) of existing popular varieties. Creation of new mango orchards of improved local verities by high density planting.

ii. Crop Diversification, Intensification and Integrated Farming System (IFS) approaches (Integration of potential crops, animal and fishery) and advanced management practices like nutrient management and plant protection measures.

iii. Introduction of exotic germplasm through AI not exceeding 50% genetic makeup. For high yielding, crossbred dairy cattle may be promoted but not exceeding exotic blood level more than 50%. Replacement of stock at least 10 % with units can improve the production.

iv. Introduction and conservation of Indigenous breeds: In the scenario of climate change it is very much essential to identify and conserve local germplasm of cattle suited for local coastal climate. Through selective breeding and purifying local breed development is essential. The indigenous high yielding breeds of Indian continent also needs to be introduced as per requirement of farmers.

v. Community Dairy Farming: For creating self-employment and to engage youth in dairy farming community dairy farming concept will be useful.

vi. Organization of cattle markets for facilitating sale/purchase of high quality breeding animals of farmers among themselves.

vii. Slaughter house and meat processing units for small animals and strengthening the veterinary services.

viii. Fishing is one of the major economic livelihoods of fishermen in the State. There is a wide scope to improve the income and livelihood of fishermen through diversification of fish species to increase stock density, better availability of the fish seeds, promotion of mussel farming, capacity building and awareness creation, etc.

ix. Improved storage facilities – cold ice plants, insulate vehicles, etc can also play an important role for marketing of the fish catch.

x. Development of integrated farming systems with fishery as an important enterprise can ensure regular income and improved production.

xi. Post-harvest handling, value addition, allied activities like ornamental fish farming also have potential to contribute to improvement in income.

xii. Improved technologies like cage culture technology, satellite hatcheries for raising cultures can help farmers to increase their fish catch.

xiii. Providing subsidized cages and ensuring timely and adequate supply of fish seeds to the farmers are essential to boost farmer's income.

xiv. Fish production strategies like diversification of inland fish production through new finfish species and methodologies and promotion of ornamental fish culture through self-help groups

A. The proposed action plan for Goa state include mainly the productivity improvement in major crops like paddy, cashew and coconut, diversification in agriculture, creation of IFS models, mechanisation, value addition and policy reforms in agriculture including marketing strategies

B. The potential pilot models in agriculture and allied sectors in each districts of Goa need to be established in the farmers' field. The performance and progressive income from the models need to be documented to showcase the doubling of income in the state by respective implementing agencies.

Further, the committee recommends constituting of District Level Monitoring and Evaluation Committees under the Chairmanship of District Collectors who are Chairmen of ATMA. Programme Coordinators, KVK will be the Convenors for the above committees with the representatives from all line departments as Members for both South and North Goa for effective monitoring of action plan.

8

GUJRAT

Gujarat is a State in north western India, has varied terrain and numerous sacred sites. In its urban centre of Ahmadabad is the Calico Museum of Textiles, displaying antique and modern Indian fabrics. Out of the total geographical area of 196.0 lakh ha of the State, 99.63 lakh ha (more than 50 per cent) was under net cultivable area. About two-third of the area of the State falls under arid and semi-arid tropics and the rainfed area in the State was about 66 lakh ha. The gross irrigated area was 56.14 lakh ha accounting for 45.97 per cent of total cropped area in which about 12.16 lakh ha was found to be saline and alkaline.

The gross cropped area was around 1.17 million ha. The cropping intensity across the State was 118.23 per cent and irrigation intensity was 132.62 per cent. Among the major crops the largest cropped area was occupied by cotton (18.95 lakh ha) followed by groundnut (16.31 lakh ha); wheat (13.21 lakh ha); pulses (8.24 lakh ha); rice (7.81 lakh ha); bajra (7.79 lakh ha); castor (7.06 lakh ha) and maize (5.13 lakh ha). The area under fruits and vegetables together comprised of 2.16 lakh ha in 2015-16. The total operational land holders in the State were 48.86 lakh with an average of 2.03 ha per land holder. Among the landholders, 37.16 per cent were marginal farmers, 29.25 per cent were small farmers, 22.10 per cent were semi- medium farmers, 10.49 per cent were medium farmers and 1.21 per cent were large farmers.

The size-wise distribution of operational holdings and area operated (Table 2) shows that in the year 2011-12, a majority of farm operators belonged to marginal and small farmer categories cultivating less than 2 hectares of land. Though they constituted about 62.9 per cent of total number of operational holdings, they operated only 26.8 per cent of total operational area. On the other hand, the large farmers (operating land area more than 10 hectares) and medium farmers (with operating land area of 4 - 10 ha) constituting only 24 per cent of total holdings occupied a substantial proportion (i.e., 43.9%) of total operational area.

Gujarat is divided into seven agro-climatic regions:

i. Southern Hills (Dangs and Valsad districts), having humid climate and 1793 mm average rainfall;

ii. Southern Gujarat (Surat and Bharuch districts) with semi-arid climate, with 974 mm rainfall;

iii. Middle Gujarat (Vadodara, Kheda and Panchmahal districts) having semi-arid climate, with 904 mm rainfall;

iv. Northern Gujarat (Ahmedabad, Mehsana, Gandhinagar, Sabarkantha and Banaskantha districts) semiarid climate and average rainfall of 735mm;

v. North-west Arid (Kutch district) having extremely arid climate and 340 mm rainfall;

vi. North Saurashtra (Amreli, Bhavnagar, Surendranagar, Jamnagar and Rajkot districts) having semiarid climate with 537 mm of average rainfall, and

vii. South Saurashtra (Junagadh district); climate here is dry sub-humid with 844 mm average rainfall.

8.1 Productivity Gaps and Major Constraints:

- Fragmentation of land holdings
- Water and labour crisis
- Increasing cost of production
- Pest and Disease incidences
- Wild animal menace.
- Lack of mechanization and small tools and machinery
- Climate change effect – biotic and Abiotic pressure
- Lack of quality planting materials.
- Inadequate farmer field schools and FPOs.
- Non-availability of credit and inadequate crop insurance coverage.
- Lack of policy and credit orientation for developing rural non-farm employment.

8.2 Strategy and interventions for doubling of farmers' income

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
	(1)	(2)	(3)	(4)
a)	**Agriculture**			
1.	Low Seed Replacement Ratio (SRR) Low rate of replacement of varieties & cultivation of unsuitable crops and varieties. L o w awareness on scientific Seed t r e a t m e n t techniques	The SRR in Wheat, Desi Cotton, Pulses, Groundnut and Soybean are less than 50 % in Gujarat. Currently, the change in cropping pattern and sequences are not adequately coping with the ongoing implications of climate variability. Varieties which are more than 20 years old are still in cultivation. Changes have to be brought in wheat, tobacco, maize, pearl millet and groundnut cultivation. Most of the farmers do not follow scientific seed treatment practices.	a. Replacement of local and inferior quality seeds with high quality seeds. b. Conversion of breeder seed to foundation and certified seeds on university farms. c. Promote Seed village concept for certified and TFL seed production. d. Crop and variety should be selected on the basis of climatic factors, edaphic factors, resource availability and market situation. e. Adequate quantity seed of the new and high yielding varieties need to be made available along with applicable new packages of practices. f. Encourage scientific seed treatment practices for protection against iseases and pests. g. Promote seed inoculation with bio-fertilizers.	a. Seed certification agency should encourage NGOs/ PSUs as well as SAU farms for seed production of improved varieties. b. SAUs and ICAR centres should be facilitated for large-scale breeder seed production. c. University farms need to be facilitated for converting breeder seeds of improved varieties to foundation and certified seeds d. NGO/Public Sector participation need to be encouraged for producing timely certified and TFL seeds. e. Training extension functionaries and progressive farmers. f. Research in the context of climate variability implications. g. Production of required quantities of breeder seed of new improved varieties. h. Imparting training to extension functionaries and progressive farmers on scientific seed treatment and seed inoculation.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
2.	Less exposure of farmers to non-monetary inputs	Most of the farmers neglect the importance of non-monetary inputs despite the fact when they have become immensely relevant in the current context of climate variability and change.	a. Selection of biotic & abiotic stress resistant varieties. b. Timely sowing/planting c. Providing optimum plant geometry. d. Irrigating at critical growth stages. e. Timely adoption of crop protection practices. f. Timely harvesting. g. Practicing system of intensification in rice, sugarcane, wheat & cotton.	Imparting training to extension functionaries of SAUs, ICAR centres, Line departments, NGOs, and progressive farmers on the efficacy of non-monetary inputs in the context of climate change scenario.
3.	Expedite Integrated Nutrient Management	Either under or over use of fertilizers leading to deficiency or toxicity of certain elements in the soil coupled with development of soil salinity. Use of natural nitrification inhibitors and enriched organic manures is not prevalent.	a. Guiding farmers to use recommended dose of nutrients as per soil test. b. Balanced nutrition with organic / inorganic / biofertilizers c. Supplementing deficient nutrients. d. Reducing soil-water-air pollution. e. Incentivizing slow release fertilizers.	a. Imparting training to extension functionaries of SAUs, ICAR centres, Line departments, NGOs, and progressive farmers to ensure proper use of the soil health card b. Production of biofertilizers in PPP mode.
4.	Promoting Precision Agriculture	Most of the farmers are unaware of precision farming technologies	a. Mapping soil fertility status including secondary and micronutrients b. Laser land levelling c. Application of fertilizer based on STR and site specific nutrient management	a. Imparting training to extension functionaries & progressive farmers on precision agriculture b. Demonstrating crop specific precision farming techniques with real time models.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
5.	Prioritizing Micro-Irrigation Structures (MIS)	Farmers still adopt surface irrigation methods without calculating amount and time of water requirements. Indiscriminate use of water especially in canal command areas.	a. MIS need to be made compulsory through incentivized schemes. b. Prioritize water conservation practices. c. Persuading farmers to practice irrigation at critical growth stages. d. Promoting furrow, band and foliar irrigation methods. e. Promoting Laser land leveling to increase irrigation efficiency.	a. Imparting training to Extension functionaries and progressive farmers on improving WUE and FUE. b. Policy interventions promoting the availability of crop-specific superior grade liquid fertilizers/ secondary/ micronutrients at affordable rates.
6.	Leverage Integrated Weed Management	Most farmers still practice hand weeding and inter-culturing operations without considering crop-weed competition period.	a. Take preventive measures to check weed dispersion. b. Consider crop-weed competition period for effective & economical weed control. c. Cultivation of green manure crops. d. Intercrop with cover crop to check weed.	a. Imparting training to extension functionaries and progressive farmers on economical and effective weed management practices. b. Testing new and efficient molecules to be used as weedicides
7.	Prioritize Integrated Pest /Disease Management	Farmers follow haphazard and indiscriminate use of agro chemicals for controlling pests and diseases. While spraying, insecticides and fungicides are liberally mixed and applied without worrying about the incompatibility of the chemicals.	a. Select pest tolerant or resistant variety b. Popularize cultivation with trap crops. c. Follow integrated approach for effective and economical pest control. d. Follow mechanical control measures to control pests/ diseases	a. Imparting training to extension functionaries and progressive farmers on IPM and IDM. b. Promoting safe use and application of chemicals. c. Prioritizing training of input dealers. d. Research on new or emerging/ recurring pests and diseases by SAUs and ICAR centres.
b)	Horticulture:			

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
1.	Lack of availability of quality planting material	Shortage of quality planting materials of fruits, vegetables and flowers crops. Planting materials obtained from outside the state are not quarantined.	a. Establish plug nurseries for fruit, vegetables and flowers. b. Increase subsidies for nursery along with restructuring nursery modules with latest infrastructure prices. c. Strengthen domestic quarantine to avoid introduction of new pests/ disease into state.	a. Establish new nurseries on priority calculating demand- supply gaps. b. Develop planting materials suitable for processing and exports through PPP mode. c. Encourage Tissue culture research and dissemination.
2.	Diversifying area toward high value horticultural crops	Only 16 percent of gross cultivated area in the state is under horticultural crops. Efficient utilization of land by growing vegetables & Fruits simultaneously is not taken up on a large scale.	a. Increase awareness regarding profitability of horticultural crops. b. Increase area under horticultural crops by diversifying area toward remunerative fruit crops and intercropping. c. Popularize research and adoption of minor fruit crops (such as jamun and jackfruit).	a. Cultivable barren lands (5 lakh ha in Gujarat) need to be brought under horticultural crops. b. Soil reclamation and breeding measures need to be promoted in marginal lands. c. Popularize adoption of remunerative minor fruit crops and medicinal & aromatic crops.
3.	Increase productivity of hortticultural crops through high-tech technology	Lack of awareness regarding HDP, canopy management, pruning, soil and leaf analysis, mulching, ratooning etc.	a. Conduct training on different high- tech technologies in horticulture crops. b. Promote & standardize PoP for protected cultivation of vegetables and flowers during off-season.	a. Awareness through Demonstration and training. b. Arrange farmers' visits to Ultra High Density Mango Plantations. c. Promote affordable protected cultivation.
c)	Livestock sector:			

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
	Improving availability of feed and fodders	Huge shortage of dry and green forage in the state.	a. Improve fodder production by utilizing proven fodder varieties. b. Development of pasture lands in the villages. c. Use of industrial and agro-forestry by-products to curtail cost of animal feeding. d. Encourage farmers to establish fodder banks. At least 50 acres land in every village should be identified for the fodder banks. Switch over towards forage, fodder production and storage, e.g. Fodder cowpea- Lucern + chicory cultivation will ensure availability of green fodder throughout the year.	a. Increase availability of high-grade seeds. b. Identify district-wise areas for surplus fodder crop and intimate the gram panchayat through mobile apps wherever there is shortfall in fodder production. c. Use crossbred fodder sugarcane & NB -21. d. Identification and use of different industrial by-products especially groundnut, maize and rice industry. e. Timely collection of agro-forestry by-products and use them with the consultation of animal nutritionists. f. Develop district-wise data base on cattle and buffalo productivity, availability of different feed resources and animal requirement. g. Develop area specific mineral mixtures considering mineral availability and requirement.
2.	Promote Breeding of livestock animals	Semen supply from good proven bulls needs to be operationalized throughout the state. Upgradation of indigeneous breeds is yet to be prioritized.	a. Assure semen supply of good proven bulls on subsidized rates for Artificial Insemination in dairy animals. b. Upgradation of indigenous breeds through selection and crossbreeding of non-descriptive animals with the semen of proven bulls. c. Promote oestrus synchronization program all over the state.	a. Bulls testing at molecular level. b. Performance evaluation of good pedigree bulls at field level. c. Implementation of Progeny testing at field level. d. Execute village level infertility camps at regular intervals. e. Different oesterous synchronization modules should be implemented at village level
3.	Formulate housing Management for livestock sector	Scientific rearing of calves and heifers is not widely practiced in the state.	Scientific rearing of calves and heifers to minimize mortality in calves and infertility problems in heifers.	a. Conducting local vocational courses for creating awareness on scientific animal husbandry practices. b. Extensive short duration research on animal shelter.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
4.	Formulate Health management of livestock animals	Diagnostic facilities for infectious diseases and their management are not done on regular basis.	a. Operationalize mechanism for diagnostic facilities of infectious diseases as well as their reporting and vaccination. b. Timely reporting of infectious diseases need to be prioritized. c. Develop modalities for prompt and accurate diagnosis, along with	a. Execute health checkup camps at village level at regular intervals. b. Conduct testing of infectious materials in state registered laboratories. c. Timely vaccination against diseases including FMD, brucellosis, and Hemorrhagic septicemia (HS).
d)	**Poultry sector**			
1.	Develop efforts for Breeding in poultry sector	Large existing demand for location specific poultry bird varieties in Gujarat state.	Development of location specific varieties for rural/ backyard poultry farming.	a. Develop crossbred by crossing native / non-descript breeds with high yielding breeds/strains. b. Disseminate already developed superior germplasm suitable for backyard poultry farming
2.	Prioritize feed & nutrition development for poultry sector	Available suitable crop residues are only partially utilized as poultry feeds.	a. Promote maize and soybean cultivation for utilizing as poultry feed. b. Reduce feed cost of commercial poultry farming. c. Provision for poultry feed at subsidized rate for rural/ backyard poultry farmers.	a. Promote maize and soybean growers by providing seeds of high yielding varieties at a subsidized rate. b. As soybean De-oiled cake (DOC) is being used in poultry feed, improve soyabean processing facilities. c. Explore the possibilities of usage of alternative poultry feed resources for partial replacement of major poultry feed ingredients.
3.	Formulate health management in poultry sector	Emerging issues of poultry disease diagnostic facilities need to be addressed on regular basis with timely interventions.	Diagnosis and control measures for emerging and re-emerging diseases of poultry.	a. Establish poultry disease diagnostic facilities at regional levels and schedule appropriate vaccinations. b. Short duration training on package of practices for rearing of birds and health management.
e)	**Fisheries sector:**			

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
1.	Fresh water fish production: • Low per ha productivity in ponds & lakes. • Reservoirs lack quality fingerlings • Low catchability • Poor utilization of resources • Untapped ornamental fish Trade	Fish production in ponds: • Nation- 2400 kg/ha • State – 500 kg/ha Fish production in reservoirs: - Nation: • 50 kg/ha/yr (Small) • 12kg/ha/yr (Medium) • 11 kg/ha/yr (Large) -State: • 55.66 kg/ha/yr (Small) • 35.01 kg/ha/yr (Medium) • 47.36 kg/ha/yr (Large)	a. Production and stocking of stunted yearling and ranching programmes. b. Species diversification & establishment of hatcheries. c. Exploitation and technological advancement in ornamental fish culture. d. Maximum utilization of water bodies. e. Small scale and commercial fish feed plant.	a. Promote cage and pen farming policies in reservoirs and lakes. b. Strengthen existing and creation of additional infrastructural facilities c. Conduct research, training and extension programmes. d. Ensure optimum utilization of water resources for maximizing production. e. Improve location specific and economically feasible technology generation. f. Design and develop advance fish harvesting methods g. Establish disease diagnosis centres. h. Ensure economical and critical fish farming inputs.
2.	Brackish water fish production: Lack of quality seed. • Depletion of coastal water bodies. • Lack of insurance cover.	• Only 5.8 % is allotted of the brackish-water area is allotted for fish culture. • Disease diagnosis laboratories do not exist. • Poor species diversification. • Lack of infrastructure facilities.	a. Develop & domesticate commercially important fin fishes' brood stocks and SPF, SPR, SPT brood stocks for shrimps. b. Promote species diversification & establishment of hatcheries.	a. Implement research, training and extension programmes on optimum utilization of water resources for maximizing per ha production. b. Promote location specific and economically feasible technologies generation c. Establish disease diagnosis centres/ laboratories. d. Provide insurance cover to shrimp/ fish crop. e. Develop proper policies at par with agriculture sector. f. Promote land allotment on the basis of carrying capacity of water bodies.
3.	Marine-water Capture fisheries: • Low catch per unit • Poor or unexploited fisheries resources.	• Mariculture policy does not exist. • Poor mechanization of fishing crafts and gears • Poor species diversification	a. Designing fishing gears, crafts, methods & equipments. b. Effective utilization & outreach programmes on Potential Fishing Zones (PFZ).	a. Promote cage, pen, seaweed, oyster, and mussel farming policies in marine waters. b. Species diversification by including seaweeds molluscs. c. Promote research, training and extension programmes. d. Promote sea ranching programmes and marine ornamental fish culture.
2.	Promoting on-farm ancillary activities:			

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
1.	Promoting on-farm honey production (Apiculture)	At present, there is no prevailing scheme / project on honey production or apiculture popularization in the state.	a. Purchase, distribution and maintenance of honeybee colonies. b. Increasing awareness on bee conservation by avoiding pesticide usage at the time of flowering.	a. Devise mechanism for purchase of honeybee colonies. b. Identify farm pockets and distribute honeybee colonies to farmers. c. Train farmers on apicultural activities. d. Conduct research on beekeeping especially on bee breeding and nucleus colonies.
2.	Incentivizing mushroom cultivation	A viable venture with low input and high income. However, expertise is critically lacking in the state on profitable production and marketing.	a. Prioritize training on mushroom cultivation and marketing. b. Strengthen spawn laboratory and other infrastructure among stakeholder agencies.	a. Promote training on different aspects of mushroom cultivation and marketing. b. Create awareness on functional / nutritional benefits of mushroom. c. Develop Spawn availability and substrate pasteurization centers along with dehydration facilities. d. Incentivize mushroom growers association.
3.	Invigorating organic farming			
1.	Increasing area under organic farming	• The state is most suited for organic farming as a significant portion of its agricultural land is rainfed. • Pioneer state to establish first ever Organic University in the country.	a. Demonstrate and organize training on different organic farming techniques. b. Conduct research on organic farming techniques c. Promote use of bioagents.	a. Provide special attention for bringing rainfed areas under organic mode. b. Bring area under cultivable barren lands into organic horticulture cultivation. c. Develop protocols for organic production based on the entire cropping system approach. d. Develop preferential policy instruments by declaring one or two organic districts
	Value-Chain Development, Market Linkages &Trade Potentia			
a.	Value-Chain Development:			
1.	Improving farm pre- and post- harvest management techniques in crop sector	Nearly 20 to 25 per cent post harvest farm output losses in the state due to improper handling.	**a.** Demonstrate and organize training on different pre- & post-harvest techniques. **b.** Promote farm gate processing. **c.** Incentivize low-cost processing technologies through start-ups	**a.** Promote taluka level cold chains, rural godowns and village level agro-processing industries and commoditybased value-chains. **b.** Establish Quality Certification Laboratories at APMC level

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
2.	Improve recycling of crop residue at farm-level		**a.** Organize training on available technologies of value addition of crop residues. **b.** Prioritize research on residue recycling of fruit crops. **c.** Commercializing crop bio-mass.	**a.** Create awareness about crop recycling measures through demonstration and training. **b.** Develop technologies for waste recycling of all horticultural crops.
3.	Improve milk quality & introduce value addition in livestock sector	Poor hygienic quality of milk. There is no value addition in milk at farmers' level such as conversion of milk into dahi, lassi, shrikhand, khoa, paneer etc.	**a.** Promote clean milk production. **b.** Increase shelf-life and quality of milk. **c.** Encourage small scale start-ups for value added dairy product units.	**a.** Awareness training for farmers on clean milk production and increasing shelf-life. **b.** Promote Community milking. **c.** Promote machine milking. **d.** Establish farm cooling practices using affordable technologies.
4.	Promote post-harvest technologies in fisheries sector	Fewer manufacturing units for value added products	a. Create infrastructure facilities like fish loading & unloading devices and onsite ice making machines b. Establish hygienic fish collection (mobile vans), marketing and cold chain facilities.	a. Strengthen existing harbour infrastructure facilities. b. Create ddітional infrastructural facilities in fish market. c. Conduct research, training and extension programmes.
b.	Market Linkages:			
1.	Leverage market intelligence for all major agricultural crops	Forecasting / market intelligence system for all agricultural commodities / majorcrops is grossly inadequate in the state.	a. Robust price forecasting techniques need to be utilized on a full-time basis. b. Market intelligence mechanism for horticultural crops need to be studied.	a. SAUs need to have a separate Market Intelligence Centre in Agricultural Economics Department. b. Fairly accurate estimates on price forecasting should be made available to the farmers well before the harvest season. c. Training farmers to utilize and appreciate market intelligence services.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
2.	Promote contract farming and direct marketing, wherever feasible	Though the State has modified APMC Act allowing contract farming and direct marketing, the efficacy of such reforms is not up to the mark. Direct marketing of farmers account barely 5 per cent of volume transacted.	a. APMCs need to encourage contract farming. b. Better coordination between Farmers, Industry and APMC. c. Facilitate contract farming with a mechanism of assured pricing.	a. Devise appropriate policies to make the contract farming enterprising. b. Ensure participation of small and marginal farmers by the firms entering into the agreement of contract farming c. Establish Special Agricultural Zones (SAZ) to cater to special farm trade groups with specific requirements. d. Promote direct marketing by modernizing market infrastructure at taluka level.
3.	Leapfrogging Electronic-National Agricultural Market (e-NAM)	Though Gujarat is the frontrunner state in e-NAM, it is still in the nascent stage and neither farmers are adequately aware about its benefits, nor are facilities and coverage up to the mark.	a. Speedily link all APMCs and Market Yards in Gujarat to E-NAM. b. Encourage large mandis to actively participate in e-NAM. c. Wide publicity of e-NAM benefits	a. Create awareness about E-NAM and its usefulness to the farmers esp. Small & marginal. b. Incentivize and award farmers with maximum transactions through E-NAM. c. Establish select "Organic Markets" for agricultural commodities under E-NAM.
4.	Involve cooperatives in marketing of horti. produce	At present cooperatives are not involved in and marketing of horti. produce.	Promote cooperatives for marketing of horticultural produce.	Plan exposure and motivation to co-operatives in the state through visits to successful co-operatives in India.
5.	Leveraging Farmers Producers Organization (FPOs)	Number of FPOs in the state is one of the lowest in India. The potential of FPOs among small and marginal farmers is yet to be realized in the state. External Commercial Borrowings (ECBs) is currently permitted for NGOs and NBFCs engaged in micro-finance alone and not for FPOs.	a. FPOs should be allowed to market members' produce directly to buyers of their choice, through all platforms, physical or electronic. b. Extend tax exemption to FPOs at par with Cooperatives. c. Incentivize FPOs for creation and maintenance of rural agriculture infrastructure. d. Ensure provisions for easy issue of licenses to FPOs to trade in inputs.	a. Provide collateral free loans upto Rs.25 lakh to the FPOs. b. Rate of interest for FPOs should be at par with the rate charged to individual farmers for crop loans. c. Group insurance schemes should be established for members of FPO. d. Extend external commercial borrowings (ECBs) for FPOs. e. Single state-wide license with every point of sale for all agri. inputs which will facilitate FPOs dealing with agro-inputs.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
6.	Innovate livestock marketing	Awareness among small and marginal farmers about marketing prospects in livestock is highly skewed.	a. To conduct certificate course on creating awareness. b. Develop regulated livestock market for selling live animals.	a. Conduct local vocational courses for creating awareness among small and marginal livestock keepers about rearing, marketing, bank loan facilities and establishment of cattle, buffaloes, sheep, goats and poultry farms. b. Develop Apps related to livestock management to disperse quick scientific information. c. Establish indigenous milk cooperatives for facilitating production and marketing of desi (A2) milk.
7.	Accelerate marketing for poultry products	Partially existing demand for poultry products in the state	Promotion of consumption of poultry products, wherever possible	a. Creating awareness regarding nutritive value of poultry products through media and mass coverage. b. Promoting local / indigenous poultry breeds and their products.
c.	Trade Development:			
1.	Doubling the current level of exports	Share of India in world exports is very low and hardly 1.5 % on an average during the last decades. Farm level awareness on SPS measures is still very poor.	Double the current level of 1.70 lakh crores worth of agri. exports within 5 years. Boost to RTAs(Regional Tariff Agreements) to address the issue of Non-Technical Barriers such as TBT and SPS Measures and to attract investment	a. Promote Crop Stewardship Programs, Good Agricultural Practices (GAP) and Certification procedures. b. Promote Global Commodity Boards like California Walnuts, Washington Apples for our own farm produce like Talala Kesar Kheri or Kutchi Dates. c. Promote quality consciousness and health safety issues among farmers for both domestic and international trade.
d.	Policy and Investment Requirements and Role of Government			

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
1.	Zeroing in on water management problems	Currently, 57.52 % of area of Gujarat is under rainfed agriculture. Only 20 % of the rainfall gets utilized in the state.	Promote rainwater harvesting. Enhance groundwater irrigation efficiency. Using waste water from dairy and other domestic effluents	Promote in-situ conservation, water harvesting and management at farms. Encourage raised beds with block furrow irrigation. Incentivize roof-water harvesting in rural/ urban areas. Promote and train Water User Groups (WUGs) on a large-scale. Enhance subsidy on 5 HP solar water pumps on cooperative basis to farmers' groups. Train farmers on biodegradable mulching practices. Divert urban run-off to recharge zones. Ensure steps for reducing BOD and COD levels of effluent irrigation water. Conduct crop-water balance and optimal crop planning studies at taluka levels.
2.	**Facilitating farm mechani-zation**	Available farm power is only about 1.20 kW/ha in Gujarat, which is less than the national average. Farmers' skill-sets need to be improved.	PPP mode production of machinery for top down and bottom up approach. Providing vocational skills to youth on farm machinery.	a. Promote need based affordable farm machineries especially for small and marginal farmers. b. Identify and train rural/urban youth on skills relating to repair, maintenance and innovation of small tools. c. Incentivize entrepreneurs for farm machinery production through start-ups. d. Innovate and proliferate panchayat level custom hiring centers (CHCs). e. Establish Agricultural Engineering Directorate at state levels for better proliferation of farm mechanization.
3.	Proliferating market led extension & e-extension opportunities	Market led extension is a low key affair in thestate. Utilization of available e-extension services is very poor.	Promote use of market price information and market intelligence services. Assure affordable high speed internet connectivity in villages.	**a.** Promote use of market intelligence and market information services in extension trainings and programmes. **b.** Improve awareness and use of e-extension programmes like i-khedut, e-krishi kiran and other mobile applications *via* e- extension programmes.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
4.	Managing yield gap and reducing costs	Yield rates of all major crops in Gujarat are only 50 per cent to 75 per cent of their potential yields.	**a.** Strengthening the distribution of quality inputs. **b.** Improvising farm mechanization. **c.** Increasing the production and utilization of bio-agents.	a. Follow-ups of Krishi mahotsavs by line departments to improve adoption of technologies. **b.** Increasing budget on 'Farmers Inter-State Exposure Visits and Training Scheme' . **c.** Improving farm mechanization by innovating small implements and proliferating custom hiring centres (CHCs) . **d.** Encouraging use of green manures, biofertilizers and Biopesticides among farmers through awareness programmes.
5.	Alleviating farm financial distress	Financial distress alone accounted for 38.7 per cent of farmer suicides in India. Presently, only 15 % of the loan is disbursed as investment credit.	Provisioning farm credit avenues on marketing, storage and consumption. All financial benefits, mainly the subsidies in different forms, should be provided and transferred directly to farmers account through e-governance.	**a.** In line with self-liquidating production loans, short duration marketing loans may also be considered. **b.** Increase the proportion of investment credit. **c.** Operationalize credit linked warehousing facilities at APMC level. **d.** Promote pledge financing through a network of rural godowns and negotiable warehousing receipt system to reduce distress sale
6.	Doubling the current level of exports	Share of India in world exports is very low and hardly 1.5 % on an average during the last decades. Farm level awareness on SPS measures is still very poor.	Double the current level of 1.70 *lakh* crores worth of agri exports within 5 years. Boost to RTAs(Regional Tariff Agreements) to address the issue of Non Technical Barriers such as TBT and SPS Measures and to attract investment	**a.** Promote Crop Stewardship Programs, Good Agricultural Practices (GAP) and Certification procedures. **b.** Promote Global Commodity Boards like California Walnuts, Washington Apples for our own farm produce like Talala Kesar Kheri or Kutchi Dates. **c.** Promote quality consciousness and health safety issues among farmers for both domestic and international trade.
7.	Encouraging agro-forestry	Potential of agro-forestry lies untapped in the state	Barren lands and field bunds can be utilized such as: Boundary plantation Silvi- pastoral system Agri-Horti system Horti-Pastoral system, Industrial-agroforestry system.	a. Tree species with 8-10 years rotation age such as Ailanthus (match stick tree), araduso (Melia dubia) can be taken up in marginal lands and affected soils. b. Encourage tissue culture labs to produce clones which may further reduce the rotation age upto four years.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
8.	Harnessing solar potential	Solar infrastructure is not affordable by majority of the farmers even after the prevailing subsidy.	Making solar infrastructure affordable. Ensuring incomes by assured power purchase agreements	**a.** Conduct training programmes for improving awareness on on-farm solar infrastructure. **b.** Mandating Power Purchase Agreements (PPAs) for 25 years with feed-in tariffs of Rs 8-9 / unit. **c.** Devise strategies in as such a way that solar infrastructure need to benefit small and marginal farmers as well.
9.	Promoting Agro-tourism Rural/ Agricultural Environment+ Farm Commodities + Tourism Services= Agro tourism	As of 2014-15, the potential of Indianagri-tourism industry is Rs 4,300 crore, while the global agri- tourism market is $10 billion USD. Though prospects are immense, agro-tourism in Gujarat is still at nascent stage.	Promote active participation of all stakeholders in the agro-tourism sector. Corporate sector need to join hands with the linedepartments for commercial development of agro-tourism.	**a.** Promote active participation of all stakeholders including experts, local communities, hoteliers, tour operators and government agencies. **b.** Organize agro-eco-tourism in a more integrated way by using the local resources and local folklore in the farms to attract the tourists. **c.** Establish Agro Rural Tourism (ART) centers to protect ecology by avoiding plastics, promoting greenery, supporting biodiversity and conserving water bodies to benefit agro-tourism sector. d. Establish Agro-Technology Parks (e.g. Mango orchard based bee keeping farms or greenhouse based floriculture or olericulture) for quality production on commercial scale which may also serve as agro- tourism destinations. e. Develop horti Silvi-pastoral or agri-horti-silvi culture system to boost agro-eco tourism.
10.	Promoting rural non- farm employment sector	Creation of non-farm employment opportunities within the rural areas seems to be somewhat dormant as of now. Only 5 % of labour force in the 20-24 age category have vocational skills compared with as much as 96% for South Korea.	Provide appropriate assistance to small scale sector in rural areas in terms of information base, availability of technology, technology transfer, improved credit availability and infra-structural and marketing support.	a. Prioritize skill training programmes to sufficiently reflect the market demand by roping in industries as one of the collaborators. b. Simplify licensing procedures, laws and regulations for developing small scale enterprises in rural areas. c. Ensure rural works programmes achieving the twin objectives of creation of rural infrastructure and additional incomes. d. More than subsidies and welfare schemes, ensure entitlements (raw materials, credit and markets) of rural enterprises as an industry.

Sl	Issue	Status	Action Plan (Including policy No reforms)	Implementing Strategy
11.	Leveraging Pradhan Mantri Fasal Bima Yojana (PMFBY)	Crop and livestock insurance in Gujarat has not attracted farmers sufficiently. Awareness among farmers about the benefits of PMFBY is being promoted by the State government machinery. The modalities of Crop Cutting Experiments (CCEs) are cumbersome. The man-power involved in conducting CCEs is also grossly insufficient.	a. Prioritize crop and livestock insurance an integral part of farming among all sections of farming community. b. Strong need of awareness creation about insurance products. c. Encourage PPP mode in agricultural insurance and provide private insurers the same level of subsidy on par with government agencies. d. Promote group insurance for small and marginal farmers under FPOs.	a. May be made compulsory for all farmers so that a non-loanee farmer is not pushed to extremes in case of crop-loss. b. Ensure one hundred per cent subsidy on premium at least for a few years in case of small and marginal farmers. c. Promote PMFBY similar to general insurance with the help of commission agenta. d. Design crop insurance products with a village as a unit representing similar crops or cropping patterns. e. To increase competition, instead of selecting one agri-insurance player through bid system for a district, all the districts should be made open to all the players. f. A separate Agriculture Insurance Regulatory Authority needs to be established. g. A Toll Free Agri Insurance number should be launched.

8.3 Specific recommendations for doubling farmers' income in Gujarat state:

Agriculture sector

- District and Taluka wise crop planning & cluster approach should be practiced to enhance yields.
- The technologies available today in Gujarat can increase yield levels up to 75%, improve farm profitability up to 100%, besides reducing per unit production cost. Strategy: Follow-ups of krushi mahotsava by the line departments in a phased manner need to carried out to improve the adoption of technologies / GAPs.
- Though Soil Health Cards (SHCs) can bring down cultivation costs by 10-25%, it is still found to be supply driven as farmers fail to realize nutrient management. Strategy: Demonstrate & train the usefulness of the recommendations of SHCs by applying recommended doses of fertilizer on experimental plots at every GP.
- Focus on production of pulses by utilization of rice fallows and intercropping with coarse cereals, oilseeds and commercial crops (sugarcane, cotton).
- Incentivizing the use of improved varieties such as: GAR 13, GAR-1,2,3, GNR-3 and 4 and Mahisagar in rice; Vaishali, GT-103 and GJP- 1 in tur; Meha, Gujarat 4, GM-5, GNM

– 6 in moong; Guj 2, Guj Gram 3, Guj Gram 3, Guj Gram 5 in gram; and GW 366, GW 11, GJW 463, GW 451, GAD- 3 (rainfed) in wheat.

- Low SRR in wheat, desi cotton, pulses, groundnut and soybean. Quality seed production need to be scaled up on war footing which will improve productivity by 20-30%.
- Tribal areas have relative advantage in organic farming due to: i) low level of input use, ii) shorter conversion period and iii) smaller yield reductions. These areas should be identified as organic zones and training support need to be provided
- In situ moisture conservation practices (ISMCP) to reduce irrigation cost by 50% and improve yield levels and popularizing of ride and furrow makers improves the adoption of ISMCP by 75%, thereby their access have to be ensured by CHCs & localized subsidies.
- Promoting INM modules with biofertilizers: E.g. Rhizobia for legumes and Azotobacter and Azospirillum for non-legumes and PSB / ZSB / KSB can reduce cost up to Rs. 5400 / ha.
- Special Agricultural Zones (SAZs) need to be established in the peri-urban and semi-urban areas for fruits, vegetables, milk and egg production focusing on exports and urban areas.

Horticulture sector

- Reclaiming 5 lakh ha of barren lands within the next two years by encouraging contract farming for horticultural crops (which will improve income levels up to 25% to 40%) and buyback arrangement by the institutional agencies can attract and retain next generation farmers.
- Area expansion in date palm, pomegranate, papaya and coconut (hybrid) is possible. But the constraint lies in the growing incidences of drying roots and wilting shoots. The effective strategy could be tissue culture units for date palm and pomegranate plantlets and by establishing plug nurseries for F &Vs & flowers.
- South Gujarat has high rainfall & humidity which can be exploited by promoting the cultivation of black pepper, turmeric, ginger, cashewnut and banana.

Livestock sector

- By Fertility Improvement Programme (FIP) conducted between 2011-12 and 2015-16: 6.95 lakh animals have become fertile. If the average milk yield is 5 Lit./animal/day then total milk production is 34.74 LLPD & additional income is Rs.14 crore /day @Milk price of Rs. 40 / litre.
- Thereby, there is an urgent need that FIP programme be implemented across Gujarat through aggressive campaign to reduce NPA besides improving milk availability.
- Encourage artificial insemnination with proven bulls.
- Establish indigenous milk co-operatives for production and marketing of desi (A2 milk).
- Improve fodder production by utilizing proven fodder varieties. E.g. CO (GG)-3 dry

matter yield of 553.7q/ha/year which was up to 85% higher. Fodder banks need to be encouraged at village level.

Fisheries sector

- Marine water fish production: Promote cage, pen, seaweed, oyster, and mussel farming policies in marine waters (Except North and Middle Gujarat agro-climatic zones).
- Fresh water fish production: Promote cage & pen farming policies in reservoirs and lakes.
- Improve fish processing and export infrastructure

Processing and Value Addition sector

- Cluster based emphasis on HPS groundnut for exports & table purpose in Junagadh, Kutch, Jamnagar, Porbandar and Bhavnagar will enhance farmers' income up to 25% in 3 years.
- Mechanization in production and post-production will reduce per unit cost of production up to 50%.
- Roughly, 30% of fruits and vegetable are lost in Gujarat accounting for Rs. 9,000 crores in the state. Processing at least 10% at farm gate level will increase farmers' income by 15 to 20%.
- Cluster based Agro Processing Centre for all crops: Primary processing, grading and milling of produce may increase the market rate by about 10 to 30%.
- Not less than 81% cold storages suitable only for Potato. There is a need to upgrade the facilities for multi commodities.
- High potential for improving fish processing facilities, especially in Saurashtra zone.

SUCCESS STORIES

1. Fresh Water Aquaculture for Pearl Production

Bhargavbhai S. Desai a 35 years old MBA from village Talavchora, block: Chikhli, district: Navsari got training of Pearl production from Central Institute of Freshwater Agriculture, Bhubaneshwar and is carrying out pearl production successfully from fresh water oysters.

- He grows oysters in his own pond of 2 Hectares by scientific methods. He injects decorative images of different size, shape and designs into the oysters through this method pearls of Rs. 500/- to 50,000/- per pearl can be produced.
- He produces aesthetic jewellery and articles with attractive designs i.e. Ganesha, Saibaba , and religious symbols of Islam & Christianity.
- Cultured pearls are more beautiful with proper size, shape, design and also have more shine than natural pearls. During 2 years of rearing 10,000 to 12,000 numbers of cultured pearls are produced from 1 hectare.
- In 2006, he recovered two a natural pearls from his pond having size of 48 carat with

whitish pink colour which were approved by The Gem & Pearl Testing Laboratory, Bahrin. The market price of this Pearls ranges from Rs. 300 to 400 Lacs.

- By doing Fisheries along with pearl production, approximately 2 Ton of fish per Hectare are also produced.

Income Detail from Pearl Production

Detail	Traditional Pearl Production Technique	Modern Pearl Production Technique
Production	Approx. 50 to 200 Pearl / Ha	10,000 To 12,000 Pearl / Ha
Expenditure	Rs. 0.50 Lakh / Ha	Rs. 17.50 Lakh / Ha
Income	Rs. 1.00 Lakh / Ha	Rs. 28.75 Lakh / Ha
Profit	Rs. 0.30 Lakh / Ha	Rs. 11.25 Lakh / Ha

2. Establishment of Ideal Poultry Farm

Ajitkumar Jagamalabhai Gohil 26 years old farmer from village Mitiyaja, block Kodinar, district Gir Somnath raised chicken and sold eggs and chicken for the local market. Local practices earned him less income and profit.

- After joining ATMA projects, he received training related to broiler chicken farming and got full information by visiting different poultry farms in Bhavnagar district.
- In the first year, he raised 200 Cobb variety of Broiler chickens in area of 500 square feet. In the first lot, he raised 500 chickens and got good profit.
- Now, he raises 400 Cobb variety of Boiler Chickens in area in area 1000 square feet. In the first lot, he raises 1000 chicken.
- Prepared High-quality lots by destroying bacteria and other parasites as well as keeping the farm clean.
- Developed new species of chicken and which mature in a short time.
- He received District level "Best ATMA Farmers Award" in the year of 2013-14 for ideal poultry farming.

Details of income from poultry farming

Year	No. of Chickens	Total Income (In Rs.)	Expenditure (Rs.)	Net Profit (Rs.)
2010-11	200 Cobb	3,65,750	2, 74,425	91, 325
2011-12	300 Cobb	5,39,000	3,78,625	1,60,375
2012-13	400 Cobb	8,20,050	5,51,025	2,69,025

9

HARYANA

Haryana in Northern India is located between 27° 37' to 30° 35' latitude and between 74° 28' to 77° 36' longitude. It is surrounded by Uttar Pradesh (UP) on the east, Punjab on the west, Uttaranchal, Himachal Pradesh & Shivalik Hills on the north and Delhi, Rajasthan and Aravali Hills on the south. The altitude of Haryana varies between 700 ft to 900 ft above the sea level. An area of 1,553 sq km is covered by forests. The state has a total of 81 cities & towns and 6,759 villages. For administrative purpose, the state has been divided into four divisions (Ambala, Rohtak, Gurgaon and Hissar) and 22 districts.

Situated in northwest, Haryana is one of the leading agriculture state of the country. It is also the most intensively cultivated (184 % cropping intensity) state. Farmers have continued to grow rice and wheat as dominant crops due to government incentives and market price ignoring the suitability of soil, climatic conditions and long term repercussions. The inappropriate land use and introduction of canal irrigation have resulted in soil degradation, soil erosion (8.5% by water and 12% by wind), salinity and alkalinity (9.7%) and water-logging (3.3%), besides nutrient losses as well as depletion of ground water at an alarming rate. The problems of salinity, sodicity and water-logging have been attributed to irrigation without providing drainage in the aeo-fluvial plains of semi-arid region of Haryana.

Salinity and sodicity has been created in the highly intensive canal irrigation areas in the central and eastern part of the state. Water table is falling in the central east zone due to over exploitation of ground water where rice –wheat crop rotation is plasticized. It has gone down by of 6.0-7.5 m in a short span of 10 years and thus, has increased the cost of irrigation. Soil fertility has also been declined here due the constant growing of nutrients exhaustive rice and wheat crops. The above situations, thus, pose serious threats to sustainability of agriculture in this high productive zone of the state. The contribution of the State in the National Gross Domestic Product at constant (2011-12) prices has been estimated to be 3.5 percent as per.

Based on ecology and cropping pattern, the state can be divided into three agro-eco regions.

Zone I: constitutes nearly 32 per cent of total area of the State consists of eight districts, namely Panchkula, Ambala, Kaithal, Kurukshetra, Yamunanagar, Karnal, Panipat and Sonepat.

Zone II: consists of seven districts namely Sirsa, Fatehabad, Hisar, Jind, Rohtak, Faridabad and Palwal covering 39 per cent of total area of the State.

Zone III: consists of six districts, namely Bhiwani, Charkhi Dadri, Mahendergarh, Rewari, Jhajjar, Gurgaon and Mewat/Nuh districts covering nearly 29 per cent of the total area of the State.

The area falling under Zone I and II are ideal for crop diversification with wheat, rice, pulses, cotton and sugarcane as well as raising dairy cows, buffaloes, poultry and beekeeping as these zones have better irrigation facilities and overall infrastructure, however, the Kandi area in these zone have serious problem of soil and water erosion and hence they are suitable for agro-forestry and agro-horticulture systems. Zone III is having major area under pearl-millet and rapeseed & mustard, and is also suitable for arid-horticulture, agroforestry, sheep and goat rearing, etc. The major cropping systems followed in the State are rice-wheat, *bajra*-wheat, cotton-wheat, and sugarcane-wheat. The gross cropped area in the State was 65.05 lakh hectares in 2011-12. About 3.069 m ha (84% of cultivated area) was irrigated and the cropping intensity had been over 184 %. The State is second largest contributor to the central food grains pool and largest exporter of *basmati* rice.

9.1 Major Constraints

Weaknesses and threats

- Soil health and water quality declining. Total saline soil (49157 ha.) and alkaline (541430 ha): The status of critical inputs such as soil and water is alarming in the state. About 70% soils have low (<0.4%) Organic Carbon Matter (OCM). Only 37% sub-soil waters are of good quality and about 55 and, 8 % waters are of poor, and marginal quality. Around 19% area is under rain-fed.
- There is a gap in the potential yield and average yield of different varieties. Also, there is gap between average yield of varieties and average productivity of the State.
- Animal dung is not properly utilized for composting. Mostly used for fuel
- Soil organic carbon is low and organic matterrecycling is not practices as mostly paddy straw is burnt in fields
- Ground water is brackish in arid region
- Shortage of labour during peak season
- Partial adoption of recommended practices particularly use of micronutrients, IPM and INM and crop rotation, etc.
- Less developed/inadequate postharvest and processing infrastructure
- Rising cost of cultivation
- More area under rice-wheat cropping system and declining acreage under leguminous crops
- Degrading soil fertility/health with low organic matter, sulphur, potash and micro nutrients
- Fast depletion of ground water
- Rising salinity and water table in arid areas

- Fast urbanization and industrialization
- Discouraging trend of youth in agriculture
- Lack of entrepreneurial spirit in youth

9.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

Agricultural Zone wise Specific Action Plan for Doubling Farmers' Income based on Recommended Interventions/Technologies in Haryana

ZONE 1: DISTRICT PANCHKULA, AMBALA, KURUKSHETRA, KARNAL, PANIPAT, YAMUANANAGAR, KAITHAL

Strategy 1: Crop Production	❖ **Strengthening of traditional water storage structure** ❖ Creation of additional water storage in Morni hills. ❖ Digging of trenches for high percolation of water in valley area in Morni and lower areas of *Kalka* block.
	❖ **Management of wild animal problem** ❖ Cultivation of lime/lemon at larger scale in fruit crops, ginger or turmeric in shady areas, Lemon grass to ward off wildlife in cultivated field. ❖ Enacting legislative measures for protection of crop from wild animals. ❖ Promotion of protected cultivation.
	❖ **Management of soil health in low or valley areas** ❖ Organic cultivation of wheat and maize especially in Morni block. ❖ Promotion of soil amendments in reclaimation of problematic and degraded soil in *shald* and other belts. ❖ Promotion of moong and Dhaincha in Zaid season for green manuring.
	❖ **Crop diversification** ❖ Cultivation of mango, ber, guava with intercrops. ❖ Cultivation of vegetable crops – carrot, tomato & cucurbits. ❖ Promotion of mushroom production. ❖ Promotion of cultivation of short duration crops.. ❖ Cultivation of spice crops – turmeric, ginger, chilli, onion, garlic etc. ❖ Cultivation of medicinal plants. ❖ Promotion of processing units for spices & medicinal plants. ❖ Promotion of Agroforestry.

Strategy 2: Dairy Farming, Goatry, poultry	❖ Adoption of dairy farming enterprise. ❖ Rearing of improved buffalo and other milch animals. ❖ Improved feeding practices. ❖ Timely disease management practice. ❖ Quality fodder production and availability. ❖ Value addition of milk and milk products. ❖ Skill development for marketing of milk and milk products. ❖ Establishment of milk chilling plant. ❖ More incentives for popularization of bio gas plants thereby promoting organic farming. ❖ Establishment of hatcheries for need of broilor or croilor in Barwala & Raipurrani block. ❖ Establishment of garbing pastures. ❖ Organisation of timely health check-up of animals. ❖ Regular vaccination and medicine management against FMD, Galghottu and ❖ other parasitic pests in cattle ❖ Management of mites ❖ Promotion of river side fish farming in local water reservoirs.
Strategy 3: Productivity Enhancement	❖ Accelerate seed replacement practice. ❖ Selection of high yielding improved varieties of crops for specific agro-ecological conditions. ❖ Promotion of seed treatment technology for insect-pest and disease management in different crops. ❖ Promotion of balanced use and scheduling of fertilizer based on soil health report. ❖ INM & IPM approach. ❖ Proper Scheduling of irrigation.
Strategy 4: Seed Production	❖ Promotion of seed production program of vegetable and field crops. ❖ Introduction & promotion of buy back policy. ❖ Skill development for seed production technology. ❖ Establishment of seed processing, storage and packing facilities.
Strategy 5: Integrated Farming System	❖ Promotion of different integrated farming system modules such as:- ❖ Crops production/ fodder crop+animal husbandry+vermicomposting +value addition of milk products. ❖ Crop production+orchards+vegetable crops+Bee Keeping ❖ Crop production+mushroom production+Vermi composting

Strategy 6: Reduced cost of Cultivation	❖ Promotion of zero tillage technology in rice-wheat system. ❖ Promotion of happy seeder in paddy and sugarcane based systems in anchored/ loose residue ZT situations. ❖ Alternate crop establishment techniques (DSR and mechanical transplanting) in paddy ❖ Promotion of organic manures and bio-fertilizer. ❖ Adopting of low cost inputs such as bio-fertilizer, gypsum, seed treatment technology, organic chemicals. ❖ Judicious use of pesticides. ❖ Adoption of improved farm machinery and implements such as hand wheel hoe, improved sickles spraying equipments. ❖ Follow up of metrological advisory for sowing and other farm operations to avoid repeated operational cost. ❖ Use of liquid fertilizers.
Strategy 7: Reducing post harvest losses and value addition	❖ Creation of storage facilities for food grain. ❖ Creation of cold storage facilities for perishable vegetable crops and fruits. ❖ Creation of refrigerated transport facilities to avoid transport losses. ❖ Establishment of food processing units.
Strategy 8: Marketing	❖ Development of e-market/ e-mandi at district level for better price of produce. ❖ Creation of direct linkages with food processing industries for better price. ❖ Development of mobile apps for online management. ❖ Development of call center at district level to resolve the problems of farmers. ❖ All the produce should be purchased from the farmer at MSP at block level. ❖ Establishment of industries based on dominant cropping pattern viz. rice shellers in rice belt; fruit processing unit in fruit growing areas.

Strategy 9: Enabling policies	❖ Enhancing of MSP for more number of crops including millets, spices and other crops. A separate provision of fund and identification of agency to procure and disposal of surplus produce to stakeholders. ❖ Implementation of Pradhan Mantri Fasal Beema Yojna and Soil Health card scheme in each block. ❖ Development of crop insurance scheme for more crops including other factors particularly drought, hailstorm etc. ❖ Organization of monthly review meetings at block level to solve the problems related to the farmers. ❖ Promotion of Phone use in programs at radio and TV for solving the problems of farmers and effective transfer of technology at district level. ❖ Popularization of various government policies by organizing kisan melas, agriculture summit etc. ❖ Ensure sustainable agriculture through more efficient utilization of land, water and other natural resources. ❖ Creating effective and workable nursary act to avoid spurious or unreliable planting material in the district. ❖ Promotion of mandatory metreological/ observatory at block level to get first hand information on climatic changes.
Strategy 10: Landless farmers and farm women	❖ Promotion of skill development for landless farmers, farm women and rural ❖ youth in various activities such as. ❖ Nursery production, land scaping & maintenance of lawns ❖ Mushroom production ❖ Bee Keeping ❖ Cutting and tailoring ❖ Fruits and vegetables preservation ❖ Tie, Die and Embellishment of Fabric ❖ Processing and marketing of milk and milk products. ❖ Candle making ❖ Household decorative items etc.

Strategy 11 : Conservation of biodiversity	❖ Promotion of plantation of Neem, Peepal, Bargad (*Ficus Bengalensis)*, Sehzan (*Moringa Prolifera*) and other ornamental plants to save excessive loss of nutrients in waste land and conservation of different breeds of birds. ❖ Promotion and popularization of water recharge system for storage of rain water in monsoon season. ❖ Promotion of drip irrigation in orchard and wider spaced crops. ❖ Promotion of Ber, Aonla, Falsa, Guava, Pomegranate and *Aloe vira* and other fruits and medicinal plants which requires less water and poor land for their production. ❖ Promotion of agroforestry for enhancing organic carbon and wood availability.
Strategy 12 : Women Empowerment	❖ Scientific orientation of women in Agriculture and Animal Husbandry for ❖ their effective involvement and sustainable agriculture. ❖ Health and nutrition education specially to combat malnutrition among ❖ female child and anaemia among adolescent girls and pregnant women. ❖ Economic empowerment of women through skill up-gradation such as ❖ cutting and tailoring and embellishment of clothes etc. ❖ Promotion of use of improved sickles by farm women for drudgery ❖ reduction. ❖ Promotion of use of protective clothing by farm women for drudgery ❖ reduction and better health.
Strategy 13: Off-farm income.	❖ Promotion of subsidiary occupation like poultry, fish farming and mushroom production. ❖ Establishment of Agriculture Tourism at suitable locations. ❖ Preparation of value added product on their farms like organic gur, biscuit, lassi, sweets, flavoured milk and sugarcane juice etc. ❖ Growing of organic produce like vegetables, fruits, sweet-corn, baby corn, exotic vegetables and flowers. ❖ Direct marketing of their farm produce through E-marketing and in whole sale markets.

ZONE II: District: SONIPAT, SIRSA, FATEHABAD, HISAR, JIND, ROHTAK, FARIDABAD

Strategy 1 : Productivity Enhancement	❖ Crop production ❖ Promotion of salt tolerant and less water requirement crops ❖ Promotion of salinity resistant varieties and practices ❖ Promotion of quality seed and optimum seed rate ❖ Maintaining optimum plant population especially in paddy, sugarcane and potato ❖ Organic crop production ❖ Crop intensification by adoption of summer moong ❖ Selective use of chemicals ❖ Promotion of cultivation ber, date palm and aonla
Strategy 2 : Resource conservation and management	❖ Soil Health Management ❖ Crop residue management ❖ Integrated nutrient management ❖ Judicious use of chemical fertilizers ❖ Promotion of soil amendments in reclamation of problematic soils. ❖ Green manuring and composting ❖ Use of water drainage techniques ❖ ❖ Efficient water use ❖ More crop per drop ❖ Laser land levelling ❖ Adoption of micro-irrigation namely drip and sprinkler ❖ Ground water recharge and rain water harvesting & management. ❖ Raised bed cultivation and mulching ❖ ❖ Management of wild animal problem ❖ Legislative measures. ❖ Promotion of protected cultivation. ❖ Promotion of Zero tillage, Direct seeded rice (DSR), Laser guided land ❖ leveling, crop residue management ❖ Energy conservation ❖ Precision farming ❖ Drudgery reduction ❖ Soil and Water management

Strategy 3 : Farm Diversification	❖ Diversification towards vegetables and floriculture ❖ Promotion of allied agri enterprises ❖ Promotion of agro forestry in low lying areas with eucalyptus ❖ Promotion of orchards with intercropping
Strategy 4 : Integrated Farming system	❖ Adoption of different Integrated Farming Systems including: ❖ Agriculture + Animal Husbandry (Desi cow, cross breed and Murrah Buffalo) ❖ Agriculture + Horticulture ❖ Protected cultivation ❖ Seed production ❖ Production of fruit, vegetable and forestry planting material ❖ Mushroom cultivation (button, milky and dhingri) ❖ Vermi composting ❖ Agriculture + Agro forestry (Poplar, Eucaliptus and Moringa) ❖ Agriculture + Apiculture
Strategy 5: Efficient use of irrigation water	❖ Adoption of More crops per Drop ❖ More area under irrigation with the help of advanced micro irrigation ❖ techniques ❖ Use of land lazer leveller ❖ Use of mulching in orchards
Strategy 6 : Post harvest management and value addition	❖ Promotion of suitable varieties for value addition ❖ Promotion of canning of mushroom , baby corn and sweet corn ❖ Farm level grading, waxing, packaging and storage ❖ Establishment of Food and Processing Units ❖ Promotion of cluster approach i.e. FPO/FIG/SHG/JLG/ Kisan Club for efficient handling of surplus fruits and vegetables . ❖ Value addition of local produce i.e. potato, tomato, carrot, cauliflower, mushroom and different types of corn etc ❖ Strengthening of Ware House and Cold Storage facilities

Strategy 7: Reduced cost of Cultivation	❖ Promotion of well decomposed FYM, vermi compost and bio fertilizers to minimize the use of chemical fertilizers ❖ Promotion of line sowing and fertilizers application in crops ❖ Promotion of recommended seed rate ,spacing, depth and seed treatment specially wheat,mustard, barley and guar ❖ Promotion of need based application of pesticides and other agricultural inputs ❖ Promotion of hand tools in agricultural and horticultural operations ❖ Promotion of use of power tiller, power weeder , paddy thresher , ❖ wheat tresher, wheat hand hoe, manual/ power operated wheat/paddy reapers ❖ Promotion of mulching to maintain moisture and reduce intercultural operation cost. ❖ Promotion of tillers and other garden tools for reduction of drudgery
Strategy 8 : Income generation from secondary agriculture	❖ Promotion of subsidiary occupations like dairy, mushrrom, bee keeping, poultry and fish farming. ❖ Promotion of mushroom and apiculture for marginal and landless farmers. ❖ Promotion of pig, sheep and goat rearing ❖ Promotion of skill development in women and youth in allied agriculture ❖ Promotion of Carps cultivation in saline waters
Strategy 9: Marketing and value addition in specific agro-ecological region	❖ Strengthening of direct, e-marketing and group marketing approaches ❖ Promotion of contract farming ❖ Strengthening of backward and forward linkages ❖ Promotion of Apni Mandi concept ❖ Establishment of Cold chain and processing units ❖ Creation of better infrastructure and transportation facilities ❖ Establishment of collection centre locally ❖ Establishment of zero energy cooling chambers at village level ❖ Strengthening of existing pack house and storage facilities ❖ Promotion of indigenous onion and garlic storage
Strategy 10: Group approach and risk management	❖ Formation of commodity specific farmers' groups (FIGs, SHGs, JLGs, FPOs, ❖ Kisan clubs and cooperatives) ❖ Group approach in marketing ❖ Promotion of cluster approach ❖ Farm finance and risk management

Strategy 11 Use of ICTs	❖ Effective Implementation of Extension reforms namely E-chaupal and ATMA ❖ Effective convergence of line departments with research institutes to avoid ❖ repetitiveness in extension approach ❖ Use of ICT enabled tools for technological dissemination ❖ Creation of ICT hubs at village level ❖ Use of KIOSKs ❖ Blending of modern and traditional media for efficient and timely farm ❖ information dissemination
Strategy 12 : Livestock: Goatry, Poultry, Fisheries	❖ Conservation of murrah buffalo and desi cow ❖ Promotion of mineral mixture feeding ❖ Promotion of high yielding and nutritive fodder varieties ❖ Promotion of cooperative milk societies ❖ Establishment of milk chilling plant. ❖ Promotion of round the year green fodder availability ❖ Promotion of backyard poultry for marginal and landless farmer ❖ Management of traditional water bodies (Johad) and low lying areas for fishery ❖ Promotion of Sheep and goat rearing ❖ Promotion of Carps cultivation in saline waters
Strategy 13: Landless farmers and farm women	❖ Production of Achar, Chatni, Jam , jelly by vegetable farmers ❖ Production of secondary products by farmers ie Making flour, Dal from Green gram ❖ Community juice manufacturing unit for Kinnow farmers ❖ Promotionary subsidiary operations, fish farming and mushroom cultivation ❖ Promotion of agriculture for small landless farmers ❖ Promotion of skill development in women and youth ❖ Encouraging SHG's, FIG's, NGO's for promotion of agricultural based ❖ economy by developing small scale enterprises i.e. candle making, Jam and Jelly making etc.
Strategy 14: Online management and evaluation	❖ Development of mobile apps/software for online management and evaluation at district level ❖ Development of E- marketing and kiosk at district level to have information of surplus commodities at block level ❖ Organization of monthly review meeting at district to solve the problems related with farmers ❖ Promotion of use of radio, TV talks and use of whatsapp etc. for effective implementation of programme

Strategy 15 : Reclamation of water logged and problematic soils	❖ Development of sub surface drainage system ❖ Promotion of Eucalyptus plantation as bio drainage in water logged areas ❖ Promotion of fish farming in water logged and Jhinja in saline areas.
Strategy 16 : Off- farm income	❖ Promotion of subsidiary occupations like dairy farming, fish farming, mushroom ❖ production, value addition of fruits and vegetables and vermi composting etc.. ❖ Promotion of apiculture for small and landless farmers. ❖ Promotion of cultivation and collection of medicinal plants. ❖ Promotion of skill development in women and youth.

ZONE III : DISTRICT: BHIWANI, MAHENDERGARH, REWARI, JHAJJAR, NUH (formerly MEWAT),

Strategy 1 : Productivity Enhancement	❖ Necessary step may be taken to recharge the ground water by increasing the fresh water supply through canal system and rain water harvesting so that receding trend of ground water can be arrested. ❖ Saline ground water should be used in conjunction with canal water. ❖ Scientific management of ground water using sprinkler and drip system of irrigation. ❖ Adopting all strategies leading to ' More crop per drop' ❖ Promotion of ber, guava, beal, anola and organic vegetable because of proximity to the huge market of NCR. ❖ Promotion of marigold cultivation in Daruhera, Bawal and Rewari Tehsil. ❖ Promotion of kharif onion in all block of District. ❖ Bring more cultivable area under fruits, vegetables and flowers ❖ Enacting legislative measures for protection of crop from wild animals. ❖ Promotion of protected cultivation in all blocks. ❖ Providing subsidy for fencing the field. ❖ Popularizes Karonda as bio fencing. ❖ Promotion of serrated sickle for reduction of drudgery in farm women. ❖ Popularization of manually operated mini crop harvesters for millets. ❖ Popularization of ripper for wheat harvesting ❖ Promotion of hand hoe for weed management in kharif crops ❖ Organic cultivation of local grain and millets in different blocks. ❖ Promotion of soil amendments in reclamation of sodic soil ❖ Promotion of green manure crop such as dhaincha ❖ Residue retention for adding organic matter in soil.

Strategy 2 Efficient use of irrigation water	❖ Promotion of short duration and less water requiring crops/varieties. ❖ Use of Hydrogel in crops, vegetable and orchards. ❖ To increase area under sprinkler, micro sprinkler and drip irrigation techniques. ❖ Improvement in water management and distribution system for water bodies to take advantage of the available source which is not tapped to its fullest capacity (deriving benefits from low hanging fruits). At least 10% of the command area to be covered under micro/precision irrigation. ❖ To enhance organic matter of soils by adding more FYM, compost and resource conservation techniques. ❖ Proper scheduling of irrigation for optimum use of water. ❖ Creating and rejuvenating traditional water storage system.
Strategy 3: Crop Diversification	❖ Promotion of pulses cultivation like chick pea and green gram. ❖ Promotion of vegetable crops – Carrot, Tomato, kharif onion along with processing plant. ❖ Introduction of Castor + intercrops in orobanche affected areas, bajra + green gram and raya + chick pea. ❖ Promotion of cultivation of short duration crops like Pearl millet,Mung bean ❖ Cultivation and establishment of value addition and processing unit for medicinal and horticulture plants such as Aloe vera,Aonla etc.
Strategy 4: Reduced cost of Cultivation	❖ Promotion of organic farming. ❖ Promotion of low cost inputs such as biofertilizer, gypsum, seed treatment technology, vermicomposting, green manuring, gypsum, seed treatment technology, organic chemicals and minimal use of chemical fertilizers. ❖ Supply of metrological advisory proper timelike sowing and other farm operations to avoid repeated operation cost. ❖ Promotion of RCTs like zero tillage technology in rice-wheat and non rice-wheat system. ❖ Promotion of organic farming. ❖ Judicious use of pesticides. ❖ Promotion of improved farm machinery and implements such as hand wheel hoe, improved sickles, spraying equipment's etc.
Strategy 5: Seed Production	❖ Promotion of seed production programme of pulses, vegetable crops and other field crops. ❖ Promotion of value addition at farmer level. ❖ Introduction of buy back policy. ❖ Skill development for seed production technology. ❖ Promotion of seed processing, storage and packing facilities at farmer level.

Strategy 6: Integrated Farming System	❖ Promotion of different integrated farming system modules such as:- ❖ Crops production/ fodder crop + Poultry ❖ Crops production/ fodder crop + dairy farming +Bio gas unit + vermin composting + value addition of milk products. ❖ Crop production + orchards + vegetable crops + Mushroom +Bee Keeping ❖ Crop production + Goatry +Bio gas unit +Vermi composting ❖ Fish farming (Brackish water available)area
Strategy 7: Reducing post harvest losses and value addition	❖ Timely harvesting & threshing of crops. ❖ Provide better storage facilities for food grains and cold storage for perishable items like vegetable crops and fruits. ❖ Creation of refrigerated transport facilities to avoid transport losses. ❖ Establishment of food processing units at village or block level. ❖ Promotion of cluster approach for efficient procurement and disposal of surplus vegetables.
Strategy 8: Marketing facility	❖ Development of e-market/ e-mandiplateformat district level for providing better price of produce to the farmers. ❖ Ensure remunerative price to the farmers for their product for their financial improvement. ❖ Development of mobile apps for online management. ❖ Creation of direct linkages with food processing industries for better price. ❖ Development of call center at district level to resolve the problems of farmers. ❖ Establishment of strong linkages with various stakeholders to furnish information on crop produce and surplus.
Strategy 9: Enabling policies	❖ Implementation of Pradhan Mantri Fasal Beema Yojna and Soil Health card scheme in each block. ❖ Development of crop insurance scheme for more crops and including other factor particularly drought, hailstorm etc. ❖ Organization of monthly review meetings at block level to solve the problems related with the farmers. ❖ Promotion of use of Phone in programs at radio and TV for solving the problems of farmers and effective transfer of technology at district level. ❖ Popularization of various government policies by organizing KisanMelas, Agriculture Summit etc. ❖ Ensure sustainable agriculture through more efficient utilization of land, water and other resources. ❖ Creating effective and workable Nursery act to avoid spurious or unreliable planting material in the district. ❖ Promotion of mandatory meterological/ observatory at block level to get first hand information of climatic changes.

Strategy 10: Landless farmers and farm women	❖ Promotion of skill development for farmers, farm women and rural youth in various activities such as. ❖ Bee Keeping ❖ Mushroom production ❖ Seed production ❖ Vermicomposting ❖ Poultry farming ❖ Fish farming ❖ Cutting and tailoring ❖ Fruits and vegetables preservation ❖ Tie, Dye and Embellishment of Fabric ❖ Dairy farming ❖ Candle making
Strategy 11: Dairy Farming, Goatry and Bee Keeping	❖ Adoption of dairy farming enterprise. ❖ Rearing of improved buffalo and breeds. ❖ Improved feeding practices. ❖ Timely disease management practice. ❖ Quality fodder production and availability. ❖ Value addition of milk and milk products. ❖ Skill development for marketing of milk and milk products. ❖ Establishment of milk chilling plant. ❖ Biogas of bio gas plants and promoting organic farming. ❖ Raveling of improved breeds for meat and milk purpose. ❖ Establishment of garbing pastures. ❖ Marketing facilities. ❖ Adopting of bee keeping enterprise. ❖ Management of mites. ❖ Seasonal management / migratory bee keeping. ❖ Multiplication and sale of bee hives. ❖ Creating marketing facilities for honey and other biproducts.

Strategy 12 : Online Management and Evaluation	❖ Development of Mobile apps/ software for online management and evaluation at district level. ❖ Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level. ❖ Organization of monthly review meeting at district to solve the problem related with farmers. ❖ Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

9.3 SUMMARY RECOMMENDATIONS

Agriculture in Haryana has although shown a remarkable growth due to contribution of yield to total output and that too coupled with proper basic and market infrastructure. The annual income of farm household in Haryana is far higher than national average. The growth in real income should be at the rate of about 12.25 per cent per annum so that the goal of doubling the same can be achieved by 2022. The production technology seems to be the major key to improve the prospects of agriculture in the state. Research should be encouraged for evolving suitable production technologies to push up the prevailing technological frontiers. Investments in this direction may be envisaged, particularly for the rainfed regions with scarce water resources, and for regions where there is possibility of water harvesting. Agricultural development has to be integrated with the overall economic growth and generation of livelihood opportunities in the rural sector. Diversified and high value agriculture is the pre-requisite for high growth of nonfarm sector as it opens possibilities for value addition and strengthens backward and forward linkages with non-agricultural sectors, leading to livelihood opportunities for the indigent. The grain based cropping system is the main source of income (54.5%), followed by wages and salaries (24.2%) and animal (18.3%).

Specific recommendations for doubling farmers' income in Haryana state are:

- The resource-scarce farming community such as small and marginal farmers, tenant farmers, share croppers, etc, deserve special attention. Devise micro-level action at district and block for crops & cluster approach should be practiced to enhance yields.
- Land productivity enhancement with focus on efficient management of natural resources. The challenge of climate change is real and there is a crying need to develop a climate resilient agriculture. Development of climate resilient and input efficient improved hybrids/varieties.
- Available technologies has potential to increase yield levels in case of wheat (19 -30%), gram (20-100%,), rapeseed and mustard (22-32%), paddy (40-45%), bajra (20-45%), and maize (50- 60%), Hence there is a scope of improving farm profitability and income.
- Salt tolerant varieties and adoption of good agricultural practices can save the existing loss in the state of Rs. 655 crores.

- Focus on production of pulses by utilization of rice fallows and intercropping with coarse cereals, oilseeds and commercial crops
- Nutrient management based on Soil Health Cards (SHCs) need to be adopted extensively, as it can bring down cultivation costs by 10-25%, particularly on fertilizers.
- The efficiency in input use can bring down the cost of production and enhance the farm incomes. Cost reduction technologies such as RCTs like zero tillage (reduces the cost to the tune of Rs. 3400/ha), rational use of resources (seeds, fertilizers and water) through diversification and adoption of conservation agriculture, bed planting in wheat, micro irrigation techniques like drip and sprinkler are recommended as it can save about 25 per cent seed, 30 per cent water and 25 per cent nitrogen leading to higher use efficiencies. Besides, solar-energy-based tubewells to be provided to farmers to bring down their input costs of energy.
- There should be separate solar and water grids for agriculture to ensure availability on sustainable basis
- An integrated multi-enterprise model consisting of diverse components (field and horticultural crops, fishery, cattle, poultry and beekeeping) can substantially cut the production costs by synergistic recycling of resources among different components and enhance the returns due to complementarities.
- Potential of horticulture including mushroom cultivation, bee keeping can be harnessed through
- adoption of cluster approach. Cultivar of guava, i.e. Hisar Safeda and Hisar Surkha and Gola, Ilaichi, Umran for ber are very popular and have vase potential for enhancing the returns of the farmers in the State and in the neighbouring states.
- Haryana has popular world class Murraha buffalo breed and has good potential for export of quality germ plasm. Further, Possibility to import of Gir semen from Brazil may be explored. In addition, livestock championships, yield competitions and mini dairies may be encouraged through better incentives. Farmers may be encouraged to import high quality germplasm of livestock. Emphasis should be put on conservation and improvement of indigenous cows.
- Marketing is the key to success in farming. Creating the market linkages by establishing terminal
- markets, direct sale by farmers to the consumers through Apni Mandi/Kisan Bazars, and cooperative marketing, specialized markets for the perishable commodities, quality control and pledged storage and warehousing facilities, establishment of multi-commodity agro-processing centres/complexes in production catchments, efficient value chain, establishment of food quality testing laboratory and standards will certainly help in enhancing the farmers' income.

- Ensured remunerative prices for agricultural produce to farmers is important and therefore, MSP should be at least 150 per cent of the cost of production. Further, MSP need to revise in accordance to the traditional crops of the state.
- Farmer Producers Organizations (FPOs), contract farming, niche markets needs to be encouraged.
- Infrastructure creation in connectivity, irrigation, marketing, storage, communication, small farm equipment, etc, is also important for reducing cost of production and improving efficiency.
- Information dissemination must be done using digital technology for extensive outreach.
- Land laws require changes to formalize land leasing practice, in the absence of which term investments are not made by the tillers to enhance production and productivity.
- Enhancement of labour productivity through mechanization and protected agriculture. Suitable skill building and enterprise development in the farm and off-farm sector warrants attention.
- Adequate policy mechanisms that ensure skill and capacity development of small farmers to reach markets and ensure decent and stable prices for their produce needs to be of high priority.
- Create a healthy credit environment by enhancing access to credit through technology in an equitable manner.
- Effective crop insurance schemes are necessary but remain a curative exercise. What is additionally required are systems and capacities for communities to be informed of the vulnerabilities in agriculture and ways to adapt to the vagaries of climate change. This needs investments in effective and timely information systems, planning and decision making support to farmers in order to ensure adequacy in preventive action for crop failure.
- *Krishi mahotsava/Kisan Melas/*Agri Expo/Farmer-Acedemia-Industry meet by R&D institutes and extension agencies involving the line departments need to carried out to improve the adoption of technologies / bridging yield gaps.

About one third of the increase in farmers' income is easily attainable through better price realization, efficient post-harvest management for reduction of post-harvest losses and value addition, competitive value chains and adoption of allied activities. This requires comprehensive reforms in production and marketing, and institutional level as well as at enterprise level. Earlier, the focus of the state was on enhancing productivity of crops but now it needs to be shifted towards maintaining the sustainability of natural resource endowments, growth oriented innovations, shifting of rice-wheat rotation towards high value crops, diversification of agricultural enterprises and enhancing income of the farmers, especially the small and marginal farmers. The state has already taken initiative through Department of Agriculture and Farmers' Welfare to promote ICT and farm innovations, modernization of mandies and warehouse & storage facilities, promoting of direct marketing and electronic trading etc.

Further, implementation of crop insurance scheme in a more better way, strengthening of agro-processing, value addition and by-product utilization & waste management, grading & standardization of quality produce as well as by promoting organic farming will certainly help in enhancing the farmers' income.

SUCCESS STORIES

1. Kinnow and other horticultural plants

A 34 years old farmer Rajender Kamboj from village Darbi, district Sirsa brought his undulated land under orchard plantation and practiced drip irrigation system (under NHM). At present, he is growing field crops in 10.0 acres as conventional farming in paddy-wheat rotation and kinnow in 7.0 acres. Subsequently, he has intercropped his orchard with most of the vegetables in kharif and rabi seasons. He has also propagated 1, 2, 4, 4, 7, 10, 12, 18, 28 and 80 plants of jackfruit, ber, pomegranate, banana, guava, aonla, phalsha, jamun, mango and hybrid papaya, respectively, and having 200 trees of teek at field boundaries. In addition, he has a small dairy farm comprising of four buffaloes and four cows. Last year, he has started bee-keeping with 10 boxes. He is earning net income to the tune of Rs. 18.85 lacs per annum from farming and allied aspects. He was awarded first prize for the best kinnow grower in Sirsa district in 2014 during Kinnow Mela at Sirsa.

His farm is the best example of integrated Farming, involving Agricultural crops (Paddy, wheat, cotton and fodder (jowar/berseem), Horticulture crops: Kinnow, guava, ber, aonla, banana, mangoes etc., Livestock : Four buffaloes and four cows. Other enterprises undertaken are : Vermi-compost, bee-keeping, drip irrigation in kinnow and cotton, water recharge well.

Economics of Farm

Farm Component	Number/Area	Input cost (Rs./year)	Net income (Rs./year)
Paddy- wheat	10.0	2,90,000	6,40,000
Kinnow	700 Plants	1,05,000	6,25,000
Other horticultural plants in Kinnow orchard as intercropping	165 Plants	25,000	1,00,000
Livestock (4 buffaloes and 4 cow)	8.No.	50,000	90,000
Total		**4,70,000**	**14,55,000**

2. Dairy enterprise

Sanjeev (age 42 years, education 10+2), a resident of village Nangla, Karnal has association with KVK, NDRI since 2004. Mr. Sanjeev who along with his friends registered Mishti Farmers Producer Co. Ltd and enrolled 270 farmers as member. He joined Entrepreneurship Development Programme organized by BPD Unit of NDRI for the skill enhancement in 2013 and purchased the technology of Bajra lassi and joined with SINED (TBI) as incubatee company for the manufacturing of bajra lassi and other dairy products. Under the business incubation the company has started commercial production of bajra lassi, whey drinks, sweets, ghee, butter, lassi and curd suing the plant & machinery available at SINED (TBI). Thereafter launch the dairy products such as paneer and whey drink with a brand name 'Misty' in 2014. Before this, he was in a private job during 2006 to 2010 and earning low salary of Rs. 4000 to 5000 per month. He has also started mushroom cultivation and farming of baby corn and dhania but could not found a profitable venture. He started with 20 liter milk processing per day and his firm is handling and processing upto 5000 liter per day. The milk collected from 270 resource poor farmers is processed and at present the company has 14 outlets in five district of Haryana. The net benefits are to the tune of Rs. 20.0 lakh per annum.

10

HIMANCHAL PRADESH

Himachal Pradesh is located in the foot hills of the Western Himalayas and lies between 30^{o} 22' 40'' to 33^{o} 12' 20'' N latitude and 75^{o} 45' 55'' to 79^{o} 04' 20'' E longitude. It shares boundaries with Jammu & Kashmir in North, Punjab in the West, Haryana in the South and Uttarakhand and Uttar Pradesh in South-East. Its altitude ranges from 350 meters to 6,975 meters amsl , and is endowed with a myriad of climatic niches. The state is having an area of 556.7 m ha, the 3D surface area being 863.8 m ha. However, due to hilly terrain, the area amenable for cultivation is only 10% of the total geographical area.

The population of Himachal Pradesh is approximately 6 million and nearly 62% of the population is engaged in agriculture, which accounts for 15% of the Gross State Domestic Product (GSDP). More than 86% of the farmers are marginal and small landholders with < 2.0 ha. The state is divided into 12 districts, with four major land agro-climatic regions. Maize and rice are the major cereals grown in the rainy season, while wheat and barley are grown in the winter season. Blackgram, green gram, Phaseolus beans (Rajmah) and cowpeas are the main pulses in the rainy season, while chickpea and pea are grown in the winter season. The pulse crops are often inter-cropped in maize and wheat, although the traditional inter-cropping system is disappearing fast. In recent times, agriculture in Himachal Pradesh has diversified into temperate and subtropical fruits, off-season protected cultivation of vegetables and flowers, and aromatic and medicinal plants. In addition, turmeric, Calocasia (Arbi), garlic, and spices are being cultivated as cash crops in some pockets. An area of 772 thousand hectares is under food grain production, with a total production of 1,537 thousand MT. Vegetable production has increased from 991 thousand MT in 2006-07 to 1466 MT in 2013-14, while apple production rose from 103 thousand MT in 1970-71 to 866 thousand MT in 2014-15. About 800 hectares area is under floriculture, which is only 0.4% of the total area under floriculture in India. The average monthly income per agricultural household in Himachal Pradesh during 2012-13 was higher (Rs 8,777) than the national average (Rs 6,426). The per capita income of people in Himachal Pradesh has increased from Rs 651 in 1970/71 to Rs 1,30,067 in 2016/17 as compared to the all India average of Rs 823 and 93,231 respectively. Several abiotic (drought, frost, hailstorms, floods, and insufficient chilling) and biotic (insect pests, diseases, nematodes, monkeys, stray/wild animals, and birds) are the major constraints to increase farm productivity. Because of the monkey menace and crop damage by the wild/ stray animals, many farmers have given up crop cultivation in many parts of Himachal Pradesh.

Himanchal Pradesh is divided into four Agroclimatic zones:

Shivalik Hill Zone (350-650 m amsl). Sub Tropical area including Una, Hamirpur, parts of Kangra, Sirmaur, Solan, Mandi and Bilaspur

Mid Hill Zone (651-1,800 m amsl). Temperate area including Solan, Sirmaur, Bilaspur, parts of Kangra, Mandi, Shimla, Kullu and Chamba

High Hill Zone (1,801-2,500 m amsl). Humid Temperate area including Shimla, Kinnaur, Chamba, parts of Mandi and Kangra

Cold Dry Zone (Above 2,500 m amsl). Dry Temperate are including Lahaul & Spiti, parts of Chamba and Kinnaur

Major Crops grown in the different agro-climatic zones

Zones	Crops				
	Field crops	Fruits	MAP	Flowers	Spices
Shivalik Hill Zone	Wheat, Maize, Paddy, Gram, Sugarcane, Mustard, Potato, Vegetable etc.	Mango, Litchi, Citrus, Aonla, Pomegranate, Low chilling varieties of Peach, Plum, Pear, Strawberry	Safed Musli, Aloe, Rose	Gladiolus, Lillium, Marigold, Chrysanthemum, Rose	Ginger, Turmeric
Mid Hill Zone	Wheat, Maize, Barley, Black Gram, Beans, paddy etc.	Stone fruit (Peach, Plum, Apricot, Almond), Pear, Pomegranate, Pecan nut, Walnut, Kiwi Fruit, Strawberry	Dil, Thyme, Tulsi, Aloe, Rose, Stevia	Carnation, Gladiolus, Lillium, Marigold, Chrysanthemum, Alstroemeria	Ginger, Garlic, Turmeric
High Hill Zone	Wheat, Barley, Lesser millets, Psedo cereals (Buck wheat & Amaranthus), Maize and Potato.	Apple, Pear (soft), Cherry, Almond, Walnut, Chestnut, Hazel-nut, Strawberry	Lavender, Rose, Taxus, baccata, Kuth	Gladiolus, Lillium, Marigold, Chrysanthemum	Ginger, Garlic,
Cold Dry Zone	Wheat, Barley, Psedo cereals (Buck wheat & Amaranthus), Peas and Potato etc.	Apple and Hops, Grapes, prunes, Drying type of Apricot, Almond, Chilgoza, Pistachio nut, Walnut, Hazel-nut	Hops, Seabuck-thorn, Kuth, Kala Jeera	-	-

10.1 Productivity Gaps and Major Constraints:

The major limitations to increase crop productivity, profitability and diversification are:

- Less than 20% of the total cultivable area is irrigated, while the rest of the area is rainfed along the steep slopes of the mountains.
- Because of lack of irrigation, most of the farmers are not able to take up intensive protected cultivation of high value cash crops (vegetables, fruits and flowers).
- Except sheep and goats, which are largely owned by the nomads, animal husbandry, poultry and fisheries have not been taken up commercially.
- Lack of transport and marketing facilities and lack of storage, processing and value addition are the major bottlenecks in turning farming into an economically viable enterprise.
- Cultivation of temperate fruits has made a huge impact in the mid and high-hill regions of Himachal Pradesh. However, fruit cultivation has not been taken up on a commercial scale in the lower Shivalik Hills, which accounts for nearly 60% of the total area and population.

There is a need for a mission mode approach to double the farm income by focusing on critical inputs for doubling the farmers' income. To achieve this objective, it is imperative that we overcome the major constraints to increasing crop production such as shortage of irrigation facilities and farm roads, improve input use efficiency, adopt integrated crop – livestock farming and develop facilities for marketing the farm produce. To realize a major boost in farmers' income, it is equally important that we invest in developing newer technologies and innovations, as well as increase the collaboration between different departments of the central and state governments, and promote public – private partnerships in agri-food system. The following interventions can be made to double the farmer's income in Himachal Pradesh over the next 5 years.

- Strengthening of water storage structures, and efficient management of rain water harvesting.
- Promoting timely and judicious use of fertilizers based on soil and water testing reports.
- Adoption of cluster approach for holistic development of vegetables, fruits, flowers, and spices.
- Timely availability of quality seeds/ seedlings of vegetables and fruits.
- Promotion of high density plantations in fruits.
- Efficient and timely use of integrated pest management practices.
- Enacting legislative measures for protection of crops from wild animals.

10.2 Zones- Wise Strategies for doubling of farmers' income

A. Shivalik Hill Zone

Strategy 1: Productivity Enhancement

i. Strengthening of traditional water storage structure

ii. Creation of additional water storage in valley and low hills for lean season.

iii. Promotion of water conservation techniques like mulch, sprinkler and drip in juvenile plants in low or valley areas.
iv. Adoption of cluster approach for holistic development
v. Timely and local availability of high yielding varieties of all the cereal, pulse, High Value Crops like vegetable, fruits, spices, etc.
vi. Efficient management of rain water harvesting
vii. Cultivation of fodder crops & medicinal crops
viii. Efficient and timely use of IPM and IDM practices
ix. Management of wild animal problem
x. Cultivation of lime/lemon at larger scale as fruit crops, ginger or turmeric in shady areas, Lemon grass to ward off wildlife in cultivated field.
xi. Enacting legislative measures for protection of crop from wild animals.
xii. Promotion of protected cultivation in all blocks.

Strategy 2: Livestock: Goatry, Poultry, Fisheries

i. Introduction of high milch breeds of buffaloes and cattle.
ii. Establishment of milk chilling plant at Betalghat.
iii. Establishment of hatcheries for need of broilor or croilor at block level.
iv. Strengthening of traditional water bodies/rivulets with Mahaseer and Carp.

Strategy 3: Integrated Farming system

i. Protected cultivation+ Composting + Goatry/backyard poultry
ii. Fodder production+ Mini dairy +Composting+ Protected cultivation
iii. Seed production (Jethi rice, Lentil, onion, radish, French bean, Pea)+ Planting material supply+Mushroom

Strategy 4: Reducing post harvest losses and value addition

i. Establishment of Processing Units at Distt. Level.
ii. Promotion of cluster approach for efficient procurement and disposal of surplus fruits and vegetables in areas.
iii. Promotion of common resources on custom hire basis viz. Power tiller, Mini thresher etc.

Strategy 5: Waste land development and waste water

i. Afforestation of plants and perennial grasses in steep slope of more than 40% slope.
ii. Promotion of plantation of mulberry, wild fruit plants and fodder trees (Bheemal, Alnus, Celtis, Oak).
iii. Construction of check dam and artificial structure to maximize water percolation rate in marginal and denudated areas.

iv. Construction of tank for storage of water for lean season.

Strategy 6: Reduction of cultivation cost

i. Promotion of well decomposed FYM, Vermi-compost and Bio-fertilizers to minimize the use of chemical fertilizers.

ii. Promotion of hand tools in agricultural and horticultural operations.

iii. Promotion of use of Power tillers, Power weeders, Paddy threshers, Wheat threshers, Maize Sheller, Wheel Hand hoe, Manual/ power operated Wheat/Paddy reapers

iv. Promotion of mulching (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.

v. Promotion of pressurized irrigation techniques in horticultural crops.

Strategy 7: Off-farm income

i. Promotion of subsidiary occupations like poultry, fish farming and mushroom production.

ii. Promotion of apiculture for small and landless farmers.

iii. Promotion of sericulture in low hills or valley areas.

iv. Promotion of cultivation and collection of medicinal plants.

Strategy 8: Enabling Policies

i. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.

ii. Labelling of organic inputs and certification mechanism for various crops.

iii. Establishment of wood bank to meet the present and future demand of germplasm in horticultural crops.

iv. Implementation of Soil Health Card Scheme in each block

Strategy 9: Marketing and value addition

i. Creation of better transportation facilities with cool chain van at Block level.

ii. Creation of direct linkages with food processing industries for better prices.

iii. Establishment of strong linkages with various stakeholders to furnish information on crop produce and surplus.

iv. Establishment of procurement and collection centre at panchayat level for agricultural surplus with proper labelling.

v. Installation of mini-grading machines at village level.

Strategy 10: Online Management and evaluation

i. Development of Mobile apps/ software for online management and evaluation at district level.

ii. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.

iii. Organization of monthly review meeting at district to solve the problems related with farmers.

iv. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

Mid-Hill Zone

Strategy 1: Productivity Enhancement

i. Replacement of old and traditional varieties with HYV

ii. Balanced use of chemical fertilizers and liquid fertilizers.

iii. Construction of water harvesting tank in mountain region including roof water harvesting.

iv. Promotion of water saving techniques viz. drip irrigation, sprinklers and others.

Timely supply of seed and other inputs

v. Promotion of sufficient and assured supply of HYV seed and inputs in all panchayat.

vi. Distribution reliable planting material of temperate and subtropical plants to farmers.

Management of wild animal problem

vii. Minimising the damage of wild boar in field crops through legislative control

viii. Promotion of ITK practices in management of monkey, porcupines, langoor and others.

Strategy 2: Livestock - Goatry, Poultry, Fisheries

i. Upgradation of local breeds with high milch breeds viz. cross bred jersey in cattle and introduction of Murrah breed in buffaloes.

ii. Establishment of service bulls at block level for improvement of cattle breeds.

iii. Introduction of Barbari breed for meat purpose in goat.

iv. Promotion of fast growing green grasses rich in digestible proteins viz. Bhemal, Utees and Oak in perennial trees and Napier as grass for lean season .

v. Establishment of hatchery at Distt. level for easy and more supply of chicks.

vi. Regular Vaccination and medicine management against FMD, Galgottu and other parasitic pests in cattle.

vii. Promotion of river side fish farming in local rivulets.

Strategy 3: Integrated farming system

i. Protected cultivation+ Composting+Goatry/backyard poultry

ii. Fodder production+ Mini dairy+ Composting+ Protected cultivation

iii. Seed production (Jethi rice, Lentil, onion, radish, French bean, Pea) + Planting material supply+ Mushroom

Strategy 4: Reducing post harvest losses and value addition

i. Establishment of small processing units for Juice and pickle making of limited or heterogeneous stocks.

ii. Establishment of mini-grading fruit plant.

iii. Cluster approach is useful for small and marginal farmers to procure input and disposal of surplus in areas.

iv. Use of common resources on custom hire basis viz. Power tiller, Mini thresher etc.

Strategy 5: Waste land development and waste water

i. Afforestation of plants and perennial grasses in steep slope of more than 40% slope.

ii. Plantation of Mulberry plants, Wild fruit plants, Fodder trees (Bheemal, Alnus, Celtis, Oak) may be promoted.

iii. Development of soil bunds to save excessive loss of nutrients in wasteland

iv. Construction of trenches or silages for percolation of water to avoid surface run off.

v. Construction check dam and artificial structure to maximize water percolation rate in marginal and denudated areas.

Strategy 6: Reduced cultivation cost

i. Encourage use of well decomposed FYM or vermicompost, biofertilizers and avoid or minimum use of chemical fertilizers.

ii. Avoid broadcasting of seeds and fertilizers in crop production program

iii. Encourage optimum and recommended seed rate at optimum spacing and depth.

iv. Promoting use of Power tillers, Power weeders, Paddy threshers, Wheat threshers, Maize Sheller, Wheel Hand hoe, Manual/ power operated Wheat/Paddy reapers

v. Promotion of mulch (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.

Strategy 7: Off-farm income

i. Encouraging SHG's, NGO's for promotion of agriculture based economy by developing small scale enterprise (Candle making, Pickle making, Jam & Jelly making),

ii. Promotion of Beekeeping for small and landless farmers.

iii. Promotion of Dingri and button mushroom for small land holders in Solan and Simour belts owing to nearness to commercial market.

Strategy 8: Enabling Policies

i. Extending MSP for more number of crops including all fruit crops and other crops.

ii. Establishment of mandatory meterological/ observatory at block level to get first hand information of climatic changes.

iii. Development of crop insurance scheme for more crops including hail storm attack in stone and pome fruits.

iv. Establishment of wood bank to meet the present and future demand of germplasm in horticultural crops.

v. Extending soil health card scheme for each farmers.

Strategy 9: Marketing and value addition

i. Popularisation of Cooperative societies as a tool of marketing channels for various commodities.

ii. Promotion of better transportation facilities with provision of cold chain van at Block level.

iii. Establishment of direct linkages with food processing industries for better prices.

iv. Establishment of procurement and collection centre at block level for agricultural surplus with proper labelling.

v. Installation of mini-grading machines and cold room at village level

Strategy 10: Online Management and Evaluation

i. Development of mobile apps/ software for online management and evaluation at Distt. level.

ii. Development of e-Marketing and kiosk at Distt level to have information of surplus commodities at block level.

iii. Organisation of monthly review meeting at Distt level for market surplus and situation of hill agriculture.

iv. Promotion of radio, TV talks Whatsapp and FB for effective implementation of program.

High-Hill Zone

Strategy 1: Productivity Enhancement

i. Cluster approach for holistic development of Horticultural sector and traditional millets and grains.

ii. Promotion of Spur and colour mutants in apple in high hills in Shimla and Kinnaur Distt.

iii. Distribution of seed and other inputs timely.

iv. Promotion of sufficient and assured supply of HYV seed and inputs.

v. Distribution of reliable planting material of temperate plants to farmers.

Management of wild animal problem

vi. Minimizing damage of wild boar in field crops through legislative control.

vii. Promotion of ITK practices in management of monkey, porcupines, langoor and others.

Input management

viii. Promotion of vermi-composting and vermi-wash.

ix. Promoting timely and judicious use of fertilizers based on soil and water testing reports.

x. Promote conservation and water harvesting techniques.

xi. Promotion of mulch in fruit crops in juvenile stage.

xii. Construction of small plastic sheet tank (5x3x2mts) for water storage.

xiii. Development of small sprinkler and drips for small and large land holding.

Strategy 2: Livestock: Goatry, Poultry, Fisheries

i. Replacement of local breeds with high milch breeds viz. cross breed jersey cow.

ii. Introduction of Gaddi and Barbari breed of goat and Merino cross and Gaddi of sheep in high hills for high income.

iii. Availability of poultry feed with low prices.

iv. Organisation of timely health check-ups of animals.

Strategy 3: Integrated Farming System

i. Protected cultivation+ Composting+Goatry/backyard poultry

ii. Fodder production+ Mini dairy+Composting+ Protected cultivation

iii. Seed production (Amaranthus or Kuttu)+ Planting material supply

Strategy 4: Reducing post harvest losses and value addition

i. Establishment of small processing units for local milk.

ii. Establishment of grading and packing units for apple and other temperate fruits at block level.

Strategy 5: Waste land development and waste water

i. Implementing wild fruit plants like Bhamora, chestnut, hazelnut and black walnut to meet future needs.

ii. Promotion of different fodder trees (Khirik, Utees, Oak).

Strategy 6: Reduced cultivation cost

i. Encourage use of well decomposed FYM or vermicompost, biofertilizers and avoidance or minimum use of chemical fertilizers.

ii. Avoid broadcasting of seeds and fertilizers in crop production program.

iii. Encourage optimum and recommended seed rate at optimum spacing and depth.

iv. Encouraging use of hand tools in agricultural and horticultural operations.

v. Adoption of Power tillers, Power weeders, Wheat threshers, Wheel Hand hoe etc.

vi. Promote the use of mulch (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.

Strategy 9: Marketing and value addition

i. Popularisation of cooperative societies as a tool of marketing channels.

ii. Promotion of better transportation facilities with provision of cold chain van at Block level.

iii. Creating of direct linkages with food processing industries for better prices.

iv. Installation of Mini Grading machines at village level.

v. Establishment of cold room.

Strategy 10: Online Management and Evaluation

i. Development of mobile apps/ software for online management and evaluation at Distt. level.

ii. Development of e-Marketing and kiosk at distt level to have information of surplus commodities at block level.

iii. Organisation of monthly review meeting at Distt level for market surplus and situation of hill agriculture.

iv. Promoting use of radio, TV talks, Whatsapp, FB for effective implementation of program.

Cold Dry Zone

Strategy 1: Waste land development and waste water

i. Promotion of high yielding varieties of crops mainly rajmash, amaranths, Buck-wheat, etc. in high hills of Lahaul & Spiti and Kinnaur.

ii. Promotion of temperate fruit crops apple, pear, walnut.

iii. Promotion of scientific cultivation of medicinal crops (kuth, hops seabuckthorn and kala jeera, etc.)

iv. Promotion of protective cultivation, use of polyhouses and polytunnel for off-season vegetable cultivation.

v. Organisation of regular trainings programmes and feedback with experts regarding scientific methods of cultivation in each cluster

Strategy 2: Livestock: Goatary, Poultry, Fisheries

i. Promotion of pure genetic breeds of sheep/ goat and Yak.

ii. Development of pasture (Bugyal) for grazing.

iii. Establishment of Fodder Bank at block level to meet fodder requirement of area.

iv. Organisation of timely de-worming and vaccination programmes of livestock.

v. Organisation of regular training programmes & awareness.

Strategy 3: Integrating Farming system

i. Pulse + Fruits + vegetable+ Medicinal plants + sheep/goat rearing

Strategy 4: Integrating Farming system

i. Installation of mini-grading & processing centres for Fruit, vegetable and wool.

ii. Establishment of packing & storage facilities for Processed/raw fruits and vegetables.

Strategy 5: Waste land development and waste water

i. Development of pasture (Bugyal) and Meadow for grazing.

ii. Construction of trenches, check dams/ trenches at each cluster.

Strategy 6: Reduction of cultivation cost

i. Adoption of Power weeders, horticultural kits, power tree sprayers through custom hiring centre at each Panchayat.

ii. Promotion of timely availability of seeds, fertilizers, insecticides, pesticides etc. at Panchayat level.

iii. Strengthening Chakbandi of scattered land

iv. Organisation of training programmes to increase scientific Knowledge.

v. Promotion of practice of IPM and INM by farmers

Strategy 7: Off-farm income

i. Encouragement to existing SHGs for collective farming, opening small scale enterprise like Pickle making, Jam & Jelly making, & packing etc. for better performance at cluster level.

ii. Establishment of distillation unit for medicinal & aromatic plants.

iii. Promotion to micro entrepreneur employment through Bee keeping, Processing of fruits, vegetables, Woollen knitting & Handicraft, Agri-clinic at each cluster.

Strategy 8: Enabling Policies

i. Promotion of secondary agriculture

ii. Checking migration by attracting rural youth in agriculture.

iii. Promotion of eco-village tourism through rural youth

iv. Ensure sustainable agriculture through more efficient utilization of land, water and other resources.

v. Implementation of Soil Health belts.

Strategy 9: Marketing and value addition

i. Popularisation of Cooperative societies may become a tool of marketing channels.

ii. Promotion of better transportation facilities with cold chain van at Block level.

iii. Creating direct linkages with food processing industries for better prices.

iv. Establishment of fruit & vegetable processing units in clusters.

v. Creation of post harvest facilities including grading, packaging for Processed /raw fruits and vegetables in each belts.

Strategy 10 : Online Management and Evaluation

i. Development of mobile apps/ software for online management of farmers as well as concerned experts.

ii. Creation of link between district level committees of State line departments and KVK experts for field and as well as online monitoring, evaluation and feedback.

iii. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.

iv. Organization of monthly review meeting at district to solve the problems related with farmers.

v. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

10.3 Comprehensive Strategy and interventions for doubling of farmers' income

The following interventions can be made to double the farmer's income in Himachal Pradesh over the next 5 years.

Technological Interventions

- Of the total 5.40 lakh hectares of farmland in the state, only 18-20% is irrigated, which is far below the national average of 49% in India. Since there is plenty of water in Himachal Pradesh, there is an urgent need to improve irrigation infrastructure to cover > 50% of the cultivable area under irrigation for increasing the production and productivity of different crops. This can be achieved by tapping the water from rivers and rivulets through water channels and pipes along the hill slopes; construction of small and medium sized dams, barrages, and tanks on All of Small Rivers and Rivulets, and use the stored water by lift irrigation and/or gravity flow.
- Supplement irrigation water supply through storage of spring water in large tanks, rainwater harvesting and recharge of the groundwater through check dams and percolation tanks.
- Improve water use efficiency through drip and sprinkler irrigation, and moisture conservation through crop residue/polythene mulching and intercropping for sustainable crop production. Adopt precision farming, hydroponics and multi-story cropping systems.

Adopt high/low/ultralow density plantings of different fruit trees to increase productivity.

- Diversification of agriculture/ horticulture/ forestry through high value cash crops such as fruits (apple, plum, peach, pear, apricot, pecan nut, kiwi fruit, pomegranate, mango, litchi, orange, cherry), vegetables (tomato, peas, capsicum, beans, cole crops, and cucurbits), flowers(rose, carnation, chrysanthemum, Gerbera, marigold and gladiolus), agroforestry (Grevia, mulberry, poplar, willow), timberwood, mushrooms, beekeeping and medicinal plants (*Valeriana jatamansi*, *Viola odorata*, *Picorrhiza kurroa* Amla, and grafted Harar).
- Improved and timely availability of quality seed of cereals, legumes, vegetables, flowers, and saplings of fruit plants (for example, hybrid seeds of okra, tomato, radish, carrot, cauliflower, bell pepper chilies, cabbage and beetroot), and appropriate varieties suited for

protective cultivation to the farmers.

- Varietal shift and use of improved management practices for different fruit crops in different zones. For example:
  - **Mango-** Regular bearing and frost tolerant varieties in Zone I, and cultural management practices to regulate plant growth and fruit bearing for high productivity.
  - **Citrus**- Varietal shift and management practices, use of selective insecticides, and use of grass/ polythene mulching for moisture conservation.
  - **Litchi**–Ensured irrigation to avoid fruit cracking.
  - **Peach, Plum, Apricot and Kiwi** - Varietal shift and management practices with emphasis on training, pruning, and drip irrigation.
  - **Apple and Pear** - Shift to clonal rootstock based high/low/ultralow density plantations of self-fruiting varieties, supplemented with drip irrigation, proper training and pruning, managed pollination through pollinators and pollinizers.
  - **Cherry** - Management practices + use of drip irrigation.
  - **Potato-** Varietal shift to KufriHimalini andcultural management practices (potato - French bean system), effective white grub management can increase the yields by 17%.
  - **Maize-**Mixed cropping with pulses.
  - **Wheat-** Mixed cropping withmustard, chickpea or peas.
  - **Mushroom-**Integration with farming systems (crop – livestock system) under low and mid-hill regions.
- Promotion of improved pasture and grassland management, agroforestry, and cultivation of sweet stalk sorghum, maize and pearl millet to increase milk production through cooperative societies.
- Promotion of integrated farming comprising of crossbred, exotic or Indigenous milch breeds of dairy cattle/Yak, fisheries, sheep, goats, backyard poultry, pig, emu and rabbits. Use of advanced fingerlings of fish for increasing productivity **in fisheries**.
- Promotion of **Cluster approach/Contract farming** for efficient crop management, and linking production centers with markets and value addition through processing.

Market Interventions

- Reduction of post-harvest and in-transit losses by developing a chain of cold stores, reefer trucks in strategic alliance with agribusiness cooperatives.Strengthening of main and link roads, timely availability of transport vehicles, market intelligence, cold storages, warehouses, processing units, and promotion of grower societies (Co-operative marketing), and auction yardsto increase net profits.

- **Post-harvest technology** for **value addition,** value added products of ginger, mango, citrus, ginger, garlic and vegetables, extraction of pectins, kernel oil of apricot, and value added/dried products of apple, plum, pear, apricot, fig and vegetables.

Institutional Support

- **Land fragmentation**has resulted in disruption of economies of scale, and hence, it should be mandatory to define the minimum size of holdings that areeconomically viable.
- **Cultivation of arable lands** should be made mandatory, and the stray cattle and wild animals be controlled through policy/ legislation.
- **Promote public -** private partnership.
- **Define** quality standards for crop produce and link it to prices.
- **Minimum support price** and buy back mechanisms to reduce on-farm losses.
- **Promotion of e-trading,**both for the agricultural inputs and the crop produce.
- Reform **Import/Export policies**to promote farming.
- Provision of loans at **differential rates** of interest for different categories of farmers (linked to size of land holdings).
- Farm mechanization support for reducing labor input costs.
- Bringing majority of the farmers under **Crop Insurance Schemes** to mitigate risks of crop failures. Only 4.4% farmers have been brought under Weather Based Crop Insurance Scheme (WBCIS) in apple crop only.
- Allotment of “Nautaur land” out of the ceiling-surplus, and wastelands specially in the tribal areas, to increase the size of land holding to small farmers.
- Implementation of Prof MSSwaminathanCommittee Report for **50% profit pricing** of agricultural produce to the farmers.
- Development of **farmers’ produce organizations (FPO’s)**for leveraging institutional support and facilitating direct farmer-consumer linkage to vanish the role of middle/ business man.
- Levy a fee of Rs10 per quintal of produce, and allocation of an equal amount by the central Government, and use these funds for supporting research and development activities in agricultural universities/institutions, as is the case in several countries in the Northern Hemisphere.

Strengthening on-farm and off farm training services

- Formal trainings and use of communication media to enhance farmers’ knowledge for undertaking farming on scientific basis and generating employment opportunitiesduring the off season.
- Orientation of farmers towards cashless transactions for purchasing inputs and sale of farm produce.Enhancing managerial and marketing skills of the farmers in production of high value cash crops.

- Research and development programs through public and private partnership will lead to doubling the farmers' income for food and national security.

10.4 Summary and Recommendations

Sustainability of the agricultural production systems, and food and nutritional security are the major challenges due to climate variability and climate change in Himachal Pradesh. Farming systems in Himachal are frequently threatened by floods, prolonged periods of droughts, pest outbreaks, hailstorms, low chilling in high hills and frost damage in the lower Shivalik Hills. Because of availability of food grains at cheaper rates in the public distribution system, and the aspirations of the youth for white collar jobs, crop damage by the stray cattle and wild animals, the people are giving up farming, as result, nearly 50% of the arable land is lying vacant, which is being increasingly infested by weeds. Therefore, there is an urgent need to develop cost-effective alternative farming systems to attract the youth to farming to increase farmers' income in Himachal Pradesh. There is an urgent need to:

- Improve irrigation from 19 to cover >50% of the area under cultivation through check dams-tanks.
- Integrate wheat/maize based cropping system with legumes and agro-forestry/ horticulture.
- Timely availability of quality planting material of vegetables, flowers, fruits.
- Adopt high/ ultra high-density planting of fruit crops to increase productivity.
- Reduce post harvest losses, promote drying and value addition.
- Diversification of farm income through crop-livestock farming, beekeeping, sericulture, fisheries, mushroom cultivation, agro-forestry, floriculture and aromatic and medicinal plants.
- Adoption of protected cultivation, aquaponics and aeroponics.
- Consolidation of land holdings: Define the minimum size of land holdings.
- Cooperative/contract farming: Need of the hour.
- Minimum support price: Buy back mechanism to reduce on-farm losses.
- Farm mechanization: Technological support for reducing labour input.
- Crop insurance: To mitigate the risk of climate change and crop failures.

SUCCESS STORIES

1. Dairy farming of Indigenous Cows

District Kangra is the largest producer milk in Himanchal Pradesh. Majority of the farmers are rearing crossbred animals, which have high production potential, but are more susceptible to various parasites and diseases. Additionally, the milk produced by these crossbred animals is more likely to be of A1 type, which is considered to be less health promoting as compared to A2 milk produced by hte indigenous dairy breeds such as Red Sindhi and Sahiwal. If a farmer starts a dairy comprising of indigenous cows and gets the milk certified to be A2 type from established labs, he/ she can market the milk at a premium and earn more income. The urine and farmyard manure produced by these animals is also considered more useful for organic farming.

Fixed Cost	
Cost of indigenous animals 5 No.@ Rs 50,000 each	Rs. 2,50,000
Cost of Shelter/housing	Rs. 1,00,000
Depreciation @10%	Rs. 35,000/year
Running Cost	
Cost of Fodder	Own resources + 1,00,000
Cost of Feed@ Rs2,000/animal/month	Rs 1,20,000
Income	
Sale of Certified A2 milk @ Rs 60/l	Rs 6,00,000
Average 2,000/year/animal x5	
Sale of Urine	
Sale of FYM/Compost/Vermicompost	Use at own farm
Net income per annum	Rs 6,00,000- 2,55,000= 3,45,000 per year

2. Success story from NICRA Village

A brief statement of the Problem: NICRA village Lagga in District Chamba is situated at a height of 1500- 2,000 m amsl. The annual average rainfall is about 1,100 mm. During winters, this area receives moderate to high snowfall. This zone has a single crop in a year. Maize, cabbage, cauliflower, apple, beans and potato are the major crops grown in this area.

Farmers of this area have very small land holdings, that too without irrigation facilities. Before starting of NICRA project in this village, the farmers were earlier producting small amount of maize to meet their domestic requirements.

Natural resources: The area has a highly rugged hilly terrain, and most of the rain water is lost by surface runoff resulting in very limited ground water storage. At present, 11 water harvesting structures with 60,000- 80,000 litres storage capacity have been to augment irrigation of crops.

Plan Implementation and support

Alternate technologies: The agro-climate conditions, of this region are suitable for the cultivation of cabbage, cauliflower, beans, potato and apple. Under protected cultivation, the construction of polyhouse in the village started in 2011. The Department of Agriculture along with KVK identified the farmers for financial assistance and KVK provided the necessary inputs to the farmers.

Extension strategies: With an increase in the construction of polyhouses in the village, the training needs of extension functionaries and farmers for protected cultivation were identified by the KVK under the project, and organized 200 training programs in 2017 in which 3,000 farmers were trained for protected cultivation.

Facilities of critical inputs: Establishment of one Custom Hiring Centre in the form of machinery and other agricultural inputs helped the farmers for improved production of various vegetables crops under open as well as protected conditions.

Technical support (consultancy, advisories, training, exposure visits, farmer and scientist interface: Exposure visits of 60 farmers were conducted at CSK HPKV Palampur and PAU Ludhiana. Off campus training programmes were also conducted in the NICRA village.

Output

Initially, a group of 20 progressive farmers took up the cultivation of vegetable crops in eight village of the region. Gradually, more and more farmers took up the cultivation of vegetable crops under protected condition. At Present, there are 30 polyhouses of 1.300 sq m and more than 40 farmers are growing vegetables under protected and open field conditions.

Cultivation of vegetable crops in the area has resulted in increased income of Rs 5-6 lakhs per famers in a single cropping season.

Shift in Area under Cultivation of Different Crops at Lagga Village after KVK Intervention

Crop	Pre- NICRA	Post- NICRA	% Increase/Decrease
Maize	57.68	35.00	-39.30%
Potato	7.40	12.60	+70.30%
Apple	5.12	18.00	+251%
Cabbage	0.30	8.00	+2566%
Cauliflower	0.40	6.00	+1,400%

11

UT OF JAMMU & KASHMIR AND LADAKH

Jammu and Kashmir, state of India, located in the northern part of the Indian subcontinent in the vicinity of the Karakoram and westernmost Himalayan mountain ranges. The state is part of the larger region of Kashmir, which has been the subject of dispute between India, Pakistan, and China since the partition of the subcontinent in 1947.

The vast majority of the state's territory is mountainous, and the physiography is divided into seven zones that are closely associated with the structural components of the western Himalayas. From southwest to northeast those zones consist of the plains, the foothills, the Pir Panjal Range, the Vale of Kashmir, the Great Himalayas zone, the upper Indus River valley, and the Karakoram Range. The climate varies from alpine in the northeast to subtropical in the southwest. In the alpine area, average annual precipitation is about 3 inches (75 mm), but in the subtropical zone (around Jammu) rainfall amounts to about 45 inches (1,150 mm) per year. The Vale of Kashmir is a deep asymmetrical basin lying between the Pir Panjal Range and the western end of the Great Himalayas at an average elevation of 5,300 feet (1,620 metres). During Pleistocene times it was occupied at times by a body of water known as Lake Karewa, it is now filled by lacustrine (still water) sediments as well as alluvium deposited by the upper Jhelum River. Soil and water conditions vary across the valley.

Being a hill and mountainous state, the climate varies greatly over short distances, giving specific niche areas of cultivation. However, broadly speaking, the state of Jammu and Kashmir can be divided into four distinct climatic zones:

A. Cold arid desert zone (Ladakh region)

B. Temperate zone (Kashmir valley and Pir Panjal region)

C. Sub-tropical temperate transitional zone (Punch, Bhadarwah and Kishtwar regions)

D. Low altitude humid sub-tropical zone (Foot-hill plains and Siwalik hills of Jammu region)

The climate is characterized by annual precipitation of about 30 inches (750 mm), derived partially from the summer monsoon and partially from storms associated with winter low-pressure systems. Snowfall often is accompanied by rain and sleet. Temperatures vary considerably by elevation; at Srinagar the average minimum temperature is in the upper 20s F (about −2 °C) in January, and the average maximum is in the upper 80s F (about 31 °C) in July.

The majority of the people of Jammu and Kashmir are engaged in subsistence agriculture of diverse kinds on terraced slopes, each crop adapted to local conditions. Rice, the staple crop, is planted in May and harvested in late September. Corn, millet, pulses (legumes such as peas, beans, and lentils), cotton, and tobacco are—with rice—the main summer crops, while wheat and barley are the chief spring crops. Many temperate fruits and vegetables are grown in areas adjacent to urban markets or in well-watered areas with rich organic soils. Sericulture (silk cultivation) is also widespread. Large orchards in the Vale of Kashmir produce apples, pears, peaches, walnuts, almonds, and cherries, which are among the state's major exports. In addition, the vale is the sole producer of saffron in the Indian subcontinent. Lake margins are particularly favourable for cultivation, and vegetables and flowers are grown intensively in reclaimed marshland or on artificial floating gardens. The lakes and rivers also provide fish and water chestnuts.

Cultivation in Ladakh is restricted to such main valleys as those of the Indus, Shyok, and Suru rivers, where it consists of small irrigated plots of barley, buckwheat, turnips, and mustard. Plants introduced in the 1970s by Indian researchers have given rise to orchards and vegetable fields. Pastoralism—notably yak herding—long has been a vital feature of the Ladakh economy; breeding of sheep, goats, and cattle has been encouraged. The Kashmir goat, which is raised in the region, provides cashmere for the production of fine textiles. Some Gujjar and Gaddi communities practice transhumance (seasonal migration of livestock) in the mountains. In addition to supplying pasture for the livestock, the mountains also are a source of many kinds of timber, a portion of which is exported.

11.1 Productivity Gaps and Major Constraints:

The major constraints and challenges for agriculture and allied sectors in J&K state include:

i. There is no law on minimum land ceiling for areas used for crop production. The State has not been enforcing a strict ban on use of irrigated land for non-agricultural purposes.

ii. State cultivation has not focused on increasing cropping intensity, average yield by way of optimal use of inputs and adoption of recommended production technologies.

iii. Less credit flow in the beginning of the cropping season for the farming community with a guaranteed minimum price support.

iv. Lesser emphasis on post-harvest technologies, including handling, storage, transportation, processing and marketing. Post-harvest losses especially of perishable goods like fresh vegetables, fruits, milk, fish etc. may account for 20-40%.

v. Lack of facility for insurance cover for major crops

vi. Lack of on-farm adoption of improved technologies and varieties developed by the research institutions

vii. Lack of training to fish farmers is a major constraint in fish industry. Currently, only 1,183 fish farmers are being trained annually in J&K as against over five lakh in the country. At present, the state has only two Fish Farmers Development Agencies as against a total of 414 in 26 States of India.

viii. Major chunk of cultivated are (around 58%) in J&K is rainfed. Only about 50% of the ultimate irrigation potential of the state has been harnessed. It is responsible for low and unstable agricultural productivity in the state.

ix. The most important constraint for the animal and sheep husbandry sector is the problem of fodder in the winter season, particularly for the Valley. Prevalence of 22 certain ecology and hygiene-related diseases in domestic animals (liver fluke in domestic animals, mastitis etc.) is another constraint in realizing quality produce. The third challenge is high livestock farming costs.

x. Marketing is a major constraint in maximizing farmers' profits. Lack of satisfactory storage facilities, value addition infrastructure and regulated markets, especially w.r.t. perishable commodities, is discouraging even the rural people to adopt agriculture as a livelihood option.

11.2 Strategy and interventions for doubling of farmers' income

Agro climate specific strategy for scaling out these technologies

Agro-climatic Region: Jammu

Elevation: 305 m (1,001 ft)

Population: 5,350,811

Population density: 200/km^2 (530/sq mi)

Strategy 1 : Productivity Enhancement

Agriculture

i. Establishment of **Special Agricultural Zones** based on climate/physiographic factors and niches with emphasis on **cash crops/commodities**.

ii. Promotion of balanced use of chemical fertilizers and liquid fertilizers, judicious use of chemical pesticides, fertigaion.

iii. Promotion of drip irrigation, protected cultivation, poly tunnel for nursery raising of vegetable crops, canopy management, rejuvenation of old and senile orchards etc.

iv. Production and supply of quality **planting material** and **seed** – hybrid and HYVs; development of seed banks/stores.

v. Seed Management and Seed Replacement Rate (SRR); to sustain continuous growth in productivity, seed management plays a vital role.

vi. Focus on manure and bio-fertilizers; fertigation etc. to increase efficiency of fertilizers.

vii. Water management in both irrigated and rainfed areas which includes: Water harvesting (rainfall, runoff, roof top water etc.), rejuvenation of traditional water bodies, augmentation of water storage structures, micro-irrigation, fertigation etc to enhance water use efficiency; Creation of additional water storage low hills for lean season; Promotion of water conservation techniques like mulch, sprinkler and drip in juvenile plants in low or valley areas.

viii. Mechanization for increasing farm efficiency - by providing prototypes, subsidizing and developing custom hiring centers. Farm mechanization in Jammu & Kashmir is limited to operations like ploughing etc.

ix. Promotion of Integrated Farming System (IFS); viz poultry + livestock + horticulture + Composting + or horticulture + fisheries + dairy + Composting + Protected cultivation etc

Horticulture

i. Crop diversification and value addition: high value crops like mango, guava, olive, strawberry etc, niche specific cropping, floriculture, medicinal & aromatic plants. Diversification towards these high value and labour intensive commodities can provide adequate income and employment to the farmers dependent on small size of farms. Due importance should be given to quality and nutritional aspects.

ii. Intensive cultivation e.g. High Density Plantation (HDP), intercropping, multiple cropping etc.

iii. Production of quality planting material, bud-wood and rootstocks for high density planting.

iv. Canopy management and plant architectural engineering

v. Hi tech horticulture for nutritional security, breeding for health traits, high altitude research, value added plant propagation, providing soil health cards.

vi. Rejuvenation and revival of old and senile orchards and revival of traditional apple variety Ambri through breeding, selection and orchard management.

vii. Modernization and establishment of hi-tech nurseries with facilities of virus indexing, bud wood/root stock banks etc

viii. Creation of irrigation network/systems through CSS like PMKSY, establishment of microirrigation models,, augmentation of irrigation assets over 65% land area that is at the mercy of monsoon and sporadic rainfall.

ix. Establishment of centre of excellence for production of quality planting material of elite varieties, breeding for development of trait specific varieties, import of new germplasm lines, crop improvement and molecular characterization of horticultural crops etc

x. Pollination management in horticultural crops for different densities

xi. Hort-Net facilities and state coordination cell for development of efficient coordination between universities and various line departments for uniformity in data collection, human resource development etc.

xii. Protected and Precision farming: Promotion of polyhouse technology; use of technology to manage the inputs at the micro level – hydroponic, aeroponics, minimum tillage, micro-irrigation & fertigation etc

xiii. Management of soil health in low or valley areas: Organic cultivation of local grain, millets etc in different blocks; Promotion of soil amendments in reclamation of problematic and degraded soil in some regions of the valley. Attention should be given to balanced use of nutrients.

Areas have been identified for growing fruits plants in different areas of Jammu Division as:

i. Jammu with potential area of 17000 ha having sub-tropical climate we can grow mango, citrus, guava, ber, loquat, aonla and cash crops like grapes and strawberry

ii. Samba is having 8000 ha potential area having sub-tropical climate crops like mango, citrus, guava, ber, loquat, aonla and cas crops like grapes and strawberry can be grown

iii. Kathua with 17000 ha, Udhampur with 15000 ha, Reasi with 17000 ha, Rajouri with 15000 ha of potential area having sub-tropical to intermediate/temperate zone crops like apple, pear, walnut, pecan nut, stone fruits in intermediate/temperate climate and mango, citrus, guava, ber, loquat, aonla and cas crops like grapes and strawberry in sub-tropical region are recommended.

iv. Kishtawar, Doda, Ramban and Poonch having 12000, 20000, 7000 and 22000 potential area for fruit crops with temperate climate and thus crops like apple, pear, walnut, pecan nut, stone fruits are recommended.

Animal husbandry and poultry

i. Promotion of good quality breeds.

ii. Selection of high milk breeds in cattle and buffalo.

iii. Establishment of Fodder Bank in Rajouri, Poonch, Doda etc to meet fodder requirement of area.

iv. Establishment of milk chilling plant at Jammu, Udhampur, Reasi and Rajouri districts.

v. Establishment of elite mutton type stud rams mother farms. The superior rams produced in these farms can be distributed in niche belts suited for mutton production

vi. Devising pilot projects in a phased manner for introduction of AI in sheep and goat.

vii. Popularization of welfare schemes for the benefit of farmers like Dairy

viii. Entrepreneurship Development Scheme, Poultry Venture Capital Fund

ix. Scheme, Rural Backyard Poultry Development Scheme, Private Paravet

x. Scheme, Livestock Insurance Scheme etc.

xi. Shift from traditional rearing mode to in house management for round the year availability of quality mutton.

xii. Promotion of exotic hens having higher laying potential;

xiii. Production of quality fodder – reclamation of wasteland, hydroponics etc

xiv. Increase egg production through improved variety of backyard poultry

xv. To make backyard poultry sector an effective tool for production of poultry meat in the state

xvi. Production of quality fodder – reclamation of wasteland, hydroponics etc

xvii. Ensuring availability of feed material at lower prices.

xviii. Organization of health check-ups camps for animals.

xix. Appointment of veterinary experts at block level.

xx. Regular vaccination and diseases management on time

Fisheries:

i. Increasing hatching and rearing space for production of quality fish seed in the existing hatcheries/fish farms of the department.

ii. Development of Recreational Fisheries (Sport and Ornamental Fisheries)

iii. Reclamation of hitherto un-exploited areas for development of Fisheries

iv. Development of Sport Fisheries Jammu Regions.

v. Development of Marketing Facilities for fish and fish product by way of establishment of Wholesale /Retail Fish Markets.

vi. Large scale development of fish ponds

vii. Fish processing and storage infrastructure development

Strategy 2 : Access to market for better realization of farmers'produce

i. Development of cold chain system for fruits and vegetables

ii. Promotion of farmer producer organization (FPOs);

iii. Promoting special commodity markets;

iv. Establishment of platform where farmers can be connected to e-market;

v. Adoption of contract farming;

vi. Public Private Partnership in creation of farm level infrastructure;

vii. Strengthening value chain;

viii. Use of ICT in marketing;

ix. Creation of better transportation facilities with cool chain van at Block level.

x. Creation of direct linkages with food processing industries for betterprices.

xi. Establishment of strong linkages with various stake holders to furnish information on crop produce and surplus.

xii. Establishment of procurement and collection centre at panchayat level for agricultural surplus with proper labelling.

xiii. Installation of mini grading machines at village level.

xiv. Establishment of cold room in different clusters

Strategy 3 : Policy support

i. Amendment of APMC

ii. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.

iii. Labelling of organic inputs and certification mechanism for various crops.

iv. Land holding ownership, leasing policy;

v. Water management policy;

vi. Implementation of centrally sponsored schemes without delay.

vii. Minimum Support Price based on cost of production and profit margin;

viii. Forewarning about natural calamities to the farmers;

ix. Immediate relief to farmers in case of natural calamities;

x. Training and sensitization to the farmers to adopt latest technique;

xi. Implementation of Soil Health Card Scheme in each block.

Strategy 4 : Infrastructural Development

i. Strengthen R&D activities in farm Universities/Institutions for providing site-specific technical support to all farm developmental agencies operating in the State.

ii. Road connectivity & provision of uninterrupted power supply;

iii. Strengthening infrastructure based on PPP mode, such as go-downs, cold storage etc.

iv. Creation of modern infrastructure for preservation and processing of agri produces

v. Mini Grading machines should be installed at village level

vi. Fruit & vegetable processing units should be installed in cluster.

vii. Packing facilities for Processed /raw fruits and vegetables should be incorporated in clusters

viii. The public investment in agriculture has been declining and is one of the main reasons behind the declining productivity and low capital formation in the agriculture sector. With the burden on productivity - driven growth in the future, this worrisome trend must be reversed.

ix. Private investment in agriculture has also been slow and must be stimulated through appropriate policies. Considering that nearly 70 percent of India still lives in villages, agricultural growth will continue to be the engine of broad-based economic growth and development as well as of natural resource conservation, leave alone food security and poverty alleviation. Accelerated investments are needed to facilitate agricultural and rural development

Strategy 5 : HRD and Extension

i. Skill development training: This one of the most important flagship programmers of Govt. of India (Kaushal Vikas Se Krishi Vikas) which emphasizes that farmer's income can be enhanced by imparting skill development training in agriculture. Due to its importance Agriculture skill Council of India (ASCI) was established.

ii. Use of ICT in extension: It is essential for rapid dissemination of customized information to the farmers for increasing the rate of adoption of innovations.

iii. Farmers to farmer extension (F2FE): Farmers seek advice and information related to agriculture from fellow farmers. The NSSO date also reveals that only 40 per cent farmers had access to any source of information on modern technology. Of those who had access to such information, the highest proportion obtained information from other progressive farmers.

iv. Village knowledge centre: There should be knowledge centre at Village level so that farmers get access to modern technologies in the village itself.

v. Strengthening of convergence: Convergence of KVK, ATMA, Line department, bank, cooperatives etc need to be strengthened for resources as well as expertise.

Strategy 6 : Waste land development and waste water

i. Contour making for arable purpose in waste land in hilly areas of Jammu division. Aforestation of plants and perennial grasses in steep slope of more than 40% slope.

ii. Promotion of plantation of horticultural crops, medicinal and aromatic plants and floricultural crops

iii. Popularization of trenches or silages for percolation of water to avoid surface run off.

iv. Construction of tank for storage of water for lean season.

Strategy 7 : Reduced cultivation cost

i. Application of deficit fertilizers and micronutrients

ii. Popularization of power tillers, power weeders, paddy threshers, wheat threshers, millet threshers for reducing cost of cultivation.

iii. Promotion of line sowing and judicious use of fertilizer application in crops.

iv. Promotion of recommended seed rate, spacing and depth.

v. Promotion of organic farming; mulching (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.

vi. Establishment of sales and community centres for easy and timely availability of seeds, seedlings, fertilizers.

vii. Promotion of practice of own seed production by farmers,

viii. Promotion of practice of IPM and INM by farmers

Strategy 8: Off-farm income

i. Creation of SHGS and encouragement of micro-entrepreneurship and collective farming.

ii. Promotion of value added product making, mushroom production, and apiculture.

iii. Promotion of skill development in women and youth

iv. The encouragement to existing SHSs for collective farming, opening small scale enterprise like Candle making, Pickle making, Jam & Jelly making, woollen knitting, handicraft & packing, etc. may be provided for better performance.

v. New SHGs may also be created other villages of the district.

Strategy 9: Online Management and Evaluation

i. Information is power and will underpin future progress and prosperity.

ii. Efforts will be made to strengthen the informatics in agriculture by developing new databases, linking databases with international databases and adding value to information to facilitate decision making at various levels.

iii. Development of production models for various agro- ecological regimes to forecast the, production potential should assume greater importance. Using the remote sensing and GIS technologies, natural and other agricultural resource can be mapped at micro and macro levels and effectively used for land and water use planning as well as agricultural forecasting, market intelligence and e-business, contingency planning and prediction of disease and pest incidences.

iv. Facilitation with easily operative mobile app and software for online management, evaluation, monitoring, feedback and reading by farmers, state agriculture department and KVKs.

v. Development of Mobile apps/ software for online management and evaluation at district level.

vi. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.

vii. Organization of monthly review meeting at district to solve the problems related with farmers

viii. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

ix. Formation of digital library, digital kisan centre at village level.

Strategy 10: Accent on Empowering the Marginal & Small Farmers

i. Greater emphasis needs to be placed on non-farm employment and appropriate budgetary allocations and rural credit through banking systems should be in place to promote appropriate rural enterprises.

ii. Specific human resource and skill development programmes to train them will make them better decision-makers and highly productive.

iii. Watershed development and water saving techniques will have far reaching implications in increasing agricultural production and raising calorie intake in the rainfed areas. Livestock sector should receive high priority with multiple objectives of diversifying agriculture, raising income and meeting the nutritional security of the poor farm households.

iv. Need based and location-specific community programs, which promise to raise nutritional security, should be identified and effectively implemented.

v. Expansion of micro credit programmes for income-generation activities.

vi. Development of the postharvest sector, co-operatives, roads, education, and research and development should be an investment priority.

vii. Small-mechanised tools can minimise drudgery without reducing employment and add value to the working hours for enhancing labour productivity.

viii. Creation of rural centres of production and processing by masses through co-operatives can be encouraged.

Agro-climatic Region: Kashmir

Strategy 1: Productivity Enhancement

Agriculture & Horticulture:

i. Establishment of Special Agricultural Zones based on climate/ physiographic factors and niches: Department of Agriculture in consultation with other departments and SAUs/ ICAR Institutes shall develop agricultural zone map of Kashmir region and identify niche crops/commodities to be promoted (with increased focus) in that zone, with emphasis on cash crops/commodities. Crops like kala zeera and potato should be promoted in Gurez region of Bandipora district, vegetable promotion in Narakara area of Budgam, saffron cultivation in Pulwama, walnut cultivation in district Ganderbal etc.

ii. Replacement of old and traditional varieties with high yielding varieties in apple, pear, walnut, apricot, cherry, peach and plum crops.

iii. Production and supply of quality planting material and seed – hybrid and HYVs; development of seed banks/stores. Quality seeds of vegetables and planting material of horticultural crops need to be assured through registered nurseries/institutions/ departments. Virus free planting material of horticultural crops, disease free seeds of pulses, millets, cereals etc. Development of seed banks for storage and timely supply of seeds at block level.

iv. Focus on manure and bio-fertilizers; fertigation etc. to increase efficiency of fertilizers.

v. Water management in both irrigated and rainfed areas which includes: Water harvesting (rainfall, runoff, roof top water etc.), rejuvenation of traditional water bodies, augmentation of water storage structures, micro-irrigation, fertigation etc to enhance water use efficiency; Creation of additional water storage low hills for lean season; Promotion of water conservation techniques like mulch, sprinkler and drip in juvenile plants in low or valley areas.

vi. Mechanization for increasing farm efficiency - by providing prototypes, subsidizing and developing custom hiring centers;

vii. Promotion of Integrated Farming System (IFS); viz poultry + livestock + horticulture + Composting + or horticulture + fisheries + dairy + Composting + Protected cultivation etc

viii. Crop diversification - high value crops like apple, pear, peach, plum, apricot, cherry, almond, walnut, olive, kiwi fruit, hazel nut, strawberry etc, niche specific cropping, floriculture, medicinal & aromatic plants, high value vegetable like lettuce, parsley, celery, artichoke, Chinese cabbage etc will fetch more price and increase the economy of the farmers.

ix. Intensive cultivation e.g. High Density Plantation (HDP) with suitable architectural engineering systems in apple, cherry, peach etc to accommodate more number of plants with higher yield potential. Use of new generation cultivars suitable for high density orcharding systems grafted on clonal root stocks. In annual crops use of cultivars with less juvenile period to enhance cropping intensity and productivity.

Protected and Precision farming

– Promotion of polyhouse technology; use of technology to manage the inputs at the micro level

– hydroponic, aeroponics, minimum tillage, micro-irrigation & fertigation etc.

Management of soil health in low or valley areas

Organic cultivation of local grain, millets, saffron, walnut etc in different blocks; Promotion of soil amendments in reclamation of problematic and degraded soil in some regions of the valley.

Animal Husbandry

i. Management of genetic resources by adopting central herd registration and progeny testing.

ii. Establishment of genetic resource pools for making available elite germplasm to attain desirable level of upgradation in cattle

iii. Introduction of elite semen for improving quality of local cattle Improved breeds; through crossing

iv. Development of cooperatives (Non-Government cooperatives) Selection of high milk breeds in cattle.

v. Since repeat breeding is the main problem in crssing therefore more research work on repeat breeding need to be done

vi. While breeding exotic blood/proportion should not exceed 60% because it reduces hybrid vigour.

vii. Development of proper vaccination to control all the strains of virus casing FMD in cattle

viii. Establishment of Fodder Bank in Ganderbal, Anantnag, Bandipora, Kupwara and Handwara districts to meet fodder requirement of area.

ix. Establishment of milk chilling plant at Srinagar, Budgam, Ganderbal, Pulwama and Kupwara districts69

x. Establishment of elite mutton type stud rams mother farms. The superior rams produced in these farms can be distributed in niche belts suited for mutton production

xi. Devising pilot projects in a phased manner for introduction of AI in sheep and goat.

xii. Shift from traditional rearing mode to in house management for round the year availability of quality mutton.

Poultry

i. Popularization of dual purpose poultry breed "Kashmir

ii. Commercial Layer" which gives about 150-180 eggs/year against 70-80 eggs in conventional breeds and also attains a weight upto 2 kgs in 6 months and thus can increase the economy both ways.

iii. Development of hatcheries in Kashmir division to avoid the financial inputs upto the tone of RS 30 lakh/month in importing the one day old chicks from rest of the state.

iv. Adoption of back yard poultry;

v. Promotion of exotic hens having higher laying potential;

vi. Increase egg production through improved variety of backyard poultry

vii. To make backyard poultry sector an effective tool for production of poultry meat in the state.

viii. Popularization of corn cultivation can have dual benefits as fodder and poultry feed and thus can be important part of IFS.

Fisheries

i. Cold water fisheries; fish farming, high nutrition fish feeds

ii. Large scale development of fish ponds in Ganderbal, Budgam, Bandipora, Kupwara, Handwara, Srinagar, Budgam and Kulgam districts

iii. Increasing hatching and rearing space for production of quality carp and trout seed in the existing hatcheries/fish farms of the department.

iv. Development of Recreational Fisheries (Sport and Ornamental Fisheries)

v. Reclamation of hitherto un-exploited areas for development of Fisheries

vi. Development of Sport Fisheries Kashmir Regions.

vii. Development of Marketing Facilities for fish and fish product by way of establishment of Wholesale /Retail Fish Markets.

viii. Introduction of Cold storage facilities for maintaining the hygiene in the Marketing of fish

Strategy 2: Access to market for better realization of farmers' produce

i. Development of cold chain system for fruits and vegetables in all the districts of Kashmir with special attention to fruit growing districts like Baramulla, Shopian, Pulwama and kulgam

ii. Promotion of farmer producer organization (FPOs);
iii. Promoting special commodity markets;
iv. Establishment of platform where farmers can be connected to e- market;
v. Adoption of contract farming;
vi. Public Private Partnership in creation of farm level infrastructure;
vii. Strengthening value chain;
viii. Use of ICT in marketing;
ix. Creation of better transportation facilities with cool chain van at Block level.
x. Creation of direct linkages with food processing industries for better prices.
xi. Establishment of strong linkages with various stake holders to furnish information on crop produce and surplus.
xii. Establishment of procurement and collection centre at panchayat level for agricultural surplus with proper labelling.
xiii. Installation of mini grading machines at village level.
xiv. Establishment of cold room in different clusters.

Strategy 3: Policy support

i. Amendment of APMC
ii. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.
iii. Labelling of organic inputs and certification mechanism for various crops.
iv. Establishment of mandatory meteorological/observatory at block level to get first hand information of climatic changes.
v. Land holding ownership, leasing policy;
vi. Water management policy;
vii. Implementation of centrally sponsored schemes without delay.
viii. Minimum Support Price based on cost of production and profit margin;
ix. Forewarning about natural calamities to the farmers;
x. Immediate relief to farmers in case of natural calamities;
xi. Training and sensitization to the farmers to adopt latest technique;
xii. Implementation of Soil Health Card Scheme in each block.
xiii. Promotion of secondary agriculture
xiv. Implementation of schemes like National Livestock Mission in the whole state and redrafting of National Mission on Protein Supplements.

Strategy 4: Infrastructural Development

i. Strengthen R&D activities in farm Universities/Institutions for providing site-specific technical support to all farm developmental agencies operating in the State.

ii. Road connectivity & provision of uninterrupted power supply;

iii. Strengthening infrastructure based on PPP mode, such as go-downs, cold storage etc.

iv. Creation of modern infrastructure for preservation and processing of agri produces, establishment of grading, packing, storage and processing facilities to reduce post harvest losses and value addition of fruits and vegetables in districts like Pulwama, Shopian, Baramulla and Budgam.

Strategy 5 : HRD and Extension

i. Skill development training: This one of the most important flagship programmers of Govt. of India (Kaushal Vikas Se Krishi Vikas) which emphasizes that farmer's income can be enhanced by imparting skill development training in agriculture. Due to its importance Agriculture skill Council of India (ASCI) was established.

ii. Use of ICT in extension: It is essential for rapid dissemination of customized information to the farmers for increasing the rate of adoption of innovations.

iii. Farmers to farmer extension (F2FE): Farmers seek advice and information related to agriculture from fellow farmers. The NSSO date also reveals that only 40 per cent farmers had access to any source of information on modern technology. Of those who had access to such information, the highest proportion obtained information from other progressive farmers.

iv. Village knowledge centre: There should be knowledge centre at Village level so that farmers get access to modern technologies in the village itself.

v. Strengthening of convergence: Convergence of KVK, ATMA, Line department, bank, cooperatives etc need to be strengthened for resources as well as expertise.

Strategy 6: Waste land development and waste water

i. Contour making for arable purpose in waste land in hilly areas of Kashmir division.

ii. Afforestation of plants and perennial grasses in steep slope of more than 40% slope.

iii. Promotion of plantation of horticultural crops, medicinal and aromatic plants and floricultural crops

iv. Popularization of trenches or silages for percolation of water to avoid surface run off.

v. Construction of tank for storage of water for lean season.

Strategy 7: Reduced cultivation cost

i. Promotion of well decomposed FYM, Vermicompost and Bio-fertilizers to minimize the use of chemical fertilizers.

ii. Promotion of line sowing and judicious use of fertilizer application in crops.

iii. Promotion of recommended seed rate, spacing and depth.

iv. Promotion of organic farming; mulching (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.

Strategy 8: Off-farm income

i. Promotion of occupation like silkworm, bee keeping, poultry, fish farming and mushroom will harness the potential of new or improved technology in farming occupation.

ii. Promotion of cultivation and collection of medicinal plants.

iii. Promotion of skill development in women and youth

Strategy 9: Online Management and Evaluation

i. Development of Mobile apps/ software for online management and evaluation at district level. Mobile applications like Nutrient Diagnoser and Manager has been developed by CITH, Srinagar and also one software application Predictor and Planner for Almond cultivation which has been licensed. Use of these type of softwares/mobile applications can play an important role in bridging the gap between laboratory and land and thus increase the efficacy of farming.

ii. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.

iii. Organization of monthly review meeting at district to solve the problems related with farmers.

iv. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

Agro-climatic Region: Ladakh

Strategy 1: Productivity Enhancement

Agriculture & Horticulture:

i. Organic farming in Ladakh: Ladakh region is highly suitable for sustainable organic farming of agriculture and horticultural crops.

ii. Focus on vegetable intensive production: Regarding the interventions made by various research and developmental institutions like Defence Institute of High Altitude Research (DIHAR), there has been a tremendous improvement in the diversity, quantity and quality of cultivated crops (especially vegetables). It has been demonstrated (on field conditions) that around 68 different kinds of vegetables (both European and Asiatic type) can be successfully grown in Ladakh. Presently, local farmers in Ladakh are successfully growing newly introduced crops like kale, parsely, celery, summer squash, okra, and various cucurbits also. The increase in crop diversity has helped them to increase their income and improve their nutritional uptake. At present 51% of Army's (a major market for local produce) total fresh vegetables requirement (7000 MT) is fulfilled by the local farmers. At present local farmer's cooperative is supplying 28 different kinds of vegetables to army. It not only provides income to the local farmers but also saves a large chunk of expenditure incurred on transportation.

iii. Green house cultivation: In Ladakh region the greenhouse technology is of immense use to the farming community. This technology helps farmers grow fresh vegetables during winter months also when temperature dips down below freezing level. As per the diversified farming community of Ladakh, DIHAR has designed various types of passive solar greenhouses to cater to the needs of local farmers as per their resource availability e.g. polycarbonate and FRP greenhouses for Resource Rich Farmer (RRF), Polytrench and trench greenhouses for Resource Poor Farmers (RPF).

iv. Vegetable seed production: For seed production of certain vegetables crops climatic conditions of Ladakh are suitable. The region enjoys the availability of long photoperiod, high light intensity, low rainfall and humidity and low disease and pest incidence. All the fields where wheat and barley are growing in Ladakh are suitable for seed production of vegetables.

v. Focus on manures & bio-fertilizers and fertigation etc. to increase efficiency of fertilizers: Productivity enhancement depends on the soil health and nutrient status, soil in Ladakh region are not so fertile and therefore use of balanced fertilizers is required to obtain the potential yield of crops.

vi. Diversification of Ladakh's agricultural base, so as to minimise the risk of a single crop failure. Promotion of Sea-buckthorn, the thorny shrub with diverse uses ranging from medicinal to cosmetic, has the potential to change the economy of India's Himalayan desert region of Ladakh, where it is sometimes referred to as gold but also destroyed as a weed.

vii. Introduction and domestication of high yielding crop varieties.

viii. Motivating and supporting farmers to adopt the appropriate technologies so as to increase production.

ix. Promoting the horticultural sector in the region.

x. Value addition and marketing of agricultural products.

xi. Dissemination of technical knowledge of agricultural extension through trainings, workshops and meetings.

xii. Water management: Ladakh region is considered as cold arid region and therefore water management plays important role in enhancing the productivity of crops. Water harvesting (rainfall, runoff, roof top water etc.), rejuvenation of traditional water bodies, augmentation of water storage structures, micro-irrigation, fertigation etc to enhance water use efficiency; Creation of additional water storage low hills for lean season; Promotion of water conservation techniques like mulch, sprinkler and drip in juvenile plants in low or valley areas is required.

xiii. Mechanization for increasing farm efficiency - by providing prototypes, subsidizing and developing custom hiring centres;

xiv. Promotion of Integrated Farming System (IFS); viz Protected cultivation + Composting + livestock/backyard poultry or Fodder production + Mini dairy + Composting + Protected cultivation etc

xv. Crop diversification with high value crops, niche specific cropping, floriculture, medicinal & aromatic plants. ICAR-CITH, Srinagar, SKUAST-Kashmir, SKUAST-Jammu and other Institutes/departments in the valley have identified the high value crops like kiwi fruit, olive, hazelnut, pecan nut, pistachio nut, Cape goose berry etc which can be fitted under crop diversification for maximizing the economic returns of the farmers.

xvi. Intensive cultivation: High density plantation (HDP) in high chill apple, apricot etc.

xvii. Protected and Precision farming: Promotion of polyhouse technology; use of technology to manage the inputs at the micro level– hydroponic, minimum tillage, micro-irrigation & fertigation etc. DIHAR, a laboratory of premier Defence Research and Development Organisation (DRDO) based in Leh has been researching on techniques of growing fruits and vegetables in the cold desert of Ladakh, and is helping hundreds of farmers here to earn better living and higher production. While greenhouses for maintaining temperature are expensive and not affordable for all farmers, the Leh-based laboratory has developed simple techniques like trench farming and use of polythene sheets that help farmers grow a variety of vegetables like cabbages, onions, spinach, gourd and even watermelons in a highland which did not know any of these vegetables a decade back.

xviii. Management of soil health: Organic cultivation of local grain and millets in different blocks; Promotion of soil amendments in reclamation of problematic and degraded soil in Leh and Kargil

Animal husbandry and poultry

i. Up gradation of cattle with exotic breeds like jersey breed through Artificial Insemination with frozen semen technology as well as with natural service.

ii. Selection of high milk breeds in yak and cattle.

iii. Conservation and propagation of native breeds of Yak and Zanskari Horse/ Ponies.

iv. Up-gradation of Russian Merino Farms, Matho; Mohair Goat Farm, Stakna; Intensive Fodder Development Farm Stakna; Pashmina Goat Farm Khuril (Nyoma); Upshi Pashmina Goat Project and other farms and projects to improve the quality and output efficiency of these farms for enhancing outcome.

v. Establishment of Fodder Bank in Zanaskar, Leh and Kargil region to meet fodder requirement of area.

vi. Establishment of milk chilling plant at Leh

vii. Optimum utilization of goats / sheeps for pushmina /wool production;

viii. Establishment of elite mutton type stud rams mother farms. The superior rams produced in these farms can be distributed in niche belts suited for mutton production

ix. Devising pilot projects in a phased manner for introduction of AI in sheep and goat.
x. Promotion of exotic hens having higher laying potential;
xi. Production of quality fodder – reclamation of wasteland;
xii. Increase egg production through improved variety of backyard poultry.

Fisheries

i. Development of high altitude Lake Fisheries and introducing Pen and Cage Culture in the State.
ii. Cold water fisheries; fish farming, high nutrition fish feeds High yielding fish strains.
iii. Fish processing and storage
iv. Increasing hatching and rearing space for production of quality carp and trout seed in the existing hatcheries/fish farms of the department.
v. Development of Recreational Fisheries (Sport and Ornamental Fisheries)
vi. Reclamation of hitherto un-exploited areas for development of Fisheries
vii. Development of Sport Fisheries Ladakh Regions.
viii. Development of Marketing Facilities for fish and fish product by way of establishment of Wholesale /Retail Fish Markets.
ix. Introduction of Cold storage facilities for maintaining the hygiene in the Marketing of fish

Strategy 2 : Access to market for better realization of farmers'produce

i. Promotion of farmer producer organization (FPOs);
ii. Promoting special commodity markets;
iii. Establishment of platform where farmers can be connected to e-market;
iv. Adoption of contract farming;
v. Public Private Partnership in creation of farm level infrastructure;
vi. Strengthening value chain;
vii. Use of ICT in marketing;
viii. Creation of better transportation facilities with cool chain van at Block level.
ix. Creation of direct linkages with food processing industries for better prices.
x. Establishment of strong linkages with various stake holders to furnish information on crop produce and surplus.
xi. Establishment of procurement and collection centre at panchyat level for agricultural surplus with proper labelling.
xii. Installation of mini grading machines at village level.
xiii. Establishment of cold room in different clusters

Strategy 3: Policy support

i. Amendment of APMC

ii. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.

iii. Labelling of organic inputs and certification mechanism for various crops.

iv. Land holding ownership, leasing policy;

v. Water management policy;

vi. Implementation of centrally sponsored schemes without delay.

vii. Minimum Support Price based on cost of production and profit margin;

viii. Forewarning about natural calamities to the farmers;

ix. Immediate relief to farmers in case of natural calamities;

x. Training and sensitization to the farmers to adopt latest technique;

xi. Implementation of Soil Health Card Scheme in each block.

Strategy 4: Infrastructural Development

i. Strengthen R&D activities in farm Universities/Institutions for providing site-specific technical support to all farm developmental agencies operating in the State.

ii. Road connectivity & provision of uninterrupted power supply;

iii. Strengthening infrastructure based on PPP mode, such as go-downs,

iv. cold storage etc.

v. Creation of modern infrastructure for preservation and processing of agri produces.

Strategy 5: HRD and Extension

i. Skill development training: This one of the most important flagship programmers of Govt. of India (Kaushal Vikas Se Krishi Vikas) which emphasizes that farmer's income can be enhanced by imparting skill development training in agriculture. Due to its importance. Agriculture skill Council of India (ASCI) was established.

ii. Use of ICT in extension: It is essential for rapid dissemination of customized information to the farmers for increasing the rate of adoption of innovations.

iii. Farmers to farmer extension (F2FE): Farmers seek advice and information related to agriculture from fellow farmers. The NSSO date also reveals that only 40 per cent farmers had access to any source of information on modern technology. Of those who had access to such information, the highest proportion obtained information from other progressive farmers.

iv. Village knowledge centre: There should be knowledge centre at Village level so that farmers get access to modern technologies in the village itself.

v. Strengthening of convergence: Convergence of KVK, ATMA, Line department, bank, cooperatives etc need to be strengthened for resources as well as expertise.

Strategy 6: Waste land development and waste water

i. Contour making for arable purpose in waste land in Leh and other areas.
ii. Afforestation of plants and perennial grasses in steep slope of more than 40% slope.
iii. Promotion of plantation of seabuck thorn, wild grapes for resin purpose, wild apricot etc
iv. Popularization of trenches or silages for percolation of water to avoid surface run off.
v. Construction of tank for storage of water for lean season.

Strategy 7: Reduced cultivation cost

i. Adoption of drudgery prone implements viz improved sickle, small threshers, tillers and other garden tools indirectly improve the production resulting in income of small farmers.
ii. Promotion of well decomposed FYM, Vermicompost and Biofertilizers to minimize the use of chemical fertilizers.
iii. Promotion of line sowing and judicious use of fertilizer application in crops.
iv. Promotion of recommended seed rate, spacing and depth.
v. Promotion of organic farming; mulching (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.

Strategy 8: Off-farm income

i. Promotion of subsidiary occupations like rearing of goat, yak, sheep, poultry.
ii. Promotion of cultivation and collection of medicinal plants.
iii. Promotion of skill development in women and youth
iv. Promotion of value added product making in dried apricot and sea buckthorn juice

Strategy 9: Online Management and Evaluation

i. Development of Mobile apps/ software for online management and evaluation at district level.
ii. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
iii. Organization of monthly review meeting at district to solve the problems related with farmers.
iv. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

Summary recommendations:

- State could shift its agricultural development strategy from food security mode to the value addition mode. The state should grow certain products like high-valued fruits, vegetables and some cash crops, which could give adequate monetary returns to the cultivators. Low productivity and decreasing returns from agriculture are the main reasons for low motivation among cultivators.

- For optimum utilization of the productive potential of the primary sector, diversification should be the main focus. However, the state should not follow a uniform policy of diversification for all the physiographic regions of the state. Agro-climatic crop planning for each physiographic region should be evolved with the help of experts. This calls for in-depth studies to:
- Make a realistic assessment of the available resources.
- Explore cost-effective means of transfer of technologies.
- Work out forward and backward linkages.
- Availability of inputs, e.g., seeds, fertilizers, pesticides, credit, etc., should not only be ensured regularly but their quality extensively checked. There are already some provisions existing in the state but more needs to be done.
- The state government should encourage a mix of supplementing crops in each region. For instance, in the Valley floor and plain areas of Jammu region, the crops which do not either compete with each other or can be grown off season should be the basis of diversification. The Karewas of Kashmir and kandi areas of Jammu region are best suited for dry farming, horticulture and fodder crops. The side valleys should be earmarked for fodder cultivation and cultivation of medicinal plants. However, these examples are illustrative and demonstrate the need for evolving the micro-region specific diversification strategies. Comprehensive cost of cultivation studies needs to be conducted in each zone.
- The farmers of the Ladakh region have successfully experimented the cultivation of vegetables in the poly green houses. Three varieties of tomato namely SL-12, PED and AC-238 and N-13 Nasik red onion have shown a positive result in production. Among other vegetables are brinjal, capsicum, broccoli, green chilli and paprica. This can ensure supply of vegetables to metropolitan cities during off-season and fetch a good price. From Ladakh the only viable mode of transport is air freight. Hence there is a need for working out an arrangement so that quick transportation of these products can be organized.
- The state government should also encourage the production of high-value, low volume crops like saffron, black zeera and other spices. The Kashmir region is ideally suited for the cultivation of these kinds of non-traditional crops. It has been observed that during the past three years the area coverage and production of the spices has been constantly declining.
- The state has extensive inland water bodies, particularly in the valley, which provide excellent habitat for almost any kind of temperate fish. The lakes cover an estimated 0.3 lakh hectare, predominantly in the valley (about 98 per cent of total). River Jhelum flowing, over 162 km in the valley, with its extensive tributaries has enough potential to sustain fish production. The Indus river system has carps, catfishes, the exotic rainbow and brown trouts. The trouts of Kashmir are very rich and attract sport fish enthusiasts. The state offers a favourable habitat for sport-fish like trout in its cold-water streams, particularly

in the Lidder and Sindh valleys. Paddy-cum-fish culture is gaining rapid ground in the tropics and subtropics but not in temperate climate. Fish farming as an adjunct to paddy cultivation has a lot of potential either as integrated simultaneous crops or as different crops in the same lands in alternate seasons. Such possibilities with particular reference to compatible fish species should be studied scientifically and a package of technical and management practices evolved for propagation among farmers.

- To improve marketing of fish, particularly the fish harvested in Jammu region, which is closer to the Punjab, the possibility of selling fish in the neighbouring Punjab districts of Gurudaspur, Amritsar, Jalandhar and Ludhiana should be explored and private enterprise encouraged for the marketing of fish. Infrastructure support by way of purchase of refrigerated containers or vehicles and working capital, should be extended to private sector.
- The use of non-conventional feed and fodder resources is one of the important areas for development of livestock in the state. The Agriculture University of Kashmir has done some research work to convert the agricultural waste into cattle feed. What is needed is that the state government should commercialize this research output either through its own or private initiatives.
- Jammu and Kashmir provides a suitable climate for cattle breeding. In other parts of the country, one has to create an artificial climate for cattle breeding and the success rate is also low. In Kashmir this initiative gives an added advantage and the success rate is also high. The state government should take steps to establish cattle breeding centres. It should open frozen semen centres in remote areas to cover all local cattle population.
- The demand for poultry products is constantly increasing. Due to climatic conditions, it has become the part of the regular diet. The state government should encourage the development of poultry through modern technology and take up some short duration projects along with NGO development.
- Improvement of local sheep by cross-breeding with fine wool breeds (Kashmir Merino, Russian Merino, Starapol, Caucasian Marino, Ramboulleit) can improve wool production qualitatively as well as quantitatively.
- Sheep crossbreeding with Polled Dorst (Mutton breed) has remained confined to selected pockets in the Valley such as Hajan block. Corriedale breed has shown good adaptability and performance in the orchard belt of Kashmir, i.e., Shopian area. The government should promote this initiative in other areas of the state as well. It is advisable to develop biotechnology research for enhancing animal productivity.
- In Jammu and Kashmir, feed and fodder which forms 60 per cent of milk production cost is a major constraint to the growth of dairy development. In the Kashmir and Ladakh region there is no fodder available for animals during winter. So the government should spearhead a feed and fodder development programme to develop this area.
- Establishment of Special Agricultural Zones based on climate/ physiographic factors and niches.

- Delineation of all possible sources of water (zone-wise), strengthening of existing water resources, rejuvenation of dwindling water resources and creation of new possible water resources.
- Production and supply of quality seed/ planting material/Improved breeds of animals and poultry; development of seed banks/stores.
- Promotion of Organic farming, Integrated Farming System, Protected Cultivation among farming community.
- Increased focus of departments on promoting farm Mechanization.
- Promotion of High Density Plantation (HDP) in Apple, Almond, Mango, Guava etc.
- Promotion of back-yard poultry/exotic hens having higher laying potential/pashmina goats etc.
- Strengthening Extension activities in the state for making farmers also aware and knowledgeable about modern agriculture and agricultural practices. There is strong need for the development of agri-based infrastructure for transportation, storage, value addition, and avoiding post-harvest losses especially in perishable commodities. Agri-based industry needs to be promoted in the State for value addition and avoiding post-harvest losses.
- The R&D facilities/activities in farm Universities/Institutions for providing site-specific technical support to all farm developmental agencies operating in the State need to be strengthened.
- The State Govt. should bring appropriate amendment in APMC, Land holding ownership, leasing policy; Water management policy, Minimum Support Price policy
- The entire centrally sponsored schemes w.r.t. agriculture sector needs to be implemented without delay.

SUCCESS STORIES

1. Integrated Farming System (IFS model) Beneficiary:

Mohammad Ashraf Mir, S/O Abdul Gani Mir, R/o; Bragam, Doru Shahabad, District Anantnag, Kashmir (J&K)

Technology adopted:

Cultivation of high yielding, disease tolerant varieties of paddy, maize, oilseed and oats;

Commercial cultivation of flowers (Gladiolus, Lilium);

Rearing of backyard poultry (Vanraja, Krioler);

Establishment and use of vermi-compost and vermiwash units, and use of the organic inputs;

Establishment of biogas plant;

Scientific cultivation and management of fruit crops, viz. apple, walnut, pear, etc;

Leaf and soil testing for proper dosage and judicious use of fertilizers along with integrated nutrient management.

Impact:

Fast bio-decomposition of organic matter for use as manure

Improved soil health

Availability of biogas for domestic use

Increase in net income per day from Rs. 250 to Rs. 1014; net income per year increased to Rs. 3,70,400; Area-1.5ha.

Thus, shift from single crop/commodity/enterprise to integrated farming system, combining crops, dairy, horticulture, fisheries, poultry and floriculture, has the potential to generate regular income, year round employment and to ensure efficient resource management for improving water, nutrient and energy use efficiency on the small land holdings.

2. Rearing of pashmina goat for increasing livelihood–a case study/success story from Kargil:

Beneficiary: Mohammad Musa, Kargil

Technology adopted:

Mohammad Musa, a labourer, started rearing of 10 pashmina goats as initial strength and after three years he reached up to 53 pashmina goats with current unit value of Rs 2,65,000 @ Rs 5,000/animal. He started getting additional income from sale of pashmina in 1st and 2nd year @ Rs 10,000, and additional income from the sale of extra male animal @ Rs 30,000 (6 no.). Thus, expected income/family/year from the sale of pashmina and extra animal after 5 years will be Rs 45,000, and thus expected unit value after 5 years will be Rs 2,50,000 for 50 animals. Thus, rearing of pashmina sheep will enhance the economy of the farmers' manifolds.

12

JHARKHAND

The State of Jharkhand formerly a part of Bihar was formed on November 15th, 2000 with Ranchi as its capital. The 28th state of the Indian Union, Jharkhand has a total geographical area of 79714 sq. km. The State extends between 22 degrees North to 25.5 degrees North latitudes and 83 degree East and 87.75 East latitudes. Jharkhand largely comprises of the forest tracks of Chhotanagpur plateau and Santhal Pargana and has distinct cultural traditions.

A total of 3.3 crore population of the state comprises 76% rural population. About 26% population belongs to tribal community and about 80 lakh (91%) tribal inhabits in rural area. Sex ratio as well as population density and decadal growth rate are higher than national averages.

The total geographical area of the State is 79.70 lakh hectares, out of which 23.22 lakh hectares(29.33%) are under forests; 5.66 lakh hectares (7.12%) are barren lands; 7.24 lakh hectares(9.10%) are put to non-agricultural use; 0.90 lakh hectares (1.15%) are under pastures & other grazing lands 3.07 lakh hectares (3.86%) are cultivable wastelands; 0.88 lakh hectares (1.11%)are under miscellaneous trees and groves, 12.04 lakh hectares (15.14%) are current fallows;8.45 lakh hectares (10.63%) are under other fallows; and 17.95 lakh hectares (22.58%) are the net sown area.

Jharkhand forms a part of agro-climatic Zone VII of the country known as Eastern Plateau and Hill Region. The state has further been divided into three agro-climatic regions *i.e.* Central and North-eastern Plateau (Region-I), Western Plateau (Region-II) and South-eastern Plateau (Region-III), The central and north eastern plateau has 50% of the net cultivated area and 13% of the area under forests, whereas the western and south eastern plateau together have the rest 50% of the net cultivated area and a larger forest cover.

Key characteristics of the three subzones of Jharkhand:

Sub Zone IV

1. Low water retentive capacity of the soil particularly that of uplands.

2. Late arrival and early cessation of monsoon and erratic and uneven distribution of rainfall.

3. Lack of safe disposal of runoff water during monsoon and water storage and moistureconservation practices for raising *rabi* crops.

4. Drying of tanks and wells by February results in no *rabi* crop production.

Sub Zone V

1. Late arrival and early cessation of monsoon.
2. Erratic /uneven distribution of rainfall.
3. Low water retentive capacity of soils.
4. Lack of soil and water conservation practices.

Sub Zone VI

1. Uneven distribution of rainfall.
2. Low water holding capacity.
3. Eroded soils.
4. Poor soil fertility.

On an average annual rainfall of Jharkhand is 1289 mm and it varies from 1285 to 1308 mm between different sub-zones, out of which around 85 per cent is received during four monsoon months. The land is undulating and farming situations are based on types of land i.e. upland (Tanr I& II), medium land (Tanr II and Don III) and low land (Don II and Don I).

Out of the cultivable area of 3.8 million ha. 80% of the area is drought prone and about 7% area is flood prone. The highly variable rainfall in Jharkhand mainly occurs during the Southwest monsoon period between June to September with the number of rainy days varying between 60 and 80.

The state is one of the largest producers of the mineral resources of the country spreading over majority of the districts with a paradox to be among the bottom lying states in terms ofdevelopment. An area of 24.4 lakh hectares (30.61%) is under agricultural wastelands thathave to be beneficially utilized for rural development.

At present there is one agricultural university (Birsa Agricultural University) with one each of agriculture, veterinary and one forestry colleges. The State government has decided to establish Agriculture Engineering College at BAU, Ranchi; Dairy College at Godda; Horticulture College at Chaibasa; College at Garhwa; Veterinary College at Jamtara; Fisheries College at Gumla which will increase the availability of technical manpower in the State. KVKs are present in all 24 districts of Jharkhand for technology assessment and refinement and demonstrations of locally relevant production technologies; capacity building of the farmers and other stakeholders in the target area and now set to work in close in association with ATMA for technology transfer.

Table. Physiographic condition of the state

Agro-climatic zone	Characteristics/ Challenges	Districts
Eastern Plateau & Hills *Region-VII*	**Rain-fed agriculture**, Moisture stress, drought and **Soil acidity**, Iron toxicity, **low SRRs**, non availability of electricity, high population growth, poor road, **poor Input delivery** and communication infrastructure	Orissa , Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal
Agro-climatic sub zones		
Central and North Eastern Plateau *Sub Zone IV*	i. Erratic and uneven distribution of rainfall ii. Coarse textured soils, crust formation on the soil surface iii. Low water retention capacity of the soil. iv. Lack of safe disposal of runoff and drying of tanks.	Bokaro, Deoghar, Dhanbad, Dumka, Giridih, Godda, Jamtara, Khunti, Koderma, Hazaribagh, Pakur, Ramgarh, Ranchi & Sahebganj
Western Plateau *Sub Zone V*	i. Erratic/ uneven distribution of rainfall ii. Low water retentive capacity of the soil.	Chatra, Garhwa, Gumla, Latehar, Lohardaga, Palamau and Simdega
South Eastern Plateau *Sub Zone VI*	i. Uneven distribution of rainfall ii. Low water holding capacity, eroded soils iii. Shallow soil depth iv. Poor soil fertility.	East Singhbhum , Saraikela and West Singhbhum

12.1 Productivity gaps and major constraints

Constraints, Opportunities and Challenges

Despite good rainfall in the region, the cropped area, growing period and cropping intensity are low. The level of technology adoption is also poor leading to lower productivity in general. Cultivable area in Jharkhand is estimated around 3.8 million ha. However, the net sown area is 2.56 million ha and only 12% of the cropped area is under irrigation. The total cultivable land in the state, which is 52%, compares well with 55% of the country; but only 43% area of this under net sown area compared to national average of 76%. The state as a whole suffers from several critical gaps in agricultural and allied sectors though a number of opportunities exist to make the state self-sufficient in agricultural production.

The agricultural development of Jharkhand should also mainstream with national strategic goals, viz., improving food security, enhancing opportunities for inclusive growth, improving competitiveness of agriculture, improving and sustaining the status and quality of natural resources for agriculture, enhanced risk management and creation of adequate quality manpower for the sectoral development. Major constraints and challenges faced by the agricultural sector are:

Edaphic

i. The sloping landscape of the State coupled with narrow spread of rainfall has led to soil erosion and shallow depth of soil. Soil erosion in the form of sheet and gully erosion over an area of 2.3 million ha every year.

ii. Poor soil conditions, i.e, soil pH < 5.5 in about 1 million ha of cultivated area and 0.15 million ha of cropped area deficient in sulphur, coron zinc, and copper; toxic levels of iron and aluminium. About 60% of the soils deficient in phosphorus availability.

iii. In general, erratic distribution of rainfall, poor water holding capacity, high infiltration rate, unproductive soil texture, poor fertility of soil and acidity have put a heavy stress on crop productivity and crop diversification in the state.

Climatic

i. Erratic high rainfall combined with high rate of leaching of nutrients.

ii. Hail storm during spring and summer season result in severe damage to both fruit and vegetable crops.

iii. Low rate of success of plant multiplication due to prevailing low humidity and temperature conditions is also a major constraint for expansion of area under horticultural crops.

Biotic

i. High incidence of blast, false smut (in hybrid), brown hopper in paddy; weeds in direct seeded paddy; wilt in rabi pulses; white rust and aphids in mustard.

ii. High incidence of hopper, shoot gall psylla, fruit fly, powdery mildew, anthracnose in mango, mite of litchi, wilt of guava, shoot and fruit borer in brinjal, powdery mildew in cucurbits, wilt of solanaceous vegetables, termite attack, rhizome rot in horticultural crops.

Developmental

i. The fertilizer consumption is also very low, i.e., 33.52, 17.39 and 4.82 kg/ha, respectively, of nitrogen, phosphorus and potassium. Low availability of boronated SSP and slow release fertilizers.

ii. Large acreage under dry land agriculture with lack of suitable high yielding crop varieties.

iii. Poor crop management, low input use and inadequate crop planning leading to less efficient production.

iv. Wastage of rain water in the absence of appropriate watershed management systems.

v. Indiscriminate use of insecticides and fungicides, especially in vegetable cultivation and other crops leading to health hazards.

vi. Poor adoption of modern agro-technology due to inappropriate technology, lack of awareness among the farmers and also due to poor access to research institutions.

vii. Inadequate input availability (Irrigation- 12%; low seed replacement rate for paddy

(16%), maize (12%), pulses (13%) and oilseeds (30%); inadequate availability of seed and planting material, in general.

viii. Economically constrained farmers (BPL population- 31.8%).

ix. Low Credit / Insurance, and inadequate Infrastructure.

x. Low adoption of horticultural plantation.

xi. Inadequate post-harvest infrastructure.

xii. Lack of organized marketing facilities, and absence of effective value chain management.

xiii. Poor infrastructure, roads, communication, power supply, storage, processing and marketing facilities for agricultural produce.

xiv. Inadequate extension and other service delivery mechanisms (ICTs).

Technological

i. Poor adoption of technologies on location-specific soil and water conservation models.

ii. Integrated nutrient management strategies for different crops, protocols for organic farming, bio-mulches for vegetable crops

iii. Collection, characterization and evaluation of lesser known wild crops.

Opportunities

i. There is scope for of bringing about 3.5 million ha of land under net sown area, up by about 1.0 million ha from the current, as per the State Directorate of Economics and Statistics 2006-07.

ii. The state receives average annual rainfall of 1300 mm which gives opportunity for better water use through water conservation technologies. It is estimated that only about 20% of the rain water is utilized.

iii. Large scale quality seed production on community basis can be taken up.

iv. Existing soil type and weather condition provides ample opportunity for horticulture, floriculture and other sectors.

v. The state as a whole is having sufficient scope for food processing industries, if availability of power is improved.

vi. The present milk production capacity of 1.46 million tons, which is about half of the requirement, can be enhanced.

vii. Good untapped potential of aquaculture in water bodies and agro-aquaculture through integrated watershed development.

viii. Provides unique climatic situation for cultivation of both tropical and subtropical crops.

ix. Strategically located for harnessing export potential of vegetables, fruits and flowers to SE Asian countries.

x. Organic farming can be taken up for select vegetables, spices, medicinal plants, aromatic rice, etc.

xi. Jharkhand is the leading producer of lac and tasar; there is ample scope strengthening these sectors along with apiculture through integration with general agriculture for enhancing the income of the growers and local enterprises for value addition.

xii. The tribal farmers have retained useful traditional crops and practices, which can be mainstreamed for food security and appropriate technologies, acceptable to them.

Challenges

i. By and large, mono-cropping system prevails in the state hence the cropping intensity is very low, i.e., 116%.

ii. Predominantly rain-fed agriculture, 75% of the net sown area is rainfed in the state.

iii. Water productivity is very low (0.26 kg/m3) in Jharkhand. Similarly, out of 5.25 BCM available ground water, the state hardly utilizes 1.09 BCM (~20%), indicating the scope of improvement in both.

iv. The per capita availability of food grains is currently at 250 g/day, which needs to enhanced up to 400-500 g/day; similarly per capita availability of fish, meat, milk and egg is very low compared national averages.

v. The farmers of Jharkhand, especially the tribals, lead a conservative life style and do not readily accept and adopt new technologies.

vi. Area under forest is recorded to be about 29%. Tribal communities that constitute 26.30% of the population, solely depend on forests spread over 2.33 m ha for firewood, fodder, food and timber. Deforestation, over-grazing by livestock and loss of wetland due to siltation and exploitation of forest are putting tremendous pressure on plant biodiversity in the state.

vii. Heavy mining activities lead to emergence of degraded lands, which need to restored through planting appropriate MPTs.

12.2 Strategy and interventions for doubling of farmers' income

1. Central and North Eastern Plateau *Sub Zone IV (*Medium Land (Don- II) and Lowland (Don-I) –

14 districts (Area=14.5 lakh ha). Rice is a major crop that occupies about 70% area in *kharif,* rest 30 % is covered under maize, pigeon-pea, Horse gram (*kulthi*), vegetables, etc. Main constraints in the region are: (i) Low availability of hybrid/HYV/quality seed, (ii) Acidic Soils and (iii) imbalanced use of fertiliser for hybrids

- Increasing availability of hybrid seed on larger scale production of location specific hybrids from the current production of 3750 tons to 6750 ton for increasing area under 2lakh ha to 4 lakh ha
- Judicious use of nutrients (NPK) in hybrid rice (150:70:90 to 100:50:60) for reducing cost of cultivation

- Jharkhand soils are highly acidic that limit the productivity due to inefficient uptake ofthe nutrients. Lime application needs to be popularized along with recommended dose offertilizers.
- Area under SRI needs to be increased from 0.75 lakh ha to 1.5 lakh ha through awareness& capacity building of farmers for increased productivity.

2. Western Plateau *Sub Zone V (*Medium Upland (Don- III) - 7 districts (9.30 lakh ha)

Medium upland consisting of 2.0 lakh ha is very much vulnerable and transplanted rice and needs to be diversified with coarse cereals and pulses as rice cultivation is not remunerative because of higher incidence of pests and diseases (Pod borer, Wilt).

- Diversification of rice cropping system with Maize, Pigeon-pea, Sorghum and Pearl Millet is required by promoting cultivation of Maize, Pigeon-pea, Sorghum and Pearl Millet in cropping system. Present area under diversified cropping system needs to be increased from 10, 000 ha to 2.0 lakh ha.
- Sowing of identified crops in ridge and furrow method is recommended by capacity building of farmers as they still practice traditional system
- Early maturing and high yielding HYVs/hybrids through introduction of early maturing and high yielding HYVs/hybrids like Sorghum (CSV-20), Pigeon-pea (Birsa Arhar-1),Maize (HQPM-1), Pearl millet (JB-3)
- Popularization of recommended INM and IPM modules (25 % RDF through organic and75% chemical fertilizers

3. South Eastern Plateau *Sub Zone VI (*Upland (*Tanr*) -3 districts (3.20 lakh ha)

Upland consisting of 1.0 lakh ha is acidic in nature, therefore, productivity is low. Rice cultivation in upland is less remunerative because of poor management of uplands

Diversification of Upland rice with Ragi, Blackgram, Soyabean, etc. in cropping system

Ensuring availability of quality seeds *Beej Gram (from 1053 to 4500 Beej Grams)*

Introduction of need based and location specific varieties of Ragi (Birsa Marua-2), Blackgram (Birsa Urid-1), Soyabean (Birsa Safed Soyabean-2)

Horticulture – Vegetables

Vegetables accounts for 14.01% of net area sown in the state. Major constraints encountered are:

i. Less availability of suitable quality seed,

ii. Imbalanced use of fertiliser for hybrids& poor irrigation facilities and

iii. High incidence of pests (Borers) & diseases (Bacterial wilt)

Steps to be taken:

- Bringing additional 20 % area under HYV/Hybrid vegetable cultivation. Production of800t of quality seed, 200 t of Foundation seed and 75 t breeder seed through Public Private Partnership (PPP)
- Application of RDF followed by INM with drip irrigation by capacity building of farmers
- Promotion of cultivation of rainy season tomato by targeting existing 36431 ha area ofTomato under traditional system (23.4 t/ha) by replacing with SwarnaLalima (50-60t/ha), Swarna Sampada F1(70-80 t/ha)
- Promotion of cultivation of rainy season Brinjal by targeting existing 23140 ha area of Brinjal under traditional cultivation (22.6 t/ha) by replacing with Swarna Shyamli, Swarna Pratibha (50-60 t/ha)

Horticulture – Fruits

- Fruits accounts for 6.01% of net area sown in the state and suffer with low productivity of traditional orchards because of poor quality of planting material.
- Promoting Multitier systems for rain fed system (with *Doba*) like Mango based system in the existing 51840 ha under traditional orchards from 1000 ha to 2000 ha (Suitable for Sub zone VI)
- Promoting Multitier systems for rain fed system (with *Doba*) like aonla based system in500 ha from existing 7900 ha (Suitable for Sub zone V)
- Litchi based system 200 ha irrigated area from existing 5330 ha (Suitable for Subzone IV)
- Promotion of high density orcharding in guava (25-30 t/ha) in the existing 8780 ha area of guava under traditional cultivation (8-10 t/ha) from 300 to 1000 ha.
- Strengthening the nursery sector
- Policy intervention by the state government to introduce the nursery Act

Fisheries sector:

Per capita availability of fish in Jharkhand is 22 g/day against the national average of 24 g and production of fish is 1785 kg per ha per year against the national average of 2150 kg due to the following constraints:

i. Rain-fed Ponds, old & silted seasonal Tanks & Ponds,

ii. Lack of quality Brood Fish,

iii. Economically weak stake holders reluctant to use of factory formulated feed and

iv. Climate not very suitable for diversification of aquaculture

Steps to be taken:

- Ensuring availability of fish feed by production at cottage level from existing 9000 to 30000 tons
- Increasing fish production from 2.00 to 2,60 lakh ton by bringing more number of farm families under fisheries sector.

- Target oriented area expansion & coverage for Aquaculture through renovation of old ponds and digging of new ponds from 120000 to 140000 ha.
- Introducing fisheries in newer areas by increasing number of beneficiaries from 128000 to 190000

Poultry:

Most of the poultry population is under backyard management.

Main constraint is low egg (120) and meat productivity (0.64 kg/animal /annum to 1.0 kg) of native bird and poor management practice under backyard.

Steps to be taken:

- Promotion of improved breeds of Chicken *e.g.* Jharsim (160-170), Vanraja (150), Gramapriya (180-200)for eggs.
- Improved management practices for backyard poultry through regular vaccination and de-worming.
- Ensure availability of improved variety of chicken (Vanraja-2.0kg meat/animal) for backyard by maintaining the parent stock BAU through financial support by the government schemes.

Goatry:

- Major breed of small ruminate is Black Bengal Goat under extensive management across thestate and has very low meat productivity (8.64 kg / animal / year) due to inbreeding.
- Introduction (10+1 Black Bengal bucks per household), conservation and promotion ofpure productive (15-18 kg / animal / year) Black Bengal goat.
- Mass vaccination and de-worming to reduce mortality to 5%.

Piggery:

- Most of the population is of local / desi under extensive / semi-intensive management with low productivity (27 kg / animal / year) due to inbreeding; tribals are unawareness about disease (swine flu), vaccination etc.
- Improve the pig meat production by popularizing of Jharsuk Pig (60-70 kg / animal / year).

Dairy:

Share of exotic / crossbred cattle is less than 3% of total cattle population (8.7 million cattle)in Jharkhand. Indigenous cattle have low productivity. Major constraints are:

i. Pooroutreach of veterinary services at village level’

ii. Inbreeding & poor management practice and

iii. Scarcity of fodder and processing units.

Steps to be taken:

- Promotion of crossbred cattle by supporting viable dairy units (2-5 lactating cows / hh)to increase productivity from 6.0 kg / animal / day to 7.0 kg
- Providing preventive & therapeutic veterinary service to the remote areas through para-veterinary experts
- Promoting exotic milch breeds among progressive farmers to increase their population from < 3% to > 10% of total stock and good quality indigenous milch breed among resource poor farmers
- Promoting cut & carry fodder supply to the farmers on cost basis and distribution of planting material / seed of drought tolerant grasses species Anjan grass *(Cenchrusciliaris),* Marvel grass *(Dicanthium annulatum),* Guinea grass *(Panicum maximum), Styloseabrana* and *Clitoriaternatea* to farmers in villages to reduce open grazing area by 0.50 lakh ha..
- Promotion of Jharkhand Milk Federation (JMF) by strengthening Cooperative network procurement centers at village level and milk plants in each district (24) for value chain.

Improvement of milk production in Indigenous cattle

- State indigenous cattle population 83.62 (lac) with milk production of 1.7 kg / day / cow and per capita availability of milk if only 159 gm in comparison to 263 g at national level. Most of the cattle population is of native low producing type. Constraints encountered are: (i) Anoestrus and repeat breeding problem, (ii) Low conception rate and (iii) Unawareness about disease, vaccination etc. To improve the milk productivity of native cattle (1.7 kg / day / animal to 3.0 kg) by Artificial Insemination of Indigenous milch breed with Sahiwal, Red Sindhi, Gir and Tharparkar
- To improve fertility and conception rate by oestrus synchronization to get better result (50 %) through AI
- Awareness and capacity building of dairy farmers about scientific dairy management and health care

Reducing cost of cultivation - Farm Mechanization

- Traditional farm operations are time consuming, have higher cost of operation and more drudgery. Farm Mechanization increases the productivity by 12 to 34%. The availability of total farm power in the State is less than 0.9 kW/ha. Major share of power available for agricultural operations is of animate energy (54%) followed by mechanical (43%) and electrical (3%). The state has undulating topography and Fragmented land holding; Majority of the farmers are small and marginal (84%).
- Adoption of Improved Agricultural Implements and Machinery by demonstration of improved agricultural implements and machinery done through KVKs, SAMETI, ATMA,NFSM, NHM, MIDH
- Making agricultural implement banks in all 24 districts (3 in each panchayat).
- Involving industries for ensuring the availability of implements at subsidized rates.

Agro-forestry:

- About 30% of the Geographical area *i.e.* 24 lakh ha land is fit for agro- forestry activities. Poor nutrient status of degraded lands and Non-existent of wood/ bamboo based industriesare main constraints
- Plantation of Multipurpose trees species like Gamhar, Eucalyptus, bamboo, neem, lachosts (*Ber*and *Palas*), etc. on bunds of farms and waste land; Nursery establishment andPlant distribution to farmers
- Improvement of nutrient status of soil by increasing organic residue from < 0.5 to > 2.0% through Agri-silviculture, Horti-silvi Pastoral system. Tree, Crops, Grasses – litterdecomposition
- Production of fodder grass under silvi pasture system by planting fodder tree *viz*. Subabool, *Ficus*sp. and grasses *viz*. Dinanath, Napiers, Sudan, Guinea grass etc. on community land to increase the area from 0.15 lakh ha to 0.50 lakh ha.

Lac Production

Jharkhand - the leading state in lac production (60% of national production). 25-32% of total farm income in major lac growing areas comes from lac cultivation. It is a major source of livelihood and income generation especially for tribal farmers in rain-fed areas. About one million man-days are generated in the existing lac processing units alone. Lac cultivation is an important vocation for inhabitants of 45 out of 150 disadvantaged districts

- Policy interventions:
- Formation of National / State Lac Development Board
- Declaring lac as agricultural produce
- Effective implementation of MSP
- Establishment of Regional Testing Laboratories
- Credit and insurance to lac growers
- Increasing production by introducing lac in newer areas
- Introducing Lac Integrated Farming System Models for assured livelihood in rain fed Agriculture

Tasar Silk

Tropical tasar silk is produced only in India. Tasar silk industry provides livelihood to nearly 3.5 lakh families. Tasar silk has high demand in domestic as well as global market. It is a profitable traditional occupation that requires least investment to get good return.

- Promotion of *Tasar* by-product based Enterprises

General Recommendations

- **Increase Net Sown Area:** The State suffers from high levels of current fallow, even during *Kharif*, mainly due to deterioration of soil status, erratic rainfall and lack of seeds.

It is proposed to bring 2.10 lakh ha of current fallow into cultivable land.

- **Convert wasteland to cropped area:** It is recommended that watershed based development may be extensively encouraged to bring large areas of cultivable waste into cropped area. It is envisaged to convert 50,000 ha of waste land through watershed development, bunding, land terracing, moisture conservation measures, water harvesting links etc.
- **Soil management:** The soil of state mainly suffers from extreme to high acidity (50% of TGA), low to medium organic carbon (47% of TGA), low available N (20% of TGA), low available P (66%), low available potassium (18% of TGA), low available sulphur (38% of TGA), zinc deficiency (7%of TGA), and boron deficiency (45% of TGA). The problem of toxicity of iron and aluminium pose serious problem in moisture deficient regime. Multipronged strategy combining short-term and long-term approaches is fundamental for agricultural development of the State.

Soil and water conservation: Some of the recommended systems for different situations are:

i. Micro level water resource development through tank cum well system which works on drainage line in a watershed is recommended for plateau areas having slope of 2 to 5%;

ii. Check-dams built across the direction of water flow on shallow rivers and streams for the purpose of water harvesting;

iii. The farm ponds constructed at the lower side of the fields and the runoff from the higher side of the fields are channelized into the pond. Further facilitation of micro-irrigation through promotional schemes, setting up of demonstration-cum-training centres at district level is needed to bring in improved practice for water use efficiency.

iv. Similarly, promotion of integrated nutrient management and use of slow-release fertilizers and micronutrients are needed for improving fertilizer use efficiency. Balanced use of major nutrients (NPK), provision of micronutrients like sulphur, zinc and boron can help to increase yield by over 50% in dryland farming areas.

- **Soil Health Cards:** Lack of soil health cards has given lot of stress on the soil reserves of nutrients on account of wanton use of fertilizers without soil testing. While soil health care would have to be given utmost care in any agriculture development plan, it is envisaged that each farmer need to be given ‘Soil Health Card’ for his land which would contain all required information relating to pH factor, nutrient status, soil depth, texture and structure, organic matter.
- **Improve SRR:** Seed replacement rate is around 10-15% currently. It should be possible to increase SRR initially to 30% and eventually to 50 or 75% by the end of the current plan by ensuring timely availability of certified seeds for which the state can assist the formation of seed villages in each district, arrange to supply foundation seeds and other infrastructure for seed production and processing. The state seed farms also can be gainfully utilized in a public-private partnership mode for seed production.
- **Animal Health Clinics:** New / strengthening AI Centers proposed @ one AI Center

for every 1000 adult female cattle population. Community pasture / *Gauchar* land / Silvipasture / Grass land @ one per 50000 Adult Cattle Units have been proposed.

- **Agricultural Prices:** The terms of trade in agriculture are adverse. This calls for extra support in price and / or integrated farming through better implementation of Minimum Support Price to the farmers.
- **Electricity for Agricultural Purposes:** The share of consumption of electricity for agricultural purposes was estimated at a very low 0.62% against all India overage of 20.95% with increasing requirements for energizing pump-sets, operating gender friendly farm equipments, heat and light requirements for birds and animals etc. it is recommended that the State Government may take steps to reach electricity supply to all farm families within a stipulated time frame.

SUCCESS STORIES

1. System of Rice Intensification (SRI)

System of rice intensification is based on six principle (i) use of 10-12 days seedlings (ii) seedlings raised on MAT nursery (iii) transplanted single seedling (iv) use of organic manures 10t/ha (v) 4 times weeding through use of cono-weeder at 10 days interval from date of transplanting (vi) alternate wetting and drying. In SRI single seedling is transplanted at 25 X 25 cm spacing. Of the recommended dose of fertilizer (100:50:25 kg N: P2O5: K2O/ha) ½ dose of nitrogen + full dose of phosphorus and ¾ th of potash is applied at sowing and remaining ½ dose of nitrogen and 1/4th of potash is applied at panicle initiation stage. System of rice intensification is more advantageous as it gave 10.15% higher grain yield (5032 kg/ha) than conventional method of rice cultivation (4568 kg/ha).

Dhaincha in between the rice rows

System of rice intensification

System of rice intensification is more advantageous as it gave 10.15% higher grain yield (5032 kg/ha) than conventional method of rice cultivation (4568 kg/ha) (BC ratio 2.04 as compared to 1.37 in conventional method).System is suitable for medium land situation of Jharkhand. Lesser input requirement (seed, labour & water), Use of cono-weeder and markers generates employment for rural youth. The technology has been adopted on large scale by farmers of Jharkhand through Jharkhand Government schemes.

2. Conservation agriculture in maize-wheat cropping system

Conservation agriculture through zero tillage, minimum tillage and permanent beds offsets the production cost and other constraints associated with land preparation. The conservation tillage practices combined with crop residue retention on soil surface increases moisture infiltration, reduces erosion, increases water use efficiency and forms more stable soil aggregate structure. Conservation agriculture advanced the sowing date and resulted in proper placement of seed, early emergence and availability of higher nutrient and moisture content which helped the crop to compete with the crop sown under conventional tillage. Cultivation of maize and wheat crop in permanent narrow bed gave 20.33% and 18.0% higher grain yield of maize (6275 kg/ha) and wheat (5371 kg/ha) respectively than maize (5215 kg/ha) and wheat (4404 kg/ha) yield under conventional tillage. B:C ratio in permanent narrow bed conservation agriculture was 2.19 as compared to 1.44 in conventional tillage.

Conservation agriculture in maize-wheat cropping system

13

KARNATAKA

Karnataka is an agrarian economy and overall development of the State is mainly depending on the growth and development of agriculture and allied sectors. A large tracts of the state practice rainfed agriculture and hence the state is a victim of frequent droughts in the recent past. There is a wide-spread concern about distress in agriculture and falling incomes of farmers. There is also an unequivocal support for the cause of improving the livelihood conditions of farmers by enabling the farm families to earn a decent livelihood.

Karnataka State falls in Zone X (Southern Plateau and Hilly region) and Zone XII (West Coast Plains and Ghat region) as per the Agro-Climatic Regional Planning. The State is divided into 10 Agro-Climatic Zones and has six major soil types. Due to its varied agro climate, almost all cereals, pulses, oilseeds and commercial crops (fruits, vegetables, spices etc) are cultivated in different parts of the State.

Total geographical area of Karnataka is 190.50 lakh ha, out of which 122.47 lakh ha is total cropped area. Cropping intensity of the state is 121.93%. Around 16.% of the area was covered under forests, 6.67% area was under non-agricultural uses, 4.13% land was barren and uncultivable land and 2.15% land was cultivable waste. Permanent pastures, grazing land and miscellaneous tree crops constituted 6.20% of the total geographical area. About 11% of the total area falls under current fallow and other fallow land.

13.1 Productivity Gaps And Major Constraints

India's farm yields are much lower as compared to other developing countries. Per hectare rice production in India is 3.6 tonnes compared to 6.7 tonnes in China, 5.1 tonnes in Indonesia and 5.6 tonnes in Vietnam. Similarly, per capita wheat production in India is 3.1 tonnes compared to 5.0 tonnes per hectare in China. Similarly, it was observed from the results of FLD's data with improved production technologies that there exists a wide yield gap under real farm situations across crops in Karnataka. The yield gap varied from 11% in linseed to 30% in bajra. Hence, there existed a vast potential for increasing the existing level of production by adopting improved technologies advocated for different agro-ecological situations.

Table 1:- Potential for increasing the existing level of production

Crops	Average yield at farm (Kg/ha) 2014-15	FLD yield 2014-15	(Kg/ha)	Yield gap (%)
Paddy	4534		5150	11.96
Sorghum	1392		1913	27.23
Bajra	1060		1525	30.49
Maize	5126		6001	14.58
Ragi	1985		2278	12.86
Wheat	2584		3169	18.46
Chickpea	766		913	16.10
Tur	2639		3141	15.98
Urad	501		593	15.51
Groundnut	1516		1838	17.52
Niger seed	250		306	18.30
Soybean	1540		1936	20.45
Sunflower	1406		1826	23.00
Linseed	731		821	10.96
Cotton	1365		1826	25.25
Sugarcane	2114	2499		15.41

Source: Annual Report 2015-16, ICAR-Agricultural Technology Application Research Institute, Bengaluru.

Karnataka state is having second largest area under rainfed agriculture next only to Rajasthan. The State also is one of the most drought prone States of the country. For instance, of the 176 blocks, over140 were declared as drought hit during the year 2016-17. Despite this, the state has been contributing significantly to the nation's food basket. However, farmers in general and those in particular engaged in rainfed agriculture are facing wide spread distress due to increase in cost of living and decreasing profitability.

The impetuous being accorded to *Doubling the Farmer's Income* is very timely and the dire need of the hour especially in the State of Karnataka. There is ample scope as evidenced by several important studies that the farming is support by required inputs at affordable cost and the farmers realizes higher market prices for his produce, the goal of *Doubling the Farmer's Income* within the given time frame is very much achievable.

Certain studies have shown that unless the farmers share in the consumer rupee increases from the current 22%-24% to an expected 55-60%, farming will remain an unprofitable proposition. However, realizing higher share for farmers in the consumer price is fraught with several challenges.

Primarily it calls for major market reforms. Improved grading and processing infrastructure besides technology led weather forecasting, market intelligence and insurance. Improving production by adopting better planting materials and improved agricultural technology will enable to contribute approximately 30% to the farmer's income.

Another 30% of income contribution can be realized by adding value through grading, primary processing and cost reduction through improvement in input use efficiency. The remaining 30-40% increase in income must be realized through institutional innovations such as reforms in pricing, aggregation of producers into companies to have a collective bargaining power in terms of buying inputs and selling output and a robust agricultural insurance product covering all gamut of farming including crop, livestock, fishery, horticulture, sericulture etc. The noble goal of *Doubling Framers Income* will only be realized if there is a concerted effort in all sectors and by implementing an action plan at the ground level involving all the stakeholders.

13.2 The strategies for Doubling Farmer's Income in different zones

Karnataka has enormous potential for development of horticulture, livestock, fisheries and agro-forestry sectors due to its varied Agro Climatic Zones. The strategies for Doubling Farmer's Income based on potentials to develop different sectors in different zones have been given below:

A. North Eastern Transition Zone

i. Protective irrigation for pulse production.

ii. Facilitating minimal processing of Dal.

iii. Integration of small ruminants in agriculture.

iv. Bio-ethanol production from sugarcane cultivation.

v. Dryland horticulture coupled with post harvest processing and cold storage facilities.

vi. Intercropping in sugarcane with vegetables and pulses.

vii. Crop cultivation with cash crops like ginger, turmeric and flowers.

viii. Promotion of mango cultivation.

B. North Eastern Dry Zone

i. Integrated crop management in Red gram and Bengal gram.

ii. Establishment of mini Dal mills at Panchayat level for primary value addition.

iii. Establishing of processing and packing industry at district level.

iv. Rainwater harvesting through watershed development approach.

v. Hi-tech horticulture/protected cultivation with recharged groundwater.

vi. Integrated crop management in cotton and floriculture, groundnut and sunflower cultivation.

vii. Reclamation of problematic soils.

viii. Replacing rice under bore well irrigation with floriculture, and olericutlure.
ix. Facilitating processing of papaya, pomegranate and fig.
x. Expanding irrigation facility by completing lift and tank irrigation projects.
xi. Promoting FPO of oilseed growers with complete value chain (Eg Erode of TN).
xii. Integration of small ruminants with rainfed farming in areas with high rainfall variability.
xiii. Horticulture based IFS.

C. Northern Dry Zone

i. Groundwater augmentation through watershed development.
ii. Integration of dry land horticulture and small ruminants and buffalo calf rearing with agriculture.
iii. Bio-remedying of excavated soils in mining areas.
iv. Building farmers' capacity for seed production of oilseeds.
v. Intercropping in orchards with Greengram, Cowpea, Horse gram, sunflower and millets in dry conditions.
vi. Intercropping in orchards with vegetable crops like Beans, Chilli, Onion, Watermelon, Ridge gourd, Cucumber and Okra under limited irrigation.
vii. Promotion of pomegranate and grape cultivation.

D. Central Dry Zone

i. Soil and moisture conservation and RWH through watershed approach.
ii. Dry land horticulture (mango and sapota, pomegraganate, amla) and alternate land use systems.
iii. Large scale production of short duration crops:green gram, sesame, onion, groundnut.
iv. Small ruminant and poultry production.
v. Enhancing yield potential of maize and cotton based cropping systems.
vi. Introduction of efficient intercrops in arecanut plantation.
vii. Increasing compost/manure production for improvement of soil fertility status.
viii. Dryland horticulture (amla, pomegranate, custard apple, mango, sapota, cashew) medicine/ aromatic plants.
ix. Alternate land use systems - agro forestry, horti-pasture, agri-horti, silvi-pastures.
x. Promotion of Mango + Cowpea intercropping.

E. Eastern Dry Zone

i. Soil moisture conservation & soil fertility improvement through watershed approach.
ii. Soil enrichment through composting/green manuring/ tank silt application.
iii. Alternate land-use systems like Agri-horti system for arable lands (mango, sapota,

tamarind, jack fruit etc.), Horti-silvi system (mango, sapota + silver oak, casurina, teak), Silvipasture (block plantation of acacia, silver oak, casurina, D.sisso, Melia azardicta, cassia and muthuga + S. hamata, S. scabra, calaproimum, anjan, Guinea macuaena, etc.) for non-arable lands.

iv. Dryland vegetables (chillies, beans, brinjal, tomato, cluster bean, gourds etc.), Floriculture (chrysanthemum, jasmine, crossandra marigold, roses etc.) fruits (guava, amla, sapota, cashew and mango), sericulture and coconut plantations.

v. Livestock component (dairy, sheep, piggery, rabbitry).

vi. Facilitating processing, value addition and export of fruit products and flowers.

vii. Protective farming in vegetable crops (tomato).

F. Southern Dry Zone

i. Watershed development for augmenting surface and groundwater.

ii. Development of orchards - mango, cashew, jack and sapota.

iii. Water-saving irrigation methods and cost-saving planting methods for irrigated ginger and turmeric.

iv. Fruits and vegetable cultivation with dairying in conjunction with feed and fodder development.

v. Promotion of millets, sericulture and small onions cultivation.

G. Southern Transition Zone

i. Development of cashew, mango, sapota, (dryland orchards) and oil palm, banana, coconut, papaya, guava with seasonal irrigation.

ii. Promotion of vermi composting and organic farming.

iii. Alternatives to tobacco based cropping systems.

iv. Promotion of exotic fruits like rambutan, avacado, etc.

H. Northern Transition Zone

i. Watershed development for soil and water conservation.

ii. Development of sheep, dairy and fodder/pasture production.

iii. Promotion of intercropping in mango and sapota orchards with legumes and vegetables.

iv. Promotion of exotic vegetables for export.

v. Recirculatory aquaculture using minimum water and area.

vi. Promotion of seed production.

I. Hilly Zone

i. Promotion of hi-tech horticulture and exotic fruits and orchids with agro-eco tourism.

ii. Management of soil health in low lands or valley areas.

iii. Effective management of animal menace.
iv. Strengthening of traditional water storage structures.
v. Improve the productivity of livestock.
vi. Promotion of different Integrated Farming System modules.
vii. Promotion of aquaculture in seasonal water bodies.
viii. Plantation based IFS.

J. Coastal Zone

i. Rain-shelter horticulture and value addition for export.
ii. Management of soil acidity and associated problems.
iii. Management man-animal conflict.
iv. Strengthening of traditional water storage structures.
v. Improve the productivity of livestock.
vi. Brackish water aqua culture; backwater cage culture; bioflock method of prawn culture.
vii. Feeding with fish dressing waste in cage culture.
viii. High density cashew plantations.

Role of Technologies for doubling the farmers' income

1. Agriculture

It is essential to bridge the yield gaps, enhance the productivity and profitability, minimize risk and improve the livelihoods of millions of people dependent on agriculture through agricultural technology. Improved and tolerant varieties along with the proper management practices can enhance the productivity through risk reduction in vulnerable environments. Considering the need, State Agricultural Universities in Karnataka have developed several improved crop varieties. The field trials showed that the yield of the new improved varieties can add 20-25 % to increased productivity, even if other components of production remain the same. A recent study revealed that improved crop management technology packages (integrated nutrient management, integrated pest management, conservation agriculture etc) increased average productivity up to 205% and average farm net income by 160%.

Table: Technologies Related to Agriculture for doubling the farmers' income

S. No.	Technology Title	Brief description	Potential income increase due to adoption of technology(in percentage)
1.	Improved varieties/ hybrids of different crops	Paddy- GGV-05-01(Gangavati sona), IET 19251, GNV-10-89, Pigeonpea: TS-3R, GRG-811, Greengram: BGS-9, Chickpea- GBM-2, Sunflower- RSFH-1887, RSFH-130, Cotton; SCS-793, SHH-818	15-20%
2.	Direct seeded rice in irrigation command	University of Agricultural Sciences, Raichur has developed production technologies and popularized direct seeded rice in Tungabhadra and Upper Krishna Project of domain area. Advantage of DSR over transplanted rice include requires 17-35 % less water, timely sowing of the crop, Less seed rate (8-10 kg/acre), Puddling is not required, saving in energy (diesel 8-10 l/acre), Saving in 25-30% fertilizers, less cost of cultivation and high net returns and savings of Rs. 7-8000/ acre. Due to continuous efforts of the university DSR has spread to more than 60,000 ha and farmers are university DSR has spread to more than 60,000 ha and farmers are	20-25%
3.	Integrated farming syste models for rainfed and irrigated condition	<u>Rainfed model (Zone-2)</u> Components detail: Crops: Pigeonpea+ Navane/greengram (1:2), clusterbean-jowar, Clusterbean-safflower 40-60% Vegetables: Amaranthus, pundi, palak, chilli, onion-15% (5mx5m) Animal husbandry: Female goat (5) + male goat (1) Azolla unit Silo-pits Drumstick, Karileaf on bunds <u>Irrigated model (Zone-2)</u> Components detail: Crops: Bt-cotton, Maize, Chickpea 40-60% Vegetables: Amaranthus, pundi, palak, tomato, chilli, avare -15% Animal husbandry: Female goat (5) + male goat (1) Dairy: Crossbreed cows: 2 Poultry birds: 50 Home garden: Banana/avare/drumstick Vermicompost: Biodigester tank Crops on bunds: Perennial grasses/Hybrid Napier, Guinea grass	2-3 times

S. No.	Technology Title	Brief description	Potential income increase due to adoption of technology(in percentage)
4.	Use of growth regulator in pulses	Pulse Magic is developed by combining Nutrients (Major & Minor) and PGRs and the results are encouraging. The product is a combination of important nutrients and PGRs for boosting yield of Red gram. Developed and tested for the last three years on the farm and Farmers field. The product is use full in management of Flower and pod drop and enhance yield in Redgram. Spray @ 10 g/liter of water at 50% flowering and 15 days after 1st spray. Treat seeds in 2% CaCl2 solution for 7-8 hours and then dried in shade will increase drought resistance in green gram. When green gram is at maturity stage, spraying 5 ml Paraquat in 1 lit of water will defoliates the leaves facilitating easy harvesting.	10%
5.	Climate Resilient Maize Hybrids	Maize hybrids deployed by CIMMYT for the major maize agro- ecologies of Karnataka (Kharif maize in central Karnataka and Rabi maize in Belgaum and Dharwad).	20%

2. Horticulture

Technological change has been the major driving force for increasing crop productivity and promoting horticulture development in Karnataka. Several income augmenting technologies in terms of higher productivity, saving production costs and minimization of horticultural crop losses have been demonstrated by Agriculture Universities and ICAR institutes in Karnataka. For example, planting of cashew under ultra density planting technique developed by ICAR-Directorate of Cashew Research, Puttur in selected cashew varieties such as VRI-3, Ullal-1, NRCC Sel-2 and hybrid H-130 has been successfully demonstrated in farmers field. About 3-4 tones of nut yield per ha can be harvested in the early stage of orchard life from ultra high density orchards. These technologies are package intensive and are more successful in increasing the income by 100-200%. In mango high density planting, use of vigour regulating root stock, application of growth retardants and canopy management increases the income by 150%. Similarly, planting ICAR-IIHR developed Guava hybrid "Arka Kiran" doubles the farmer's income as compared to other traditional varieties.

The State is one of the major producers of variety of horticulture crops. Fruits (such as Sapota, Grapes, Pomegranate, Watermelon, Mango, Jackfruit, Papaya, Lime/ Lemon, Orange, Banana, Guava etc), Vegetables (such as Onion, Potatoes, Gherkins, Capsicum, Green Chilly, Tomato, Cucumber, Carrot, Beans etc), Plantation & Spice Crops (such as Coffee, Arecanut, Tamarind, Coconut, Vanilla, Black Pepper, Cloves, Cardamom, Dry Chilly, Turmeric, Cashewnut, Ginger, Garlic etc) and Flowers (such as Rose, Jasmine, Gerbera, Carnation, Anthurium, Orchids, Lillies, Chrysanthemum, Tuberose, Crossandra, Aster, Marigold etc.,) are grown in the State. Horticulture production area in the State accounts for about 16% of the total cultivable area. It includes plantation crops (45%), vegetables (23%), fruits (20%), spices (10%) and other commercial crops like flowers, medicinal and aromatic plants (2%). During the year 2013-14, the State has produced 66.26 Lakh MT of Fruits, 82.50 Lakh MT of Vegetables, 4.85 Lakh MT of Plantation Crops, 6.56 Lakh MT of Spices, 2.14 Lakh MT of Commercial Flowers, 11351 MT of Medicinal Plants, 14282 MT of Aromatic Plants. In Karnataka, only about 1% of the total production of fruits and vegetables is currently being processed for value addition. About 25–30% of post harvest loss is estimated due to inadequate cold storage, required transport, poor handling, insufficient processing and other value addition facilities. A recent study jointly conducted by the management consultancy firm, McKinsey & Co. and the Confederation of Indian Industry (CII), determined that at least 50% of the production of fruits and vegetables in the country is lost due to wastage and value destruction. The cost of wastage is estimated at Rs. 23,000 crores on an annual basis. Levels of wastage differ in accordance with the fruit or vegetable concerned. At present in Karnataka, there are only 98 cold storage units having 2.97 Lakh MT for handling fruits and vegetables. Of these units, 2 are in co-operative, 90 are in private and 6 are in public sector. Suitable post harvest infrastructure in terms of cold storages, processing units and road networks in inaccessible areas can give a big boost to the horticulture sector by promoting value addition and food processing. Value addition plays a significant role in improving farm income of small scale farmers. For example, presently, the cashew farmers sell their produce to major processors at a lower price. In case they themselves adopt small scale processing, the overall returns will be higher by 50-60%.

Table : Technologies Related to Horticulture for doubling the farmers' income

S. No.	Technology Title	Brief description	Potential income increase due to technology
	Ultra high density planting	Planting of cashew under ultra density planting technique (3 m x 3 m or 2.5 m x 2.5 m) 400 to 600 plants per by super imposing regular productive pruning using selected cashew varieties such as VRI-3, Ullal-1, NRCC Sel-2 and hybrid H-130 has been successfully demonstrated in farmer's field. About 3-4 tones of nut yield per ha can be harvested in the early stage of orchard life from ultra high density orchards. These technologies are package intensive and are more successful in hilly terrains of coastal and main land tracts.	100 – 200 %

S. No.	Technology Title	Brief description	Potential income increase due to technology
1.	Intercropping in cashew	In the high rainfall zones and also in the regions of availability of irrigation facilities, intercrops such as locally important marketable vegetables, pulses and medicinal plants can be grown as intercrops in widely spaced cashew plantations in the initial years of cashew crop. The suitability of season and type of intercrops is a most critical factor.	50 – 100% Depending on selected crop
2.	High yielding varieties/ hybrids	Till date, 43 high yielding cashew varieties have been released and recommended for cultivation of these; regionally suitable varieties can be grown successfully in different zones. A few hybrids viz., H-130, H-126, H-32/4 and NRC 493, NRC 301 with big apple and bold nut are under evaluation and in pipeline for release. Most of these are very high yielding (20-30%) and with premium kernel grade recovery (W 110 to W 180).	50 – 60 %
3.	Value added products	Protocols for the products from cashew apple such as cashew apple juice (RTS), jelly, jam, halwa and cider (low alcoholic beverage) have been standardized and market acceptability is being evaluated. This activity ensures effective utilization of cashew apple which is presently going waste, and will enhance the total income from cashew orchards.	20 – 40 %
4.	Homestead cashew processing units	Presently, the cashew farmers sell their produce to major processors at a lower price. In case they themselves adopt small scale processing the overall returns will be much higher. Further the retail rural economy will get a boost.	40-50 %
5.	Converting wastelands into cashew orchards	The existing wastelands can be converted into cashew plantations through appropriate soil management practices. By this effective land utilization can be achieved and additional quantity of raw nut targeted can be obtained to meet the local processing needs of the nation.	50 – 60 %

S. No.	Technology Title	Brief description	Potential income increase due to technology
6.	Mango	Arka Saka Nivarak (to control spongy tissue in Alphonso mango)	60%
		Regular & synchronized flower inducer formulation	60%
		Mango micronutrient foliar formulation	40%
		AM Fungi culture, Arka Microbial Consortium	25%
7.	IPM for mango, banana, tomato, brijal, cabbage, gerbera and carnation	IPM for major pests (lure traps, crop sanitation, need based insecticide application)	20%-25%
8.	Improved varieties of flowers	Planting recently developed Flower and vegetable varieties by ICAR-IIHR.	2-4 times
9.	Mango, Custard apple, Grapes and hybrid guava capsicum	High density planting, Use of vigour regulating root stock, application of growth retardants and canopy management	2.3 times
10.	PHM technologies for mango, guava, papaya, banana, sapota, oranges, capsicum	Existing technologies to reduce postharvest losses & increase farmers income through PHM technologies	30%-75%
11.	Protected cultivation	Maintenance and efficient use of Protected structures like green house, shade net, poly house etc. Protected cultivation of flowers and vegetables. Bringing the beneficiaries of Krishi Bhagya Yojana (Protected cultivation) on a common platform to educate them for profitable use of the structures.	2 fold increase
12.	Minimal processing and grading at the farmers level and marketing directly to the consumers.	❖ Minimal processing of Fresh fruits and vegetables ❖ Modified atmosphere packaging (MAP); ❖ Use of Natural food preservatives, Integration across the supply chain. ❖ Grading is sorting of vegetables and fruits into different grades according to the size, shape, colour, and volume to fetch high price in market.	2 fold increase

S. No.	Technology Title	Brief description	Potential income increase due to technology
13.	Promoting Low cost or no cost technologies for the management of pests, diseases and weeds.	❖ Prevention practices and monitoring ❖ Traps to monitor insect pests ❖ Curative methods ❖ Trap cropping ❖ Biological control	5 fold increase
14.	Value addition, packing and marketing	❖ Tetra packaging ❖ Bamboo mat holed boxes ❖ Polypropelene boxes ❖ Corrugated fibre board ❖ Vacuum packaging ❖ Conventional raw materials into finished or semi finished products	
15.	Reducing the cost of cultivation by adopting organic practices	❖ Crop diversity ❖ Soil Management ❖ Weed Management ❖ Controlling other organisms ❖ Livestock	2 fold increase
16.	Efficient use of farm resources to reduce the cost of purchased inputs	❖ Low external input and sustainable agriculture (LEISA) ❖ Organic agriculture ❖ Precision agriculture ❖ Conservation farming (CF)	2 fold increase
17.	Enhancing production per unit area using latest technologies	❖ Per Drop More Crop ❖ GM Technologies ❖ Hi-tech horticulture ❖ Precision Farming ❖ High Value Horti Commodities Cultivation ❖ Hybrid seed production	2 fold increase
18.	Incorporating the allied Agril. activities	❖ Dairy, poultry, goat & sheep rearing, apiculture or Sericulture	10 fold increase

S. No.	Technology Title	Brief description	Potential income increase due to technology
19.	Agri-Horti-Silvi practices	❖ Horti-silvi- Livestock ❖ Agri-silvi-horticulture ❖ Agri-horti-silviculture ❖ Agri-horticultutre	10 fold increase
20.	Measures to avoid in the marketing system of agri, horti, vet. products.	Marketing channels Direct to Consumers Regulated Markets Cooperative Marketing Societies (CMS) Commodity Groups Direct Channel- Farmers- Processors/ Bulk consumers	10 fold increase

3. Livestock and Fisheries

Livestock and fisheries sector has gained prominence during the past three decades owing to its impressive growth and increasing GDP contribution within the agricultural sector. Livestock rearing practices have dramatically changed in recent years from subsistence to commercial, subsidiary to main-occupational and unorganized to intensively organized systems. In Karnataka, livestock sector plays an important role in improving the economic status of the rural farmers who are dependent on the livestock for their livelihood. Karnataka is the 9th largest state in cattle and buffalo population in the country, accounting for 4.3 per cent of the total population as per the latest Livestock Census, 2012. It has 2.9 crore of livestock and 5.3 crore of poultry population. The share of livestock sector in gross state domestic product of agriculture and allied activities was 20.27% during 2014-15. The share of Karnataka in all India poultry and livestock population was 5.41% and 7.33% respectively. Government of India has declared the State as a render pest disease free zone. To provide health care to the animals and for improvement and development of breeds of animals, various programmes are implemented successfully by the Department of Animal Husbandry and Veterinary Services, through its institutional network.

However, according to the latest research conducted by ICAR on foot and mouth disease (FMD) in livestock, the reoccurrence of foot-and-mouth Disease (FMD) outbreaks remain a major challenge. India is losing a whopping Rs 18,000 crore annually due to the dreaded foot and mouth disease (FMD) in livestock and indirect losses due to FMD are to the tune of Rs. 30000 – 35000 crores annually. These losses are because of lower milk production and meet of infected animals is not good for consumption.

Development of livestock and fisheries must receive a high priority in the efforts for diversifying agriculture and doubling farmer's income. Over the past few decades, research institutes working on this sector offered a number of technological options that could raise the productivity of different species if adopted area-wide. These include genetic enhancement of indigenous breeds through crossbreeding with exotic breeds, improvement of nutritive quality of feed and fodder through biological and chemical treatments, development of vaccines against animal diseases, improved livestock management practices, and post harvest management. Karnataka government and Veterinary University's animal health care or disease control programs as well as improved veterinary services and other farm management programs have helped mitigate animal losses, maintain disease-free status and increase the farmers income. For example, clean milk production and control of sub clinical mastitis can increase farmers income by 40% and adoption of improved breeds instead of local goats as well as supplementation with assured health care service delivery can increase the famers income by 50%.

Table: Technologies Related to Livestock and Fishery for doubling the farmers' income

S. No.	Technology Title	Brief description	Potential income increase due to technology (in percentage)
1.	Clean milk production and control of sub clinical mastitis	A better diagnostic and strategic control measures have been developed which reduced the occurrence of mastitis cases both in cows and buffaloes after imparting knowledge and skills on the mastitis detection and control techniques. The keeping quality of milk has also improved in both cow milk and buffalo milk. There was one lakh reduction in the somatic cell count of cows and buffaloes milk by the adoption of the practices. As a whole, the effort of multidisciplinary team in prevention and control of SCM at field conditions will help in improved production performance	40%
2.	Strategic feeding regimen to boost production and reproduction in dairy animals	Strategic feeding regimen of 30 kg of cereal green fodder, 5 kg leguminous green fodder 4 kg dry fodder and concentrate feed 2.5 kg for an animal yielding 10 litres of milk per day. This helps to increase in milk yield to the tune of 3.0-5.0L per animal. In addition, improvement in the quality of milk in terms of SNF and Fat encouraged the farmer to adopt the recommended feeding regimen.	25%
3.	Up gradation of local goats, supplemen-tation with assured health care service delivery	The improved breeds namely, Osmanabadi, Telicherry, Boer, beetel breeds of goat can be introduced for up gradation of local goats through community based groups. In addition, 250 g of concentrates may be supplemented in last two months of gestation and one month after kidding. Further, regular deworming and vaccination against PPR, HS and ET has to be carried out. It will increase in the annual income to a tune of Rs.20.000/-. In addition, an asset of goats boosts the confidence of rural farmers to lead their livelihood.	50%

S. No.	Technology Title	Brief description	Potential income increase due to technology (in percentage)
4	Integrated sheep management practices	❖ Selective breeding with elite rams of far off farms to overcome inbreeding depression results in increased birth weight, growth rate and marketable weight. In addition, it reduces genetic abnormalities and inbreeding depression ❖ Strategic supplementation of 200-250 g of concentrate in last two months of gestation and one month after lambing improves mothering ability, birth weight and marketable weight and better returns. In addition, it reduces kid mortality to a tune of 15-20% ❖ Health care service: regular deworming and vaccination against PPR, HS and ET to improve general health and production ❖ Marketing intervention: Marketing of sheep on the basis of body weight by taking actual weight instead of approximate lumbar assessment through regulated market / farm.	40%
5.	Ram lamb fattening	The majority of shepherds sell ram lambs at the age of 2-3 months to optimize their flock size and replacement stock. Instead, these ram lambs can be well reared for another 6-8 months to harvest higher meat and income by stall fed rearing system. A flock of 30-50 ram lambs of 2-3 months old can be easily reared by a farmer or an entrepreneur for another 8 months yields net profit of Rs, 2500- 3000 per ram lamb. In addition, it also strengthens the food security needs.	30%
6.	Rural hatchery to augment Back yard poultry production	In recent years, local bird's meat and eggs gaining lot of demand in the market. In response to this, many of the farmers are rearing local birds and fetching better returns. But, the farmers are finding difficulty in getting day old chicks of local birds/ improved birds at reasonable price. In addition, their production cost is also high because of low FCR. Hence, a rural hatchery unit of capacity from 202-1000 eggs can be very well established at farmer's door step/ community based group to meet the local demand of chicks and better returns	15%

S. No.	Technology Title	Brief description	Potential income increase due to technology (in percentage)
7.	Dairy Enterprise Farming Model	Enterprise farming Model: in this model he will become an entrepreneur. He will produce good quality milk, convert into value added product and sell directly consumers in nearby places against online orders from them, instead of through intermediaries by itself may double the income of farmers.	16%
8.	Area specific mineral mixture for dairy animals in Karnataka	Mineral mixture was formulated based on survey of mineral status of soil, feeds/fodders and in dairy animals of different agro-climatic zones of Karnataka, field tested and found to improve reproductive efficiency and health in dairy animals. The technology is cost effective for adoption at field level and has been commercialized. The product is available in dairy cooperative societies and in retail market for end users.	15%
9.	Mineral mixture for small ruminants	Specific mineral mixture for sheep and goat were formulated based on the most limiting minerals, specific requirements and commonly deficient minerals in feeds and fodders of small ruminants. The formulation was field tested and found to improve growth and immunity. The Technology is commercialized and the product is available in retail market for end users.	10%
10.	Areca sheath as source of dry fodder	Use of shredded areca sheath as dry fodder as an alternative to paddy straw in the form of total mixed ration to dairy animals has shown improvement in milk yield and milk quality. The technology is simple to adopt, reduced the cost of feeding and successfully adopted in diary cooperative societies in coastal Karnataka.	20%
11.	Pineapple fruit residue silage as source of green fodder	Silage technology from residue of pineapple fruit processing was developed and evaluated as a source of green fodder and found very useful in terms of nutritive value to cattle and sheep. The technology is simple to adopt and being used in areas of Uttara Kannada in Karnataka.	20%

S. No.	Technology Title	Brief description	Potential income increase due to technology (in percentage)
12.	Strategies for methane amelioration in livestock	Enteric methane amelioration strategies were developed using tanniniferous phyto-sources at specified levels in straw based basal diet. About 20 per cent reduction in enteric methane emission was achieved during in vivo studies without any adverse impact on feed fermentation. If, these strategies propagate across the country, about 2 million ton less methane and 50 million ton less CO2 will be dispensed annually from Indian livestock. This saved biological energy will be diverted for other productive functions in the body.	10%
13.	Enhanced egg production with red lighting	Red lighting (LED 4 Watts) in commercial poultry farm improved the egg production by 2% in high performing white leghorn layers and reduced electricity consumption in the farm. It is cost effective and adopted in a layer poultry farm near Mysore in Karnataka.	10%
14.	Semen quality assessment test	Low quality semen is one of the reasons for less conception and repeat breeding. A novel test has been developed to identify the sub-fertile bulls. Use of this test in semen stations will help to improve fertility rate.	5%
15.	Azolla cultivation	Cultivation of azolla as a backyard activity and supplementation as green feed improves milk yield and milk quality.	10%
16.	Grain sprouts as fodder source	Sprouting of cereal grains like maize with water sprinkling with or without straw bedding has shown to be a supplementary green fodder source as a contingency measure and also improves water use efficiency.	15%
17	Ration balancing using Feed chart and Feed Assist	Tools for Balancing major nutrients in dairy animals using local feed resources have been developed. This will improve milk yield and health of animals.	20%
18.	Fishery farming	Transforming one acre of paddy farming into fish farming increases the farmer's income by 15 folds. One rears the fish seed separately for 2-3 months and then stock the ponds scientifically there are very less chances of failure in fish culture. Using local cheap feed material one could reduce the cost of cultivation to a greater extent and increase the net income.	15 fold increase

Summary Recommendations:

Karnataka state is having second largest area under rainfed agriculture next only to Rajasthan. The State also is one of the most drought prone State of the country. For instance, of the 176 blocks, over 140 were declared as drought hit during the year 2016-17. Despite this, the state has been contributing significantly to the nation's food basket. However, farmers in general and those in particular engaged in rainfed agriculture are facing wide spread distress due to increase in cost of living and decreasing profitability. The impetuous being accorded to Doubling the Farmer's Income is very timely and the dire need of the hour especially in the State of Karnataka.

There is ample scope as evidenced by several important studies that the farming is support by required inputs at affordable cost and the farmers realizes higher market prices for his produce, the goal of Doubling the Farmer's Income within the given time frame is very much achievable. Certain studies have shown that unless the farmers share in the consumer rupee increases from the current 22%-24% to an expected 55-60%, farming will remain an unprofitable proposition. However, realizing higher share for farmers in the consumer price is fraught with several challenges. Primarily it calls for major market reforms. Improved grading and processing infrastructure besides technology led weather forecasting, market intelligence and insurance. Improving production by adopting better planting materials and improved agricultural technology will enable to contribute approximately 30% to the farmer's income. Another 30% of income contribution can be realized by adding value through grading, primary processing and cost reduction through improvement in input use efficiency. The remaining 30-40% increase in income must be realized through institutional innovations such as reforms in pricing, aggregation of producers into companies to have a collective bargaining power in terms of buying inputs and selling output and a robust agricultural insurance product covering all gamut of farming including crop, livestock, fishery, horticulture, sericulture etc. The noble goal of Doubling Framers Income will only be realized if there is a concerted effort in all sectors and by implementing an action plan at the ground level involving all the stakeholders.

SUCCESS STORIES

1. Integrated Farming System: a success story in Karnataka

Shri Basavaraj Huchchayyanavar, S/o Shri Virupakshappa Huchchayyanavar of Chikkamalligawad village, is a BA graduate and has completed Diploma in Dairy. He has got 4.0 ha. land with irrigation facility at Chikkamalligawad village of Dharwad taluka. Shri Basavaraj Huchchayyanavar has adopted Integrated Farming System (Agri-Horti-Silvi-Pasture system, Animal husbandry, Production and use of organic manures and pesticides, Soil and water conservation techniques and Sericulture). With his self interest and motivation, cultivating field crops (0.6 ha), horticulture crops (1.0 ha), involved in sericulture (2.0 ha), vermicomposting (0.4 ha), agro-forestry, dairy, poultry and fishery.

He has adopted innovative technologies such as labour saving equipments and tools viz., tractor, sprayers, bullock and tractor drawn implements and other minor agricultural implements. Shri Basavaraj has adopted integrated farming system and strongly endorses organic farming in all his agricultural practices. He grows a versatile crops including field crops such as jowar, maize, paddy etc., He is cultivating mango, guava, lime, sapota, as well as vegetables and has grown teak, fodder crops, acacia and sandal wood all along the bunds. He has attained household food security which is self-sustainable. He has constructed large scale open pit for production of vermicomposting (75'x75') and 4 small pits (4'x20') through which he produces 90 tons of vermicompost every year. Besides, he also produces vermicompost of 90 tons/ year in heap system (40'x 40') with minimum labour engagement. He has enhanced production of vermicompost through utilization of bio gas and bio-digester slurry. He has adopted wider row spacing (5'x3') in sericulture with improved mulberry varieties (V-1) and growing vegetables as intercrop. He is also rearing sericulture eggs at farm level which is transported and marketed to Mysore. He has cultivated mango with guava, lime and mulberry as intercropping in organic form. Bio gas generated from agri and animal waste is utilized for cleaning Chandrike. The innovative farmer is cultivating local/native varieties of paddy so as to protect and preserve endangered local paddy varieties. He is conserving resources through collection of run of water through contour bunding, insect and pest management through need based pesticides application, use of pheromone traps, growing of trap crops, regular spray of panchagavya etc. Integrated water management practices in the form of drip with fertigation has been implemented. Indigenous technical knowledge such as smudging in mango, neem based pesticides, application of organic manure @ 5 tons/ha and tank silt @ 20 tons/ha are being practiced for mango. For adoption of IFS and outstanding innovations in the field of organic farming and sericulture, he has been credited with the several awards. Before adoption, his farm income was Rs. 6,12,800/-. After the adoption of IFS with multi-enterprise agriculture enhanced his annual income by 62% (Rs. 9,90,000).

2. Benefits of FPO: a success story in Karnataka

Since Karnataka does not have an exclusive market to sell their organic produce, farmers who followed the organic methods of farming were unable to market their produce. This resulted in the ending up in a common market, thereby defeating the whole purpose. At this juncture, Sahaja Samrudha, an organisation led by farmers and farming experts has developed a connectivity network of consumers and producers for procurement and marketing under the brand name "Sahaja Organics". Sahaja Samrudha Organic Producers Company Ltd., has been formed to market organic produce. Presently, the company has over 750 organic producers, who are also the shareholders. This apart, the company has around 2500 farming families (30 farmers' group) in its network.

The Producer Company will facilitate farmers to exhibit and sell their produce with a good price ear marked. The produce is procured directly from the farmer and supplies it to the network outlets. This chain has been created for the produce to reach the consumer directly. The firm pays a premium price of 15-20 percent higher than the traditional market price, while it retains a nominal amount for its sustenance.

Sahaja promotes only organic and traditional crops of rice, millets and pulses. These crops are in great demand in the urban areas for their nutritional value and medicinal value, especially the millets and red rice. Being one of the largest wholesalers of organic grains in the state, it supplies organic products to around 80 retail outlets in Bangalore and around. However, the company has only one storehouse and retail outlet.

In addition, as a direct sales initiative, it organizes annual red rice melas, seed festivals and safe food melas in cities, tier-2 and tier-3 towns in which the farmers sell their produce to consumers at a fair price. These dedicated farm markets allow consumers to have access to locally grown, farm fresh produce, enables farmers the opportunity to develop a personal relationship with their customers, and cultivate consumer loyalty with the farmers who grows the produce.

Initially, being a producer company, Sahaja started with a policy that it will solely depend on farmers' money. The producer company in the year 2010, started with a capital of Rs 5 lakh, raised through pooled funds from farmers and farming groups. In 2014-15, the company's turnover increased tremendously to Rs 3.6 crore and it made a profit of Rs 30 lakhs. Out of this, Rs 5 lakh was distributed to the famers and some money was pooled back into the business.

According to a 66-year-old farmer, Mr. Nagaraj from Hosahalli, who grows carrot and beetroot says that, after the direct market access, he has benefitted a lot and his income level has doubled since last four years. "If the market price for the carrot of normal variety is Rs 12-18, I get about Rs 25-35 for my organic produce through Sahaja. Even if we deduct a nominal charge for the Sahaja initiative, we still end up getting 60-80 percent higher for our produce," Nagaraj says.

Though farmers in this region have small plots that range from 0.5 acres to 2.5 acres, farmers here leading a dignified life due to marketing of their produce through FPO.

14

KERALA

Kerala agriculture is distinct from that of rest of India in terms of resource endowments, land use and cropping pattern, scale of farming as well as socioeconomic factors. Geographically, the state has a vast coastal line (low lands, 10 %), midlands (42 %) and highlands (48%). The state receives high rainfall (2500 – 3000 mm), yet faces acute shortage of water in summer. The relative humidity favours cultivation of most of the tropical and subtropical crops but at the same time harbors all major pests and diseases. The diversity in soil, climate and socio economic endowments in the state favors cultivation of a variety of crops, contributing to a rich and varied crop cafeteria spread across its length and breadth. Another specialty of Kerala is abundance of home gardens estimated at around 64 lakh numbers, presenting a combination of crops, livestock, poultry/duckery and aquaculture.

The road to achieving higher farm income is full of challenges. With wide variations in agro-ecosystems in the state, broad-based recommendations are difficult to be implemented. Another difficulty is the large variations in climate, soil quality and social situations at micro-level. Even the cropping practices being followed vary from season to season and are highly influenced by anticipated economic returns. The small farms which account for the large chunk of cultivated area require special attention. Thus, technological support needs to be highly specific to crops/regions and should be customized to suit local social and economic realities. This is true for the diary, poultry, fisheries and all other allied sectors of the economy. Shrinking resources (land, labour, skilled farm operators, farmers) changing mind sets towards farming is another major challenge. Accordingly, the nature and purpose of farming is undergoing changes which is to be addressed specifically.

The terrain in Kerala is highly diverse, ranging from high-altitude zones that has temperate climate to low altitude coastal regions endowed with humid tropical climate. The soil type also vary substantially according to altitude and topography and a variety of soils like alluvial soil, sandy soil, sandy loam, laterite soil, red soil, black soil, peat and acid-saline soils are present within the limited geographical area of the state. The state is opulently endowed with rainfall with an annual precipitation of around 3100 millimeter against a national average of 1200 mm.

Based on the altitude, rainfall, soil types and topography, Kerala is delineated into 13 agroclimatic zones with each zone specialized to support a variety of niche crops of Kerala. Being a high rainfall region, Kerala is also a land of abundant water bodies. Along with 44 rivers and 34lakes, there are innumerable numbers ponds, streams and other types of water bodies that are not only useful as source of irrigation but also supports a variety of aquatic life.

Agricultural land-use changes in Kerala during the past half-century were marked by an initial increase in gross cropped area followed by shifts in the coverage of individual crops. The cropping pattern of the state has also undergone a dramatic shift since the sixties with a large skew towards cash crops. The area under food crops decreased from 45 per cent of the total cropped area to 10.32 per cent between 1960-61 and 2013-14, while the area under cash crops increased from 36.6 per cent to 62.30 per cent during the same period.

In Kerala four major types of cropping systems are followed:

i. Rice based system in lowlands with single or two crops of paddy, summer vegetables, pulses or oil seeds with or without aquaculture component,
ii. Coconut based mixed cropping system comprising a number of intercrops like pepper, arecanut, cocoa, clove, banana, vegetables, green manures and covercrops,
iii. Mono crop rubber plantations and
iv. Homesteads, unique to Kerala comprising a large number of components like trees, food and fodder crops, livestock, fishery and poultry.

14.1 Productivity Gaps and Major Constraints

There are several inherent as well as man-made constraints that limit expansion of agriculture in Kerala.

i. High and increasing share of marginal farms and fragmentation
ii. Extreme human labor shortage and resultant high wage rates.
iii. Low orientation towards food crops.
iv. Weak agricultural extension activities in spite of elaborate institutional infrastructure.
v. Lack of regulation and poor investment in agricultural marketing/Limited presence of new formats of agricultural marketing.
vi. Low adoption of resource conservation technologies like micro-irrigation, precision farming, zero tillage, conservation agriculture, climate smart agriculture, etc.
vii. Low scale of farm level value addition and processing.
viii. Limited institutional mechanisms to cover risk in agriculture.
ix. Rapid rate of urbanization and increasing population density.
x. Exodus of workforce towards non-agricultural sectors.
xi. High out-migration of labor force.
xii. Conversion of farm land for nonfarm purposes
xiii. Fast depletion of ground water levels.
xiv. Losing competitiveness of niche crops in international markets.
xv. High influx of cheap imports of farm products like edible oil, tea, spices, etc.

Technological interventions for Doubling Farmers' Income in Kerala

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Field crops: Paddy	High yielding medium and short duration varieties released from the different research stations and for specific situations could be suitably used with support from State Department of Agriculture for seed production and distribution. • Establishment of seed production units for large scale production certified HYV seeds. • Popularising scientific upland rice production technology. • Modifying the crop geometry by paired row planning of upland rice and utilizing inter spaces for growing crops like cowpea, millets, vegetables • Popularizing suitable rice based cropping system viz., Rice-Rice-Pulses/Vegetables/ Oil seeds, Rice- cassava, Rice- sweet potato etc. for each agroclimatic zone. • Promotion of organic production package of rice especially in njavara, basmati etc. for expert.	New improved HYV include Uma, Jyothi, Kanchana, Aishwarya, Anaswara, Ahalya, Harsha, Manupriya, VTL-7. Speciality rice, varieties jeerakassala Gandhakassala (aromatic), Kalladiyaran (drought resistant), chovvaryan (salinity tolerant), Edavaka (pest resistant) Chennthadi (flood tolerant) Veliyan (drought and tolerant). Traditionala varieties: Kalldiuaran, Adukkan	Varieties suitable for mid-land a n d lowlands. Aromatic and medicinal varieties are specially suited for upland districts such as Waynad and Idukki. Salinity tolerant varietie are promising in pokkali/kole/kaipad regions in mid-land and low land districts.
Field crops: pulses and oil seeds	Adoption of high yielding varieties of pulses and oilseeds suited to each locality and situation Timely availability of good quality rhizobium culture for compulsory seed inoculation of pulses before sowing. Productivity enhancement by adopting scientific irrigation schedule based on IW/CPE ratio, moisture depletion approach and critical growth stages. Revival and intensification osesamum cultivation in the Onattukara tract.	Cowpea: Kanakamany, Anaswara, Krishnamani, Pournami (for summer rice fallows) and Shubra (as summer rice fallows of southern Kerala and Sreya and Hridya in summer rice fallows of Onattukara). Black gram: Syama, Sumanjana, T-9, CO-2, TAUI (partially shaded). Green Gram: Pusa Baisakhi, CO-2 and Pusa 8973. Horse gram: CO-1, Pattambi Local, AK-21 and AK-42Groundnut: Sneha Snigdha Sesamam 1, Tilottama, Thilathara.	Mid-lands and low land districts such as Palakkad, Malappuram and Ernakulam.
Field crops: Tuber crops	Adoption of released or locally accepted high yielding varieties of tuber crops • Promotion of soil test based integrated nutrient management utilizing the service in the soil testing laboratories and Krishi bhavan. • Retaining only two shoots in opposite direction by removing excess ones at 30 DAP. • Plant vine cuttings of 20-30 cm length from middle and top of vines • Adopting minisett technology for yams • Providing organic mulch to colocasia.	Tapioca varieties: Sreevijaya and Sreeathidya (hybrids), Sreejaya (early maturing), Sreesahya (drought tolerant), Sreeprabha and H-165 and H-226. Yam: Indu,Coleus: Suphala	All three regions. Main growing districts are Thiruvananthapuram, Kollam, Idukki, Pathanamthitta and Malappuram.

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Plantation Crops: Coconut	Improved coconut varieties Crop improvement research, through evaluation and utilization of coconut genetic resources in the country, has resulted in the development of several improved varieties, through mass selection and hybridization approaches. Till date, about 20 improved varieties of coconut, including six high yielding hybrids, have been released by ICAR-CPCRI for cultivation in India. These includes tall, dwarf and hybrid varieties and varieties for tender and copra production in different parts of India and also varieties resistant/tolerant to root (wilt) disease, moisture stress tolerance, and varieties for ornamental purpose. Economic aspects: Traditional or coconut yield up to 9000 Kg/ha of husked nuts and 15 kg Copra/palm that is 2.6 tonnes of copra/ha/year. Improved varieties have the potential to give Kg/ha of husked nuts and 25 kg copra/palm that is 4.4\ tonnes of copra/ha/year. By cu tivating improved varieties, farmer can realise an additional 6000 Kg/ha of husked nuts	CPCRI Coconut Varieties Chowghat Orange Dwarf,Kalpasree,Kalpa Jyothi, KalpaSurya, Kalparaksha, Chandra Kalpa, Kerachandra, KalpaPratibha, KalpaDhenu, KalpaMitra, Kalpatharu, KeraKeralam, KalpaHaritha, KalpaShatabti, Chandra Sankara, ChandraLaksha, KeraSankara, KalpaSankara, KalpaSreshta	All three regions
	Replanting old and senile palms with high		
	Hybrids Old and senile palms in Kerala which account for the major area under cultivation is low in productivity. Comprehensive strategy to replant in a phased manner with HY hybrids developed at KAU like KeraSree, KeraSoubhagya, Kera Ganga, Laksha Ganga and Ananda Ganga is core theme. Expected yield return is to the tune 120 nuts / palms under good management practices.		
	Comprehensive Coconut Care Package of KAU Soil test based nutrient management plans for the crop as well as the intercrops. The status of major secondary and micronutrient status have to be examined and recommendations are to be formulated. Strategies for improving soil organic matter status and better soil health. Integrated management plans for the system. Encouraging intercrops and mixed crops in scientific manner to effectively harvest the solar radiation. Water saving irrigation and nutrient management plans. Development of comprehensive farming suited to small, marginal and large scale farms. Studies conducted at ORARS, Kayamkulam have revealed that even in the hot spot „root wilt" affected areas the yield increased from 14-44 nuts/palm/year.		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
	Improved aeronaut varieties Improvement of arecanut through evaluation and utilization of genetic resources in the country has resulted in the development of improved varieties, through selection and hybridization. Till date, about 9 improved varieties and two hybrids of arecanut have been released by ICAR-CPCRI for cultivation in India. These include tall, semi-tall and dwarf varieties, suitable for dry kernel yield, tendernut yield as well as dual purpose. **Economic aspects:** The improved varieties are capable of producing 4.5 tonnes of dry kernel/ha/year. Traditional or local varieties in arecanut yield up to 2600 kg dry kernel/ha/year. Improved varieties have the potential to give yield up to 5200 kg/ ha/year of dry kernel. By cultivating improved varieties, farmer can realise an additional 2000 kg dry kernel/ha/ year (about 80% increases in production). At the present value of Rs. 2,00,000/- per tonne of dry kernel, the additional income is approximately Rs. 5.0 lakhs per annum per hectare. (180-190% increase in income).	**CPCRI arecanut varieties** Motinagar, Swarnmangla, Nalbari, Shatamangla	All the three regions
	Nutrient and water management in Arecanut Arecanut responds to application of nutrients and water. The crop cannot be grown without water. The decrease in water resources is a concern in the cultivation of arecanut. A study conducted at ICAR-CPCRI has indicated that adoption of drip irrigation will save water and increase the yield of arecanut. Further application of ferilizer along with drip irrigation improves the use efficiency of both water and nutrients and increases the yield. Thus savings in input and increased yield will help the farmer in doubling his income.		
Plantation Crops: Cocoa	**Improved cocoa varieties** Cocoa improvement through selection and hybridization strategies for high dry bean yield, industrial value, tolerance to biotic and abiotic stress resulted in development of eight improved varieties of cocoa. Economic aspects: The improved varieties are capable of producing a minimum of 2 kg to a maximum of 4 kg dry bean yield per tree per year in an average management conditions under coconut and arecanut based cropping systems with medium canopy.1200-1800 kg dry bean yield/ ha will provide an additional income of Rs. 2.4- 3.6 lakhs with Rs.200/ kg dry bean rates.	CPCRI Cocoa varieties: VTLCS-1 (Vittal Cocoa Selection- 1), VTLCS-2 (Vittal Cocoa Selection- 2), VTLCH-5 (Vittal Cocoa Hybrid- 5)	Highlands of Idukki, Kottayam and Ernakulam.

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Plantation Crops: Rubber	**High yielding rubber hybrids:** Clones developed by Rubber Board for planting in different agro-climatic regions and tolerant to all major diseases of rubber (Abnormal leaf fall, Colletotrichum leaf spot and Corynespora leaf disease). **Root Trainer propogation technology:** Rubber Board pioneered the customization and standardization of protocol for the root trainer technique in developing planting materials of rubber to enable mass production of good quality plants in nurseries	RRII 105, RRII 400 Series clones, clones RRII 414 and RRII 430 are tolerant to all major diseases of rubber. RRII 208: This cold-tolerant, hybrid clone was successfully developed and released in 2016 for exclusive cultivation in the cold-prone areas	The midlands of almost all districts. Highest area in districts such as Kottayam, Ernakulam, Pathanamthitta, Malappuram, Kannur, Kollam and Thiruvanathapuram.
	Minimum tillage and planting in small pits Experiments have shown that in deep soils, rubber can be planted in small pits with minimum tillage operations. By adopting this technique, cost of initial plantation management can be reduced. Apart from reducing the cost, this technique will reduce soil disturbance and thus reduce the extent of fertile soil lost through erosion.		
	Establishment of ground covers: Establishing ground covers along with rubber in the interspaces will restrict weed growth and reduce cost of weed control.		
	High quality of tapping, weekly tapping and controlled upward tapping: Quality standards for scientific tapping have been developed by Rubber Board through long term research carried out by RRII. Low Frequency Tapping (LFT) such as weekly tapping to address shortage of tappers and reduce cost of production without compromising yield and extending economic life of the trees **Economic aspects:** Good quality tapping will improve yield anywhere between 10-30%, depending on the current quality of tapping. Weekly tapping will reduce taping cost by almost 50%compared to twice a week tapping frequency.	Rubber Board has successfully adapted Controlled Upward Tapping (CUT) with periodic panel change as suited for the agro- climatic conditions of the country.	

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Plantation crops: Tea	**Biclonal seed stock and high yielding clones** Explosion of biclonal seed stock from BISS-1 to BISS-5 and recommended graft combination for infilling. Ensuring adoption of high yielding clones like UPASI 3,8,17,25,28 for new planting. Planting of identified clones for problems zones	UPASI 3/UPASI 2/UPASI 3/ UPASI 6 (biclonal UPASI 3, 8, 17 , 25, 28 (High yielding clones) #Drought prone areas- UPASI 9. # wind prone areas UPASI2, UPASI 10 # Frost prone areas UPASI 15, 16	Highlands of Idukki, Waynad, Ernakulam, Thiruvanthampuram and Kollam
	Production of quality planting materials Adopting vegetative propagation with one leaf and intermodal cutting with axillary bud; from a periodic shoot from pruned tea bush**.**		
	Adopting hedge system of planting •Training techniques like cantering for arresting apical dominance, to prevent growth of Premature pruning at the end of 5 years at a height of 45cm above ground level. •Maintaining a pruning cycle of 4 years is low and midelevation areas and 5 years for fields in high elevation are as Advocate tipping, where 4 leaves and a bud constitute the budding material.		
Plantation crops: Coffee	**Production of quality plants materials** Planting of improved varieties combining high yieldand rust resistant and semi dwarf stature and goodquality beans like Cauvery, CxR hybrids. Use of basket nurseries for raising quality planting materials Advocate plant protection measures against brown eye spot in nursery.		Highlands of Idukki, Waynad, and Palakkad.
Plantation of Cashew	**Planting of soft wood grafts of improved varieties.** Soft wood grafts have been identified as the best planting Material for realizing maximum and consistent yield. Cultivation of high yielding varieties is the most important step in improving productivity in cashew. Use of improved varieties with bold nuts, good kernel size of first grade quality, high shelling percentage and with very high yield can lead to high returns from cashew plantations.	Hybrids like Priyanka, Dhana, and Poornima	Midlands of Kannur, Kasargode Kollam, Palkkad, Malappuram, Kozhikode
	Development of High density orchards Adoption of High Density Planting with 625 tress/ha at a spacing of 4m x 4m proved to be better than normal density of planting with 170-180 trees/ha, at spacing of 7.5mx7.5m , for realizing maximum production in the initial years of cashew plantation. This can be brought to the normal density by selective felling or can be managed by regular pruning and fertilizer application.		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Spices and Black Pepper	**Improved varieties** Improved varieties in pepper can improve yield levels and reduce cost of production thereby enhancing farm income. The varietal technology adoption needs to be strengthened through facilitation of access and availability of planting material across the state. Some of the varieties in spice crops and their varietal characteristics are given below.	Girimunda, IISR Malabar Excel KAU varieties: Varieties for open condition- Panniyur 1, 2, 3 Vijay Partially shaded situation – Panniyur 5, 8 Sreekara, Subhakara High altitude – Panniyur 9, For disease prone areas- Panniyur 8, Panniyur5 For drought prone areas Panniyur 5, 8.	
	Scientific management practices Prophylactic plant protection measures, Shade regulation, Timely and adequate manuring, Moisture conservation measures, Open precision farming, Timely under planting and replanting, Grafted planting materials. Post-harvest practices: Cleanliness during harvesting, threshing, drying and storage, Avoiding contact with chemicals, soil and other contaminants during harvest, drying and storage.		
Spices: Cardamon	**Location specific varieties:** Improved and high yielding varieties, varieties suitable for drought prone areas.	Varieties PV 2 and Njallani Green Gold suited to Idukki distrit Malabar types like TDK 4, ICRI- 1, ICRI-5, ICRI- 6 are suited for drought prone areas ICRI- 7 for Wayanad	Highlands of Idukki, Wayanad and Palakkad
	Selection of appropriate planting material In Kerala where viral diseases are not a problem, vegetative propagates can be used for planting.		
	Rapid clonal multiplication: Closer spacing and good management practices, Easy and cheap method		
Spices : Ginger	Use of high yielding varieties	Varieties like IISR Varada, Athira, Karthika, AswathyVarada, Rejatha, Mahima are high yielding varieties with good quality	Highland and midlands of Wayanad, Idukki, Palakkad, Kollam and Pathanamthitta.
	Good cultural practices: Weeding, Manuring, Earthling up, Providing drainage, Seed treatment in storage, Timely application of plant protection agents, Rouging **Ginger transplanting**: Preparation of or tray plants reduces planting material requirement, Can prepare off season planting material		
Spices: Turmeric	**Use of high yielding varieties with high curcumin:** Varieties with curcumin more than 5% fetches the premium in the market	Varieties like Kanthi, Sobha, sona, Varna, Sudarshana, IISR Prabha, IISR Prathibha, IISR Alappey Supreme and IISR Kedaram are some of the varieties with high curcumin.	Highland and midlands of Wayanad, Idukki, Palakkad, Kollam and Pathanamthitta
	Use of turmeric transplants: Use of protrays reduces the requirement of planting material, Reduces seed loss in storage, Establishes well inthe field, Resulting in higher yield.		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Fruits: Banana	**Use of new high yielding varieties:** Tolerant to Eumusae leaf spot, pseudo stem borer and suitable for annual cropping.	Varieties: Grand Naine, Yangambi km5,Big Ebanga, Manjeri Nendran II,Attu Nendran	Midlands and lowlands of all districts.
	Large scale production and popularization of tissue culture banana seedlings; Virus indexing of TC plants: Virus indexing of TC banana is a technology for banana bunchy top virus (BBTV), banana bract mosaic virus (BBrMV), cucumber mosaic virus (CMV) and banana streak virus (BSV) are the four viruses infecting banana. Zero to eight percent incidence of viral diseases was observed across Kerala. Serological (ELISA) and molecular (PCR) methods have been standardized for the detection of all banana viruses. The cost of serological indexing is Rs. 150 per sample for 3 viruses and molecular indexing is Rs 200 per sample for one DNA virus and Rs. 300 per sample for one RNA virus. This will save an economic loss of Rs. One lakh per hectare.		
	Organic nutrient schedule in Nendran: The technology involves the application of FYM 10 kg/ plant + Neem cake 1.25 kg/ plant + vermi-compost 5 kg/ plant + wood ash 1.75 kg/ plant + bioagents/ biofertilizers (AMF 25g/pt + Azospirillum 50g/pt + PSB 50g/pt + T. Harzianum 50g/pt) along with triple green manuring with cowpea can give a comparable yield as that of chemical Fertilizer. FYM, neem cake and bio- fertilizers/ bio-agents to be applied as basal, while the time of application of vermi-compost is at 3MAP and wood ash at 5 MAP. In Kerala, about 10 % of banana cultivators turned to Organic farming considering the positive impact of organic cultivation practices.		
	Biological control: Using Entomopathogenic Nematodes (EPN) for the biological control of major weevil pests of banana.		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Fruits: Pineapple	**Promotion of pineapple hybrid:** The pineapple hybrid, Amritha, has the distinction of being the first pineapple hybrid developed in the country, which is an excellent table variety, reputed for its sweetness, high sugar content and low acidity, serving as an acceptable alternative to the ruling commercial variety, Mauritius, in fruit yield and quality, for the entire commercial pineapple growers of the state.		Highlands and midlands, of Ernakullam, Kottayam and Idukki.
	Alternate sources of planting material: The finding that apart from suckers, rooted slips and rooted crowns can be successfully used as alternative source of planting materials in Mauritius variety of pineapple, is rapidly catching up with the pineapple growers of the state, who are facing acute shortage of planting materials, in view of the rapid area expansion taking place, in the crop.		
	High density planting: Standardizing the spacing of pineapple as 45 cm between rows and 30 cm between plants within a row has contributed to adoption of high density planting in the crop and its feasibility as an intercrop in rubber plantations, facilitating one paired row of pineapple between two rows of rubber, impacting 75-80 per cent rubber growers of the state.		
	Induction of uniform flowering Technology developed at the centre, for inducing uniform flowering in the crop, guaranteeing marketable fruit yield and regulation of crop harvest to suit market needs, enjoys per cent adoption among commercial pineapple growers of the state.		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Vegetable crops	Production and supply of quality disease free planting material in pot trays in a soil less medium, compared of coir pith, vermiculite, pectite in the ratio 3:1:1 in major commercial vegetable crops, including cool season vegetables. Demonstrating and popularization of graft technology for solanceous crops like tomato, brinjal and chilli by grafting high yielding hybrids with remarkable fruit size but susceptible to bacterial wilt grafted with resistant rootstocks. Advocating open precision farming in Okra, cucumber, chilli, brinjal, tomato, employing plastic mulching and fertigation has more than doubled the income realized from these farms through high productivity and addressing the problem of scarcity of labour force effectively. Adoption of good agricultural practices by integrating organic as well as synthetic nutrient resources for optimizing productivity of vegetables is imperative in commercial farming Practicing protected cultivation in poly houses for export oriented crops like salad cucumber as well as self-pollinated crops like trailing cowpea result in substantial increase in income generation potential of the farmer. Need based application of target specific molecules of new generation chemicals has proved to be effective in controlling major groups of pests affecting vegetables like sucking pests, borers, white flies, mealy bugs jassids, etc. and diseases like downy mildew, powdery mildew, fruit rot, anthracnose and leaf spot diseases Use of repellants like reflecting ribbons for warding off birds and pheromone traps like culure traps fruit flies of cucurbits, are ecologically safe and effective methods of control. Biocontrol agents have revolutionized crop protection strategies in vegetables. Fungal antagonists like Beauveria and Verticillium are effective against lepidopteran and sucking pests respectively both as a preventive measure and for control in initial stages of infection.		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Cool Season Vegetables, Cabbage, Cauliflower, potato, Garlic, Carrot, Beetroot, Radish	**Identification and popularization of location-specific improved varieties** Presently, farmers in the highlands are not much aware of the improved varieties which necessitate popularization of high yielding cool season vegetable varieties for widespread cultivation.	Cabbage: September, Pusa drum head, golden acre, Kaveri Cauliflower: Pusa early synthetic, Himani, Swati. Carrot: Pusa Kesar, Pusa Meghali Beetroot: Detroit Dark Read, Imperator, Radish: Japanese white,Arka Nishant, Pusa Reshmi. Potato: Jyothi, Kufri Muthu,Kufri Dewa. Garlic: Ooty 1, G50	Highlands of Idukki.
Other General strategies for Yield	Improving Water use efficiency by proper lining of channels and reducing runoff in the filled by proper levelling.		Applicable in all three regions

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Other general strategies for Yield enhancement in Crops	Economize water use by adopting phasic stress irrigation schedule -instead of 5cm submergence, maintain 5cm water during critical phases of crop growth and maintenance of moisture from saturation to field capacity during other stages. Fertigation and foliar application of nutrients for yield enhancement of major crops of Kerala. Soil Test Based Site specific, Crop Specific Nutrient Management for enhanced returns. Improving Productivity in Home stead farming with optimal use of waste and nutrients. Soil health management to measure increase productivity and net returns and ecosystem security Use of biocontrol agents Pseudomonas, Trichoderma, Beauveria, Metarrhizium, Verticillium, Trichocards, pheromone traps etc. for reduction in the use of chemical insecticides, leading to „safe to eat food" and reduced residues of toxic chemicals in the environment. Plant growth promoting rhizobacteria (PGPR) for black pepper and ginger. Crop specific micronutrient mixtures for spices (Black Pepper, Ginger, Turmeric). Ensuring availability of required farm machinery to farmers at required time - Strengthen/ introduce the agro machinery repositories, as and where required and co-ordinate the working of these repositories – Introduce new machinery to meet the emerging demands Precision farming techniques to be adopted in farm mechanisation– use of advanced and precise machinery for specific operations, integration of the PFTs such as GIS, GPS etc to farm machinery operation and to ensure proper farm machinery management – for increasing profits. A model may be established at the SAUs for further development.		
Integrated Farming Systems (IFS)	Homestead based IFS – Coconut + other trees; Multi-storeyed cropping (pepper+ teak+ mango+ jack); Kitchen garden; poultry unit + Vermicompost unit + cow; Terrace garden+ water harvesting. Coconut based IFS – Coconut +border planting; multi-storied cropping interspace of tree crops+ additional area; cow. Rice-based IFS in wetlands: Popularizing suitable rice based cropping system viz., Rice-Rice-Pulses/Vegetables/ Oil seeds, Rice- cassava, Rice-sweet potato etc. for each agroclimatic zone. Introduction of profitable and proven rotational cropping practices like Rice- prawn, Rice- fresh water fish etc. in suitable locations Integration of suitable and profitable enterprises viz., fishery, duckery, piggery, livestock rearing, apiary etc. along with rice cultivation, for each agro-climatic zone.		Applicable mainly in mid-lands and low-lands.

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Below sea level farming in Kuttanad	Adoption of coconut + one rice +one fish model in kuttanad ecosystem. Promotion of pokkali farming. Cage farming of brackish water fish species.	Technologies available with International Research & Training center for Below Sea Level Farming , Kuttanad	Lowlands of Eranakula, Alappuzha, Thrissur and Kannur.
Livestock: Dairy	**Promotion of two cent one cow concept** The average milk yield of dairy cattle in the state per animal per day is estimated to be 9.11 liters. This is against the estimated potential of 11-12 liters per crossbred animal per day. Deficiency in quantity and quality of the feed and fodder resources is the main reason for the decrease in milk yield. Hence improving the feed base is of prime importance in enhancing the production of the animals and to improve the income of the farmers. The deficit in fodder requirement of the state is 40% and the quality of the fodder is poor in nutritional values. For supporting the dairy production system intensive fodder cultivation is proposed through "Tumbukiza" model, meaning to put into a hole. It is a method of fodder cultivation followed in African countries for intensive cultivation of fodder through optimum resource utilization and overcoming the lacunae in the conventional cultivation practice of hybrid Napier fodder. Economic aspects: Harvesting can be done once in 60 days and the yield from one pit will be at least 15kg. Harvesting of fodder from two pits will be sufficient for feeding one cow with 30 kg fodder (6kg dry matter) that will ensure 60% of daily dry matter requirement of the animal yielding 10 litres of milk per day.The expected total yield: 15 kg x 64 pits x 250 cent x 6 harvest = 1440 t/ha Total yield from two cents = 11,520 kg.	The technical programme for Tumbukiza" model is available with Kerala Veterinary and Animal Sciences University, Pookode.	All regions.
	Enhancing the productivity through scientific feeding and ration balancing Ration balancing as the name indicates is a process by which level of various nutrients from available feed resources is balanced to meet the animal"s nutrient requirements for maintenance and production. The different steps in ration balancing include Assessing nutrient status of the animals Assessing the chemical composition of the locally available feed stuffs Assessing the nutrient requirement of the animal Formulating least cost ration with available feed resources	The technical programme is Available with Kerala Veterinary and Animal Sciences University, Pookode	

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
	Establishing calf nurseries in various livestock farms Raising healthy high producing crossbre heifers as replacement stock is essential for the sustainability of the dairy sector in Kerala. However, the current calf rearing practices prevailing in the state are characterized by poor selection and breeding, lack of scientific management, inadequate feeding of colostrums and milk, unavailability and high cost of calf starter/ feed, low growth rate, poor disease resistance, infertility and higher mortality rate. These factors necessitate the design and promotion of calf nurseries suitable to the state. A strategy for selection, scientific breeding by assisted reproductive technologies like super ovulation, ovum pick up, in-vitro fertilization and embryo transfer technology and other scientific management practices are the need of the hour as it is very important for the viability of crossbred calves/heifers/ salvaged bull calves. Scientific management practices need to be adopted for the enhanced growth and performance of elite heifers/ salvaged bull calves.	The Technical programme is available with kerala Veterinary and Animal Sciences University, Pookode.	
Livestock: Poultry	**Improved poultry rearing techniques:** Supplies of parent stock chicks to improve the productivity 6of farmer stock as well as supply of day-old commercial chicks to farmers are important strategies to be undertaken on a larger scale in order to augment farmer income.	Technologies available with KVASU	
	Promotion of high-tech layer farming High-tech cages designed specifically to grow improved layer varieties that integrate automatic feeding and watering systems and convenient waste disposal systems. Promising layer varieties suitable for back yard or roof top poultry rearing include Athulya (white leghorn) and BV 380 that yield more than 300 eggs per annum.		
Livestock: Meat (Pig, buffalo, Goat)	**Improved meat production techniques** Farming animals for meat production is the most profitable and risk free venture in the animal husbandry sector. The following action programmes may be undertaken under the leadership of KVASU: Maintenance of good quality breeding stock to progressive farmers to establish certified satellite breeding units. Following standard operating protocols for breeding and fattening units The certified units to provide good quality fattening young ones to farmers. Meat technology unit to make arrangements to buy back the adult fattening stock from the certified units. Training progressive farmers on scientific feeding and management practices.	Technologies available with KVASU	

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Livestock: other general Strategies	**Timely prevention and diagnosis of animal diseases** Livestock disease management can reduce disease through improved animal husbandry practices. These include: controlled breeding, controlling entry to farm lots, and quarantining sick animals and through developing and Improving antibiotics, vaccines and diagnostic tools, evaluation of ethno-therapeutic options, and vector control techniques. Livestock disease management is made up of two key components viz., prevention (biosecurity) measures in susceptible herds and adoption of control measures taken once infection occurs. Some priority areas include: Prevention and control of mastitis Prevention and control of parasitic infestations- both internal and external Immunization and seromonitoring Rapid Diagnosis	Technologies available with KVASU.	
Aquaculture	**Genetically improved fish seeds** Conventional tilapia used for present farming attains marketable size of 200gm by one year, but the Genetically Improved Farmed Tilapia (GIFT) attains the same size within four months. Using the seeds of GIFT, Farmers can make two crops in a year thereby enhancing their income prospects.	Improved fish seeds like GIFT Tilapia, Jayanti Rohu and Amur carp. Breeding and rearing technologies available with KUFOS, Panangad.	All Regions
	Nutritional management in fish culture The use of species specific feed can enhance fish growth. This enables farmers to take two crops per year.		
	Re-circulatory Aquaculture System (RAS) Diversification of aquaculture from conventional to Re-circulatory Aquaculture System (RAS) has the potential to enhance the productivity by multiple times. Such a shift is suitable for land scarce state like Kerala, where the limited area can be utilized converting into RAS-based aquaculture		

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Marine Fisheries	**Intensification of deep sea fishing** Deep resources such as oceanic squid, oceanic tuna, tuna-like fishes, non-conventional resources which is estimated to be 2.08 lakh tonnes can be sustainably exploited. **Introducing m@krishi service** The portal, m@krishi launched by CMFRI in partnership with INCOIS, Hyderabad and Tata Consultancy Service (TCS) for the fishermen of Maharashtra is an excellent example which can be emulated in Kerala. Based on a survey conducted by the CMFRI at Maharashtra coast, it is estimated that adoption of m@krishi service has resulted in 30-40 per cent increase in fish catch and 30 per cent saving in fuel costs and increase in fishing revenues by 40-50 per cent. **Modernizing fishing fleet** Enhancing the efficiency of existing fishing fleet through suitable conversion and up-gradation together with Introduction of improved crafts and gears could increase Profitability of marine fishing. Low-cost fuel-efficient and solar power-operated fishing vessels designed and developed by ICAR-CIFT together with improved fishing gears such as juvenile excluder, semi-pelagic trawl system, short-body shrimp trawl and cut-away top belly shrimp trawl could help the fishers in efficient use of inputs and thereby cut costs. **Piloting of Vessel Monitoring System (VMS)** VMS is a promising application of space technology which could ensure efficient fishing operations besides warranting fool proof monitoring, controlling and surveillance (MCS) as well as enhanced security across the coastline.	Technologies are available with ICAR- CMFRI and ICAR- CIFT which are different stages of commercialization/ popularization.	All regions

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Mariculture	**Green Mussel (Perna viridis) farming Technology** Open sea green mussel (Perna viridis) farming has been developed during the 1970s by CMFRI. The farming technology was successfully demonstrated in the coastal waters and estuaries of India with community participation and is now being taken up as a small-scale commercial venture in the various estuaries of Kerala, Tamil Nadu & Maharashtra. Taking Kerala as a model, mussel culture was taken up in other coastal states of India. **Edible oyster (Crassostrea madrasensis) farming technology** Edible oyster farming has been developed by CMFRI and demonstrated in the coastal waters and estuaries of India with community participation. The technology is taken up by several coastal farmers as a livelihood avenue.	CMFRI has transferred the technology to the mussel farmers in Kerala and Karnataka and has the potential to increase farmers' income by around 15-20%. The technology is transferred to Fishermen Cooperative Federations/ Corporations of Kerala and has the potential to enhance farmers" income by 10-15%. CMFRI has developed two different versions of indigenously fabricated 6m diameter cages suitable for different locations in India. The present innovation describes a cage culture device for open sea fish farming in HDPE and GI cages. Make: high density polyethylene (HDPE) cage and epoxy coated galvanized iron (GI) cage of 6 m diameter, 120cm height, 6m depth equipped with a main cage hanging rope, hook for top rope, and multiple side ropes.	All regions
	Cage culture for fish production (Species : Pompano, Sea bass, Red snapper, Cobia, Mullets, Groupers) Open sea cage farming is a promising venture which offers the fishers a chance for optimally utilizing the existing water resources. By integrating the cage culture system into the aquatic ecosystem, the carrying capacity per unit area is optimized because the free flow of current brings in fresh supply of water and removes metabolic wastes and excess feed. Thus economically speaking, cage culture is a low impact farming practice with high economic returns.		All coastal Districts.
	Nursery rearing of food fishes (Speceis : Cobia, pompano, grouper, seabass) Nursery rearing is an important aspect in finfish farming. Rearing of juveniles obtained from hatcheries to stocking size in nurseries ensures maximum survival of fishes in the farming system and thus maximizes the profit of farmers. The nursery rearing could be carried for a period of 10 weeks in order to achieve very good survival in grow-out phase.	Technology available with CMFRI.	

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
	Larval rearing of marine ornamental Fishes Marine ornamental seed production is a lucrative business, and an environmentally sound alternative to harvesting them from their reef habitat. CMFRI achieved breakthrough in developing a package of technologies on broodstock development, captive breeding and larval rearing.	CMFRI has the technology for 17 species of marine ornamental fishes (Clown fishes 7, Damsels 9 and Dotty backs 1). Clown fishes: 7 species: True percula/ clown anemone fish, (Amphiprion percula) Tomato clown (A. frenatus), Sebae clown, false clown Maroon clown / Spine cheek anemone fish, Orange anemone fish, and Clarkii clown; damsels fishes: 9 species: Blue damsel, Striped damsel, Three spot damsel, Peacock Damsel, Yellow tail damsel, Green chromis, Filamentous tail damsel, One spot damsel and Sapphire devil).	
	Technology for Production of Image pearls/Designer pearls The principle behind the technology is to utilize the ability of the pearl oyster to coat any foreign object implanted in the shell cavity with nacre (layers of pearl). This technology is simpler than conventional approach and is eco-friendly. Each image can be sold for a price ranging from Rs. 500 to 5000 depending on the quality, size, colour etc., resulting in better profits than spherical pearls. Cost of production of nuclei used for implantation is cheaper than spherical nuclei,which are imported at present. This technology will improve the social and economic status of weaker section of the society like fishermen, gold smiths and will develop allied small scale industries like pearl nuclei production units, pearl extraction and processing units.	Technology available with CMFRI	
Strategies 2: Utilizing Waste Lands/ fallow lands for enhan-Cing production	Re-cultivation of fallow lands. Reclamation of degraded lands. Terrace and contour making in difficult terrain lands for arable purpose. Adoption of soil conservation measures and installation of bunds and other artificial structures to check erosion. Growing cover crops in sloppy areas. Consolidation of fragmented holdings. Restricting conversion of farm lands for commercial purposes.		All regions.

Domain	Actionable points/Strategies	Specific technologies available	Regions where applicable
Strategy 1: Productivity Enhancement			
Strategy 3: Promoting Climate Smart Agriculture (CSA)	Identifying and diagnosing impacts of climate change with reference to specific crops and local conditions. Managing landscapes for improving sustainability, building resilience and mitigating adverse impacts. Water management at watershed and river basin for minimizing vulnerability of production systems. Promotion and extension of improved technologies i.e., seed, integrated nutrient management (INM) including micronutrients, soil amendments, integrated pest management (IPM), input use efficiency and resource conservation technologies along with capacity building of the farmers/extension functionaries. Demonstration and popularization of heat and salt tolerant crop varieties, promotion of micro-irrigation system, etc. Training of extension functionaries/farmers on climate change adaptation and mitigation practices.	Technologies available with KAU	All regions

Summary Recommendations:

As much as Kerala's natural resource endowments and socio-economic characteristics are distinct from that of the rest of the country, its problems and prospects in agriculture too are divergent from others. The absolute predominance of marginal and small farmers involved in crop production, livestock rearing and fishery are demanding small-farm solutions to the day today problems of farming. Considering this, this report presents a multi-pronged strategy to sustainably enhance incomes of farmers in the state.

The task calls for comprehensive optimization of all factors of production besides integration of promising options such as production of high-yielding seeds/planting materials responsive to inputs, arresting the area decline under major crops through localized initiatives; strengthening agricultural research, education and extension to leverage technological advancements; emphasis on vertical intensification of farming for higher yields from limited area; improving farm mechanization; adopting resource conservation technologies; stress on organic farming and agro-processing; developing value chains for better market linkages and promoting trade; boosting collective farming and micro-enterprises in agriculture; better coverage of farm insurance; strengthening agricultural marketing system; labor solutions to address its shortage; measures to ensure food safety; and other future thrust areas like strengthening agricultural statistics, developing livestock feed supply chains, promoting entrepreneurship in fishery and aquaculture and efficient governance for successful implementation of various government programs.

In addition to the broad requirements mentioned above, some of the specific measures in this context include replacing costly human labour with machinery, improving collateral income from specialized practices like bee keeping, mushroom production, product diversification and value addition and adopting the most professional approaches in marketing. Organic farming and branded organic produce could increase farm gate revenues on a farmer cluster basis.

Linking incentives to production could be another option on the part of planners and policymakers. Assuring realistic pricing structure of produce, credit linking at subsidized rates, and above all, farmer centric budget that takes care of reduced price of inputs and assured better returns of produce will serve as an impetus for not only for doubling the production but also sustained growth. Special emphasis is given to adopt scientific farming practices with due regard to the physiographic and agro-ecological characteristics of various regions and the niche crops grown.

It is to be noted that, the strategic development framework portrayed above has a strong emphasis on productivity enhancement and quality improvement. To conclude, the future of Kerala agriculture would depend considerably on how the scarce resources of the state are put into best use and the way in which a judicious balance between the competing sectors is achieved. Ideally, such a situation can be achieved when all factors of production and integration of agriculture and allied forms of activities are combined in the best possible manner.

SUCCESS STORIES

1. Rice-based Integrated Farming System

Rice fields in the coastal Kerala are typical wetland eco-system with numerous ecological and economic functions. High rainfall coupled with undulating topography of Kerala generates different moisture regimes for crop growth resulting in a wide range of micro-environments. Given the combination of season, and topography, rice in Kerala is grown under a variety of agronomic conditions ranging from totally dry to floating rice under rising flood conditions, from rainfed to irrigated conditions, sandy to clayey soils and saline to acidic soils. Crop diversification has immense potential in rice-based ecosystems. The studies conducted at Cropping Systems Research Centre, Karamana revealed that raising green manure (dhaincha), bhindi or short duration cassava in paddy fields during summer not only enhanced the profitability and employment but also resulted in a shift of the obnoxious weed flora Echinochloa crusgalli. In rice-based diversified cropping systems, one crop of rice followed by two crops of Nendran banana offers high income potential. In such a system, over 10 t/ha crop residues are available for nutrient recycling. The economics of the rice-based IFS is presented in Table 4.

Economics of Rice-based IFS in Kerala

Treatments	Rice yield (t/ha)		Mean rice yield (t/ha/yr)	Mean yield of summer crop (t/ha)	Rice equivalent (t/ha/yr)	Net income (Rs/ha/yr)	B:C ratio
	First season	Second season					
Rice-rice- fallow	4.51	3.59	8.09	-	8.09	12,167	1.27
Rice-rice- green manure (dhaincha)	4.76	3.74	8.50	14.5	9.54	20,801	1.41
Rice-rice- bhindi	4.63	3.95	8.58	13.38	14.35	32,434	1.38
Rice-banana	4.64	-	1.16	24.01	28.61	77,108	1.35

2. Rice-Fish-Duck-Buffalo Integration in Submerged Wetlands

Integrated farming involving poultry and aquaculture has great relevance to the coastal rice lands such as Kuttanad, Kole and Pokkali/Kaippad. The coastal saline soils along the Ernakulam district are referred to as pokkali fields, whereas in the Alappuzha and Kannur districts they are known as Karilands and Kaipad, respectively. The traditional paddy cultivation involving a salt-resistant and tall pokkali variety of paddy, which is practiced during the rainy season from May-June to September-October is followed by shrimp filtration from November to April, in the saline phase. Shrimp filtration is essentially a trapping cum holding system in which water is let into the field through sluice gate during high tide, but when the level reaches the same as outside, the gate is closed trapping valuable fish and shrimp. There are many advantages to this system of integrating traditional farming of paddy and fish/shrimp together. The paddy field provides room for naturally available fish or shrimp juveniles to grow and attain marketable size, providing natural feed for fishes and shrimps while the animal excreta provide nutrients for the ensuing paddy crop. Such a system will not only reverse the present trend of non-utilization and under-utilization of rice field but also make rice farming more attractive, consequent to the increase in productivity and profitability. As buffalo/poultry/duckery also forms an integrated constituent of such a farming system, it can sustain food security. This system of farming could trigger a process of change whereby the income and economic prosperity of people living in these areas will increase leading to economic resurgence.

Economics of rice -fish-duck-buffalo integration in wetlands of Kerala

Component	Production tons/ha		Cost of production (Rs lakhs)	Sale income (Rs lakhs)	Net income (Rs lakhs)
	Rice	Straw			
Rice	6.00	10.91	0.60	1.32	0.72
Fish	1.50	-	0.30	1.95	1.65
Duck- 5 batches, @200/ha, 550 kg	2.75	-	2.60	3.57	0.97
Meat buffalo@32 nos/ha	0.30	-	0.30	0.45	0.15
Total (Rs/ha)					3.49

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MADHYA PRADESH

Madhya Pradesh is located in Central India, having 51 districts and 48 KVKs under 11 different agro-climatic zones in the state. Six more KVKs have to be established for the process has begun. Madhya Pradesh is contributing significantly in the food basket. As per 2016 statistics, country's 24.66 per cent oilseeds, 31.08 per cent pulses and 18.91 per cent wheat are being produced in Madhya Pradesh. The state is poised for a breakthrough in soybean cultivation. As per statistics 2016, country's 57.15 percent soybean is produced in the Madhya Pradesh. Livestock contributes around 24 per cent to the total value of output from agriculture and allied sector.

In Madhya Pradesh, there are 51 districts and 48 KVKs under 11 different agro-climatic zones in the state. Six more KVKs have to be established for the process has begun. The total geographical area of Madhya Pradesh is 30825 thousand hectare of which 48.57 per cent i.e. 14972 thousand ha is being cultivated out of which 6449 thousand ha is cultivated more than once. Around 28 per cent of total geographical area is covered by forest in the state.

The economy of state is predominantly based on rainfed agriculture (only 1/3rd of gross cropped area is being irrigated) and the major crops are paddy, wheat, maize and sorghum among cereals, chickpea, pigeon pea, blackgram and greengram among pulses, soybean, groundnut and mustard among oilseeds and cotton and sugarcane among commercial crops. Horticulture crops like potato, onion, garlic, along with fruits like papaya, banana, oranges, mango and grapes are also grown in the state of Madhya Pradesh. In some parts of the state medicinal crops and narcotic crops are also cultivated.

Madhya Pradesh is contributing significantly in the food basket. The agriculture of the state is characterized as small holder agriculture (average size of holding is 2.02 ha) and nearly 29.16 per cent of total 15060557 holdings are small (< 2 ha) where the dissemination of modern agricultural technologies like farm mechanization is challenging task. As per 2004-05 poverty census, around 37 per cent of total rural population is Below Poverty Line in the state. Low literacy (35.45 per cent), undulating topography, large waste land (13.2%), under developed irrigation potential (23%), low ground water utilization, large proportion of rain fed agriculture, practice of Kharif fallows (3.6%), moderate cropping intensity (143 %), low fertilizer consumption (50 kg/ha), high proportion of low value crops, and high population of low productive live stock are the major constraints of the state.

As per NSSO (2014), the average monthly income (Rs.) per agricultural household was Rs. 6210 for the agricultural year 2012-13. The farm's income targeted both in real terms and nominal terms as Rs. 1, 16,788 (base year: 2015-16 & at 2015-16 prices); Rs. 2,30,999 (Terminal year: 2022-23 & at 2015-16 prices) and Rs. 3,25,039 (Terminal year: 2022-23 & at current prices). This is very challenging and painstaking efforts to make such drastic change in the farmers' income facing the climatic, marketing and policy variations. The strategy document has focused on all these areas through suitable technological and policy intervention to achieve these targets at farmer's level.

Major Constraints in productivity enhancement

- Non-availability suitable high yielding varieties
- Heavy weed infestation
- High incidence of disease and pest
- High cost of inputs
- High rates of labour/wages
- Lack of support price and profitable marketing system
- Lack of technological interventions
- Poor fertility of soil
- Occurrence of pest and diseases due to high humidity
- Crop damage due to erratic rainfall
- Lack of awareness about production technology

Technological options for doubling the farmers' income

1. AGRO-CLIMATIC ZONE: - CHHATTISGARH PLAINS

Crops/Enterprises	Technology
Paddy	❖ Popularization of short duration hybrids like JRH-5, JRH-8, JRH-19, Indira barani, Samleshwari, IR 64 ❖ Life saving Irrigation during critical stages ❖ Use of hybrid and quality seed ❖ Production of Poha quality rice ❖ Use of paddy transplant and power weeder ❖ Popularization of harvesters, threshers and grading ❖ Seed processing and marketing Linesowing with chemical weed management + Integrated pest management + Integrated nutrient management Soil test based Nutrient management ❖ Use of seed saving technology like SRI ❖ Short duration varieties of rice with INM, IPM and succeeding pulse/oilseed ❖ Seed processing and marketing

Crops/Enterprises	Technology
Pigeon pea	❖ Use of hybrid varieties ❖ Integrated Nutrient management ❖ Chemical weed management ❖ Life saving Irrigation during critical stages ❖ Spray of NAA during flowering with Integrated nutrient management ❖ Processing (Dal making)
Black gram	❖ Popularization of improved varieties ❖ Integrated crop management, Integrated nutrient management, weed management ❖ Processing (Dal making)
Maize	❖ Use of hybrid varieties ❖ Planting in ridge furrow method ❖ Life saving Irrigation during critical stages ❖ Use of Chemical weed management+ Integrated nutrient management ❖ Processing of maize grains (feed, ethanol)
Vegetables	❖ Use of quality seed ❖ Low water requiring varieties ❖ Additional area under Horticultural crop in paddy fallow areas ❖ Chemical weed management ❖ Utilization of dry land area ❖ Use of integrated nutrient management ❖ Life saving Irrigation during critical stages ❖ Processing/value addition, ketchup preparation ❖ Popularization of High Yielding Resistant variety ❖ Popularization of improved varieties like Arka Rakshak, Arka Samrat
Fruits	❖ Plantation of Mango, Guava, Banana, Drumstick and Papaya
Goatary	❖ Popularization of high meat and milk yielding varieties ❖ Improved housing ❖ Training regarding new species and health issues ❖ Health monitoring of goats
Poultry	❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Rearing and management ❖ Promotion of community rearing ❖ Housing management & health management

Crops/Enterprises	Technology
Integrated farming system	❖ Animal based farming system
Aquaculture	❖ Production of Water chestnut ❖ Production of Makhana

2. AGRO-CLIMATIC ZONE: - NORTH HILLS OF CHHATTISGARH

Crops/Enterprises	Technology
Paddy	❖ Popularization of Direct seeded rice and short duration varieties like Indira barani, amleshwari, IR 64 IR-36, MTU-001, MTU-1010, Sahbhagi ❖ (Irrigated) Popularization of medium duration varieties like JRH-5, JRH-8, PS-5 ❖ Life saving Irrigation during critical stage ❖ DSR and line sowing with chemical weed management+ IPM+INM ❖ Use of quality seed ❖ Use of custom hiring centre for use of farm machinery ❖ SRI technique ❖ Soil test based Nutrient management ❖ Line sowing with chemical weed management ❖ Use of integrated nutrient management ❖ Use of quality seed ❖ Popularization of harvesters, threshers and grading ❖ Use of Bio-Fertilizers ❖ Dry & Line sowing & Transplanted
Maize	❖ Introduction of hybrid varieties ❖ Integrated Nutrient management ❖ Integrated weed management ❖ Use of hybrid seed ❖ Life saving Irrigation during critical stages ❖ Use of integrated nutrient management, Integrated Pest Management, Integrated Disease Management ❖ Processing of maize grains for animal feed

Crops/Enterprises	Technology
Black gram	❖ Popularization of improved YMV resistant varieties PU-35, PU-31, PU-19 and YMV resistant varieties ❖ Integrated crop management, Integrated Nutrient Management ❖ Processing (Dal making)
Chickpea	❖ Popularization of improved YMV resistant varieties PU-35, PU-31, PU-19 and Popularization of HYV wilt resistant JG-14, JG-63 ❖ Integrated crop management, Integrated Nutrient Management ❖ Processing (Dal making)
Wheat	❖ Line Sowing ❖ Introduction of HYV ❖ Integrated Nutrient management ❖ Chemical weed management ❖ Irrigation during critical stages ❖ Processing of wheat grains
Millets	❖ Improved varieties with use of Bio-Fertilizers ❖ Inter cropping with Pigeon Pea ❖ Management of Blister beetle ❖ Millets processing and value addition
Niger	❖ Management of cuscuta, 2% salt solution and Pre-emergence application of Pendimethline
Pigeon pea	❖ Popularization of High Yielding wilt Resistant variety – TJT-501, ICPL88039 ❖ Use of quality seed ❖ Chemical weed management ❖ IDM & IPM ❖ Use of integrated nutrient management ❖ Life saving Irrigation during critical stages ❖ Processing/value addition

Crops/Enterprises	Technology
Vegetables (Irrigated)	❖ Popularization of High Yielding Resistant variety of tomato & onion ❖ Use of quality seed onion ❖ Low water requiring varieties ❖ Bringing additional area under Horticultural crop in Kharif fallow areas ❖ Popularization of improved varieties like Kashi Vishesh, Pusa Rubi Onion-AFLR, AFDR, NR-53, Sweta ❖ Integrated weed management ❖ Use of integrated nutrient management, Integrated Pest Management, Integrated Disease Management ❖ Life saving Irrigation during critical stages ❖ Processing/value addition
Beekeeping	❖ Popularization of improved beekeeping technology ❖ Rearing and management ❖ Promotion of community based beekeeping ❖ Popularization of improved beekeeping technology ❖ Promotion of community based beekeeping ❖ Rearing and management
Dairy	❖ Popularization of high milk-yielding breeds ❖ Efficient utilization of animal power ❖ Ensuring green fodder round the year ❖ Health monitoring of the livestocks ❖ Promotion of AI ❖ Society/community farming ❖ Processing of milk products ❖ Society/community farming ❖ Fodder Management

Crops/Enterprises	Technology
Fisheries	❖ Improvement of survival rate nursery pond through control of aquatic insects ❖ Promotion of fish cultivation in group by leasing of pond ❖ Distribution of ice box and supplementary feed ❖ Promotion of species Katla, Rohu, Mrigal ❖ Use of composite fish culture ❖ Promotion of community village ponds ❖ control of fairy shrimp (Branchinella sp) in fish nurseries ❖ Use of composite fish culture ❖ Promotion of community village ponds
Goatary	❖ Popularization of high meat and milk yielding varieties-Jamunapari ❖ Health monitoring of the goats ❖ Training regarding new varieties and health issues ❖ Housing management ❖ Breed improvement ❖ Vaccination
Integrated farming system	❖ Animal based farming system
Poultry	❖ Introduction of backyard poultry ❖ Promotion of community marketing ❖ Popularization of improved breeds ❖ Rearing and management ❖ Kadaknath & Narmada Nidhi
Vermicompost	❖ Popularization of improved Vermi-composting technology ❖ Rearing and management ❖ Promotion of community based production of vermin composting

3. AGRO-CLIMATIC ZONE: - BUNDELKHAND REGION

Crops/Enterprises	Technology
Rice	❖ Availability of quality Seed ❖ Promotion of SRI Method ❖ Blast Management
Wheat	❖ Timely Sowing ❖ Temp. Tolerant Variety ❖ Integrated Weed Management

Crops/Enterprises	Technology
Sugarcane	❖ Availability of quality Seed ❖ Red Rot Management ❖ Inter Copping of Wheat/ Potato/ other crops
Black gram	❖ Availability of YVM resistant Seed ❖ Promotion of R&F Sowing ❖ Yellow Vain Mosaic Management
Mustard	❖ Timely Sowing ❖ Improved variety ❖ Aphid Management
Tomato	❖ Leaf Curl Virus management ❖ Hybrid seeds ❖ Integrated Crop Management (Staking)
Chilli	❖ Leaf Curl Virus management ❖ Hybrid seeds
Dairy	❖ Feeding management ❖ Breed Up gradation ❖ Vaccination
Fisheries	❖ Feeding Management ❖ Water Quality Management
Goatary	❖ Housing management ❖ Breed Improvement ❖ Vaccination
Poultry (100 birds)	❖ Housing Management ❖ Feeding Management ❖ Vaccination

4. AGRO-CLIMATIC ZONE: GIRD ZONE

Crops/Enterprises	Technology
Paddy	❖ Integrated Nutrient management, Integrated weed management, Integrated Pest and Disease management and popularization of thresher ❖ Direct Seeded Rice/SRI ❖ STV based nutrient management ❖ short duration variety

Crops/Enterprises	Technology
Groundnut	❖ Popularization of short duration varieties like GG 2, LJ 501 etc. ❖ Life saving Irrigation during critical stages ❖ Broad bed furrow with chemical weed management ❖ Use of integrated nutrient management ❖ Use of quality seed ❖ Popularization of harvesters, threshers and grading
Soybean	❖ Use of optimum seed rate ❖ Maintain row to row spacing 45 cm ❖ Use of short duration and drought tolerant variety ❖ Integrated Nutrient Management ❖ Integrated Pest Management ❖ Ridge-Furrow and BBF Planting ❖ INM+ IPM+IWM+ STV based Marketing
Maize	❖ Introduction of hybrid varieties + INM + IWM+ IPM ❖ Use of hybrid seed ❖ Life saving Irrigation during critical stages ❖ Use of dibbler for planting ❖ Broad bed furrow and Ridge & furrow Planting ❖ Soil test based fertilizers ❖ Use of Mulch ❖ Use of hybrid seed ❖ Use of dibbler for planting
Wheat	❖ Improved variety With nutrient management ❖ High yielding variety With nutrient and weed management ❖ Short duration high yielding variety with INM and IWM
Pearl millet/ Sorghum	❖ ❖ Improved variety With nutrient management ❖ Hybrid variety With nutrient and weed management ❖ Short duration Hybrid variety With INM and IWM

Crops/Enterprises	Technology
Blackgram	❖ Optimum Seed rate ❖ Popularization of Improved varieties ❖ Integrated Crop Management ❖ Integrated Weed Management ❖ Use of YMV resistant Variety ❖ ICM + IWM+ STV based INM ❖ Use of YMV resistant Variety + BBF Planting and Marketing
Chickpea	❖ Improved variety with Gram pod borer management ❖ Improved wilt tolerant variety with IPM, INM
Mustard	❖ Improved late sown variety With nutrient and weed management ❖ Improved late sown variety With optimum seed rate
Sesame	❖ ❖ Improved variety, Line Sowing ,Seed treatment, Weed management ❖ Improved variety With soil based bio fertilizer application , Line Sowing
Vegetables	❖ Improved Seed, Nutrient management and weed management ❖ Nursery Management, Mulching, IPDM, IWM, INM ❖ Mechanization, Grading, Value Addition ❖ Improved variety, Broad Bed Furrow ❖ Plant Growth Regulator ❖ Inter cropping , Micro irrigation
Poultry	❖ Popularization of improved breeds like Kadaknath ❖ Introduction of backyard poultry ❖ Rearing and management ❖ Promotion of balanced feeding ❖ Promotion of community culture ❖ Promotion of Indigenous breed ❖ Feeding + housing and Health Management
Goatary	❖ Popularization of high meat and milk yielding breeds ❖ Health monitoring of the goats ❖ Feeding Management ❖ Improved wilt tolerant variety with IPM, INM ❖ Introduction of new breeds ❖ Health issues and Feeding Management

Crops/Enterprises	Technology
Dairy	❖ Improved Breed ❖ Cultivation of fodder crops throughout the year ❖ Deworming ❖ Scientific Dairy farming
Bee keeping (25 bee colonies)	❖ Technology of scientific beekeeping for honey and wax production ❖ Technology of scientific beekeeping for honey, wax, propolis, pollen production ❖ Processing, packaging and marketing of honey, wax and other products. ❖ Increasing of pollination in crops
Intregated Farming system	❖ Animal based farming

(5) AGRO-CLIMATIC ZONE:KYMORE PLATEAU AND SATPURA HILLS

Crops/Enterprises	Technology
Paddy	❖ Short duration drought hardy rice variety- JR-201 ❖ Soil test based application of fertilizers ❖ Conservation of rainfall water & use as life saving irrigation ❖ Direct Seeding ❖ Weed control- timely application of herbicide ❖ Timely Disease control- blast, bacterial leaf blight ❖ Popularization of short duration varieties like Indira barani, Samleshwari, Danteswari, JR-201, ❖ Deep summer ploughing, ❖ Line sowing by fertilizer cum seed drill, ❖ Use of vermin compost, chemical weed management, ❖ Use of liquid fertilizers (npk), proper ipm etc ❖ Line sowing with chemical weed management + ipm+inm ❖ Sri technique + inm+ipm ❖ Soil test based nutrient management ❖ Popularization of harvesters, threshers and graders ❖ Use of seed saving technology like sri, swi, spi, dibbling, ❖ Line sowing etc

Crops/Enterprises	Technology
Soybean	❖ Popularization of Improved varieties like JS 93-05 J S -95-60 ❖ Seed treatment of fungicide and bio fertilizer ❖ Summer ploughing ❖ Improved varieties –JS -2029, JS-20-34 J.S -20-69 ❖ Weed management ❖ Selection of improved varieties JS-2029, JS-20-34 JS -20-69 ❖ Line sowing using ridge and furrow technique
Pigeonpea	❖ YVM tolerant variety ❖ Seed priming and Inoculation ❖ Weed control- timely application of herbicide ❖ Ridge & furrow ❖ Soil test based fertilizer application (STFA) ❖ Timely Disease control measures
Chickpea	❖ Popularization of Improved varieties like JG -11,JG 130 ❖ Seed treatment with fungicide and bio fertilizers ❖ Summer ploughing ❖ Popularization of Improved varieties JG-14, JAKI-9218, ,JG 16,JG 130 ❖ Proper use of insecticide and fungicide ❖ Sowing by zero tillage seed drill, seed treatment by liquid Rhizobium+ PSB followed by Trichoderma, use of HYV like JG-11, JG-63, JG-130, JAKI-9218, proper IPM. ❖ Sowing by zero tillage seed drill, seed treatment by liquid Rhizobium+ PSB followed by Trichoderma, use of HYV like JG-11, JG-63, JG-130, JAKI-9218, proper IPM ❖ Sowing by zero tillage seed drill, seed treatment by liquid Rhizobium+ PSB followed by Trichoderma, use of HYV like JG-11, JG-63, JG-130, JAKI-9218, proper IPM
Blackgram	❖ Popularization of improved varieties like PU-19, PU-31, PU-35, IPU-94-1, line sowing by seed cum fertilizer drill, seed rate @20 kg/ha, ❖ Use of vermicompost, seed treatment with Thiamethoxam 30% FS @10ml/kg seed, weed management by Imazethapyr @ 100g a.i./ha at 20-25 DAS, proper IPM

Crops/Enterprises	Technology
Mustard	❖ Popularization of medium to long duration improved varieties like JKM-189, JA-4, ❖ Line sowing by seed cum fertilizer drill, seed rate @20 kg/ha. ❖ Use of vermicompost, seed treatment with Thiamethoxam 30% FS @10ml/kg seed, ❖ Weed management by Imazethapyr @ 100g a.i./ha at 20-25 DAS, proper IPM
Linseed	❖ Soil test based fertilizers application ❖ High yielding variety ❖ Insect control- Aphid ❖ Seed treatment and inoculation ❖ Timely sowing ❖ Produce quality seed
Sesame	❖ High yielding variety ❖ Foliar application of nutrients ❖ Soil test based fertilizers application ❖ Seed treatment and inoculation ❖ Conservation of rain water and uses aslife saving irrigation ❖ Safe storage of grains
Chickpea	❖ Crop rotation with sorghum ❖ Raised bed sowing ❖ Disease control- Wilt and root rot ❖ Seed treatment and inoculation ❖ Un irrigated Veriety ❖ Produce quality seed ❖ Popularization of Improved varieties like JG -11,JG 130 ❖ Seed treatment with fungicide and bio fertilizers ❖ Summer ploughing ❖ Popularization of Improved varieties JG-14, JAKI-9218, ,JG 16,JG 130 ❖ Proper use of insecticide and fungicide

Crops/Enterprises	Technology
Onion	❖ Promotion during kharif season, suitable variety like AFDR-1, Bheema super, N-53 proper nursery raising, raised bed planting, use of vermicompost, proper IPM ❖ Promotion during kharif season, suitable variety like AFDR-1, Bheema super, N-53 proper nursery raising, raised bed planting, use of vermicompost, proper IPM ❖ Promotion during kharif season, suitable variety like AFDR-1, Bheema super, N-53 proper nursery raising, raised bed planting, use of vermicompost, proper IPM
Poultry	❖ Maintaining Hygienic living Condition-Properly ,neat, clean, ventilated low cost shed ❖ Maintaining in house proper temperature during brooding ❖ Timely and regular vaccination(MD, R2B, Fowl Pox) ❖ Timely and regular vaccination (HS,BQ,FMD) ❖ Deworming at regular interval ❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Popularization of improved breeds in backyard poultry ❖ Introduction of new breed of Kadaknath, Narmadanidhi, White leghorn ❖ Vaccination and De-worming ❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Housing management & health management ❖ Promotion of community culture
Dairy	❖ Selection of climate resilient breed ❖ Timely and regular Deworming ❖ Timely control of ecto parasite ❖ Feed supplementation with mineral mixture ❖ Raising Azolla and Hydroponic fodder
IFS	❖ Animal based farming system
Fisheries	❖ Improvement of survival rate nursery pond through control of aquatic insects ❖ Distribution of ice box and supplementary feed

(6) AGRO-CLIMATIC ZONE: JHABUA HILLS

Crops/Enterprises	Technology
Soybean	❖ Popularization of short duration varieties ❖ Life saving Irrigation during critical stages ❖ Integrated weed management ❖ Popularization ridge & furrow/BBF ❖ Use of quality seed ❖ Soil test based Nutrient management IDM/IPM ❖ Popularization of Mechanization
Maize	❖ Introduction of hybrid varieties ❖ Line Sowing ❖ Life saving Irrigation during critical stages ❖ Introduction of hybrid varieties with INM ❖ Planting in ridge furrow method ❖ Soil test based nutrient management ❖ Chemical weed management IPM ❖ Use of hybrid seed
Blackgram	❖ Popularization of improved varieties ❖ Popularization of improved varieties, INM, weed management ❖ Integrated crop management
Vegetables	❖ Popularization of High Yielding Resistant variety ❖ Use of quality seed ❖ Expansion of area under vegetable ❖ INM ❖ IPM
Dairy	❖ Popularization of high milk-yielding breeds ❖ Efficient utilization of animal power ❖ Ensuring green fodder round the year ❖ Society/community farming ❖ Popularization of high milk-yielding breeds ❖ Efficient utilization of animal power
Goatary	❖ Popularization of high meat and milk yielding breed ❖ Balance feeding ❖ Popularization of high meat and milk yielding breed, Balance feeding ❖ Vaccination

Crops/Enterprises	Technology
Poultry	❖ Popularization of breeds (Kadaknath) ❖ Introduction of backyard poultry ❖ Popularization of kadaknath breeds ❖ Housing management & health management ❖ Rearing and management ❖ Promotion of community culture

(7) AGRO-CLIMATIC ZONE: NIMAR VALLEY

CCrops/Enterprises	Technology
Cotton	❖ BT Cotton With refusia ❖ Summer deep ploughing ❖ Carbendazim @ 2g /kg seed ❖ treatment ❖ 160:80:40:10 NPKZn kg/ha + ❖ azotobactor + PSB @ 20g/kg seed ❖ Introduction of Hybrid varieties ❖ Balance fertilizer ❖ Use of hybrid seed ❖ Line sowing with chemical weed management ❖ -INM, IPM ❖ -Deep summer ploughing for ❖ saving of pesticides ❖ Use of improved hybrid seed

CCrops/Enterprises	Technology
Soybean	❖ Improved variety RVS-2001-4 and ❖ JS-9560, of soybean. ❖ Summer deep ploughing ridge and furrow system with enter cropping of soybean with pigeon pea in 4:2 ratio ❖ Follow INM,IPM,IDM and IWM ❖ Popularization of short & medium duration varieties like JS ❖ 20-34, JS 95-60 & RVS-2001-4, JS 20-29, JS 93-05 ❖ Popularization of harvesters, ❖ threshers and graders ❖ Improved seed with seed treatment ❖ Weed management ❖ Use of liquid biofertilizer ❖ Use of pre emergence weedicides ❖ Use of integrated nutrient management
Pigeon pea	❖ Grow wilt resistant varieties JKM- ❖ 189,TJT-501, Asha, BSMR-736 of pigeon pea ❖ Summer deep ploughing ❖ Seed treatment with 2gm ❖ vitavax+5gm trichoderma/kg seed.

CCrops/Enterprises	Technology
Maize	❖ Use of improved/hybrid varieties ❖ like JVM-421 and other private varieties ❖ Summer deep ploughing ❖ Use of herbicide Atrazin 1.5 kg/ha 15-20 DAS ❖ Use of IPM module for pest control ❖ Introduction of hybrid varieties ❖ Integrated Nutrient management ❖ Line sowing with chemical weed management ❖ Use of hybrid seed ❖ Use of INM based on STV ❖ Processing of maize grains ❖ Introduction of hybrid varieties with INM ❖ Planting in ridge furrow method ❖ Processing of maize grains (feed, ethanol) ❖ Life saving Irrigation during ❖ critical stages ❖ chemical weed management ❖ Use of hybrid seed
Wheat	❖ Use of high yielding varieties like ❖ HI-8663, GW-322, GW-366 & HI-1544 ❖ Seed treatment with Vitavax 2.5 gm/kg seed ❖ Use of herbicide ClodinofopPropargyl 15% + Metsulfuran 1% @ 400 gm/ha 25-30 DAS
Gram	❖ Improved variety ❖ BBF method of sowing ❖ Seed treatment with 2gm vitavax+5gm trichoderma+1gm ammonium molybdate/kg seed. ❖ Popularization of improved varieties INM , IWM, IPM ❖ Integrated crop management, processing (Dal making) ❖ Integrated Nutrient management ❖ Integrated Pest Management
Chilli	❖ Use of 25 micron, silver-black plastic mulch in chilli
Onion	❖ IWM : (Oxyflurofen 23.5 % EC @ 1 ml/lit + Quizalofop ethyl 5% EC 2 ml/lit at 20-25 DAT + 1 HW at 40-45- DAT)
Tomato	❖ Use of 25 micron, silver-black plastic mulch in chilli

CCrops/Enterprises	Technology
Guava	❖ INM : (50% RDF+ 50 kg FYM + 25g *Azospirillium* +25 g PSB/tree)
Dairy	❖ 2 cows of Gir breed ❖ Medicine (Albendazol 120ml, Fenbendazol 3g, Ivermectin 10ml/animal.) ❖ Mineral mixture 3kg/animal ❖ Multi vitamin oral 300ml/animal ❖ Fodder like lucern, ❖ sorghum, barseem, to be grown
Poultry	❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Rearing and management ❖ Promotion of community culture
Fisheries	❖ Improvement of survival rate nursery pond

(8) AGRO-CLIMATIC ZONE: SATPURA PLATEAU

Crops/Enterprises	Technology
Intercropping system Maize + greengram/ Blackgram/soybean	❖ Use of hybrid seeds with INM and use of herbicide ❖ Life saving Irrigation during different critical stages ❖ Developed the Processing units for maize grains eg. Cornflax, floor and poultry feeds
Paddy	❖ Use of hybrid and high yielding variety on low land area ❖ Use of integrated nutrient management ❖ Use of quality seed ❖ Popularization of harvesters, threshers and grading
Blackgram/ green gram	❖ Popularization of improved varieties ❖ Integrated crop management with intercropping system ❖ Integrated crop management ❖ Developed processing (dal, floor badi, papad making)
Chick pea/red gram	❖ Popularization of improved varieties ❖ Integrated crop management with intercropping system ❖ Developed processing (dal, floor badi, papadmaking)
Nursery management of vegetable Fruit crops	❖ Tomato , Brinjal, Onion, Chilli, Cabbage, Cauliflower and Papaya,
Hi-tech vegetable production	❖ Popularization of High Yielding variety of Tomato and Chilli with poly mulch

Crops/Enterprises	Technology
Goatary	❖ Popularization of goatary farming for meat and milk ❖ Health monitoring of the goats ❖ Training regarding new species of goat for higher income generation
Poultry	❖ Popularization of improved breeds of Kadaknath ❖ Introduction of backyard poultry
Fisheries	❖ Improvement of survival rate nursery pond through control of aquatic insects ❖ Distribution of ice box and supplementary feed ❖ Use of composite fish culture ❖ Promotion of community village ponds ❖ Control of fairy shrimp (Branchinellasp) in fish nurseries
IFS	❖ Animal based farming system ❖ Farming system with Goatary +Clustered apple backyard management

(9) AGRO-CLIMATIC ZONE:VINDHYA PLATEAU

Crops/Enterprises	Technology
Soybean	❖ Short duration variety JS 2034, 2029, JS 9305, JS 9560 ❖ Weed Management in proper time INM ❖ Integrated pest management ❖ Improved varieties like JS-2029, 2034, RVS2001-04 ❖ Sowing by Ridge & Furrow ❖ Use of integrated nutrient management with essential nutrient ❖ Use of herbicide for weed control by IWM ❖ Improved cultivation of crops cum processing and Value addition of soybean ❖ Use of integrated nutrient management including sulphur ❖ Use of herbicide to weeding by Power operated mechanical weeder ❖ Value addition in soybean ❖ Nutrient management based on STCR ❖ Mechanical planting weeding P.P. etc ❖ INM Practices ❖ Promotion of BBF& Raised Bed Planter ❖ Sowing Method

Crops/Enterprises	Technology
Paddy	❖ SRI+ direct sowing ❖ Improved variety. ❖ SRI. ❖ INM, IWM, IPM ❖ Improved variety Pusa-1509, Pusa-1121. ❖ Life saving irrigation at critical stage ❖ Popularization of harvester & Thresher
Green gram/ Black gram	❖ Improved variety- TJM-37,HUM-12, JU-86, Uttara ❖ Seed treatment ❖ Integrated Pest Management ❖ Integrated Nutrient Management ❖ Use of Bio fertilizers ❖ Intercropping with Pigeon pea IPM ❖ Nutrient Management as per STV ❖ Yellow vein mosaic resistant variety IPU 94-1, PU 31, Shekar -2Yellow vein mosaic ❖ Yellow vein mosaic resistant variety PDM 139, Virat, TM 3799, TJM-3 ❖ Weed Management resistant variety + Weed Management in proper time INM ❖ Popularization of improved varieties ❖ Integrated crop management, processing (Dal making
Onion (Kharif)	❖ Improved varieties- Bheema Super, AFDR ❖ Nursery management ❖ Integrated Pest Management ❖ Nursery management ❖ High yield variety vill- satariya ❖ High yield variety+ IPM+IDM

Crops/Enterprises	Technology
Maize (Cobs)	❖ Improved Varieties- Sugar baby ❖ Integrated Nutrient Management ❖ Integrated Pest Management ❖ Integrated Weed Management ❖ Improved Varieties- Sugar baby ❖ Nutrient Management as per STV ❖ Planting geometry ❖ Seed treatment ❖ Introduction of hybrid varieties ❖ Chemical weed management in hybrid maize crops +Life saving Irrigation during critical stages ❖ Use of BBF and FIRB for sowing & ❖ Processing of maize grains ❖ Pre and post l weed management ❖ Use of hybrid seed ❖ Life saving Irrigation during at critical stages ❖ Processing & value addition of maize (feed, ethanol)
Wheat	❖ Recommended variety- HI-1605, DBW- 110, JW-3288, JW-3211 ❖ Seed treatment ❖ Sprinkler Irrigation ❖ Integrated Nutrient Management ❖ Recommended variety- HI-1605, DBW-110, JW-3288, ❖ Seed treatment ❖ Integrated Weed Management ❖ Improved Varieties- Sugar baby ❖ Planting geometry ❖ High yield variety vill Jortala block –patahriya ❖ High yield variety+ weed management ❖ Improved variety Duram – Pusa Anmol, Posan, pusa Mangal Astivum- GW- 322, GW-366, RVW-4106 ❖ INM in wheat (Bio-fertilizer + Chemical Fertilizer) ❖ Weed control and efficient irrigation management techniques ❖ IPM & IDM Package and Value addition through SHG

Crops/Enterprises	Technology
Chickpea	❖ Improved variety- RVG-202, JAKI-9218, ❖ JG-16, JG-130, JG-14 ❖ Seed treatment ❖ Integrated Pest Management ❖ Integrated Nutrient Management ❖ Use of Bio fertilizers ❖ Intercropping with Pigeon pea ❖ Wilt resistant varieties i.e. JG 16, 63, JG 412 ❖ Seed and soil treatment by *Trichodermaviride*
Lentil	❖ Improve Variety of Lentil ❖ IPM & IDM for Pest & disease Management ❖ Crop management techniques & Value addition of produce
Tomato	❖ High yield variety+drip ❖ Seed and seedling treatment by *Trichoderma viride* ❖ Stalking ❖ INM
Cucurbits (Summer)	❖ Improved Variety ❖ Protray for nursery ❖ Seedlings treatment ❖ Plastic Mulching with drip ❖ Integrated Pest Management ❖ Integrated Nutrient Management ❖ Integrated Weed Management ❖ Fertigation
Onion	❖ High yield variety vill- satariya ❖ High yield variety+ IPM+IDM
Animals	❖ Feed management ❖ De worming ❖ Disease management ❖ Vaccination ❖ Round the year green fodder production ❖ Balance ration (Feed) for milch animals, ❖ De worming for Endo and ecto parasites, ❖ Improved breed &Dairy cow (10 animals)

Crops/Enterprises	Technology
Goatry	❖ Feed management ❖ Vaccination ❖ De worming ❖ Health Management ❖ Disease management ❖ Housing Management ❖ Introduction of improved breeds ❖ Improved breed & goatary (9+ 1 animals)
Backyard Poultry	❖ Feed management Vaccination Feed management ❖ Vaccination Disease management ❖ Disease management ❖ Feed management ❖ Housing Management ❖ Improved breed (kJ-7 kalehrajabera) ❖ Improved breed (kadaknath)
Custom Hiring	❖ Deep Ploughing ❖ Laser Levelling ❖ Straw Management
Agro-Processing & Value Addition	❖ Soybean Processing ❖ Dal Milling ❖ Fruit & Vegetables processing
Orchard	❖ Improved variety ❖ Planting distance ❖ Integrated Pest Management ❖ Integrated Nutrient Management ❖ Training and Pruning ❖ Post-harvest Management

(10) AGRO-CLIMATIC ZONE: CENTRAL NARMADA VALLEY

Crops/Enterprises	Technology
Paddy	❖ Popularization of Improved Variety +INM+IWM ❖ SRI Technique ❖ STV based nutrient management +green manuring, short duration var. with IWM & IPDM ❖ Mechanization for harvesting, threshing and grading.
Sesame	❖ Improved Var. with weed management ❖ Improved variety with seed treatment bio-fertilizer application and line Sowing
Soybean	❖ Improved variety ❖ Short duration Hybrid variety (Line Sowing) With Integrated Nutrient Management and Integrated weed Management ❖ Quality seed of high yielding variety, Seed treatment, Raised bed planting, water management
Black gram/ Green gram/ Pigeon pea	❖ Ridge-furrow sowing method ❖ Raised bed sowing method ❖ High yielding short duration varieties, ❖ Seed treatment, ❖ Integrated Nutrient Management and Integrated weed Management ❖ Quality seed of high yielding variety ❖ Disease resistant varieties, ❖ Seed treatment, ❖ Timely sowing, ❖ Line sowing, Resource conservation technologies
Wheat	❖ Integrated Nutrient Management , ❖ Integrated weed and disease Management ❖ Varietal improvement ❖ Crop residue management ❖ Varietal improvement and crop residue management ❖ Quality seed of high yielding variety, Seed treatment, ❖ Boarder strip method of irrigation, ❖ Resource Cons. Tech ❖ Integrated Nutrient Management, ❖ Chemical weed management

Crops/Enterprises	Technology
Kharif Maize	❖ Hybrid varieties, Integrated Nutrient ❖ Management , Ridge & furrow method ❖ Varietal improvement
Vegetables	❖ Improved Seed, ❖ Nutrient management weed management ❖ Micro irrigation Nursery management ❖ Intercropping with sugarcane
Goatry	❖ Popularization of high meat and milk yielding varieties ❖ Mechanization, Grading, Value Addition ❖ Improved breed
Backyard Poultry	❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Housing management & health Management ❖ Improved breeds, ❖ Feed management, Vaccination, Back yard rearing ❖ Improved& hybrid varieties,
Vegetables	❖ Raised bed planting, Integrated ❖ Nutrient Management, Integrated ❖ Pest Management, Staking ❖ Plastic mulching
Dairy	❖ Improved breed of milch animal, ❖ Feed management, Disease management, ❖ Green fodder round the year
Fishery	❖ Improved fingerlings, ❖ Feed management, pond management, ❖ Aquatic insect pests management
Fruits	❖ Quality Planting material/sapling, ❖ Water management, ❖ Canopy management ❖ High density planting

(11) AGRO-CLIMATIC ZONE: MALWA PLATEAU

Crops/Enterprises	Technology
Soybean	❖ Popularization of short duration like JS-95-60, JS93-05 ❖ Sowing with RCT (BBF & FIRB) ❖ Weed Management by mechanical methods (Handwheel hoe) ❖ INM- soil test based fertilizer application ❖ Seed treatment with corboxin + Thiram / trichoderma sp.+ Thiomethoxam + brady rhizobium & PSB culture ❖ Popularization of Seed Production through SHG's ❖ Chemical weed Management ❖ Inter cropping with maize (4:2), Arhar / Pigeonpea (4:2) ❖ Grading by Sprial seed separator ❖ STCR based fertilizer application-IWM & IPM ❖ Community based threshing by multi threshes ❖ Ridge and Furrow System ❖ IPM In soybean ❖ Improved varieties JS 95-60 JS 20- 69/NRC-86/JS 20-29 ❖ Seed Treatment, ❖ Proper sowing geometry FIRB sowing technique ❖ INM with use of sulphur
Maize	❖ Sowing of composite varieties /HPQM for small & marginal farmers on RCT for nutritional security ❖ INM- soil test based fertilizer application (100: 60: 40: 20). ❖ Post harvest management, grading, cleaning etc ❖ Seed saving by dibbling ❖ Intercropping with pigeon pea/ green gram/ black gram ❖ Use of Local Variety ❖ NPK application ❖ High Yielding Hybrid Maize Variety ❖ INM with Zn ❖ Sowing on Raised bed ❖ IWM with Atrazine ❖ IPM

Crops/Enterprises	Technology
Black gram	❖ Popularization of improved varieties ❖ Integrated crop management ❖ INM- soil test based fertilizer application ❖ Seed treatment with carboxin+Thiram/ trichoderma sp. ❖ Use of liquid bio-fertilizers ❖ Processing by Dal making & marketing ❖ IPM ❖ Popularization of improved varieties ❖ Integrated crop management ❖ Integrated crop management, processing (Dal making)
Chick pea	❖ Popularization of improved varieties ❖ Integrated crop management ❖ Integrated crop management, processing (Dal making)
IFS	❖ Improve Variety of Chickpea ❖ IPM & IDM Tools for Pest Management ❖ Value addition ❖ Sowing on Raised Bed Planter ❖ IPM & IDM Tools for Pest Management ❖ Animal based farming system
Poultry	❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Rearing and management in deep Liter ❖ Promotion of community culture ❖ Popularization of small hatchery for supply of chicks &self rearing ❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Rearing and management of Kadaknath ❖ Popularization of improved breeds ❖ Introduction of backyard poultry ❖ Rearing and management ❖ Promotion of community culture

Summary recommendations:

Policy Interventions:

- Warehousing and cold storage to be provided at block level. Soft loans should be provided to farmers against the produce stored in the godown/warehouse to avoid distress sale
- The loans for horticulture, animal husbandry, fisheries to be treated at par with loan for agriculture and not as commercial loans. Insurance to be provided for fisheries in fishpond
- Banks should provide loan against the farm land for establishment of the small scale agro industry, processing plant and should not ask to mortgage property in urban areas as the same is not available / owned by rural people and farmers in urban areas
- Procuring locally cultivated crops in PDS system at block level in the form of Grain Grid(like milk/power grid) to save transportation cost and subsidy amount for equivalent maybe provided to the panchayat.
- Farmers using organic fertilizers should be provided subsidy amount for chemical fertilizer (equivalent N, P, K) replaced by organic fertilizer
- Supply of three phase electricity in day time for agricultural use to avoid flood irrigation practice to reduce water and energy loss
- Branding of local scented varieties for better marketing in domestic and international market like Basmati rice
- Separate marketing channels for produce grown in tribal area at premium price through residue analysis for harmful chemicals and proper branding and marketing
- Absentee land lords (those who have purchased land as investment and land in not cultivated) should be enforced to deposit 1% money of land values /year for keeping the land fallow

Value Addition/ Post Harvest Management and Marketing:

- Formation of commodity specific groups of farmers for input purchase and marketing of farm produce to ensure higher returns to farmers and cost saving in input purchase
- Cluster based farming in partnership with agro industries through groups like FPOs, SHGs etc with financial, technical and marketing support and linking them with agro industries
- Establishment of Primary processing, grading, packaging, branding facilities at village level for marketing of farm produce at better price and control post harvest losses
- Renovation of Agricultural markets (Mandi). Use of ICT tools, e-auction (e-Hat) to enables farmers to sell his produce countrywide in different mandis. Details of stock of produce available in mandi at district level should be made available at national level for buyers
- ‘May I Help You Kiosk’ to be established in Agricultural market/ Mandi level in supply chain management and monitoring and to provide information on sell, marketing of produce in different markets countywide using ICT
- Discouraging involvement of Mandi porters using latest technology, machinery with innovative use of ICT in handling, sorting, grading and storage and also Grain Bank

could be established at mandi level to check this grain loss accounted to the farmers

R & D Intervention:

Water saving for reducing cultivation cost

- Use of micro irrigation like drip and sprinkler, mulching, hydrogel technology
- Cultivation of Dry land fruit crops like Pomegranate, Ber, Custard Apple etc in water scarce region

Nutrient saving for reducing cultivation cost

- Soil test based fertilizer application , Censor and GPS based input application devices for saving nutrients
- Bio-fertilizes and liquid fertilizers application for enhancing fertilizer use efficiency and soil fertility
- Efficiency of NPK and other fertilizers at the farmers condition needs to be increased by suitable research interventions
- Ensuring delivery of quality micronutrients at the farmers doorstep on basis of soil test report of farmers plots
- Crop residue management for retaining crop biomass in the farmers fields for sustaining soil fertility for longer period

Diversification and mechanization for higher resource use efficiency

- Crop diversification should be promoted from soybean towards high value crops for additional income and employment generation
- Diversification of agriculture to be encouraged and around 50 percent crop area of food grains towards seed production for enhancing income generation in addition to field crops
- Promotion of Integrated Farming System through group approach like SHGs, FPOs etc. for better land and other resource utilization
- Custom Hiring Centres (CHC) to be strengthened for energy & cost saving and made available on demand similar to hiring cabs through phone and mobile

Productivity enhancement for higher income

- Promotion of Intensive cropping in Paddy, Wheat, Pigeon pea using High Yielding Varieties, Line sowing, Ridge and furrow planting in the region
- Rain Water Harvesting through farm ponds for maintaining in-situ moisture and supplemental irrigation
- Protected Cultivation, Hi-tech vegetable cultivation, plastic mulching, stacking and drip irrigation for getting high productivity of quality horticultural produce Promoting floriculture and fruit cultivation by improving wasteland for income enhancement

- Skill Development of rural youth and women for off farm activities in partnership with industries like Nursery Raising, mushroom production, beekeeping, sericulture, vermin-composting etc.

Income generation through livestock, goatary, poultry and fisheries

- Focus on Poultry, Dairy, Fishery and other enterprises for increasing Off farm income
- Breed up-gradation of non-descript cattle
- Feed, Housing, Breed and Health management of livestock and goatery
- Promoting dairy on cooperative mode based on Anand model
- Improved fish species like *Jayati Rohu* and integrated fish farming by farmers
- Effective utilization of Public and private water bodies for fisheries through group approach.

SUCCESS STORIES

1. Raised bed planting of soybean in Madhya Pradesh

Soybean is one of the major oilseed crops in Madhya Pradesh and mostly sowing is on raised bed planting method (54% area). Change from line sowing method to raised bed planting and more effective control over irrigation and drainage as well as their impacts on transport and transformations of nutrients, and rainwater management. It saves the water from 30% to 50% compared to line sowing method

The advantages in terms of saving of precious resources and yield increase, the demonstrations were conducted by KVKs on Furrow Irrigated Raised Bed planting method, particularly in soybean crop

Large scale adoption of raised bed planting of soybean in Madhya Pradesh on following points:

Number of raise bed machines – 56000 (Seed drill with attachment)

Efforts made by KVKs of Popularization of this technology – FLD, KVKs- ATMA Converge, CFLD on Oilseeds & Pulses, NICRA, Farmer First

Adoption of this technology during 2016-17 - Total soybean cultivated area in MP (59.06 lakh ha) which covered of raised bed planting method (32 Lakh ha).

Water Saving – Time saving (25-30%) in irrigation.

Particular	Raised Bed	Farmers' practice	% increase in yield/income
Grain yield (kg/ha)	1937	1152	40.5

Particular	Raised Bed	Farmers' practice	% increase in yield/income
Net Return (Rs/ha)	38805	18898	51.3
Water use efficiency (kg/ha/mm)	2.09	1.24	

Reduction insect and Disease infestation - Raised bed saved the plants from heavy rains and water stagnation escape from the incidence of Insect.

Crop grown	Additional income(Rs/ha)	Crop productivity (q/ha)	Biotic stress Insect-pests (%)	Biotic stress Diseases (%)
JS 9560	47040	15.68	05	04
Farmer practice JS 9305	40020	13.34	25	20
Change over control (%)	7020	17.54	20 (reduction)	20 (reduction)

Reduction in weed infestation - Integrated weed management strategy focus on economic effective control of the weeds. During observation of raised bed method weed count was found 8 (Nos./sq.m.)

- Productivity of Soybean during last three Years - 8.78 q/ha
- Total monitory benefit as result of adoption of the technology in the stat e –
- According Ridge and furrow/BBF/FIRBS = 32.00 Lakh ha
- Monitory benefit Rs./ha = 27660/-
- Total Profit as adoption of technology (Raised bed) = 8851 Cores

Other benefits of Raised bed planting –

- Crop stand improved by 70-75%
- Required 20-25% lower seed rate
- Better crop management
- Obtained 10-15% higher yield

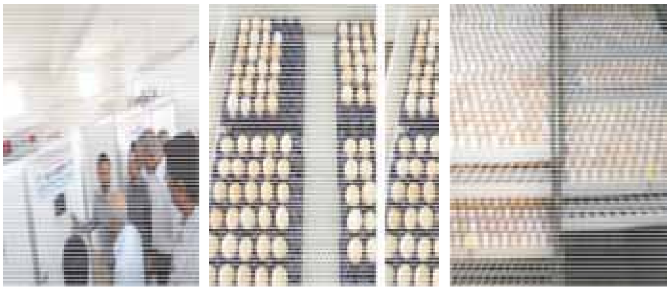
2. Raring of Kadaknath Poultry

Kadaknath is one of the rarest poultry bird of India which is native to Jhabua district of Madhya Pradesh. Kadaknath is popular for its black meat and known as BMC (black meat chicken).

The name Kadaknath is derived from "kala masi" meaning the fowl having black flesh. Kadaknath is famous for its black meat which has unique quality, texture and flavour. The breed is reared mainly by the tribal community of Bhil and Bhilala of Madhya Pradesh.

Promotion of Kadaknath poultry:

No hatcheries in Madhya Pra desh	30
No of Chicks supplied to farmers	79205
No of farmers benefited	1141
Horizontal expansion in other states	15 districts of 9 states (MP, CG, UP, AP, Rajasthan, Gujarat, Kerala , Maharashtra, Delhi)



Hatcher and shelter machine with eggs

Kadaknath chicks

Benefits of Kadarknath rearing

- Conservations of species
- Mortality reduce upto 12%
- High yield & More Income
- Rate upto Rs 600-800 per bird
- Employment generation
- Minimize the migration

Merits of Kadaknath Chicken Meat:

- High nutrition, the protein content higher than other native chicken.
- High Protein more than 25% (highest of all chicken breeds).
- Low fat 0.73-1.05% only (lowest of all chicken breeds).
- Vitamins B1,B2,B6,B12, C and E, niacin, protein , fat, calcium, phosphorus, iron, nicotinic acid etc.
- High levels of 18 essential amino acids as well as hormones that are required by the human body.
- The Central Food and Research Institute, Mysore, studied its medicinal qualities and found it suitable for cardiac patients as it increases blood supply to the heart.

Comparative nutritive value of Kadaknath black meat:

S. No	Properties	Kadaknath	Other Chickens
1	Protein content (%)	25	18-20
2	Fat content (%)	0.73-1.03	13-25
3	Linoleic Acid (%)	24	21
4	Cholestrol (mg/100 g)	184.75	218.12

16

MAHARASHTRA

Maharashtra occupies the western & central part of the country and has a long coastline stretching nearly 720 km along the Arabian Sea. The Sahyadri mountain ranges provide a natural backbone to the State on the west, while the Satpuda hills along the north and Bhamragad-Chiroli- Gaikhuri ranges on the east serve as its natural borders. The State is surrounded by Gujarat to the northwest, Madhya Pradesh to the north, Chhattisgarh to the east, Telangana to the south east, Karnataka to the south and Goa to the south west.

Maharashtra is the second largest state in India in terms of population and has geographical area about 3.08 lakh sq. km. As per Population Census-2011, the population of the State is 11.24 crore which is 9.3 per cent of the total population of India and is highly urbanised with 45.2 per cent people residing in urban areas. Agriculture is major occupation of the people in Maharashtra. Both food and cash crops are grown in the State. Maharashtra is spread over 9.4 % of the geographical area of the nation and hosts about 9.3% of the population of the country. About 7.4 % of the rural population and 13.5% of the urban population of the country reside in Maharashtra. Literacy rate in the state is 82.3 which is slightly more than the national average. Net area sown to various crops in the state is about 12.3 % while gross area sown accounts for 11.3 % as compared to the corresponding figures at the national level. The state contributes 55.4, 34.6, 21.9 and 10% of the area sown to sorghum, cotton, sugarcane, and the bajra respectively. However, contributes only 6.2 % to the national livestock population. About 9.3% of the national electricity is produced by the state but consumption is about 13.9% indicating that the state faces electricity problems.

Diversity of agriculture in Maharashtra is largely influenced by rainfall ranging from 500 to 6000 mm rain and diverse types of soil with varying level of water holding capacity. Since more than 12 ICAR institutes and 5 SAUs are in action and hence there is scope to address the issues relevant to doubling the farmers income in concerted manner. In addition to crops, livestock can play a significant role in enhancing the farmer's income if the marketing channel is streamlined. While substantial areas are covered by fruits and vegetables, a small proportion of cultivated land is devoted for floriculture.

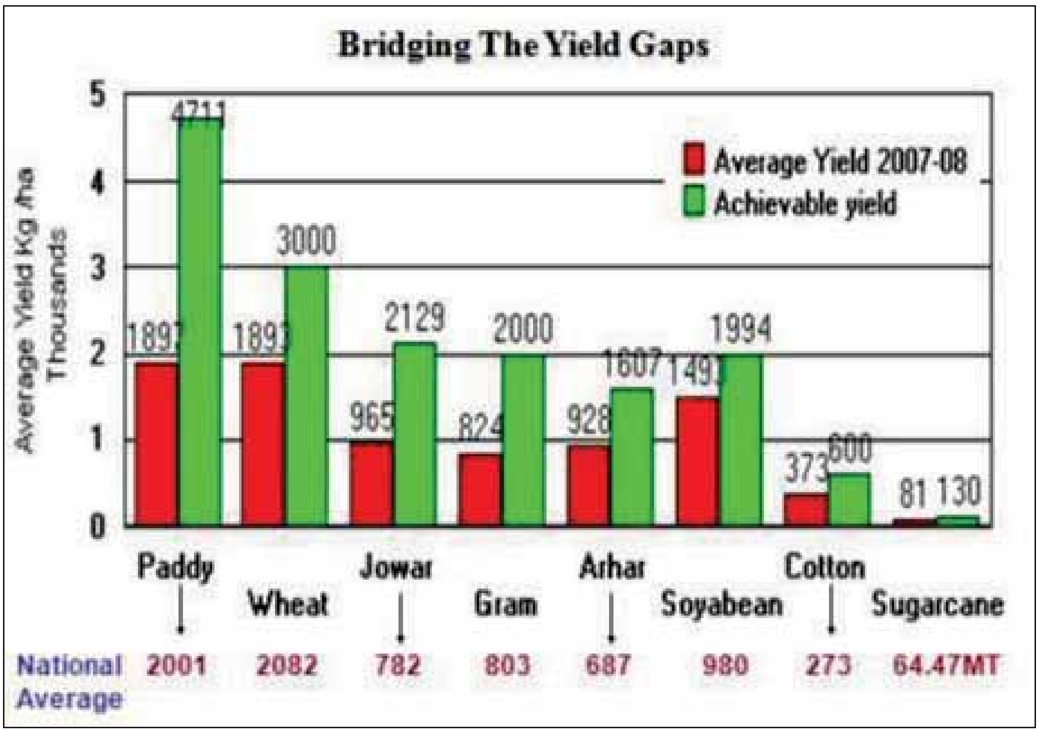
In order to maximize the production from the available resources and prevailing climatic conditions, need-based, location specific technologies need to be generated. Delineation of agro-climatic zones based on soil, water, rainfall, temperature etc. is the first essential step for sustainable production. The planning aims at scientific management of regional resources to meet the food, fiber, fodder and fuel wood without adversely affecting natural resources and environment. Agro-climatic conditions mainly refer to soil types, rainfall, temperature and water availability which influences the type of vegetation.

16.1 Productivity Gaps and Major Constraints

Agricultural crops

Despite significant advances in agricultural sciences there is a significant yield gaps in many of the crops in Maharashtra. Though not a major rice growing state, the productivity of rice is marginally less than the national average and less than 50% of the achievable yield/ha. There is at least 1000 kg/ha gap in wheat productivity relative to achievable yield. Though more than the national average the productivity of sorghum is less than 50% of the achievable yield. Only 40% and 60% of the achievable yield is obtained by chickpea (gram) and pigeonpea (arahar) farmers respectively. Though soybaean productivity is higher than the national average the productivity gap relative to achievable yield is nearly 500 kg/ha. Similarly, the productivity of cotton and sugarcane fall short of achievable yield by 227 kg/ha and 49 MT/ha respectively. These data clearly indicate scope for enhancing the productivity and hence the income of farmers.

Yield Gaps in food grain crops



Yield gap analysis between potential productivity of a region and actual crop yields are necessary. The ultimate target is to tap the maximum potential of a crop from a particular region and do the suitability analysis for that purpose. Though the yield gap analysis is generally done using experimental data, an attempt is made here to identify the regions with low productivity retaining heterogeneity of practical farming at district level. The criteria adopted in the demarcation of the zones are based on area as well as yield of different crops. District is placed in different categories depending on the area and productivity levels. Nine categories are considered viz., High area-High yield (HH), High area - Medium yield (HM), High area - Low yield (HL), Medium area - High yield (MH), Medium area- Medium yield (MM), Medium area - Low yield (ML), Low area - High yield (LH), Low area - Medium yield (LM) and Low area - Low yield (LL). Depending upon the availability of water resources, management strategies may have to be evolved to bridge the yield gap in different regions.

This comparison may ultimately result in identifying production constraints so as to bring all the zones to higher productivity level. Production constraints can be identified crop diversification efforts can be made to replace the low yielding crops by the high potential crops. The productivity level of crops has to be enhanced and sustained and this is possible only when efficient locations have been identified for the crops. This information would help to replace the uneconomical crop in the identified zones.

In case of paddy, scope for the improvement of productivity exists in Sangli, Satara, Pune and Nashik districts. Depending upon the availability of water resources, management strategies may have to be evolved to bridge the gap in yield levels. The area under kharif sorghum is sufficiently large in Jalgaon and Latur. There is a need to improve its productivity by implementing efficient production techniques in Nanded, Yavatmal, Sangli and Satara districts.

In case of pearl millet area is sufficiently large in Ahmednagar, Nashik and Beed districts. Area and productivity in Jalgaon, Dhule, Pune, Aurangabad districts is medium hence there is large scope to increase area and productivity in these districts by providing suitable varieties performing better under rainfed conditions. In case of wheat crop, there is large scope to increase productivity in Ahemadnagar, Solapur, Nahsik, Pune, Amravati, Buldana, Nagpur, Beed districts which are high in area but medium in productivity by implementing suitable package of practices. Area under rabi sorghum is more in Solapur, Ahmednagar and Pune districts. There is great scope to increase productivity of rabi sorghum in Dhule, Jalgaon, Akola, Washim, Buldhana and Kolhapur districts.

Production and productivity of pulses like red gram, black gram and green gram indicate that more area under pigeon pea may be encouraged in the Vidarbha and Marathwada districts (Fig. 43). The area of black gram in paddy growing district in konkan region declined in recent years, and the introduction of high yielding and disease resistant cultivars may help to bridge the yield gap compared to that in the adjacent Western Maharashtra districts. However, scope exists to improve the productivity of black gram growing areas in Latur, Nanded and Osmanabad districts.

In case of green gram, Akola, Amravati, Buldana and Washim are leading in production. There is large scope to increase area and production of Dhule, Nandurbar, Nahsik, Pune, Wardha, Aurangabad, Beed and Hingoli districts by implementing pulses development programmmes. Among oilseed crops, groundnut a conventional crop grown largely in Kolhapur, Satara, Pune and Sangli districts.

In Dhule, Nandurbar, Nahsik, Nagpur, Aurangabad, Beed, Latur and Nanded districts yield levels can be improved through the adoption of rain water conservation and introduction of cultivars which can stand mid-season dry spells as the rainfall is highly erratic in these districts during the SW monsoon season.

During recent years, soybean is replacing roundnut in western Maharashtra districts. Soybean productivity is high in Satara, Sangli, Kolhapur and Pune districts and there is great scope to increase area under this crop. While, Amravati, Nagpur, Washim and Yavatrnal and districts have large area but low in productivity hence adoption of proper package of practices for soybean is necessary in these districts.

Productivity levels of sugarcane are highly variable among the major cane growing districts; the low productivity levels in Beed, Jalana, Osmanabad and Parbhani districts require a special attention Cotton, another commercial crop shows wide scope for yield improvement i n Ahmednagar, Nanded, Buldhana and Yavatrnal and to some extent in Jalgaon, Aurangabad and Jalana districts

Table: Criteria adopted for categorization of productivity zones of major field crops

Crop	Area ("00"ha)			Yield (Kg/ha)		
	High	Medium	Low	High	Medium	Low
Paddy	>1400	700-1400	<700	>2000	1000-2000	<1000
Kharif	>1000	500-1000	<500	>1500	1000-1500	<1000
Pearl millet	>1500	600-1500	<600	>750	500-750	<500
Ground nut	>400	400-100	<100	>1000	750-1000	<750
Soybean	>2000	1000-	<1000	>2000	1000-2000	<1000
Red gram	>600	300-600	<300	>1000	500-1000	<500
Black gram	>300	150-300	<150	>750	500-750	<500
Green gram	>300	150-300	<150	>750	500-750	<500
Cotton	>2250	800-2250	<800	>500	250-500	<250
Wheat	>550	350-550	<350	>2250	1250-2250	<1250
Rabi	>2800	1400-	<1400	>1200	600-1200	<600
Safflower	>250	100-250	<100	>800	500-800	<500

Crop	Area (“00”ha)			Yield (Kg/ha)		
	High	Medium	Low	High	Medium	Low
Sugarcane	>900	300-900	<300	>75000	50000-75000	<50000

Constraints in rice cultivation

i. Inadequate irrigation

ii. Uncertainity in monsoon i.e early and late start

iii. Irratic rains

iv. Less no. of rainy days compare to normal *viz*., booting, flowering and grain filling stage in September- October

v. Dry spell during critical crop growth stages

vi. Change in climatic condition- Drought, Heavy rains, flood, cloudy weather for longer time, sudden increase/decrease in temperature.

vii. Low organic carbon, deficiency of Nitrogen, Phosphorous, Zinc and Sulphur in soil

viii. Insects – Gall midge, Stem borer, Brown plant hoppers, White backed plant hoppers, Green leaf hoppers, Leaf Folder, Case Worm, Army Worm, Gundhi Bug, Sheath mite.

ix. Diseases – Blast, Bacterial leaf blight, Sheath Blight, Sheath Rot, Stem rot, Brown spot, False smut

Constraints for Soybean

i. Almost rainfed crop, therefore influenced by vagaries of monsoon.

ii. Lack of diversification in varieties cultivated.

iii. Lack of technical knows how.

iv. Lack of adoption of improved technology

v. Lack of timely availability of appropriate quantity and quality of agriculture input.

vi. Lack of varieties resistant to biotic and abiotic stresses.

Constraints for Safflower

The National and International scenario indicates an yield gap of >21% over World Average and >100% yield gap over highest yield of 1564 kg/ha in USA. FLD organized by Institutions of ICAR/SAUs during Rabi 2012-13 indicates an average yield gap of 109% over National Average Yield (NAY) and 21% to 300% over SAY under irrigated/rainfed conditions in the safflower growing States, which could be minimized by adoption of improved package of practices including application of protective irrigation.

State	Yield kg/ha		Yield Gap (%)
	SAU	FLD	
***Rabi* 2012-13 (Irrigated)**	544	1079	98
***Rabi*-2012-13 (Rainfed)**	544	1038	91
All India	576	1203	109

Constraints in Sugarcane

i. Lack of scientific varietal and seasonal planning for planting and harvesting by the sugar mills.

ii. Lack of consideration of varieties according to maturity group and genetic characters.

iii. No implementation of three phase / tier quality seed production (B, F, C) chain.

iv. Over irrigation/moisture stress (Load shedding, uncertain monsoon).

v. Non adoption of INM, IPM, IDM and Weed Management technology.

vi. No proper crop rotation.

vii. Improper intercropping.

viii. Poor and neglected ratoon management.

ix. No adoption of improved farm implements and machinery and advanced technology.

x. Over number of sugar mills without considering ecological jurisdiction and potential.

xi. Fluctuating / Non assurance of cane prices.

xii. Unforeseen natural calamites namely drought, excess rains, outbreak of pests-diseases, uncertain climate (temperature) etc.

Constraints in Cotton

i. More than 95 % area is under rainfed cultivation

ii. Growing of cotton on low fertile and shallow soils.

iii. Due to erratic and irregular rainfall pattern, crops suffer and there is also a risk of crop failure under aberrant weather situation.

iv. Sometime due to delayed onset of monsoon and early withdrawal, prospects of good crop cannot be assured.

v. Intermittent dry spells during July and August followed by cessation of monsoon activity usually by the middle of September leads to non-availability of requisite moisture and concomitantly nutrients at the later stage of boll development usually in the latter part of October.

vi. Non availability of quality seed of promising cultivars.

vii. Gap in adoption of improved production technologies like IPM, IRM and intercropping etc.

viii. Losses due to pest and diseases.

ix. Temperature increased during square & flowering resulted into dropping of square & flowering of bolls.

x. Para-wilting and reddening in Bt cotton increasing day by day.

xi. Crop rotation not followed by farmers, facing N, P, K,S, Fe and Zn deficiency in soils.

xii. Lack of irrigation facilities.

xiii. High incidence of Pink boll worm drastically reduces the yield.

Horticulture

Data reveal that productivity of many of the horticultural crops grown in Maharashtra are less than the achievable yield. Though the yield gaps are less for crops llike grape, productivity of gua is less than 50% of the achievable yield. As per potential reported by SAUs nearly 5 times more mango and cashew can be obtained when compared to present average yield. The yield gap for banana is nearly 30 MT /ha. For other fruit crops the productivity gap ranges from 2 to 5 MT/ha.

Table: Yield Gap Analysis For Major Fruit Crops (Mt/Ha)

S. No.	Crop	State Average	Potential reported by SAU
1	Mango	3.50	15.00
2	Pomegranate	10.20	15.00
3	Mandarin Orange	9.10	15.00
4	Sweet Orange	13.00	15.00
5	Cashew	1.14	5.00
6	Banana	58.00	87.50
7	Kagzi Lime	9.65	10.00
8	Guava	12.15	25.00
9	Grapes	28.20	30.00

Constraints for grape cultivation

Although hot extremes and heat waves are set to become more frequent over the course of this century (IPCC, 2007), the most imminent challenges facing the wine, table grape and raisin industries in arid and semiarid regions are probably not heat waves per se, but increasing drought and salinity because of higher evaporation coupled with declining water availability. The precipitation patterns are changing, perhaps raining at undesirable times, and encouraging excessive vigour during early period after fruit pruning and increase loses due to downy mildew. Warming climates are sure to encourage new pests and diseases, notably insects following their habitat change. They may also affect the natural parasites and predators increasing pest attack due to change in the natural ecosystem. There may be changes in pathogen populations and introduction of new pathogens to new areas. Further, seasonal changes in climatic conditions, too, are impacting grape productivity either in terms of reduced fruitfulness due to high temperature, increased disease and pest problems due to unseasonal rainfalls and/or salinity due to reduced rainfall. In fact, the seasonal changes can also influence the formation and ratio (at favorable levels) of sugar and pro-phenols in grapes, thereby affecting the quality of produce.

Thompson seedless is main variety under cultivation contributing 80% share in national grape export. But it consumes substantial amount of plant growth regulators to achieve bold size and intercultural operations in this variety are very labor intensive which has to be carried out frequently to get better crop. Grape grower has to invest Rs. 50,000 - 60,000 per acre per season on such inputs which leads to huge rise in cost of cultivation. This situation is the representative picture of all the varieties grown in country. Such a expenditure can be saved by introducing new varieties which will give desired quality grapes without use of growth regulators.

Despite of intensive efforts export quality produce of grape was only 1.98 lakh MT during 2016-17 (APEDA, 2017) which is merely about 7% of total grape production. There is a scope to increase exports.

Only handful varieties under cultivation in country leads to monotony leaving us with fewer options for grape marketing. At international level consumers demand for new varieties with vivid berry colour (white, red and black), aromas (muscat, vanessa and foxy) and seediness (seeded as well as seedless) is increasing. This is why India is at seventh position when it comes to export in spite of being second largest producer of table grapes in world. With increase in new varieties cultivation in table grape growing countries like Chile, South Africa, Peru, Australia, Spain, Italy etc., exports from India will be in trouble. At present more than 85 % of our exports are Thompson Seedless. There is a demand for red variety for export in most countries including EU.

For distant transportation or export, better shelf life is a prerequisite but feeble storage ability of Indian cultivar is main concern which restricts our export to neighboring countries only. Moreover colored cultivars like Red Globe, Crimson Seedless, Flame Seedless which are under cultivation in India faces difficulty in uniform colour development under hot climate.

Varieties with export quality are globally available with different private firms such as International Fruit Genetics (IFG), California; GRAPA, California; Special New Fruit Licensing (SNFL) Group, USA; Sun World group etc. There is urgent need to intensify the efforts for bringing new varieties in country which will bring sustainability in export potential of India. Introduction of varieties with great market potential like Prime seedless, Ivory, Melanie, Timpson, Autumn King, ARRA 15 (white) and Scarlet Royal, Allison, Timco, ARRA 19 (red)) in India can help to increase our export share of table grape in global market. All these promising varieties are patented ones, in order to bring these varieties in India for their commercial cultivation, it is required to pay royalty to the owners of these varieties. Thus the fund availability in order to get the legal rights of these cultivars is need to be ensured.

Constraints for vegetable production

i. Semi perishability of Potatoes and harvesting of about 90% Potatoes in the country at the beginning of summer possess major problems in post-harvest managements.

ii. Narrow genetic base.

iii. Inadequate arability of processing varieties.

iv. Inadequate quantity of quality planting material.

v. High cost of production.

vi. Potential water scarcity.

vii. Potato productivity gaps across country.

viii. Little awareness about its nutritional and medicinal values and taboos and superstition about mushrooms.

ix. Illegal and unrecognized mushroom training centers.

x. Low domestic consumption of mushrooms.

xi. Less number of recognised mushroom labs in the states.

xii. Low and inconsistent yield due to non availability of high yielder and good quality strains.

xiii. High input cost due to non availability of abundant indigenous technologies.

xiv. Lack of marketing channels and proper prices.

xv. Lack of coordination and collaborations among growers and researchers.

xvi. Regular supply of energy at affordable costs is one of the constraints in commercial production of mushrooms.

xvii. Hygiene is perhaps the single most important issue to ensure adequate production of quality mushrooms.

Dryland Agriculture constraints

i. Lack of new implement for soil and water conservation measures. New implements are not available at village level or watershed level, so the adoption of new technologies especially soil and water conservation measures are very poor in small and marginal farmers.

ii. The project implementing agencies should involve the farmers / beneficiaries in design of plan. Common interest group of farmers should be formed and strengthened through P.I.A.

iii. Labourers in village prefer EGS and other similar Govt. schemes rather than working in farmers field. For working labourer on the field, it is necessary to have a group of major crop-wise unemployer which will monitor the availability of work, provide labour service to the small and marginal farmers.

iv. Poverty and seasonal adversity resulted in negative attitude towards developmental activities.

v. Fragmentation of land and availability of water, electricity and other important

vi. inputs i.e. compost, FYM, herbicides, bio-fertilizer.

Salt affected soils

In Maharashtra, total area of salt affected soil is 6.06 lakh ha. Out of this, 4.23 lakh ha area is sodic soils and 1.84 lakh ha. area is saline soils. In Maharashtra 10 per cent soils of canal command area of western Maharashtra deteriorated every year due to excess use of irrigation water and mono-cropping system like sugarcane

Table: District wise salt affected area in Maharashtra.

District	Saline soils (ha)	Sodic soils (ha)	Total(ha)
Western Maharashtra			
Ahmednagar	-	142160	142160
Sangali	18169	4746	22915
Satara	16814	-	16814
Solapur	-	38263	38263
Pune	66250	6645	72895
Nashik	-	17234	17234
Kolhapur	13612	13239	26851
Dhule	1792	-	1792
Jalgaon	12587	76836	89423
Vidharbha Region			
Akola	-	46733	46733
Amrawati	-	31702	31702
Buldhana	-	32127	32127
Yavatmal	-	1462	1462
Marathawada Region			
Aurangabad	-	11523	11523
Beed	216	-	
Konkan Region			
Mumbai	3268		
Raigad	16416	-	

District	Saline soils (ha)	Sodic soils (ha)	Total(ha)
Thane	34967	-	
Total	184089	422670	606759

Animal husbandry

A study conducted on contribution of livestock production system to farmers' livelihood in western region of Maharashtra reveals that major constraints for livestock farmers are lack of the manpower in family, lack of required number of availability of hired labour and scarcity of water to maintain livestock. These were followed by high prices of livestock to buy (21.00%), high wages of labour (20.00%), lack of capital to invest (19.00%). Inadequate space to house livestock (17.00%), inadequate veterinary facility (14.00%) and lack of space to store FYM (12.00%). Very few respondents mentioned transport problem to directly sell milk (6.00%), non availability of green fodder (5.00%) and diseases for small ruminants (3.00%).

Fisheries

Fish seed:

The paucity of quality and quantity of fish seed of desired size (On demand) is the most important constrain faced by the fish farmer.

The fish farmer are being duped by private fish seed supplier selling adulterated seed, small sized seed, exotic species, unwanted species seed.

Fish feed:

In aquaculture production, feed is the single most important input (share by 60% of the total cost). Availability of formulated commercial feed for carp fry is still constrain for which farmer resort to use traditional feed mixture. Supply of least-cost feed ration to achieve a certain production target, which could be represented in a model by a cost-minimization.

Lack of awareness of Modern technology:

i. Lack of scientific aquaculture know how the pond culture activities.

ii. Aquaculture technology is not adopted by farmers leading to meagre production level.

iii. Dependency for quality seed, feed and other inputs on state agency.

iv. Low productivity due to aquatic vegetation in small reservoirs, lack of capital and insufficient credit facilities, life insurance.

v. Multi-ownership of natural water bodies like reservoir, lakes

vi. The estimation of catch and catch composition in riverine fisheries poses considerable problem due to the geographical coverage and remoteness of fishing activity with no specific landing centre and markets in comparison to marine fisheries sector.

Marketing:

i. Fish marketing differs from that of marketing of agricultural product. Innovative marketing arrangement need to be development to ensure that farmers get remunerative price with development of local market and cold chain.

ii. Most of the aquaculture production sites are small and remotely located and hence farmers have problem in sending their small produce to city markets for fetching better price.

Policy and legislation:

i. Lack of coordination or linkage between financial institution and fishermen cooperative societies.

ii. Policies need to be opened up for cross border exchanges especially at the grass root levels.

iii. Increasing dominance of political factions in fishermen cooperative societies.

iv. Concurrence of fishermen cooperative society on leasing water bodies rights policy guidelines.

v. Apart from development of technology a holistic approach taking into consideration technical, environmental and socioeconomic factors needs to be taken.

Role of Technology

Technology will continue to be a dominant driver of agricultural growth and, therefore, it must be paid due attention. The major issues which need attention for bringing a transformative change in production systems are

A. application of existing stock of knowledge to harness productivity potential,

B. access to proprietary technology,

C. farm mechanization for higher input use efficiency

D. technology for agro-processing.

The technologies can contribute to doubling the farmers' income primarily by enhancing the productivity of the system through enhanced production, reduced cost of cultivation and effective communication about market intelligence. There is also a need to prioritize crops which are likely to experience a technical change similar to that observed in maize (single cross hybrid), cotton (Bt for bollworm resistance) and hybrids in vegetables and flowers and implementation of programs in 'mission mode.' Along with such technological innovations, last mile delivery of technology, skill development and information flow to farmers should be strengthened.

The recent research output from universities and ICAR institutes have clearly revealed the potential of improved crop varieties and natural resource management technologies for enhancing the productivity of crops, livestock and fisheries in addition to allied sectors such as sericulture. In addition, a lot of agro chemicals including the growth promoters are being commercialized in the Indian market. Farmers are in dilemma while using chemical and organic fertilizers; they don't know how to do budget farming. There is poor coordination between agriculture universities and farmers and it is increasingly observed that technologies emerging from research are not reaching farmers who need to be trained in using that technology and it is necessary to increase their capacity to make right choice at right time while making decision on purchase of inputs particularly for high tech agriculture.

General observations

Technology is not limiting factor; remuneration is the concern hence action plan is needed including all the sectors , small farmers and land less labours; it is necessary to specify site specific modules for doubling the income of farmers

All of us know the problem and some solutions already exist but it is not clear who has to reach them to the farmer and hence it is necessary to focus on what is needed for poor farmers and how to achieve in next five years so that it can help to double the farmers' income.

This should focus on comprehensive package which is needed to prioritize action plan: Short term and medium term goals for accomplishing the task; Action plan should include where to grow? What to grow? When to grow?

Some of the options are risk mitigation with respect to both weather and market: Promotion of water conservation and rain water harvesting for soil moisture security; watershed planning promotion of group farming, promotion of agri. produce export; product branding; training in primary processing; competitive price and quality of commodity; site specific land use models; remunerative components of IFS including small ruminants for dry areas

Land use plan and integrated farming system should consider issues such as use of high end science and high resolution data; comprehensive soil health card; global distribution crop and supply and international demand possible technology available; Estimation of harvesting potential; crop plans for mixed cropping

Soil information of Maharashtra available with ICAR-NBSS & LUP could be used to develop area specific crop productivity enhance intervention in the state. Soil fertility status particularly micro-nutrient states at district level need to be developed to enhance crop productivity

Soil based crop sustainability maps could be developed for major crops at district level for different agro ecological regions of Maharashtra to enhance crop productivity

Augmentation and synergies of existing Govt schemes should consider infrastructure subsidies instead of individual subsidies; employment opportunities; enhanced staff strength to achieve the task; work modules in partnership mode; coordination between SAUS, ICAR institutes and department; assured water and electricity; focus on post-harvest technology

Production technologies

Several crop production technologies for cereals, pulses, oilseeds, sugarcane and cotton in addition to other crops have been evolved regularly by the State Agricultural Universities and ICAR institute in the state. They are being periodically published. These technologies encompass integrated management of crops involving the best selection of varieties, crop protection technologies, irrigation schedule and machines for harvest and post harvest technologies. Some of the success stories have been described in the subsequent section in this chapter.

Strategy and action plan for Doubling of Farmers' Income

The empirical evidence shows that if same level of progress in various sources of growth, as experienced in the previous 10-15 years, is maintained, it can achieve 75 per cent increase in per farmers income by 2022-23 over base year of 2015-16 with better price realisation. This falls short of doubling the income (100 per cent increase) by 25 per cent. Thus, to double farmers' income by 2022 the progress in various sources of growth has to be accelerated by 33 per cent. This change could be across the board or more in some area and less in others with overall acceleration of 33 per cent.

Crop productivity is required to increase by 4.1 per cent and livestock value added by 6.0 per cent per year to double farmers' income by 2022. TFP growth, which is mainly contributed by agricultural R&D, extension services, new knowledge, efficient practices like precision farming, is required to follow annual increase of 3.0 per cent. Indian farmers should raise area under two crops to 53 per cent from the present 40 per cent recorded in recent years. Area under high value crops is required to follow an increase of 4.4 per cent each year. Market reforms are required to enable farmers to get 17 per cent higher prices than base level in real terms. This requires 2.26 per cent increase in prices received by farmers in real terms. Finally, total number of cultivators is required to come down by 2.4 per cent each year.

Suggested strategy to achieve the goal

i. Promoting Integrated Farming System (IFS)
ii. Strengthening Crop Diversification
iii. Promoting in-situ Water Conservation in Rainfed
iv. Promoting Organic Farming
v. Popularizing Concept of IPM
vi. Expanding Coverage Under Micro-irrigation
vii. Broad basing Agricultural Extension
viii. Empowering through Grass root Level Organizations
ix. Creating Post Harvest Handling Facilities
x. Adding Value through Agro-processing
xi. Sensitizing towards quality Agro-produce
xii. Encouraging Public-Private Partnership
xiii. Making Agricultural Research More Relevant
xiv. Making Agricultural Education More Useful
xv. Revitalizing Agricultural - Extension Education

xvi. Increasing Use of IT through Cyber-Extension

xvii. Access to market intelligence

xviii. Bringing in Institutional Reforms particularly those with credit, insurance and marketing.

Overall Strategy

i. By increasing productivity of crops

ii. Timely supply of good quality of sufficient seeds prior to season.

iii. Timely availability of good quality of inputs

iv. Applying short duration high yielding varieties.

v. Increase SRR of hybrid seeds

vi. By promoting Farm Mechanization

vii. Application Integrated Nutrient Management

viii. Application Integrated Pest Management

ix. By increasing irrigation facilities

x. Adoption of DSR/Zero Tillage/SRI

xi. By increasing cropping intensity

xii. According to land situation, irrigation and other facilities farm plan should be prepared for Kharif, Rabi and Garma for 03 years e.g.

- Paddy - wheat/pulses/Maize
- Maize – Wheat/Pulses/Maize
- Maize – Wheat/Pulses/Maize - Mung
- Vegetable (cauliflower) - potato - onion – mung
- Maize/Vegetable – Potato-Potato-Onion-Mung
- Paddy (short duration) - vegetable - onion - maize
- Paddy - vegetable - maize

xiii. Short duration hybrid/HYV seeds to be used.

xiv. Use of rice fallow land

xv. Rice- Makhana cropping System

xvi. Diversification of cropping system with high value crops

xvii. Cash crops- Sugarcane, cotton, soybean and Vegetables

xviii. Spices - Turmeric, Ginger, Dhania, Garlic, and Ajwain

xix. Mushroom Cultivation

xx. Rearing of honey bee

xxi. By Reducing cost of production

xxii. Subsidy on farm inputs

xxiii. Provision of subsidy on HYV/ hybrid in light of market price.

xxiv. Subsidy on mechanization in light of market price.

xxv. Use of green manuring e.g. Dhaincha, Moong, Cowpea, Sunhemp etc.

xxvi. Application of balance dose of fertilizer on the basis of soil testing.

xxvii. Provision of subsidy on diesel.

xxviii. Promotion of custom hiring system.

xxix. Use of bio fertilizers e.g. Rhizobium, PSB, Azotobactor, Azolla, Blue green Algae, Mycorrhiza

xxx. Subsidy of transport

xxxi. Use of Gobar/Bio gas

xxxii. Promotion of zero tillage technology.

xxxiii. Promotion of DSR

xxxiv. Use of Organic fertilizers and Manures

xxxv. Promotion of integrated farming system

xxxvi. Synergise blending of crops/horticulture, dairy, fishery, and poultry to provide regular income.

xxxvii. Protected cultivation of vegetables and flowers with Micro irrigation

xxxviii. Constitution of FPO to create market.

xxxix. Effective procurement strategies to procure on MSP

xl. Regular region wise weather forecasting.

xli. Provision for practicing kitchen gardening for arban households and poor people.

xlii. Facilities of more warehouses and cold chain.

xliii. Post harvest management to reduce crop losses.

xliv. Required value addition and processing.

xlv. Market linkages and reforms

xlvi. The sericulture or other allied activities could be the supplementary/additional source of income to the small farmers. Structure of modules to be designed for each district. It is the general opinion that single enterprise alone cannot substantially enhance the income of farmers. However there may be few exceptional cases such as high value horticultural crop. Hence, the modules for enhancing the income of farmers and dependent agriculture and non-agricultural rural mass should involve IFS and forward support for marketing the produce at remunerative cost. Some of the hypothetical modules suggested in the figure needs to be optimised for their income and feasibility in different regions.

xlvii. Crop diversification: Diversification of crops like fruits, vegetables and other field crops allocated to portion of land in total field so that, farmer can get income year round.

Also when one crop fails, the farmer can get income from other crops.

xlviii. **Direct marketing** of fruits to big store chains, residential colonies etc. so that intermediaries are avoided and farmer can get income at the rate of retail prices.

xlix. **Irrigation method to save water:** Creation of irrigation, micro-irrigation facilities, water conservation, rain water harvesting approaches would lead to stability and sustainability to citrus cultivation.

Resource management to reduce cost

l. Soil suitability has been delineated by NBSSLUP- has to be utilized by others for implementing the action plan for doubling the farmers income.

li. Micro irrigation should cover all sugarcane fields by 2020 (Nala irrigation to drip irrigation a lot of investment).

lii. Base line 2016-17 for example soil health status; where we want to go and how we can and action mode; Which department will do which job;

liii. Cotton should not be grown on land which is unsuitable for it for example Telangana replaced cotton with red gram.

liv. Desi cotton can reduce 50% of cost of production and hence to be promoted. Seed is major concern; KVK should promote this technology- to be in farmer's field.

lv. Geoportal about new technology for decision making to be developed with inputs from all the members of SCC.

lvi. The plans for future should include for both land holding and land less farmers with focus on increase in number of man days for land less farmers

lvii. Common property land to be put for proper use considering the need for animal fodder/ forage

lviii. Fertilizer dependent agriculture to less fertilizer dependent agriculture to reduce the cost of production for both farmer and environment.

lix. Cost of production in fish can be reduced by addressing fisheries co-management; Feed through local ingredients; Proper marketing of-Seed, fish, and Value addition

Region based strategy for Doubling of Farmers' Income

Konkan

i. Paddy - Increase area under Hy. Rice, Use of Urea DAP briquettes , Popularising "Chatu-Sutri"-Four point paddy production technology

ii. Cashewnut - Area expansion , Productivity enhancement , Promotion of organic cashew

iii. Mango -Area expansion under Alphonso , Post-harvest management including better transportation of mango, Adoption of GAP

iv. Construction of Konkan Jalkund, Check dams, Diversion Bundhara

v. Adoption of specialty flowers like heliconias, ginger lily in intercropping with plantation crops.

vi. Promotion of suitable crops of region like orchids, anthurium which required high humidity for cultivation

vii. Promotion of flowers like jasmine, Michelia champaca, rose and other native flower crops.

viii. Promotion of nursery industry which can cater the need of nearest huge Mumbai market

ix. Sugarcane - increase productivity & release area for foodgrains and soybean

x. Soybean – increase area & productivity

xi. Grapes & Banana – major stress on export

xii. Pomegranate -area expansion in DPAP blocks

xiii. Floriculture & high value vegetables-cultivation under controlled conditions

xiv. Promote organic fruits & vegetables

xv. More emphasis on ICM & IPM for horticultural crops like Pomegranate, Grapes

xvi. Promote floriculture & Cold chain

xvii. Adoption of intercropping of seasonal flowers in major horticultural crops like grapes, pomegranate, mango, etc. where wider spacing is used for cultivation

xviii. Value addition of flower crops: extraction of essential oils, natural pigments and pharmaceutical compounds Development of cold chain and integrated marketing centers.

xix. Development of flower based by product industries

xx. Promotion of dry flower industry in the tribal areas of Nandurbar and Dhule

xxi. Flower seed production of various seasonal flower crops

Marathwada

i. Cotton - Increase the yield & promote Clean & quality cotton

ii. Maize -Increase the area for cattle feed & industrial use

iii. Oilseeds & pulses - Bridge the yield gaps

iv. Promote the cultivation of sweet oranges,mangoes & banana

v. Kharif sorghum - Promote industrial use

vi. Discourage the cultivation of sugarcane and divert the area under soybean & gram

vii. Promote protective irrigation through the farm ponds, dug wells and other water harvesting structures

viii. Promotion of loose flowers like marigold, tuberose, gladiolus, annual chrysanthemum, chrysanthemum, aster, gaillardia, etc

ix. Adoption of intercropping of seasonal flowers in major horticultural crops like pomegranate, ber, mandarins etc. where wider spacing is used for cultivation

x. Production of natural colours/gulal/holicolours and dry flowers

Vidarbha

i. Paddy- SRI method for increasing productivity
ii. Soybean- increase the area & productivity
iii. Cotton- promoting Clean & quality cotton through contract farming, reduction in cost of cultivation through INM & IPM
iv. Organic cotton & mandarin promotion campaign
v. Pulses – promoting as intercrop in soybean and cotton
vi. Mandarin Orange – improving the quality & productivity through improved packages of cultivation and quality planting material
vii. Promoting PHM of mandarin orange through better packing , transportation & preservation
viii. Promoting Public Private partnership to develop clusters of pulses, vegetables, flowers & fruits for the ultimate market in the urban areas
ix. Water harvesting through farm ponds, dug wells, check dams, malgujari tanks & bodies
x. Promotion of loose flowers like marigold, tuberose, annual chrysanthemum, chrysanthemum, aster, gaillardia, etc and cut flowers like gladiolus and tuberose
xi. Promotion of dry flower industry in the tribal areas of the region
xii. Promotion of nursery industry in cities like Nagpur, Amravati, Akola, etc

Dryland Agriculture Strategy

Strategy 1: Productivity enhancement

i. Strengthening of soil moisture conservation technologies and storage structures
ii. *In situ* soil moisture conservation strategies viz., compartment bunds, ridges & furrows, tied ridges, contour bund before onset of monsoon
iii. Scooping in between rows to harvest rainfall
iv. Hoeing at 25 DAS.
v. Hoeing at 3rd, 5th and 8th week after DAS for rabi sorghum
vi. Preparation of furrows for moisture conservation after harvest of intercrop
vii. Opening of alternate dead furrows for water / moisture conservation 30 DAS
viii. One weeding and one hoeing before 30 DAS
ix. Ex-situ moisture conservation i.e. harvesting of excess rainfall in farm pond, cement nalla bund, earthen embankment etc.
x. Desilting of water harvesting / storage structures
xi. Adoption of improved, high yielding, drought resistance varieties.
xii. Sunflower - Phule Bhaskar, LSFH-171
xiii. Pigeonpea -Vipula, BDN-708, Phule Rajeshwari, BDN-711, BSMR-853
xiv. Pearlmillet - Adishakti, Dhanshakti
xv. Rabi sorghum -Phule Vasudha, Phule Suchitra

xvi. Safflower - Bhima / SSF-708, SSF-733, SSF-748, PBNS-12

xvii. Chickpea - Vijay / Digvijay

xviii. Adoption of improved package of practices

xix. Reduced tillage

xx. Hoeing at 25 DAS.

xxi. Intercropping of Sunflower (Phule Bhaskar, LSFH 171) + Pigeonpea (Vipula, BDN-708, BDN-711, BSMR-853, Phule Rajeshwari) (2:1)

xxii. Intercropping of Pearlmillet (Adishakti, Dhanshakti) + Pigeonpea (Vipula, BDN-708, BDN-711, BSMR-853) (2:1),

xxiii. Intercropping of Soybean (Phule Agrani, Phule Sangam, JS-335) + Pigeonpea (Vipula, BDN-708, BDN-711, BSMR-853) (3:1) (Barshi area)

xxiv. Intercropping of Pigeonpea + Black gram (TAU-1, TPU-4) (1:3)

xxv. Strip cropping of Chickpea + Safflower (6:3)

xxvi. Strip cropping of Rabi sorghum + Chickpea (6:3)

xxvii. Contingent crop planning for delayed onset of monsoon

xxviii. Strengthening of disease and pest management technologies

xxix. Use of preventive control measures

xxx. Use of botanical and bioagents

xxxi. Need based application of chemical pesticides

xxxii. Adoption of farm mechanization

xxxiii. Use of bullock drawn (Phule Sheti Yantra) and tractor drawn seed-cum ferti drill.

xxxiv. Use of cycle hoe for interculturing

xxxv. Use of combine harvester for safflower

xxxvi. Management of soil health in dryland condition

xxxvii. Integrated nutrient management approach should be followed

xxxviii. Fertilizers should be applied at the time of sowing

xxxix. Organic cultivation of local grain and millets in different blocks.

xl. Promotion of soil amendments in reclamation of saline and sodic problematic and degraded soil

xli. Soil and crop stress management

xlii. Use of crop residue management for mulching

xliii. Use of soil amendments

xliv. Use of foliar sprays of anti-transpirants.

xlv. Use of potash and zinc foliar sprays.

Strategy 2 : Livestock: Goatry, Poultry, Fisheries

i. Promotion of animal breeds
ii. Selection of high milk breeds in buffaloes (Pandharpuri) and cattle.
iii. Selection of heat tolerant breeds
iv. Promotion of goat rearing of Osmanabadi breed
v. Establishment of three hatcheries for need of broilor such as Giriraj, Vanraj
vi. Establishment of milk chilling plant
vii. Animal nutrition management.
viii. Silage making
ix. Use of Hydrophonics and Azolla in fodder
x. Establishment of Fodder Bank to meet fodder requirement of area.
xi. Promotion of Urea, Molasses, Multinutrient Blocks at Nyaypanchayt level.
xii. Promotion of dryland fodder trees/ crops/ grasses viz., Subabhul, Shevari and Stylo
xiii. Health cover
xiv. Vaccination at proper time
xv. Use of anthelminitic at regular interval

Strategy 3 : Integrated Farming system

Table: Promotion of different Integrated Farming System modules such asIntegrated Farming System for dryland agriculture for small farmers (1 ha area)

Area (ha)	% Area Alloted	Season		Summer
Crop component (50%)		**Kharif**	**Rabi**	
0.30	30	Cowpea	Sorghum	Fallow
0.10	10	Maize fodder	Sorghum fodder	Fallow
0.10	10	Fallow	Chickpea	Fallow
Horticulture component (40%)				
0.40	40	Dry land orchard with inter crop of (Pearl millet+ Pigeon pea 2:1)		
Animal component (5%)				
0.05	5	Dairy farming: 1 Buffalo (Pandharpuri), Back yardPoultry:30 birds in 5 lot/year (Giriraj), Goat rearing: 10 female + 1 male (Osmanabadi)		
Farm pond (5%)				
0.05	5	Size 15 X 15 X 3 m		
		Protected cultivation+ Composting+ Goatry/ backyard poultry Fodder production+ Mini dairy+ Composting+ Protected cultivation		

Strategy 4 : Reducing post harvest losses and value addition

i. Establishment of mini Dal mill plant
ii. Establishment of Food and Processing Units for pickle making
iii. Promotion of cluster approach for efficient procurement and disposal of surplus fruits and vegetables in areas.
iv. Promotion of cold storage
v. Promotion of Anardana, Custard apple rabadi, sorghum by-products
vi. Promotion of common resources on custom hire basis viz. farm implements and processing equipments
vii. Promotion of small scale oil extraction units of Safflower and Sunflower.
viii. Promotion of plantation of mulberry, dryland fruit plants, fodder trees, and green manuring trees
ix. Popularization of contour bunds, CCT to save excessive loss of nutrients in wasteland.
x. Popularization of trenches for percolation of water to avoid surface runoff.
xi. Construction of check dam and artificial structure to maximize water percolation rate in marginal and denudated areas.
xii. Construction of farm ponds for storage of water for lean season.
xiii. Storage of rain water in monsoon season.

Strategy 6 : Reduced cultivation cost by promotion of

i. Organic manuring with well decomposed FYM, Vermicompost and Biofertilizers to minimize the use of chemical fertilizers.
ii. Recommended seed rate, spacing and depth.
iii. Need based application of pesticides and other agricultural inputs.
iv. Hand tools in agricultural and horticultural operations.
v. Use of Power tillers, Power weeders, Threshers, Maize Sheller, Wheel Hand hoe, Combine harvester, Ferti-seed drills
vi. Mulching (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.
vii. Promotion of pressurized irrigation techniques in horticultural crops.
viii. Tillers and other garden tools for reduction of drudgery
ix. Promotion of subsidiary occupations like poultry, fish farming and mushroom production.
x. Promotion of apiculture for small and landless farmers.
xi. Promotion of sericulture
xii. Promotion of cultivation and collection of medicinal plants.

xiii. Promotion of skill development in women and youth

Strategy 8 : Enabling Policies

i. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.
ii. Labelling of organic inputs and certification mechanism for various crops.
iii. Popularization of Udhyan and Krishak Cards for widespread use of government incentives/ subsidies to farmers.
iv. Establishment of seed bank, fodder bank to meet the present and future demand
v. Implementation of effective and workable Nursery Act to avoid spurious or unreliable planting material in the state.
vi. Ensure sustainable agriculture through more efficient utilization of land, water and other resources.
vii. Implementation of Soil Health Card Scheme

Strategy 9: Marketing and value addition in specific agro-ecological region

i. Creation of direct linkages with food processing industries for better prices especially for pomegranate, ber, custard apple, banana, grape, sorghum.
ii. Establishment of strong linkages with various stack holders to furnish information on crop produce and surplus.
iii. Establishment of procurement and collection centre for agricultural surplus with proper labelling.
iv. Installation of mini grading machines at village level.
v. Establishment of cold room in different clusters.

Strategy 10: Online Management and Evaluation

i. Development of Mobile apps/ software for online management and evaluation at district level.
ii. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
iii. Organization of monthly review meeting at district to solve the problems related with farmers.
iv. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

Summary and Recommendation

Farmer's income in Maharashtra is substantially lower than those who are in other sectors and particularly in service sector. Though he is responsible for feeding ha million his struggle to have comforts in life in in progress despite significant advances in agricultural sciences and technologies. Hence aptly though mission for doubling the farmers income by 2022 needs a strategic plan and implementation modules to realize this dream in all the villages of all the 34 districts of Maharashtra and also in Metro districts such as Mumbai where some are involved in urban farming, animal husbandry or dairy and fisheries.

Nearly 50% of the geographical area in Maharashtra is under cultivation and half of it depends totally on rains. Only about 18% of the cultivated area has access to irrigation. Despite these constraints the state is contributing significantly to agricultural produces particularly pulses, jowar, sugarcane, grapes, pomegranate etc. with farmer's active involvements of farmers cooperatives. However, despite clear demonstration of profits from horticultural crops, many farmers are below poverty level. The n and natural endowments are not really sufficient to make farmers rich. Water scarcity is one of the major constraints and hence huge gap between crop productivity and achievable yield exist for different crops including both field and horticultural commodities. To great extent limited infrastructures for post harvest storage and processing further limits income from perishable horticultural commodities and also important pulse crops.

Several technologies and success stories have been demonstrated by SAUs and ICAR-institutes in the state which needs to replicated as they have great potential to enhance the income for farmers. Since profit from single commodity or sector is unlikely to help in doubling the farmers income, it is essential to develop site specific integrated farming system modules involving crops, horticulture, livestock and fisheries wherever feasible. Such systems can significantly contribute to sustainable and more income for the farmers.

There is a lot of scope for enhancement of farmers' income through technological interventions for increasing the production through enhanced productivity, reduction in cost of cultivation through input use efficiency and enhancing the remuneration for product through market reforms and value addition. This can be achieved through integrating the farm activities with well thought government schemes at central and state level.

The plan for implementation of strategies for doubling the farmers income in Maharasthra should start with delineation of agro-climatic features at district level supported by technological interventions for enhancing the productivity, reducing the cost and income generation through diversification, intensification and improved marketing support involving information technological tools. The plan should bring together all the promising technologies to design appropriate site specific Integrated Farming System modules for each district. This needs involvement of SAUs, ICAR institutes in the state and department of agriculture of the State. Improved infrastructure for post harvest storage, value addition and direct marketing can significantly contribute towards doubling farmer's income.

The agriculture prices are not fixed taking into livelihood needs of the farmers. The rising inflation always had a double impact on farmers with increasing costs of living and decreasing incomes due to reduction in agriculture prices as a result of price intervention mechanisms of the government. Minimum Support Prices are announced for 25 commodities and market intervention operations exist only for rice and wheat. So farmers growing other crops are left to the mercy of the markets.

Hence,

i. MSPs should take into account actual costs of cultivation and living costs (corrected to inflation rise)

ii. NFC's recommendation (Cost C2+50 %) can be used as a guide (Rs. 1800/q for 2010 paddy and wheat based on 2009 cost calculations)

iii. Price differential (MSP –actual realised/procurement price) should be paid directly to farmer

iv. There is a provision for enhancing the production by technology interventions for bridging the yield gap and reducing the cost of production.

Hence,

i. Government should promote and give a boost to dissemination of promising technologies to the farmers

ii. Incentives should be tagged with adoption of Soil health card based input use and integrated pest management that can reduce pesticide load on environment and also the adverse effect on human health

iii. Cost intensive soil moisture conservation and soil conservation technologies to be supported by the Government in the larger interest of sustainable agriculture

iv. Soil health card schemes should be effectively utilized as ground truth data to employ GIS based mapping technologies for devising decision support system on choice of crop and appropriate production and protection technology

v. Diversification and value addition can add income for farmers and this can involve non farm or off-farm activities to reduce total dependence on agriculture.

Hence,

i. Government should encourage district level or even tehsil level crop plan

ii. Introduction of new crop or cropping system

iii. Storage, processing and marketing structures even at smallest administrative setup such as Tehsil by appropriately bridging the gaps in existing system

iv. Should promote rural artisans which can boost agro tourism

v. Doubling the income of farmer's income by 2022 is not an easy task but not an impossible task if a perfect coordination is established between research and educational institute implementing agencies i.e state departments

Hence,

i. Necessary action has to be taken to ensure involvement of SAUs, ICAR institutes and line departments are established

ii. The government schemes to be appropriately tagged with technology dissemination with initiatives for adoption

iii. There should be custom hiring centres and storage structure at smallest unit of administration

SUCCESS STORIES

1. High density planting of Straight variety of Dr PDKV AKH081 cotton with intercropping under tribal area of Akot tehsil of Akola district

Bt cotton grower shifted to organic farming with Straight variety of cotton due to severe attack of sucking pests. A farmer Shekhadsingh Aabassinh Chavan of Borva, tribal village of Akola district grew Dr PDKV Hirsutum variety AKH081 which is short duration variety and matured in 140 days. Added 1 ton FYM and also used 1 ton biodynamic compost/acre (S-9 culture) before sowing and Used high density population about 1.66lakh/ha (60x10cm) with 15 kg seed rate /ha and after 8 row of cotton two row of Pigeonpea PKV Tara 2 kg seed rate/ha was grown as intercrop. . Biocultures were used for seed treatment. Furrow opening was done on 40 days after sowing for better conservation of moisture under rainfed. IPM was used for bollworm management. (NSKE 5%, taral khat, cow urine was used). The HDPS seed cotton yield was 1875 kg/ha and 500 kg Pigeonpea grain yield with straw for animals. And farmers practice with Bt cotton Ajeet hybrid was 20.75 q/ha Intercrop yield was bonus and it was profit over farmers practice. SCY and net profit was higher due to Short duration variety AKH081 variety and PKV tara for pigeonpea, which is drought tolerant , moisture conservation practice also adopted and addition of FYM improved moisture status which helped for boll development and seed development under rainfed. Improved yield of FLDs on intercropping and performed better under climate change because this year monsoon was started right time but after sowing there was dryspell of 25-30 days in the region

Net returns of HDPS cotton with pigeonpea intercrop was Rs 67938/ha and B: C was 2.44 and B: C of farmers practice was 1.94 So better remuneration with intercropping system with cotton under rainfed area..

Intercropping with pigeonpea in (8:2) with cotton increased more additional profit and moisture conservation practices also improved moisture status which helped for boll development.

HDPS in cotton demonstration Year 2015-16

Name of Farmer	SCY Kg/ha		GMR (Rs)		COC(Rs)		NMR(Rs)		BC	
	Intercrop	FP (Bt cotton)	IT	FP	IT	FP	IT	FP	IT	FP
Shekhadsingh Aabassinh Chavan Borgao Tq-Akot District - Akola	5	20.75	115000	84038	47063	43313	67938	40725	2.44	1.94

2. Goat Rearing Technology

Generally, goat is considered as more efficient digester of feed as compared to other ruminants. Flushing is conditioning of does for breeding. Does two weeks prior to breeding are provided with good pasture, balanced feed and additional concentrate supplementation. This will result in more uniform kids, increasing kidding rate and incidence of multiple births in flocks.

Plan, Implement and Support: For upgradation of goat and semi stallfed goat rearing, KVK conducted PRA in different villages where goat is the major enterprise and identified gaps in technologies adoption. For PRA, help of Famers Clubs also taken. Based on these gaps identified, interventions were planned. For training beneficiaries selected with the help of Farmers Clubs, SHGs. News also given in daily new paper and in Community Radio Center. Technological and skill imparting training organized at KVK as well as in villages. Need based demonstrations; OFTs were also conducted on farmers field in order to show the performance of the goat. Exposure visits were arranged in different goat unit. Similarly different inputs also made available to the farmer in order to increase adoption and diffusion.

For promotion of goat rearing, KVK conducted short duration training for farmer farm women and rural youth considering the importance of goat rearing and its future for meat and milk. Likewise group meetings and seminar also conducted in which more than 250 farmer farm women and rural youth participated. KVK focused on two aspects i.e. up-gradation of local breed and introduction of semi stall fed goat rearing as commercial venture of goat farming. For up-gradation of local goat, KVK introduced Osmanabadi for milk and meat purpose. Osmanabadi breed is more suitable in both backyard as well as semi-stall fed goat rearing. Initially KVK reared the goat at KVK farm and made available the goats as well as breedable bucks to the beneficiaries. Self Help Groups (SHGs) were involved for promotion of the goat farming. Various activities were conducted to the SHG members besides demonstration of new breeds, preparation of homemade concentrate feed and introduction of some fodder crops. KVK introduced the up-gradation of goat concept in more than 40 villages with more than 26 Osmanabadi goats unit having capacity 10 +1 started among the rural youth. Similarly village Chinchpur was adopted for complete replacement of the existing breed with Osmanabadi with the help of SHG members. Under NICRA project Osmanibadi bucks are provided among the farmer for increasing weight gain and twining percentage in rainfed area.

Outcome: Due to up-gradation of goat programme, more than 3500 goats were up-graded during last 5 to 6 years period. Due to this up-gradation, average weight gain has been increased by two to three kg. per goat besides increasing the twinning by 65 percent. Due to KVKs intervention more 118 stall fed goat-rearing farm units started with average 10 to 25 goats/ units. Every family is getting additional income of Rs. 20 to 30 thousand per annum With this intervention, gain of 20000 to 25,000 kg. meat and 1300 kids per annum to the farmers resulted in more than 70 to 75 lakh additional income to more than 14000 goats. On an average increase of Rs. 1400 to 1500 per family due to up-gradation of goat and semi stall fed goat rearing.

***Impact*:** One hundred and eighteen rural youths and women are self-employed in last year due to semi stall-fed goat rearing. These units are providing the good quality breed able bucks and goats to other farmers for starting goat units and upgradation local non-descript goats.

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MANIPUR

Manipur is often described as "A Little Paradise on Earth" with diverse agro ecologies. Out of total geographical area of 22,327 sq km, 90% area is under hill tract and rest is central valley. The gross cropped area account for about 16% of the total land areas and the about 66.64% of the gross cropped areas is utilize for paddy cultivation. Agriculture play a crucial role in the state economy and about 80% of the state population is engaged in agriculture and allied activities.

Majority of the farmers are small and marginal with limited resources adopting subsistence farming system. Permanent cultivation is practised in valley area while terrace and shifting cultivation is being adopted in the hill areas. Due to traditional farming, the productivity of crop in the state is low and is not able to meet the domestic requirement. Less income from crop production leads to poor socio-economic condition and poor adoption of improved technologies by the farmers.

The state faces problem of lack of availability of improved seed and planting material, irrigation facilities, cold storage, rural godown, credit facilities, etc. The climatic vulgarities experienced in the state over the last decades in term of dry spell during sowing season, rain during crop harvesting season, flood, etc has pose additional hardship and challenges to the farmers in the state. Marketing problems in the state in term of price volatility, exploitation by middleman and farmers not getting remunerative prices are other challenges which affect the income and earning of the farmers.

The pathway for doubling of farmer's income require consideration from different dimensions in term of providing improved packages of practices for production, timely availability of critical agri inputs, assured irrigation, improved marketing facilities, etc. There is a need for transformation of traditional crop to Cash crops, subsistence farming to commercial

Market driven farming, food production to Food production with Processing, mushroom production and processing, adoption of protected cultivation, etc. Rearing of livestock especially pig and poultry have a big role to play in doubling farmer income as high return is obtained in a short period as compared to other farm activities taken up by the farmers in the state. Fishery sector has a huge potential in the state especially in the valley area where there is abundant marshy areas and lakes for fish farming. There is a huge gap in the production and requirement of the fishery and livestock products in the state. There is a need for location specific farm mechanization to doubling the resource use efficiency and promotion of Agri entrepreneurs is required. Integrated Farming System (IFS) model based on the concept of undertaking multiple enterprises in the farm for optimum resource utilization and round the year employment and income generation is very much important for the state.

The agricultural production system in the state is mostly rainfed, mono cropped and at subsistence level. Use of local varieties, limited use of agro-chemicals (especially in hills), low moisture retention capacity of upland soil and lack of irrigation facilities along with traditional management practices have resulted into low productivity of crops and low cropping intensity in the region. Problems of high rainfall (12.10 per cent of country's total precipitation), soil acidity, aluminium toxicity in upland and iron toxicity in valley land have added to the problem of low agricultural productivity in the region. About 80% of the state total population is engaged in agriculture and allied activities and it plays an important role in the social and economic life of people in Manipur, and will continue to do so in the foreseeable future. Manipur agriculture can be characterized by low productivity, diverse food basket, rainfed and based on traditional wisdom. The gross cropped area of 3,55,620 ha which account for about 16% of the total land areas of the state and the about 66.64% of the gross cropped areas is utilize for paddy cultivation. The tribal people living in the hills usually practice Jhum cultivation. The mean cropping intensity of the state is 151.9% only. However, fertilizer consumption during 2014-15 was 31.75 thousand MT.

Horticulture plays an important role in the subsistence farming which is being practised by majority of the small and marginal farmers, especially in hill districts of Manipur. The state is bestowed with all kinds of pre-requisite for successful cultivation of various horticultural crops. The major fruit crops of the state are pineapple, banana, passion fruit, khasi mandarin and kachai lemon. Recently temperate fruit crops like kiwifruit and plum has gained popularity. Almost all kinds of vegetables can be grown in the state; however, cole crops, legumes and cucurbitaceous crops are mostly preferred. Some indigenous vegetables like tree bean, water mimosa, leek and chinese chive are very popular among the people. The major spices are turmeric, ginger and chilli. The state is known for king chilli, one of the hottest chilli in the world.

Moreover, Manipur is a treasure trove of many underutilized and indigenous horticultural crops, some of them are really rich in bioactive properties and are being used in traditional and ethnic medicines. But, the horticulture sector has still remained unexploited from commercial point of view. The total area under horticultural crops was 103.52 thousand hectares in 2015-16 with a production value of 955.91 thousand MT (Department of Horticulture and Soil Conservation, Govt. of Manipur, 2016).

Amongst the allied enterprises of agriculture, livestock and poultry is the important sector in Manipur. Development of animal husbandry is an essential feature as livestock plays a pivotal role in the state's rural economy. A large number of small and marginal farmers, agricultural labourers and other economically weaker section depend up on livestock for gainful employment. The main categories of livestock reared in Manipur are cattle, buffalo, sheep, goat, Mithun, pig etc. Rearing of pigs and poultry are important sources of income generating activities, especially in hill districts. There is decrease in livestock population over 2007 to 2012 from 0.78 million to 0.69 million excluding 42 stray cattle) registering a decline of 11.76% in the total number of animals of various species. During 2015- 16, the state has produced 81.77 thousand tonnes milk, 924.97 lakh numbers eggs and 11.32 thousand tonnes meat (Source : Directorate of Veterinary & Animal Husbandry Services, Manipur).

Fish is the main food item of the majority of the people in the state. The state has no marine fisheries. It has vast potential of fisheries resources comprising ponds, tanks, natural lakes, marshy areas, rivers, reservoirs, submerged crop land, low lying paddy fields etc. The largest source of fish is Loktaklake (230 sq. km. surface area) in Bishnupur district. The total water area in Manipur state has shrunk from around 1 lakh hectares in 1990 to around 56.46 thousand hectares in 2009-10. The state has produced 31.99 thousand tonnes of fish and more than 219 million fish seed in 2015-16.

Productivity Gap and Major Constraints

Manipur has made significant strides on the agricultural front during the last two decades. Much of the credit for this success should go to the small farming farm families that form the backbone of state agriculture and economy. However, the pace of the progress is still not up to the mark. Apart from rice and passion fruit, the productivity of other crops is still low. Majority of the farming community is small and marginal. They do not have access to easy credit from the banking institutions, as a result of which they are compelled to continue with small scale production system. Due to absence of proper land tenure system, sense of belongingness to the lands is comparatively less. Shifting cultivation is still prevalent in hill districts. There is also a general lack of knowledge among the farmers regarding improved farm technologies.

Majority of the farmers do not get quality seed and planting material in sufficient quantity. Farmers in hill districts do not have access to agri-inputs like seed, fertilizers and pesticides. The rugged terrain hampers the delivery of various services to the farmers. The cost of cultivation is also high due to undulating lay of the land. The faulty land use pattern and non-adoption of conservation measures has aggravated the degradation of resource base. There is acute scarcity of water during winter months as a result of which farmers cannot provide lifesaving irrigation to the plants. Soil acidity, micronutrient deficiency and soil erosion are the common challenges of hill agriculture. Climate change is a reality and the farmers are suffering from intermittent drought, flood and erratic rainfall. In hilly areas, farm mechanization is still at its infant stage.

Good roads and communication network are keys to development. But, the transport network in the region is in a very poor shape. Marketing, processing, value addition and storage infrastructure is almost nonexistent. The per capita availability of power is very low in the state. There is a lack of regulated market and retail chain to sell the produce at a profitable price. The farmers resort to distress sale of their produce. There is low market surplus due to subsistence farming rather than market-driven farming. The small scale processing units normally procure from local markets where there is no control over the grades and quality, which reduces the processing efficiency. The overall investment on agriculture sector is comparatively less as compared to other parts of the country.

Potential for Development of Horticulture, Livestock, Fisheries, Agro-forestry and Post-harvest Processing

The agro climatic conditions of the state are highly favourable for growing a variety of field crops, vegetables and horticultural crops. Many of these crops are grown indigenously in the state and need to adopt the scientific cultivation packages for getting the optimum yield and return. The vast hill areas can be used for growing horticultural crops which will help to generate raw material for post-harvest industries. There is a huge demand for livestock products viz. pig, poultry, egg, milk, etc in the state and are brought from other states to meet the local requirement. Improved breeds and scientific rearing practices may be adopted to harness the optimum production potential in livestock farming. Manipur is endowed with fisheries resources of about 56,461.15 ha. Water areas in the form of lakes, seasonal and perennial swampy beels, rivers, tanks, ponds, reservoir, low lying paddy field, etc. If the available fisheries resources are utilized properly through modern and scientific fish farming techniques and intervention,the state has got potential of producing 53,000 MT of fish annually. Presently, the state is producing only 31,266 MT of fish per year (2015-16) whereas, the total fish requirement of the state is 42,780 MT per year.

Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

VALLEY

Small farmers, landless to 0.25 ha: Poultry+fish +polyhouse/mushroom

Medium holding: 0.30-.5 ha: Fish+ mushroom+ poultry+Org.vegeables+mushroom 0.6ha and above: Double field crops+ poultry+ Fish+beekeeping+eri-silk+cattle/pig.

Wetlands: Paddy cum pisciculture + water vegetables+Zizania+Mimosa+duckery.

HILLS

Terrace/ foothills- Mid hills

A. 0.25ha: High value crops like king chilli+apiary+ backyard poultry+goats/pigs, etc.

B. 0.25-.5 ha Mid hill slopes: Rice/maize/vegetables+ fish/pig+goat+poultry+eri silk, etc.

C. 0.6- 2 ha: Rice/maize+soybean+peas/potatoes/vegetables/rapeseed/apiary, etc.

D. Above 2 ha: Rice/maize+soybean+peas/potatoes/rapeseed/apiary, etc.

E. Hill tops: Plantations+trees+ fruits+ org. ginger/turmeric+mushroom, etc.

F. High altitutdes (Mao, Ukhrul): Tree beans + peach/ pear+ kiwi vines+ginseng+potato seeds+ rice+ peas+colecrops+piggs+poultry, etc.

G. Mid altitudes (Senapati, Chandel, Kangpokpi,Tamenglong, Churachanpur): Tree beans+ rice+ peanuts+soyabeans +ricebeans +org.cucurbits + ginger/turmeric+yams+colocasia, etc.

H. Jhumlands:Rice+maize+beans+pigs+goats+chicks+fruits/rees+rapeseed+peas+potatoes + colocasia+ tapiocca+ yams etc.

I. Varieties: There are well established varieties of rice and other crops like, RC Maniphou 6, RC Maniphou 7, RC-Maniphou 10, RC Maniphou 11, RC Maniphou 12, and CAU R1 and newly released varieties like RC Maniphou 13, CAU R2, CAUR R3 and CAU R 4 are adapted under Manipur conditions. RC Maniphou 6 which a cross derivative of Ch 988 and IR 24 could thrive well under the upland and rainfed conditions.

Similarly, for maize many hybrids like HQM series and composites like Pusa Composites and pre released Composite lines like RCM-1-64 are doing very well. North eastern region being the secondary origin of maize, there are possibilities of high value cash crops like, pop corn, sweet corn, baby corn varieties provided market and packaging links are created locally. There are already proven varieties of pulses through AICRP, but could not be released due the unawareness of the local State Variety Release system. It was decided to submit the release proposal process for release of all the suitable varieties by concerned AICRP Centres in CAU. As such for Arhar varieties like seeds can be made available by CAU & ICAR if indents by the state government is given on time (one year ahead as seed crop need to be raised).

- Fix the procurement price at production cost plus 50 per cent to enable small farmers enough surpluses.
- Animal and Fishery components are an integral part in any farming system. Dairy farming and poultry are important for organic source.
- Revitalisation of state cattle breeding policy with selection in the progeny generation for crossbreeding/grading up programme. Low managerial skill of the dairy owner is critical, local agro-climatic conditions viz., temperature of Jersey breed is higher than place of origin; Jersey may be used as the prime/main improver breed to the selective local dairy cattle/cows. However, in resource rich areas, semen of Holstein- Friesian can also be utilised as another choice of breed.
- Feed problem, particularly concentrates due to dependence from outside the region and high transport cost may be addressed to some extent by utilising locally produced ingredients like soybean, maize, rice bean, by-products of rapeseed, by-products of pulses, *etc.* as animal feeds which may be linked with cropping of each locality.
- To solve fodder issues, identification and mapping of available land, feasibilities of fodder crops cultivation, both in valley and hill areas mainly, fallow foot hills are necessary for development of intensive fodder production activities. Dairy cooperative societies, farmers clubs, district councils, village level small milk production units may be entrusted to manage with available spaces for growing fodder by providing skill oriented managerial trainings and provision of inputs like fodder seeds, organic/chemical fertilizers and insecticides, pesticides, *etc.*

- Strengthening of district level disease diagnostic and improving of health care and management facilities through regular deworming, vaccination at regular interval to protect from disease outbreaks and timely intervention as well as treatment of ailing animals after confirmative diagnosis. Local veterinary dispensaries and hospitals should be well equipped for timely management during adverse situations as well as facilities for mobile clinic round the clock to minimise any kind of health related accidents/problems.
- In poultry the state has a high shortage of poultry products, particularly eggs. High cost of production due to high cost of concentrate feeds, lack of scientific manpower, losses due to diseases are the constraints for ensuring a remunerative income to the poultry farmers. To minimise the cost of production, all sorts of production components, transportation cost, timely availability of veterinary aids including, vaccines, medicines, mineral mixtures, and other poultry equipments, *etc*. must be ensured at the door step of the rearers.
- Like in dairy sector, effort must be made to encourage contract farming in the state for commercial production of feed ingredients such as maize, wheat, soya bean, *etc*.
- To ensure higher income, rearing of low input high output birds, like dual purpose breeds *viz.*,Giriraja/Vanaraja/Gramapriya/Kruoiler/FFGN/Gramapariya/Srinidhi/CARI Shyama/ Priya/Nirbheek/Devendra/ Kamarupa, *etc.,* may be encouraged in rural hill areas where the vegetation are available under rural poultry farming. Due to lower mortality, higher life time production, more meat acceptability, farmers' income will be enhanced.
- Ensure regular monitoring of diseases and prompt treatment of observed cases.
- Being the most important livestock for hills and valley areas, pig production may be prioritised for doubling the farmer's income.
- For enhancing piggery development in the state, more breeding farms for multiplication of piglets/pork production should be established under sustainable conditions with the expert guidance of breeding professional.
- Utilisation of non-conventional feed resources, such as wild colocassia, banana stem, tapioca, kitchen waste and value addition therein.
- Rigorous health care programme such as deworming vaccination, improving farm sanitation and monitoring of Procine Reproductive and Respiratory Syndrome and other trans-boundary diseases must be ensured regularly to be taken up under the strict supervision of State Veterinary Department.
- Setting up of biogas plants for controlling environmental pollution.
- Establishment of hygienic pork production, pork processing plant and abattoir for ensuring market to the producers. Introduction of regulation and enforcement of safety animal food production mainly in urban and semi urban areas at the initial stage.
- For enhancing animal based Integrated Farming Systems in the state, greater efforts may be given to encourage duck-cum-fish farming, pig- cum-fish farming in areas where water bodies are available.
- For doubling the household income, the ideal combinations would be to maintain i) 2-3

dairy cattle, 100 chick and 20-30 ducks in semi urban areas; ii) 2-3 dairy cattle, 3-4 pigs, 25 - 100 chickens and 20 ducks in rural areas of valley; and iii) 1-2 cattle, 100 chickens, 15 ducks and 3-4 pigs in hill areas for a household having at least 0.5 hectare of land.

- Livestock like goat may be encouraged in the hills integrated with other crops in small holdings.

Recommended Animal Breeds

- Cattle: Cross-breds of Holstein-Friesian/Jersey, etc. (Source of germplasm to be arranged from NDRI, Karnal/West Bengal/ AAU, Assam, Khanapara in the form of frozen semen mainly in addition to procurement of bulls (selected units) for cross breeding & up-gradation).
- Pigs: Cross-breds of Hampshire/Yorkshire/ Berkshire/Large Australian, etc. through vertical expansion directly by procuring parent stock from NRC, Pig, Assam / AAU, Assam.
- Poultry: Strains/Commercial parents of Classic Hubbard/Cobbs/Vencobbs/Gramapriya/ Srinidhi/Giriraja/Vanaraja/FFGN/CARIShyama/ Nirbheek/Priya/Devendra, etc (Initially procurement of eggs of commercial parents and rearing at the research station for production of high yielding chicks)
- Ducks: Cross-breds of Khaki Campbell/ Pekin/Indian Runner/ Muscovy, etc. (Initially procurement of eggs of commercial parents and rearing at the research station for production of high yielding chicks)
- Goats: Cross-breds of Black Bengal, Assam local, etc. (Direct procurement of animals from AAU, Khanapara, Assam & multiplication at the research station for supply to the target indexing groups of the state).
- For different farming systems with fishery components the major recommendations were rearing of local high value fishes like Ngaton/ pengba which are labour intensive in less than 0.5 ha holdings.
- For hill terraces: Paddy cum Pisciculture with Indian major carps is recommended.
- Taking up fish breeding and making readily Availability of quality fish would be one option for earning higher returns. It would also be one strategy for higher fish production.
- To prevent increasing fish production by only increasing or converting paddy field to fish ponds, we need to target to hill areas aqua culture to increase farmers' income.
- Cage culture in Loktak Lake could also raise the fish farmers' income.
- Producing good quality fish feed by increasing production of mustard seed, oilcake, etc. as in animal needs to take up as a strategy.
- Local fish species like pengpa, khabak fetching higher market value need to be reared.
- Local fishes like, ngamu, ngakra,ukabi may be bred separately and raised in organic paddy lowland fields as these fetches very high income.
- Insurance coverage of fishes particularly in case of food may be required to retain fish

famers from restraint.

- Use of running water in hills for local fish production as these fishes are more paying.
- Utilization of existing water bodies and lowland area (marshy low land) to get additional income for o culture water.
- Integrated farming with fish component particularly with poultry, duckery in small holdings.
- Enhancement of water harvest for crops with supplement fish component.
- High paying prawn culture may also be promoted with proper liming and feeding.
- Promotion of feed units for fish would also add rural income generation.
- Cold chain and fish processing (drying, etc.,) and marketing may be given major thrust.
- Creation of water resources and improve irrigation efficiency.
- Popularizing food processing and value addition.
- Promotion of packaging facilities and market linkage.
- Creating and promoting assured market linkage (including e-market place) with a regional branding.
- Development of suitable agri-entrepreneurships.
- Provision for transport subsidy.
- Fixing of minimum support price at production cost plus 50 per cent.
- Commercial nursery under protected conditions – fruits, vegetables, ornamentals, medicinal and aromatics, plantation crop and forest trees.
- Commercial plantation of fruits in the hills, integrated with processing/cold chain and packaging – pineapple, Khasi mandarin, kachai lemon, acid lime, banana, kiwifruit, high value vegetables including exotic vegetables.
- Protected cultivation of high value crops integrated with processing/cold chain and packaging – High value vegetables, Flowers.
- Organic production and collection, packaging, processing, certification – turmeric, ginger, chilli, king chilli, large cardamom.
- Organic certification may be clubbed with seed certification agency as in Tamil Nadu and Karnataka.
- Food processing integrated with packaging – Local fruit crops
- Mushroom integrated with spawn production, processing and packaging – Oyster and Shiitake
- Bee keeping integrated with honey processing and agro-forestry/suitable crops.
- Land productivity precision agriculture, microirrigation, improved farm advisory, improved varieties.
- Cropping intensity can be raised only with increasing the area under irrigation (cultivation

of *Rabi* crops).

- Resource use efficiency, Soil and water conservation, innovative and gender sensitive farm mechanization, soil test based nutrient management, agri-entrepreneurship, food processing, beekeeping, mushroom, nursery, market driven agriculture, Certified organic farming, Floriculture, Specialty agriculture, high value horticulture, accredited nursery are required to give more attention.
- Opportunity beyond farm: Food processing, integrated cold chain management. Marketing efficiency. Packaging, promotion and linkage, credit flow, farmers-bank linkage, crop insurance, decision making power growers association, producers company, farming skill development trainings.

Summary and Recommendations

Doubling of farmer income is a multitask activity where all concerned departments and stakeholders need to work out a framework for the task and role to be performed by all concern. It encompasses a holistic approach where resources are judiciously utilized to get the best return from the farm. For this high yielding good quality seed, soil nutrients and fertilizers, assured irrigation facilities, ready market, credit and financial support and adoption of scientific package of practices is very important. Moreover, training and skill development for adoption of modern farming practices is required. A well-established forward and backward linkage is important to achieve doubling of farmer income. Support to farmers through organization of Farmer's Club, Producer organization, Joint Liability group, SHGs, Grower groups, Contract Farming , etc will help to motivate the farmers to take up new farming practices will help to double the farm income.

The important points and recommendation with respect to doubling of Farmer's Income are summarized as follows.

Adoption of suitable farming system models suitable for different locations and farmers land holdings size.

For Valley Area

Small farmers, landless to 0.25 ha: poultry+fish+polyhouse/mushroom

Medium holding: 0.30-.5 ha: Fish+mushroom+poultry+Organicvegeables+mushroom

0.6 ha and above: Double field crops+Poultry+Fish+beekeeping+eri-silk+cattle/pig.

Wetlands:

Paddy cum pisciculture+wetlandvegetables+Zizania+Mimosa+duckery.

For Hills Area

Terrace/ foothills- Mid hills

a. 0.25ha: High value crops like king chilli+apiary+backyard poultry+goats/pigs, etc.

b. 0.25-.5 ha Mid hill slopes: Rice/maize/vegetables+fish/pig+goat+poultry+eri silk, etc.

c. 0.6- 2 ha: Rice/maize+soybean+peas/potatoes/vegetables/rapeseed/apiary, etc.

d. Above 2 ha: Rice/maize+soybean+peas/potatoes/rapeseed/apiary, etc.

Hill tops:

Plantations+trees+fruits+org.ginger/turmeric+mushroom, etc.

High altitudes (Mao, Ukhrul):

Tree beans+peach/pear+ kiwi vines+ginseng+potato seeds+ rice+peas+colecrops+piggs+pou ltry, etc.

Mid altitudes (Senapati, Chandel, Kangpokpi, Tamenglong, Churachanpur):

Tree beans+ rice+ peanuts+ soyabeans+ rice beans+ org. cucurbits +ginger/ turmeric+yams+colocasia, etc.

Jhumlands:

Rice+maize+beans+pigs+goats+chicks+fruits/trees+rapeseed+peas+potatoes+colocasia+tapio ca+ yams, etc.

i. Important rice varieties that are locally developed and can be adopted by farmers in Manipur are RC Maniphou 7, RCManiphou 10, RC Maniphou 11, RC Maniphou 12 and CAU R1 and newly released varieties like RC Maniphou 13, CAU R2, CAUR3 and CAU R 4.

ii. Revitalization of state cattle breeding policy for crossbreeding/grading up of local cows.

iii. To solve fodder issues, identification and mapping of available land, feasibilities of fodder crops cultivation, both in valley and hill areas mainly, fallow foot hills are necessary for development of intensive fodder production activities. Dairy cooperative societies, farmers clubs, district councils, village level small milk production units may be entrusted to manage with available spaces for growing fodder by providing skill oriented managerial trainings and provision of inputs like fodder seeds, organic/chemical fertilizers and insecticides, pesticides, etc.

iv. Strengthening of district level disease diagnostic lab. Local veterinary dispensaries and hospitals should be well equipped for timely management during adverse situations as well as facilities for mobile clinic round the clock to minimize any kind of health related emergencies.

v. In poultry the state has a high shortage of poultry products, particularly eggs. High cost of production due to high cost of concentrate feeds, lack of scientific manpower, losses due to diseases are the constraints for ensuring a remunerative income to the poultry farmers. To minimize the cost of production low cost concentrate feed should be made available to the poultry farmers.

vi. To ensure higher income, rearing of low input-high output birds, like dual purpose breeds viz., Giriraja/ Vanaraja/Gramapriya/Kruoiler/ FFGN/Gramapariya/ Srinidhi/ CARI Shyama/Priya/ Nirbheek/Devendra/ Kamarupa, etc., may be encouraged.

vii. Being the most important livestock for hills and valley areas, pig production may be prioritized for doubling the farmers income. For enhancing Piggery development in the state, more breeding farms for multiplication of piglets/pork production should be established under sustainable conditions with the expert guidance of breeding professional.

viii. For doubling the household income, the ideal combinations of livestock would be to maintain

i. 2-3 dairy cattle, 100 chick and 20-30 ducks in semi urban areas;

ii. 2-3 dairy cattle, 3-4 pigs, 25 - 100chickens and 20 ducks in rural areas of valley; and

iii. 1-2 cattle, 100 chickens, 15 ducks and 3-4 pigs in hill areas for a household having at least 0.5 hectare of land.

Recommended animal breeds

Cattle:

Cross-breds of Holstein-Friesian/Jersey, etc. (Source of germplasm to be arranged from NDRI, Karnal/West Bengal/ AAU, Assam, Khanapara in theform of frozen semen mainly in addition to procurement of bulls (selected units) for cross breeding and upgradation).

Pigs:

Cross-breds of Hampshire/Yorkshire/ Berkshire/Large Australian, etc. through vertical expansion directly by procuring parent stock from NRC, Pig, Assam / AAU, Assam.

Ducks:

Cross-breds of Khaki Campbell/ Pekin/ Indian Runner/ Muscovy, etc. (Initially procurement of eggs of commercial parents and rearing at the Research station for production of high yielding chicks)

Goats:

Cross-breds of Black Bengal, Assam local, etc. (Direct procurement of animals from AAU, Khanapara, Assam & multiplication at the research station for supply to the target indexing groups of the state)

Taking up fish breeding and making readily availability of Quality Fish would be one option for earning higher returns. It would also be one strategy for higher fish production.

Producing good quality fish feed by increasing production of mustard seed, oilcake, etc. as in animal needs to take up as a strategy.

Fixing of Minimum Support Price at production cost plus 50 per cent.

Emphasis should be given for development of commercial nursery under protected conditions –fruits, vegetables, ornamentals, medicinal and aromatics, plantation crop and forest trees.

Commercial plantation of fruits in the hills like pineapple, khasi mandarin, kachai lemon, acid lime, banana, kiwi fruit, high value vegetables including exotic vegetables, integrated with processing/cold chain and packaging.

Doubling of farmer's income will be possible only when all concerned departments and stakeholders work together on a consortium mode taking into consideration the real challenges and hardships aced by the farmers of the state both in the hill and valley areas. Reformation and streamlining of the functioning of the different departments working for uplifting the socioeconomic condition of the farmers is required. Along with the infrastructure development like roads, irrigation, storage, value addition, market, empowering the extension functionaries and imparting entrepreneurship skill to the farmers will help a lot in achieving the objective of doubling of farmer income of the state.

SUCCESS STORIES

1. Success story on Integrated Farming System for higher productivity and better profitability

An integrated farming system model was developed in the field of Mr. A. S. Somi in Nungshangkhong village, Ukhrul district of Manipur during 2011–12 to 2014–15 on an area of 6 hectares with adjacent 2 hectares area under natural forest. His IFS models integrated with secondary agriculture like mushroom cultivation, bee keeping and vermicomposting. He has constructed four ponds covering 0.75 hectares which are used for fingerling production. Besides he has constructed one jalkund for providing lifesaving irrigation to hs crops during lean period. After intervention, he could store approximately 75000 litres of water in the *Jalkund*. In addition to 2 ha area under under field crops (paddy var. RC Maniphou-10 and groundnut var. ICGS-76) he has developed 3.5 ha area under horticulture growing vegetables. The fruit crops include kiwifruit (Allison and Hayward), khasi mandarin and kachai lemon. After paddy Mr. Somi grows rapeseed mustard (M-27) under zero tillage. He integrated bee-keeping (5 boxes) with the rapeseed mustard and agro-forestry component. In livestock component he has 5 goats (Assam Local) and 520 poultry birds (Vanaraja). He successfully harvested 4.20 t/ha paddy after intervention as compared to 2.85 t/ha before intervention. He has grown groundnut (ICGS-76) for the first time in his village which gave 2.30 t/ha dry pod yield. Vegetable yield also considerably increased after intervention which gave 1.15 lakh gross returns. In poultry, Vanaraja is performing well and he is getting 145 eggs/annum/bird. He also started selling goat kid @ Rs. 7000/-. Fishery is the most profitable component in his IFS where he is earning more than 3.00 lakhs annually. From mushroom and apiculture, he earns around Rs. 50000.00 per annum. From 6 ha land on an average he earned the total net returns Rs 3,95,000.00/year under IFS as compared to Rs 65000.00/year in 2011-12 under traditional farming system. Now, he has become a role model for not only in his village but also for the entire tribal community in the district.

2. Success story of achieving sustainability through Integrated Farming System

Mr. R. D. Peter, S/o R. Dakho from PurulAkutpa Village in Senapati district has come from very poor family. Based on sloping agricultural land technology, the integrated farm has an area of 13 ha, in which different agro-forestry species have been grown at the hill top (10 ha), followed by horticultural crops, agricultural crops, animal and fishery component (3 ha) in descending order of elevation. His integrated farm now has 8 ponds (with polyethylene lining) covering 1 ha area. He is using the ponds mainly for production of fish fingerlings. Every year he is producing 2.5 to 3.0 lakh fish fries and fingerlings and selling to his fellow farmers. Besides, Mr. Peter successfully adopted paddy cum fish culture and producing 150-170 kgs of fish/ha

almost without any extra investment. He has also established one poultry and one piggery unit. Horticulture is one of the major component in his farm. Every year he sells more than 1500 pods of tree bean and earned Rs. 16200/- annually; whereas *Prunus nepalensis* fruits are utilized for making various value added products. Recently Mr. Peter has obtained FSSAI Food Licence for his small fruit processing unit. He is producing 500-600 litres beverages from various indigenous fruits with net profit of Rs. 25,800/-. In addition, he has also integrated the horticultural component with bee keeping and annually he harvests around 20 litres of honey from 2 bee boxes and earns a net profit of Rs. 22000/-. The conserved water in *Jalkund* is used for providing life saving irrigation to the crops during lean period. He is also using drip irrigation for judicious use of water. He also practices mulching for minimizing the soil erosion. Presently he is earning Rs. 5.21 lakhs annually with a B:C ratio of 7.78.

18

MEGHALAYA

Meghalaya emerged as a full-fledged state within the union of India on 21st Jan 1972. The State lies within 25º1´ and 26º5´ North latitudes and 85º49´ and 92º52´ East Longitudes. Meghalaya is subject to vagaries of the monsoon. The climate varies with altitude. The climate of *Khasi* and *Jaintia* Hills is uniquely pleasant and bracing. It is neither too warm in summer nor too cold in winter, but over the plains of Garo Hills, the climate is warm and humid, except in winter.

The Meghalayan sky seldom remains free of clouds. The average annual rainfall is about 2600 mm over western Meghalaya, between 2500 to 3000 mm over northern Meghalaya and about 4000 mm over south-eastern Meghalaya. The temperature range is approximately 2 degree centigrade to 36 degree centigrade depending upon the altitude ranging between 300 mts above mean sea level (MSL) to 2000 mts above MSL.

The economy of Meghalaya is basically agrarian as 81% of the state's population depends on Agriculture. Though, 81% of the population depends on agriculture, the net cropped area is only about 9.87 % of the total geographical area of the State. The state is deficit in food grains by 1.22 lakh tonnes annually to feed a population of 2.9 million. The major food crops are Rice and Maize, however, the State is also renowned for its Horticultural crops like Orange, Lemon, Pineapple, Guava, Litchi, Banana, Jack Fruits and Temperate fruits such as Plum, Pear, Peach etc. Potato, Ginger, Turmeric, Black Pepper, Areca nut, Tezpatta, Betelvine, Short-staple cotton, Jute, Mesta, Mustard and Rapeseed etc. are some of the important cash crops in the State.

Today the State has 42 percent area under paddy with HYV having the average productivity of 2.3 t/ha. So also is the case with Maize and Wheat where the productivity have increased tremendously with the introduction of HYV from 534 kg/ha during 1971-72 to 1218 kg/ha of Maize and from 611 kg/ha to 1508 kg/ha of Wheat during 2015-16. The potential for Agro-based industries in the state of Meghalaya is very high. The state produces substantial quantities of oranges, peaches, pineapples, pears, guavas, plums and bananas of superb variety.

It also grows plenty of potatoes, tapioca, bay leaves, ginger, maize and jackfruit. Meghalaya's turmeric, particularly the variety that is grown in Shangpung in the Jaintia Hills, is considered the best in the world and its curcumin content is as high as 7.5%. One of the areas in which there is tremendous potential for investment and development is food processing. There is ample scope for setting up a large scale fruit processing unit.

The major food crops of rice and maize, Meghalaya is known for its oranges (Khasi Mandarin), pineapple, banana, jackfruits, temperate fruits like plums, peaches and pears etc. The popular cash crops, which are traditionally cultivated, include turmeric, ginger, black pepper, areca nut. Strawberry, flowers, etc. are grown commerciality. Temperate zones of Meghalaya face climatic barriers against agricultural growth. High soil erosion also reduces fertility. Meghalaya has a very high percentage of cultivable wasteland compared to the total net sown area, indicating the scope for expansion of crop cultivation in the state.

Table 1. Agro-climatic Zone wise Technologies Identified for Doubling Farmers Income

S No.	Agro-climatic Zone	Technology
1	Sub tropical plain zone, Mild tropical plain zone and mild tropical hill zone	Agri-horti-fish-pig IIFS
2	Sub tropical plain zone and Mild tropical plain zone	Paddy (RCM 10/ Gomati)– pea (Arkel/ Praksh) cropping system
3	Subtropical hill zone and Mild tropical hill zone	Maize (RCM 76/DA-61A)+ French bean (Anupam) (1:2) cropping system
4	All zones	Low cost protected cultivation of vegetables and flowers
5	Subtropical hill zone and Mild tropical hill zone	Ginger + soybean (JS-335) intercropping system
6	Sub-tropical hill and Mild tropical hill	Double row planting of Pineapple using mulching with black polythene
7	All zones except Sub-Alpine & sub temperate	Oyster Mushroom production
8	All zones	Low cost water harvesting structure (Jalkund)
9	Sub-tropical plain zone and Mild tropical plain zone	Raised and Sunken Beds
10	Subtropical hill zone, Sub tropical plain zone and Mild tropical plain zone	Rice- fish farming system
11	All zones except Sub-Alpine & sub temperate	Backyard poultry farming with Vanaraja / kroiler birds
12	All zones except Sub-Alpine & sub temperate	Low cost improved pig production with Deep litter housing system
13	All zones	Vermicomposting for income generation
14	All zones except Sub-Alpine & subtemperate	Beekeeping for income generation
15	Sub-tropical hill and Mild tropical hill	Ginger candy/slices, turmeric powder,

18.1 Productivity Gaps and Major constraints

Analysis of productivity gap of major crops reveals that the gap between average productivity in farmers' field and Front Line Demonstration varies from 24-205 %. The data presented in the following figure reveals that the maximum yield gap of 205 % is recorded in spices followed by pulses (142 %) and lowest is recorded in fruits (24 %). It has been observed that the percent share of agriculture in GDP has been decreasing over the years in Meghalaya. The share in GDP has been decreased from 20.15% in 2007- 08 to 15.54 % during 2014-15. This is very alarming situation for a state like Meghalaya where in more than 80 % of its population depends on Agriculture.

Major Constraints/ gaps are grouped in four sub-heads to understand the situation in a more elaborate way. The following are some of the constraints/ gaps identified by various stakeholders meeting.

I. TECHNOLOGICAL GAPS

- Unscientific & Traditional method of crop cultivation
- Minimal use of improved cultivars/HYV/hybrids
- Poor soil management practices
- Traditional rearing of livestock & animal breeds
- Poor utilization of available resources

II. KNOWLEDGE GAPS

- Poor knowledge of pest and disease management
- Poor post harvest management of farm produce
- Inadequate knowledge about processing and value addition of farm produce
- Inadequate Knowledge of proper housing and management of livestock breeds.
- Lack of Knowledge on improved bee keeping techniques

III. SKILL GAPS

- Poor skill of scientific Mushroom production
- Poor skill of scientific Beekeeping
- Poor skill of Knitting & Tailoring/ handicraft
- Poor skill on Value addition

IV. INPUT/RESOURCE GAPS

- Inadequate availability of quality seeds/ planting materials/ breeds of livestock
- Rainfed agriculture & Water scarcity during winter months
- Marketing through middleman, High Cost of inputs, Non - availability of critical inputs at village, Non- Profitable price from the produce, Absence of Group/organised

Marketing

8.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income.

Strategy I: Area expansion and productivity enhancement of crops, Livestock & fisheries.

Action points:

- Popularization of new varieties/ breeds of fish and livestock for commercial cultivation with INM and IPM approach.
- Bringing more area under double/ triple cropping in paddy/ maize fallow in cluster approach linked with PMGBY and PMKSY
- Integrated Farming System in cluster approach
- Organic crop production & certification of selected crops like ginger, turmeric, Pineapple, Orange, beans, cole crops etc including input production in cluster mode
- Promotion of protected cultivation of high value crops and medicinal and aromatic plants in cluster mode linked with e NAM.
- Establishment of nurseries/ pig breeding units/ fish & poultry hatchery involving youth
- Construction of check dams, irrigation channels, micro water harvesting structures (Jalkund), sprinkler and drip irrigation etc
- Group farming by SHGs/ FPOs/ Co-operatives for promotion of double/triple cropping

Strategy II: Reduction of Cost of Cultivation

Action points:

- Mechanization with small farm implements through custom hiring approach
- Mission mode production of enriched FYM, Vermicompost and bio- fertilizers/ pesticides.
- Promotion of mulching (bio or degradable plastic) in crops
- Promotion of Drip/ Sprinkler irrigation in crops
- Introduction of Zero/ Minimum tillage for double/ triple cropping

Strategy III: Reducing Post Harvest loss and enhancing marketability

Action points:

- Awareness for harvesting of crops at appropriate maturity based on use.
- Establishment of pack house and cold storage facilities in production belt.
- Establishment of cluster based common processing / storage facility with branding.

- Establishing FPOs for direct marketing through contract farming.
- Establishment of primary and secondary market in district/ block level linked with e NAM in a phased manner.
- Linking growers with business house like Patanjali, Dabor etc at national/ international level.

Strategy IV: Off Farm Income and Enhancing Knowledge & Skills

Action points:

- Skill development in machinery repairing, handicraft, Knitting & embroidery, bee keeping, Retail marketing of field produces, container gardening, organic input seed production including seeds and planting materials.
- Promotion of small scale enterprises like pickle making, jam/jelly making, spice processing &packaging, mushroom production, homemade value added products (candy, slices, papad, potato & tapioca chips, biscuits), Waste utilization etc
- Capacity development programme for School drop outs/ educated youth/ SHGs for commercial farming, IIFS and value addition etc.

Strategy V: Enabling Policies for Doubling Farmers Income

Action points:

- Introduction of agriculture as one of the subjects in school education
- Designing programmes for popularization of Integrated farming system
- Community based approach for mode of production and process of production
- Assured institutional support to small and marginal farmers with minimum interest.
- Implementable policies for controlling wild animal/ free grazing in agricultural areas.
- Legislation for appropriate convergence among Departments relating to Agriculture

Potential contribution to farmers income and strategy for scaling out these technology

The above mentioned strategies and action need to be implemented in a more planed and systematic way by bringing more area under cultivation in different crops and focused programmes for livestock and fishery development.

Detail of year wise expansion of area under different crops

Crop	Technology	Additional area to be expanded (ha)				
		2017-18	2018-19	2019-20	2020-21	2021-22
Paddy- pea	Paddy (var. RCM 10/Meg-2)- pea (var. Vikash) cropping system + INM +IPM	17	22	22	22	22
Paddy-Carrot	Paddy (var. Meg-2)- Carrot(var new Koroda) cropping system + INM+IPM	5	10	10	10	10
Paddy-Blackgram	Promotion of Paddy (var. RCM-10)- Blackgram (var. TMK) cropping system + INM	20	20	20	20	20
Paddy-Broccoli/Cabbage	Promoting crop rotation Paddy (var. RCM 10) - Broccolli/Cabbage (var. Aishywarya/Mahyco 139) cropping system + INM	2	2	2	2	2
Paddy-Potato	Promoting crop rotation Paddy (var. RCM 10)- Potato (var. Kufri Jyoti) cropping system + INM	5	5	5	5	5
Groundnut -vegetables	Popularization of HYV of groundnut (Var. ICGS 76)	5	5	5	5	5
Maize + french Bean/green gram	Maize (RCM 1-3/ RCM 76) + French Bean/greengram (Var- Anupam,S-9, Meha) intercropping System	10	12	13	13	13
Maize- winter vegetables	Cropping intensification through popularization of Maize (var. RCM76) – Winter vegetables	10	10	10	10	10
Maize intercrop with soyabean – French bean+ Lime	Promoting of intercropping of Maize(local) and Soyabean (var JS 335) -French bean (var. Local pole) using stalk of maize as support + INM	5	5	5	5	5
Maize – toria/ black gram + Lime	Popularization of HYV of Maize (RCM 76/DA-61A) -Toria var. TS67 cropping system	5	5	5	5	5
Broccoli-Tomato	Introduction of hybrid variety + INM	5	5	5	5	5
Ginger/ Turmeric - French bean	Ginger (Nadia)/Turmeric (MT 1) – French bean (Sel-9) cropping system	5	5	5	5	5
Okra-Frenchbean /broccoli	Popularization of Okra var. Arka Anamika – frenchbean/broccoli	8	8	8	8	8
Ginger/ Turmeric + Soyabean	Promoting of intercropping of Ginger (Nadia)/ Turmeric (Lakadong) with Soyabean (var JS 335)+INM	5	5	5	5	5

Crop	Technology	Additional area to be expanded (ha)				
		2017-18	2018-19	2019-20	2020-21	2021-22
Vegetable Nursery	Community nursery (100 m^2& 200 m^2) for winter vegetables	8	8	8	8	8
Bitter brinjalcabbage+french bean cabbage	Promoting vegetable based cropping system Bitter brinjal-cabbage intercropped with french bean followed by brocolli intercropped with pea	1	1	1	1	1
Pineapple	Promoting Pineapple cultivation	1	1	1	1	1
Blackgram - Tomato	Introduction of blackgram (var. TMK) followed by tomato (var. Megha Tomato 3) in Pre- rabi and rabi season 5 x 4 x 1.5 m^3)	5	5	5	5	5
Nursery Raising & Homestead Gardening	Introduction and Popularization of vegetable crops and Nursery Raising in Pro trays	19	10	10	10	10
Tea	Package of Practices of tea	1	1	1	1	1
Fodder	Popularization of QP Maize Variety, Napier Hybrid	1	1	1	1	1
Protected	Protected cultivation for round the	15	15	15	15	15
cultivation	year vegetable production (unit size: 100 m2 & 200 m2)					
Peach	Introduction of Peach-Pratap, Flordasun	0	0.2	0.4	0.4	0.4
Low cost micro-water harvesting structure	Construction of water harvesting structures like pond, jalkunds(5 x 4 x 1.5 m^3 or 5x4x2cum) for provision of irrigation in winter crops	25	25	25	25	25

Summary Recommendation:

- Mission mode programme on integrated farming system and organic agriculture.
- Adoption of cluster based double/ triple cropping in paddy/ maize fallow linked with PMKSY, PMFBY and Farm Mechanization.
- Assured procurement with minimum support price to reduce the gap between farm gate price and consumer price.
- Focused programme on livestock and horticulture development with appropriate post harvest management &value addition and marketing infrastructure with a target for export to ASEANs and other countries utilizing e-NAM platform.

- Strengthening of R&D programme for organic production system.
- Skill development programme for entrepreneurship development.

SUCCESS STORIES

1.Intercropping of Ginger with Soyabean increases Farmers Income in North-Eastern Hill Region Introduction:

More than 70% of the total population is living in rural areas in North-Eastern Hill Region and most of them have been cultivating crops in jhum field resulting in heavy soil erosion. Ginger is one of the main cash crops where almost every farmer cultivates in their field. Ginger cultivation in jhum land leads to very heavy losses of top fertile soils not only in the current year but also in the next harvesting year.

Details of Technology:

Intercropping ginger with soybean under Rainfed terraces upto slope 50%.The recommended dose of NPK along with neem cake was applied. The Technology makes the cultivation more profitable by intercropping soybean with ginger in same plot of land. More over the cultivation is carried out in the terrace land where there is very less erosion of top fertile soils. Mulching is done on the terrace with saw dust/ cut grass; this reduces the weed growth before the soybean grows. When the soybean grows up it acts as a shade as well as the mulch materials for ginger. Soybean being a Nitrogen fixing crop provides Nitrogen, thereby making mutual benefit to each other.

Output & Outcome:

Great enthusiasm was aroused amongst the Farmers of different villages after witnessing the results of demonstration. The income of the farmers increased 3 fold after adopting the technology due to decrease in disease and pest intensity, decrease in depletion of soil and nutrient, reduction in weed infestation and increase water holding capacity of soil. This has finally resulted into the higher benefit cost ratio owing to fewer requirements of total man days.

Technology	Yield q/ ha	Net Return(Rs./ha)	B:C ratio
Intercropping of ginger with soybean under rainfed terrace cultivation	Ginger – 208 Soybean –15	Ginger 2,45,000/+ Soybean 90,000 **Total = 3,35,000.00**	2.64

Impact:

More farmers are adopting the technology and the famers who adopted the technology increased their cultivation area. Farmer having terrace land shifted their cropping pattern and changed their crops to ginger cultivation intercropped with soybean.

2. Rice-Fish culture: A new dimension of Farming in Meghalaya

In recent years, many farmers shows keen interest in fish culture and hence, construction of ponds came up in many feasible areas but sadly, there are also many farmers who convert their productive paddy fields into fish ponds since most of them have no choice as they are small land holders. Even though many farmers take up fish culture, yet there is no encouraging

results in terms of productivity and profitability due to poor management, lack of technical knowhow and also because they cannot afford to buy fish feed (rice/ wheat bran and mustard oil cake). Integrated Farming Systems hold special position as in this system nothing is wasted, which can also help poor small farmers who have very small land holding to diversify farm production, reduce input cost and exploitation of unutilized resources.

Details of technology

Paddy field was modified by digging canals or trenches of 0.5 - 0.6 m deep and 1 m wide connecting (intersect) to the small central sump in the middle of the field. The dykes had been elevated and installed with inlet and outlet protected with fine screening. Fencing with netting material was also done at the lower part of the field to prevent fish from escaping during heavy rains. Local rice variety (ba lwai) was transplanted when the field is ready. After two weeks of transplantation, fingerlings of Common carp (main species), silver carp, gonius, etc were stocked @ 6000 nos. per hectare of paddy area. Minimal feed were given with rice bran and mustard oil cake in the ratio of 1:1. Liming and manuring were also done regularly.

Output & Outcome:

Before intervention, the yield of paddy was about 15q/ha but after intervention, the yield of paddy enhanced to 20q/ha and what is more interesting, she also got fish from the same plot. The yield of fish from the paddy field was 500 kg/ha. According to her, this technology is very simple and low cost with high economic return. The increase in rice production is also a result of stocking fish (common carp as the main species) as a component of integrated pest management. Due to the integration of fish in the field, use of pesticides is completely stopped. But there are also difficulties because many paddy fields are not feasible for fish integration due to the hilly terrain that restricts the size of the field. 1 ha of paddy field having different form and size of trenches (Average: 0.5 m deep and 1 m wide) with common carp as the main species gave a net profit of Rs 70,315.

Impact:

The technology is gaining acceptance not only in Nonglwai village but also in other villages because of the simplicity of the technology and improved production. Now rice-fish culture in the district is a regular cropping practice in many of the villages in the district.

19

MIZORAM

Mizoram is the one of the vast geologically, climatologically and biologically diverse sister-land among the seven sister north east Indian states with a vast diversity in wild and domesticated flora and fauna as it falls under the Indo-Burma biodiversity hotspot. The landscape of Mizoram is dominated by the relentless belt of north-south trending rolling hills (>95% of total geographical area) with some fragmented valleys. Indian states, the highest share of total population (51.02%) in Mizoram lives in urban area (Devi, 2012). Mizoram is inhabited by the vast ethnic and religious alike tribal population of diverse origin and a repository of huge wealthy traditional knowledge.

Agriculture has been traditionally a subsistence profession in Mizoram. The dependency on the seasonal rainfall for agriculture is very high. In Mizoram, majority of the cultivable area is under rainfed shifting agriculture.

The dependency of agricultural production on monsoonal rainfall is also very high with increasing proneness of Mizoram agriculture towards the relative consequences of annual and seasonal rainfall variability. Rainwater harvesting during peak monsoon months, will gain its increasing importance to maintain the resiliency of rabi agriculture at Mizoram in the coming days. Moreover, the increasing dryness in the winter season amplifies the risk of uncontrolled forest fire and more assets damage during jhum burning in near future. Slash and burn technology with proper fire lining will be the major interventions to be adopted under sustainable agricultural development scheme for this region.

Productivity Gaps and Major Constraints

Mizo farmers are not very reluctant to leave their age old traditional shifting cultivation practices and to accept the modern technological interventions towards the improvement of net agricultural crop productivity. The major constraints for lower crop productivity in Mizo agricultural production sector are as follows:

Lower productivity for the lands under shifting cultivation: Traditional preference of tribal farmers for practicing shifting cultivation at subsistence level with mixed farming systems. The practices are often resulting extensive C emission during burning, natural habitat destruction, accelerating soil erosion from post burn fallows and mixed cropping with erosion prone crops (maize, ginger, tomato etc.) in jhum lands. As shifting cultivation is an indispensible part of

Mizo culture, it is difficult to eradicate jhum practices completely, even though implementation of different subsidized schemes for promotion of commercial crop production on Government side.

Extensive burning of live vegetation during March-April checks the initial weed growth during the early crop stages in jhum fields. Thus the main crop gets additional time, experiencing less competition for available resources (light, water and nutrient) from the suppressed weed regeneration process during critical crop-weed competition period. This comparative advantage often secures the minimum crop yield, as it rarely satisfy the jhum farmers. However, majority of the farmers are still unwilling to invest for any external pesticides application for cultivating the potential low yielder landraces of different crop species in their jhum fields. This steely behaviour often resulted in profuse weed infestation, high incidence percentage of pest and diseases at later crop growth stages due to high relative humidity percentage and yield loss during kharif season (biotic stress factor).

Lacking of community based rainwater water harvesting and supportive irrigation facility for agriculture: Roof water harvesting is one of the most common facilities to ensure the daily water supply for the mizo household usage during kharif season. For the agriculture sector, ample amount of rainwater is commonly available during the wet months (April – October). There is very limited infrastructure for large scale water harvesting for agriculture in Mizoram. Selected dams engineered the conjunctive use of water for hydropower generation sector (Table 3). However, the collective area of influence is still limited with restricted scope of the stored water usage for fishery and agriculture sector, other than solving problem for house hold scarcity during winter.

Therefore, water scarcity is often intensified in agriculture sector during the post monsoon and winter months (November –February). There is no scope for ground water exploitation in the hill tracts of Mizoram. Additionally, limited availability of the agricultural water storage as well as supportive irrigation infrastructure facility (pumping/ distribution pipes/canals, sprinkler, drip irrigation network etc) is one of the major hurdle to increase the net cropping intensity of Mizoram; leaving the extended rabi fallow after rice as the major problem that dominates over the extensive hill tracts and existed limited plain areas Mizoram (Kolasib, Chemphai, Sercchip district) of Mizoram. Hence, standing crop and established orchards are experiencing acute water deficit stress during the postmonsoon and winter months that often limits their average productivity also.

Limited farm input availability: Inadequate, less efficient agricultural input delivery systems (preferably quality seed materials, newly released formulation of plant protection chemicals) and supply chain deformities. Quality Seed material is difficultly available to farmers of Mizoram. The Mizoram mostly relies on the traditional low yielder land races only.

Limited resource inventory: No systemic cadastral surveys on soil/ecological resources were performed with limited land records exist from the faulty land tenure system. Even, ICAR – NBSSLUP has made the resource inventory for Mizoram at early 1990s. The dataset should be updated immediately covering all the newly formed district boundaries of Mizoram. Remote sensing images are often used to acknowledge the issue but with very limited ground validation process, preferably due to difficult inaccessible terrain condition in Mizoram.

Other constraints

- Poor soil health due to extensive soil acidity problem that reduces nutrient availability at critical crop growth stages that ultimately limits the crop growth and soil biological pool, adversely.
- Lack of post harvest storage and value addition facilities
- Poor communication and road infrastructure facility
- Poor access to farm mechanization and livestock services
- Unawareness of off-season and high-tech modern crop production technologies
- Inexperienced human resources and poor research infrastructures.

19.1 Productivity gaps and constraints in animal husbandry and fishery sector:

Aquaculture and fisheries has been playing vital role in ensuring livelihood and nutritional security to the tribal people of Mizoram by way of providing cheap animal protein, employment and income. Fish constitute one of the most important diets among the people of Mizoram who are considered more than 90% fish eating population. Presently, the state produced 6980 MT of fishes with a productivity of 1.28 MT per ha and the per capita availability remains relatively low at 5.88 kg leaving a shortfall of 6220 MT to meet the recommended per capita requirement of 11 kg indicating the need to improve fish production in the state. A total of 13546 families and 5355 families are directly engaged in fish culture and capture fisheries respectively in the state indicating the importance of fisheries for livelihood security through employment and income generation. However, fish culture and capture fisheries has been facing several challenges such as:

Low productivity:

Aquatic resources in the state generally show low pH which is not conducive for fish growth. Fish require neutral or slightly alkaline medium for better growth. Further water holding capacity of the soil in many places is poor due to sandy soil. In addition, low temperature regimes of the state poses difficulty in breeding and rearing of fishes in addition the slow growth rate. Siltation due to jhum cultivation, deforestation, unscientific land use is also contributing towards the low productivity from natural resources.

Poor adoption of technology:

One of the most important constraints that lead to poor unit area productivity in the state is due to poor adoption of modern fish farming technology as a result of inadequate extension support. The state fisheries departments are facing the problem of shortage of technical staff for extension work. Poor adoption can also be attributed to illiteracy of farmers. Further as the rural farm families cannot afford the input cost adoption of technology becomes a problem with the existing difficulty in availing credit facilities. In addition, lack of entrepreneurship has been one of most reason in the state for not taking up fish culture on large scale. The farmers are also facing vulnerability to risk involved such as- floods, droughts, theft, etc.

Non availability of inputs:

- In adequate availability of critical quality farm inputs such as quality seeds and cost effective feeds is a major concern in the state that hinder the development of aquaculture.
- Lack of scientific knowledge on fish culture Although the modern fish farming technologies are available maximum of the farmers from the state still follow traditional fish culture practice with no management strategies adopted during the culture. Farmers do not have knowledge on scientific management procedure and do not follow scientific pond preparation steps, right species combination, stocking density etc which has led to the low productivity and overall production of fish from the state.

Lack of reliable database on resource availability:

The state Mizoram is blessed with rich fish diversity and other natural resources. There have been several reports on discovery of new species from the region in the recent past, indicating inadequate information on reliable database on the diversity of fishes in the rivers of the state which poses hindrance in planning strategies for conservation and propagation of important fishes of the state.

19.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

Crop production sector:

Strategy	Action Plan
Enhancing crop production	Reshuffle the activity nods of current seed supply chain at ground level, for timely and efficient supply of hybrid seeds/ high yielding variety seeds/ planting materials to the farmers under different state sponsored projects. Construct the suitable infrastructure (Community water reserve tanks, village level check dams to ensure the agricultural water supply, efficient pumps/ delivery pipes, drip system, sprinklers etc) to increase the water application efficiency with ensure sufficient irrigation water supply to the farmers preferably during rabi season. Adaptation of integrated nutrient supplementation strategy to maintain soil health and nutrient efficient crop production system in jhum lands. Regular soil health check up with soil health cards will be also useful Skill development of rural youths for hi-tech modern crop production system.

Strategy	Action Plan
Cost reduction	Promote crop/site specific farm mechanization and livestock services Promote community farming for maximize utilization of fixed cost sharing involved in present crop production sector by farmers. Construction and facilitating the accessibility of post harvest infrastructure for the farmers across Mizoram state. To fetch good market price for off-season supply of farm produce. Reduction in transportation cost by improving infrastructure of road network and facilitating communication facilities
Quality improvement	Adaption of organic agriculture practice and strengthening the process for organic certification. Selective on farm conservation of potentially nutritious landraces (maize, chilli, French bean etc), those are already reported for their superior food quality and preferred by the local tribal communities. Precision nutritional management to ensure timely supply of different nutritional elements based on real time detection.
Generating additional income	Promotion/inclusion of cash crop cultivation (spices, medicinal aromatic plants etc.) in the jhum crop archives under Jhum improvement programme. Progressive initiatives like rainwater harvesting and its efficient utilization through micro irrigation, aiming to increase the crop intensity during Rabi season. Demonstration on the scientific mushroom cultivation (Oyster mushroom, butter mushroom etc.), bee keeping, sericulture, lac culture are some alternative ways to secure extra income to the farmers , other than the traditional source of farm income (crop cultivation, rearing livestock and fishery/ aquaculture etc)

Animal Husbandry and Veterinary Sciences:

Strategy	Action Plan
Enhancing crop production	Providing an improved quality breed of livestock and poultry to the farmers. Construct the suitable infrastructure (water reservoir tanks, water supply, efficient pumps etc.) to fulfil the water demand. Regular health check up and efficient use of medicine/antibiotic under the supervision of a veterinarian.
Cost reduction	Good linkage of farm to the main road. Location of farm near market area.
Quality improvement	Selective breeding on native breeds. Upgrading of non-descript animals with superior breeds. Cross breeding of improved breeds to produce superior offspring by taking advantage on heterosis. Avoidance of inbreeding. Health management by routine deforming and vaccination. Nutritional management by providing balanced ration for each age group.

Strategy	Action Plan
Generating additional income	Promotion of integrated farming in order to utilize the waste products of animals for fishes, agricultural and horticultural crops. Utilization of animal hairs, skin, hides etc. for making products such as brush, bags, etc. Utilization of animal bones for making bone meal

19.3 Summary recommendations

Based on the existing infrastructure and State developmental scenario, the following recommendations were made for doubling farm income for the Mizo farmers:

i. Popularization of medium duration glutinous HYVs of rice, viz. Gomati and CAU R-1 would increase the scope of introduction of Rabi crops in the state besides increasing productivity and income.

ii. Popularization of resource conservation technologies like zero tillage rapeseed-mustard, pea and lentil on rice fallows would improve the income and employment opportunities of the Mizo farmers.

iii. Cultivation of HYVs of maize like HQPM-1 and RCM-75/76 on hill slopes follow by soybean on maize fallows would improve the socio-economic conditions of jhumias in the state.

iv. Extensive multiplication of low cost water harvesting structures with suitable irrigation infrastructure facilities are essentially required to increase the net cultivation area as well as average cropping intensity of the state.

v. Supply of quality seed material to the farmers will be ensured by strengthening supply of quality seeds to the farmers and establishment of site specific breeder seed block for open pollinated varieties of different cultivated crops that proved their production potential in Mizoram. Ensured supply of quality planting material for different tropical fruit crops, improved livestock breeds and quality fingerlings are also essentially required by strengthening of accredited and registered nursery. Setting up of state variety release committee should be given top priority.

vi. Integrated farming system based on horticulture, fish and animal husbandry component may be replicated based on their site specific evaluation on comparative profitability. High value horticultural crops (strawberry, grape, dragon fruit, king chilli, bird's eye chilli, capsicum, French bean, etc.), floriculture (Anthurium, Lilium, Gerbera), paddy cum fish culture, honey bee, mushroom cultivation etc. should also be included in the farming system for enhancing farm income.

vii. Development of road infrastructure and other communication facilities, creation of post harvest, value addition, processing and storage unit is essentially required for long term storage and value addition of the farm produce.

viii. Entrepreneurship and skill development and promotion of farm mechanization are essential to achieve doubling of farm income in agriculture and allied sector. Suitable market chain development is also recommendable to ensure the profit earning to the farmers

ix. Collaborative programme implementation with the State Government and ICAR (including KVKs) will increase the efficiency of project implementation at the remote corners of Mizoram. ICAR may narrow down the technology gap and State Government may take lead to narrow down the knowledge gap at individual farmers' level.

x. Organic farming has good potential to flourish with good institutional support for ensuring quality produce along with on farm conservation of local landraces for different cultivated crop species (maize, birds eye chilli, ginger, turmeric, frenchbean, soybean etc. in Mizoram.

xi. Market intelligence and ICT services should be strengthened to bring better benefits to the farmers and adequate exposure to institutional credits finally benefit the farmers in expanding their farming and entrepreneurship abilities.

SUCCESS STORIES

2. Introduction of strawberry variety Sweet Charlie on hill slopes

Jhum cultivation is a predominant farming system in the state which is manifested with low productivity and low income. Strawberry is found to be a promising crop in the state due to suitable agroclimatic condition and high income. Two cultivars of strawberry, viz., Sweet Charlie and Festival were evaluated for yield performance at Kolasib and NAIP cluster village, Saiha. Although, Festival variety (5.2 kg/plant) was found to be more superior to Sweet Charlie (4.1 kg/plant) in terms of productivity, the farmers in Saiha district preferred the later because of its sweet taste.

Performance of strawberry cultivar Sweet Charli and Festival at ICAR farm, Kolasib (mean data of 2 years)

Particulars	Sweet Charlie	Festival	Particulars	Sweet Charlie	Festival
Plant height (cm)	10.8 ± 2.3	11.1 ± 1.2	Flower/plant	22.8 ± 0.8	25.5 ± 1.5
Leaves/plant	24.2 ± 6.8	20.8 ± 2.5	Fruit length(cm)	3.8 ± 0.3	3.9 ± .4
Plant spread (cm)	25.1 ± 4.4	27.5 ± 2.8	Fruit breadth(cm)	2.4 ± 0.4	2.6 ± .2
Crown/plant	5.8 ± 0.8	6.1 ± .7	Fruits/plant	15 ± 0.8	2.6 ± 1.5
Days of runner production	220-235	245-250	Fruit weight(g/fruit)	7.6 ± 1.1	12.1 ± 1.7
Runners/plant	18.6 ± 4.2	17.8 ± 3.5	Mortality (%)	5-10	3-4
Days to 50% flowering	70-75	65-70	Yield (g/plants)	129.8 ± 4.1	160.8 ±5.2

Demonstration of Sweet Charlie variety was conducted in Km Sawm village, Saiha district under NAIP project during August-September 2012-2014. Ten progressive farmers were selected based on the suitability of resources. An area of 1000 sq.m was selected for each farmer. After clearing of land, terraces of 1-1.5 meter width of convenient length were made manually. Ridges were opened with 10-15 cm height from the base of the furrows. Due to inherent acidity of the soil, liming at 4.5 t/ha was made before laying out of mulch polythene. Black polythene rolls of 1m width were laid out in terraces which covered both the ridges and furrows. Planting were done in ridges. Excess water of monsoon and water from natural streams was collected in Jalkunds for irrigation in winter. Jalkund (40,000 liter capacity) excavation in selected sites was completed before the onset of monsoon. Farmers used vermin culture and organic manure through low cost vermin composting unit, which sustained soil productivity. On an average each farmer is getting 1750 kg of strawberry and earning a net income of Rs. 1.61 lakhs per annum. After realising the success of beneficiary farmers, 105 terrace farmers in the area got motivated and have diverted to strawberry cultivation in small scale. The benefit cost ratio was estimated to be 2.59. At present the village is declared as strawberry village by the Government of Mizoram.

Increasing farmer's income through strawberry cultivation

2. Introduction of HYVs of Kharif vegetables on Jhum land

HYVs of kharif vegetables *viz*., okra (Arka Anamika), brinjal (Pusa Kranti), bittergourd, pumpkin (Arka Surjamukhi), cowpea (Pusa Komal), frenchbean (MSB-48), coriander (Ramses), chillies (IC- 590587), amaranthus, etc. were demonstrated in 40 ha area covering 280 households during *Kharif* 2013 and 2014 in the 8 NAIP cluster villages, Saiha district. HYVs of okra, cowpea, brinjal and bittergourd were highly preferred by the households because of higher productivity (30% more than local) and income. The *Jhumias* grow these crops either as sole crop or in mixture in *Jhum* areas. 3 numbers of training programmes were also organized to acquaint the farmers about the technology

Doubling farmer's income through introduction of HYVs of *kharif* vegetables on *jhum* land.

20

NAGALAND

Nagaland with a geographical area of 16579 sq kms is a hill state located in the extreme north eastern region of India with Kohima as its capital. The state shares common boundaries with Myanmar in the East, state of Assam in the West; Arunachal Pradesh and a part of Assam in the North with Manipur in the South. Its Longitude lies between $93^\circ 20^{1}$E and $95^\circ 15^{1}$E and Latitude between $25^\circ 6^{1}$N and $27^\circ 4^{1}$N. Nagaland emerged as a state, out of the Naga Hills district of Assam and NEFA province on 1st December, 1963. It is administratively divided into 11 districts and 74 development blocks. The state is a home to 16 major tribes who are known for their own distinct and fascinating cultures. About 90% of the state's population is Christian. With a population of 19.78 lakhs as per the 2011 census, Nagaland is the only state in the country that registered a negative decadal growth rate of -0.58%. The population density in the state is 119 persons per sq. km.

The economy of the state is predominantly agrarian. Agriculture (27.18%), public administration (14.89%) and business and other services (31.50%) comprise three-fourths of the State's NSDP (2010-11 at current prices). The near absence of contribution from manufacturing (1.69%), banking and insurance (2.17%) reflects the lack of industrial activity in Nagaland and the weak supporting environment. The Naga hills are a part of the complex mountain range name the Arakan Mountain Range which falls on both in India and the Burmese sides. Mount Saramati is the highest peak of Nagaland, with an altitude of 12,552 feet. There are a number of rivers which originate and flow through the state. Rivers like the Barak in the southwest, the Doyang and Diphu towards the north and the Chindwin river of Burma in the Southeast flows through the state. Around 20% of the total land area of Nagaland is covered in wooded forest.

Nearly 70% of the cultivable area in the state is located in the hills at an elevation range upto 2500 m. The traditional form of shifting cultivation i.e. Jhum, is widely practised across Nagaland. Rice is the dominant crop and also the staple food of the people. It occupies about 61% of the total area under food grains cultivation and constitutes about 71% of the total food grain production in the state. Kharif is the main season of the state. Ninety percent of cereals and commercial crops are produced during this season.

The yield gaps are associated with many factors such as quality of seeds and irrigated area under crop. Yield gaps can be addressed by expanding irrigation, use of improved seeds in sowing and better credit access.

20.1 Major constraints:

- Lack of skill/ knowledge on improved farming practices
- Fragmented land holding
- Non-availability of quality seeds and planting materials
- Inadequate irrigation facilities and storage facilities
- Reluctant in adopting improved technology

Which may be further hindered by

- Poor credit mechanism
- Poor agro-based industries
- Lack of proper post-harvest technology
- Lack of proper marketing channel
- Lack of proper storage facilities
- Improper soil and water conservation practices
- Hilly terrain and poor road infrastructures.

Besides cereals, horticultural crops, there are significant gaps in milk production and fisheries productivities also.

Potential for Development of Horticulture, Livestock, Fisheries, Agro-forestry and Post-harvest Processing etc.

Horticulture

Nagaland agro-climatic conditions are quite conducive for cultivation of fruits, vegetables, plantation crops, flowers and spices, yet for majority of farmers horticultural crop production is a backyard activity. In Nagaland the total horticultural crop area in the year 2010-11 was 33,274 ha with 2,09,538 metric tons of fruit production. The main fruit crops are Apple, Peer, Plum, Peach, Orange, Lemon, Pomelo, Pomegranate, Papaya, Banana, Guava, Jack fruit, Pineapple and Passion fruit. Farmers produce vegetables mainly for self-consumption and as an income generating activity.

The total vegetable production of the state in the year 2010-11 was 3,30,391 MTs from anl area of 43, 325 ha. Principal vegetable grown in the state are Cabbage, Potato, Beans, Sweet potato, Cauliflower, Brinjal, Chillies, Bean, Tomato, Ginger, Garlic, Radish, Onion, Naga Cucumber, and Leafy vegetables. Since production of vegetable does not meet the local demand, the state depends on outside and imports about 20-30% of state vegetable requirements. In *Jhum* area and interior villages, local mangoes, wild tomatoes, wild apples, amla, wild jack fruit, wild walnut, wild fig, wild chestnut, wild litchi etc. are produced which are consumed locally. Although, these fruits are resilient to climatic variability and having local importance are not included in the horticultural development programme resulting in gradual extinction. Apart from non-inclusion in horticultural development programmes, other reasons for their extinction are agricultural practices adopted by farmers. In *Jhum* cultivation, burning of bio resources damages some of these local aromatic /medicinal plants. The agro climatic conditions in Nagaland are also conducive for producing flowers and thus, floriculture in a long run could be a potential diversification option for the Nagaland farmers.

Considering its potential, the Horticulture Department has identified Lillium, Alstromeria, Anthurium, Carnation and Roses as potential crops for the export market. Already farmers have been producing these crops on commercial scale and started exporting. Nagaland produces high quality tea in the hills and foothill areas adjoining Assam state. About 9800 ha of land has been identified for the development of tea on a commercial scale. At present, about 750 ha. of land is under tea cultivation. Tea is produced mostly in Mokokchung district but Wokha and Mon are also potential areas for producing tea. The state also has the potential to produce medicinal plants which have essential oil bearing properties. The department has identified Citronella, Patchouli, and lemon grass, Geranium, Agar and Ginseng as medicinal and aromatic plantsfor commercial development. Elevation range and climate are two factors on which horticultural crop production system is based.

Spices cultivation of a few major spice crops and protected cultivation especially in the districts of Dimapur and Kohima are other activities to focus on for development.

Livestock

Livestock is considered as subsidiary income for the rural households. In Nagaland along with agriculture, backyard pig and poultry rearing is integral to the livelihoods of farmers. Dairying is not generally practiced by farmers except in some small pockets of Dimapur district as Nagas are not milk consuming people. In Nagaland, the trend shows that the stocking rate of all species is declining mainly because of increased management costs, lack of quality breeds, lack of feed resources, increased risks due to disease and lack of market stimulus.

Pig development under livestock sector has tremendous scope, but is still largely unorganized. The per capita consumption of pork in Nagaland is the highest in the country. It is also the largest importer of pigs in the country both for meat and breeding purposes. Scaling up and intensification of pig production is required to reduce the large deficit of slaughter pigs. There is a need to shift from the current small scale household to semi commercial production system (NABARD policy paper, 2016-17).

Fisheries

Scope:

- Integrated fish farming
- Development of nursery village to cater fish seed requirement
- Breeding and rearing of indigenous fish with ornamental value
- Inclusion of more areas under Paddy cum fish farming

- Introduction of Amur carp and GIFT Tilapia into the farming system especially in upland areas (Phek, Tuensang, Longleng & Zunheboto district) Huge scope for value addition of fish (especially smoked and dried fishes)

20.2 Strategy and action plan for enhancing production, cost reduction, quality improvement and generating additional income

- Emphasis on adoption of integrated agro-climatic zone centric farming with suitable and sustainable technologies need to be given for diversification of agricultural activities in the state.
- Need for harnessing, the potential for organic farming and ensuring its proper marketing.
- Enhancing controlled atmosphere (CA) storage facility, value addition, packaging and branding of agri-produce.
- Strengthening and restructuring of marketing system through establishment of national markets, eNAM and regional markets (Mandis) across the borders of adjoining states suggested for the mutual benefits the farmers of all northeast states of the country.
- Formation of farmers' associations and cooperatives to help the farmers in production enhancement and providing marketing support to fetch better returns. Establishment and promotion of Farmers Producers Organizations (FPO).
- Simplifying and enhancing farm credit system.
- Linkage with industry
- Creation of meat processing, packing and storage facility.

Strategies for production enhancement

- Promotion of Location specific IFS models
- Promotion of high value crops: large cardamom, black pepper etc. in cluster basis.
- Promotion and introduction of location specific high quality breeds of livestock, poultry piggery etc.
- Promotion of Artificial technology in piggery and livestock for quality breeds.
- Proper vaccination and deforming measures for animal healthcare should be provided at farmers door step to control the outbreak of diseases and maintain the animal production.
- Promotion of fodder crops for livestock
- Fish seeds: Fish seed production in different location should be enhanced to meet out the requirements of the farmers.
- Integrated fish farming: Fish-cum-paddy, Fish-cum-poultry, fish-cum-duck, fish-cum-pig should be promoted for better farm returns.
- Backyard poultry: Suitable chicks for region specific backyard poultry should be provided to the farmers.

- Different integrated farming approaches should be adopted for enhancing the farm production. Tested models are available with ICAR &SAUs for this purpose.
- Cold storage: Cold storage capacity should be enhanced through Government schemes or private service providers to store of excess produce and getting better market price.
- Post-harvest processing: Establishment of small industries for post-harvest processing of fruits, crops and animal produces especially kiwi, citrus and other fruits and milk
- Value added livestock products should be prepared through local entrepreneurs
- Promotion of rain water harvesting structure
- Promotion of farm mechanization

20.3 Summary and Recommendations

Following improved agricultural interventions are recommended for doubling farmers' income in Nagaland.

- Popularization of rice – toria/linseed/green or black gram based cropping system through zero tillage cultivation practices in Dimapur, Wokha, Peren and Longleng district of Nagaland.
- Introduction of improved crop varieties of rice (Bhalum 3), groundnut (ICGS-76), Maize (HQPM -1, RCM-76/75), Soybean (JS 335), Sesame, French bean in different agro-ecological situation of Nagaland.
- Introduction of medicinal, Horticultural and aromatic plants for jhum rehabilitation in different districts of Nagaland.
- Integrated Farming System Models like Model 1: Horticulture + Piggery + Fisheries; Model 2: Agriculture + Horticulture + Duckery + Fishery; Model 3: Agriculture + Horticulture + Piggery + Fishery; and Model 4: Agriculture + Horticulture + Poultry + Fishery + Azolla + Mushroom.
- Low-cost rain water harvesting for efficient utilization of water for enhancing crop production and productivity
- Oyster mushroom cultivation
- Backyard farming of Pig and AI in Pig
- Backyard poultry farming
- Scientific cultivation, protected cultivation and value addition of Horticultural crops etc. are potential technological options for doubling farmers' income in Nagaland.

SUCCESS STORIES

1. Oyster mushroom cultivation by using farm waste for the small and marginal farmers of Nagaland

Mushroom production can generate a good source of income for small and marginal farmers of Nagaland by utilizing the waste generated at farm level and utilize surplus manpower in rural areas. In Nagaland, rice is the staple crop which is growing in low land area, occupies about 70% of the total area under cultivation during rainy season. After rice cultivation, lot sof straw are generated in the farmers filed and wasted as such without using for anything. Therefore, utilizing the straw generated at farm level gives an alternative income source for the farmers of Nagaland to increase the farm income.

Oyster mushroom can grow at moderate temperature ranging from 20 to 300 C and relative humidity of 70-90% and enough ventilation during cropping. The weather condition prevailing in the Nagaland is very much congenial to go for the mushroom cultivation round the year.

Impact of technology: The oyster mushroom cultivated by using paddy straw is one of the simple methods of mushroom cultivation and it has been adopted in the farmer's field. The cost economics of the oyster mushroom cultivation has been considered at farmer's field to assess the feasibility of the technology. The practicing of mushroom cultivation by small farmers was enhanced the income level by utilizing the waste generated at the field level. The increase in net income of Rs. 27,540.00 was achieved by the small farmers in a thatched roof of 3m x 6m size of Mushroom cropping room with a capacity of 250 beds having B:C ration of 1.8.

2. Promotion of rural poultry farming in Nagaland

Nagaland is recognized for very high consumption of animal protein. The gap between demand and supply of eggs and chicken meat is always very high due to predominating area of traditional backyard poultry farming with available low producing indigenous birds. Commercial scale production for any livestock and poultry component is rarely undertaken by the farmers or any private entrepreneur. Non availability of critical inputs and quality germplasm suitable for the region, lack of scientific knowledge of improved production practices are the major challenges in augmenting poultry productivity in the state. In order to ensure the availability of improved germplasm at farmer's doorsteps, ICAR Nagaland Centre has popularized the rural poultry farming in Nagaland with improved poultry birds like Vanaraja, Srinidhi and Gramapriya along with improved production practices.

Rural poultry farming involves rearing of improved chicken varieties (Vanaraja, Gramapriya and Srinidhi) under free range, semi-intensive or intensive conditions. The technology involves rearing of parent stock, recording their production and reproduction parameters at ICAR farm. Chicks are being produced at hatchery unit which are then vaccinated and distributed to the farmers with hand on training on scientific poultry farming. A hen starts laying egg at an age of 20 weeks and lay eggs upto 72 weeks. Vanaraja birds lay up to 150 eggs, Srinidhi up to 220 eggs in one laying cycle.

The chicks hatched in the hatchery unit were supplied to the beneficiaries either as day old chicks or as grown up after rearing for one to four weeks. The centre has till December 2016 supplied more than two lakhs fifty thousand chicks to more than 5000 farmers of Nagaland, Manipur, Assam and Arunachal Pradesh

21

ODISHA

Odisha has a geographical area of 1,55,707 km^2 with a population of 4.19 crores. Agriculture is the mainstay of State's economy providing livelihood support to a very large section of population. Agriculture in the state is characterized by low productivity due to traditional agricultural practices by poor farmers, inadequate irrigation infrastructure, skewed land distribution, marginal and small size of land-holding, low investment and capital formation and natural calamities occurring in quick succession. The State is divided into 10 agro-climatic zones, viz., North-Western Plateau, North-Central Plateau, North-Eastern Coastal Plain, East and South-Eastern Coastal Plain, North-Eastern Ghat, Eastern Ghat High Land, South-Eastern Ghat, Western Undulating Zone, West Central Table Land and Mid-Central Table Land. The climate of the State is tropical, characterized by high temperature, high humidity, medium to high rainfall, short and mild winter. The normal rainfall in the State is 1450 mm, of which about 80% is confined to monsoon months (June-September). Soil types range from fertile alluvial deltaic soils in Coastal Plains, mixed red and black soils in Central Table Land, red and yellow soils with low fertility in Northern Plateau to red, black & brown forest soils in Eastern Ghat region.

he total cultivated land of the state is 61.80 lakh ha out of which 29.14 lakh ha (47%) is high land 17.55 lakh ha (28%) medium land and 15.11 lakh ha (25%) low land. About 84% of the farmers are small and marginal and have limited access to resources. Literacy too is a concern for this vulnerable group of farming community. As per Agricultural Census 2010-11, the number of operational holdings of the state is 46.67 lakh with operational area 48.52 lakh ha. The state witnessed a decline in operational area due to urbanization and more of land put to nonagricultural use. Agriculture in the state is characterized by low productivity due to traditional agriculture practices by poor people, inadequate irrigation infrastructure, skewed land distribution, small size holding, low investment and capital formation and natural calamities occurring in quick succession.

The climate of the state is tropical, characterized by high temperature, high humidity, medium to high rainfall, short and mild winter. The normal rainfall in the State is 1451 mm, of which about 80% is confined to monsoon months (June-September).

Rice is the most important food crop of Odisha. Nearly 70% of the state's population directly or indirectly depends upon rice cultivation. It is grown in an area of 41.8 lakh ha with productivity of 1821 kg ha^{-1} (rice) during 2013-14. Pulses are the second most important group of crops next to cereals in Odisha. The state grows ten important pulse crops namely, greengram, blackgram, pigeonpea, horsegram, lentil, gram, cowpea, rajmah, lathyrus and ricebean.

Groundnut, sesame, castor, mustard, niger, sunflower, safflower, soybean and linseed are the major oilseed crops grown in the state. Of these, groundnut, sesame, mustard and niger are the major ones. Now, sunflower is gaining popularity in the State. The oilseed situation demands to enhance the production to meet the domestic need.

Among the fiber crops, jute and mesta are the most important ones. Jute is mainly cultivated in the coastal districts of undivided Balasore, Cuttack & Anandpur subdivision of Keonjhar and Mesta in the interior districts of Mayurbhanj, Keonjhar and Koraput. The area under jute & *mesta* is shrinking fast, mainly due to invasion of polythene & synthetic fibers as a cheaper & convenient substitute in addition to the inadequate marketing support.

The agro-climatic condition of the State is favourable for production of brinjal, chilli, tomato, okra, cucurbits, greens and bean, peas. Odisha is the second largest producer of vegetables in the country next to West Bengal. The major vegetables having commercial significance grown in the State are *solanaceous* vegetables (brinjal, tomato and chilli), cole crops (cauliflower, cabbage, knolkhol), cucurbits, okra, legumes, greens and tropical tuber crops (sweet potato, *dioscorea, amorphophalus, colocasia*). The vegetable growers of the State are now taking much interest in cultivation of hybrid vegetables and high value exotic vegetables like broccoli, red cabbage, lettuce and Chinese cabbage.

Major fruits grown in the State are mango, guava, citrus, banana, litchi, papaya, etc. Commercial floriculture has been identified as a profitable venture, which can open up great opportunities to the farmers. Besides, there is vast scope for promotion of allied sectors such as dairy, poultry, pisciculture, mushroom cultivation, bee keeping, value addition to agricultural produce, etc.

21.1 Productivity Gaps and Major Constraints

Productivity Gaps

Yield rate is one of the major indicators to assess the production trend of the agriculture crops in the State. The yield rate of food grains in Odisha is below the average yield rates in some of the major States and at all India level. There is, therefore, a need for greater efforts through different policy interventions to increase the productivity of major crops.

The average yield rate of rice has increased from 18.21 quintals per hectare in 2013-14 to 23.63 quintals per hectare in 2014-15. But during 2015-16 it declined to 14.91 quintal per hectare. However, the yield rate of Potato and Sugarcane decreased from 123.24 to 101.73 and from 719.51 to 644 quintals per hectare respectively during 2015-16 over previous year. The yield rate of wheat, Ragi, and Groundnut has declined during 2015-16. The yield rate of Gram and Jute increased slightly i.e. from 7.70 to 7.75 and from 16.25 to 21.74 quintals per hectare respectively during 2015-16 over 2014-15.

Production constraints of Different crops

Cereals

- Low yield of direct sown upland rice due to severe weed problem and moisture stress
- Low fertilizer use and want of balanced fertilization
- Severe weed problem in direct sown upland & medium land rice
- Non availability of high yielding export quality aromatic rice to make rice production more remunerative
- Iron toxicity in low land paddy fields
- Pests and disease problems like gall midge caseworm, leaf folder, gundhi bugs, BLB and sheath rot

Pulses

- Low productivity of horsegram
- Stored grain pests
- Lack of improved package of practices for greengram, blackgram, bengalgram, lentil and arhar
- YMV, PMB & leaf curling in winter sown greengram
- Pod borer and blister beetle damage in arhar
- Leaf spot and powdery mildew in greengram and blackgram

Oilseeds

- Gradual yield reduction in groundnut due to continuous cropping
- Tikka disease in groundnut
- Collar rot & bud necrosis in groundnut
- Difficulty in digging of rainfed kharif groundnut due to hardening of soil at maturity
- Low yield of linseed taken as pyra in low and medium lands
- Low yield of niger
- Severe incidence of aphids in mustard
- Lack of suitable variety in toria group
- Lack of development of suitable agro-technique for yield maximization
- Severe pest attack at flowering and podding

Vegetables

- Non-availability/ non-adoption of seeds of improved/ high yielding varieties of vegetables
- Low and imbalance use of manure and fertilizes
- Severe wilt in solaneceous vegetables

- Flower and fruit drop in solaneceous and curcurbit crops
- Micronutrient deficiency due to excess use of high analysis fertilizers
- Problem of phompsis fruit rot and root knot in brinjal
- Vine borer and white grub attack in pointed gourd
- Yellow vein mosaic virus disease in okra
- Cultivation of local variety of sweet potato with poor management practices resulting in low yield
- Problem of tuber rotting

Fruits

- Poor bearing of mango, ber, guava, citrus & papaya
- Die back in citrus
- Severe wilt and bunchy top in banana
- Canker disease attack in guava fruits
- Fruit drop, jassid and fruit fly attack in mango

Commercial crops

- Low yield of Sabai grass
- Fruit drop and fruit rot in jack fruits
- No suitable fodder cultivation technique is available
- Survival of plantation of crops is difficult due to non availability of water for Irrigation

Fodder Crops

- Unwillingness of the farmers to use cultivable lands for fodder cultivation
- Lack of suitable cultivars of fodder and its agro-techniques
- Non-adoption of suitable package of practices for fodder crops
- Marketing problem of fodders
- Seed supply problem at farmers level
- Storage problem for green fodders

Animal Production

- Foot and mouth disease and diarrhoea in cattle
- Ranikhet disease in poultry
- Lack of fodder cultivation and feeding of live-stocks with less nutrients feeds
- Less milk production due to rearing of more desi breeds of cows and buffaloes than cross bred
- Cross bred animals are not preferred as they are more susceptible to diseases

21.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

Farmers' income can be improved when productivity goes up, cost of production comes down, risk is reduced, post-harvest loss is minimized and commodities produced get a remunerative price. It should also improve income from allied activities to agriculture. The strategy should integrate these all. The following options are available for increasing farmers' income.

1.1. Improving productivity and quality

- Providing quality seed and enhancing seed replacement ratio
- Promoting high-yielding varieties and hybrids
- Growing nutrient rich rice (CR Dhan 310 and 311) and aromatic rice
- Increasing cropping intensity in rice-fallow areas

1.2. Increasing input use efficiency

- Crop planning to identify areas where the crop can be grown with least input
- Promoting water harvesting and micro-irrigation to achieve per drop-more crop
- Using soil health card and site-specific crop management
- Promoting farm mechanization and solar energy

1.3. Reducing crop loss

- Adopting plant protection measures
- Promoting resistant varieties and e-surveillance
- Crop insurance to mitigate risks at affordable cost
- Weather services and forecasting system

1.4. Diversification

- Dairy husbandry for small farmers
- Promotion of intensive vegetable production
- Promotion of inland fisheries
- Promotion of ancillary activities like poultry, beekeeping and mushroom cultivation
- Strengthening Organic Food Program

1.5. Market price realization and value addition

- Community/co-operative farming with crop-value chain
- Use of the crop biomass to make products through small industry
- Creation of a national farm market with information system for export and online selling
- Agribusiness Incubation Centres to promote agri-preneurship

Agro-Climatic Zone 1: North Western Plateau

Districts: Sundargarh, Deogarh, parts of Sambalpur & Jharsuguda

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed upland	Rice Khandagiri Annapurna - Fallow 22 q ha^{-1} Rs 11,000/-	• Less remunerative • Monocrop with broadcasting of seed	1) In-situ and ex-situ rain water harvesting (Field bunding/ check dam/ tank cum well system) 2) Crop diversification with Arhar var. UPAS-120 with line sowing 10 q ha^{-1} Rs 18,250/-	3) INM practices: Soil application of PSB @ 5Kg ha^{-1}, Seed treatment, Rhizobium culture @ 20gm per Kg seed with STFR. 4) Weed management in Arhar (Imazethapyr 10% SL) @750 ml ha^{-1} Arhar 12 qtl ha^{-1} Rs 23,250/-	5) Pod borer management (pheromone trap , neem oil and Spinosad) 15 q ha^{-1} Rs 25,000/-	6) Adoption of technology as of 3rd year 15 q ha^{-1} Rs 25,000/-	7) Same technology to be adopted as on 4th year 15 q ha^{-1} Rs 25,000/-	127.27
Rainfed medium land	Rice (MTU-1010, Lalat) – Mustard (loc. Var.) Paddy 28 q ha^{-1} Rs 12500/-	• Broad-casting • Low yield due to stem borer infestation	1) In-situ and ex- situ rain water harvesting (check dam/ tank cum well system/ Flexi rubber check dam) 2) Improved rice varieties Pyari, CR Dhan 203, CR Dhan 209, CR Dhan 300, CR Dhan 303, CR Dhan 304, Maudamani, CR Dhan 310, Naveen, Swarna 3) Line transplanting 4) Stem borer management 31.75 q ha^{-1} Rs 14,750/-	5) Weed management in Paddy (Preemergence of Pretilachlor 6% + Bensulfuran Methyl 0.6% @ 10 5Kg ha^{-1} at 3 DAT) Paddy : 36.5 q ha^{-1} Rs 18,000/-	6) INM in paddy 42.5 q ha^{-1} Rs 21,250/-	7) Adoption of technology as of 3rd year 42.5 q ha^{-1} Rs 21,250/-	8) Same technology to be adopted as on 4th year 42.5 q ha^{-1} Rs 21,250/-	70.00

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Irrigated medium land	Paddy (var. MTU-1010) – Paddy (var. MTU-1010, Lalat) 38.5 q ha^{-1} Rs 16250/-	• Staggered planting • Weed infestation • Indiscriminate use of aquaculture application • Stem borer and sheath blight infestation	1) Improved irrigation infrastructure 2) Line transplanting with RDF (80:40:40) 3) Weed management 4) IPM in paddy 42 q ha^{-1} Rs 19,100/-	5) Paddy hybrid Ajay / Rajalaxmi in kharif with line transplanting Kharif :52 q ha^{-1} Rs 25,125/- Rabi :46.75 q ha^{-1} Rs 19,875/-	6) BPH management 7) INM Kharif 56 q ha^{-1} Rs 26800/-	8) Same technology to be adopted as 3rd year 42.5 q ha^{-1} 56 q ha^{-1} Rs 26800/-	9) Same technology to be adopted as 4th year 56 q ha^{-1} Rs 26800/-	64.92
	Vegetable (Cabbage-180q ha^{-1}) Rs.18,000	• Imbalanced aquaculture application • Diamond back moth in cabbage	1) Improved nursery raising and planting technique of cabbage 200q ha^{-1} Rs.21,000	2) Snosad 45% SC@ 125ml ha^{-1} for management of DBM in cabbage 225q ha^{-1} Rs.25,000	3) STB fertilizer application in cabbage 235 q ha^{-1} Rs.29,000	4) Adoption of technology as of 3rd year 235 q ha^{-1} Rs.29,000	5) Same technology to be adopted as on 4th year 235 q ha^{-1} Rs.29,000	61.11
Irrigated lowland	Paddy (var. Swarna) – Paddy (var. Swarna) Kharif 41.5 q ha^{-1} Rs 17,500/	• Staggered planting • Indiscriminate use of aquaculture • Sheath rot & sheath blight • BPH and Stem borer	1. Rice Var. Swarna Sub-1, Reeta, Sumit, CR Dhan 407, Poorna Bhog, CR Sugandh Dhan 907, CR Dhan 701 (Hybrid), Savitri 2. Line transplanting 3. INM 4. BPH management 5. Pond based rice-fish-horti farming System Kharif 50 q ha^{-1} Rs 21000/-	6. Paddy var. Rani Dhan / Sarala / Pooja replaced with Swarna Kharif 52.5 q ha^{-1} Rs 23,750/-	7. IWM in paddy Kharif 55 q ha^{-1} Rs 26,250/-	8. Adoption of technology as of 3rd year Kharif 55 q ha^{-1} Rs 26,250/-	9. Same technology to be adopted as on 4th year Kharif 55 q ha^{-1} Rs 26,250/-	61.42

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Green gram 2.6 q ha^{-1} (Rs.9950)	• Low yield • YMV incidence	1. IPM 02-3/ IPM 02-14 2. Seed Treatment with T. viridae @5gm/kg 3. Spraying of neem oil (1500 ppm) @ 2 ml/ lt. at 25 DAS/ Thiamethoxam @ 150 gm ha^{-1}. at 40 DAS 4.5 q ha^{-1} (73%) Rs.18900/ha	4. STFR in green gram 5. Spraying Water soluble fertilizer (19;19:19::NPK) @ 10 gram/lt. at 30 & 45 DAS 5.4 q ha^{-1} (20%) Rs.21800/ha	6. Seed inoculation with rhizobium @ 20g /kg of seed + ammonium molybdate @ 3 g/10 kg of seed 7. 7. Installation of yellow sticky traps @ 50/ha. 5.9 q ha^{-1} (9.2%) Rs.23700/ha	8. Adoption of technology as of 3rd year 5.9 q ha^{-1} (9.2%) Rs .23700/ha	9. Same technology to be adopted as on 4th year 5.9 q ha^{-1} (9.2%) Rs. 23700/ha	138.19
Lowland, low lying areas	Flooded rice fields/ low lying areas	• Flooded rice fields/ low lying areas • Rs.20,000/ha	1. Low input extensive aquaculture system with yield of 1 t ha^{-1}	2. Low input extensive aquaculture system with yield of 1 t ha^{-1} Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100
	Extensive Paddy-cum-fish culture	• Extensive Paddy-cum-fish culture • Rs.20,000/ha	1. Scientific paddy –cum- fish culture	2. Scientific paddy –cum- fish culture Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	140 300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 33.33 140

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ ha	9. Adoption of technology as of 4th year Rs.2,50,000/ ha 10. Adoption of technology as of 4th year Rs.4,50,000/ ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial quaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-
	Intensive pangasius culture	• Intensive Pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like Murrel, Magur, Pabda	2. High value cat fish culture like Murrel, Magur, Pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ ha	5. Adoption of technology as of 4th year Rs.10,00,000/ ha	100
Homestead	Poultry (10 nos) 1 Kg body wt. per bird Rs 1500/-	• Less egg and meat production from local poultry bird	1. Backyard poultry rearing of Pallishree (10 nos) 2 Kg body wt. per bird Rs 2500	2. Rearing of Pallishree / Rainbow rooster bird (20 nos) with proper brooding management, vaccination- 38 Kg meat : Rs 3600/-	3. Rearing of Pallishree bird (30 nos) with proper feeding 43 Kg meat Rs 4300	4. Adoption of technology as of 3rd year 43 Kg meat Rs 4300	5. Same technology to be adopted as on 4th year 43 Kg meat Rs 4300	186.60
	Goatery (5 nos/farmer)- Rs.2000/-	• Mortality of kids • No additional feeding	1. Goatery (5 nos/ farmer)- Rs. 2000/-	2. Deworming Rs. 2750/-	3. Feed management Rs. 3200/-	4. Adoption of technology as of 3rd year Rs. 3200/-	5. Same technology to be adopted as on 4th year Rs. 3200/-	60.00
	Average Increase in Income over 5 years							148.81

Agro-Climatic Zone 2: North Central Plateau

Districts: Mayurbhanj, major parts of Keonjhar, (except Anandapur & Ghasipura block)

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed Upland	Rice-fallow 14 q ha^{-1} Rs.7200/ha	• Guda dhana • Broadcast sowing • No fertilization	1. In-situ and ex-situ rain water harvesting (Field bunding/ check dam/ tank cum well system) 2. Reclamation of acid soils wherever applicable 3. Crop diversification 4. Arhar Var. LRG-41 5. Indoxacarb @1ml/l 8.2q ha^{-1} Rs.10260	6. Line sowing 7. Weedicide, Pendimethalin 1 kg a.i ha^{-1} 10 q ha^{-1} Rs 12300	8. IPM against pod borer in arhar (Use of ph. Traps @8/ac, T. chilonis @ 1lakh ha^{-1}, spraying of Indoxacarb @1ml/lt) Line sowing11.5 q ha^{-1} Rs.13400	9. Adoption of technology as of 3rd year Rs.13400	10. Same technology to be adopted as on 4th year Rs.13400	86.11
	Maize-fallow 17.5q ha^{-1} - Rs 9500/ha	• Local var • Broadcasting • Weed menace • Drudgery in harvesting of grains	1. Hybrid maize (S-36) 2. Line sowing (60X25 cm) 25q ha^{-1} Rs.15100	3. Herbicide Atrazine @1 kg a.i ha^{-1} 4. STB fert application 28q ha^{-1} Rs.16500	5. Mech. Maize shelling 28 q ha^{-1} Rs.17200	6. Adoption of technology as of 3rd year Rs.17200	7. Same technology to be adopted as on 4th year Rs.17200	81.05
Medium land	Rice-fallow 23 q ha^{-1} Rs.10000/ha	• Lalat • Broadcasting • Drought at later stage of crop growth	1. In-situ and ex-situ rain water harvesting (check dam/ tank cum well system/ Flexi rubber check dam) 2. Manaswin/ Hiranmayee/ Naveen/DRR-42 3. Line transplanting	4. STB quacultur application 5. Weedicide (Ben sulfuronmethyle +Pretilachlor @ 10 5Kg ha^{-1} at 3 DAT+ One HW at 35 DAT) 28 q ha^{-1} Rs. 13000	6. IPDM practices against blast, stem borer (Use of ph. Traps@20ha^{-1}, 7. *T. japonicum* @ 1lakh ha^{-1}, spraying of Cartap hydrochloride@2 gm/lt against stem borer),	8. Adoption of technology as of 3rd year Rs. 15300	9. Same technology to be adopted as on 4th year Rs. 15300	53.00

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
			25.5 q/ha Rs.10500		Spraying of Tricyclazole @ 1gm/lt against blast 30.0 q ha^{-1} Rs. 15300			
Irrigated shallow lowland	Rice-vegetable Rice:38 q ha^{-1} Rs. 13300	• Var. Pratishkya • Broadcast sowing • Beushening • Imbalanced fertilization • Disease and pest infestation	1. STFR 2. Rice Var. Swarna Sub-1, Reeta, Sumit, CR Dhan 407, PoornaBhog, CR SugandhDhan 907, CR Dhan 701(Hybrid) 3. Line Transplanting 42.0 q ha^{-1} Rs. 16300	4. Herbicide: Bispyribac Na 5. STFR 6. Line Transplanting 46.0 q ha^{-1} Rs.21500	7. Herbicide: Bispyribac Na 8. STFR 9. Line Transplanting 10. IPM 50.0 q ha^{-1} Rs.25000	11. Adoption of technology as of 3rd year Rs. 25000	12. Same technology to be adopted as on 4th year Rs. 25000	87.96
	Cultivation of tomato variety Utkal Kumari) (140 q ha^{-1} Rs.34000)	• Low keeping quality due to thin skin (Utkal quacu) • Low yield	1. Cultivation of tomato variety Utkalpragnya 2. RDF of NPK (100:50:150 5 Kg ha^{-1}) 190 q ha^{-1} (Rs.42000/ha)	3. Management of early blight of tomato 205q ha^{-1}. (Rs.46000/ha)	4. Foliar application of $CaCl_2$(0.6%) +borax(0.2%) for enhancing plant growth yield and quality of tomato 5. Value addition 6. Collective marketing 225 q ha^{-1} (Rs.52000/ha)	7. Adoption of technology as of 3rd year Rs.52000/ha	8. Same technology to be adopted as on 4th year Rs.52000/ha	52.94
Lowland, low lying areas	Flooded rice fields/ low lying areas	• Flooded rice fields/ low lying areas • Rs.20,000/ha	1. Low input extensive aquaculture system with yield of 1 t ha^{-1}	2. Low input extensive aquaculture system with yield of 1 t ha^{-1} Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100
	Extensive Paddy-cum-fish culture	• Extensive Paddy-cum-fish culture • Rs.20,000/ha	1. Scientific paddy –cum- fish culture	2. Scientific paddy –cum- fish culture Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	140 300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1}	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha	33.33

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
			2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 140
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs. 2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs. 2,50,000/ha 4. High value fish based culture Rs. 4,50,000/ha	5. Adoption of technology as of 2nd year Rs. 2,50,000/ha 6. Adoption of technology as of 2nd year Rs. 4,50,000/ha	7. Adoption of technology as of 3rd year Rs. 2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs. 2,50,000/ha 10. Adoption of technology as of 4th year Rs.4,50,000/ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs. 3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-
	Intensive pangasius culture	• Intensive Pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like Murrel, Magur, Pabda	2. High value cat fish culture like Murrel, Magur, Pabda Rs. 10,00,000/ha	3. Adoption of technology as of 2nd year Rs. 10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ha	5. Adoption of technology as of 4th year Rs.10,00,000/ha	100

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Home-stead	Goatery (5 nos/ farmer)- Rs.2000	• Worm infestation • Mortality of kids • No additional feeding • Poor shed mgt.	1. Deworming Rs. 2600	2. Feed management Rs. 3900	3. Shed management and sanitation 4. Vaccination against PPR Rs. 5200	5. Adoption of technology as of 3rd year Rs. 5200	6. Same technology to be adopted as on 4th year Rs. 5200	160
	Local poultry bird (10 birds) Rs. 1500/-	• Low growth • No additional feeding	1. Banaraja -10birds /farmer 2.0 kg /bird Rs.1800	2. RD Vaccination at 7th day, 21st day 2.5 kg/bird Rs. 2000	3. Shed management and additional feeding 2.8 kg/bird Rs.2300	4. Adoption of technology as of 3rd year Rs.2300	5. Same technology to be adopted as on 4th year Rs.2300	53
	Under-utilised paddy straw	• No value to aquaculture straws	1. Oyster Mushroom (20beds/ farmer) Rs.850	2. Paddy straw- Apr-Sep-20 beds, Oyster Mushroom- Oct-Mar-20 beds) Rs.1200	3. Value addition 4. Marketing Rs.1200	5. Adoption of technology as of 3rd year Rs.1200	6. Same technology to be adopted as on 4th year Rs.1200	41.17
	Average Increase in Income over 5 years							141.1

Agro-Climatic Zone 3: North Eastern Coastal Plain

Districts: Balasore, Bhadrak, parts of Jajpur & Hatadihi block of Keonjhar

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed bunded upland	Rice- fallow (32.5q ha^{-1}) (Rs. 10200/ ha)	• Low yield of paddy • High cost in manual weeding/ cultivation	1. Varietal substitution of Khandagiri with Jogesh 34.2q ha^{-1} (Rs.12640/ha)	2. Postemergence application of bispyribac Na@ 250ml ha^{-1} followed by one hand weeding 35.5 ha^{-1} (Rs.13600/ha)	3. Mechanical Transplanting & Harvesting 4. Market linkage 38.5q ha^{-1} (Rs 15140/ha)	5. Adoption of technology as of 3rd year 38.5q ha^{-1} (Rs 15140/ ha)	6. Same technology to be adopted as on 4th year 38.5q ha^{-1} (Rs 15140/ha)	48.43
Rainfed Medium land	Rice (Limited irrigation) (40q ha^{-1}) (Rs. 12290/ ha)	• Sheath blight in paddy • Hand weeding • High cost of cultivation	1. Seed treatment with Thiophenate methyl@1.5g/kg seed and alternate spraying of (Trifloxystrobin+ Tebuconazole) @ 0.4g/ltr& Thiflu-zamide24SC@ 1ml/ltr water 43.5q ha^{-1} Rs.17840/ha	2. Pre-emergence application of Bensulfuron methyl+ pretilachlor@ 105Kg ha^{-1} followed by one hand weeding 47.5q ha^{-1} (Rs.15,437/ha)	3. Mechanical Transplanting & Harvesting 51.5q ha^{-1} Rs.16,737/ha)	4. Adoption of technology as of 3rd year 51.5q ha^{-1} Rs.16,737/ ha)	5. Same technology to be adopted as on 4th year 51.5q ha^{-1} Rs.16,737/ha)	36
Rainfed shallow lowland	Rice-fallow 32.9 q ha^{-1} Area:1.0ha Rs.15200	• Local var.(Pateni and others) • Random transplanting • Blanket fertilization • Hand weeding • Rabi fallow	1. (Var.Option 1) HYV Luna Suvarna/ Luna Sampad 2. (Var. Option 2) Local var. Pateni 3. Line transplanting 4. Infield refuge system for rice-fish integration 5. STFR	7. (Var.Option 1) HYV Luna Suvarna/ Luna Sampad 8. (Var. Option 2) 9. Line transplanting 10. STFR 11. Herbicide-Penoxsulam	13. HYV Luna Suvarna 14. Line transplanting 15. STFR 16. Herbicide-Penoxsulam	18. Adoption of technology as of 3rd year 41.5 q ha^{-1} Rs.19200 3.0 q ha^{-1} Rs.6200	19. Same technology to be adopted as on 4th year 41.5 q ha^{-1} Rs.19200 3.0 q ha^{-1} Rs.6200	67.10

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
			6. Blackgram paira, var.PU 35/Prasad 38.5 q ha^{-1} Rs.17700 1.7 q ha^{-1} Rs.4200	12. Blackgram as paira (PU 35/ Prasad, NPK 20-40-20 41.5 q ha^{-1} Rs.19200 3.0 q ha^{-1} Rs.6200	17. Blackgram as paira (PU 35/ Prasad, NPK 20-40-20 41.5 q ha^{-1} Rs.19200 3.0 q ha^{-1} Rs.6200			
Irrigated Medium land	Rice-fallow Area:1.0 ha Rice:42 qha^{-1} Rs. 15300 Fish Small tanks (5-30 cent) 1q/20 cent Rs. 5000	• (Option 1) Broadcast sowing • Beushaning • Imbalanced fertilization • (Option 2) Random transplanting • Imbalanced fertilization • Rabi fallow • Fish production – low profit	1. Line sowing 2. Herbicide: Bispyribac Na 3. STFR 4. Line Transplanting 5. STFR 6. Fish seed production (spawn-fry) 45.0 q ha^{-1} Rs. 16300 166000 fry Rs. 7500	7. Line sowing 8. Herbicide: Bispyribac Na 9. STFR 10. Line Transplanting 11. STFR 12. Greengram (IPM 2-14)/ blackgram (PU 35) as paira 13. Fry+SFL and SYL production 47.0 q ha^{-1} Rs.17500 2.5 q ha^{-1} Rs.7000 70000 fry 20000 SFL/SYL Rs.9000	14. Line sowing 15. Herbicide: Bispyribac Na 16. STFR 17. Line Transplanting 18. STFR 19. Greengram/ blackgram with NPK 20-40-20 20. Fry+SFL and SYL production 47.0 q ha^{-1} Rs.17500 4 q ha^{-1} Rs.11000 70000 fry 20000 SFL/SYL Rs.9000	21. Adoption of technology as of 3rd year 47.0 q ha^{-1} Rs.17500 4 q ha^{-1} Rs.11000 70000 fry 20000 SFL/ SYL Rs.9000	22. Same technology to be adopted as on 4th year 47.0 q ha^{-1} Rs.17500 4 q ha^{-1} Rs.11000 70000 fry 20000 SFL/ SYL Rs.9000	84.72
Lowland, low lying areas	Flooded rice fields/ low lying areas	• Flooded rice fields/ low lying areas • Rs.20,000/ha	1. Low input extensive aquaculture system with yield of 1 t ha^{-1}	2. Low input extensive aquaculture system with yield of 1 t ha^{-1} Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Extensive Paddy-cum-fish culture	• Extensive Paddy-cum-fish culture • Rs.20,000/ha	1. Scientific paddy –cum- fish culture	2. Scientific paddy –cum- fish culture Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	140 300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ ha	5. Adoption of technology as of 4thyear Rs.1,50,000/ha	500

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 33.33 140
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ha 10. Adoption of technology as of 4th year Rs.4,50,000/ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Intensive pangasius culture	• Intensive Pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like Murrel, Magur, Pabda	2. High value cat fish culture like Murrel, Magur, Pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ ha	5. Adoption of technology as of 4th yr Rs.10,00,000/ ha	100
Home-stead	Dairy 1 desi cow Milk: 1.5 Rs.4000 Poultry (Desi variety, 10 Nos.) Rs.2000	• No green fodder supplements • High cost of concentrate feeding, low milk yield • Slow body weight gain	1. Hybrid napier var. CO 4/ Paragrass 2. Backyard poultry, Rainbow Rooster/Kegg (10 birds) Milk : 1.5l/day Rs. 4500/yr Body wt: 2.0 kg/ bird+350 eggs/yr Rs. 2500	3. Hybrid napier , var. CO4/ Paragrass 4. Azolla production (FLD 6) 5. Farm made feed (broken rice, DORB, pulse bran , wheat bran , GNOC , salt , mineral mixture) 6. Rainbow rooster in 2 batches(10 Nos./batch) /yr (FLD 7) Milk: 2.2 l/day Rs.5000 Rs.3500	7. Hybrid napier / Paragrass 8. Azolla production 9. Farm made feed 10. Value addition of milk (50%)for chhena making 11. Rainbow rooster in 2 batches(10 Nos./batch) /yr Milk: 1.0 L/day Chhena: 0.25 kg/ day Rs.6000/yr Rs.5000	12. Adoption of technology as of 3rd year Rs.6000/yr Rs.5000	13. Same technology to be adopted as on 4th year Rs.6000/yr Rs.5000	83.33
	Average Increase in Income over 5 year							148.6

Agro-Climatic Zone 4: East & South Eastern Coastal Plain zone

Districts: Kendrapara, Khurda, Jagatsinghpur, Cuttack, Puri, Nayagarh, part of Ganjam

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Upland	Rice-Fallow Cropping System Rice (Khandagiri)- Fallow 17 q ha^{-1} (Rs. 7589)	• Low income from paddy	1. Crop diversification-High yielding sweet corn C.v-Madhuri Rs. 16500/ha (117%)	2. Weed control by pre emergence application of Atrazine @ 1-1.55Kg ha^{-1} 0-3 DAS Rs. 20100/ha (21.8%)	3. Line sowing of Maize 4. Spacing 60x45cm Rs. 26450/ha (31.5%)	5. Adoption of technology as of 3rd year Rs. 26450/ha	6. Same technology to be adopted as on 4th year Rs. 26450/ha	248.53
Medium land	Rice-Groundnut/ Chilli cropping system Rice(Lalat)- 28 q ha^{-1} (Rs.14100)	• Low yield due to old var- Lalat, MTU- 1001- • Inadequate application of fertilizer	1. Cultivation of hybrid rice Var-Rajalaxmi/Ajay 2. RDF of NPK 120:60:60 5Kg ha^{-1} 35 q ha^{-1}, (28.5%) Rs.20600/ha	3. Line transplanting of paddy 4. Weed management in paddy- Pre-emergence weedicide: Londax power (Bensulfuron methyl + pretilachlor) @ 105Kg ha^{-1} 0-5 DAT or post emergence Byspyrabic sodium 200 ml per ha 25 DAT/ 41 q ha^{-1} Rs.24700/ha (19.9%)	5. Soil test based nutrient management in hybrid rice 6. Micronutrient application as per soil test results 7. Market linkage 51 q ha^{-1} Rs.30300/ha	8. Adoption of technology as of 3rd year 51 q ha^{-1} Rs.30300/ha	9. Same technology to be adopted as on 4th year 51 q ha^{-1} Rs.30300/ha	114.89
	Groundnut 11 q ha^{-1} (Rs. 14300)	• Low yielding variety • Low income • from G. nut • Soil acidity	1. Var: Devi 2. Application of lime @ 0.2 LR and Sulphur @ 405Kg ha^{-1} in groundnut 14 q ha^{-1} (27.2 %) Rs.18300/ha	3. Seed treatment with Vitavax power 1.5 gm/ kg of seed or Trichodermaviride 5gm/kg 4. Application of RDF 16 q ha^{-1} Rs. 20900/ha	5. Seed inoculation with Rhizobium culture 20 gm/ kg of seed 6. Soil test based quacultur application 18 q ha^{-1} Rs.23600/ha (12.9%)	7. Adoption of technology as of 3rd year 18 q ha^{-1} Rs. 23600/ha (12.9%)	8. Same technology to be adopted as on 4th year 18 q ha^{-1} Rs. 23600/ha (12.9%)	65

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Chilli 25 q ha^{-1} (Rs 10500)	• Low yield • Leaf curl of Chilli • Flower drops	1. Var:Suryamukhi / Daya 2. Seed treatment with Imidacloprid 17.8SL@ 7 ml per kg of seed and foliar spray of Imidacloprid 17.8SL@.5ml/l of water twice starting from 45 DAT at 15 days interval 29 $qtha^{-1}$ Rs 12500	3. RDF application 125:50:100 kg N: P2O5:K2O ha^{-1} 4. Spraying of 0.125% Tricontanol and IAA 10ppm reduce flower drop and increasing fruit set. 31 q ha^{-1} Rs 14700	5. Spray Planofix @ 10 ppm at flowering and three weeks later to increase yield or agripro-2 gm/ litre 6. Market linkage 35 q ha^{-1} Rs 18900	7. Adoption of technology as of 3rd year 35 q ha^{-1} Rs 18900	8. Same technology to be adopted as on 4th year 35 q ha^{-1} Rs 18900	80
Lowland	Rice (Pooja) 30 q ha^{-1} (Rs.14000)	• Flood prone • Susceptible to false smut • Inadequate application of fertilizer	1. Cultivation of rice Var- Swarna Sub-1 2. Seed treatment with Vitavax power 3. RDF of NPK 80:40:40 5Kg ha^{-1} 4. Pond based farming system (Horti-Fish) 35 q ha^{-1}, Rs.20000/ha	5. Line transplanting of paddy 6. Weed management in paddy- Pre-emergence weedicide:- Londax power (Bensulfuron methyl+ pretilachlor) @ 105Kg ha^{-1} 0-5 DAT or post emergence Byspyrabic sodium 200 ml per ha 25 DAT/ 42 q ha^{-1} Rs.24700/ha	7. Soil test based nutrient management in rice 8. Micronutrient application as per soil test results 9. Market linkage 45 q ha^{-1} Rs.29000/ha	10. Adoption of technology as of 3rd year 45 q ha^{-1} Rs.29000/ha	11. Same technology to be adopted as on 4th year 45 q ha^{-1} Rs.29000/ha	107.14
	Green gram 2.6 q ha^{-1} (Rs.9950)	• Low yield • YMV incidence	1. Greengram- IPM 02-3/ IPM 02-14 2. Seed Treatment with T. Viridae @5gm/kg 3. Spraying of neem oil(1500 ppm) @ 2ml/lt. at 25 DAS/ Thiamethoxam @ 150 g ha^{-1}. at 40 DAS 4.5 q ha^{-1} Rs.18900/ha	4. STFR in G.gram 5. Spraying Water soluble fertilizer (19;19:19: :NPK) @ 10 gram/lt. at 30 & 45 DAS 5.4 q ha^{-1} Rs.21800/ha	6. Seed inoculation with rhizobium @ 20g /kg of seed + ammonium molybdate @ 3 g/10 kg of seed 7. Installation of yellow sticky traps @ 50 ha^{-1}. 5.9 q ha^{-1} Rs.23700/ha	8. Adoption of technology as of 3rd year 5.9 q ha^{-1} Rs.23700/ha	9. Same technology to be adopted as on 4th year 5.9 q ha^{-1} Rs.23700/ha	138.19

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions 1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	Increase in income by 2022 (%)
Rainfed medium land	Rice – Fallow Rice (Lalat)-broadcasting 35.7q ha^{-1} Rs.12975/-	• Lack of suitable variety • High weed incidence • Improper nutrient management	1. Bina dhan 11 42.3q ha^{-1} Rs.15350/-	2. 1st year intervention 3. Post emergence spray of Bispyribac sodium @200ml ha^{-1} followed by one hand weeding 45q ha^{-1} Rs. 16700/-	4. 2nd Year intervention 5. STFR application 48.3 q ha^{-1} Rs. 17975 /-	6. Adoption of technology as of 3rd year 48.3 q ha^{-1} Rs. 17975 /-	7. Same technology to be adopted as on 4th year 48.3 q ha^{-1} Rs. 17975 /-	38.53
Irrigated medium land	Vegetable (Cabbage-180q ha^{-1}) Rs.18,000	• Imbalanced aquaculture application • Diamond back moth in cabbage	1. Improved nursery raising and planting technique of cabbage 200q ha^{-1} Rs.21,000	2. Spinosad 45% SC@ 125ml ha^{-1} for management of DBM in cabbage 225q ha^{-1} Rs.25,000	3. STB fertilizer application in cabbage 240 q ha^{-1} Rs.32,000	4. Adoption of technology as of 3rd year 240 q ha^{-1} Rs.32,000	5. Same technology to be adopted as on 4th year 240 q ha^{-1} Rs.32,000	52.38
Lowland, low lying areas	Flooded rice fields/ low lying areas	• Flooded rice fields/ low lying areas • Rs.20,000/ha	1. Low input extensive aquaculture system with yield of 1 t ha^{-1}	2. Low input extensive aquaculture system with yield of 1 t ha^{-1} Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4thyear Rs.50,000/ha	100
	Extensive Paddy-cum-fish culture	• Extensive Paddy-cum-fish culture • Rs.20,000/ha	1. Scientific paddy – cum- fish culture	2. Scientific paddy – cum- fish culture Rs.50,000/ha	3. Adoption of technology as of 2nd year Rs.50,000/ha	4. Adoption of technology as of 3rd year Rs.50,000/ha	5. Adoption of technology as of 4th year Rs.50,000/ha	100
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	140 300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 33.33 140

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ ha	9. Adoption of technology as of 4th year Rs.2,50,000/ ha 10. Adoption of technology as of 4th year Rs.4,50,000/ ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ ha	5. Adoption of technology as of 4th year Rs.3,50,000/ ha	-
	Intensive pangasius culture	• Intensive pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like murrel, Magur, pabda	2. High value cat fish culture like murrel, Magur, pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ ha	5. Adoption of technology as of 4th year Rs.10,00,000/ ha	100
Allied activities Homestead	Deshi cattle-65 lit /month (Rs.1500)	• Deshi Breed • Low yield of milk due to stray grazing • Supply of local available feed	1. Breed improvement through AI 2. Azolla cultivation for supplementary feed (20%) increase milk yield up to .5-1lit/ per day. 85 lit/Month (30.7%) Rs. 2000/per month	3. Azolla supplementary feed (20%) increase milk yield up to 1-1.5lit/ per day. 4. Supplementation of vitamin mineral mixture @30gm/meal 5. Fodder Cultivation var. Hybrid nippier var. CO-4 240 lit/Month Rs. 4000 per month	6. Management of Hybrid Napier 7. Value addition of milk 8. Market linkage 270 lit/Month (12.5%) Rs.5000 per month	9. Adoption of technology as of 3rd year 270 lit/Month (12.5%) Rs.5000 per month	10. Same technology to be adopted as on 4th year 270 lit/Month (12.5%) Rs.5000 per month	233.33

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Poultry birds- (Rs. 3800)	• Low income from poultry due to rearing of local bird	1. Backyard poultry 10 nos (Vanaraja) 2. Vaccination of birds (Laasota + Gumber) Net Income-Rs. 6,250/ (64%)	3. Backyard poultry 10 nos (Vanaraja) with proper vaccination (Lassota+ Gumber) 4. Supplementary 5. feeding with azolla Net Income-Rs. 7750/-	6. Backyard poultry 10 nos (Palishree) with proper vaccination (Lassota+ Gumber) 7. Supplementary feeding with azolla 8. Calcium supplementation to birds Net Income-Rs.10,500/-	9. Adoption of technology as of 3rd year	10. Same technology to be adopted as on 4th year	176.31
	Mushroom Net Income (Rs. 4000/yr)	• Low income due to im-proper management	1. Mushroom production of OSM-11 (20 beds/ month) and Blue Oyster mushroom cultivation2 bags/ day 2.4 kg/day (Rs.9000/yr)	2. Mushroom production of OSM-11 (20 beds/month)and Blue Oyster mushroom cultivation (20 beds/ month) 3. Management of competitor moulds and diseases in straw mushroom 3.2 kg/day (Rs.10500/yr)	4. Value addition of Mushroom 4.5 Kg/day Rs. 13200/yr	5. Adoption of technology as of 3rd year 4.5 Kg/day Rs. 13200/yr	6. Same technology to be adopted as on 4th year 4.5 Kg/day Rs. 13200/yr	230
	Average Increase in Income over 5 years							163.16

Agro-Climatic Zone 5: North Eastern Ghat

Districts: Kandhamal, Gajapati, Rayagada, part of Ganjam and patches of Koraput

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed upland	Rice-Fallow 18.6 q ha^{-1} (Rs. 7340/ ha)	• Water stress • Old var. Khandagiri/ Pathara • Broadcast sowing • Blanket fertilization • Hand weeding • Damage by Stem borer	1. Drought tolerant variety Sahabhagi Dhan/ Jyotirmayee/ DRR 44 22.3 q ha^{-1} Rs 10300/-	2. Line sowing 3. STFR 24.5 q ha^{-1} Rs. 12830/-	4. Chemical weed control 5. Stem borer control- Cartap Hydrochloride 50% SP @ 2g/ litre of water 27 q ha^{-1} Rs. 14300/-	6. Adoption of technology as of 3rd year 27 q ha^{-1} Rs. 14300/-	7. Same technology to be adopted as on 4th year 27 q ha^{-1} Rs. 14300/-	94.82
Rainfed Medium Land/ Shallow lowland	Rice- Black gram Rice: 32.5 q ha^{-1} (Rs.12800/ ha) Black gram (Paira) 2.2 q ha^{-1} (Rs.7800/ ha)	• Local varieties- RGL/ MTU 1010/Lalat/ IR 64 • Hand transplanting • Blanket fertilization • Hand weeding • Damage by stem bore • Local variety • No fertilizer application • Local Blackgram variety	1. HYV Naveen/ DRR-44 38q ha^{-1} Rs.16700 2. HYV PU 35/ Jyoti 3. Use finger lings of composite fish culture 3.0 q ha^{-1} Rs.9000/- 3.9 q ha^{-1} Rs.10400 Rs.60000 from fish culture	4. Line transplanting 5. STFR 6. Herbicide: Butachlor/ Bispyribac Na 42.2q ha^{-1} Rs.18000 7. Application of N and P @ 20-40 5Kg ha^{-1} in 10 days before sowing 4 q ha^{-1} Rs.12000	8. Transplanting of Paddy by self propelled transplanter 9. Harvest of paddy by Paddy reaper 45.4q ha^{-1} Rs.21000 10. INM with seed quaculture of Rhizobium and PSB 4.2q ha^{-1} Rs.15000	11. Adoption of technology as of 3rd year Rice: 45.4q ha^{-1} Rs.21000 Blackgram: 4.2q ha^{-1} Rs.15000	12. Same technology to be adopted as on 4th year Rice: 45.4q ha^{-1} Rs.21000 Blackgram: 4.2q ha^{-1} Rs.15000	71.29

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Semi-Irrigated upland	Maize- Fallow 23q ha^{-1} (Rs.23300/ha)	• Use of composite variety • Blanket fertilizer dose • Weed	1. Hybrid maize PAC 34/OMA 14 2. NPK @ 120:80:80 27q ha^{-1} Rs.27400/- (17.6%)	3. Weed control- Atrazin @ 1 l ha^{-1} Simazine $^{-1}$ @ 1 5Kg ha^{-1} 31.6q ha^{-1} Rs.30100/- (29.2%)	4. 4.Cultivation of sweet corn variety Sugar 75/ Misti 36.3q ha^{-1} Rs.34200/- (46.8%)	5. Adoption of technology as of 3rd year 36.3q ha^{-1} Rs.34200/- (46.8%)	6. Same technology to be adopted as on 4th year 36.3q ha^{-1} Rs.34200/- (46.8%)	46.76
	Arhar-Fallow 5.8 q ha^{-1} (Rs.13850/ha)	• Local var. (desi kandula & sana kandula, bada kandula) • Broadcasting • Blanket fertilization • High weed infestation	1. HYV Arhar ASHA/ LRG 41 7.1 q ha^{-1} Rs. 19600/- (41.5%)	2. Line sowing 3. STFR 4. Herbicide- Pendimethalin @15Kg ha^{-1} 8.3q ha^{-1} Rs.23100/- (66.8%)	5. Seed production of Arhar C.v BRG- 176 / BRG-4/BRG 5 10.3 q ha^{-1} Rs. 26100/- (88.4%) Rhizobium	6. Adoption of technology as of 3rd year Rs. 26100/-	7. Same technology to be adopted as on 4th year Rs. 26100/-	88.44
	Brinjal- fallow 150 q ha^{-1} (Rs.28000/ha)	• Fruit and Shoot borer problem • Rabi fallow • Old variety- Blue Star • Shoot and fruit borer	1. Cultivation of brinjal var. Muktakeshi / Utkal Jyoti / Utkal Tarini 185q ha^{-1} Rs. 35500/-	2. Control of shoot and fruit borer: Use of tricho cards @ 5-6 Nos. per acre and at in interval of 7-10 days, 195 q ha^{-1} Rs. 41800	3. Market linkage for sale of brinjal. 208 q ha^{-1} Rs.52100/-	4. Adoption of technology as of 3rd year Rs.52100	5. Same technology to be adopted as on 4th year Rs.52100	86.07
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ ha	13. Adoption of technology as of 4th year Rs.1,50,000/ ha 14. Adoption of technology as of 4th year Rs.2,50,000/ ha 15. Adoption of technology as of 4th year Rs.4,50,000/ ha	140 300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ ha	5. Adoption of technology as of 4th year Rs.1,50,000/ ha	500
	Carp poly culture pond aqua-culture	• Carp poly culture pond aquaculture • Rs.1,50,000/ ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ ha	13. Adoption of technology as of 4th year Rs.2,50,000/ ha 14. Adoption of technology as of 4th year Rs.2,50,000/ ha 15. Adoption of technology as of 4th year Rs.4,50,000/ ha	33.33 33.33 140

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ ha 10. Adoption of technology as of 4th year Rs.4,50,000/ ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ ha	-
	Intensive pangasius culture	• Intensive Pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like Murrel, Magur, Pabda	2. High value cat fish culture like Murrel, Magur, Pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ha	5. Adoption of technology as of 4th year Rs.10,00,000/ha	100
Homestead	Dairy 2 Cow Milk: 1 lit /day Rs. 5800/yr	• No green fodder supplements • High cost of concentrate feeding • No value addition in milk	1. Vaccination 2. Maintaining of sanitation of cattle shed Milk : 1.5 lit / day Rs.7000/yr (20.7%)	3. Hybrid nappier ,/ var. CO 4 . CO4(0.25 acre) 4. Farm made feed (broken rice , pulse bran), hay of pulses 5. Artificial insemination Rs.7000/yr	6. Location specific mineral mixture @ 80g/day. 7. Value addition of milk for cheese making Rs.9000/yr	8. Adoption of technology as of 3rd year Rs.9000/yr	9. Same technology to be adopted as on 4th year Rs.9000/yr	55.17
	Average Increase in Income over 5 year							153.1

Agro-Climatic Zone 6: Eastern Ghat High Land

Districts: Major parts of Koraput, Nawarangpur

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed Upland unbounded	Maize- Fallow 23q ha^{-1} (Rs.23300/ ha)	• Use of composite variety • Blanket fertilizer dose • Weed problem	1. Hybrid maize PAC 34/ OMA 14 2. NPK @ 120:80:80 27q ha^{-1} Rs.27400/- (17.6%)	3. Weed control- Atrazin @ 1 l ha^{-1} Simazine^{-1} @ 1 5Kg ha^{-1} 31.6q ha^{-1} Rs.30100/- (29.2%)	4. Cultivation of sweet corn variety Sugar 75/ Misti 36.3q ha^{-1} Rs.34200/- (46.8%)	5. Adoption of technology as of 3rd year 36.3q ha^{-1} Rs.34200/- (46.8%)	6. Same technology to be adopted as on 4th year 36.3q ha^{-1} Rs.34200/- (46.8%)	46.76
Rainfed upland	Niger 2 q ha^{-1} Rs 4700	• Local variety • High weed infestation • imbalance aquaculture use and • High incidence of disease	1. HYV utkal niger 150 2. IWM pendimethalini1kg ha^{-1} Yield- 3 q ha^{-1} Rs. 7800/-	3. STFR 4. Application Yield-4q ha^{-1} Rs 9200	5. IPDM in niger Yield- 5 q ha^{-1} Rs.11000	6. Adoption of technology as of 3rd year 5 q ha^{-1} Rs.11000	7. Same technology to be adopted as on 4th year 5 q ha^{-1} Rs.11000	134
	Ragi 6 q ha^{-1} Rs 5000/-	• Growing of local variety variety • High weed infestation • Imbalance aquaculture use • Incidence of blast	1. HYV bhairabi/ Subhra 2. IWM in Ragi with pendimethalin 1kg ai ha^{-1} Yield- 10 q ha^{-1} Rs. 9000/-	3. STFR Application Yield-11.8q ha^{-1} Rs 10000/-	4. IDM in ragi for blast 5. Seed treatment with pseudomonas fluroscence 10g/ kg of seed 6. Foliar spray of tricyclazole 6g/l Yield- 12.5 q ha^{-1} Rs.10300/-	7. Adoption of technology as of 3rd year Yield- 12.5 q ha^{-1} Rs.10300/-	8. Same technology to be adopted as on 4th year Yield- 12.5 q ha^{-1} Rs.10300/-	106

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Ginger – fallow 40q ha^{-1} Rs10,000	• Local var. • Severe rhizome rot • Blanket fertilizer application • Micronutient deficiency in acidic soil	1. HYV- Suprabha 50q ha^{-1} Rs 15000	2. STBRF application 3. Seed treatment with T.Viridae + Soil application with T. Viridae @ 105Kg ha^{-1} 4. Soil drenching with redomil MZ 2g l^{-1} 56 q ha^{-1} Rs 15800/-	5. management of ginger with boron (4.5 kg) and zinc (6.0 kg) due to acidic soil 60q ha^{-1} Rs 18200/-	6. Adoption of technology as of 3rd year 60q ha^{-1} Rs 18200/-	7. Same technology to be adopted as on 4th year 60q ha^{-1} Rs 18200/-	82
	Vegetables 85q (Potato) *kharif* Rs 20000/-	• Imbalance aquaculture use • High weed infestation • Diseases and pest incidence	1. STFR application 2. IWM (metribuzin @0.5 kg ai ha^{-1} 98q Rs26400/-	3. Ipm for 4. For termite, Chlorpyriphos 2g/l, white fly imidachlorpid 1ml/3lof water 103q Net income Rs. 28000	5. Disease management through IDM 112q Rs 29300 Yield 110q ha^{-1} Rs. 28000	6. Adoption of technology as of 3rd year Yield 110q ha^{-1} Rs. 28000	7. Same technology to be adopted as on 4th year Yield 110q ha^{-1} Rs. 28000	40
	Tomato *kharif* Yield 90q Rs 21000	• Imbalance aquaculture use • High weed infestation • Diseases and pest incidence	1. STFR application 2. IWM (metribuzin @0.5 kg ai ha^{-1} Yield 102q ha^{-1} Rs 24400	3. Ipm for termite, Chlorpyriphos 2g/l, white fly imidachlorpid 1ml/3lof water IPM Yield 107qha^{-1} Rs25100/	4. INM Yield 108q ha^{-1} Rs26000	5. Adoption of technology as of 3rd year Yield 108q ha^{-1} Rs26000	6. Same technology to be adopted as on 4th year Yield 108q ha^{-1} Rs26000	23.80
Irrigated (Medium land)	Paddy-Vegetables 30q ha^{-1} (Rs.12000)	• use of imbalanced fertilizer • high rate of insect pest infestation (BPH& Stem Borer)	1. Use of Green manuring in Paddy (Dhannicha 205Kg ha^{-1}) 2. STFR 33q ha^{-1} (Rs.15000)	3. BPH management 4. Split application of N-fertilizer 36q ha^{-1} (Rs.18000)	5. IPM 39q ha^{-1} (Rs.20000)	6. Adoption of technology as of 3rd year 39q ha^{-1} (Rs.20000)	7. Same technology to be adopted as on 4th year 39q ha^{-1} (Rs.20000)	66.66

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Vegetables (Cabbage & Cauliflower) Rs. 70,000	• Use of low quality planting material • DBM in Cauliflower and leaf webber in Cabbage.	1. Introduction of Hybrid tolerant planting material 160q ha^{-1} (Rs.80000)	2. STFR 180q ha^{-1} (Rs.90000)	3. DBM management 200q ha^{-1} Rs110000	4. Adoption of technology as of 3rd year 200q ha^{-1} Rs110000	5. Same technology to be adopted as on 4th year 200q ha^{-1} Rs110000	57.14
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ ha	60
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	140 300 620

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 33.33 140
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ha 10. Adoption of technology as of 4th year Rs.4,50,000/ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Intensive pangasius culture	• Intensive pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like murrel, Magur, pabda	2. High value cat fish culture like murrel, Magur, pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ha	5. Adoption of technology as of 4th year Rs.10,00,000/ha	100
Homestead	Poultry Desi Breed (20no) Rs. 8000	• Low production due to single enterprise	1. Poultry (Banaraja) (20) Rs 12000	2. Feed management of Banaraja Rs. 16000	3. Feed management of Banaraja Rs. 16000	4. Adoption of technology as of 3rd year Rs. 16000	5. Same technology to be adopted as on 4th year Rs. 16000	100
	Average Increase in Income over 5 year							140.16

Agro-Climatic Zone 7: South Eastern Ghat

Districts: Malkangiri & parts of Koraput

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed Upland	Rice-fallow 21.7 q ha^{-1} Rs.8100	• Local var. Trimurti • Broadcast sowing • Blanket fertilization • Hand weeding	1. Paddy var. Sahabhagidhan, 2. Line Sowing, 3. STFR Yield-32.5q ha^{-1} Rs-10500	4. Brown manuring (Dhanicha 15 5Kg ha^{-1} with application of 2,4-D Ester 1kg ai ha^{-1} at 30DAS. 5. STFR 6. Herbicide-Bispyribac Na Yield-34.5q ha^{-1} Rs-12000	7. Use of power reaper 8. Thresher for cost reducing implements in rice. Yield-34.6q ha^{-1} Rs.14000	9. Adoption of technology as of 3rd year Yield-34.6q ha^{-1} Rs.14000	10. Same technology to be adopted as on 4th year Yield-34.6q ha^{-1} Rs.14000	80.24
Rainfed Medium land	Rice- Greengram Rice 31.8q ha^{-1} Rs.12250 Greengram Rs .3000	• Hand weeding • Manual transplanting • Late planting, 2nd week of August. • Local seeds • YMV, Low yield	1. Paddy var-Hybrid Ajay/Bina 11 2. Line transplanting Early planting (Last week of July 3. STFR 4. Green gram in Var-TARM-1 /IPM02-3,IPM02-14 Yield 42.6q ha^{-1} Rs 22000 Yield 2.5 q ha^{-1} Rs.2500	5. INM (Dhanicha incorporation, soil application of PSB 5kg ha^{-1} and Azosporilium 10 5Kg ha^{-1} 6. Weed management with Bispyribac sodium @25 g ha^{-1} at 20-25DAT 7. STFR Yield-44.0q ha^{-1} Rs-23000 Yield 3.0 q ha^{-1} Rs.3500	8. Use of power reaper , thresher for cost reducing implements in rice. Use of zero till drill showing 9. YMV mgmt 10. IDM - Moong IPM 2-14+ yellow sticky trap @ 30 ha^{-1} and Thiomethoxam spray @ 200 g ha^{-1} Yield-45.0 q ha^{-1} Rs.24000 Yield 3.5 q ha^{-1} Rs.5000	11. Adoption of technology as of 3rd year Yield-45.0 q ha^{-1} Rs.24000 Yield 3.5 q ha^{-1} Rs.5000	12. Same technology to be adopted as on 4th year Yield-45.0 q ha^{-1} Rs.24000 Yield 3.5 qha^{-1} Rs.5000	90.16

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Irrigated Medium land	Hyv paddy- 37.8q ha^{-1} Rs.17920	• Rice weed menace high cost in transplanting stemborer	1. Paddy Hybrid Ajay/ Binadhan/ Hiranmayee 2. Fripronil in nursery 1.5kg/ 1000m^2 and 15 5Kg ha^{-1}15 DAT, 50 nos of Phermeno traps ha^{-1} and Trichogamma japanicom 50,000/ha. 3. Pre emergence application of Bensulfuron (0.6%)Pretilachlor @660g ha^{-1} at 3 to 7 DAT Yield 42.6q ha^{-1} Rs.22580	4. Hiranmayee 5. line trans planting 6. STFR Yield 43.0q ha^{-1} Rs.23500	7. Use of power reaper, 8. Thresher for cost reducing implements in rice. Yield 43.0q ha^{-1} Rs.24000	9. Adoption of technology as of 3rd year Yield 43.0q ha^{-1} Rs.24000	10. Same technology to be adopted as on 4th year Yield 43.0q ha^{-1} Rs.24000	33.92
	Pointed guard Rs.4000	• Fruit drops , • Unavailability of planting material	1. Var. Kajola Rs.5000	2. Trailing system 3. STFR Rs.7000	4. Trailing system 5. Production of planting material Rs.7500	6. Adoption of technology as of 3rd year Rs.7500	7. Same technology to be adopted as on 4th year Rs.7500	87.50
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ ha 14. Adoption of technology as of 4th year Rs.2,50,000/ ha 15. Adoption of technology as of 4th year Rs.4,50,000/ ha	140 300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000 /ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ ha 14. Adoption of technology as of 4th year Rs.2,50,000/ ha 15. Adoption of technology as of 4th year Rs.4,50,000/ ha	33.33 33.33 140

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ ha 10. Adoption of technology as of 4th year Rs.4,50,000/ ha	80
	Semi-intensive two species commercial quaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ ha	-
	Intensive pangasius culture	• Intensive pangasius culture • Rs.4,00,000/ha	1. High value cat fish culture like murrel, Magur, pabda	2. High value cat fish culture like murrel, Magur, pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ha	5. Adoption of technology as of 4th year Rs.10,00,000/ha	100
Homestead	Poultry Rs. 3000	• Less growth of local birds	1. Pallishree (10 birds), vaccination, feeding 2 kg/6 month/ birds 20 kg Rs.4000	2. Supplementation of vitamin and mineral mixture (@10-15gm/day) 1.5kg/bird Rs.6000	3. 15 birds each Rs.8000	4. Adoption of technology as of 3rd year Rs.8000	5. Same technology to be adopted as on 4th year Rs.8000	166.66
	Goatery 3 nos. Rs.5000	• Low income Rs.6500 from goatery unit due to local breed	1. Improved Black bengel Live body weight (kg/annum) 6kg, Rs.7000	2. Deworming of goats Albendazole @10mg/ kg body weight (upto 6 months) and Zycloz@ 1lm/10kg body weight) after 6 months. Live body weight (kg/annum) 10kg, Rs. 9000	3. Improved feed management Live body weight (kg/ annum) 12kg, Rs.10000	4. Adoption of technology as of 3rd year Rs.10000	5. Same technology to be adopted as on 4th year Rs.10000	100.00
	Average Increase in Income over 5 years							160.32

Agro-Climatic Zone 8: Western Undulating Zone

Districts: Kalahandi & Nuapada

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed Upland	Cotton-Fallow 8 q ha^{-1} (Rs. 18,000)	• High incidence of sucking pest and bollworm. • Rampant use of fertilizer & indiscriminate use of plant chemicals	1. Demonstration of IPM practices 2. Growing castor and marigold as trap crop 3. Sowing of imidacloprid treated seed (5 g/kg of seed) 4. Installation pheromone traps 20nos. ha^{-1} 12q Rs.22,000	5. Demonstration of IPM practices 6. Application of HaNPV @ 500 l ha^{-1}. & handpicking of harmful larvae 7. Neem pesticide for management of sucking pests and bollworm at early vegetative stage @ 2 l ha^{-1} 8. Set up bird perches @20 nos. ha^{-1} 13.5q Rs.25,000	9. Plough deeply to expose resting pupae. 10. Avoid excess use of nitrogen fertilizers at the reproductive. 11. Use 5% neem seed kernel extract (NSKE) at 45 DAS. 12. Topping cotton twigs at 90 days after sowing. 13. Application Indoxacarb 14.5 SC @ 250 ml ha^{-1} 15q ha^{-1} (Rs. 28,000)	14. Adoption of technology as of 3rd year 15q ha^{-1} (Rs. 28,000	15. Same technology to be adopted as on 4th year 15q ha^{-1} (Rs. 28,000	55.55
Rainfed Medium land	Rice-Green gram Paddy(MTU 1001) 28 q ha^{-1} (Rs.13000)	• High weed incidence • Imbalance dose of fertilizer • application Low yield due to terminal drought • Incidence of BLB	1. Weed management in paddy-Pre-emergence weedicide Londax power (Bensulfuron methyl+ pretilachlor) @ 105Kg ha^{-1} 0-5 DAT 35 q ha^{-1}, Rs 17,000./ha	2. Post –emergence weedicide Bispyribic sodium200ml ha^{-1} followed by one hand weeding 37q ha^{-1} Rs.19,000/ha	3. Cultivation of short duration rice Var-Sahabhagi 4. STFR 5. Spraying of Plantomycin @ 1gm/l of water or Streptocycline (2gm/10lit) + copperoxychloride (1gm)/l of water. 40 q ha^{-1}, Rs. 20,000/ha	6. Adoption of technology as of 3rd year 40 q ha^{-1} Rs. 20,000/ha	7. Same technology to be adopted as on 4th year 40 q ha^{-1} Rs. 20,000/ha	53.80

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Green gram- 4.0q ha^{-1} Rs.10000	• High seed rate • Farmers do not apply fertilizer and bio fertilizer • YMV infestation	1. Demonstration on Green gram (var. IPM 02-3) 2. Seed inoculation with rhizobium& PSB @ 20 gm/kg of seed 3. Seed sowing behind the plough 5.8 q ha^{-1} (Rs.16000)	4. Demonstration on Management of YMV 5. Installation of yellow sticky trap 6. Spyaring of Imadichloroprid 5ml@15lit of water 6.0q ha^{-1} (Rs.18,000)	7. Demonstration on Green gram 8. (IPM 02-14) 9. STFR 1. 2q ha^{-1} (Rs.22000)	10. Adoption of technology as of 3rd year 40 q ha^{-1} Rs. 20,000/ha	11. Same technology to be adopted as on 4th year 40 q ha^{-1} Rs. 20,000/ha	100
Rainfed Low land	Rice- Green gram Rice: 30qha^{-1} Rs. 16,000	• Heavy weed incidence • Incidence of sheath blight disease in paddy • Micro-nutrient deficiency • Blanket fertilizer	1. Demonstration effect of Herbicide in paddy 2. Pendimethalin (38.7% SC) @ 750g ha^{-1}/ Bispyribic Na 200ml ha^{-1} at 0-3 DAT 35 q ha^{-1} Rs. 19,000	3. Application of Validamycin @ 1l ha^{-1} for control against sheath blight 36.0 q ha^{-1} Rs.20,000	4. Foliar application of application of zinc @2.5gm/lit of water 5. SFTB 38.0 q ha^{-1} Rs.22,000	6. Adoption of technology as of 3rd year 40 q ha^{-1} Rs. 20,000/ha	7. Same technology to be adopted as on 4th year 40 q ha^{-1} Rs. 20,000/ha	25.00
	Rabi Green gram (residual moisture) 3.8 q ha^{-1} Rs. 8,000	• Blanket fertilization and seed inoculation is not followed • Incidence of leaf spot & Powderly mildew • Lack crop management practices	1. Seed inoculation with rhizobium& PSB @ 20 gm/kg of seed before sowing 2. STFR 5.5 q ha^{-1} (Rs.14000)	3. Spraying of Copper oxychloride 1gm/lit of water to control leaf spot. 5.9q ha^{-1} Rs.16,000	4. Application of Sulphur 3gm/lit of water to control Powdery mildew. 5. Planofix hormone 250ml ha^{-1} before flowering for better pod development. 6. 2q ha^{-1} Rs.18,000	7. Adoption of technology as of 3rd year 6.2q ha^{-1} Rs.18,000	8. Same technology to be adopted as on 4th year 6.2q ha^{-1} Rs.18,000	125

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Irrigated Upland	-Paddy-vegetables 18.7 q ha^{-1} Rs. 9800	• Cultivation of upland paddy varieties • Low yield • Weed infestation • Blanket fertilization	1. Paddy cultivation 2. Herbicide - Pendimethalin 23.8 q ha^{-1} Rs.13700	3. Onion (*Kharif&rabi*) with herbicide – Quizalpfop ethyl5% EC+ Oxyflurofen 32.5% EC 122.0 q ha^{-1} Rs. 20800	4. Copper oxychloride + Thiomethaxom 5. STFR 139.0 q ha^{-1} Rs.27000	6. Adoption of technology as of 3rd year 139.0 q ha^{-1} Rs.27000	7. Same technology to be adopted as on 4th year 139.0 q ha^{-1} Rs.27000	175.50
	Yield of cauliflower 138-145.0 q ha^{-1} Rs. 88600	• Unavailability of quality seed • -Imbalance use of fert. • -Pest and disease	1. Good quality seed of cauliflower (Var-Barkha/ Megha / Early Kuanri) 146.0 q ha^{-1} Rs.89300	2. Cauliflower 3. STFR 153.0 q ha^{-1} Rs.96400	4. Cauliflower 5. Flonicamide @ 60gm/acre/ Emamectin Benzoate 100gm/acre 162.0q ha^{-1} Rs. 98800	6. Adoption of technology as of 3rd year 162.0q ha^{-1} Rs. 98800	7. Same technology to be adopted as on 4th year 162.0q ha^{-1} Rs. 98800	11.51
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ ha 14. Adoption of technology as of 4th year Rs.2,50,000/ ha 15. Adoption of technology as of 4th year Rs.4,50,000/ ha	140 300 620

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha 14. Adoption of technology as of 4thyear Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 33.33 140
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ha 10. Adoption of technology as of 4th year Rs.4,50,000/ha	- 80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Intensive pangasius culture	• Intensive pangasius culture • Rs.4,00,000/ ha	1. High value cat fish culture like murrel, Magur, pabda	2. High value cat fish culture like murrel, Magur, pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ha	5. Adoption of technology as of 4th year Rs.10,00,000/ ha	100
Allied activities	Goatery (20 Goats) Rs 8975/-	• High endoparasitic infestation, high morbidity and mortality rate of kids with lower birth weight • No use of supplementary feeding	1. Control of endo-parasitic infestation in small ruminants 15 gm of mineral mixture/goat for 2-3 months. 2. Antherimetics @5-7.5mg/kg body weight in 2 doses per month-Quarterly deworming per year 3. Liver tonic @0.25-0.5ml/ goat for 5-7 days along with 50gm of concentrate feed for 3 months Rs 14,175/- per annum	4. Supplementary feeding (Concentrate feeding @ 200gm/day/ doe 1month before kidding and 1 month after kidding. Rs 16,855/- per annum	5. Supplementary feeding (Concentrate feeding @ 200gm/day/doe 1month before kidding and 1 month after kidding. Rs 18500/- per annum	6. Adoption of technology as of 3rd year Rs 18500/- per annum	7. Same technology to be adopted as on 4th year Rs 18500/- per annum	106.12
	Mushroom cultivation	• Not cultivating mushroom • New intervention	1. Mushroom production of Paddy straw mushroom (20 beds) and Oyster mushroom(20 bags) Net Income 16kg PSM@100 30kg OM@60 (Rs. 3400/-yr)	2. Mushroom production of OSM-11 (25 beds/month) and Blue Oyster mushroom cultivation- 40bags/day Net Income 20kg PSM@100 37kg OM@60 (Rs. 4420/-yr)	3. Mushroom production of OSM-11 (35 beds/ month)and Blue Oyster mushroom cultivation(35beds/ month) Management of competitor moulds and diseases in straw mushroom Net Income 28kg PSM@100 50kg OM@60 (Rs. 5800/-yr)	4. Adoption of technology as of 3rd year (Rs. 5800/-yr)	5. Same technology to be adopted as on 4th year (Rs. 5800/-yr)	70.58
	Average Increase in Income over 5 years							157.52

Agro-Climatic Zone 9: West Central Table Land Zone

Districts: Bargarh, Bolangir, Boudh, Sonepur, Parts of Sambalpur and Jharsuguda

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Up land (bunded) Rainfed	Rice-Fallow 15 q ha^{-1} Rs 6,000/-	• Local var. • Broadcast sowing Blanket fertilization • Hand weeding • Rabi – fallow • Incidence of Gundhy bug	1. Paddy var. Sahabhagidhan 2. staggered transplanting 3. STFR application 18q ha^{-1} Rs.8,000/-	4. Paddy var. Sahabhagidhan 5. 15 days early & line transplanting 6. STFR application 7. Herbicide Oxadiargyl and one hand weeding 22 q ha^{-1} Rs.10,000/-	8. Paddy var. Sahabhagidhan 9. 15 days early & line transplanting 10. STFR application 11. Herbicide Oxadiargyl and one hand weeding 22 q ha^{-1} Rs.10,000/-	12. Adoption of technology as of 3rd year 22 q ha^{-1} Rs.10,000/-	13. Same technology to be adopted as on 4th year 22 q ha^{-1} Rs.10,000/-	66.66
Medium land, Irrigated	G.nut- Vegetables G.Nut 4 q ha^{-1} Rs 12,000/- Vegetable 130 q ha^{-1} Rs 20,000	• Local var • Hand weeding • Blanket quaculturen • Incidence of White grub and Cercospora • Wilt and fruit borer in vegetable	1. Devi var . 2. Herbicide Imazethapyr 3. STFR, Micronutrient mix 4. Brinjal var. AN Kranti 5. Tomato var. Swarna Sampad, G.Nut 6 q ha^{-1} Rs 18,000/- Vegetable 220 q ha^{-1} Rs 30,000	6. As in 1st yr 7. Drenching of Chloro-pyriphos 8. Seed dressing with(biofert) 9. Growing of Onion (AFDR), Watermelon (garden baby),Cauliflower (snow ball) as vegetables G.Nut - 6 q ha^{-1} Rs 18,000/- Vegetable 240 q ha^{-1} Rs 33,000.	10. As in 1st yr 11. Growing of Onion (AFDR) , Watermelon (garden baby),Cauliflower (snow ball) as vegetables. G.Nut 6 q ha^{-1} Rs 18,000/- Vegetable 250 q ha^{-1} Rs 35,000	12. Adoption of technology as of 3rd year G.Nut 6 q ha^{-1} Rs 18,000/- Vegetable 250 q ha^{-1} Rs 35,000	13. Same technology to be adopted as on 4th year G.Nut 6 q ha^{-1} Rs 18,000/- Vegetable 250 q ha^{-1} Rs 35,000	65.62

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed lowland	Rice – Greengram (paira) Rice 18 q ha^{-1} Rs 8,000/- G.Gram 0.8 q ha^{-1} Rs 3000	• Lalat var. • Late trans-planting • Blast and Stem borer • Hand weed-ing • Rabi – Green gram (Paira) • No nutrients • No YMV control measure	1. Transplanting before 15 days 2. Spray of Tricyclazole &Propheno-phos 3. Green-gram (paira) local 4. Protection against YMV DAP 50 5Kg ha^{-1} 5. Rice-fish Inte-grated System (in-field refuge system) 22 q ha^{-1} Rs.10,000/- 1 .5q ha^{-1} Rs 4000/-	6. Transplanting before 15 days 7. Mgt of Blast & Stem borer 8. Herbicide 9. Bispyribac Na 10. Green-gram (paira) with 11. Var. TARM-1 12. Micronutrient appln. STFR 2% DAP spray at flowering and 15 days after 22 q ha^{-1} Rs.10,000/- 2 q ha^{-1} Rs 8000	13. Transplanting before 15 days 14. Measures for Blast & Stem borer 15. Herbicide 16. Bispyribac Na 17. Green-gram (paira) 18. Var. TARM-1 19. Micronutrient appln. 20. 2% DAP spray 22 q ha^{-1} Rs.10,000/- 3 q ha^{-1} Rs 8000/-	21. Adoption of technology as of 3rd year 22 q ha^{-1} Rs.10,000/- 3 q ha^{-1} Rs 8000/-	22. Same technology to be adopted as on 4th year 22 q ha^{-1} Rs.10,000/- 3 q ha^{-1} Rs 8000/-	63.63
Pond Sys-tem	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ ha	1. Extensive scien-tific carp culture with yield 3 t ha^{-1}	4. Extensive scien-tific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha	7. Adoption of technology as of 2nd year Rs.1,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha	140

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
			2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	300 620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3 t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture 3. High value SIFS with exotic horticulture	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha 9. Adoption of technology as of 2nd year Rs.4,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha 12. Adoption of technology as of 3rd year Rs.4,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha 15. Adoption of technology as of 4th year Rs.4,50,000/ha	33.33 33.33 140

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1} 2. High value fish based culture	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha 4. High value fish based culture Rs.4,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha 6. Adoption of technology as of 2nd year Rs.4,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha 8. Adoption of technology as of 3rd year Rs.4,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ha 10. Adoption of technology as of 4th year Rs.4,50,000/ha	- 80
	Semi-intensive Two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-
	Intensive pangasius culture	• Intensive pangasius culture • Rs.4,00,000/ ha	1. High value cat fish culture like murrel, Magur, pabda	2. High value cat fish culture like murrel, Magur, pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ ha	5. Adoption of technology as of 4th year Rs.10,00,000/ ha	100
Home- stead	Milch Cows (2 nos) Rs 10,000/ yr Local poulty bird (nos) Rs 150/-	• No fodder supplement • high cost concentrate • Low milk yield • Free forazing of birds • Under-utilized homestead	1. Mineral mixture @ 50 gm/cow 2. ten beds;Dhingri mushroom 3. Pallishree birds 10 no 4. Pomogr-anate sapl-ings (5 no) Milk 5 lit/ day Rs 15,000/yr Mushroom 1.4 kg/bed Rs 1000 1.8 kg/ bird Rs 3000	5. Intervention of 1st yr 6. Hyb napier CO4 7. Dhingri mushroom 20 beds; Milk 5 lit/ day Rs 15,000 /yr #Banaraja birds 20 no 1.8 kg/ bird Rs 5000	8. Interven-tion of 2ndyr 9. Hyb napier CO4 10. Dhingri / Milk 6 lit/ day Rs 16,000 /yr 11. Banaraja 15 nos . with overlap bird batches of two yrs 1.8 kg/ bird Rs 8,000	12. Adoption of technology as of 3rd year Milk 6 lit/ day 13. Rs 16,000 /yr 14. Banaraja birds 20 no 1.8 kg/ bird Rs 8000	15. Same technology to be adopted as on 4th year Milk 6 lit/ day Rs 16,000 /yr 16. Banaraja birds 20 no 1.8 kg/ bird Rs 8000	108.69
	Average Increase in Income over 5 years							165.1

Agro-Climatic Zone 10 : Mid Central Table Land Zone

Districts: Angul, Dhenkanal, Parts of Cuttack and Jajpur

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
Rainfed Upland	Rice yield-19.0 q ha^{-1} Net return Rs.4160	• Old variety • Hand weeding • Broadcast sowing • Injudicious fertilization	1. HYV-Satyabhama 2. RDF NPK 60:30:305Kg ha^{-1} 24q ha^{-1} Rs.5600	3. HYV-Satyabhama/ Sahabhagi dhan 4. Herbicide-Oxadiargyl / Oxyflourfen 28 q ha^{-1} Rs.6872	5. HYV Satyabhama/ Sahabhagi dhan 6. Herbicide-Oxadiargyl /Oxyflourfen 7. Line sowing 8. STFR application 35.0 q ha^{-1} Rs.9280	9. Adoption of technology as of 3rd year 35.0 q ha^{-1} Rs.9280	10. Same technology to be adopted as on 4th year 35.0 q ha^{-1} Rs.9280	123.07
Rainfed Upland	Blackgram (*Kharif*) Yield- 3.2 q ha^{-1} Net return Rs.1020	• Local variety • Injudicious fertilization • Pest (Aphid attack) • Broadcast sowing • No weeding	1. 1.HYV- PU 35 4.4 q ha^{-1} Rs.1604	2. HYV- PU 35/ 3. PU 30 4. Rhizobium culture 5. NPK (20-40-20 5Kg ha^{-1}) 6. Imidachloprid/ Thiomithoxan 5.2 q ha^{-1} Rs.2132	7. HYV PU 35 8. Rhizobium culture 9. NPK(20-40-20 5Kg ha^{-1} 10. Imidachloprid/ Thiomithoxan 11. Herbicide- Pendimethalin 12. Line sowing 5.9q ha^{-1} Rs..2340	13. Adoption of technology as of 3rd year 5.9 q ha^{-1} Rs.2340	14. Same technology to be adopted as on 4th year 5.9 q ha^{-1} Rs.2340	129.41
Rainfed Upland	Mango Orchard (yield-48 q ha^{-1}) Net return Rs.6480)	• Attack of pest (Mango hopper) • Canopy management	1. Application of Thiomethoxam Yield-53 q ha^{-1} Rs.7160	2. .Application of Thiomethoxam/ Quinalohos 3. Canopy management Yield-55 q ha^{-1} Rs.7800	4. Application of planofix + etheryl 5. Canopy management Yield-57 q ha^{-1} Rs.7800	6. Adoption of technology as of 3rd year Yield-57 q ha^{-1} Rs.7800	7. Same technology to be adopted as on 4th year Yield-57 q ha^{-1} Rs.7800	20.37

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
		• Distress sale • Home consumption Unhygenic	1. Mango leather with 0.1% KMS by sun drying 0.2q mango leather Rs.1250	2. Mango leather with 0.1% KMS by solar dryer 0.2q mango leather Rs.1480	3. Mango leather with 0.1% KMS and spices by solar dryer 0.3q Spicy mango leather Rs.2025	4. Adoption of technology as of 3rd year Rs.2025	5. Same technology to be adopted as on 4th year Rs.2025	62
Irrigated medium land	Paddy (var. MTU-1010) – Paddy (var. MTU-1010, Lalat) 38.5 q ha^{-1} Rs 16250/-	• Staggered planting • Weed infestation • Indiscriminate use of quacultur application • Stem borer and sheath blight infestation	1. Line transplanting with RDF (80:40:40) 2. Weed management 3. IPM in paddy 42 q ha^{-1} Rs 19,100	4. Paddy hybrid Ajay / Rajalaxmi in kharif with line transplanting 52 q ha^{-1} Rs 25,125/-	5. BPH management 6. INM 56 q ha^{-1} Rs 26800	7. Adoption of technology as of 3rd year 56 q ha^{-1} Rs 26800	8. Same technology to be adopted as on 4th year 56 q ha^{-1} Rs 26800	64.92
	Vegetable (Cabbage-180q ha^{-1}) Rs.18,000	• Imbalanced quacultur application • Diamond back moth in cabbage	1. Improved nursery raising and planting technique of cabbage 200q ha^{-1} Rs.21,000	2. Spinosad 45% SC@ 125ml ha^{-1} for management of DBM in cabbage 225q ha^{-1} Rs.25,000	3. STB fertilizer application in cabbage 235 q ha^{-1} Rs.29,000	4. Adoption of technology as of 3rd year 235 q ha^{-1} Rs.29,000	5. Same technology to be adopted as on 4th year 235 q ha^{-1} Rs.29,000	61.11
Pond System	Small farm pond (<0.2 ha)	• Small farm pond (<0.2 ha)	1. Seed production of carps Rs.30,000/ha	2. Seed production of carps Rs.30,000/ha	3. Adoption of technology as of 2nd year Rs.30,000/ha	4. Adoption of technology as of 3rd year Rs.30,000/ha	5. Adoption of technology as of 4th year Rs.30,000/ha	-

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Seasonal water bodies	• Seasonal water bodies • Rs.30,000/ ha	1. Early maturing species culture like minor carps, tilapia, prawn aquaculture	2. Early maturing species culture like minor carps, tilapia, prawn aquaculture Rs.60,000/ha	3. Adoption of technology as of 2nd year Rs.60,000/ha	4. Adoption of technology as of 3rd year Rs.60,000/ha	5. Adoption of technology as of 4th year Rs.60,000/ha	60
	Medium sized farm pond (0.2 to 1 ha)	• Medium sized farm pond (0.2 to 1 ha) • Rs.50,000/ ha	1. Extensive scientific carp culture with yield 3 t ha^{-1} 2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture	4. Extensive scientific carp culture with yield 3 t ha^{-1} Rs.1,50,000/ha 5. Integrated farming of fish-poultry, fish-livestock,	7. Adoption of technology as of 2nd year Rs.1,50,000/ha 8. Adoption of technology as of 2nd year Rs.2,50,000/ha	10. Adoption of technology as of 3rd year Rs.1,50,000/ha 11. Adoption of technology as of 3rd year Rs.2,50,000/ha	13. Adoption of technology as of 4th year Rs.1,50,000/ha 14. Adoption of technology as of 4th year Rs.2,50,000/ha	140 300
			3. High value SIFS with exotic horticulture	fish-poultry-horticulture Rs.2,50,000/ha 6. High value SIFS with exotic horticulture Rs.4,50,000/ha	9. Adoption of technology as of 2nd year Rs.4,50,000/ha	12. Adoption of technology as of 3rd year Rs.4,50,000/ha	15. Adoption of technology as of 4th year Rs.4,50,000/ha	620
	Derelict multiple use village pond	• Derelict multiple use village pond Rs.20,000/ ha	1. Extensive carp culture system with yield of 3 t ha^{-1}	2. Extensive carp culture system with yield of 3t ha^{-1} Rs.1,50,000/ha	3. Adoption of technology as of 2nd year Rs.1,50,000/ha	4. Adoption of technology as of 3rd year Rs.1,50,000/ha	5. Adoption of technology as of 4th year Rs.1,50,000/ha	500

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Carp poly culture pond aquaculture	• Carp poly culture pond aquaculture • Rs.1,50,000/ ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1}	4. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha	7. Adoption of technology as of 2nd year Rs.2,50,000/ha	10. Adoption of technology as of 3rd year Rs.2,50,000/ha	13. Adoption of technology as of 4th year Rs.2,50,000/ha	33.33
			2. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture	5. Integrated farming of fish-poultry, fish-livestock, fish-poultry-horticulture Rs.2,50,000/ha	8. Adoption of technology as of 2nd year Rs.2,50,000/ha	11. Adoption of technology as of 3rd year Rs.2,50,000/ha	14. Adoption of technology as of 4th year Rs.2,50,000/ha	33.33
			3. High value SIFS with exotic horticulture	6. High value SIFS with exotic horticulture Rs.4,50,000/ha	9. Adoption of technology as of 2nd year Rs.4,50,000/ha	12. Adoption of technology as of 3rd year Rs.4,50,000/ha	15. Adoption of technology as of 4th year Rs.4,50,000/ha	140
	Semi-intensive carp poly culture	• Semi-intensive carp poly culture • Rs.2,00,000/ ha	1. Semi-intensive system of carp culture with yield 6 t ha^{-1}	3. Semi-intensive system of carp culture with yield 6 t ha^{-1} Rs.2,50,000/ha	5. Adoption of technology as of 2nd year Rs.2,50,000/ha	7. Adoption of technology as of 3rd year Rs.2,50,000/ha	9. Adoption of technology as of 4th year Rs.2,50,000/ha	-
			2. High value fish based culture	4. High value fish based culture Rs.4,50,000/ha	6. Adoption of technology as of 2nd year Rs.4,50,000/ha	8. Adoption of technology as of 3rd year Rs.4,50,000/ha	10. Adoption of technology as of 4th year Rs.4,50,000/ha	80
	Semi-intensive two species commercial aquaculture (Andhra model)	• Semi-intensive two species commercial aquaculture (Andhra model) • Rs.3,00,000/ ha	1. Improved efficiency through genetically improved carps, better quality feed and scientific management	2. Improved efficiency through genetically improved carps, better quality feed and scientific management Rs.3,50,000/ha	3. Adoption of technology as of 2nd year Rs.3,50,000/ha	4. Adoption of technology as of 3rd year Rs.3,50,000/ha	5. Adoption of technology as of 4th year Rs.3,50,000/ha	-

Farming situation	Major existing practices (2016-17)	Constraints	Technological interventions					Increase in income by 2022 (%)
			1st year (2017-18)	2nd year (2018-19)	3rd year (2019-20)	4th year (2020-21)	5th year (2021-22)	
	Intensive pangasius culture	• Intensive pangasius culture • Rs.4,00,000/ ha	1. High value cat fish culture like murrel, Magur, pabda	2. High value cat fish culture like murrel, Magur, pabda Rs.10,00,000/ha	3. Adoption of technology as of 2nd year Rs.10,00,000/ha	4. Adoption of technology as of 3rd year Rs.10,00,000/ha	5. Adoption of technology as of 4th year Rs.10,00,000/ ha	100
Home stead	Paddy straw introduction	• Non-utilisation of paddy straw • Improper substrate management	1. Mushroom Cultivation Var. OSM11(12 Beds) 0.12q Rs.1000	2. Var. 3. V.Volvaceae/ OSM 11 4. .Presoaking of Paddy straw with 2% CaCO3 (12 beds) 0.26 q Rs.1300	5. 3. Var. 6. V.volvaceae/ OSM 11 7. Presoaking of Paddy straw with 2% CaCO3 (24 beds) 0.53 q Rs.1600	8. Adoption of technology as of 3rd year (48 beds) 0.53 q Rs.1600	9. Same technology to be adopted as on 4th year (48 beds) 0.53 q Rs.1600	60.00
Home stead	Dairy: 1 CB cows 5 lit/day Rs.16750	• Imbalanced feeding • Improper disease management • Delayed puberty	1. Azolla 5. 6 lit/day Rs.23035	2. .Feed prepn. 3. .Deworming and mineral mixture supple-mentation 6.5 lit/day Rs.29480	4. Feed prepn. 5. Deworming and mineral mixture supple-mentation 6. Disease management of FMD 7.2 lit/day Rs.35268	7. Adoption of technology as of 3rd year 7.2 lit/day Rs.35268	8. Same technology to be adopted as on 4th year 7.2 lit/day Rs.35268	110.55
	Goat (5 nos.) (Live wt.13.5 kg/ goat) Net Profit Rs.15000/ year	• Poor management • Disease occurrence • Less income	1. De worming with albendazole @10mg/kg body wt 4 No. Kids Live wt. 14.2 kg/goat Net Profit Rs. 17000	2. .Deworming 3. PPR vaccination 6 No. Kids Live wt.14.5kg/ goat Net Profit Rs.18000	4. Deworming 5. PPR Vaccination 6. Feeding @250gm / pregnant doe 1 month before & 1 month after kidding 12 No. Kids Live wt.14.5 kg/ goat Net Profit Rs.23000	7. Adoption of technology as of 3rd year Rs.23000	8. Same technology to be adopted as on 4th year Rs.23000	53.33
	Average Increase in Income over 5 years							141.65

21.3 Summary recommendations

Average agricultural productivity and farmers income of Odisha is low compared to other states in the country. To increase crop productivity, quality and judicious use of inputs such as water, seeds, fertilizer and pesticides need to be improved with efficient use of modern technology and diversification of enterprises. To increase income of farmers, a range of strategies (Economic, Technological, Infrastructural/ Information, Political/Policy and Social) need to be adopted to transform the current production-driven cropping system to income-driven farming system and reduce the disparity among farmers of different regions of India. Agricultural research should be re-oriented with farmers' participatory approach to unshackle the vicious circle of poverty and drudgery and fulfill the aspirations of resource-poor, smallholder farmers. The state should enhance its investments on agricultural research and development to achieve the target of doubling farmers' income and address the growing challenges of resource degradation, escalating input crisis and costs with overarching effects of climate change.

An agro-climatic zone-specific action plan has been developed to address the constraints of increasing farmers' income. Attempt has been made to identify improved practices, their potential and constraints for increasing farmers' income in different agro-climatic zones of Odisha. The Committee has worked out the strategies for different agro-ecologies at block level. The block may have different farming situations such as upland, lowland, irrigated, shallow lowland, deepwater, etc. The administrators/implementing agencies can refer the ready reckoner to identify the agro-climatic zone of the block. Further, one can refer the recommendations for specific ecology under the block within the agro-climatic zone and farming situation to increase the farmers' income. Besides the technological interventions in different farming situations, the following action points should go hand-in-hand for doubling the farmers' income:

(1) Value addition and market linkage for getting better price of the farm produce,

(2) Enhancement of minimum support price by the Government,

(3) Increasing subsidy and improving availability of farm inputs,

(4) Insurance coverage for crops/animal/fisheries activities undertaken by the farmers,

(5) Promotion of technologies by the line departments and development agencies and

(6) development/modernization of infrastructure like markets, storage and processing units.

Success Stories

1. Commercial Production of Fish Fries in Small Ponds

Technology: For nursery pond one meter water depth, pH ranging between 7.5 to 8.5 is highly productive for spawn stocking (@ 3 lakhs/10 cents/cycle) and rearing. Survival and growth of spawn are influenced by quality and quantity of food available in the pond. To ensure healthy growth of spawn, artificial feeding is necessary and is restored from the next day after stocking. The most commonly used artificial feeds are groundnut oil cake, rice bran, coconut, mustard cakes, etc. Finely powdered and sieved groundnut oil cake and rice bran mixed at 1:1 are used. It has a short culture period of 15 – 21 days and 4 culture cycles were possible during 4 months of monsoon.

Agroclimatic Zone where the technology is successful: The technology is tested and found successful in North-Eastern Coastal Plain Zone of the state.

Success: Fry yield was found to be 1 lakh/10 cents/crop. The total net income within 4 production cycles was Rs. 60,000/-. The poaching problem in the introduced system is almost nil as it deals with tiny fishes of 20-30 mm size (Fry). Total investment made by the farmer was Rs 20,000/- in 4 culture cycles and the B:C Ratio is found 3.0. As many as 400 numbers of small tanks with water spread area of 21 ha, involving 289 farmers, have been covered for fish fry production in the district.

Farmers' views: Sri Purna Chandra Majhi, Sri Sanjay Kumar Sahoo and Kirtan Majhi were some of the farmers who adopted the technology and found the technology to be simple and remunerative.

Existing technology to be replaced: Practice of unscientific table size fish production solely for domestic consumption purpose is replaced by the current technology.

To which other agro-climatic zones it can be upscaled: The technology can be upscaled in all climatic zones except hilly areas of the state.

Suggested action plan for upscaling and Linkages with the on-going Government programmes: Fishery Department, Government of Odisha can promote the said technology so that the produced frys will be utilized through "Fingerling raising program, RKVY". The OLM, Government of Odisha can promote the technology under "Livelihood development in rural Odisha" program.

Contact address: In-Charge, KVK, Bhadrak, Odisha.

2. Cultivation of Flowers

Technology: In order to check the poor quality of flower & low yield of tuberose, soil test based nutrient management practice with 75% RDF + FYM (1 kg/sqm) + Vermicompost (300 g/m^2) + Azospirillum 2g/plant + PSB 2g/plant were recommended to the farmer. Subsequently, a marigold demonstration was conducted in the farmer's field with the application of plant growth regulator GA_3 @ 200 ppm in 15 days interval during bud initiation stage.

Agro-Climatic Zone: The technology is successfully piloted in East & South Eastern Coastal Plain Zone of Odisha and covered more than 12 villages across the district. The cropping pattern is mainly irrigated.

Success: As a result, the farmer got an increased yield of 46.35% to a tune of 6.03 q ha^{-1} with an average 25 number of florets per spike. The benefit-cost ratio per ha area reveals that the net profit of Rs. 3,45,930/- can be achieved with an investment of Rs. 2,30,620/- with a higher B:C ratio of 2.50. Similarly, in marigold, the farmer got an increased yield of 41.3% (130 q ha^{-1}) and relished a net profit of Rs. 3, 19,742/- per ha area with an elevated B: C ratio of 2.59.

Farmers' views: The smile shows on the tined face of the farmers and satisfied with the demonstration results and also advocating fellow farmers to adopt the technology as well as the flower varieties.

Existing technology to be replaced: Up land paddy and vegetable area converted to floriculture for better remuneration.

To which other agro-climatic zones it can be upscaled: It can be up scaled for Eastern Ghat High Land and North Eastern Ghat of Odisha.

Action Plan: Procurement of tuberose, marigold and Gerbera under NHM programme and exposure visit for farmers are to be included by Dept. of Horticulture, Govt. of Odisha.

Linkage with the on-going Government programme: It can be linked with NHM, Horticulture Department and Reliance Foundation for better convergence of services including inputs, production, marketing and technology dissemination.

Contact Address: In-Charge, KVK, Ganjam-II, Odisha

22

PUNJAB

Punjab is the leading agricultural state of India and is popularly known as the "Granary of India" or "India's bread-basket". Over the last few years major challenges have, however, emerged. Punjab is regarded as an agrarian economy despite the fact that the contribution of agriculture to State GDP has declined from more than 50 per cent in 1960-61 to around 24 per cent in 2014-15. About two-third population of the state lives in rural areas and around 35 per cent of the total work force is engaged in agriculture. The State of Punjab, the land of five rivers, is located in North-West of India at 35° Latitude and 74° Longitude and is blessed with almost plain and fertile soil.

The State is divided into 22 districts. All towns and villages are electrified and well-connected. Of the 4.2 million hectares of cultivated area, almost 99% is irrigated by a vast network of tube-wells and canals. Punjab produces an important portion of India's food grains and contributes a major share of the wheat and rice stock held by the Central Pool (a national repository system of surplus food grains). Much of the state's agricultural progress and productivity is attributable to the so-called Green Revolution, a technological movement launched in the 1960s that introduced not only high-yielding varieties of wheat and rice but new agricultural practices also.

Punjab has an inland subtropical location, and its climate is continental, being semiarid to sub-humid. Summers are very hot. In June, the warmest month, daily temperatures usually reach about 40^0 C and above. In January, the coolest month, daily temperatures normally range from 7-10 °C. Annual rainfall is highest in the Siwalik Range, which may receive more than 1,150 mm, and lowest in the southwest, which may receive as low as 380 mm; state wide average annual precipitation is roughly 500 mm. Punjab state is broadly divided into 3 agro-ecological zones depending upon temperature, rainfall, land topography, soil type, groundwater resources, etc. These zones along with their agro-climatic conditions, area covered and some problems relating to crop patterns, productivity, water resources, etc. Punjab state is a leading state in agriculture production and development. With mere 1.53 per cent of the geographical area of India, it produces around 20% of wheat, 9% of rice and 5% of cotton production of the country.

Punjab is regarded as an agrarian economy despite the fact that the contribution of agriculture to State GDP has declined from more than 50 per cent in 1960-61 to around 24 per cent in 2014-15. About two-third population of the state lives in rural areas and around 35 per cent of the total work force is engaged in agriculture. Consequently, agriculture is one of the most important sources of livelihood to a very large section of population primarily living in rural areas. Due to its backward and forward linkages and multiplier effects on the growth of other sectors of economy, accelerating growth in agriculture and enhancing farm income are the most important twin objectives of the policy.

Punjab livestock sector's contribution to agriculture and allied GDP increased from 16.1% during 1960-61 to 35.90% during 2015-16. Livestock sector, in addition to regular income, provides house-hold nutritional security and employment to small and marginal rural households which has a huge impact on minimizing risks to income, as income from crop sector is seasonal.

The major challenges before state agriculture which is facing deceleration of growth due to slow down in productivity growth, rise in cost of production, over-exploitation of ground water resources and rise in variability in weather, are:

i. Diversification of mono-cropping of rice and wheat to other crops for conserving for improved remuneration and sustainability.
ii. Managing the declining water table in the central region and poor-quality ground water in south-west Punjab and soil health in all districts.
iii. Overcoming the adverse effects of climate variability on crop productivity through mitigation and tolerance strategies.
iv. Managing crop residues as about 20 million tonnes of paddy straw and sizable portion of wheat straw, which are burnt resulting in the micro-nutrient deficiency and environmental pollution.
v. Reducing the cost of production and increasing Farmers' returns from fragmented land holdings and reducing farm size. About 65per cent farmers have less than 4 ha of cultivated area due to which the cost intensive technologies remain underutilized leading to higher cost of production.
vi. Improving the productivity of livestock sector particularly dairying through breed improvement and better feed, fodder and health care.
vii. Developing and refining the agro-processing technologies for value addition to both crop and livestock produce and developing functional foods to control life style diseases.
viii. Narrowing down the time gap between technology development and technology transfer and building the capacity of farmers in understanding and using modern scientific methods of raising crops and livestock.

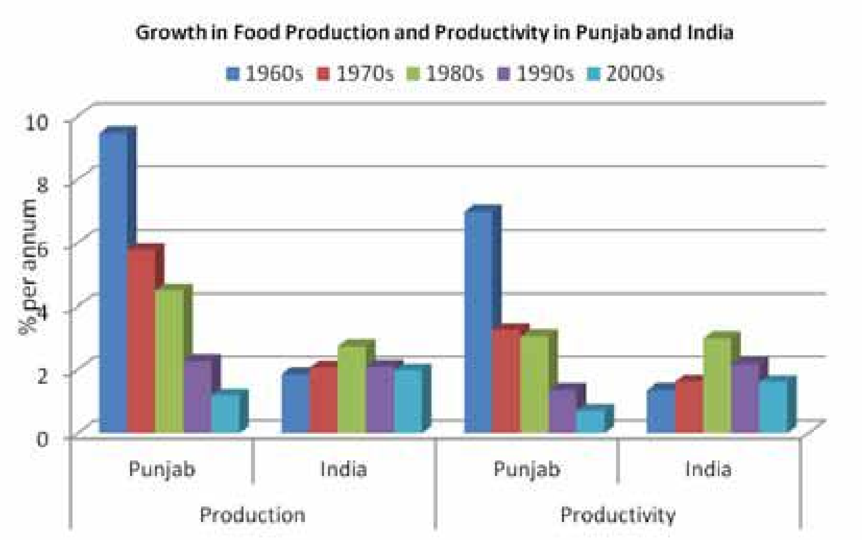
22.1. Gaps and Constraints

1.1 Crop Sector

After a tremendous performance for about three decades since the mid-1960s, the agriculture sector in Punjab is believed to be facing many challenges. Slow down in agricultural growth, escalation in costs of production, falling profitability in farming, reduction in employment in agriculture sector, increased incidence of landlessness, indebtedness among the farmers and farmers' suicides are the major issues currently afflicting the Punjab agriculture. Fall in the ground water table, increasing incidences of micro-nutrient deficiency and insect-pest/ diseases attacks on the crops are also posing major threats to the sustainability of agriculture, food production and productivity in the long run. Further, there are emerging uncertainties of weather, climate change and global warming. Though their impacts are yet to be quantified yet a rise in temperature will have a direct bearing on water availability and crop yields. At the same time demand for water and energy from other sectors will also increase. Some of these challenges are briefly discussed in the following section.

Slowdown in Agricultural Growth:

After following a high growth trajectory for more than almost three decades, the Punjab agriculture has shown significant slowdown during the last more than one decade. It is basically due to slow down in the growth of productivity of wheat and paddy corps, which occupies about 82 per cent of the cropped area of the state. This slow down is expected as we already have had more than 11.5 tons/ha of production of these two crops.



Source: Agricultural Statistics at a Glance, Government of India.

Declining profitability

The farmers have to use higher level of inputs to maintain yield of crops. Further, the prices of inputs like fertilizers, chemicals, petroleum products, labor etc. have increased at higher rates than the MSP/output prices during the last few years. As a result, the profitability of important crops has declined during recent years.

Farm indebtedness and Farmers' suicides:

The problem of growing farm expenditure and declining farm incomes manifested into the problem of growing indebtedness and farmers' suicides in the state. The cotton belt (south-western region) is the worst sufferer where debt is the highest. The problem has further accentuated in this belt due to cotton crop failure last year (2015). The problem of indebtedness is more severe among small and marginal farmers who are not able to return such loans. A per recent survey report of NSSO, the debt in Punjab at Rs 1,09,000 is the highest among all the states of the country.

A large number of farmers and agricultural labourers have committed suicide in the Punjab state during the last one decade. As per the Census Survey conducted for the whole state, 3954 farmers and 2972 agricultural labourers committed suicide during 2000-11. Further, 74.4% farmer suicides and 58.6% agricultural labourers suicides were committed due to economic distress. More than 80 per cent of the suicide victims belonged to small and marginal farm households. The indebtedness and suicides were more serious in south-west and western districts of the state.

Farmers leaving agriculture in distress:

The declining profitability has also pushed the small and marginal farmers out of farming as further sub-division of their holdings coupled with squeezing farm business income rendered their holdings economically unviable. Almost 2 lakh small and marginal farmers have left farming in Punjab during 1991 to 2005. About 22 per cent of such farmers have been forced to do the labour work. Majority of the remaining farmers who left farming joined lowly paid jobs and petty enterprises. In nutshell, the economic transition of these farmers was downward in nature. Their shift to the non-agricultural sector cannot be viewed as a smooth sailing but it has been a painful transition due to lack of sufficient and remunerative employment opportunities in the non-farm sector.

Depletion of Groundwater Resources:

Dominance of rice and increase in cropped area contributed to significant rise in demand for irrigation water, which was largely sourced from the groundwater. The dependence on groundwater increased further as there was a significant decline in the extent of rainfall over time. Consequently, groundwater is being over-exploited and water table is falling down. The fall in water table was sharp at the rate of more than 80 cm per annum during 2000-08, while the rate has come down to 55 cm per annum during 2009-15, due to prevention of paddy transplanting before 15th June. The sharp fall in ground water table, rendered obsolete most of the centrifugal pumps in the region, necessitating their replacement by submersible pumps of greater horse power to draw the same amount of irrigation water. Currently, 110 out of 141 development blocks fall in 'dark' category. Therefore, sustainability of ground water resources is a big concern in Punjab. Apart from the fall in ground water table in central Punjab, the south-western region of the state faces the problem of salinity and rise in the water table.

Lack of value addition:

India is the second largest producer of fruits and vegetables in the World but lacks in processing and value addition. Value addition of fruits and vegetables accounts for 7 per cent and processing is less than 2 per cent of production. The situation with respect to value addition and processing facilities for agriculture sector is no different in Punjab than India. The agriculture sector of the state has reached a stage where its growth can only be encouraged by increasing area under high value crops/enterprises through encouraging their processing and value addition. Value addition and agro-processing will integrate the market from the producer end to the consumer end and will ensure better and stable prices of these products as well as their profitability over other alternatives. To achieve this objective, policy environment, infrastructure and technology shall have to be fine-tuned.

Agro-climatic regions of Punjab

Zone	Area	Climate	Problems
I. Sub-mountain undulating	This region stands in the eastern border of the state about 9.5% of the total area of the state. The Zone-1 includes districts of Pathankot, Ropar, Hoshiarpur, parts of Nawanshahr, Gurdaspur, Mohaliand SBS Nagar	The average maximum temperature is 28.1+/-1.0°C whereas the minimum temperature is 15.5+/- 0.6 °C. The average annual rainfall exceeds 900mm.	-Soil type: Predominantly sandy loam/silty loam -Agriculture productivity: Low -Crop diversification: Relatively good - Water table: Deep -Terrain: Undulating -Soil erosion -Water run-off
II. Central Plain	This region cuts through the state from north-west to south-east. This region covers about 67% area of the Punjab. Zone-2 is comprised of districts of Amritsar, Barnala, Faridkot, Fathegarh Sahib, Ferozepur, Jalandhar, Kapurthala, Ludhiana, Moga, Patiala, Sangrur, Tarn Taran, and parts of Bathinda, Gurdaspur, Nawanshahr, Hoshiarpur, and Mohali.	The mean maximum temperature is 29.6+/-0.7°C and the mean minimum temperature 16.7+/- 0.8°C. The mean annual rainfall is 703.9+/-152.7 mm.	-Soil type: Predominantly sandy loam -Agriculture productivity: High -Crop diversification: Relatively mono-culture of paddy-wheat -Groundwater: Depleting -Injudicious use of fertilizers and agro-chemicals
III. South-Western	This region lies in the extreme south-west covering nearly 23.5% area of Punjab. It includes the parts of Bathinda district, and Mansa, Mukatsar and Fazilka districts.	The mean maximum temperature is 29.6+/-0.4 °C and the mean minimum temperature 17.2+/- 0.6°C. The mean annual rainfall is 422.8+/- 43.3 mm.	-Soil type: Predominantly loamy sand -Groundwater: Brackish -Problem of waterlogging in some parts -Crop pattern: Wheat-paddy and wheat-cotton -Irrational use of agro-chemicals

1.2 Livestock Sector

Production and productivity:

There exists a huge gap in the yield levels of the milch animals of various producing categories. If these gaps are narrowed down by improving the milk yield of small and marginal farmers, it will help a lot, in improving the growth rate of dairy sector

Animal health issues:

Huge economic losses are incurred on account of various livestock diseases and nutritional imbalances in the state. Existing facilities at veterinary dispensaries, hospitals are inadequate.

Poor quality and shortage of fodder:

Fodder is one of the most important and critical input to productivity. Availability of green fodder is inadequate as only about 10 % of the total cropped area is under fodder production.

Environmental issues:

Animal waste management, higher residue levels due to pesticide application& heavy metals, emergence of food borne pathogens, antibiotic and anthelmintic resistance, veterinary drug residues and climate changes are posing a threat to the environmental safety.

Rising input costs:

Increase in price of milk (24 – 27 %) is not commensurate with the increase in cost of milk production (32 – 47 %) during last couple of years due to which the profit margins have been squeezed.

Viability of small and marginal dairy farms:

Structure of dairy farming is changing now. Earlier animals were kept mainly at the level of marginal and small farmers. But, in current scenario, the viability of marginal and small dairy farms is affected by rising costs of input and services.

Marketing of milk:

There is a strong need to promote organized procurement and processing of milk as currently only 15-20% of milk is handled by organized sector.

Poor livestock extension services:

There is urgent need to strengthen the livestock extension network as very less farm households (5%) in India have access to information on livestock.

Value addition of livestock products:

Value addition at farm level is a good option for making livestock farming sustainable. But, value addition in milk and meat at farm is negligible at present.

Diversified livestock farming i.e. promotion of Goatry and Piggery:

There is need of diversifying the livestock farming by promoting goatry and piggery as these enterprises are more profitable compared to dairy farming.

Lack of market infrastructure for goat, pig and fisheries:

The market infrastructure is not well developed for goat and pig farming compared to dairy farming. The development of goat and pig farming, adequate market infrastructure is need of the hour.

Culling of stray and unproductive cattle:

There is no concrete govt. policy regarding culling of stray and unproductive animals. This poses a great chance to the emergence of infectious/communicable diseases. Fodder pool is also shrinking due to unproductive animals.

22.2 Strategies and Interventions for doubling of Farmers Income

Strategies to be followed in Crop Sector:

- Enhancing farm productivity and stability of production by supporting the farmers in the areas of soil health care, water harvesting and management, choice of appropriate technology and inputs, credit and insurance, opportunities for remunerative and assured marketing
- Encourage crop diversification among farmers so that they allocate larger proportion of their cultivated land to crops having more comparative advantage rather than growing rice or wheat alone
- Promotion of intensive vegetable production by using improved varieties, organic manure and drip irrigation, can provide higher annual income to the farmers (BAIF's experience in Andhra Pradesh, Karnataka & Maharashtra)
- Precision farming techniques which can help to enhance productivity and reduce the cost of production should be promoted
- Increase Farm Mechanization through custom hiring centres
- Low cost storage facilities and quality packing materials should be developed so that farmers can store their produce at farm level and avoid distress sale
- Primary processing at the farmers level
- Develop value chain for all the commodities
- Quality of the produce should be ensured

Strategies to be followed in Processing and Value Addition:

- Small farmers needs to associate and form commodity groups/ processor companies for better earning profits. Women can be given training in the area of processing and can go for value addition through small scale processing of fruits and vegetables.

- Development of integrated pack house is required for grading, sorting, packaging agricultural and horticultural produce. It will have mechanical grading and sorting line, pre-cooling chamber, cold storage, reefer van and pick up van.
- Promoting Agro-Processing Centres (APC) at the production catchments. APC has facilities for primary and secondary processing, storage, handling and drying of cereals, pulses, oilseeds, fruits, vegetables and spices, which may be made available on rental/ charge basis to producers. This type of centre can be managed by individuals/ co- operatives/ community / organizations / voluntary organization. Machines and equipment of small to medium capacity are used by these centres so that it will be easy to operate and handle. The centre meets the processing, preservation, handling and marketing needs of surplus produce available in a village or a cluster of villages.
- Skill Development Centre in horticultural crop processing and packaging. Trained manpower in the production, post-harvest & processing industries is required to cater to the demand for processed horticultural products for domestic trade and export purpose.

Marketing Strategies to be followed

- Revision of the APMC Act and monitoring its implementation in the state
- Better price realization for farmers through competitive markets, value chains and improved linkage between field and fork

Extension Strategies to be followed

- Entrepreneurship development among farmers particularly focusing on the youth.
- Skill development training as this is one of the most important flagship programmes of Govt of India (*Kaushal Vikas se Krishi Vikas*) which emphasises that Farmers' income can be enhanced by imparting skill development training in agriculture.
- Provide information on entire food and agricultural value chain, starting from forecasts of weather condition to market price of the produce instead only on on-farm activities.
- Effective use of social media and ICT tools for need based and timely dissemination of information to farmers.
- Strengthening of convergence of KVK, ATMA, line departments, banks, cooperatives etc need to be strengthened for resources as well as expertise.
- Mobilization of farmers and networking with different stake holders such as research institutions, input dealers, processors, buyers and financial agencies for accessing technology and inputs, and for better price realization.
- There should be Village knowledge centre at village level so that farmers get access to modern technologies in the village itself.
- Farmer to farmer extension (F2FE) as farmers seek advice and information related to agriculture from fellow farmers, who had access to such information.

Strategies to be followed in Animal Husbandry Sector

- Promoting dairy, goatry, piggery, poultry and fish production as a viable diversification option to declining economics of traditional crop production
- Ensuring quality feeds to dairy animals and scientific feeding of the animals
- Making hay and silage which will support for conservation of green fodder for year round availability
- Establishment of slaughter houses
- Training and skill development of farmers in handling and preservation techniques, value addition, packaging, quality and hygiene of milk and milk products.

Strategies to be followed in Fisheries Sector

- Usage of good quality fish seed can increase farmers income by 20-30 per cent
- Using fast growing varieties of fishes like Amur Carp, Jayanti Rohu for fish farming can increase farmers income by 10-15 per cent
- Cultivating brackish water shrimp *L. vannamei*in saline areas can increase farmers income
- Proper feeding of fish with good quality fish feed can increase farmers income by 25-50 per cent
- Fish integration with piggery is proving very beneficial to increase fish production
- Training farmers for advance methods of live fish handling and transportation. Use of advanced techniques for live fish transportation which can fetch them 30-40per cent more income than selling fish in dead and iced form
- Establishing infrastructure facilities for dead fish icing and packaging that will reduce post-harvest loss due to decrease in value through spoilage
- Establishing well equipped and scientifically designed fish markets for auctioning and retailing fish with proper facility of live-fish stocking, dead-fish icing, packaging, waste disposal and sewage treatment plants etc.
- Encourage fish processing and value addition among farmers
- Training of fish famers and other stakeholders for post-harvest handling

22.3 Summary Recommendations

Agrarian distress has been contributing to disillusion in the farming profession. The State farmers have been contributing to food security of the country while he remaining in perpetual stress, so much so that most of their offspring do not want to continue in farming. Increasing income substantially from farming is the way forward to alleviate this distress.

Punjab is a relatively progressive state so far as agricultural growth and development is concerned. Agricultural productivity is very high and the State tops in agricultural income among all the states of the country. As is expected, the future growth in agricultural income will be slow. The challenge becomes more ardous keeping in view the dominance of wheat-paddy cycle, smaller increase in output prices than input prices, fall in water table, higher incidence of pests and diseases and greater climate variability affecting productivity and enhancing cost of production. Yet, there are many avenues and opportunities through which farmers' income can be enhanced. We do hope that there is still a possibility of increase in productivity of important crops grown in the state through genetic improvement and plugging some deficiencies in production and protection practices.

Punjab agriculture is considered to be over-capitalised and follows input use intensive farming. Therefore, cost of farming operations especially in case of marginal, small and semi-medium farmers can be significantly reduced through cooperative/collective/group ownership of farm machinery or utilizing the farm machinery services on custom hiring basis. Similarly, expenditure on inputs especially fertilizers and pesticides need to be optimized through strengthening and improved agricultural extension services.

Inefficiency in the agricultural markets is another grey area. Price realization is poor especially in case of perishables, pulses and maize. Planned and collective marketing, government intervention during the period of distress prices and tapping the scope of distant and export markets can help raising agricultural price and consequently farm incomes.

Likewise, expansion in horticulture sector, livestock sector and agro-processing has got the potential of enhancing farm income in the state. Production of fruits and vegetables can be expanded by about 60-70% in next five years with improved market efficiency and value addition. Processing of vegetables, fruits and cereals carries the scope of increasing income of farmers by adding value to the produce, reducing wastage and raising agricultural output prices. Due to change in consumption patterns and consequent higher demand for dairy, fishery and other livestock products, livestock sector has also the potential to increase farm income in the state. Improvement in productivity, more processing, better health care, etc. in case of livestock products are required to tap this potential.

Emphasis will have to be laid on setting up of multi-commodity small agro-processing centers in rural areas for primary processing and value addition. The farmers shall be organized into Producer Groups/Companies to produce products conforming to uniform standards and required quality. Suitable incentives shall be provided to facilitate the setting up such centers and marketing of their products. Medium and large scale processing units will also be, promoted in public sector and in PPP mode. Tax incentives and capital assistance/equity participation shall be provided to facilitate their establishment in order to provide front end linkages to the producers of alternative crops.

Success Stories

1. Integrated Farming System (Field Crops + Vegetable Crops + Goatry + Dairy + Fodder)

Sh Sekhar Singh of Pathankot district is successfully following the IFS in which paddy-wheat crop rotation has been integrated with vegetable crops and livestock (goatry and cows) as the major enterprises. His annual net income turns out to be Rs 1614500. The dairy component of this IFS consisting of a unit of 20 cows contributed the major part of net income followed by the goatry. Compared to the commonly followed monoculture of wheat and paddy, this IFS yielded about 38 per cent higher net income.

Net income from integrated farming system, Pathankot district

Components of IFS	Area (ha)	Herd size	Initial cost (Rs)	Gross income (Rs)	Cost of production (Rs)	Net income (Rs)
Vegetables*	1.2	-	-	137500	63750	73750
Goatry	0.16	20	8000 (2 goats)	275000	30000	245000
Dairy (Cows)	0.16	20	35000 (2 cows)	2520000	1350000	1170000
Paddy-wheat	1.8	-	-	165750	40000	125750
Fodder	0.8	-	-	Own use	-	-
Total	4.12	-	-	3098250	1483750	16,14,500
Net income from commonly followed paddy-wheat crop rotation						11,71,875
Per cent increase of income from IFS over paddy-wheat crop rotation						37.8%

*Radish, turnip, brinjal, coriander, okra, sponge gourd, carrot, saag

2. Mushroom Production as subsidiary occupation:

Mushroom production can be taken up as a subsidiary occupation to augment the income of the small/marginal famers as the Punjab State is endowed with numerous advantages like abundance of raw materials (wheat/paddy straw, farm yard manure, etc) required for mushroom production, a strong technical base and better purchasing power of the masses. Moreover, the State has suitable environmental conditions for the production of five different varieties of mushrooms including, Button mushroom, Oyster mushroom, Shiitake mushroom, Chinese mushroom and Milky mushroom. In winter two crops of button mushroom (September–March), three crops of oyster (October–March), and one crop of Shiitake (September–March) can be taken. In summer, one can have up to 4 crops of paddy straw mushroom (April–August) and 3 crops of milky mushroom (April–October).

The most widely grown and commercially produced mushroom is button mushroom. A marginal farmer can supplement his income by adoption of mushroom production technology recommended by PAU. A small start-up unit comprising of a covered area of 250 sqft can process up to 20 q of straw for the production of approximately 6 qtls. Of fresh mushrooms at a price of Rs 80/kg (Rs 24,000 variable cost of spawn, compost and casing plus 7000 fixed cost calculated at the rate of 25 per cent depreciation) thereby increasing the income of the farmer by Rs. 17,000/- per crop.

Therefore, a farmer can supplement his income by Rs. 17,000 per crop of button mushroom. Currently, about 0.5 lakh tonnes of mushroom are produced in the state, which can be very easily increased to 1 lakh tonnes. **It will generate additional income in agriculture sector by Rs 141.7 crore.**

The economics of mushroom cultivation of a mushroom grower Mr. Yashpal Singh of Pathankot District is given below. Mushrooms were grown under two situations: 1 kanal shed with semi-automatic AC unit and 1 kanal area with temporary shed. The farmer earned a profit of Rs 2,95,000/- from mushroom production.

Case Study-Economics of Mushroom cultivation

Area under Mushroom cultivation	**2 Kanal**	**1 Kanal (semi-automatic)+1 Kanal (Temporary shed)**
		Amount Rupees
Initial cost	AC Unit + Temporary Sheds	Rs. 17,00,000
Gross income	From whole sale	7,30,000/-
	Total	7,30,000/-
Cost of production (3000 bags)	Initial Raw material (Bag + Spawn + Casing)	3,25,000/-
	Electricity+ Packing + Labor Charges	1,10,000/-
	Total	4,35,000/-
Net income		Rs 2,95,000/-

23

RAJASTHAN

Rajasthan is the largest State having the maximum geographical area in the country. About 61 per cent area of Rajasthan is arid, 16 per cent semi-arid, 8 per cent sub-humid and 15 per cent humid. The importance of agriculture in the socio-economic fabric of Rajasthan can be realised from the fact that the livelihood of majority of the State's population depends on agriculture. The agriculture sector contributes only about 26.5 per cent of the total Gross Domestic Product (GDP) with 65 per cent population dependence, resulting in low per capita income in the farm sector. Consequently, there is a large disparity between per capita income in the farm sector and the non-farm sector. Therefore, it is essential to deal with those issues and activities which impact the income levels of farmers. The income levels are determined by the overall production, supported by reasonable levels of yield and prices realised by the farmers. Several constraints, such as preponderance of small and marginal holdings accounting for about 82 per cent of total holdings, imperfect market conditions and lack of backward and forward linkages affect the income levels of fanners adversely.

Agro-climatic zones in Rajasthan and cropping patterns of different zones:

- Arid Western Plain (Ia)
- Irrigated North Western Plain (Ib)
- Hyper Arid Partially Irrigated Zone (Ic)
- Transitional Plain of Inland Drainage (IIa)
- Transitional Plain of Luni Basin (IIb)
- Semi-arid Eastern Plain (IIIa)
- Flood-Prone Eastern Plains (IIIb)
- Sub-humid Southern Plains and the Aravalli Hills (IVa)
- Humid Southern Plains (IVb)
- Humid South-Eastern Plains (V)

Rajasthan has 34.22 million ha geographical area and accounts for 10.4 per cent of total geographical area of the country. Rajasthan was divided into nine Agro-climatic Zones (ACZs) under the National Agriculture Research Project (NARP)(1981-1993) for the purpose of micro-level planning.

About 4.54 m ha area covering most parts of Barmer (except Siwana block) and Jodhpur (except Bilara and Bhopalgarh blocks) districts lies in this zone. It is one of the most arid zones of the state where the annual rainfall is low and erratic and droughts are very common. Rainfall ranges from 216 to 496 mm. During summer season, maximum temperature may goas high as 49°C but nights are usually cool and thus diurnal temperature range may be 20°Cor more. During winters, minimum temperatures may sometimes dip below zero.Net area sown is 58% of reporting area of the zone with 113% cropping intensity.

Surface water resources are almost non-existent. Groundwater is deep and often brackish. Net irrigated area is 17% of net sown area and 98% irrigation is through groundwater. Natural vegetation is mostly seasonal. Pearl millet, clusterbean, moth bean, mung bean, rapeseed & mustard, wheat, castor seed, groundnut, sorghum, sesame, cotton and onion are major crops. Ganganagar and Hanumangarh districts fall in this zone covering 2.06 m ha area. It is an alluvial and aeolian plain. This zone has mostly medium and fine textured deep to very deep soils.

There are 6.9 m holdings in Rajasthan occupying 21.1 m ha area. Marginal and small holdings occupy only 16 per cent of total area while their share is 58 per cent in total number of holdings.

23.1 Major constraints

About 80-90% of annual rainfall is received during monsoon season. Rainfall is low (580 mm) and erratic. Growing period is short due to late onset and early withdrawal of monsoon. Early, mid-season or terminal droughts are common due to late onset, breaks in monsoon or early withdrawal.

About 61% area is arid. Soils of arid zone are light textured; have poor fertility, low water holding capacity and high infiltration rate. Soil organic carbon is less than 0.2% in most soils of this region. The south east and eastern part of Aravali range have sandy loam to clay loam soil type with relatively better water holding capacity.

Groundwater is deep and of poor quality in several parts. Over-exploitation of groundwater is becoming a major challenge for sustainable resource use.

Wind erosion is a major problem in arid areas, while hilly southern region faces problem of water erosion.

A large tract of land is saline and alkaline in nature. Problem of secondary salinization is emerging in irrigated tracts due to poor water management or irrigation with poor quality water.

Poor adoption of improved technologies in rainfed areas due to high perceived risk of crop failure.

Common grazing resources are in very degraded condition due to high grazing pressure and no management.

Very less availability of green fodder during non-monsoon seasons is a major challenge. During drought years, fodder scarcity poses strong challenge before the farmers.

23.2 Strategies and Role of technology for Doubling of Farmers' Income

Strategies to enhance income

- Producing marketable surplus (increase in farm and livestock productivity)
- Stabilizing prices of local commodities
- Enabling policies and their implementation
- Reducing cost of production
- Reducing risk factor (PMFBY, IPM, INM, IFS, livestock)
- Diversification in farming and cropping systems through high-value crops and components
- Secondary agriculture and value addition
- Production taking cognizance of natural resources
- Improved terms of trade for farmers
- Augmenting income from other sources including agro-tourism
- Capacity building and use of ICT

A. State level Action plan

- Increasing cropping intensity through efficient water management
- Enhancing micro-irrigation (existing 10% area). Narmada model should be replicated in IGNP
- Promoting low-water requirement crops instead of groundnut, castor, rice)
- Increasing irrigated area and cropping intensity with saved water
- Amalgamation of water harvesting and crop production, solar pumping, agri-voltaic system/solar farming (Rs. 22 lakh/ha annual income)
- In-situ and ex-situ water harvesting
- Groundnut should not be planted before 15 June

Livestock-based IFS approach

- Single commodity output in rainfed farming gives low income
- Round-the-year employment
- Appropriate combination of horticulture, grasses, livestock, boundary plantation, crops
- Adding income avenues in fodder, food, fruit
- Developing entrepreneurship (FPOs, SHGs, PPPP) for marketing milk of goat, indigenous cow, camel

Improving livestock productivity

- Average daily milk yield of cow, buffalo, goat is better than the country average
- Augmenting fodder supply (30-40% shortage) through rejuvenation of grasslands
- Region-specific multi-nutrient mixture, feed blocks or pellets to address mineral deficiency
- Breed improvement of livestock
- Establishing environmental friendly abattoir, meat and byproduct processing facilities

Increasing productivity

- Enhance SRR of disease and pest-resistant varieties and hybrids. Promoting early maturing cultivars especially in drought prone areas (maturity from 90 days to 60 days)
- Quality planting material of fruits
- Breed improvement of livestock

Diversification with high-value crops

- Horticulture
- Protected cultivation
- Vegetables
- New crops (e.g. Quinoa, Chia)
- Management of blue-bull and wild boar

Reducing cost of production

- Integrated Nutrient Management
- Integrated Pest Management
- Farm Mechanization (CHCs)

Supporting pioneer and unique crops of Rajasthan - Pearl millet and maize to be procured and included in PDS

- 50-60% of country's area under pearl millet (50 lakh ha) is in Rajasthan
- 2nd most important state for maize in country (15 lakh ha)
- Area of these crops is decreasing in spite of increase in productivity
- Little incentive for higher production

Promote mechanization

- Better crop establishment
- To reduce cost of cultivation
- To avoid losses

Improved marketing

- Marketing intelligence

- Linking to e-NAM

Enhancing skill (particularly youth) for

- Dairying
- Farming
- Small scale processing for seed spices, arid fruits, etc.
- Starting custom hiring centers, repair of farm machinery, rewinding of electric motors etc.
- Trainings of suitable duration related to handicrafts, cottage, small and medium scale industries relevant for the region

Market reforms (Model APMC Act)

- Contract farming
- Direct sale by farmers
- Direct purchase by bulk buyers
- De-notify fruits and vegetables from APMC
- Electronic trading
- Single levy
- Single traders license
- Setting up of private markets

Enhancing storage facilities to avoid losses

- Creation of more warehouses, cold storage facilities
- Better storage facilities for storage of crops, fruits, onions, garlic, spices

Value addition to local produce

Through co-operatives Federations

B. Agro-climatic zone wise Action plan

Arid Western Plain (Ia):

- IFS components should include grasses (anjan and dhaman); early maturing crops pearl millet, mothbean, mung bean; ber, pomegranate, boundary plantation with trees having economic values/shelterbelts (Gross annual returns from a rainfed IFS model of 7 ha was Rs. 4.59 -5.16 lakhs with B:C ratio of 1.76-1.96. The system generated 823-931 man-days of employment.
- Emphasis on balanced feed and location-specific nutrient supplements (available now).
- Cultivation of senna, *Aloe vera*, grasses, fodder trees in wastelands.
- Solar farming (agri-voltaic system) in arid region has considerable scope.

- Popularization of low cost protected cultivation technology like insect-proof net houses rather than costly poly-houses.
- Water is the most scare resource in this ACZ. There is considerable scope of pressurized irrigation technology. Wide coverage of this technology will save water, increase cropping intensity, encourage crop management and enhance production.
- Water conservation, harvesting at farm to watershed scale, groundwater recharge need to get a very high priority.
- Promotion of 'Good management Practices' particularly for seed spices like cumin, fennel, coriander and fruits to reduce cost and pesticide residues; and enhance acceptability in local and international markets.
- Establishment of export-oriented farm hubs for cumin, fenugreek, onion, etc.
- Safe and hygienic drying of vegetables like chillies through solar driers for good quality and better prices.

Irrigated North Western Plain (Ib):

- IFS components may include early maturing crops pearl millet, moth bean, cowpea; cluster bean, wheat, barley, mustard, kinnow, pomegranate, ber, lasoda, vegetables, buffalo, improved cow breeds, goats, etc.
- Groundwater (GW) utilization is only 45% in Ganganagar district. Emphasis on conjunctive use of GW and canal water. Promote use of pressurized irrigation technology. Save water for other areas.
- Discourage cultivation of high water requiring crops like rice, groundnut and castor in arid region and use the saved water for high value crops like fruits, vegetables, protected agriculture, fodder for livestock, etc.
- Planting of widely spaced crops like cotton should be encouraged using drip irrigation.
- Boundary plantation of teak/shelterbelts for improving micro-climate particularly for orchards.
- Emphasis on commercial dairying as fodder supply will not be an issue.
- Hybrid seed production of pearl millet during summer season in irrigated areas.
- Value addition to kinnow and other citrus fruits, date palm and arid fruits, vegetables, etc. Waxing of kinnow increases its self-life.
- High temperature during maturity stage of rabi crops has started adversely affecting their yields. Promotion of high temperature tolerant/ short duration varieties of rabi crops.

Hyper Arid Partially Irrigated Zone (Ic):

- Strengthening fodder supply.
- Rejuvenation of grasslands. .
- Establishing fodder banks.

- Transporting dry stover from other areas e.g. Punjab where dry stover is burnt.
- Strengthening of fodder supply system.
- Date palm in canal command area only. Value addition to date palm and arid fruits.
- Tharparkar, Rathi cattle in rainfed areas and Buffalos in irrigated areas.
- Promotion of early maturing varieties of native crops.
- Boundary plantation/shelterbelts for improving micro-climate.
- Solar farming (agri-voltaic system).
- Conservation of soil and water in Khadin systems in Jaisalmer and linking it with crop production.
- Income generation from wastelands through cultivation of hardy medicinal plants like senna and timber trees that also reduce wind erosion.
- Promotion of commercial dairying in canal command areas.
- Promotion of better breeds of sheep and goats for rearing in rainfed areas of Jaisalmer and Bikaner districts. Prolific sheep strain Avishaan, having 30% more body weight and meat yield over single lamb bearing Malpura sheep, will be promoted for meat purpose.
- Emphasis on balanced feed and location-specific nutrient supplements which improve both reproduction and production.
- Safe and hygienic drying of commodities like khejri pods, kair fruits, vegetable clusterbean, etc. through solar driers for good quality and better prices.
- Groundnut sowing before 15 June should be prohibited.

Transitional Plain of Inland Drainage (IIa):

- Promotion of new early maturing varieties of pulse crops and early to medium dualpurpose varieties of pearl millet.
- Diversification options include Nagauri methi, coriander, fennel, fenugreek, senna, aswagandha, safed musali, *Aloe vera*, vegetables and arid fruits.
- For small and marginal farmers under irrigated situations crops + goatry + vegetables + mushroom was found more remunerative as compared to crops alone.
- Cultivation of malt barley in salinity affected areas.
- Promotion of intercropping of methi, moth bean, mung bean, etc. in agri-horti systems for enhancing land use efficiency.
- Processing of Nagauri methi through walking/ high tunnel technology.
- Agroforestr y system with multipurpose trees like Khejri (*Prosopis cineraria*), Rohira (*Tecomela undulata*), desi Kikkar (*Acacia nilotica*), Ardu (*Alianthus excelsa*) and Anjan (*Hardwickia binata*) were most beneficial agroforestry systems.
- Cultivation of capsicum, cherry tomato and khira under poly houses and off season watermelon under drip and mulching system.

- Solar drying of sangri (khejri fruit) for better quality. Processing of and value addition to arid fruits like ber, bael, sangri, kair, lasoda, phalsa.
- Promotion of indigenous cattle breeds – Gir, Tharparkar, Shahiwal in place of existing non-descript/exotic cattle breeds.
- Emphasis on balanced feed and location-specific nutrient.
- Safe and hygienic drying of vegetables and other commodities like methi, chillies, khejri pods, kair fruits, vegetable clusterbean, etc. through solar driers for good quality and better prices.
- Water conservation, harvesting at farm to watershed scale, groundwater recharge need to get a very high priority.
- Promotion of 'Good management Practices' particularly for seed spices like fennel, coriander to reduce cost and pesticide residues; and enhance acceptability in markets.
- Income generation from wastelands through cultivation of hardy medicinal plants like senna as well as grasses and timber/fodder trees.

Transitional Plain of Luni Basin (IIb)

- Diversification options include quinoa, chia, dil, coriander, fennel, fenugreek, henna, senna, ashwagandha, *Aloe vera*, vegetables, arid fruits, Sirohi goat; Marwari, Chokla breeds of sheep, backyard poultry, bee keeping, etc.
- Intercropping of peas in rabi and arid legumes in kharif season in orchards.
- Cumin and isabgol seed production in Jalore.
- Pearl millet hybrid seed production during summer, cumin seed production during winter season.
- Popularization of magnetic technology for use of moderately saline water.

Semi-arid Eastern Plain (IIIa)

- Diversification options include quinoa, hybrid castor, pomegranate, aonla, ber, gonda, mango, ajwain, fennel, fenugreek, chilies, garlic, turmeric, ginger, coriander, safed musali, *Aloe vera*, etc.
- For small scale farmers crops + dairy + goatry + vegetables + poultry combination was found more remunerative under irrigated situations as compared to crops alone or crops +livestock.
- Rejuvenation of old orchards.
- Local marigold is cultivated in large area near Ajmer and Jaipur cities. Improved varieties like Pusa Narangi and Pusa Basanti will be promoted. Discarded flowers of marigold will be used in poultry feed.
- Promotion of Tharparkar, Gir and Sahiwal cattle breeds to replace non-descript animals.
- Promotion of organic farming of vegetables, pulses and wheat.

- In Tonk area, water tanks will be promoted for small scale gardening, fruit trees, etc. Fish production will be promoted in large tanks.
- Increased emphasis on green fodder cultivation for increasing livestock productivity.
- Processing and value addition to mung, urad, pea at small scale.
- Fish farming in large ponds.
- Kinnow, pomegranate, ber and guava orchards will be brought under drip irrigation.

Flood-Prone Eastern Plains (IIIb)

- Diversification options include quinoa, chia, dil, hybrid castor, pomegranate, aonla, ber, gonda, mango, papaya, ajwain, fennel, fenugreek, chillies, garlic, ginger, coriander, safed musali, *Aloe vera*.
- For small and marginal farmers crops + dairy + mushroom + bee keeping + poultry were more remunerative under irrigated situation. Such systems will be promoted. • Heat tolerant varieties of wheat such as Raj 4238 and frost tolerant varieties of mustard and gram will be popularized for mitigating the adverse effect of high or temperature.
- Drip irrigation will be promoted in relatively wider crops like cotton, potato.
- Adoption of organic farming of vegetables, wheat, pulses and mustard.
- Adoption of groundwater recharge technology: Model tested and refined by KVK, Kumher will be popularized to improve groundwater recharge.
- Rejuvenation of old orchards.
- Small/medium scale processing units for guava, mustard.
- Organizing farmers' clusters into Farmers Business Centers with self-help groups under a Producer Marketing Company.

Sub-humid Southern Plains and the Aravalli Hills (IVa)

- Popularization of improved intercropping system in rainfed areas. Integration of fishcum-horticulture farming for additional income from horticulture crops planted on the bunds of fish ponds with increased fish production.
- Promotion of suitable IFS models like goat unit (6-8 goats of Sirohi breed) + backyard poultry for land less farmers; : crop production + vegetable cultivation + papaya plants as intercrop/ on farm boundary + 2 buffaloes for small farmers.
- Diversification options include quinoa, linseed, yam, Colocassia, sweet potato, hybrid castor, pomegranate, aonla, guava, mango, dragon fruit, lemon, papaya, sapota, custard apple, ajwain, fennel, fenugreek, chilli, garlic, turmeric, ginger, coriander, safed musali, *Aloe vera*, tulsi, opium.
- Seed production of rabi maize and soybean.
- Promotion of minor forest products like mahuva, *Cassia tora*, etc.
- Popularization of nematode control strategies under poly-house cultivation.
- Wherever possible, construction of Jal kund of 20-25 m^3 capacity at farm level to be

promoted. During 2014-2017, 23,322 water storage structures with 3,000 crore liter capacities (30 M m^3 capacity) have been constructed in Rajasthan.

- Promotion of on-farm composting and vermin-wash production to improve soil productivity.
- Promotion of organic farming of high value crops default organic areas of Udaipur, Rajsamand and Banswara.
- Increased emphasis on green fodder cultivation for increasing livestock productivity.
- Improvement in existing goat breeds by introducing bucks of pure Sirohi breed.
- Popularization of improved breed of poultry (Nirbheek and Pratapdhan) for backyard poultry units.
- Popularization of balanced feeding schedule for livestock to increase their productivity.
- Introduction of fish farming in farm ponds. Popularization of fish seed rearing in cages for rearing carp fingerlings in bigger water bodies.
- Reducing post-harvest losses by promoting use of grain storage bins.
- Organizing farmers' clusters into Farmers Business Centers with self-help groups under a Producer Marketing Company.

Humid Southern Plains (IVb)

- Diversification options include quinoa, hybrid castor, linseed, pomegranate, guava, ber, gonda, mango, dragon fruit, lemon, papaya, sapota, custard apple, strawberry, ajwain, sua, fennel, fenugreek, chillies, garlic, turmeric, ginger, coriander, safed musali, opium.
- Diversification of maize area to pomegranate, orange, guava, custard apple, papaya and lemon.
- Integration of fish- cum-horticulture farming for additional income from horticulture crops planted on the bunds of fish ponds with increased fish production.
- Wherever possible construction of Jal kund of 20-25 m^3 capacity at farm level to be promoted.
- Promotion of on-farm composting and vermin-wash production to improve soil productivity.
- Promotion of organic farming of high value crops (isabgol, ashwagandha, opium poppy and kalmegh) in default organic areas of Pratapgarh, Dungarpur and Banswara districts.
- In Mahi CCA, bara-bandi system will be strictly followed to avoid wastage of irrigation water.
- Increased emphasis on green fodder cultivation for increasing livestock productivity.
- Improvement in existing goat breeds by introducing bucks of pure Sirohi breed.
- Popularization of improved breeds of poultry (Nirbheek and Pratapdhan) for backyard poultry units.

- Popularization of balanced feeding schedule for livestock to increase their productivity.
- Introduction of fish farming in farm ponds. Popularization of fish seed rearing in cages for rearing carp fingerlings in bigger water bodies.
- Reducing post-harvest losses by promoting use of grain storage bins.
- Organizing farmers' clusters into Farmers Business Centers with self-help groups under a Producer Marketing Company.
- Small scale processing of pigeonpea, custard apple, mango, dragon fruit.

Humid South-Eastern Plains (V)

- Crop diversification options are quinoa, chia, guava, pomegranate, strawberry, custard apple, papaya, lasoda, drumstick, chironji, safed musali, turmeric, aswagandha, ajwain, fennel, kalaunji, roses, gladiolus, potato, makhen grass.
- Promotion of two tier system of agri-horti (aonla – turmeric) and three tier system of agri-horti-medicinal plants (guava – turmeric – safed musali) to enhance land, labour and capital productivity.
- Land configuration methods (ridge and furrow, broad bed furrow) are useful both under excess rainfall and water stress conditions. Their adoption will be promoted for enhancing crop productivity and input use efficiency.
- Direct seeding of rice will be promoted over transplanting method.
- Irrigation is mostly given through flood method. Drip, mini sprinklers will be popularized.
- Fertigation to be promoted in orchards, vegetables, floriculture and high value crops.
- Goat rearing is quite popular in Sawai Madhopur and Bundi. Breed improvement through Sirohi bucks.
- The productivity of local cows is low and dairying is negligible though there is ample scope of good-quality fodder production due to existing irrigation facilities. Commercial and small scale dairies will be promoted with improved/ pure breed of cattle.
- Bee keeping is becoming popular in this region. Bee keeping will be promoted along with establishment of honey processing units.
- Up scaling of low cost storage technology for garlic and onion.
- Post-harvest processing of soybean, coriander, garlic, guava, oranges, honey, etc. for higher returns.

Summary recommendations:

- The agro-climatic conditions of Rajasthan pose serious challenges in production of crops and livestock resulting in low productivity and income of farmers. However, there exist certain strength and opportunities in agriculture sector of the state. This report examines both challenges and strengths of agriculture and allied sector in

Rajasthan in enhancing net returns from farming through improved technological interventions. The analysis of data indicated that annual compound growth rate is highest in livestock sector (18%), followed by fisheries (11%), crop sector (4.7%) and forestry sector (3.8%). There exists a tremendous scope not only to maintain this rate of growth but also to raise it further using an inclusive approach of increasing crop and livestock productivity through proper technological interventions, stabilizing prices of local commodities through appropriate marketing policies in case of extra production, reducing cost of production, diversifying farming and cropping system, promoting secondary agriculture and value addition, and augmenting income from other sources. Multi-pronged strategies and actions are needed to enhance income of farmers' which are discussed in the report.

- ***Increasing water productivity and cropping intensity through efficient watermanagement*****:** Rajasthan has access to 1% of water resources in spite of having 10% geographical area of the country. Despite this, micro-irrigation technology is being used only in 10% of irrigated area which has to be substantially increased for increasecropping intensity in the state using same amount of water. It has been demonstrated that drip irrigation saves water up to 80%. The model of Narmada canal, that makes water to be essentially used only through pressurized irrigation, needs to be replicated in canal command area of IGNP. Low-water requirement crops like wheat, chickpea and mustard instead of water guzzlers like groundnut, castor, and rice in the irrigated areas needs to be promoted by legislation. In-situ and ex-situ water harvesting would also play an important role in increasing cropping intensity. Utilization of waste water for irrigation purposes has a great potential especially in peri-urban areas.
- ***Livestock-based integrated farming system (IFS) approach*****:** Cultivation of crops only ina typical rainfed farming situation was found to give, on an average, a net return of Rs.] 16,000/ha, while average net return from an integrated farming system was Rs.35,000/ha. In addition, IFS approach offers round-the-year employment. Several IFS models have been suggested having an appropriate combination of horticulture, grasses, livestock, boundary plantation and crops for various agro-climatic zones of the state. Developing entrepreneurship among farmers through FPOs, SHGs etc. is very important to maximize profit from IFS
- ***Improving livestock productivity*****:** There is reported 30-40% shortage of dry stover for livestock and therefore augmenting fodder supply through rejuvenation of degraded grasslands become critically important. Use of region-specific multi-nutrient mixture, feed blocks or pellets can further help in improving the livestock productivity. Improvement of local breeds of livestock needs special emphasis and establishment of Artificial Insemination centers at block level is essential to achieve it. Semen-sexing is a potential technology to control population of non-productive animals.
- ***Increasing crop productivity*****:** The yield gap between productivity levels obtained at farmers field with and without improved technology in various field crops in Rajasthan

ranges from 17% to 41% highlighting the potential role of up scaling of production technology. Further, there is only 8-15% seed replacement rate of pulses and 50-60% of pearl millet and maize hybrids that needs further enhancement. Promoting early maturing cultivars especially in drought prone areas and quality planting material of horticultural crops would play a very important role in further enhancing income levels.

- ***Diversification with high-value crops and commodities*****:** Diversification of agriculture offers a great opportunity to augment income. Specific interventions include cultivation of high-value fruits and vegetables. Protected cultivation is also emerging as viable option in Rajasthan especially in peri-urban areas having good market connectivity. New crops like Quinoa, Chia offer additional opportunities for diversifying the farming. Agrivoltaic system, also termed as solar farming, can also be an option of getting high annual returns per unit of land with a potential of Rs. 22 lakhs/ha, though it requires a heavy investment in beginning.
- ***Reducing cost of production*****:** Reduction of cost of production can also be an additional avenue to increase net returns from farming. Integrated nutrient management based on fertility status of soil and nutrient requirement of crops are being suggested to reduce cost of inputs. Custom hiring centers have an important role to play in reducing the cost of production as mechanization helps in reduction of labour requirement and to reduce losses during harvesting.
- ***Supporting pioneer and unique crops of Rajasthan*****:** Rajasthan is known for crops with unique attributes. Pearl millet is cultivated on 40 lakh ha (>50% acreage in the country) and maize on 9 lakh ha. These two crops have shown highest growth in productivity since last more than 4 decades. Despite being drought tolerant, nutritionally rich, climate-change ready crops, the area under these two traditional food crops of Rajasthan is continuously declining as there is no incentive for farmers to produce more. The supply of wheat in PDS in Rajasthan, even in those areas where pearl millet and maize are traditional foods, has led to lesser importance of these two crops. There is need to procure pearl millet and maize and to distribute them in PDS in western and southern parts of state, respectively. Similarly, Rajasthan is known as hub for seed spices but there are few processing plants and mandies for their marketing. It adds to the transportation cost while taking them to adjoining states for processing and marketing. There is urgent need of establishing processing industries of cumin, isabgol, coriander, fennel and fenugreek in the area of their production.
- ***Capacity-building of farmers***: Enhancing skill (particularly of youth) in dairying, farming, small scale processing of seed spices, repair of farm machinery and protected cultivation structures etc. would provide additional avenue to increase farm productivity and to add additional sources of income. Trainings in handicrafts, cottage, and small and medium scale industries relevant for the region can be other option.
- ***Providing better marketing and ushering reforms:*** Contract farming of fruits, vegetables, pulses, oilseeds, seed spices and medicinal plants is a potential area to fetch

assured income to farmers. Arranging direct purchase by bulk buyers and setting up of private markets would further encourage farmers for additional production of such commodities. Government of Rajasthan has already de-notified fruits and vegetables through APMC which is good initiative to provide free marketing. There is also need to connect remaining mandies of state to e-NAM. Establishment of export-oriented farm hubs for cumin, isabgol, fenugreek, fennel, poppy seed, etc. is also required.

- ***Enhancing storage facilities and value addition*:** Creation of more warehouses, cold storage facilities for fruits, onion, garlic, seed spices would be very helpful in avoiding losses. Primary processing of local produce through co-operatives, federations, FPOs and SHGs would lead to value-addition resulting in higher market price.

SUCCESS STORIES

1. Integrated Disease Management reduced cost of cultivation of vegetables, increased productivity

The case of 10 Farm families of Village Singod Khurd, Jaipur having an average land of 1 ha/ family.

The families have been cultivating vegetables namely onion, tomato, chilli and watermelon. Yields were low due to diseases especially purple blotch and downy mildew of onion, collar rot, root rot, early blight and fruit rot of tomato, anthracnose of chilli and anthracnose and downey mildew of watermelon. Expenditure on pesticides was also high.

Three years back, KVK, Chomu (Jaipur) conducted on-farm trials and gave On/Off Campus trainings for IDM Technologies. KVK advised them for soil treatment with *Trichoderama viride* (3x107 cfu) @ 2.5 kg/ha during kharif and rabi season and also gave them proper schedule of fungicides application.

Earlier their expenditure on plant protection measures was Rs. 9,000/- to 10,000/- per ha per year and now it is about Rs. 6,000/- to Rs. 8,000/- per ha per year.

Earlier their annual income was Rs. 1.75 to 2.0 lakh per ha per annum which has now increased to Rs. 3.5 to 4.0 lakh per ha per year.

2. IFS- Boon for sustainable income generation

Sh Jivan Lal Patel of Village: Bhujara, Dungarpur Land Crops: Holding: 3.25 ha Maize, rice, wheat, black gram, green gram, gram, soybean; Vegetables: tomato, brinjal, coriander, chilli and okra; Livestock: 7 cows (HF cross breed), 3 buffaloes (Murrah); Poultry unit: one commercial unit (Pratapdhan); Supplementary interventions: Vermi-compost unit, Azolla unit, Milk collection centre.

In 2012, he purchased 7 HF crossbred cows and 3 murrah buffalos worth Rs 5 lakh through bank loan. Since 2013, he has been participating in on and off campus trainings organized by KVK, Dungarpur. His net income has increased substantially since 2012 and presently he is earning over Rs 8 lakh per annum.

24

SIKKIM

The second smallest state of Indian Union, Sikkim lies in the Eastern Himalayan Range between $27^{0}5'$ and $28^{0}9'$ north and $88^{0}56'$ longitude. Because of geographical position, it is wholly a hilly state having varied elevation ranging from 300 to 8400 meters. The mean annual rainfall varies from 2000 mm to 5000mm with intensity from drizzling to snowing. The wealth of the state is derived from its forests, agriculture and livestock.

The household income of the farmers contributed (24%) by farming, livestock (16%), non-farm activity (14%) and income from wages and salary (34%). The farm household having outstanding loans has declined over the years it is about 14% with an average of INR 14,645 per hectare. Maize, rice, wheat, millet, buckwheat, pulses and oilseeds are the major cereal crops grown in the state. The productivity of these crops is lower than both regional and national averages for all the major field crops. Agriculture, horticulture and livestock are the backbone of Sikkim's rural economy. In recent years, rural tourism home stays are also emerging as a component of farm household income. The state is bestowed with favorable climatic conditions to grow wide variety of agri-horti crops, abundant water, and biological diversity. In addition to nature's bounty, it has people friendly administration, state and central research and development institutions to guide and advice policy makers and executors to execute them at grass root level. The agriculture sectors needs attention with regard to enhancing production, productivity, diversification, infrastructure creation, market linkages, better breeds of livestock, production of feed and fodder and management of livestock and product processing on scientific lines.

The distribution of operational holdings in Sikkim is highly iniquitous. The marginal and small farmers taken together constitute 68 per cent of total land holdings but cultivate only 28 per cent of the total land area in the state. While the holding above 4 ha form 12.5 per cent and they control more than 44 per cent of the total operated land. The average size of holdings in the state is 1.95 ha.

Sikkim is a landlocked state in the north-eastern region of India. It is the second smallest state in terms of area after Goa and the least populous state of the country. The state shares international border with China, Nepal and Bhutan, and state boundary with West Bengal. The Kingdom of Sikkim was founded on the Silk Road by the Namgyal dynasty in the 17th century. The state is situated in the Eastern Himalayas spread below the world's third highest mountain Kangchendzonga (8595m) lying between 27 0 04' 46" to 28 0 07' 48" north latitude and 88 0 55' to 89 0 55' 25" east longitude. To its north lies the vast stretches of Tibetan plateau of the People's Republic of China, to its west is Nepal, Bhutan and China in the East and West Bengal in South.

Sikkim has a diverse climate. It is predominantly wet and moist almost throughout the year with average annual rainfall of 2000 mm to 5000 mm. The mean temperature in the lower altitudinal zone varies from 5°C to 15°C during winter and 18°C to 28°C during the summer months. In the higher reaches, the average temperature never crosses 15°C. Maximum temperature is recorded during July / August and minimum during December / January. The cropping pattern of the State over the years has transformed from cereal dominated subsistence agriculture to high value, cash crop dominated commercial agriculture. Eighty percent of the population lives in rural Sikkim. The total cultivable land in the state is around 75,000 hectares. Agriculture in the State of Sikkim is practiced under diverse conditions. The principal crops of the state are maize, rice, large cardamom.

24.1 Major Constraints

Rice	Less area under high yielding/hybrid rice Popularization of System of Rice Intensification (SRI) and Direct Seeded Rice (DSR) technologies Breeding of varieties responsive to low input and organic cultivation Improvement of local genotypes/landraces which are adaptable and preferred by the people of Sikkim
Maize	Less area under high yielding/hybrid varieties. The local land races are not yield much due to open pollination. Maize is directly sown in field by broadcasting. The raised bed planting would be beneficial for controlling diseases due to high rainfall Breeding of varieties/hybrids responsive to low input and organic cultivation Improvement of local genotypes/landraces which are adaptable and preferred by the people of Sikkim Bio-agents for seed treatment to control seed and soil borne diseases.
Wheat	Wheat is an irrigated crop grown during rabi crop. Not much attention is required for this crop as it is high input requiring crop and unsuitable for hills due to high cost of production.
Minor crops	Very less area under high yielding varieties under cultivation of barley and finger millets NBPGR has a large collection of buckwheat and selection may be made and improved varieties may be developed Popularization of buckwheat as nutritive food as it has essential minerals and also good for diabetic patient

Oilseeds	Gap between yield potential and actual performance in the field Adaptability testing and popularization of high yielding varieties A large area remains fallow after paddy cultivation Non-availability of varieties responsive to low inputs/organic cultivation Low or no access to facilities for irrigation during rabi season Low efficiency of biopesticide/botanicals needed for controlling disease and pest Breeding of varieties resistant to disease and pests
Pulses	Adaptability testing and popularization of high yielding varieties Breeding of varieties resistant to disease and pests and responsive to organic cultivation Expansion of area under pulse crop Irrigation facilities are not available Increasing area under high yielding varieties Non availability of seeds of high yielding varieties
Horticul-tural Crops Vegetables:	Increasing area under high yielding varieties Cool chain for transport/storage and processing Adaptive trails for screening high yielding varieties suitable for organic cultivation in protected as well as open conditions Promotion of local traditional vegetables of Sikkim through diversification Organic insect pests and disease management Availability of botanicals, biopesticides etc. for management of diseases and pest.
Fruits	Senile and old citrus plantations have crossed their productive life and yield is very low Nan-availability of quality planting materials of fruit crops Area suitably need to be diversified with other local fruit crops suitable in the region Introduction of high yielding varieties/exotic fruits.
Spices	Non availability of disease free quality planting material Re-plantation of old cardamom with new high yielding varieties Farmers' dry cardamom in homemade kilns hence the final product inferior in quality. Proper cardamom drying technology need to be developed Disease and pest management through organic means
Floriculture	Non availability of quality planting material No storage transport, pack-house, grading and packaging facility Proper package of practices for growing of flower crops organically Lack of Market driven variety
Animal Husbandry	Meeting feed and fodder requirement of the cattle. A feed mill is under construction at Melli, Payong. For making feed with the state would require increasing the productivity of crops like maize, finger millets etc. Fodder crops suitable for Sikkim condition should be introduced and tested for meeting fodder requirement of the cattle.

Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

a. Increasing Production and Crop Productivity

The productivity of all the cereals, pulses & oil seeds, spices and fruits and vegetable crops is below the average national productivity of the crops except a few like oilseeds and ginger, but the productivity of ginger is far below the regional productivity. In general, the crops grown in the state are performing below their potential. The productivity is the result of factors like seeds & planting materials, plant nutrients, irrigation and crop management etc. The major factors contributing to low yield are (i) low area under high yielding varieties (ii) availability of plant nutrients (iii) very less irrigated area (11% of total cultivated area) (iv)old and senile plantation of mandarin and large cardamom and (v) non adoption of scientific methods of cultivation and (vi) high incidence of disease and pests due to humid environment.

b. Increasing area under high yielding varieties

The seed replacement rate of high yielding varieties in the state is very low. The area under high yielding varieties of different crops is represented in graph below. ICAR- NOFRI and Department of Agriculture has identified improved and hybrids of various crops grown in the state. The recommended high yielding rice varieties are Pandhan-12, Pandhan-16, Pandhan-18, CAUR-1, CAU-R, PD-10/12/16/18/ and hybrid variety KRH-2. Millets- GPU-28 & MR-1; Maize-C1415; Soybean-PK1042/1029; Rajma-Varun Bomdila; Mustard-B9; Urd-PD-3; Rajma -Jwala & Varun; Soybean-VL Soya, 47/BB; Availability of seeds of improved/hybrid varieties is shown in graph below. The availability of seeds of improved and hybrid varieties are low and have greater scope for production of high yielding varieties in Sikkim involving the private seed companies.

c. Plant protection technologies for organic farming

Rich ferti plus 500g to 2 Kg/plant in fruit crops, 40-60 kg/ha in spice crops), Rich Top mix (10-15 acre for Citrus, Banana,Litchi and Apple) Vermi compost (3-5 kg per per fruit tree palnt) , Rich Combi Micronutrient (1-1.5 g/lt for all types of fruit crops) , Krishi Chuu (Soil reclamation), Cow dung Manure (2000-3000 kg for various spice crops) Rich HG I (for control of Red mite, leaf minor, red spider @ 1.5 ml/ltrof water for fruits crops), Rich HG II (for control of thrips, whitefly, aphids and leaf hopper @1.5 ml/ltr of water in fruits crops), Rich HG III (for tomato fruit borer, soybean looper, army worm, leaf eating caterpillars @1.5 ml/ ltr of water) Rich Agri Guard (for controlling disease like powdery mildew, late blight, leaf spot @ 2-3 ml/ltr of water foliar application and or drenching) Agro servo spray (for orange rejuvenation) Copper Oxy Chloride Pheromone traps (1200 No./ ha)

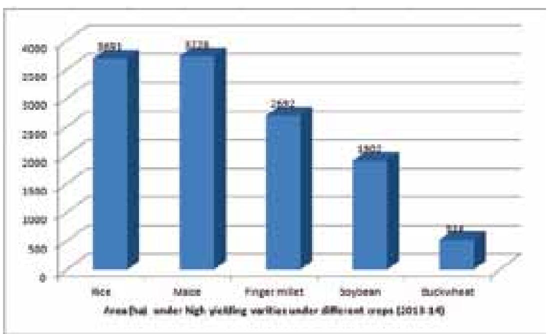
d. High Resource Use Efficiency

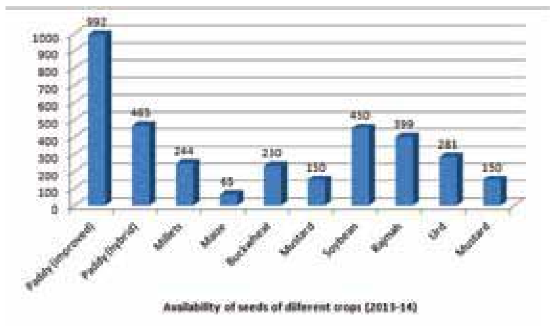
Adoption of superior cultivars also demands higher usage of resources like water and fertilizers. Eighty nine percent of total cultivated area does not have irrigation facility. The irrigation facilities are available 11% of the cultivated area. Though this region is under high rainfall zone and post monsoon there is scarcity of water. The harvesting of rain water would be beneficial. Construction of Jalkund with the capacity of 30,000 lt has been tested by the ICAR-NOFRI. The irrigation systems like drip and sprinkler need to be promoted for efficient use of water. Moisture conservation through organic mulching as well as plastic mulching should also be promoted.

Since declaration of Sikkim as organic state in 2015, the use of agriculture chemicals including fertilisers is ban. The requirement of plant nutrients are met through the organic sources like composting, farm yard manure, biopesticides, biofertlisers etc. Most soils of the state are acidic and the pH ranges from 4.5-5.5. Such soils retard microbial growth and uptake of nutrients. The application of organic sources of plant nutrients and soil amendments ameliorate physical conditions of soil and increase the pH level. The soil test based plant nutrient management would be helpful in efficient use of plant nutrients and further, intercropping with legumes and green manure crops for improving soil health. Certain crop rotations e.g. ginger + maize on raised beds and mulching with ferns and animal bedding, seed potato + pea with application of farm yard manure. Till the year 2013-14, 31, 592 soil cards have been issued by the State Agriculture Department.

d. Increasing Cropping Intensity

Sikkim has very large (89%) area under rain-fed condition and farmers to grow only one or two crops in a year. Cropping intensity is the ratio of gross cropped area to net cropped area. The cropping intensity of the state can be increased by assuring water supply and making efficient use of water through micro irrigation devices. Suitable intercrops, crop rotations are to be adopted requiring less water during the period of scarcity. Maize is the major crop of the state and nearly 50% of the area under this crop is shown once. There is enough scope in utilizing winter remains fallow for cultivation of crops like mustard and buckwheat.





e. Crop Diversification

Crop diversification is probably one of the most cost effective and assured means to boost farmers' income. There are several alternatives available viz. shifting to genetically superior hybrids and varieties, cultivation high value crops with diversified usage etc. The people of

Sikkim have realized the potential of diversification of agriculture. Various alternatives in fruits, vegetables and flowers have been tested. Fruit crops like guava, litchi, banana, apple Asiatic pear, Kiwifruit, papaya is emerging as crops for diversification of fruit crops. Similarly, growing of offseason vegetables and flower crops namely orchids, carnation, roses and gerbera etc are also gaining ground. Crop diversification holds greatest potential in doubling farmers' income in the state. However, the availability of quality seeds and planting material is the greatest challenge in meeting the goal. Further, adoption of organic agriculture in the state can help to market their produce in national and internal markets at profitable margins and can boost to income of the farmers in the state. Owing to unique agro climatic conditions and farming practices, there are larger opportunities for high-value products such as cardamom, ginger, orange, tea, kiwi fruits, passion fruit and many types of mountain vegetables and food-grains. The cultivation of these crops through organic method has more potential for national and international markets.

Reforms in Agri Sector

Increased remuneration is the best motivation for the farmers to produce more. Since, policies affect production in a considerable way, it is important that our laws, policies and schemes ensure increase in income at farm level. Farmers have often struggled to avail benefits of various policies. Hence, reforms are necessary to ensure that cultivators receive their due.

Farmer Friendly Agriculture Markets

Realization of remunerative price of the agricultural produce is one of the primary reasons for agrarian distress. Marketing of agriculture produce is done through NERMAC and SIMFED.

Use of ICT for Weather & Market Information

Like elsewhere in the country the agricultural system of Sikkim depend on vagaries of monsoon, causing heavy rainfall, dry spells, and hailstorms. The challenge is even more daunting if one considers that fact that only 11% of the net sawn area in Sikkim has reliable access to irrigation. The threat of climate change is looming and the state fragile agro-ecosystems, susceptible landslides. In such scenario, farmer's preparedness is critical. Adoption of ICT-based location specific weather and crop advisory data is highly recommended to help overcome climate change associated vulnerabilities in agriculture system.

ICT also supports in price discovery and transparency of agriculture commodities and produces. The farmers can stay alerts on prevailing prices in different markets of the country and can make informed decisions on sale of their produce. Hence, promotion of ICT in agriculture can lend a huge in facilitating better remuneration for farmers. Govt. of Sikkim has launch the website Sikkim Agris net and Sikkim Organic Mission where the package of practice for cultivation of major crops and notification about schemes, subsidies etc. are posted by the concern departments.

Improved Storage

Post harvest management plays an important role in supply chain in delivery of quality produce and fetching highest price of the produce. Unscientific and conventional methods of storage and handling of agricultural produce adversely affect the quality and price realized by the farmers. The scientific methods of storage increase shelf-life of produce reduce losses. Depending on the diverse nature of agri-commodities being produced in the state, different types of storage infrastructure viz. warehouses, cold rooms, mobile pre-cooling units, cold storages are required. The following initiatives have been taken by the Govt of Sikkim

i. HCCD Godown at Rangpo which is also use by NERMAC
ii. Central Godown (wholesale market) at Rangpo HCCD department
iii. Refrigerator van-run by SIMFED
iv. Bamboo treatment plant at Rangpo
v. Godown near ICAR office used by HCCD/FSDD
vi. Model floriculture centre at Namli East-Sikkim
vii. MPCS Godown at Namok- 100 MT capacity
viii. MPCS Godown at Darap - 150 MT capacity
ix. MPCS Godown at Mellidara - 100 MT capacities

Processing and Value Addition

The profitability of the farmers depends on multiple factors viz awareness on the demand, better markets, quality, and value addition to the produce. In general, there is lack of awareness about processing and value addition of agricultural produce in the state. Post-harvest management and value addition increases the profit margin of the farmers. The primary processing that includes cleaning, grading and sorting and packaging of the produce can be encouraged at farmer's level or cluster level with common infrastructure. The state has great potential for value addition in organically grown ginger, cardamom, turmeric, flowers including orchids, mandarin, strawberry, kiwi, etc.

i. Seed processing laboratory at Majitar
ii. Pack house run by SIMFED

Improving productivity and health of livestock

The following interventions have been suggested by the department of animal husbandry

Dairy sector

i. Raise animals in a system that takes into consideration issues of environmental pollution and human health
ii. Livestock diversification for insurance during calamities as well as household nutrition
iii. Conservation of indigenous breed (Siri Breed) suitable to organic Animal Husbandry

iv. Use of low external inputs, lessen cost of production.

v. Achieve per capita milk availability at par with developed countries, from 243gms to 280gms.

vi. Strengthen breeding facilities, AI & NS.

vii. Strengthen Veterinary infrastructure for better reproductive health care.

viii. Facilitate easy access to bank loans at low interest rates under DEDS & NLM.

ix. Promotion of good quality of fodder varieties.

x. Extensive extension and training, also exposure visits outside Sikkim.

Poultry Sector

i. Increase poultry meat production from present 3500MT to 8000MT by 2022.

ii. Strengthen Bermiok Hatchery to ensure uninterrupted supply of DOCs.

iii. Encourage poultry co-operatives for small time growers to ensure economy of scale and risk sharing.

iv. Support young entrepreneur for commercial as well as back yard poultry through poultry venture capital fund.

v. Poultry processing unit with capacity of 24,000 birds per day is under construction.

Piggery Sector

i. Increase pork production from present 150MT to 550MT by 2022.

ii. Six pig farms of the department to be strengthened with parent stock of exotic breeds for supply of good quality piglets to farmers.

iii. 2000 nos. of progressive farmers will be provided 09 sows and 01 boar for piglet production at farmers level(master farmer concept).

iv. One modern slaughter house with 50 Nos. pig line is under construction at Mazitar, East.

Goatery Sector

i. Increase chevon production from present 200MT to 600MT by 2022.

ii. Introduction of improved breeds, boyer, Sanen, betel, jamnapari, black Bengal.

iii. Selective breeding local Singharey breed goats.

iv. Setting of goat breeding farms in four districts for providing good quality breeding stock to farmers.

v. Provision of breeding bucks at panchayat units.

vi. Modern slaughter house with 50 goat line in one shift is under construction at Mazitar, East.

Integrated Farming

Livestock are integral part of farming system in Sikkim. Primarily, they are rear for milk and meat purpose and excreta of the livestock is used for organic cultivation in the state. The farmers rear cows, buffalo, goat, sheep, and poultry for various purposes. In higher hills yak is rear for milk as well as meat purpose. Apart from livestock various forestry based farming systems are adopted to supplement the income of the farmers. State of Sikkim has been declared as organic state and follows integrated farming where crops, livestock are the component of farming system. Govt. of Sikkim has taken following steps to promote integrated farming in the state.

i. Production of manure where the govt. is promoting and providing subsidies of making of Bio-fertilizer production unit, Azolla culture
ii. Vermi-culture hatcheries, Rural compost-cum-Urine Pit
iii. Govt. is producing organic seeds on its own farms and SHG groups identified for seed production.
iv. Bio-village has been setup using EM technology, 396 villages were adopted as bio-villages by the Department of Food Security and Agriculture Development in collaboration with Maple Orgtech Pvt. Ltd, Kolkata. About 14,000 farmers and 14,000 acres of land in all the 4 districts of Sikkim were benefited under the programme. Important soil enrichment and plant-protection formulations demonstrated under the strategy were EM-compost, EM-Bokashi, EM-FPE and EM-5

Role of Technology

a High yielding varieties

The seed replacement rate of high yielding varieties in the state is very low. The area under high yielding varieties of different crops is represented in graph below. ICAR- NOFRI and Department of Agriculture has identified improved and hybrids of various crops grown in the state. The recommended high yielding rice varieties are Pandhan-12, Pandhan-16, Pandhan-18, CAUR-1, CAU-R, PD-10/12/16/18/ and hybrid variety KRH-2. Millets- GPU-28 & MR-1; Maize-C1415; Soybean-PK1042/1029; Rajma-Varun Bomdila; Mustard-B9; Urd-PD-3; Rajma -Jwala & Varun; Soybean-VL Soya, 47/BB; Availability of seeds of improved/hybrid varieties is shown in graph below. The availability of seeds of improved and hybrid varieties are low and have greater scope for production of high yielding varieties in Sikkim involving the private seed companies.

b. Plant protection technologies for organic farming

Rich ferti plus 500g to 2 Kg/plant in fruit crops, 40-60 kg/ha in spice crops), Rich Top mix (10-15 acre for Citrus, Banana,Litchi and Apple) Vermi compost (3-5 kg per per fruit tree palnt) , Rich Combi Micronutrient (1-1.5 g/lt for all types of fruit crops) , Krishi Chuu (Soil reclamation), Cow dung Manure (2000-3000 kg for various spice crops) Rich HG I (for control of Red mite, leaf minor, red spider @ 1.5 ml/ltr of water for fruits crops), Rich HG II (for control of thrips, whitefly, aphids and leaf hopper @1.5 ml/ltr of water in fruits crops), Rich HG III (for tomato fruit borer, soybean looper, army worm, leaf eating caterpillars @1.5 ml/ ltr of water) Rich Agri Guard (for controlling disease like powdery mildew, late blight, leaf spot @ 2-3 ml/ltr of water foliar application and or drenching) Agro servo spray (for orange rejuvenation) Copper Oxy Chloride Pheromone traps (1200 No./ ha)

c. Resource use efficiency

Construction of Jalkund with the capacity of 30,000 lt has been tested by the ICAR-NOFRI. The irrigation systems like drip and sprinkler need to be promoted for efficient use of water. Moisture conservation through organic mulching as well as plastic mulching should also be promoted.   The Zero tillage cultivation of pea after harvesting of paddy has been tested in several location and useful technology for exploitation. The crop rotations have been tested in several locations and found to restore fertility of soil and recommended by KVKs., e.g. ginger + maize on raised beds and mulching with ferns and animal bedding, seed potato + pea with application of farm yard manure.

d. Organic production technology

Maize: Organic maize production under INM, C-1921. The average production is 26 q/ha, after intervention, the productivity enhances to 39.6 q/ha. thus there is increase about 34% in productivity and BC ratio is 2.4. Suitable for AES-II (Subtropical regions) Another variety of Maize DMH-849 in similar production system (INM) gives an yield of 26 q/ha, the interventions could increase the yield up to 41.9 q/ha, an increase of 37% over the current production and B:C ratio 2.4. Another variety of composite maize RCM1-1, RCM 1-3) having production 23.6 q/ha were able to yield 36.1 q/ha, an increase of 34% on current productivity with a B:C ratio of 2.3. Management of stem borer through neem oil can increase the yield 24.7 q/ha to 35.4 q/ha with a B:C ratio of 1.8.

Paddy: Variety Local Attey, under SRI production technology the production rose up from 18.7 q/ha to 20.8 q/ha, an increase over 10% with a B:C ratio of 1.5.; In organic production technology of variety VL-82, the production rose from 20.8 q/ha to 27.5 q/ha recorded an increase of 24% with a B:C ratio of 1.7. The two improved varieties RCM-10 & CAUR 1, the productivity was 34.3 q/ha which is 36% more productivity than prevailing varieties with B:C ratio of 1.6. The other varieties RCPL-473 and RCPL 1-123 produce 31.8 q/ha have an increase of 29% over traditional varieties (22.3 q/ha) with a B:C ratio of 1.5.; An another variety of Paddy SKR 3608 yielded 36.2 q/ha under East Sikkim which is 41% higher than traditionally grown varieties. The B:C ratio is 1.6.

Buckwheat**:** Under minimum tillage conditions, the buckwheat yields 8.7 q/ha as compared 6.4 which is 26 % higher than traditional methods of cultivation and the B:C ratio is 2.1. Organic management of pest and diseases yielded 10.5 q/ha as compared to control (7.5 q/ha) which is 28.5% higher than the traditional methods of cultivation. The B:C ratio is 2.3.

Pulses

Black gram: Organic nutrient management in production of black gram variety IPU-02-43 yields 9.2 q/ha as compared to control (5.6 q/ha). The production is 39% higher and B:C ratio is 2.3.

Green gram: The organic production technology of green gram yields 11.2 q/ha as compared to control (6.5 q/ha) which is 41% higher than control. The B:C ratio of this intervention is about 2.1.

Field Pea: Organic production of field pea variety Praksh yielded 19.6 q/ha as compared to traditional varieties. The production is higher 31% higher than traditional varieties. The B:C ratio of this intervention is 2.3.

e. Oil seed *Crops*

Soybean**:** Variety JS-335 tested under organic nutrient regime yielded 8.7q/ha which registered 27% higher yields compared to other varieties. In other report it was quoted that organic production of variety JS-335 yields 20.2 q/ha which is 32 % higher than control (13.6q/ha). The B:C ratio of this intervention is 2.6. The B:C ratio is 2.2. Another variety RCS-1-10 yields 23.4q/ha which is 69 % higher than the current yield. The B:C ratio of this intervention is 2.2.

Toria: The organic cultivation of toria variety TS 46 under late shown conditions yielded 8.7 q/ha as compared to control (6.3 q/ha). The productivity is 27% higher with B:C ratio 2.2.

Mustard: Organic pest management (aphids and white rust of mustard) variety B-9 gave a yield of 7.3 q/ha in compared to unmanaged cultivation (5.2 q/ha. The productivity is higher by 28.8 % higher with B:C ratio 1.4.

f. Horticultural Crops

Vegetable Crops: Cabbage**:** Organic production technology for cabbage production yielded 227.5 q/ha as compared non organic production (170 q/ha). The productivity is higher by 25.2% with B:C ratio 2.6. ; ***Cauliflower***: Organic production technology of cauliflower yielded 205q/ha as compared to control (132 q/ha) which is 35.6 % higher with B:C ratio 2.5.

Broccoli: Organic production technology of Broccoli yields 139.5 q/ha as compared to control (105 q/ha). The technology registered an increase of 24.7 % with B:C ratio of 3.4. ***Garden Pea***: The organic production of garden pea increased the yield 63.3 q/ha as compared to control 55.3 q/ha. The yield was increased by 12.6 % with B:C ratio of 2.8. The organic management of powdery mildew in pea variety Kashi Uday gave a yield of 104.2 q/ha which was 10.9 % higher than the control (92.8 q/ha).***Tomato***: Mulching of increased the yield from 88.1 q/ha to 111.2 q/ha. The increase in yield was 20.8% with B:C ratio 2.5. ; Bio-rational management of insects and pests in tomato (Arka Samrat) gave a yield of 295 q/ha as compare to control 252.4 q/ha. It registered an increase of 14.7 percent with a 2.6 B;C ratio. ***Red Cherry Pepper***: The organic nutrient management is red cherry pepper gave a yield of 250 q/ha which is 18 per cent higher than control (205 q/ha). ***Ginger***: The organic production technology of ginger gave a yield of 197.5q/ha as compared to control 110q/ha which is 44.3 percent higher than the control. Similarly bio-mulching of ginger recorded the yield of 215 q/ha as compared to control 110 q/ha. The yield was increased by 48.8 %.

Summary recommendations:

Sikkim is the second smallest state of Indian Union. In 2015, the state has declared itself a fully organic state. It is first state in the world which is wholly organic. Thus it holds great potential as well as challenges to sustain and flourish. The technical knowhow is limited in organic management of plant health and increasing productivity. The following are the major recommendations for doubling the farmers' income in Sikkim:

i. The cropping intensity should be enhanced by utilising fallow lands after harvesting of maize and paddy and also by developing assured irrigation facilities.

ii. The productivity of various cereal crops (maize, paddy, buckwheat,) oil seeds and pulses is far below the national average which needs to increase by making available seeds high yielding varieties and other necessary inputs timely.

iii. Making available quality seeds and planting materials of horticultural crops and spices particularly large cardamom, ginger, red pepper chilly, orchids, turmeric and mandarin.

iv. Poultry farming and Piggery is emerging major enterprise and needs to be up-scaled for which the technology is available in the state.

v. Post-harvest infrastructure like grading and packaging units, cold storage, refrigerated vans (cool chain) and processing units, needs to be developed in major crop growing area.

vi. At present only two crops (potato and ginger) are under consideration for crop insurance scheme but all focus crops like large cardamom, orange, kiwi fruit, vegetables and other important field crops should be covered under crop insurance scheme.

vii. To produce quality products fetching premium prices would require protected structure which require huge investment and beyond the capacity of small marginal farmers. Hence these may be subsided by the governments. The government should ensure that farmers are getting remunerative price for their produce. In case of glut the government may reimburse the production cost.

viii. In hilly regions transportation and marketing of produce is very difficult task that adds on sale prices. There is need to establish on regulated market in each district and two markets at block level for agricultural commodities.

ix. Provision for irrigation facilities during Rabi season to convert the paddy fields and other fallow lands in to crop production programme.

x. Rearing of livestock should be promoted for production of vermi-compost, farm yard manure.

xi. The inputs seeds (fertiliser and bio-pesticides) required in the state should be produced within the state to avoid additional cost on transportation and making them available timely.

SUCCESS STORIES

1. Women entrepreneurship development through backyard poultry farming in

Sikkim

Mrs. Pabitra Sharma is a progressive farm woman of Nandok village of East Sikkim district. She is an innovative women farmer actively involved in livestock farm activities like goatery and backyard poultry farming. Apart from working as farm labour and running a small grocery shop she is also engaging herself in different farm activities like cultivation off-season vegetable, maize etc. in homestead area to earn her livelihood.

Initially, KVK supplied 20 nos. of chicks to each selected beneficiaries of the adopted village as first line beneficiaries. In later stage, two farmers became reluctant to take up backyard poultry, and then Mrs. Pabitra Sharma on her own initiative and in consultation with Village Climate Risk Management Committee (VCRMC) took up their stock of 40 birds and started rearing 60 nos. of Gramapriya birds single handedly with the assistance of KVK, East Sikkim. She brood her chicks up to 28 days of age in a specially designed scientific but cost effective and eco-friendly brooder house made up of locally available materials i.e. bamboo and wood to maintain required body temperature to curb the chick mortality because of cold stress which is otherwise a major problem in the climatic condition of Sikkim. To maintain the temperature in brooder, she used 100 watt bulbs. The movement of the chicks was restricted nearer the heat source with the help of chicks guard made with card board.

Before taking up the enterprise she built a semi- permanent house with rough pucca floor, 2 feet brick wall with wire net in uncovered upper portion of the poultry house. She initially started with more than 360 sq. ft. area of size 18 x 20 feet. She also put some wooden nest box inside the house to control the scattered egg laying. The total cost involvement of poultry house was Rs. 10,000/-.

Mrs. Sharma used hay, pieces of straw, dry leaves, rice husk etc. as a litter material. In nursery, chicks were reared on standard broiler starter ration. In the second phase, she fed the growing birds with vegetable wastes, grass and other kinds of locally available grains like maize and rice polish besides the feed material available from free range. She made available fresh and clean water at all times in bamboo made watering and feeding trough. Mrs. Sharma also periodically supplemented the birds with multivitamin (Ambiplex @ 1ml /lt of water) and during laying period calcium supplement regularly (Calcicare @ 1ml/lt of drinking water).After attaining maturity (3-4 months) she sells her extra male birds @ Rs. 220/ kg live weight and egg @ Rs. 10/ egg at local market.

Income generated per annum by selling the product vis-à-vis cost of production per unit:

Enterprise	Breed	Stock per batch	Expenditure (Rs.)	Income (Rs.)	Profit (Rs.)	B:C ratio
Backyard poultry farming	Gramapriya	60	14,446/-	25,720/-	11,274	1.78


Ms. Pabitra Sharma inside her Poultry House

Eggs of Vanaraja / Gramapriya

2. Success story on rural entrepreneurship development through pig farming

Sri Mandip Rai a progressive educated rural youth of Nandok village of East Sikkim district. Previously he was working in Dubai as a sales man but 3 years ago he came back to his home place to do something agricultural related work in his own land. He has 2 ha land in his homestead and wanted to do integrated farming activity. Later he was engaging himself in agriculture, horticulture and livestock farm activity like dairy and backyard poultry.

Initially, KVK supplied a total of 45 piglets among 15 farmers i.e. 3 nos. of weaned piglets of 2 months old (2: female + 1: male) to each beneficiaries of the adopted village as first line beneficiaries. Before taking up the enterprise Mr. Rai built a semi- permanent pig house with rough pucca floor and 2 feet brick side wall. He initially started a pig shed of 5 compartments of equal size (8 x 8 ft. of each compartment) with the necessary guidance of the SMS (Animal Sc.). He used locally available feed resources for feeding his piglets like cereals (Maize, paddy husk and rice bran), kitchen waste, vegetable waste (leaves of Cabbage, Cauliflower and Knolkhol *Brassica oleracea*, locally available plants (Colacasia, Raipatta, Sisnu, Caina etc.), butchers house bye products (soup of head and feet of beef, poultry intestine etc.). He cooked all the feed stuffs and small amount of salt is invariably added before feeding. He made available fresh and clean water at all times in pucca made watering and feeding trough. Mr. Rai also periodically supplemented mineral mixture and vitamins to his pigs. He also vaccinated his pigs against swine fever. At first farrowing he got a total of 14 piglets from his 2 sows after 12 months of rearing.

Income generated per annum by selling the product vis-à-vis cost of production per unit:

Enterprise	Breed	No. of pig	Expenditure (Rs.) in cost of piglets and conc. feed	Income (Rs.) From sale of piglets of 1st farrowing	Profit (Rs.)	B:C ratio
Small scale pig breeding farm	Large White Yorkshire (LWY)	2 (Female +1 (Male)	18,300/-	44,800/-	26,500/-	2.45

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TAMIL NADU

Tamil Nadu State is located in the Northern hemisphere in the hot zone between 8° and 13° N latitude and between 78° and 80° E longitude. Tamil Nadu is the 11th largest State in India by area and the 7th most populous State. The State lies on the eastern coast of the southern Indian peninsula neighboured by Puducherry, Kerala, Karnataka and Andhra Pradesh States.

Agriculture is the major occupation in Tamil Nadu. The principal food crops include paddy, millets and pulses. Commercial crops include sugarcane, cotton, sunflower, coconut, cashew, chillies, gingelly and groundnut. Plantation crops are tea, coffee, cardamom and rubber. Major forest produces are timber, sandalwood, pulp wood and fuel wood. Tamil Nadu occupies a premier position in the production and extensive application of bio-fertilizers. Efforts are on to improve farming technologies so as to increase yields in the low rainfall areas of the State.

Major Industries in the State are cotton, heavy commercial vehicles, auto components, railway coaches, power pumps, leather tanning industries, cement, sugar, paper, automobiles and safety matches.

Tamil Nadu is the 5th largest contributor to India's GDP and one of the most urbanized States in India. The State has the highest number (10.56 per cent) of business enterprises in India, compared to the population share of about six per cent. In Agriculture front, the Government of Tamil Nadu has resolved to usher in a Second Green Revolution formulated to achieve equitable, competitive and sustainable growth in agriculture. There are about 82 lakh farm holdings in the State who depend on agriculture and allied sectors for their livelihoods whose income has to be at least doubled in the next five years. Tamil Nadu state is divided into seven agro-climatic zones. The North Eastern Zone is located between 8°5' and 13°2' North latitude and76°15'and 80°22' East longitude, covering an area of 31,065 Sq. km equivalent to 23.9per cent of the State area.

The land is the basic resource over which all the agricultural operations are carried out. Land use statistics indicate the way in which the available land area is put under various uses. Land as a scarce resource, has to be managed effectively. The total geographical area of the State is 13 million ha. The area under forest is around 21 lakh ha accounting for 16 per cent of the geographical area.

The various crops, food grains constituted 78.83 % of the area followed by Oil seeds (10.80%)

and Sugarcane (6.48%). Among the food grains Rice constituted (38.44%) of the total area under major crops. Tamil Nadu with 7.0 per cent of population in the country is endowed with only3.0 per cent of the water resources of India. The State's water resources are dependent on rainfall. The per capita availability of water in the State stood at 900 cubic meters only as against the All – India level of 2200 cubic meters.

25.1 PRODUCTIVITY GAPS AND MAJOR CONSTRAINTS

A. Agriculture

- The major strengths of the sector are:
- Introduction of crop specific strategies like System of Rice Intensification (SRI), System of Pulses Intensification (SPI), Sustainable Sugarcane Initiatives (SSI) and precision Farming for agricultural and horticultural crops which are developed mainly to bridge the yield gap.
- Creation/Improvement in establishment of agricultural marketing infrastructure and promoting primary producer-owned agri business ventures.
- Increasing the cultivable area and diversifying the cultivation in favor of high value, organic horticulture and commercial crops while ensuring food and nutritional security for all.
- Assessing the requirement of agricultural inputs so as to meet the local needs effectively and ensuring availability of adequate quantity of inputs at appropriate time and that are to be locally produced.
- Reclamation of saline and alkaline soil, issue of Farmers' Integrated Handbooks
- (FIHB).
- Promoting hi-tech agriculture, precision farming and micro irrigation for efficient use of irrigation water – Promoting horticulture technologies and micro irrigation as whole village concept.
- Farm level interventions for 'end to-end' involvement of extension staff with individual farmer – conducting pre-season village campaigns (Uzhavar Peruvizha) in close coordination with the all allied disciplines. Capacity building for farm based research and agriculture innovation and excellence by the farmer's Supply of gender friendly equipment such as power/cono weeders and markers.

Challenges

Agricultural operations are however constrained by sub-optimal water resources to a great extent. To ensure "more crop/income per drop of water", special emphasis has been given for the cultivation of high value – less water intensive crops for effective land use system.

The small size of land holdings inhibits investment in productivity enhancing measures and makes many agricultural holdings sub-optimal.

Such type of holdings challenges the process of marginalization of small and marginal farmers and casualization of agricultural laborers. To derive the best results and to empower them, these farmer groups have to be motivated either to form farmer's groups or some type of institutional arrangements so as to get all the technical inputs in time and to ensure judicious use of various scarce resources.

Thus, agriculture sector continues to confront with the shrinkage of area under cultivation, gross mismatched between the drawal and recharge of ground water, growing conversion of agricultural land for non-agricultural uses that made disparities in yield rate of crops across the State, imbalanced application chemical fertilizers and the dominance of small and marginal farmers.

Water Use Efficiency (WUE) has to be increased by enhancing productivity of per unit of water for which strategies such as mass adoption of Micro Irrigation Mission approach, promotion of Precision Farming, SSI, SRI and Rainwater Harvesting structures for recharging groundwater are to be promoted.

B. Horticulture

Major initiatives for increasing the area acreage and productivity were taken up in the form of cultivation, rejuvenation of old orchards, canopy management, organic farming, post- harvest management, creation of marketing infrastructure and human resource development.

The major challenges are:

- Horticultural Parks for fruits, vegetables and spices have to be developed across the State.
- More thrust has to be given to micro irrigation with fertigation.
- Expansion of area under precision farming,
- Hi-density planting
- Organic cultivation wherever possible to meet the demand from niche markets andconsumers through which income earning capacity of the farmer water can be enhanced.
- More emphasis on value addition by creating value addition centres and establishment of localized training to the farmers accordingly.

C. Agricultural Engineering and Mechanization

In Tamil Nadu mechanization in agriculture is still limited to usage of tractors and motor pumps.

The challenges in promotion of mechanization include non-standardized agricultural practices, atomistic land holdings, low investment capacity of farmers, lack of know-how and non-availability of service and maintenance facilities.

Suitable policy and structural mechanisms have to be developed and support increased mechanization in all phases of agriculture.

The State depends on ground water for irrigation and the farmers have to be motivated for solar energization of irrigation pump sets.

Provision of solar energy is beneficial to the farmers on one hand and it also reduces the burden on the State Grid on the other.

Besides, more agro-service centers have to be created at block level and promoting rural youth for custom hiring of farm machineries and equipment.

D. Agricultural Marketing and Agri Business

Owing to a number of factors such as inadequate storage facilities, lack of quick and economical means of transportation, poor withholding capacity of the farmers and urgent credit needs, the unorganized sector comprising wholesale merchants, commission agents and other intermediaries continue to dominate the sphere of agricultural marketing. Efficient market with a dynamic supply chain is indispensable for the development of agricultural sector.

The challenges are:

- Enhancing the marketability of agricultural commodities by creating necessary modern infrastructure facilities and strengthening of existing markets by providing additional infrastructure facilities,
- Formation of Commodity Groups and forward linkage for direct purchase of agricultural produce by the traders/ buyers from farmers. Creating awareness among the farmers on market intelligence by providing market– led extension
- Information, Education, Communication and Capacity Building (IEC&CB) activities.
- Integrated approach from planting to marketing which includes choice of crops (mainly banana, mango, tapioca, spices, flowers crops) grading, packaging, storage and marketing in domestic and international markets.
- Commercialization of agriculture through market driven production approach by utilizing the infrastructure and market intelligence available.
- Encouraging setting up Agri/Horti processing units by arranging backward and forward linkages and also through venture capital assistance under Small Farmers Agribusiness Consortium.
- Minimizing post-harvest losses by creating required market infrastructure, cold chain and scientific storage facilities,
- Providing adequate pack houses with gamma irradiation facilities.
- Encouraging the private sector to set up agro processing industries and Food Parks for processing, at large scale with farmers' participation.
- Implementing Food Processing Mission with special emphasis on formation of State and District level Food Processing Mission
- Initiating Food Processing Business Incubator facilities near production catchments

and Empowering farmers with knowledge on price forecasting, high price period, best priced market, quality parameters, pre and post-harvest technologies and value addition for different agricultural commodities and export opportunities for doubling their income through 'Market-led Agriculture'.

E. Agricultural Education and Agricultural Research

Agricultural Education and Research have to be focused more on the society's needs. It has to take more of changes due to globalization, technological development and growing emphasis on value addition. The thrust areas and strategies to be achieved have to be prioritized taking into consideration of positive impact and spin- off benefits.

Challenges:

- Agricultural education to cater to the globalizing agriculture needs.
- Crop improvement research on developing new varieties, hybrids and also to possess important traits such as drought tolerance, pest and disease resistance and nutrient enrichment especially in nutritional cereals.
- Standardizing precision farming technologies for more crops which will help to increase yield of quality produce and conserve resources.
- Strengthening research to develop implements and machinery considering the needs of the farming community, particularly marginal and small farmers besides paying attention to designing gender-friendly implements.
- Research activities to reduce post-harvest losses and to enhance value addition and emphasis to be given for nutritional cereals so that their consumption level increases.
- Developing bio technology and nanotechnology based solutions for enhancing input use efficiency, productivity, post-harvest life, value addition and maintaining resource quality.
- Research on Bio inoculants to augment nutrient availability and to reduce pest incidence Rhizosphere engineering to enhance soil plant relationship
- Further intensification of research on climate change and mitigation
- Market research to promote market-led agriculture.
- The hiatus in agriculture is mainly due to deteriorating soil health, declining water resources, inadequate investment in rural infrastructure, spiraling prices of inputs and change in the mind sets of people viewing of agriculture as of low value.

Hence farmer farm oriented, crop focused, region specific strategies with adequate investment in developing rural structure is absolutely essential. In sum, the desired growth rate can be achieved only through crop based technology interventions along with genetically improved seeds and newer technologies along with timely availability of inputs. In addition, development of value added process especially in millets and horticultural produces with market driven approach should be given priority. Under infrastructure development, weather proofing of food grain production, linking the river as much as economically possible to bring surplus water of one area to other, micro- irrigation, high efficiency of water, nutrients and energy are to be addressed.

Strict enforcement to avoid encroachment of the existing of tanks and also the inlet channels should be given due consideration. Water harvesting and storage structures must be improved and increased depending on the requirement so as to avoid runoff wastages. Storage capacity of the tanks should be enhanced with strengthening of the bunds and out let channels so that tail end areas also will avail tank irrigation and more area should be brought into cultivation. Maintenance of water bodies which leads the recharge of the groundwater so that over exploitation risks can be minimized. Cultivation of low fertile lands deprived of irrigation are to be used intensively for high value crops i.e., establishment of drought tolerant millet, fruit crops and agro-horti pasture. Integrated nutrient management including organic manures, green manures, compost, vermi compost and proper application of major nutrients along with bio fertilizer will avoid the yield reduction due to deficiencies and increase the yield.

Proposed strategies will lead to achieve 9 per cent growth in Agriculture production and double the income of about 82 lakhs farmers of Tamil Nadu by increasing the productivity by 50 per cent and above, increasing the cropping intensity, increasing the irrigation intensity and bringing fallow lands under cultivation. Strengthening of Agriculture infrastructure will ensure access to quality inputs, extensive adoption of innovative technologies like SRI, Micro irrigation, Precision farming resulting in increased water use efficiency. Besides, emphasis on organic farming, integrated farming systems, prevention of wild animal's menace need adequate consideration and adoption in the appropriate agro-ecological zone.

F. Resources and Challenges

Since the scope of extensive cultivation is rather limited, efforts have to be taken up for intensive cultivation. However, the cropping intensity is hovering around 120 per cent only in spite of developmental efforts taken up since independence. The scope for bringing additional land under cultivation revolve around current fallows, cultivable wastes and other fallow lands which accounted for nearly 20.00 per cent of the geographical area of Tamil Nadu State. Hence challenges are identifying the green signals of the aforesaid areas under cultivation. In fallow lands, efforts have to be taken for cultivation of fodder crops which would mitigate the deficiencies in the availability of fodder area.

Further net area irrigated to net area sown accounted for nearly 52.00 per cent. Hence efforts have to be taken up by bringing green revolution in the rainfed areas giving emphasis to short duration drought resistant millets and pulses. Since water is an essential input for agriculture, linking of rivers, water harvesting and restoration of traditional water bodies will improve the overall water availability in the State. Water use efficiency can also be achieved by modernization of irrigation system, improved service delivery, participation of farmers and popularization of micro irrigation.

The major challenges would be:

- Restoring the storage capacities of the old reservoirs and the tanks which are heavily silted up.
- Utilizing surplus flood flows draining into the sea by putting up small structures and conveying it to drought prone high level commands by pumping schemes.
- Removing the encroachments in water bodies and protecting them in an efficient manner.
- Augmenting ground water potential through construction of artificial recharge structures and rain water harvesting systems for sustainable ground water development and management.
- Augmenting the surface water potential byway of inter-basin transfer by inter-linking of rivers within the State.
- The water holding capacity, by Restoration, Renovation and Rehabilitation (RRR) of traditional water bodies.
- Preventing the pollution of water bodies such as rivers, streams, reservoirs, tanks, etc., and to reuse the treated effluent water for irrigation.
- Intensifying the public awareness and training activities on water management in order to increase the efficiency of water use by implementing change management.

G. Animal Husbandry

In livestock sector especially for cattle, the major challenge is increasing the fodder area and fodder availability. Decline in area under permanent pastures is the main reason for the shortfall of fodder requirement. Further emphasis has to be laid on optimum utilization of waste land to grow fodder. The fodder production has to be increased by promoting high yielding fodder varieties. Adequately providing proper infrastructure and equipment to the veterinary health care institution is yet another major challenge for the timely diagnosis and treatment of animal diseases. A mixture of technology, policy and institutional innovations needs to be combined for sustainable and equitable livestock sector growth.

The major challenges are:

- Provision of animal breeding, doorstep veterinary and emergency health care services, subsidized Artificial Insemination services, up gradation of milch animals, supply of feed, cultivation of fodder and insurance cover to animals of milk producers in cooperative fold.
- Ensuring clean milk production with quality testing at village level.
- Modernization of cooperative dairy infrastructure.
- Development of e-governance programs
- Bringing the landless laborers and marginal farmers especially women farmers into the fold of organized livestock rearing.

- Strengthening of Veterinary Services Delivery System and Diagnostic services.
- Improving the capability of frozen semen production stations.
- Providing marketing access and improving cold chain especially in milk handling and processing.
- Promoting Backyard Family Poultry.

H. Animal Husbandry Research

- The major challenges are
- Ensuring breeds / technologies for sustained increase in yield and to meet the end users' expectations in terms of quality and food safety.
- Ensuring service provision and to enable farmers to take informed decisions based on prices of different animal products.
- Harnessing research output of frontier sciences to increase value added animal products, storage and processing.

I. Fishery

Weakness

- Reduced Catch Per Unit Effort (CPUE) in Fishing
- Many water bodies received water only during north-east monsoon
- Non-availability of adequate infrastructure facilities for seed production, rearing, fish landing and marketing
- Fish culture in natural and small water systems is being practiced by stock and harvest method and not by scientific culture method
- Lack of post-harvest facility like cold storage and fish processing unit at the shore.
- Largely inadequate fish seed production
- Low fish productivity of tanks
- Non-availability of stock size quality fish seeds throughout the year
- Lack of efficient fishing gears for operation in deep waters
- Inadequate training packages on fish culture, breeding and seed rearing, feed formulation and fish diseases diagnosis etc.
- Paucity of funds to fish seed rearing centres
- Insufficient area for fish seed production
- Lack of hygienic handling of fish in marketing
- Low infrastructure support for artisanal fisherman impede the growth in fish production
- Poor technology adoption in the mechanized crafts and low hygiene are the major bottle necks in promoting export oriented fishing and product development
- Under-utilization of short seasonal tanks and

- Absence of dead storage level in the reservoirs affects the natural fish stock.

Opportunities

- Vast market and potential buyers
- Escalating demand for seed, and table fish
- Scope for ornamental fishes and demand for new varieties
- Increased awareness about the profitability of Integrated farming with Fisheries component
- Vast expansion of marine resources with diverse fishes in the off-shore area provides good opportunity for increasing marine fish catching
- Large scale coastal aquaculture is possible
- Mariculture, including pearl culture, spat production, lobster fattening and multiple newer fishing product preparations possible.
- Rehabilitating the affected and unutilized shrimp farms for mari-culture activities.
- Ample opportunities for developing coastal / back water shrimp farming on large scale with greater rigor.
- Effective utilization of short seasonal tanks and ponds in the network of inland water ways for fish production
- Establishment of large scale seed production and supply centres and
- Availability of seeds of short duration aquaculture species viz. GIFT Tilapia, *Pangassius* sp. etc.

Challenges

- Frequent monsoon failures, vicissitudes of cyclones and occurrence of tsunami are the natural hazards that pose major threats to the growth of the fishery industry as a whole
- More micro players in the sector pushing down the prices and ultimately collapse the market
- Inadequate infrastructure for seed production discourages the farmers in taking up inland fish culture
- High input cost especially for feed and non-availability of low cost feed
- Improper waste disposal and environmental pollution by coastal / brackish water shrimp farming act as the threat for their own survival and growth
- High siltation of tanks and water ways and lack of periodic desilting activities and
- Import of fish from other countries

25.2 STRATEGY TO BE FOLLOWED FOR DOUBLING OF FARMERS INCOME

Policy approach so far, has been diverted towards irrigated agriculture to increase agricultural production. Now the concern is that the gains from the green revolution areas have been plateauing out due to several factors and evidences suggest that the productivity and returns to investment have substantial trickle down benefits for poor not only in irrigated areas but also those in less favored areas. Hence, it is inevitable that rain fed areas need to be promoted. The major strategies to achieve higher growth could be

- Productivity Improvement by bridging the present yield gap
- Diversifying the cultivation in favour of high value horticulture and commercial crops
- Supply of Quality inputs in time through Special Purpose Vehicle (SPV)
- Bringing the fallow land under cultivation through cost-effective technology transfer
- Promoting Integrated Farming System on whole district saturation approach
- Promoting agri business venture duly with farmer's participation
- Inviting more Public Investment and through PPP mode in creating agri infrastructure to act as growth drivers rather mere hard ware's and
- Improving Knowledge Transfer to farmers through ICT enabled extension and market led agriculture

The approaches to achieve these growth parameters should be location specific and need to be drawn on felt need basis. The formulation of bottom-up plans would speed up the process of growth as they primarily address the concern of location specific and need based

Strategies to be followed in Agriculture

In agricultural sector, considering the various challenges much emphasis has to be given for the enhancement of crop production, usage of balanced chemical nutrients, organic agriculture, integrated farming system, integrated nutrient management and strengthening of infrastructural facilities. In what follows the performance of the crops across the districts action plans to double the income of farmers are discussed are presented and discussed

Enhancement in Crop Production

Rice

Over the years, area under rice had grown positively in 18 districts viz. Cuddalore, Dindigul, Erode, Karur, Krishnagiri, Madurai, Nagapattinam, Pudukottai, Ramanathapuram, Sivagangai, Thanjavur, Thiruvannamalai, Thiruvarur, Thoothukudi, Tirunelveli, Trichy, Villupuram and Virudhunagar. However, in remaining 13 districts, this trend was negative. Similarly, the growth rate of production was found to be positive in 21 districts and negative in other 10 districts viz., Coimbatore, Cuddalore, Dharmapuri, Kancheepuram, Kanyakumari, Namakkal, Perambalur, The Nilgiris, Tiruppur and Vellore. Consequently, the productivity trend was positive in 27 districts of Ariyalur, Coimbatore, Dharmapuri, Dindigul, Kancheepuram, Kanyakumari, Karur, Krishnagiri, Madurai, Nagapattinam, Namakkal, Perambalur, Ramanathapuram, Salem, Sivagangai, Thanjavur, The Nilgiris, Theni, Thiruvannamalai, Thiruvarur, Thoothukudi, Tirunelveli, Tiruppur, Tiruvallur, Trichy, Villupuram and Virudhunagar, while it was negative in the remaining four districts. This implied that the downward trend in growth rates in productivity needs special attention.

Moreover, in Tamil Nadu, rice cultivation is taken up in three seasons namely kar/kuruvai/sornavari, samba/pishanam and navarai/kodai. Among these three seasons, controlled irrigation is possible, predominantly only in kar/kuruvai/sornavari. The samba season is totally depended on the supply of water through canal/tank irrigation and SRI technology practices can be adopted in these regions. Heavy tillers, healthy root development, vigorous crop growth and non-lodging nature ultimately resulting in high yield are the main features of this technology. Therefore, the overall strategy must be to increase production through productivity increase in all the districts of Tamil Nadu by adopting modern technologies like System of Rice Intensification (SRI) and also by the distribution of quality seeds, farm machineries and other management practices.

Besides, efforts need to be taken to supply critical inputs like bio-fertilizers, zinc sulphate, micro nutrients, bio-pesticides etc. Resorting to community nursery in rice growing areas, promotion of laser leveler and demonstration would increase the yield of crops. It is proposed to cover additionally 3.55 lakh ha. under SRI in the next five years. Supply of 80,000 MT quality seeds, issuance of 17 lakh soil health cards and provision of incentives for practicing machine sowing and harvesting would lead to increase in production.

Millets

Millets form an important component of nutritional and livelihood security of resource poor farmers. These crops exhibit wide adaptation in marginal and currently occupy niche areas and provide farmers with opportunity for assured harvest, staple food, required nutrition and sufficient fodder in an environment characterized by scanty rainfall. Besides, these millets provide raw materials for agro industries such as poultry and cattle feed, value added products, potable alcohol, starch, bio fuel etc., Nevertheless, with the exception of maize, area under millets has drastically reduced and yield also considerably declined.

Maize

The area, production and productivity trend under maize crop in major districts of Tamil Nadu is presented in Table 2

Maize crop is cultivated in 19 districts with an average area of 2.53 lakh ha with a production of 11.86 lakh tonnes and the productivity is about 4,635 kg/ha. With reference to area, 16 districts of the State experienced positive growth, while three districts viz., Coimbatore, Tiruppur and Vellore had shown negative trend. Similarly, in production, all the 19 districts witnessed positive growth. The productivity of the crop witnessed an upward trend in 18 districts and only in Cuddalore district, the productivity declined. Thus, an increasing growth rates in area, production and productivity are quite perceptible in majority of the districts where maize is cultivated. Maize is thus one of the important crops introduced for crop diversification in Tamil

Nadu State. Moreover, the growing poultry feed industry keeps demanding maize, as it is an important ingredient in feed mix.

Sorghum

The compound growth rate of sorghum in major districts of Tamil Nadu is presented in Table 3.

Sorghum is grown in 22 districts in the State with an area of 2,44,408 ha, production of 2,36,547 tonnes and productivity of 984 kg/ha. The growth rate of area was positive only in two districts viz., Thoothukudi and Virudhunagar. Similarly, the production was positive in seven districts viz., Karur, Krishnagiri, Ramanathapuram, Theni, Thoothukudi, Tiruppur and Virudhunagar, whereas the productivity recorded positive in almost all the districts with the exception of Ariyalur, Madurai, Namakkal, Salem, Thiruvallur, Trichy and Vellore districts. Thus, the negative trend in majority of the districts is seen. Due to changing purchasing power and food habits, the consumption of sorghum has declined in majority of small farmer / labor households. One of the important crops that replaced sorghum is maize.

Bajra

.Bajra is an important millet crop grown in 10 districts in the State with an area of 53,409 ha, production of 88,866 tonnes and productivity of 1,691 kg/ha. The promotion of bajra crop in Tamil Nadu requires a thorough planning to increase area and production through input supplies, management practices, capacity building and special programmes, as this crop has got food value in terms of nutrition.

Ragi

Ragi is yet another agricultural crop that comes under minor millet cultivated as a major food staple crop and for its nutritive value mostly in Dharmapuri, Erode, Krishnagiri, Perambalur and Vellore districts with an average area of 84,914 ha, production of 1,80,557 tonnes and productivity of 2,140 kg/ha. All the five districts, however, showed only negative growth regarding area expansion and positive growth in productivity. The production growth was positive in Erode and Krishnagiri districts although Dharmapuri, Perambalur and Vellore districts showed negative growth trend. Ragi is considered as a wholesome food especially for diabetics. Considering the increased demand of ragi for food purposes and decreasing area due to competing crops, there is an immediate need for enhancement of ragi productivity. The strategy, therefore, must keep increasing productivity and production of ragi in the State to meet the growing domestic demand. There exists scope for value addition also.

Thus, the overall production of millets could be enhanced by adoption of system of millet intensification and transplanting of seedlings in irrigated millet, precision farming in maize, use of farm machineries, distribution of certified seeds, integrated nutrient management in maize and training farmers for adoption of precision farming. Promotion of value addition of millet crops will also augment the income of millet farmers. It is proposed to distribute 45,000 MT of quality seed, soil health management in 28,000 ha and conducting field demonstrations in 1.00 lakh ha.

Moreover, the maize crop improvement should be concentrated mainly on interventions like quality seed supply, soil health enhancement, integrated pest and disease management, irrigation management, farm mechanization, infrastructure, extension and special programs like millet mission.

Enhancement of Pulse production

Pulse crop is grown in Tamil Nadu in about nine lakh hectares and the average State productivity revolves around 600kg/ha. The productivity is considerably low due to poor crop management and lack of irrigation. Pulses are the major sources of cheap protein particularly for the vegetarians and poor. Therefore, there is a need to increase the production in the state. Pulses are more sensitive to excessive moisture and the un-usual continuous rain and flooding also devastate the entire rice-fallow pulses once in 3 or 4 years thus reducing production drastically in the State. Therefore, the development strategy must focus not only on productivity increase, but also on the water management / flood management tactics.

Pulse production could be increased by adopting precision farming, intensification of transplantation by providing incentives and adoption of System of Pulses Intensification (SPI) technology package, distribution of certified seeds, increasing area under rice fallow pulses, bund cropping and promotion of variety having synchronized maturity. It is proposed to produce and distribute 28,000 MT of quality pulse seeds, to undertake soil health management to cover 10 lakh ha in pulse growing areas and Integrated Pest Management in pulse crops.

Red Gram

Red gram is grown predominantly in four districts of the Tamil Nadu State covering about 31,163 ha of area, 22,603 tonnes of production and 601 kg/ha of productivity. The growth rate of area was positive only in one district viz. Krishnagiri. Similarly, the production was positive in three districts viz., Karur, Krishnagiri and Theni, whereas the productivity recorded positive in all the four districts. Thus, there is a need to increase area, production and productivity of red gram to meet the growing demand through adoption of red gram transplantation technology and implementation of programs like pulses mission, expansion of area under rain fed pulses etc

Black Gram

The growth rate of area, production and productivity of black gram is shown in Table 5. Black gram is cultivated invariably in almost 19 districts viz., Cuddalore, Dharmapuri, Erode, Kanyakumari, Karur, Nagapattinam, Pudukkottai, Ramanathapuram, Sivagangai, Thanjavur, Thiruvannamalai, Thiruvarur, Thoothukudi, Tirunelveli, Tiruppur, Thiruvallur, Trichy, Vellore and Villupuram of Tamil Nadu State with an area of 2,88,721 ha, production of 1,12,700 tonnes and productivity of 388 kg/ha. Most of the districts experienced positive growth trends regarding area, production and productivity. Therefore, the development strategy would sustain the growth through better management tactics practices.

Green Gram

The growth rate of area, production and productivity of green gram is shown in Table 6 With an area of 1.54 lakh ha, production of 53,605 tonnes and productivity of 343 kg/ha, green gram is grown in nearly 12 districts of the Tamil Nadu State. The growth rate of area was positive only in eight districts namely Nagapattinam, Thanjavur, Theni, Thiruvarur, Thoothukudi, Tirunelveli, Tiruppur and Virudhunagar. Similarly, the production was positive in all the aforesaid districts with the exception of Thanjavur, whereas the productivity recorded positive in half of the districts viz., Coimbatore, Theni, Thoothukudi, Tirunelveli, Tiruppur and Virudhunagar. The remaining districts recorded negative growth trend in area, production and productivity, and there exists a necessity to increase growth rate of green gram to meet the growing needs of the population through special programs like accelerated pulses production programs.

Enhancing oilseed production

In Tamil Nadu, oil seeds are largely grown as rain fed crop and only 30 per cent of the area is under irrigated condition. Further, delayed monsoon affects the crops. The deficiency of secondary nutrients like sulphur and calcium and micro nutrients like zinc, boron, molybdenum and iron also limits the productivity to a considerable extent. Consequently, the farmers are reluctant to invest much on the inputs resulting in instability in yield. Hence, identifying and adopting crop management technologies suitable to the tracts are absolutely essential. Usage of bio-fertilizers, micronutrient mixture, insecticide, bio-pesticide, pheromone traps, tractor drawn seed drill (for groundnut), training of farmers on familiarization and usage of farm equipment, gypsum application (for groundnut) and certified seeds would enhance the production and productivity of oilseed crops considerably. In oilseed crops, seed storage is a problem due to high oil content which can be resolved through treating the seeds with halogen impregnated polymer in ground nut and sesame.

Groundnut

The average area under groundnut was 4.41 lakh ha with a production of 9.74 lakh tonnes and 2,238 kg/ha of productivity, covering almost 28 districts in Tamil Nadu State. Groundnut is yet another important oilseed crop, and its area and production performance had shown negative growth in majority of the districts. Despite a positive trend in growth of productivity in groundnut was observed in all the 28 districts except Thiruvannamalai. This necessitates the need to formulate appropriate strategy for groundnut to give more thrust on area and increasing productivity in all districts by implementing groundnut mission, integrated production improvement program for oilseeds etc. The compound growth rate of area, production and productivity under groundnut crop in major districts of Tamil Nadu during 2000-01 to 2014-15 is presented in Table 7.

Gingelly

Gingelly is an important oilseed crop next to groundnut with an area of 58,422 ha, 29,060 tonnes of production and 508 kg/ha of productivity, grown in more than 10 districts of Tamil

Nadu State. The growth rate of area was positive only in two districts namely Pudukkottai and Thanjavur (Table 8). Similarly, the production was positive only in four districts viz., Ariyalur, Karur, Pudukkottai and Thanjavur, and productivity was positive in Ariyalur, Erode, Karur, Pudukkottai, Thanjavur and Thoothukudi districts. Thus, the negative trend in majority of the districts is observed. Therefore, strategic planning must aim at increasing growth trend of area, production and productivity in gingelly through oilseeds mission program, especially in districts like Nagapattinam, Ramanathapuram, Salem and Thiruvarur.

Coconut

Coconut is grown in 24 districts of the State with an area of 4,00,562 ha, production of 57,028 tonnes and productivity of 14,230 nuts/ha. The growth rate of area, production and productivity was positive in majority of the districts of Tamil Nadu. However, a negative trend in area was observed in districts like Coimbatore, Dharmapuri, Erode, Kancheepuram, Ramanathapuram and Thiruvallur. Similarly, the production was negative in six districts viz., Dharmapuri, Erode, Kancheepuram, Kanyakumari, Ramanathapuram and Tirunelveli, whereas Kanyakumari, Ramanathapuram and Tirunelveli districts recorded negative growth trend for productivity. Though a positive trend in majority of the districts is observed, the need for sustenance development strategy in coconut to give full thrust on improving the productivity in many districts is to be targeted and among the 24 districts, Ramanathapuram district requires special attention. This crop has got also value addition potential in terms of oil, dried coconut powder, candy, coir pith making etc.

Enhancing sugarcane yield

In Tamil Nadu, sugarcane is cultivated in 3.05 lakhs ha with an average productivity of 105 tonnes/ha. The total production of sugarcane is 357.07 lakh tonnes. However, the problems faced by sugarcane cultivators are high cost of cultivation, non-availability of good quality seed material, improper cultivation practices, unbalanced nutrient management and mono cropping resulting in low yields, increased pest and disease menace etc. Sustainable Sugarcane Initiative (SSI) is promising since it involves use of less seed sets, less water, optimum utilization of fertilizer and tend to achieve higher yields. Besides, it is an alternate to the conventional seed, water and space intensive sugarcane cultivation. This calls for provision of shade net, supply of critical inputs, training of the farmers and documentation. It is proposed to cover IPM and INM in 1.75 lakh ha in the next five years to increase the income of farmers. There is also need to develop short –duration sugarcane variety considering the water scarcity situation.

The growth in area, production and productivity of sugarcane was quite convincing with positive trend in more than 12 districts. The growth trend must be maintained to meet the growing demand for sugar. Therefore, the development strategy must focus on increasing sugarcane productivity as well as area increase in the years to come, so as to keep increasing production in almost all the districts especially in Madurai and Thiruvarur districts of Tamil Nadu State. However, the negative trend in area, production and productivity need to be reversed through proper strategy planning including the adoption of Sustainable Sugarcane Initiative (SSI), precision farming and production of other by-products like ethanol production etc.

Enhancing cotton yield

During the beginning of the 11th five year plan period, the area under cotton was on an average of 1.14 lakh ha with a production of 2. 48 lakh tonnes and the productivity was 364 kg/ha, covering almost 16 districts of Tamil Nadu State. Traditionally the cotton has been cultivated predominantly in Salem, Coimbatore, Erode, Madurai, Virudhunagar, Theni, and Tirunelveli districts. However, recently the area and production of cotton has been dwindling to the alarming level especially in Ramanathapuram, Theni, Thiruvannamalai, Thiruvarur, Thoothukudi and Virudhunagar districts. The crop development strategy must aim at reversing the recent trend to that of the past, so as to keep increasing cotton production and feeding the cotton textile mills in the State. The pricing is an important factor that merit consideration in addition to assured market demand through contract farming. Promotion of precision farming along with drip irrigation, advocacy of integrated pest management practices may be followed to increase area, production and productivity of cotton crop. The productivity of cotton depends on the quality of seeds especially on genetic and physical purity, adoption of Integrated Nutrient Management, Integrated Pest Management practices and other post-harvest technologies. Hence emphasize is to be given on quality seed procurement and distribution of certified seeds, supply of bio control agents, distribution of micro nutrient mixture and training programs to the cotton growers in the usage of INM/IPM technologies. Precision farming and distribution of power sprayers, battery operated power sprayers and cotton picking machine are the action plans suggested.

With regard to industries depending cotton as raw material, among 3740 mills textile mills in India, 800 textile mills are in Tamil Nadu, of which 300 mills are in Coimbatore District. The spindle capacity of this organized sector is about 12.6 million. Apart from this, there are more than 700 small scale sector units which contribute not less than 2.0 million spindles. These sectors on an average consume 7 million bales of cotton. Hence, Tamil Nadu alone consumes about 45% of the national cotton production and import cotton from other states like Gujarat, Punjab, Maharashtra and Andhra Pradesh.

The following technological supports are proposed for doubling the cotton farmers' income.

1. High density planting system of compact Hirsutum cotton varieties with a spacing of 75 x 10 cm for irrigated situation and 60 x 10 cm for rain fed situation.
2. Under rain fed conditions with marginal rainfall, high density planting of long lint Arboreum varieties with a spacing of 45 x 10 cm.
3. For increasing the productivity of Bt cotton hybrids under irrigated conditions, poly mulching combined with fertigation may be followed.
4. Cultivation of identified Bt cotton varieties for Tamil Nadu under both irrigated as well as rain fed conditions either at recommended spacing or with a spacing of 75 x 10 cm for

irrigated situation and 60 x 10 cm for rain fed situation under high density planting system for increasing the productivity of the cotton crop.

5. For reducing the cost of harvesting, the tractor drawn picking machine being developed by ICAR-CICR, Nagpur has to be demonstrated for technical feasibility and adoption.

Horticulture

Banana

Banana and plantain are the important staple foods that are critical to the nutritious and economic well being of millions of people across the globe. The fruit is part of the daily diet to more than 400 million people around the world and is the fourth most important global food commodity after rice, wheat and milk, in terms of the gross value of production. It is believed that 1000 varieties of banana subdivided into 50 groups are cultivated in more than 150 countries with the production of about 105 million tonnes per year. Among various continents, Asia has the lion's share of 60% in global banana production of which India contributes to 48% of the total production in Asia from 39% of the total area.

At present India is the largest producer of banana in the world contributing 29.1% to the global production of banana with a total production of 29.7 million tons from an area of 0.80 million hectares. In India the banana is grown in the regions from the humid tropics to humid subtropics and semi arid tropics like Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Assam and Odhisha. The national average productivity is 38.25 tonnes per hectare and a maximum of 66 ton/ha was recorded in Gujarat, Maharashtra (58.2 ton/ha) and Tamil Nadu (47.9 ton/ha) thanks to the adoption of high yielding Cavendish clones coupled with improved technologies like high density planting, fertigation and use of tissue cultured plants. The largest area under banana cultivation is in Tamil Nadu state followed by Maharashtra, Gujarat, Andra Pradesh and Karnataka. Although location specific varieties like Rasthali (Silk), Poovan (Mysore), Ney Poovan, Thella Chakkarakeli, Karpuravalli (Pisang Awak), Nendran (French Plan), Hill Banana (Pome-AAB) and Monthan (Cooking banana) are grown in large quantity in different regions of the country, the Indian banana trade mainly depends on Cavendish clones which is called by different names (Basrai, Robusta, Harichal, Grand Naine, Shrimanthi, Bhusaval and Pedda Pacha Arati) in different regions. The Cavendish clones occupies 52% of the total area under banana cultivation and contributes 64% of the total banana production.

Mango

Mango is an important fruit crop grown in 18 districts of the State. The average area and production of mango were 13.12 lakh ha and 7.27 lakh tonnes respectively with average productivity of 5,523 kg/ha. Perusal of the Table 13 indicates that Coimbatore, Dharmapuri, Kanyakumari, Krishnagiri and Thanjavur districts witnessed negative growth in area and in the remaining 13 districts, the growth rate of area under mango was positive. Similarly, Coimbatore, Dharmapuri, Theni, Thiruvallur and Virudhunagar district had negative growth in production.

The productivity trend was negative in six districts namely Coimbatore, Madurai, Sivagangai, Theni, Tirunelveli, Thiruvallur and Virudhunagar. In all the other districts, positive trend could be observed. In all these districts, Coimbatore showed the negative growth in area, production and productivity. In sum, the development of mango crop in Tamil Nadu requires planning to increase area, production and productivity as this crop has got export market as well.

Grapes

Grapes is yet another important horticulture crop, grow only in Theni district in the State. In Tamil Nadu, average area under grapes was 2,545 ha with average production of 56,428 tonnes and average productivity of 22,069 kg/ha in the year 2006-07 to 2010-11. The area and production performance had shown positive growth and productivity of grapes had shown negative trend. Therefore, strategy planning must aim at increasing growth trend in productivity of grapes through research and development and capacity building of grape growers. The compound growth rate of grapes crop in Theni district of Tamil Nadu during 2000-01 to 2014-15 is presented in Table 14.

Chillies

Chillies is an important spice crop in horticulture sector grown in five districts in the State. The average area and average production of chillies was 61,268 ha and 32,529 tonnes respectively. The average productivity of chilli was about 528 kg/ha. The rain fed chillies grown in Pudur / Vilathikulam areas of Thoothukudi district is very popular. The Sattur samba of Virudhunagar district and Paramakudi gundu Chilli of Ramanathapuram district are also popular in southern districts. Perusal of Table 15, exhibits the fact that Sivagangai district alone witnessed positive growth in area, production and productivity where as Thoothukudi district had negative growth in area, production and productivity. Hence Thoothukudi district requires special attention of chill crop. The growth trend in area was positive in Sivagangai and Ramanathapuram districts, negative in Ariyalur, Thoothukudi and Virudhunagar districts. The negative trend in production was found in Ariyalur, Ramanathapuram, Thoothukudi and Virudhunagar districts. In the case of productivity, the positive growth was seen in Ariyalur, Sivagangai and Virudhunagar districts and negative growth in Ramanathapuram and Thoothukudi districts. The development of chilli crop in Tamil Nadu requires appropriate interventions to increase productivity. The compound growth rate of chilli crop in major districts of Tamil Nadu during 2000-01 to 2014-15 is presented in Table 15.

Tomato

In Tamil Nadu, the average area under tomato crop was 22,794 ha with an average production of 2.97 lakh tonnes and average productivity was 13,054 kg/ha and mostly cultivated in five districts of the State. With reference to area, Krishnagiri district experienced positive growth, while Coimbatore, Dindigul, Salem and Theni districts have shown negative trend. The production witnessed uptrend in Dindigul and Krishnagiri districts and downtrend in Coimbatore, Salem and Theni districts. Similarly, in productivity, Coimbatore, Dindigul, Krishnagiri and Salem districts witnessed positive growth and Theni had negative trend. Theni district experienced negative growth rates in area, production and productivity. Hence, Theni district requires special efforts to boost production of tomato.

Tapioca

During the 11th five year plan period, the average area under Tapioca crop in the State was 1.28 lakh ha with production of 48.10 lakh tonnes and productivity of 37,190 kg/ha grown in 14 districts in the State. The performance of the crop with respect to growth rates shows that the growth rate of area was positive in eight districts. Similarly, the production and productivity was positive in seven districts. Negative trend in area was found in Cuddalore, Kanyakumari, Perambalur, Salem, Tirunelveli, and Thiruvallur districts. In the same way, the growth rate in production was negative in Cuddalore, Kanyakumari, Perambalur, Salem, Nilgiris, Tirunelveli and Thiruvallur districts. The area, production and productivity of tapioca were found to be negative in Cuddalore, Perambalur, Tirunelveli and Thiruvallur districts. This indicates that measures have to be taken as development strategy for tapioca to increase the productivity in these districts.

Cashew nut

The average area under Cashew nut was one lakh ha with a production of 50,034 tonnes and productivity of 500 kg/ha covering five districts in Tamil Nadu. The growth trend of area was positive in Cuddalore and Tirunelveli districts and negative trend was seen in Kanyakumari, Sivagangai and Vellore districts. The production was positive only in Kanyakumari district and negative trend was found in the remaining four districts. In the same way, positive growth of productivity was noticed in Kanyakumari and Vellore districts and negative trend was seen in Cuddalore, Sivagangai and Tirunelveli districts. In Sivagangai district, area, production and productivity of cashew nut was negative. Therefore, the development strategy must focus on increasing the area and productivity of the crop so as to keep increasing production in Sivagangai district.

Onion

Onion is the important vegetable crop, grown in six districts namely Dindigul, Erode, Namakkal, Perambalur, Salem and Tiruppur districts. In Tamil Nadu, the average area under onion was 31,592 ha with production of 3.02 lakh tonnes and productivity was 9,834 kg/ha. The growth rates presented in depict that an uptrend in area was noticed in Perambalur and Tiruppur districts and downtrend was seen in Dindigul, Erode, Namakkal and Salem districts. The positive trend of production and productivity was found in Dindigul, Erode, Perambalur and Tiruppur districts. The negative trend of production was found in Namakkal and Salem districts. Likewise, a negative growth of productivity was seen in Perambalur district. Hence, Tamil Nadu State needs development strategy to boost production of onion.

Turmeric

The average area under Turmeric in Tamil Nadu was 34,500 ha with a production of 18.81 lakh tonnes and the productivity achieved was 5,466 kg/ha. It was grown in six districts during the study period. In Turmeric, a positive trend in area, production and productivity was observed in Dharmapuri, Erode, Namakkal, Perambalur and Thiruvannamalai districts. A decline in growth rate of area under turmeric was noticed in Coimbatore district only.

Other Horticultural Crops

The growth performance of other minor horticultural crops like guava, bhendi, brinjal, cabbage, potato, beetroot, carrot, etc. is outlined in this section.

With respect to guava, in Dindigul and Sivagangai districts, an upward trend of production and productivity and downward trend of area was observed. In salem district, with regard to bhendi crop, a positive growth of area, production and productivity was found but in case of brinjal, it was reversible, as negative growth was seen in area, production and productivity. In the Nilgiris district, a positive trend of area was seen in cabbage, tuber crops (potato, beetroot, carrot), spices and condiments (ginger, cardamom, pepper) and plantation crops (coffee, tea). The negative growth of production as well as productivity was observed in cabbage, ginger and pepper crops in the Nilgiris district. In Kanyakumari district,an upward positive trend in area was observed for rubber crop. In Dindigul district, a major tobacco growing area in the State, a negative growth of area and production but a positive growth of productivity was seen.

Therefore, in the context of increasing population, urbanization and a favorable shift in the consumption of fruits and vegetables, there in a need to cover larger area under horticultural crops. Horticulture crops are grown in 14.50 lakh hectares, of which vegetables, spices, plantation crops, flowers and medicinal plants are the major crops cultivated in the State. Totally, 86 horticultural crops are grown in the State which clearly indicate wider crop choice and its diversity and also the possibility of augmenting the income of farmers. The action plans suggested are as follows:

To increase the income of the farmers, more support for establishment of pandals, trellies, staking and propping, poly green houses, (tubular structure) is proposed. Vegetables like bitter gourd, snake gourd, ribbed gourd, *pandal avarai*, pole beans, tomato, gherkin, cucumber, squash and in fruits, grapes, musk melons and in spices, pepper could be cultivated under pandal cultivation. Similarly, crops like peas, musk melon, pole beans, tomatoes, ivy gourd could be raised in trellies. High value vegetables like capsicum, beans and flowers like carnation, roses could be raised in poly houses.

With regard to fruit trees, the existing fruit trees have to be maintained properly until they attain fruit bearing stage and thereafter up to economically profitable bearing stage. This calls for proper maintenance of fruit trees with appropriate intercultural operations periodically. In general, 40-45 years old mango trees exhibit decline in fruit yield because of dense and overcrowded canopy. The trees do not get proper sunlight resulting in decreased production of shoots. New emerging shoots are weak and are unsuitable for flowering and fruiting. The population of insects and pests builds up and the incidence of diseases increases in such orchards. These unproductive trees can be converted into productive ones by pruning with the recent techniques developed. Similarly, a procedure to rejuvenate and restore the production potential of old unproductive and wilt affected guava orchards has been developed, which employs pruning of branches at different periodicity and at different severities.

Crowding and encroachment of guava trees, for instance, with subsequent inefficient light utilization is an obvious problem with many of the older orchards. The internal bearing capacity of guava trees also decreases with time, due to overshadowing of internal bearing wood.

Moreover, by providing inputs like water soluble fertilizers, hybrid / high yielding vegetable seeds and plant protection chemicals, the area under vegetables, flowers, spices, medicinal plants, banana, tapioca, annual moringa and turmeric could be raised under precision farming technology. By adopting high density planting in mango, guava and sapota, the area under fruit trees could be also increased. This is possible through supply of pedigree planting materials, integrated nutrient management and integrated pest management. Besides precision farming and high density planting, the area could be increased by normal planting as well by using pedigree planting materials in fruits, spices, flowers and plantation crops. Similarly, by extending support for the planting materials of high value vegetables, the protected cultivation of vegetable area could also be increased. Likewise, cultivation of cut flowers and filler foliage also need to be encouraged.

It is proposed to increase the production of crops by adopting advanced technology like high tech cultivation practices which includes high density planting, use of quality planting materials, tissue culture planting materials, canopy management, micro irrigation fertigation, mulching, use of bunch sleeves for banana, protected cultivation, shade net nursery and mechanization in horticulture crop cultivation by popularizing the same among the growers to enhance productivity. It is also proposed to recommend high density planting in mango, guava and sapota in select districts of the State by providing subsidy.

Vegetable portray seedlings established under shade nursery show uniformity in growth, free from pest and disease attack. These attributes lead to 100 per cent crop stand in the main field and increase the productivity.

In agriculture, post-harvest handling namely cleaning, sorting and packing, postharvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product. The most important goals of post-harvest handling is to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising and spoilage. Sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce, for example, as residue from contaminated washing water.

After the field, post-harvest processing is usually continued in a packing house. This can be a simple shed, providing shade and running water, or a large-scale, sophisticated, mechanized facility, with conveyor belts, automated sorting and packing stations, walk-in coolers and the like. In mechanized harvesting, processing may also begin as part of the actual harvest process, with initial cleaning and sorting performed by the harvesting machinery. Initial post-harvest storage conditions are critical to maintaining quality. Each crop has an optimum range of storage temperature and humidity. Also, certain crops cannot be effectively stored together, as unwanted chemical interactions can result. Various methods of high-speed cooling, and sophisticated refrigerated and atmosphere-controlled environments, are employed to prolong freshness, particularly in large-scale operations.

Regardless of the scale of harvest, from the domestic garden to industrialized farm, the basic principles of post-harvest handling for most crops are the same: handle with care to avoid damage (cutting, crushing, and bruising), cool immediately and maintain in cool conditions, and cull (remove damaged items). Once harvested, vegetables and fruits are subject to the active process of senescence. Numerous biochemical processes continuously change the original composition of the crop until it becomes unmarketable. The period during which consumption is considered acceptable is defined as the time of "postharvest shelf life". Postharvest shelf life is typically determined by objective methods that determine the overall appearance, taste, flavour, and texture of the commodity. These methods usually include a combination of sensorial, biochemical, mechanical, and colorimetric (optical) measurements.

An example of the importance of the field to post-harvest handling is the discovery that ripening of fruit can be delayed, and thus, their storage prolonged, by preventing fruit tissue respiration. This insight allowed scientists to bring to bear their knowledge of the fundamental principles and mechanisms of respiration, leading to post-harvest storage techniques such as cold storage, gaseous storage, and waxy skin coatings. Another well-known example is the finding that ripening may be brought on by treatment with ethylene. Considering the above knowledge on post-harvest handling, the action plans are suggested to establish farm gate, intermediate and final stage post-harvest facilities.

Livestock

Livestock industry continues to demonstrate a beneficial impact on rural people by improving their income, employment and consumption and thereby becoming as a potential alternative in alleviating rural poverty. The livestock population is expected to grow at the rate of 0.55 per cent in the coming years and the population is likely to be around 781 million by 2050. However, the productivity of animals is 20-60 per cent lower than the global average due to improper nutrition, inadequate health care and management.

Fodder scarcity and poor quality of available fodder are the major constraints in increasing livestock productivity. Livestock are also affected by many ailments. Delay in diagnosis will lead to increase in loss of productive days, increase in the recovery period and consequent loss of production. Further, due to difficulties in transporting the ailing animals, cost and time involved, farmers generally do not take their animals to the referral centres which are few and far apart. Hence, it is necessary to enable select veterinary institutions function as referral centres by providing them culturing technologies. Similarly, in order to achieve the projected demand for fodder, it is necessary to bring more area under high yielding fodder crops for which quality seeds of improved variety is the pre-requisite. Similarly, strengthening of veterinary institutions, livestock farms, modernization of dairy units and conduct of health camps are suggested for enhancing the activities of animal husbandry sector.

Goat farming is an extremely demanding activity. In recent years, the overall appreciation of this long under-estimated species has grown and thus enhancing its importance in the livestock industry. Hence rearing of goats should be examined in a new light and from new perspectives. Moreover, the demand for animal protein is increasing at a very faster rate. Human population growth, increasing urbanization vis-a vis income are predicted to double the demand for livestock and livestock production by 2020. The trends reveal that the role of small ruminants in meat supply is growing and meat from these animals is most preferred. The small ruminants sector will therefore play a significant role in the coming decade in impacting on the livelihoods of small and marginal farmers who rear them.

Therefore enhancing the production of livestock is absolutely essential. The production cost of cattle feed coupled with erratic supply of green fodder due to frequent drought condition aggravate the situation. Hence, improving fodder production by promoting high yielding fodder varieties is needed. Besides, emphasis has to be laid on optimum utilization of wasteland to grow fodder. Providing proper infrastructure and equipment to the veterinary health care institutions is necessary for the timely diagnosis and treatment of animal diseases. Further, a strong program for the supply of sufficient veterinary vaccine is imperative. Each veterinary health care institution is to be provided with cold storage facilities to store vaccine. Sensitization of the general public and livestock farmers on various livestock diseases through information, education and communication campaign would help in education the people about animal diseases. Training on value addition of milk and milk products and capacity building of livestock farmers, besides strengthening activities of veterinary hospitals, dispensaries and clinics, would go long way in improving this sector. The details of specific action plans are discussed below

Provision of Modern Veterinary Diagnostic aids to Veterinary Institutions

Animal health care services and prevention of animal diseases is a priority for maintenance of a healthy livestock for optimum production. Protective and therapeutic activities of the Animal Husbandry Department are being conducted through various institutions such as Veterinary Polyclinics, Veterinary Hospitals, Veterinary Dispensaries, Mobile Veterinary Units and sub-centres.

Modern diagnostic aids will enable the Veterinary Institutions function as “Referral centres” by providing them with cutting edge technologies, reduce loss of productivity due to delay in diagnosis and will significantly reduce infertility among dairy cattle and prevent loss of germplasm.

Veterinary services need to be delivered following “Good Veterinary practices” and “Good Animal Husbandry Practices” for which, minimum infrastructure like proper building, necessary equipment, furniture, etc., should be available. In the absence of any of the components of this system, the GVP and GAP shall be severely compromised. The advances in the field of Veterinary profession can be disseminated more effectively in an efficient, user friendly environment for the ultimate benefit of the farmers. Improved infrastructure facilities will provide improved veterinary services contributing to reduction in the incidences of animal diseases thereby increasing the overall productivity of animal wealth. The Rural Veterinary Dispensaries are either functioning from rented premises or in dilapidated buildings. Further, functioning of Veterinary Institutions in the rental buildings do not satisfy the requirement of a typical Veterinary Institution and with a restricted scope for further expansion, these are not ideal infrastructure.

This necessitates strengthening the infrastructure of the veterinary institutions to offer better delivery of services and to reshape it into knowledge resource centers where best practices are being disseminated to the farmers. By this, the State's impressive cross bred cattle gene pool can be favorably exploited for increased egg, meat and milk production. It is proposed to improve the infrastructure facility of 200 veterinary institutions.

With around 2600 institutions, it is imperative that such facilities are provided in block headquarters and district headquarters so that the benefits of such cutting-edge diagnostic facilities are accessible to vast majority of livestock owners. With this objective, it is proposed to provide diagnostic facilities such as Ultrasound, Computerized X rays, diathermy units, Haemocytometers, Laparoscopy etc and surgical theatres to 400 institutions over a period of five years.

Enhancement of Livestock Productivity adopting recent concepts in Breeding Management

Artificial insemination (AI) has proven to be very effective for the improvement of the genetic potential of animals for higher production and there is no surprise why today AI is the back bone of all breeding programs in India. In commercial dairy production,over 80 per cent of all the cattle are now bred artificially. A large proportion of the success is due to improvement of the genetic potential of dairy cattle through use of outstanding sires by artificial insemination.

The economic wellbeing of a dairy farmer depends on the productive and reproductive ability of the herd that he maintains. The replacement of unproductive and ageing animals in the herd and its expansion are very important to maintain the scale of economy of the farm. Oestrus synchronization with CIDR, sex-sorted semen and MOET (Multiple Ovulation and Embryo Transfer) are some of the modern scientific techniques which are proposed for effective breeding management to enhance the livestock fertility and productivity. The entire gamut of activities and processes involved in semen production, processing, storage and distribution will be modernized to improve the efficiency of the AI program. It is proposed that 10,000 animals will be synchronized in a planned manner through the veterinary institutions of the State. About 10,000 doses of sex-sorted semen will be imported and distributed to institutions. Embryo Transfer will be conducted across the State, utilizing the elite cows of farmers as donors and other healthy animals as recipients. Departmental Farms will also be strengthened to act as ET hubs to revamp the frozen semen production, processing, storage and distribution.

Improving the animal protein availability by establishing small holder dairy, sheep/goat and piggery units

Milk, meat and egg play a crucial role in fulfilling the protein requirements of human beings. In recent times, increasing urbanization has led to shrinkage of pasture land and related natural resources putting enormous strain on animal husbandry. This necessitates facilitating farmers to take up dairy, goat and sheep farming, piggery and poultry as an avocation to embolden not only the rural economy but also to enhance the animal protein availability.

It is proposed to establish 300 dairy units (both cows and buffaloes), 1000 piggery units and 5000 sheep/goat units over the next five years.

Livestock Health Management

Livestock productivity is dependent on effective health management. An all-encompassing approach covering vaccine production, sero-surveillance, vaccination, biosecurity, disease diagnosis and appropriate interventions will ensure better livestock health leading to sustained productivity will be the action plan suggested.

Up-gradation of vaccine production facilities at IVPM, Ranipet, Vellore to GMP standards

The Institute of Veterinary Preventive Medicine, Ranipet, a unit of the Department of Animal Husbandry and Veterinary Services, Government of Tamil Nadu, is engaged in the production of Veterinary Biological and Pharmaceuticals for use by the field Veterinary Institutions in the State. The WHO has mandated that any institution involved in vaccine production must have facilities compliant with GMP norms to be eligible for licensing. As most of the production facilities at IVPM, Ranipet were established several decades back, the following facilities have to be provided to make the institute GMP compliant.

- Establishment of Animal testing facility
- Establishment of QC lab
- Up-gradation of FMD regional centre to GMP standards
- Establishing PPR vaccine production unit of GMP standards
- Construction of Warehouse
- Strengthening of Brucella vaccine production unit
- Upgradation of pharmaceutical division
- Establishment of Tissue Culture facility for Sheep pox Vaccine Production
- Upgradation of Diagnostic section to GLP standards
- Improving the infrastructure facilities
- Establishment of feed milling plant.

Vaccination and Sero-Surveillance

Strengthening the sero-surveillance mechanism by improving the infrastructure facilities of Animal Disease Intelligence Units, Poultry Disease Diagnostic Labs, Central Referral Lab and the field units assumes greater significance. Establishment of more number of mobile veterinary units, mobile disease diagnostic laboratories and facilities for cold-chain management also will strengthen the disease monitoring and management capabilities of the Department.

Strengthening the Departmental Farms for enhancing Livestock Productivity

The Department of Animal Husbandry has under its control 11 Livestock Farms, one poultry Farm and one Fodder Farm. These farms were established with a mandate to demonstrate latest technologies in the field of Animal Husbandry and to supply quality genetic material to the farmers. Modern amenities will be provided taking into account animal physiology, behavior, climatic conditions of the area and scientific designing**.**

Such modern infrastructure will provide health sustaining and comfortable environment to different categories of livestock for health, longevity and ideal productivity, desirable working conditions for labor and supervisory staff of the farm, harmonized integration of housing with feeding, watering, milking and manure handling systems for efficient production.

It is hence proposed to provide modern shelters taking into consideration of factors such as heat, humidity, over-crowding, light, ventilation, sanitation etc, at departmental farms at Abishegapatti (Tirunelveli District), Sattur (Virudhunagar), Chettinad (Sivagangai), Pudukottai, Naduvoor and Eachenkottai (Thanjavur), Korukkai (Thiruvarur), Chinnasalem (Villupuram), Mukundarayapuram (Vellore), Hosur (Krishnagiri), Kattupakkam and Padappai (Kancheepuram) and Ooty.

Induction of new genetic pool

Department livestock farms serve not only as demonstration units but also provide livestock of good genetic merit for breeding purposes to the farmers. Scientific principle advocates continuous replacement of genetic pool in the breedable age group to avoid undesirable effects of inbreeding. In addition, ageing animals with declining production and reproductive potential also need to be continuously replaced. Taking the above factors into consideration, approximately 25 per cent of the breedable population in the livestock farms is proposed to be replaced every year by purchasing quality livestock from various sources. This will increase the number of quality off - springs of high genetic merit, so that more number of such animals can be distributed to the farmers for breeding purpose. This will facilitate increase in livestock production and productivity with a direct bearing on socio economic condition of the farmers.

Augmentation of Fodder availability in the State

The health and productivity of livestock are closely linked with the quantum and quality of forage production. Forage-based economical feeding strategies are required to reduce cost of quality livestock products; as feed alone constitutes 60-70 per cent of milk-production cost.

Both quantitatively and qualitatively, there exist a huge gap between the demand and supply of green fodder in the State. It is estimated that the average cultivated area devoted to fodder production is only 1.3 per cent of the total area and the pasture and grazing land comprises only 0.8 per cent of the total area to cater the need of the Livestock population in the State. At present, the State faces a net deficit of around 30-40% of green fodder.

Future development and growth of livestock sector are highly associated with the scope of availability of fodder from cultivable lands, grazing lands and efficient utilization of available fodder. Focused strategies and concerted efforts are the need of the hour to face this challenge

The action plan is to augment green fodder production and thereby enhancing the livestock productivity are detailed below

Increasing fodder biomass by bringing more area under fodder

A cost-effective feeding practice for productive crossbred animal can be achieved by decreasing the dependence on external input i.e., concentrates and increasing the internal input system through fodder production at farmer's level. Thus, cultivated fodder has an important role in meeting the requirement of various nutrients and roughage to produce milk most economically as compared to concentrates. Hence, it is proposed to encourage farmers to take up cultivation of green fodder in their own holdings to ensure year-round availability of fodder to the livestock maintained by them. At present, State faces deficit of around117.85 lakh tonnes of green fodder annually. To meet out the deficit annually around 1.83 lakh hectares need to be brought under green fodder production. Hence, it is proposed to address the issue by encouraging farmers to take up cultivation of fodder crops for green fodder production by distribution of required seed material, fertilizer, agricultural machineries, etc. It is proposed to bring 2.50 lakh acres under green fodder production over a period of five years.

Efficient Utilization of available Fodder

a. Provision of Chaff Cutters

Animals tend to eat only the succulent leaves of the plant and generally waste the stem part. By chopping the green/dry fodder, effective utilization of fodder is obtained thus reducing the wastage of fodder. Thus, to economize the use of available fodder, the farmers across the State are to be distributed with power operated chaff cutters at subsidized price to chop the fodder and feed their animals. It is proposed to provide Chaff cutter to 25,000 farmers over a period of five years.

b. Preservation of surplus fodder available during flush season

It is customary that forages are consumed by domestic animals either in grazing land or stall seasonally. However, it is possible to serve the animals round the year conserving the forage properly. The availability of green grass is mostly seasonal, only in monsoon, when plant growth is high. The green grass is highly deficient in dry season and during flood. The seasonal deficiency can considerably be reduced by conserving the surplus forage during high fodder availability period. Hence farmers are encouraged to ensile the excess fodder available during flush season for utilization during lean months by a technique called "Ensiling ". It is proposed to establish 10,000 units across the State.

Efficient utilization of water thereby optimizing the fodder yield

Water is the vital input in crop production. It is essential to maximize both yield and quality. Hence, to utilize the available water efficiently and enhance the yield of the fodder crop, it is proposed to provide financial assistance to farmers for installation of rain guns to cover 10,000 acres of farmers' land with rain gun system of irrigation.

Reducing drudgery and timely operation by distribution of Grass Cutters

The harvesting of crops is traditionally is done by using sickle. This traditional method involves drudgery and consumes long time. Timeliness of harvest is of prime importance. The use of machines can help to harvest at proper stage of crop maturity and reduce drudgery and operation time. Considering these, grass cutter/brush cutters are to be distributed to farmers. It is proposed to provide grass cutter/brush cutter to 10,000 farmers over a period of five years.

Promotion of alternate feed substitute – Azolla

The demand for milk and meat is creating new potential in the profitability of animal husbandry as an occupation. Yet, at the same time, fodder availability is a great concern. The shortage of fodder is therefore compensated with commercial feed, resulting in increased costs in meat and milk production. The search for alternatives to concentrates led to a wonderful plant azolla, which holds the promise of providing a sustainable feed for livestock. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12 and Beta- Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc. Livestock could digest the plant easily. Due to its high protein and low lignin content, the livestock could become accustom to it. Moreover, it is easy and economical to grow. Hence, to familiarize the method of propagation of Azolla among the farmers and to meet out the requirement of fodder, 50,000 Azolla units will be established across the State.

Production of quality seeds to expand area under fodder cultivation

In order to achieve the projected demand of fodder, it is necessary to bring more area under cultivated fodder crops. Sowing a new fodder area requires a reliable source of seed as quality seeds are very crucial and essential for fodder production and productivity. Therefore, an assured supply of fodder seeds at the appropriate time to farmers is crucial for enhancing fodder production.

To bring requisite area under green fodder production, annually around 7000 MT of fodder seeds of cereals and leguminous fodder crops are essential. Since, most the fodder crops are shy seed bearer; it requires adoption of better technology in seed production to enhance quality seed production. Hence, to ensure assured supply of fodder seeds at the appropriate time to farmers, fodder seed production will be taken up in Departmental Farms by adopting better technology and by providing adequate infrastructure like bore wells/open wells, farm ponds, percolation ponds, pipelines, ground level reservoirs, overhead tanks, fencing, farm roads, erection of transformers, godowns, drying yards, store rooms, procurement of agricultural machineries etc. Besides, Vermicomposting units will also be established in all the farms to enhance the fodder/fodder seed production.

Distribution of tree fodder seedlings to farmers

During dry periods, feed shortage is often experienced and therefore feed of low quality is used. The animals are not able to obtain enough energy and protein to grow or to produce milk. Sometimes animals are even fed less than the daily 'maintenance requirements' as the green fodder is scarce. During these periods, fodder trees become important source of energy and protein to maintain the animal, improve growth rates and even increase milk production. Hence, to enlighten the farmers on the importance of raising and feeding tree fodder, tree seedlings of various fodder tree varieties according to the regional adaptation will be raised in departmental farms and distributed to farmers across the State for raising them in their fields. It is proposed to distribute 50 lakhs seedlings to the farmers.

Water conserving hydroponic green forage production to augment livestock productivity

A major concern in developing sustainable dairy farming is inadequate availability of green fodder. The major constraints in production of green fodder by dairy farmers are decreasing land holdings size, high cost of land, scarcity of water, more labor requirement for cultivation (sowing, earthing up, weeding, harvesting etc.), requirement of manure and fertilizer, long growth time, non-availability of same quality green fodder round the year, influence of natural calamities etc. As an alternative to conventional method of fodder cultivation is the emergence of hydroponics technology to grow fodder for farm animals without soil and minimum water. Green fodders produced by growing seeds without soil but in water or nutrients rich solutions are known as hydroponics green fodder. Hence, it is proposed to establish Hydroponic units in the Departmental farms and popularize the method among the farmers across the State by establishing mini units in their premises.

A sum of Rs 100 crores will be required to establish Hydroponic units at Departmental farms.

Establishment of Fodder Production units in Meikkal Lands across the State

A large majority of the farming community in our State are small and marginal farmers with limited land holdings. These farmers traditionally rely on common lands and other common resources to meet out a significant portion of green fodder requirements for their livestock. There are 1.10 lakhs ha of common grazing lands in the State that are under various stages of degradation and are not producing optimum quantities of fodder due to various reasons. The deficit in green fodder production can be addressed efficiently by adopting a community centric approach by undertaking fodder production in the common property lands which are in various stages of degradation. These lands need to be converted into an area suitable for fodder cultivation so that green fodder can be made available at the village level throughout the year. It is proposed to establish Fodder Production unit in meikkal poromboke lands in all districts of the State by providing infrastructure facilities such as borewell, open wells, farm ponds, percolation ponds, pipelines, ground level reservoir, overhead tanks, fencing, farm roads, silage pits, etc.

Strengthening of infrastructure for milk processing and dairy development

In Tamil Nadu, milk contributes more than 43 per cent share in the value of output from livestock sector (Policy note on Diary development, Govt. of Tamil Nadu). There are 17 milk processing units run by Milk Producer's Unions and 12,105 Primary Milk Producer's Co-operative Societies in the State. Out of 23.01 lakh members in the Milk Producer's Co-operative Societies, about 4.60 lakhs members are regularly supplying milk to the Milk Producer's Co-operative Societies. The Milk Producer's Unions have milk processing capacity of 24.07 lakhs litre/day. Besides, there are 35 chilling centres and 299 Bulk Milk Coolers (BMC) run by the Societies. On an average about 9.78 lakhs litre/day of milk has been sold by the Co-operative Societies. There are also 42 private diaries functioning in the tate.

Some of the action plans suggested to achieve higher and quality milk production are:

- Strengthening of milk testing at village level for clean milk production.
- Strengthening of dairy plants functioning under Co-operative sector through capacity expansion.
- Enabling supply of clean, hygienic milk and milk products.
- Providing veterinary health cover, implementation of AI program, supply of cattle feed, fodder and insurance cover to animals.
- Computerization of dairy activities at various levels to improve the efficiency and ensure more transparency in milk handling.
- Training to farmers, provision of antiseptic chemicals and utensils, strengthening of lab at Union dairies and chilling cenres and installation of Bulk Milk Coolers (BMC) at societies.

Animal Husbandry

a. Animal Husbandry Research

Specific focus on bovine infertility diagnostic centre, monitoring, surveillance and controlling poultry diseases, establishment of frozen semen banks, food processing centre, establishment of nucleus jersey cross breed bull, mother farm, capacity building program to field veterinarians, centre for poultry products certification, dairy entrepreneurs training facility, hydroponic green forage production, increasing animal production and health through nanotechnology, animal mobile medical ambulance and strengthening of veterinary institutions are necessary.

Action plan on increasing fodder production through quality fodder seed production and distribution, enhancing the productivity of livestock through of superior crossbred bulls for sustainable milk production, increasing availability of green fodder, harnessing the production potential to maximize the returns from dairy farming by improved feeding, breeding and management techniques, reducing the cost of production of milk through proper care to the animals, enhancing the accessibility to veterinary services to the farmers at the door step by providing animals mobile medical ambulances for rural veterinary care, capacity building to field veterinarians and entrepreneurship training for dairy and poultry farmers, developing training models for training beneficiaries would help in modernizing this sector. Tamil Nadu Veterinary and Animal Science University will also establish Centres with special reference to buffaloes and poultry, products certification, bovine infertility diagnostic centre and for freedom from microbes for export respectively.

- Establishment of Bovine Infertility Diagnostic and Training Centre with special reference to Buffaloes
- Monitoring, surveillance and control of emerging and remerging diseases of poultry at field level
- Establishment of Frozen Semen Bank at Veterinary College and Research Institute, Namakwa
- Establishment of "State Level Food Processing Training Centre (FPTC)" at College of Food and Dairy Technology, Koduvalli
- Establishing Nucleus Jersey Crossbred Bull-Mother Farm: Production of Superior Crossbred Bulls for Sustainable Milk Production under Rural Conditions
- Augmenting Animal Productivity and Advanced Veterinary Care Delivery through Continuing Education to Field Veterinarians
- Strengthening of University peripheral centres and developing training modules for training beneficiaries towards distribution of milch animal and sheep and Goat Schemes
- Establishment of a "Centre for Poultry Products Certification for freedom from microbes for Export"
- Animal Mobile Medical Ambulance for Rural Veterinary Care in Tamil Nadu
- Establishment of "Regional Dairy Entrepreneurs Training facility (RDEF)" at Veterinary College and Research Institute, Orathanadu, Thanjavur
- Establishing Regional Feed Processing and demonstration unit
- Water Conserving Hydroponic Green Forage Production for Livestock Farming
- Nanotechnology facility to Augment Farm Animal Production and Health
- Strengthening of Diagnostic Modalities in Teaching Veterinary Hospitals of Tamil Nadu

- Establishment of Innovation and Instrumentation Centre to fabricate farm equipments/ devices for sustainable livestock farming
- Establishment of Veterinary Forensic Sciences Laboratory
- Climate resilient fodder production through Hydroponic mode to augment livestock productivity in Tamil Nadu

Fisheries

India ranks second in aquaculture production in the world and its fertile aquatic bodies offer vast scope for cultivation of commercially important finfish and shellfish. Fisheries is recognized as a powerful income and employment generation enterprise as it stimulates growth of a number of subsidiary industries and is also a source of cheap and nutritious food for the people besides a foreign exchange earner. Fishery resources of Tamil Nadu are categorized as Marine, Inland, Reservoir and Brackish water.

Marine Fisheries

Tamil Nadu State with the second longest coastline in the country covers an area of 1,076 km. The marine fisher population in Tamil Nadu is 9.85 lakh, living in 608 fishing villages. The inshore waters of 1,016 km length of the coast on the eastern side and 60 km length of the coast on the western side are found to be over-exploited, whereas the offshore and deep sea resources are yet to be exploited to its optimum levels. The marine fish production of the State presently is estimated to be 4.77 lakh tons against the estimated potential of 7 lakh.

Inland Fishery

Tamil Nadu possesses 3.83 lakh ha of effective inland water resources comprising of reservoirs, major irrigation tanks, minor irrigation tanks and short seasonal tanks and ponds, rivers, backwaters and derelict water bodies. The inland fisher population is about 2.29 lakh. There are 61 reservoirs under the control of the Fisheries Department comprising of major, medium and small reservoirs. Among these, 53 reservoirs are directly under the control of the Fisheries Department and 8 reservoirs are under the control of Tamil Nadu Fisheries Development Corporation Limited (TNFDC).The short water retention period in ponds and tanks due to erratic and scanty rain fall necessitates promoting and stocking of fast growing fish species in short duration such as Amur Carp, Genetically Improved Farmed Tilapia (GIFT), Jayanthi Rohu, Pangassius sp. etc.

Brackish water

Brackish water aquaculture has been identified as one among the high potential areas for increasing shrimp, finfish and shell fish production and for deriving maximum economic and social benefits. This sector has vast potential of creating employment generation and acts as a vital source of food supply for meeting the food security and nutritional requirements of growing India's population. Tamil Nadu is one among the states, which has good scope for promoting brackish-water aquaculture for increasing farmer's income by multi-fold times within short period of four to six months. White Leg Shrimp *P.vannamei* yields about 5.5 t/ha and the realized profitability is about 3.3 lakh/ha by 120 days.

Tamil Nadu with a coastal area of 1076 km has an estimated brackish water area of about 56,000 ha in Thiruvarur, Thiruvallur, Villupuram, Ramanathapuram, Tuticorin, Tirunelveli, Chennai districts. In addition, there are about 14880 ha of potential area in these districts, which are suitable for brackishwater aquaculture. Unlike the freshwater resources using for fish culture, brackishwater aquaculture resource is not converging its use with that of freshwater, for the purpose of drinking or irrigation. Hence the resource can be developed and used for aquaculture for the production food, employment and income generation.

In Tamil Nadu, the total extent of brackish water area can be used for capture fisheries. Apart from this, about 7,100 ha area is under coastal aquaculture production mainly shrimp aquaculture. In Tamil Nadu, shrimp farming has grown considerably and has emerged as a major commercial activity owing to the introduction of Specific Pathogen Free (SPF) Shrimp, *Litopenaeus vannamei.* So far, 1,734 shrimp farms (3,514.65 ha) and 51 shrimp hatcheries have been registered under the Coastal Aquaculture Act (CAA), 2005

Conservation and management of fisheries resources are done by adopting measures namely imposing seasonal fishing ban, stock enhancement, habitat development like sea ranching programme, installation of artificial reefs and introduction of diversified fishing methods.

Artificial reefs act as habitats to marine aquatic organisms, help in enhancing the fish production through increased breeding activity and survival of young ones. It also acts as a barrier for bottom trawling operations. The Government has taken steps for development of fish habitats, by setting up of artificial reefs in the inshore waters as a conservation/stock enhancement measure. So far, 37 artificial reefs have been setup along the Tamil Nadu coast.

The Indian Squid is available throughout the coast and is predominant in the catch in the west coast of Kanyakumari district. To take up diversified fishing, this State have introduced a scheme of extending financial assistance to fishermen for procurement of squid jigging materials with 50% subsidy assistance.

Strategies

a. Identification of suitable areas for aquaculture development through effective utilization of potential brackish water areas

Out of the 56,000 ha total potential area available for brackish water in Tamil Nadu, hardly 10% has been developed into shrimp farming and at present about 6% area is under culture. Hence there is ample scope for further development of shrimp, finfish, crab and bivalve (edible oysters) farming that can create new farming enterprise and also to improve the livelihoods of the coastal population living in the remote areas, by creating alternate livelihood options. To address this, a policy for utilizing public brackish water resource, such as leasing policy, under the Government of Tamil Nadu, need to be framed involving research and development agencies, stake holders and farmers.

CIBA has developed a methodology for identifying suitable land area for brackishwater aquaculture development based on multi-disciplinary decision support system using Geographical Information System (GIS) and Remote Sensing data. The technology includes delineation of suitable coastal land areas and inland saline areas incorporating CAA guidelines, source water characteristics, distance from the water source, drainage and carrying capacity of source water bodies for the sustainable expansion of brackishwater aquaculture.

Further, geo-spatial techniques like 3-D mapping can be adopted for assessment of resources in the potential areas considering parameters such as water depth, pH, seasonal and water depth effect on sea water temperature etc. ICAR-CIBA has initiated a programme in partnership with the Tamil Nadu Government in this direction for identification and mapping of potential brackishwater resources in Ramanathapuram district. This can be emulated for other coastal districts of the state. Once the mapping is done the same can be made available for the decision makers, at the State and Central Government levels, for the developmental purposes.

b. District level planning for promotion of brackishwater aquaculture

CIBA has developed a methodology for district level planning for brackishwater aquaculture development evaluated in Nagapattinam district of Tamil Nadu. This planning tool integrated the site selection criteria, the resource map of the district, the agro-climatic conditions, selection of suitable culture practice and evolves an overall District/State level planning tool for future integration in Integrated Coastal Zone Management Plans of the coastal states and union territories. The stake holders meeting was organized to discuss the issues identified in the field and possible solutions for them. Similar attempts can be envisaged for other potential districts of the state.

c Horizontal expansion of successful brackish water aquaculture technologies through Public Private Partnership Mode

ICAR-CIBA has developed aquaculture technologies for candidate species such as shrimps (tiger shrimp, Indian white shrimp, Exotic shrimp Vannamei), crab (mudcrab), finfishes (seabass, milkfish and etroplus) and brackishwater ornamentals (etroplus, scatophagus, moon angels). These include hatchery production of seed, nursery rearing, formulated feeds and health management. These technologies can be spread on a larger scale through Public Private Partnership (PPP) mode in the potential coastal districts of Tamil Nadu. ICAR CIBA, State Department of Fisheries and Private farmers / entrepreneurs can jointly promote these technologies. These include:

Production technology for selectively bred SPF *Penaeus vannamei* which tripled increased the country's shrimp production and increased the export earnings from Rs. 4000 Cr in 2010 to Rs. 20,000 Cr in 2014-15. Here the individual farmers income from shrimp farming has been tripled from the year 2010 to 2015, by adopting the vannamei farming, made possible by the timely intervention of institutions such as CIBA, MPEDA and Ministry of Agriculture.

1. Year round breeding techniques of seabass through seed production, nursery rearing and faming technology.

2. Indigenous shrimp feed manufacturing by compressed pelleting technology
3. Shrimp hatchery and farming technology for five potential shrimp species.
4. Production of cost effective desi feed, Vannami*Plus* by using the indigenous feed resources.
5. Production technology of selected microbial based shrimp growth promotor **“CIBASTIM”**
6. A sensitive, cost-effective and users friendly nested PCR detection kit for White Spot Syndrome Virus (WSSV) in shrimp
7. Modular hatchery and technology for fish pearlspot for homestead, SHGs and farming families
8. Production technology for crab farming in three tier or Zero stocking model
9. Cost-effective water quality kits for estimation of DO, pH, ammonia, calcium, magnesium and hardness critical water parameters.
10. Promotion of functional feeds for larvae and broodstock as alternates for imported expensive hatchery feeds.

The specific action plans suggested for enhancement of the farmers' (stake holders) income in fisheries are

1. Approaches like “production and productivity enhancement, price enhancement, value addition / rich, and market strengthening”.
2. Enlargement of culture area and efficient water usage
3. Technology intervention and to effect the migration from conventional farming to input based farming so as to produce high value fishes
4. Reduction of post-harvest loss and quality assurance for high price command
5. Integrated use of resources for holistic production approach involving all sectors and both genders without any discrimination
6. Promotion measures by the government for the wide scale adoption and assured income through creation of aquaculture park in coastal regions and specially designated areas. Marketing support through supply of transport carriers and live fish market facilities
7. Technical support from research (University and ICAR and Central Institutes)

In order to overcome the limitations, the Government is taking the following measures:

- Adopting Eco friendly and sustainable fish / shrimp aquaculture
- Introduction of fish seed rearing in floating cages in water bodies
- Adopting intensive cage farming in reservoirs
- Creation of fish seed banks to ensure the availability of fish seeds throughout the year
- Undertaking intensive fish culture in irrigation tanks

- Integrating fish culture in farm ponds / multipurpose farm ponds with agriculture to provide additional income for Farmers.
- Introduction of culture technology for fast growing fishes viz., Amur Carp, Jayanthi Rohu, Genetically Improved Farmed Tilapia (GIFT) and Pangassius, dissemination of knowledge for its propagation and establishing hatcheries for these species.
- Encouraging farmers by providing subsidy for setting up of infrastructural facilities for fish/prawn hatchery, fish culture in grow out ponds, feed mill and hygienic marketing infrastructure.
- To enhance the fishing efficiency of Inland fishermen.
- Creating job opportunities by promoting ornamental fish culture to rural women and youngsters.

Government is taking efforts on all spheres, to effectively boost the Inland fish production of the State by implementing various schemes under NADP. During 2016-17, fish culture with fast growing fish species has been taken up in 383 irrigation tanks covering an area of 9,000 hectares and this will be extended to 500 more irrigation tanks covering an area of 15,000 ha. during 2017-18.

The Government has mooted initiatives to double the income of agriculture farmers of the state by providing subsidy assistance to the tune of Rs.3.50 lakh per hectare for the integration of agriculture and aquaculture activities besides providing input subsidy assistance. The major thrust exerted by the Government during the past five years has commendably reduced the demand and supply gap of fish seed production in the State. This supply gap was reduced from 8.7 Crores last year to 6 Crores during the current year.

Capacity building

Farm advisory services, answer to farmers' queries, organizing mass awareness programs, fish farmers' meets, stake holders linkage through mass media, Industry-Institute meets and Exhibitions. The University and the State Fisheries Department are conducting various training program. With the objective of planning and execution of all outreach program in close coordination with other line departments / agencies such as the Dept. of Fisheries, Tamil Nadu Fisheries Development Corporation and other Government organizations, the University is taking a coordinating role. Besides, the Fisheries University established Centre for Sustainable Aquaculture (CESA) to enhance aquaculture production in the State, at Nagapattinam with the following mandates:

1. To develop and run the production centres at outstations of the University
2. To propose and establish new stations with focus on economically important species for the development of culture technology for adoption.
3. To establish and run the farms in the strategic locations and forming platforms for the research
4. To transfer the viable technologies through demonstration and training to the stakeholders

The marine fishermen will be taken to neighboring states for an exposure visit to the major fishing harbors, landing centres, processing plants and fish markets and training imparted to them on the best practices being followed in those places, type of crafts and gear used, fishing methods etc. Capacity building programs conducted for 1273 fisheries officials across the country to train farmers, fishers, master trainers, officers of the public-sector units concerned with fisheries development in the State

To initiate Knowledge Management (KM) activities in Fisheries and Aquaculture, the Centre for Fisheries Management, Planning and Policy (CEFIMAPP), as a constituent unit of TNFU at Chennai was established. This centre carries out the role of a knowledge aggregator, and become a clearinghouse of all data/information on existing and planned research projects and initiatives relating to Fisheries and aquaculture in the Tamil Nadu. The specific action plans are

- Hosting of geo-portal on Fisheries and Aquaculture
- Host-hub for knowledge/information sharing related to Fisheries and Aquaculture;
- Fisheries and Aquaculture Knowledge repository;
- Identification of potential research and development domains concerned with Fisheries and Aquaculture issues in the state; and
- Technical demonstration, research and development, extension and transfer of technology protocols, relating to Fisheries and Aquaculture.

The Fisheries Staff Training Institute (FSTI) under Tamil Nadu Fisheries University provides regular in-service training, refresher and orientation courses on Specialized Fisheries topics to the State Fisheries Department Officials. The University is also involved in certification of the seafood products through the Fish Quality Monitoring and Certification Centre at Thoothukudi. The State Referral Laboratory for aquatic animal diseases surveillance at Madhavaram, Chennai provides fish disease certification services

Fisheries Institute of Technology and Training (FITT) is a constituent unit of State Government funded Tamil Nadu Fisheries University (TNFU) functioning as a society, registered under Tamil Nadu Societies Registration Act, 1975 since 18.07.2008, with a vision to promote livelihood opportunities for the economic development of fishers and people involved in fisheries and aquaculture. FITT has been allotted with 1.16 ha land in Muttukadu, East Coast Road for which a master plan has been prepared to establish a state of art Skill development centre for fisheries and aquaculture. Memorandum of Understanding (MOU) between Tamil Nadu Government and TATA Sons as a technical partner was signed on 02.09.2008 for five years with a major objective to provide technical assistance to implement various marine fisheries schemes during the period of collaboration.

The Fisheries University is focusing its research and extension activities in the following issues with specific action plans like “production and productivity enhancement, price enhancement, value addition / rich, and market strengthening”, enlargement of culture area and efficient water usage, technology intervention and to effect the migration from conventional farming to input based farming so as to produce high value fishes, reduction of post-harvest loss and quality assurance for high price command, integrated use of resources for holistic production approach involving all sectors and both genders without any discrimination, promotion measures by the government for the wide scale adoption and assured income through creation of aquaculture park in coastal regions and specially designated areas and marketing support through supply of transport carriers and live fish market facilities

Enhancement of production / productivity, price and income:

The Inland fish productivity of the State was 626 kg from 3.83 lakh hectares with a total production of 2.4 lakh tonnes during 2014. This productivity can be enhanced with minimum possible technological and policy intervention to 1500 kg /ha. Similarly, the per capita production potential in the marine fisheries sector can also be increased by suitable interventions like increase in CPUE, Cold chain maintenance improved fish handling methods, post-harvest loss reduction strategies and by effective value addition.

a. For inland fish farmers:

1. Reclamation of water bodies and designating new water bodies for aquaculture work in order to increase the production area.
2. Establishing Fish seed Estate /Park with a cluster of fish read production units at a suitable location preferably in a reservoir area with necessary infrastructure. This can be operated by the Government or cooperative societies. Alternatively, farmer production organizations can also be entrusted with the responsibility of managing the Park funded by the government.
3. Establishment of "Fish Farmers Markets" at Taluk /District Headquarters, cities, rural markets, etc with facilities for sales of live fish including provision of live fish transport units. Farmers cluster groups (units) can be encouraged to take up this activity.
4. Introduction of diverse fish species for aquaculture like Air breathing fish (*Pangassius* spp., Murrel) GIFT Tilapia, *Etroplussuratensis*, *L. vannamei* (in low saline waters).
5. Encouraging Agriculture farmers to have fish culture in their farm ponds to serve as income – buffering unit. Integrating with live stock and poultry to be promoted.
6. Fresh Fish Market to be tied up with TNFDC and to get Fish price intelligence from their network.
7. To maximize income in Ornamental Fish culture practices, existing facilities are to be linked for sizing and marketing fishes.
8. Introduce Trench farming in areas where ever it is suitable to facilitate additional income (eg. 'Ayirai' fish)

b. Marine fisheries sector

1. Fish Business Incubator / Hand Holding facilities to be created in all TNFU Centres.
2. All Fish handling Centre, to be provided with fish dressing centers to facilitate primary value addition and thereby increasing the income. It also helps in easy collection of fish

waste, which can be further used for Organic Fish manure production a key ingredient for Agriculture sector input cost reduction process.

3. Migration of fishermen from their core fishing activity to fish farming activity through coastal aquaculture park and supporting fish breeding facilities.
4. Supporting the fishermen with the fish marketing and value added fish production and marketing.

Research support from TNFU for doubling the farmer's income:

Further research will be taken up in the following areas

- Technology development for mass – scale seed production and rearing of Carps
- (*Labeo calbasu* and *Labeo fimbriatus*), Catifishes (Magur and Singhi) Murrels (*Channa striatus*) and Pangas (*Pangasianodon hypophthalmus*).
- Development of technology for seed production and farming of India Spiny Loaches, *Lepidocephalus thermalis* (Ayiraimeen) along India Major Carps.
- Intercropping of Carps and Barbs in conventional major carp culture systems.
- Development of aqua feeds by formulating feed with locally available feed in ingredients/ unconventional feed ingredients.

Tamil Nadu State Apex Fisheries Co-operative Federation Ltd., (TAFCOFED), has been registered under Tamil Nadu Co-operative Societies Act, 1983 and functioning since 19.10.1992 with its headquarters at Chennai, under State Department of Fisheries. At present, 477 Marine Fishermen Co-operative Societies, 141 Inland Fishermen Co-operative Societies, 158 Fisherwomen Co-operative Societies and 9 District Fishermen Co-operative Federations have been enrolled as members in TAFCOFED. TAFCOFED is conducting various need based training programs for fisher folk with the funding support of National Fisheries Development Board (NFDB), National Agriculture Development Program (NADP) and Government of India for effective transfer of technology and propagation of welfare schemes of the Government.

As a measure of offering alternative livelihood to marine fisherwomen, TAFCOFED had conducted training program on 'Solar Lantern fabrication and servicing' to fisherwomen belongs to 13 maritime districts of Tamil Nadu, with NFDB financial assistance of Rs.5.42 lakh for 260 coastal fisherwomen. This will help the fisher women to become a self-entrepreneur in production and servicing of Solar Lanterns.

TAFCOFED is also conducting Training program on "Basics of Seamanship and Navigation, Electronic equipment and Maintenance of Marine Engine" to deep sea going fishermen of Tamil Nadu with technical assistance from Central Fisheries Nautical Engineering Technology (CIFNET) and with financial assistance from NFDB. 1,000 fishermen in 40 batches will be trained under this program. 373 deep sea going fishermen were already trained in eight batches at Fishermen Training Centre, Colachel, Kanniyakumari district.

TAFCOFED is conducting training program on "Value added fish products" for members of fisherwomen co-operative societies in coastal districts of Tamil Nadu. In the first phase, 2,500 fisherwomen will be trained in 125 batches at a cost of Rs.31.87 lakh under NFDB assistance. About 1,150 beneficiaries were already trained in 36 batches in coastal District

Other Initiatives for doubling the farmer's income

1. Bio-control production

Biocontrol agents like parasitoids, predators and microbial pathogens become invaluable components in agricultural IPM system in view of high level of specificity, safety and sustainability. In addition to the natural bio control operating in many crop habitats, applied bio control can bring about a successful suppression of crop pests, disease and nematodes without disruption of the ecosystem and help us to have residue free marketable commodities. The high level of human safety, stability of control and renewable nature, make them very attractive candidates for pest management in organic farming.

Organic agriculture has experienced rapid worldwide growth during the last decade. According to recent surveys, more than 31 million hectares are currently under organic management in approximately 120 Countries. In Tamil Nadu, around 28,114 acres were registered under organic farming which necessitates the need for the availability of quality bio-control agents for pest management. Under natural condition, the biological control agents available are in quantities not adequate to bring down the pest damage. Hence the practical methods of mass multiplying them and using under field conditions have been investigated and exploited on a large scale in India during the last four decades. Recently a spectacular success has achieved in the state for the management of papaya mealy bug. *Paracoccus marginatus* using the parasitoid *A. papayee*. However, availability of Biocontrol agents is often realized as a tough task at farmer's level.

In this connection, Mass Production of potential parasitoids, predators and pathogens can be taken up at village level using farmers, self help groups and unemployed youth. The farmers showing interest can be trained on the mass production of bio control agents by the Scientists of Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore. The trained farmer/self help group/un employed youth can initiate a Mass Production unit at village level as a small-scale cottage unit. The farmers of the village can have their own bio control agents for their crop husbandry which orient towards the bio village concept.

As a pilot project the interested farmers /unemployed youth in village /self help groups shall be provided with essential facilities for establishing mass production unit with funding. The farmers who have the training on the Mass Production of bio control agents can focus initially on the production egg parasitoid *Trichogramma spp.,* larval parasitoid *Bracon brevicornis* and coccinellid predator *Cryptolaemus montrouzieri* which will be easier and have good demand for sale. After gaining experience, they can scale up the production with addition of the bio control agents.

2. Revenue expected

If an operating farmer employs his family labor for 3 to 4 hrs/day and spends Rs.10,000/

month (by charging 10 trays /day and for 20 days per month) on food material for *Corcyra cephalonica* production, the host insect of egg parasitoid and larval parasitoid, he can earn Rs.20,000/month from six weeks after the initiation of Corcyra culture. Hence, a farmer can definitely expect a profit of Rs.10,000/month on this bio control mass production activity ensuring with sustainable and profitable to the farmer.

3. Community Entrepreneurship and Business Process Integration of Oyster and Milky Mushroom Production

Mushroom cultivation is the best rural biotechnology process to enhance the farmers income through crop residue recycling. By integrating the bioprocesses involved in mushroom growing, protein rich food, value added feed and organic biomanure can be made available at every farm holding. Oyster mushroom is an easy to cultivate tropical to subtropical climate loving mushroom, which can be cultivated by utilizing the agricultural residues like paddy straw, sorghum and maize stalks, maize cobs, saw dust. Milky mushroom (*Calocybe indica* var. APK 2) is a tropical edible mushroom and is relatively new to the world mushroom lovers. It is of Indian origin. The technology for commercial cultivation and the new variety has been introduced for the first time from Tamil Nadu Agricultural University, Coimbatore.

The Process involves

- Centralized mushroom spawn production
- Indoor cultivation of oyster and milky mushroom
- Environmentally safe packing
- Enrichment of spent mushroom compost with beneficial bio inoculants / silage additives for value added feed and bio manure

The focus

- Community Entrepreneurship - Creation of centralized facility for
- Supply of quality Spawn, Spawned beds and Casing soil
- Pilot plant for packing, post harvest processing and food quality analysis
- Buy back, common brand equity and marketing linkages
- Technical consultancy, capacity building and quality control by TNAU Scientists
- Business planning Integration through ABI platform, Directorate of Agribusiness
- Development, TNAU, Coimbatore
- Creation of a Mushroom Food Court
- Linkage with financial institutes for future expansion

Work Plan – Production

- 25 individuals (5 from 5 villages at 5 KM radius) / cluster
- 250 kg of mushrooms per day (@ 10 kg by an individual).

- Each of the individual is expected to earn a minimum of Rs. 8,000 to 10,000 /month
- Preference to unemployed rural women / youth / SHG
- Training and capacity building at Central Unit
- Quality spawn, spawned beds and casing soil will be supplied with buy-back arrangement for mushrooms
- Cropping rooms at a cost of Rs.1 lakh is to be constructed by the individuals

Expected production (calculated based on 100% Bio-efficiency Giving allowance to risk of contamination and Quality of produce) is 250 Kg /Day/ cluster and expected income per person in the group per month: Rs. 16,000

25.3 SUMMARY AND RECOMMENDATIONS

Innovations and human resources are the twin engines of agricultural growth and development. The way to double farmers' income is possible only through more productive agricultural sectors by supporting the technologies with synergising policies and support from the govt.

Agriculture is still the biggest employer and livelihood provider to the majority in the state. This sector therefore, offers considerable leverage over the growth of the economy as a whole and its development not only provides cheaper food for both urban and rural population, but it also generates employment, raises the income of poor people, creates a demand for other non government goods and services. Further it also saves our foreign exchange and encourages our international trade.

The five related challenges of food production, malnutrition, poverty, population growth and environment are more acute now and through its cutting edge technologies and extension programmes The nexus between these five elements that challenges the development. Poverty limits the opportunities for protecting and enhancing the environment because we are left out with few options but to exploit the natural resources base in order to attain food security.

A more productive agriculture also means more food at lower prices. These lower prices facilitate the complex interaction's that promote an inclusive economic growth. Research generate agricultural technologies and innovations that increase productivity and incomes while conserving natural resources for sustainability as the nucleus of the whole development process. The complexity of the challenges requires greater resources for research and committed team of scientists and extension work force.

Climate Resilient Agriculture, GIS based soil fertility maps, using soil test data, to improve the soil and water productivity through location specific nutrient and resource management are key requirements..

Understanding of farming systems and the farmers resources is very much important to design and develop technologies that are acceptable and appropriate for the resource poor farmers. Realising the importance of farming system approach the plan has laid due emphasis on farming system mode development by developing a decision support system tool (DST) to facilitate farmers in deciding the profitable components for farming system. In addition, district wise extension and development strategies for the state based on the detailed analysis of prevailing farming system prevailing in all the agro climatic conditions have been formulated.

The rural backyard poultry production system need to be strengthened by the newly developed dual purpose poultry breed which achieved body weight closer to Vanaraja breed and egg production closer to Gramapriya in 72 weeks. Diagnostic kit "DIVA" developed for differentiating FMD infected and vaccinated animals is an important innovative technique which has got potential application in the field.

The technology enters the agricultural sectors from two major sources. As primary source, farmers themselves were the main suppliers. Through their efforts in selecting plants, perfecting their tools and designing their crop mixtures and rotations, the traditional wisdom based agricultural production system evolved. Farmers efforts need to be supported by scientists through their innovative research and development approaches. Yet in today's world of shrinking natural resources and rapidly raising human populations, traditional production systems are increasingly falling to meet the food and income needs of increasingly urbanized consumers, while some are in danger of breaking down altogether.

Empowerment of farm women through development of income generating technologies and gender friendly agricultural equipments is one of the key area of focus toward empowerment of women with appropriate technologies. The innovative idea of using digital radiographs, computed tomography and magnetic resonance imaging to detect internal disorders like spongy tissues in mango samples have got bright field of application in the coming years.

SUCCESS STORIES

1. Millet cultivation and Value addition

Place of Implementation	Salem District
Sector	Agriculture and Food Processing
Type of Intervention	Cultivation of minor millets and value addition

Minor Millets	Before processing (Rs/kg)	Processed (Rs/kg)
Sorghum	30	70
Pearl millet	15	40
Finger millet	15	60
Little millet	30	75
Foxtail millet	30	100
Kodo millet	35	100
Barn yard millet	35	100

2. Popularization of Hybrid Tube rose

Place of Implementation: Dharmapuri District

Sector: Horticulture

Type of Intervention: Introduction of Tube rose Prajwal Hybrid against local

Village	Pre-demonstration (kg/ha)	Demonstration (kg/ha)	Post- demonstration (kg/ha)	Average increase over pre- demonstration stage (kg/ha)	Additional monetary gain (Lakh Rs./ha)
Kariappanalli	7.60	22.05	20.40	168.42	492800
Palavadi	8.00	22.50	23.75	196.87	496000
Makkanur	5.25	14.25	13.30	153.33	309000
Paisuhalli	5.00	14.60	16.50	230.00	327200
Kanapatti	7.50	19.20	22.50	200.00	404400

26

TELANGANA

Telangana the 29th state of India was formed on 2nd June 2014. It has a population of 39.12 Million as per 2017 census. Its capital is Hyderabad, being the largest city. Hyderabad is known as "City of Pearls". It is situated on the Deccan Plateau, in the central stretch of the eastern sea board of the Indian Peninsula with a geographical area of11.484 million ha. The State comprises of 31 districts and 584mandals (sub-districts). The compact size of each district is bound to sharpen the edge of district administration, with smooth delivery of all public services to all the families. Based on rainfall, type of soils and cropping pattern, the State is divided into three agro-climatic zones viz. Northern Telangana zone, Central Telangana zone and Southern Telangana zone. Out of total geographical area of the state, 37.3 per cent is under cultivation and around 23 per cent is under forest cover. Land put to non-agriculture uses is around 8 percent.

Agriculture has been the backbone of Telangana economy. Agriculture sector is mainly rainfed and depends to a significant extent on the depleting ground water. Out of the total geographical area of 112.08 lakh ha, the gross cropped area is 53.15 lakh ha, net cropped area is 43.76 lakh ha. The gross irrigated area is 25, 29 lakh ha and net irrigated area is 17.26 lakh ha. The cropping intensity in the state is 121 per cent. Rice is the major food crop. Other important local crops are cotton, sugar cane, soybean, turmeric, redgram, chillies, maize etc. Good performance of this sector is vital for inclusive growth. There have been significant changes in the structure and performance of the agrarian economy in the state in the recent years. The share of Telangana's economy in India is about 4.1 percent.

Based on rainfall, type of soils and cropping pattern, the State is divided into three agro-climatic zones viz. Northern Telangana zone, Central Telangana zone and Southern Telangana zone.

26.1 Agro-climatic zone-wise production constraints

Major crop/ cropping system	Farming situation	Specific Production Constraint
1. Northern Telengana Zone		
Paddy-paddy	Irrigated	In most of the cases, 2nd paddy in rabi suffers due to in sufficient availability of irrigation water.
	Irrigated	Demands higher rate of application of fertilizers particularly N due to poor use efficiency.

Major crop/ cropping system	Farming situation	Specific Production Constraint
Cotton	Red soils (rainfed)	Cotton grown on red soils with poor water holding capacity suffers due to prolonged dry spells results in low productivity. So growing cotton under this situation becomes risky. Cotton is not a recommended crop on rainfed red soils.
	Black soils (Irrigated)	Cotton suffers on black soils where there is no life saving irrigation facilities during dry spells.
	Black soils (Rainfed)	Sole cotton is very risky.
Soybean	Rainfed	Common variety (JS 335) is susceptible to pests and diseases. Needs variety replacement.
		Sole soybean is risky due to prolonged dry spells. Life saving irrigation with harvested rainwater is needed.
		In-situ water conservation measures such as Broad Bed Furrow is essential for successful crop with higher yields.
Redgram	Black/Red soils (Rainfed)	Commonly growing varieties are yielding less. Dry spells are common. Needs processing for higher price.
Turmeric	Black soils (Irrigated)	Sole turmeric produces low profits to farmers.
		Manual processing of turmeric is very expensive and time consuming
Mango	Irrigated with drips from ground water or harvested water	Most of the orchards are very old and producing low yields.
Chillies	Irrigated	Prone to pests and diseases
2 Central Telangana Zone		
Paddy-Fallow	Kharif irrigated and rabi fallow due to limited availability of water	Kharif paddy irrigated and in rabi season most of the fields are left fallow due to limited availability of water
Cotton	Red soils (rainfed)	Cotton grown on red soils with poor water holding capacity suffers due to prolonged dry spells results in low productivity. So growing cotton under this situation becomes risky. Cotton is not a recommended crop on rainfed red soils.
	Black soils (Irrigated	Cotton suffers on black soils where there is no life saving irrigation facilities during dry spells.
	Black soils (Rainfed)	Sole cotton is very risky.
Maize	Rainfed (Red/black soils)	Net income from sole maize is low due to insufficient availability of irrigation water.

Major crop/ cropping system	Farming situation	Specific Production Constraint
Mango	Irrigated with drips from ground water or harvested water	Most of the orchards are very old and producing low yields.
Guava	Irrigated with drips from ground water or harvested water	Most of the orchards are very old and producing low yields.
Chillies	Irrigated	Prone to pests and diseases
Sweet orange	With drip irrigation on different soils	Present variety is not suitable for processing industry hence the net returns are low.
Vegetables	Protected conditions/ Inter crops in orchards	Not able to meet the demand due to lack of shade net/ poly house facilities.
Floriculture	Protected conditions/ Inter crops in orchards	Not able to meet the demand due to lack of shade net/poly house facilities. There is lot of potential for shade nets in peri-urban areas.
3 Southern Telangana Zone		
Cotton	Red soils (Rainfed)	Very low productivity of cotton due to lack of irrigation combined with poor water holding capacity of soils.
		Droughts or prolonged dry spells are very common.
		Lack of interest on traditional crops such as sorghum, ragi etc.
		Lack of rain water harvesting farm ponds.
Maize	Red soils/Black soils	Poor yields due to lack irrigation water for life saving irrigations during dry spells.
Redgram	Red soils/Black soils	Poor yields due to lack irrigation water for life saving irrigations during dry spells.
Horticulture	Red soils with drips from ground or harvested water	Lack of awareness about rry land horticulture/fruit crops with drips and mulching.
Vegetables	Protected conditions/ Inter crops in orchards	Not able to meet the demand due to lack of shade net/ poly house facilities.
Floriculture	Protected conditions/ Inter crops in orchards	Not able to meet the demand due to lack of shade net/poly house facilities. There is lot of potential for shade nets in peri-urban areas.

26.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income and agro-climatic zone-wise scaling-out strategy.

The annual income of farmer's household in Telangana is about Rs 75,732 per annum. Crop sector was the major contributor to this farmers' income which contributes 67.2%. Whereas Horticulture is contributing only 6% where there is lot of potential to increase for doubling overall farmers' income. Livestock is contributing about Rs. 4488 /annum. Farmers' income from wages and non-farm business are about Rs. 17400 and Rs 3120 /annum, respectively. As per the strategic document of NITI Aayog, increased crop productivity contributes about 33%, Better price realization contributes about 33% and other sources of income contributes about 33% to the total income of farmers' income. Among these 3 sources of income, the contribution from enhanced crop productivity can be doubled by adopting successful technology interventions on farmers' fields in various sectors of agriculture. The contribution from better price realization can be increased by value addition to agricultural produce and linking it to the markets through value chain approach without involvement of middlemen. There is also possibility of enhancing non-farm income of farmers by popularizing multi-enterprise agri-clinics and agribusiness centres in rural areas particularly for rural youth.

1. Present and targeted growth rates in different sectors for doubling agricultural income of farmers by 2022-23.

- With current CAGR in agriculture & allied sector the contribution of the sector to GSDP will become 1.47 times by 2022-23.
- Targeted CAGRs during 2015-16 to 2022-23 for doubling the contribution by 2022-23 are presented in Table 6.
- The current growth in agriculture (0.02%) is negligible. It can be increased to 5% by diversification to horticultural crops in suitable areas.
- The current growth rate of livestock (9.37%) can be increased to 15% as the state government is coming up with livestock mission with Rs. 5000 crore allocation to sheep & goat rearing to bring stability in the livelihoods of small and marginal farmers and rural poor.
- The existing growth rate in fisheries (13.88) is impressive. It is further expected to enhance to 16% with the backup of state government for fish culture programme in mission Kakatiya tanks.
- Achieving the proposed growth rates will ensure doubling of the contribution of agriculture & allied sector to GSDP.

Contribution of agriculture and allied sectors in GSDP of 2015-16 at constant prices (2004-05), rates of growth (2006-07 to 2015-16) and the expected contribution by 2022-23 and required growth rate for doubling of farmer's income

Compo-nent	Amount (Rs.'000 Crores) 2015-16	CAGR (%)	Expected amount in 2022-23 (Rs.' 000 Crores) with current CAGR	% increase in 7 years (2015- 16 to 2022- 23) with current CAGR	Growth in 7 years with current CAGR	Required/ targeted CAGR (%) for doubling in 7 years (2015-16 to 2022-23)	% increase in 7 years (2015-16 to 2022-23) with targeted CAGR
Crops	11.40	0.02	11.41	0	1.00	5.00	41
Livestock	11.33	9.37	21.21	87	1.87	15.00	166
Forestry	1.77	0.57	1.84	4	1.04	0.57	4
Fisheries	1.52	13.88	3.78	148	2.48	16.00	183
Total	26.01	3.44	38.24	47	1.47	10.50	101

Area and yield of major crops and their CAGR in different agro-climatic zones in Telangana

(A) Northern Telangana Zone

- Area under cotton and soybean are increasing in the zone despite falling down yields (Table 7).
- Area under rice and maize are going down despite positive growth rate in yields.
- It indicates that farmers are driven by market forces while choosing crops
- Growth rate in mango is impressive in area as well as yield. There is scope for further expansion by promoting in suitable areas.
- Area as well as yield of sorghum and chick pea are going down.
- Area under pigeon pea, green gram and groundnut are going down in spite of positive growth rate in yields.

(B) Central Telangana Zone

- Area under cotton is showing increasing trend in response to better market for the commodity though yield is showing declining trend (Table 8).
- Both area and yield are showing increasing trend in maize
- Area under rice is declining despite positive growth rate in yield.
- All other important crops except soybean are loosing area. Soybean area in the zone is slowly picking up.
- Growth rate in yield is positive for mango, soybean, groundnut, green gram, chick pea and sorghum while it is not encouraging for pigeon pea and chillies.

(C) Southern Telangana Zone

- Rapid growth was observed in area under cotton in last 10 years despite slight decreasing trend in yield. Profitability is the key driver for increase in cotton area.
- Maize area is showing increasing trend with increasing yield while area under rice is declining.
- Area under pigeon pea, chick pea and mango is showing upward trend while sorghum is loosing area.
- Yield levels are increasing in sorghum, green gram, groundnut and mango while the crops viz., rice, chick pea, pigeon pea and chillies show declining yield trends.

1. Agro-climatic zone-wise strategies for enhancing crop productivity and net income of farmers

- The strategies such as (i) enhancing productivity through cropping system approach, (ii) Agri-horti systems, (iii) Integrated farming systems, and (iv) livestock and fisheries as components in IFS models are furnished separately for each agro-climatic zone. Whereas, strategies such as (v) Processing and value addition and (vi) Reduction in cost of cultivation and (vi) Enhancing income from non-farm sources are discussed commonly for agro-climatic zones together.
- Among the various possibilities for increasing the income for farmers, some may be realized within a year or so others may be realized over the years depending on the process involved fundamentally there are three approaches available for enhancing income of farmers' viz., increase the gross income, reduce the costs and stabilize the income.
- Broad strategies, activities and resource domain-wise action points are given under the following three approaches:

i. Enhance Gross Income

ii. Reduce Costs

iii. Stabilize Income

Approach 1. Enhancing Gross Income

Strategy	Activity	Resource Domain	Action Points
Increasing Productivity	Bridging Yield Gaps	Irrigated	Delineation of Crop Colonies based on soil, climate, water etc. Wider adoption of improved varieties/ hybrids and improved practices of rice, maize, pulses, millets &fodder crops. Implementation & popularization of improved soil & water management technologies in farmer's fields. Implementation & popularization of plasti-culture interventions viz., bed cultivation, drip irrigation & fertigation & plastic mulch in field & horticultural crops (More Crop and Income per Drop of Water). Popularization of growing vegetables flowers & herbs in greenhouses/poly houses. Implementation of soil test based fertilizer management. Popularization of multiple cropping –Crop rotation, double cropping systems. Implementation & popularization of seed to seed mechanization in rice, cotton, soybean, pulses, groundnut & sugarcane
	Bridging Yield Gaps	Rainfed	Delineation of Crop Colonies based on soil, climate, moisture availability period and potential for supplemental irrigation. Implementation & Popularization of agro-ecology specific (soil & rainfall) in situ moisture conservation practices. Popularization of recommended tank silt application in light textured soils. Mapping potential sites for rainwater harvesting in farm ponds. Popularization of farm pond technology package (selection of ideal site, digging, harvesting, lining, minimizing, evaporation losses, lifting pump, micro-irrigation system) including efficient utilization of stored water for higher water productivity (More Crop and Income per Drop of Water). Popularization of rainfed crops/ varieties with wider adaptability and resilience to climate variability for enhanced yield. Productive and risk resilient intercropping systems in major rainfed crops for minimizing risk and enhanced productivity.

Strategy	Activity	Resource Domain	Action Points
			Real-time contingency crop plan implementation to cope with delayed onset of monsoon and seasonal drought (early/midseason/terminal drought), high intensity rain all events. Soil test based nutrient management - with a focus on INM, balanced nutrition, crop residue recycling, green leaf manuring etc.
	Increasing Seed replacement Rate	Irrigate/ Rainfed	Production of breeder, foundation & certified seed. Timely supply of high yielding varieties & hybrid seeds Seed village programme
	Increasing irrigated area	Irrigated	Water resource development for Permanent irrigation. Desilting tanks to increase volume of water for irrigation of crops & groundwater stabilization. Augmenting & popularization of use of treated wastewaters for irrigation. Adoption of water saving technologies viz., Drip & sprinkler irrigation in commercial field & horticultural crops. Implementation & popularization of Water conserving technologies viz., drum seeding, aerobic & alternate wetting & drying irrigation practice in rice
		Rainfed	Popularization of in-situ and ex-situ rain water management practices for increasing area under supplemental irrigation
Enhancing output price	Marketing intelligence & creation of market infrastructure to realize higher prices	Irrigated/ Rainfed	Linking farmers to Electronic National Agricultural Market to avoid distress sales by farmers Aggregation of produce for collective bargaining; Staggered sales to avoid distress sales by farmers. Procurement of Paddy/other crops through IKP centres Improving holding capacity of produce by farmers in warehouses to avoid distress sales Processing and value addition of pulses, millets, spices, vegetables & fruits Crop planning based on market intelligence Crop colonies to regulate cropped area & production to realize higher commodity prices Seed production through contract farming

Strategy	Activity	Resource Domain	Action Points
Diversifying with in farm	Sustainable intensification	Irrigated/ Rainfed	Diversification to high value crops Implementation & popularization of integrated rice + fish culture system Implementation & popularization of integrated maize + dairy + poultry system Strengthening existing traditional rainfed farming systems Implementation & popularization of risk resilient integrated farming systems Identification of appropriate land capability / suitability based agroforestry systems Promotion of pasture, silvi-pasture systems, fodder trees, multiple tree based systems in non-arable on large scale, particularly in village common lands. Boundary plantation with perennial tree species for forage, green leaf manure, mulching and ecosystem services for moderating microclimate at individual farm level Dryland horticulture with predominant fruit crops along with micro-irrigation, micro- site improvement. Rejuvenation of existing orchads for higher productivity and introducing short duration pulses, horse-gram, Style fodder spp.
Diversifying to non-farm linked to agriculture	Individual/ Group based income generating activities		Seed production & Processing units; Agri clinics & Custom hiring services; Seedling nursery supply units; Vermicomposting; Bee keeping; Mushroom production; Artisans; Farm equipment repair & maintenance; Food processing etc.

Approach II. Reducing Production Costs

Strategy/ Priority	Activity	Resource Domain	Strategies &Convergence
Reducing purchased inputs	Organic farming	Irrigate/ Rainfed	Delineation of organic farming crop zones. Identification of multiple crop sequences including legume components. Identification of combination of organic manures Preparation of production protocols for organic Crops Standardization of certification protocols for organic crop production Green manuring of crops Wider adoption of bio-fertilizers & bio-pesticides

Strategy/ Priority	Activity	Resource Domain	Strategies &Convergence
	Soil test based Nutrient management	Irrigate/ Rainfed	Soil resource information system at individual farm level Crop residue recycling, INM & SSNM Revisiting of recommended doses of fertilizers Popularization of use of neem coated urea Soil health -crop advisories
	Fertigation	Irrigate/ Rainfed	Popularization of fertigation equipment Identification of suitable water soluble fertilizers Standardization and popularization of fertigation scheduling programmes for both commercial field & horticultural crops
	Farm mechaniza-tion	Irrigate	Development, testing and popularization of farm machinery/implements for timely agricultural operations Large scale mechanization in small & marginal farms Promotion of Custom hiring centres (CHC) as a cluster based approach. Establishing a Model Custom hiring, training and maintenance centre Developing entrepreneurship of unemployed rural youth
Harnessing comple-ment-arities to reduce input costs	Resource & Input use efficiency	Irri-gated/ Rainfed	Promotion of crop + livestock enterprises to increase soil carbon status using organic manure and reduce fertilizer costs Promotion of INM & IPM to reduce fertilizer & plant protection costs Promotion of Legumes in crop rotation & intercropping systems to fix atmospheric nitrogen and reduce fertilizer & plant protection costs Mapping soil health for precise fertilizer application to increase fertilizer use efficiency and reduce fertilizer costs

Approach III. Stabilizing Income & Risk Mitigation

Programme	Activity	Resource Domain	Action Points
Coping & Adaptation mecha-nisms	Climate Smart Agriculture	Irrigated/ Rainfed	Weather smart - Seasonal weather forecasts, ICT based agro advisories, Index based insurance, Climate analogues Water smart – Rainwater harvesting, Community management of water, Laser levelling, AWD irrigation, drip & sprinkler irrigation scheduling use of sensors etc

Programme	Activity	Resource Domain	Action Points
			Carbon smart–Agroforestry systems, Conservation tillage & IFS Energy smart – Fuel efficient engines, residue management & minimum tillage Popularization of proven climate change adaptation practices
	Monitoring & forecasting of climatic extremes	Irrigated/ Rainfed	Creating virtual weather station for covering all mandals
	Weather index based insurance	Irrigated/ Rainfed	To mitigate the risk of crop failure due to aberrant weather conditions
	Value-added weather management services	Irrigated/ Rainfed	Delineation of climate vulnerable zones; Real time agro met advisories; Mandal level contingency plans and their Operationalisation; climate predictions and pest & disease for warning systems

Summary and Recommendations:

Major strategies for achieving above growth rates and thereby doublíng farmers' income in Telangana state are:

- For doubling farmers' income by the 2022-23, milk production should grow at 5-8 % growth rate, egg production should grow at 5-7% rate and meat production should grow at 8-15% during next six years.
- Enhancing cropping system productivity, Agri-horti systems, Integrated farming systems, inclusion of livestock and fisheries as components in IFS models, Agro-forestry systems on degraded lands, cage culture fisheries, Processing and value addition, Reduction in cost of cultivation, Diversifying to non-farm sector linked to agriculture, stabilizing income and risk management etc.
- The state coordination committee (SCC) has identified technology interventions and success stories for different production systems specific to each agro-climatic zone under above strategies for doubling farmers' income.
- Accordingly promotion of horticulture, protected agriculture, livestock, poultry, fisheries is essential for doubling farmers' income in Telangana state. The success stories for enhancing crop yields and farmers' net income in all sectors of agriculture are presented in the document along with scaling out strategy.
- Infrastructure facilities for agriculture and different government schemes being taken up and to be taken up by the Government of Telangana are discussed in the document.
- Establishing FPOs for promoting processing and value addition of redgram, millets safflower etc in different agro-climatic regions and linking them to market is essential

for enhancing income of the farmers through better price realization.

- Telangana government undertaking delineation of crop colonies or clusters in different agro-climatic zones with the technical support from PJTSAU, ICAR research institutes, ICRISAT, other research institutes. Once crop colonies are delineated, all the required facilities for that particular crop colony such as input availability, processing, value addition, and marketing facilities should be developed.
- Credit of Rs.1000 Crores for Diary development, Rs.500 Crores for Poultry, Rs.5000 Crores for sheep & goat sector proposed to be mobilized by the state government from different banks. About Rs 5000 crores investment is required for the development of agriculture particularly rainwater harvesting structures, establishing processing industries, cold storage and market facilities, fisheries development etc.

SUCCESS STORIES

1. Success Stories of Shade net/Polyhouse

Farmer	Chandrasekhar	Farmer	B Srinivas
Village	Singaram	Village	Ibrahimbad
Mandal	Yacharam	Mandal	Narsapur
District	Ranga Reddy	District	Medak
Mobile #	9010700067	Mobile #	9849247033
Area	4000 m^2	Area	4000 m^2
Crop	Gerbera	Crop	Capsicum (Indra)
Yield/month	1,20,000 /m	Yield	40 t/acre
Cost of each flower	Rs. 3	Cost of cultivation	Rs. 3,00,000 /acre
Gross income/ month	Rs 3,60,000	Market price	Rs 20,000 /t
Expenditure	Rs 1,20,000 /m	Gross income	Rs 8,00,000
Net income/month	Rs 2,40,000 /acre (Rs. 6 lakh/ha/m)	Net income/month	Rs. 4,00,000 /acre (Rs10 lakh /ha/m)

2. Successful Kinnow production

Farmer name	Maheshwar Reddy
Father's name	Sanjeev Reddy
Village	Kothapally
Mandal	Gadwal
District	Mahabubnagar
Crop	Kinnow orange
Variety	Kinnow orange
Soil type	Red soil
Area under cultivation	4.00 ha.
Best practices adopted	Drip irrigation, vermi compost, tricoderma, fruit fly traps, light traps, yellow stick pads, plastic crates.
Yield obtained in traditional practice	6 to 8 tons / acre
Yield obtained in best practice	10 tons / acre
Difference of yield	2 tons / acre
Gross expenditure	Rs. 8,50,000/- (4.00 ha.)
Avg. Market price	15,000/- per ton
Gross revenue (Rs.)	Rs. 15 lakhs per 4.00 ha (Rs 2.75 lakhs /ha)

27

TRIPURA

Tripura is the second smallest but second most populated state in the North Eastern Region and occupies 1049.69 km^2 area. It shares borders with Bangladesh, Mizoram and Assam. The State is situated between latitudes 22°56' and 24°32' North, and longitudes 90°09' and 92°20' East, and the State is surrounded by the neighbouring country Bangladesh on its south, west and north. The length of its international border with Bangladesh is about 856 km (i.e. about 84 percent of its total border), while it has 53 km border with Assam and 109 km border with Mizoram. The social composition of the population of Tripura is diverse. Around one-third of the population belongs to the Scheduled Tribes.

Agriculture in various forms has been the mainstay in the lives of people in Tripura. The primary sector (Agricultural) contributes about 64% of total employment in the state and about 48% of the State Domestic Product (SDP). A variety of Horticultural/ Plantation Crops are produced in Tripura like Pineapple, Orange, Cashew nut, Jackfruit, Coconut, Tea, Rubber, Forest Plantations etc. At present both conventional settled agriculture in the plains and Jhum system of cultivation in the hills are practiced, although earlier many tribal people depended more on Jhum system of cultivation, perhaps due to their life-pattern i.e. predominantly living in the hill areas. The Industry Sector has remained undeveloped so far, despite the vast potential. The secondary sector contributes only about 5% of total employment and about 7% of the total income (SDP) of the state at present. Tourism has been declared as an Industry in the state since 1987. Handicraft is emerging as a potential industry in Tripura. The Handloom Industry also plays an important role in rural Industry of Tripura.

Tripura has a tropical climate and receives adequate rainfall during the monsoons. It has diverse range of topography, people, flora and fauna. A large part of the land is up-land / tilla land and hilly, with altitudes varying from 15 to 940 meters above sea level. The prominent hill ranges of the State are Jampui, Sakhantang, Longtharai, Atharamura, Baramura, Deotamura, Belkum and Kalajhari. Betling Shib (939 meters) in the Jampui Range is the highest peak of Tripura.

Out of the total area almost 60% area is under forest and only 2.55 lakh ha area was under cultivation with a cropping intensity of 190% (Gross cropped area 4.86 lakh ha).Tripura has a total cultivable land of 2.73 lakh ha and irrigation potential of 1.40 lakh ha. The productivity of most of the crops grown in the state is lower than the national average, although the climate is favourable to cultivate most of the crops.

27.1 Productivity Gaps and Major Constraints

The farming at Tripura traditionally operates at semi-subsistence level mostly under rainfed conditions with lower inputs using simple tools resulting lower subsistence yields. Thus, farmers traditionally diversified his activities to different agricultural sectors including crops, horticulture, livestock, fish, and food gathering to ensure his food security. Thus, the major constrains and gaps in Tripura farming are as follows.

Natural Resource Management:

Rain water is wasted through runoff due to undulated land pattern causing serious problem of soil erosion.

Due to low water holding capacity of the soils, the crops often suffers from moisture scarcity during lean period especially in the upland areas during December to February months.

The soils of Tripura are acidic in reaction and medium in organic carbon content. Acidity–induced soil fertility problems coupled with traditionally minimal use of mineral fertilizers are often held responsible for low levels of crop productivity in the state.

Tripura is rapidly shifting towards high yielding crop cultivars therefore there is a need for integrated use of plant nutrients to increase and sustain the productivity in future.

Productivity of *boro* rice, which contributes equally to Tripura's food grain basket like *kharif* rice, is suffering from low rainfall scenario due to climate change effect. Therefore, *boro* rice farmers need technologies to cope with water shortage and ways must be sought to grow rice with lesser amount of available water.

Crop Production:

1. Lack of location specific improved/sustainable production technologies for major crops
2. Lack of optimum sowing time, planting geometry, and nutrient management practices for major crops
3. Non-availability of suitable cropping sequence and intercropping systems for state
4. Poor market linkages
5. Poor fertility of soil
6. Occurrence of insect-pests and diseases
7. Poor seed germination due to low soil moisture at the time of sowing
8. Intermittent moisture stress during crop growth period
9. Non-availability of quality seed and agricultural chemicals in time
10. Inability to purchase modern agricultural implement
11. Lack of irrigation facilities
12. Non-availability of labour during peak period
13. Non-availability of timely credit facilities

14. Low market price
15. Unavailability of manure and bio-fertilizer in required quantity at reasonable price.
16. Lack of soil and water testing facility to the amount and type of bio-fertilizer to be used
17. Lack of adequate knowledge about the use of different pesticides, insecticides
18. Lack of farm mechanization
19. Non-availability of assured market and market fluctuation

Horticulture

Constraints in fruit cultivations:

- Unavailability of quality planting material.
- Lack of state of art facilities for raising disease free quality nursery.
- Unavailability of critical inputs including irrigation/ fertigation facilities.
- Lack of post-harvest processing facilities.
- Insignificant value addition and food processing facilities.
- Poor extension of scientific package of practices.
- Low skill level on modern production and value addition techniques.
- Poor marketing network
- Most of the litchi and mango orchards are very old and senile. · Very short harvesting season of pineapple, mango, litchi and jack fruit
- Lack of year round fruit production.

Constraints in vegetable cultivation:

- Unavailability of quality planting materials.
- Less availability of bio-fertilizers and vermin-compost for integrated nutrient management.
- Less availability of planting materials for off season vegetable cultivation.
- Unscientific cropping sequence.
- Poor market infrastructure for high value crops.
- Lack of post-harvest management of vegetable crops resulting into post-harvest loss.
- Lack of adoption of protected cultivation of high value vegetable crops.
- Lack of assured and micro-irrigation facilities
- Lack of technology adoption for upland and low land vegetable cultivation during rainy season.
- Lack of scientific cultivation and packaging and marketing of traditional vegetables of Tripura.
- Lack of grading, packaging, storage and transportation facilities and network.

Major constraints/challenges in Livestock sector

- **Shortage of green fodder:** Unavailability of quality green fodder throughout year is major constraint and challenge for the growth of dairy sector in the state. Presently, only 1.0 m MT green fodder is available against actual requirement of 4.0 m MT.
- **Shortage of dry fodder:** At, Tripura, paddy straw is the main source of dry fodder and only 0. 62 m MT dry fodder is available against actual annual demand of 3.82 m MT.
- **Acute shortage of feed:** Feed is one of the major inputs in the pig and poultry farming and accounts for 60-70% cost of total cost of pig and poultry farming. The important feed ingredients have marginal average at Tripura, and thus the demand of the feed is met through import from other states at huge cost. The high cost of feed make livestock farming unsustainable.
- **Lack of supply of good quality germplasm of poultry:** More than two third poultry population is local with comparatively lower body weight and egg production (60 – 70 eggs/ layer/annum).
- **Inadequate Veterinary Services:** The veterinary infrastructure in Tripura is inadequate in terms of both quantity as well as quality. The inadequacy of infrastructure had resulted in less access of livestock farmers to veterinary services. Again, the available facilities were mainly used for curative purposes and very less attention was being paid for the prophylactic measures.
- **Unscientific livestock farming:** The traditional feeding and management practices in dairy, pig, goat and poultry farming are still in vogue in rural households. Livestock are maintained under unhygienic conditions with suboptimal feed, fodder and medicine.
- Unorganized marketing of Livestock and livestock products.
- Lack of cooperative society for collection of milk, meat and eggs.
- Less awareness and training among the livestock farmers.
- Lack of food processing units like milk processing unit, meat processing unit etc. · Lack of cold storage infrastructure.

Fisheries (Capture):

The constraints in capture fisheries :

- **Habitat destruction of fish fauna:** Habitat destruction of fish fauna due to unscientific and indiscriminate sand mining operations, encroachment of river banks for agricultural purposes and drying up of water bodies due to excessive harvesting of water for irrigation and drinking purpose. Irregular river beds arising from heavy sand mining causes drowning hazards, difficulties in navigation & use of throw gears in addition to erosion of the banks. Encroachment of river banks for agriculture poses the additional risk of pollution and fish kills due to run off.

- **Genetic deterioration of the stocks due to overfishing**: Fishing ban is in vogue for two months (July and August) in large water bodies to avoid harvesting of gravid brooders and to assist in natural recruitment of the fishing stock. However, fishing using non-selective gears such as seines and gill nets are rampant during all other months. This results in the overfishing of faster growing individuals that should contribute to the brooder population. As a result, any natural recruitment in the reservoirs arise from the early maturing brooders with slow growth attributes. Over time this would result in the deterioration of the genetic quality of the population as a result of negative selection and contribute to low productivity.
- **Unscientific ranching protocols**: Ranching of hatchery produced fingerlings have been resorted to in an attempt to enhance the productivity of the reservoirs from 2002. It is estimated that 218 lakh seeds were stocked in the reservoirs from 2002-2012. However the productivity data for the same period indicates that the production trends for major carps from the reservoir was largely stagnant. On the contrary the abundance of smaller species have increased significantly during this period. This strongly suggests that the ranching program, has not contributed significantly to the supplementation of the major carp population in the reservoirs. It is unclear if scientific studies to assess the ecological status of the reservoir was undertaken before the stock supplementation measures were adopted. Ranching programs should be based on the strong foundations of ecological and population genetic backgrounds of the recipient water bodies. Importantly, individuals rising from domesticated broodstock are known to be less capable of adapting to and establishing within natural systems.
- **Shellfish resources have been scientifically less explored** in this state despite their significant contribution to the food sector here. Biodiversity surveys mention the a few crustaceans and mollusc species encountered in Tripura waters though detailed studies on systematics, biology and productivity attributes are scanty. Assessment and evaluation of finfish and shellfish resources which are economically important to the region should be encourages.
- **Underutilization of open water bodies**: Several wetland areas in the state are lying underutilized or not utilized at all for fish production.
- **Exploitation of fishermen by intermediaries**: The fishermen are forced to part with their catch at compromised process to the intermediaries due to lack of cold chain facilities for long term storage of the catch. The lack of active pro-producer involvement of the fishermen co-operatives are also blamed for the situation. This level of exploitation can be clearly made out from the stark differences in the price of fish at the farm gate level and market level. Provision for cold storage facilities at least at the fishermen co-operative level could facilitate acquisition of catch from the producers and dissemination to the consumer at fair prices.
- **Social structure and gender bias**: The population of Tripura comprises of Bengali speaking population and Tribal population. Among the Bengali speaking population,

capture fisheries is undertaken by members of specific castes while there is no restrictions among the Tribal populations. Fishing rights in large water bodies are virtually exclusively vested with members of these communities. Fishing rights in large water bodies are disbursed by the licencing system in the reservoirs, with the members of the agency being exclusively from a fishermen caste. It is not clear if women members independently have licences for fishing. Women of these communities take active part in fishing operations such as seining and trap fishing, while not in sale of fish. Tribal women on the other hand are involved in fishing operations as well as marketing of fish. There seems to be a definite gender bias in the ownership of technologies and access to resources in the capture fishing sector at least among some communities. It is also not understood if the specific fishermen communities suffer unequal social treatment, as is often the case in several other states of India

Fisheries (Captive):

The major constraints need to be addressed includes-

- **Genetic degradation in fishes:** Due to repeated use of same parental stock for inducing breeding causes genetic degradation of the offspring and ultimately loss in productivity.
- **Lack of diversification of culture fisheries:** Indian major carps and exotic carps are the dominant fish of captive culture in Tripura. However, continuous cultivation of these species is now showing the effects as under or over exploitation of aquatic resource, disease epidemics and short harvest season.
- **Lack of research facilities:** Though there are sufficient numbers of qualified technical staff to undertake the field work, but constraint of funds has been the problem to set up a research unit in the state.
- **Lack of soil and water quality mapping:** Soil and water quality mapping is essential for effective use of aqua resources and to secure a good yield.
- **Lease policy**- Leaseholders exploit the water bodies as much as possible but they are least bothered about making any improvement. Most of the rivers and other water bodies are deficient of nutrients which adversely affected the growth of fish.
- **Recurrent floods**- it damage the dikes and pond boundaries farmers hesitate for making any fresh investment.
- **Poor extension services**- Dept. employs each Fishery Officer for 14-15 Gram Panchayats without any proper vehicle facilities in rural areas, so they are unable to do their job properly.
- Less awareness and training among the fish farmers on scientific fish culture.
- Tripura soil is acidic in nature. To do fish culture, therefore heavy liming is requires in ponds which poor farmers find unaffordable.
- Poor water quality and seasonal nature of ponds

- **Socio-economic issues**- Low purchasing power of fish farmers regulates their ability to procure and use balanced fish feed in the ponds. In addition, the frequent poaching and poisoning of fish ponds by miscreants further restrict their investment options and willingness.
- **Narrow profit margin**- The farmers are often unable to get competitive price and return of their produce due to unregulated and fragmented markets. Further, the cost of fish feed takes away the major share of the gross return. It is widening the socio-economic gaps, and as a result, younger generation is least interested to adopt this program.

5. Potential for Development of Horticulture, Livestock, Fisheries, Agro-forestry and Postharvesting etc.:

The natural resources and the geographical strengths of the state must judiciously be exploited to uplift the agrarian economy and improve livelihood security by doubling the farmers' income and creating gainful employments. The promising sectors includes natural gas for power, fertilizers and agro-chemicals; plenty rainfall for irrigation, hilly lands for tea, rubber, horticulture and plantation crops; suitable agro-climate for round the year cultivation; border trade with Bangladesh, Agri-eco-tourism, agri-processing industries.

27.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

Natural Resource Management Developmental issue:

- *Watershed development*: For holistic development of the state, 997 nos of micro watershed covering an area of 10.365 lakh ha, i.e. the state`s entire geographical area, has been identified by the concerned line department based on drainage course under the Integrated Watershed Management Programme (Now Pradhan Mantri Krishi Sinchayee Yojna-Watershed Development Component). However, till 2015-16, developmental work has been initiated in 204 nos of micro watershed covering an area of 2.13 lakh ha. That is about 80% area is yet to be covered under comprehensive soil and water conservation programme. For doubling farmers' income, work under the watershed development programme is needed to be accelerated in Tripura conditions.
- *Restoration of wetlands*: Large wetlands/water bodies (like Rudra Sagar and Dumbur lake) in the state have been shrinking in size as a direct consequence of human interventions. If action for restoration of these water bodies is delayed further, these will soon become extinct. These water bodies, in addition to holding huge amount of water, help in maintaining a buffer zone which mitigates the natural extreme of excess/shortfall in water flow. Besides, they support a large number of aquatic lives and are good biodiversity spots.

Technical issue:

- Provision of *jal kund*: within few days of cessation of rainy spell, moisture content of the top layer of *tilla* and sloppy lands decreases rapidly. *Jal kund* technology could be very useful in such situation, for providing lifesaving irrigation to the seasonal crops during probable long dry spell.
- Rice-fish culture: the ecological situation of rice fields in Tripura facilitates the inclusion of fish component especially in saucer shaped lands, lowlands and waterlogged ecosystems. There exists a huge potential for integrated rice-fish farming which can generate additional net returns to the farmers along with higher crop and water productivity.
- *Cost effective liming technique*: huge requirement of liming material is often a big discouragement to the farmers for amelioration of soil acidity. In view of this, ICARNEH perfected the low cost liming technique. With this technique, it is possible to significantly increase the upland crop yields by applying 300-500 kg lime/ha/season.
- *Vermicomposting*: there is no dearth of plant biomass in Tripura. However, farmers are to be encouraged and trained to utilize that abundantly available biomass for making vermicompost. It increases the quality of compost and saves time of compost making.
- *Crop residue recycling*: Studies in AICARP suggested that incorporation of crop residues made it possible to curtail upto 25% of fertilizer NPK requirement of rice. Application of 10-20 kg N ha^{-1} at the time of incorporation of residues hastened the rate of decomposition, and consequently increased the beneficial effect in terms of grain yield and soil fertility build-up. Since 70-80% of K taken up by these crops is retained in straw component, residue recycling may be the best option to replenish K to the soil and avoid the mining of soil K reserves. Since, Tripura receives frequent rain over a span of 9 months in a year; crop residue recycling could also be an option as its in situ decomposition will not be a problem if managed systemically.

Table. Agroecosystem specific rice varieties for kharif season

S. No.	Technology	Yield Advantage
1. Kharif season crops		
Upland physiography		
1.**Aus rice**	*Tripura Aus Dhan* (TRC 2013-12): a rice variety	❖ yields up to 3.9 t/ha ❖ 10.76% yield advantage over the regional check
	Tripura Hakuchuk 1 (TRC 2013-14): a rice variety	❖ yields 3.5-3.75 t/ha ❖ average yield advantage of 15.49% over NDR 97 and 6.25 % over MTU 1010 in Front Line Demonstrations including SRI in Gomati, West Tripura and Khowai during kharif, 2012, 2013

S. No.	Technology	Yield Advantage
	Tripura Hakuchuk 2 (TRC 2013-5): a rice variety	❖ Yields 5.6 t/ha ❖ Average yield advantage of 17.45% over NDR 97 and 8.7 % over MTU 1010 in Front Line Demonstrations in south Tripura, Gomati, West Tripura and Khowai, kharif 2012 and 2013
Sesamum	*TRIPURA SIPING* : TRC TIL 1-8-1-1:	❖ Yields 160-170 capsules/plant and 58-64 seed/ plant Average yield superiority of 21.07% over B 67 and 63.4 % over Jhum Til under Front Line Demonstrations in 2012 and 2013
Mungbean	*TRIPURA MUNG 1: GREENGRAM*: TRC MUNG 131-1	❖ Ø Yield: 1300-1400 kg/ha. ❖ 32.55 % average yield superiority over Samrat, 41,86% over Pusa Vishal, 47.04 % over HUM -12 and 48.37% over Meha (one of the parental lines) in Front Line Demonstrations over 2 years in 2012 and 2013
Lowland physiography		
Aman rice	*GOMATI DHAN*: (TRC-2005-1/ IET 21512	❖ Yield 5.8 -6.0 t/ha ❖ 20.12 % average yield advantage over MTU 7029, 17.6% over MTU 1010, 14.9% over Durga and 13.95% over Varshadhan and 6.8% over TRC 2005-2 under Front Line Demonstrations in south Tripura, West Tripura over 2 years in kharif 2009, 2010
	TRIPURA NIROG DHAN : TRC 2008-6 (IET 22580)	❖ Yields 6.0-6.1 t/ha ❖ 24.52 % average yield advantage over MTU 7029 and ❖ 24.47% over MTU 1010 under Front Line Demonstrations in south Tripura, Khowai, West Tripura and Gomati over 4 years in kharif , 2010, 2011, 2012, 2013
	Tripura Aus Dhan (TRC 2013-12)	❖ yields 5.0 - 5.45 t/ha as per the FLDs of this variety as mentioned above
	Tripura Hakuchuk 1 (TRC 2013-14)	❖ yields 5.44 t/ha as per the FLDs of this variety as mentioned above
	Tripura Hakuchuk 2 (TRC 2013-5)	❖ yields 5.54 t/ha as per the FLDs of this variety as mentioned above

Table. Agroecosystem specific rice and other crop varieties for kharif and rabi season

S. No.	Technology	Yield Advantage
Kharif season crops		
Rice	Drought prone lowlands	
	TRIPURA KHARA 1 (IET 22837 , RP 52084/IR 87707-446-BB-B):	❖ Yield: 5.6-5.8 t/ha under normal condition and 3.7% higher yield than the check. ❖ 10.85% superiority over the checks in AICRIP AVT-NIL-Drought under severe drought imposed in field with an overall mean grain yield of 2032 kg/ha; whereas under moderate stress the variety recorded 23.63% yield superiority over the checks with an average yield of 3892 kg/ha.
	TRIPURA KHARA 2 :	❖ Yield: 5.6-5.8 t/ha under normal condition ❖ yield advantage of 65.96%, 5.97% and 14.87% over check and qualifying varieties, respectively with an average yield of 1258.5 kg/ha in AICRIP AVTNIL-Drought under Rain Out Shelter (ROS) ❖ 17.29%, 7.24% and 5.8% superiority over check and qualifying varieties, respectively with an overall mean grain yield of 2150 kg/ha in AVT-NILDrought under severe drought imposed in field. ❖ recorded overall mean grain yield of 3829 kg/ha, which was 21.63% higher than the check variety in AICRIP AVT-NIL-Drought- under moderate drought.
	Utlaland/semi deep water condition	
	TRIPURA JALA DHAN – 1 : TRC 2008 -1 (IET 22167):	❖ yields 4.8-5.2 t/ha ❖ 5.9 % average Yield advantage over MTU 7029 and 5.7 % over MTU 1010 under Front Line Demonstrations in south Tripura, Gomati, Khowai and West Tripura over four years kharif 2011- 2013
Rabi season crops		

S. No.	Technology	Yield Advantage
Boro rice	Shallow lowland physiography	
	TRIPURA CHIKAN DHAN: TRC 2008-4 (IET 22112).	❖ Yields up to 5.6-5.8t/ha ❖ 15.24 % average Yield advantage over MTU 7029 and 15.25% over MTU 1010 in Front Line Demonstrations in south Tripura Khowai, West Tripura and Gomati kharif over 4 years, kharif 2010-2013.
	TRIPURA SARAT DHAN : TRC 2008-5	❖ yields 5.8-6.0 t/ha ❖ 10.68% average yield advantage over MTU 7029 and 8.58% over MTU 1010 under Front Line Demonstrations in south Tripura and west Tripura over 2 years, kharif 2010-2011
	KHOWAI: (TRC 2005-3/ IET 21564)	❖ yields 5.6-5.8 t/ha ❖ average yield advantage of 9.3% over Swarna (MTU7029), 8.4% over MTU ❖ 1010 under Front Line Demonstrations in South and West Tripura, kharif 2010
	TRIPURA NIROG *DHAN :* TRC 20086 (IET 22580)	❖ Yields 6.2 -6.4 t/ha as per the FLDs of this variety as mentioned above
Black gram	*TRIPURA MASKOLAI :* TRC URD 99-2 :	❖ Yield: 1500-1600 kg/ha. ❖ 17.02 % average yield superiority over Uttara, 19.03% over Pant U 31 and ❖ 69.71% over T9 under Front Line Demonstrations over 2 years in 2012-2013
Rape seed mustard	*TRIPURA TORIA:* TRC T-1-1-5-1:	❖ Yield: 900 kg/ha ❖ Oil yield is 369 kg/ha under zone V rainfed condition ❖ Yield advantage of 11% over the local varieties with farmers practice
Fieldpea	FIELDPEA : TRCP – 9:	❖ 1973 kg / ha ❖ >10% yield advantage over the national check
	FIELDPEA : TRCP – 8:	❖ Yield: 1800-2100 kg/ha ❖ >10% yield advantage over the national check

- *Green manuring*: transplanted paddy cultivation followed in Tripura is an ideal environment for green manuring. However hardly any farmer is currently practicing this technique. Demonstrations and awareness programmes are to be conducted to popularize this technique for improving rice productivity.
- *Water efficient rice production systems*: Water surfaces have a higher evaporation rate than soil. Evaporative water loss can also be reduced by adopting the production systems and technologies, which shorten the duration that the field is flooded and/or requirement for water application. Rice systems such as *alternative wetting and drying (AWD) system, bed planting, aerobic culture, system of rice intensification (SRI) and ground-cover rice production system (GCRPS)* could be effective in this regard. For example, the water productivity in aerobic rice is ranged from 0.45 - 0.55 g grain/litre of applied water as compared to 0.25-0.30 g grain/litre of applied water in conventional system. Aerobic rice is high yielding rice grown under non-flooded conditions in nonpuddled and unsaturated (aerobic) soil. It is responsive to high inputs, can be rainfed or irrigated, and tolerates occasional flooding also.
- *Relay/paira cropping/No till planting* of lentil and mustard following kharif rice. By following these techniques, cropping intensity can be doubled in the lands which are kept fallow after kharif rice.

Crop Improvement and Production:

Crop varieties: Technological options need to be prioritized and popularized to enhance the rice productivity in *jhums* from the present level of 1050kg/ha. Two popular varieties developed by the institute viz. "Tripura Hakuchuk 1" and "Tripura Hakuchuk 2", demonstrated a yield of 2800 -3200 kg/ha. Rice productivity in these areas can be doubled by popularization, adoption and replacement of traditional land races in the *jhums*. One the other hand, popularization of a sesame variety "*Tripura Siping*" with a high productivity (1100-1300 kg/ha; market value of Rs. 90,000/-) for large scale cultivation can help to increase the farmers' income as it can be used as a cash crop, particularly in post Kharif/pre Rabi cultivation. Cultivation of long duration pigeon pea alone or intercropped with pineapple can be another remunerative activity under these type of land configuration. Mixed cropping of maize, rice, pigeon pea, tuber crops etc. will not only ensure the sustainable food production but will also help in boosting profitability by higher economic returns to farmers.

Fallow land: Area available for diversification in Tripura: Tripura has a total area about

143933 ha fallow, out of which 84341 ha Pre Kharif Fallow (April-June) and 59592 ha rabi Fallow (Dec- March), which provide a wide window for introduction of large number of crops in Tripura.

Table. Season specific crops for diversification of fallow lands

Seasons	Existing Seasonal Fallow land (Hectares)	Crops for diversification/intensification
Pre Kharif Fallow (April-June)	84341	Green gram, black gram, vegetable cowpea, vegetables etc.
Rabi Fallow (Dec- March)	59592	Vegetable pea, vegetable cow pea, lentil, field pea, mustard, maize, vegetables etc.
Grand Total	143933	

Besides that, some crop have specific characteristics for that they can grow under specific condition as given below

- Pigeonpea in hilly slopes as monocrop or intercrop and as mixed crop in *jhum*.
- Greengram in Spring and pre *rabi*seasons.
- Urdbean in late *kharif* or pre *rabi* seasons.
- Lentil and Lathyrus as *utera* crop after *kharif* rice.
- Rajmash in rabi season.
- Intercropping of rajmash with vegetables.

Tripura owing to its diverse soil types and climatic conditions as indicated; thus a variety of pulses such as pigeonpea, mungbean, black gram, cowpea, dolichos bean, rice bean, chickpea, lentil, khesari and pea etc can be grown in these regions. But scope and importance of promotion of lentil, field pea, urdbean and Mungbean is more as compared to other pulses.

- Enhancement in the productivity of rice
- Reduction in cost of cultivation of rice
- Utilization of RFR land
- Development of market linkages
- Cultivation of high value crops

Efficient utilization of fallow land: State has a total of 143933 ha fallow, out of which 84341 ha Pre Kharif Fallow (April-June) and 59592 ha rabi Fallow (Dec- March), which provide a wide window for introduction of large number of crops in Tripura. The pre kharif fallow provide a window of three months for crop production. As the state receive enough rainfall from April to October every year. Therefore, the land of 84341 ha Pre Kharif Fallow (April-June) can be used for cultivation of summer season legumes and vegetables.

Other technologies available for doubling farmers income

1. Crop diversification, inclusion of legume in cropping system,
2. Site specific nutrient management/integrated nutrient management
3. Conservation tillage and mulch based direct seeded upland rice cultivation

4. Reduced tillage cultivation of maize for fresh cob and fodder
5. Sustainable lentil production technology for rice fallow land of Tripura
6. Cultivation of aman rice either under reduce tillage (RT) + 25% N through FYM and 75% N
7. & rest of P & k through inorganic fertilizer (INM) + 30% residue retention (RR) or under RT + 25 % N through green leaf manure (GLM) + 60 kg N, 9 kg P, 17 kg K, 2 kg Boron (B) and 5 kg zinc (Zn) ha^{-1}(IPNM)+cellulose decomposing micro-organism (CDM) + 30% RR for more productivity.
8. Cultivation of boro rice conventional tillage system with 100 kg N, 18 kg P and 33.3 kg K ha^{1} along with 30 % residue incorporation of previous rice crops for higher yield.
9. Furrow application of lime 200 kg/ha with 5 tonnes of farm yard manure during cultivation of dry season crops
10. Intercropping of lentil with mustard (6: 2 ratio)
11. Relay cropping of pumpkin with potato is very popular in south Tripura, need to implement in other districts of Tripura.
12. Bund planting of pigeon pea in medium upland of rice cultivation
13. Agroforestry systems
14. Paddy-cum-fish cultivation
15. Nutritional kitchen gardens

Horticulture

Fruits

1. Rejuvenation of old and senile litchi orchards and shoot pruning technology:

Standardized the rejuvenation techniques on litchi and several demonstrations on rejuvenation technology of old Litchi tress were imparted in collaboration with the Department of Horticulture, Govt. of Tripura. Canopy management (Pruning), regular spray of micro nutrients (Zn and B) an irrigation scheduling in litchi improves the fruit quality and yield. The old, tall and senile Litchi trees were selected and 3-4 branches were marked at 2.5 m above the ground. Rest of the extra and misdirected or damaged branches were completely removed from the base. Petrol operated chain saw and pool pruner were used for reiterative pruning. Pruning was started from the top of each branch. At first step, all the leafy twigs were removed, then 2-3 m length of top portion of the branches were pruned before giving final pruning cut at 2.5 m marked point or at the base of the unwanted branched. This practice prevents tree shaking or bark spitting. Bordeaux paste was applied on each cut surface and tree trunk was white washed with lime. After 20-25 days tree basins were prepared irrigation, FYM and fertilized were applied. Shoot pruning treatments of 20 cm in combination with single spray of zinc (0.1%) at one month before panicle emergence followed by boron (0.5%) at one week before flowering was effective for better flowering and fruit set, and single spray of urea (1%) at green fruit stage, again boron (0.1%) at fruit maturity stage was effective for fruit growth and quality. Foliar sprays of zinc, boron and urea significantly reduced fruit cracking (5.1-5.6%) in comparison to control (15%) and increased yield/tree (34.6-37.8 kg).

2. Softwood and stone grafting technology for quality planting material production in mango.

Time of stone grating is May to June. Growth stage of rootstock is 15-25 days after germination at coppery leaf and shoots stage. Grafting height is 3-5 cm. Time of soft grafting of one year old rootstocks is last week of February to September. Grafting height 18-25 cm. This technology is very advantageous in providing skill development and employment to the farming youth. Demand for trained grater is very high during the propagation season *i.e.* April-September. The cost of one graft per plant is Rs. 35.00 only and charges Rs. 1-3 per graft/bud success depending upon the quantity and grafting/budding time. Considering the vast scope for the huge demand for quality planting materials in the state, there is a need to encourage more numbers of unemployed tribal youths to adopt skilled grafting for improving livelihood.

Top grafting technology of non-descript old mango plants with standard or known varieties like Amrapalli, Mallika, Arunima, Arunika etc. Top grafting old pruned seedling trees during April-May with Amrapali scions gave fruiting in the 2nd year under Tripura condition.

3. Papaya production Technology in Tripura:

Pusa Delicious, Tripura Papita, Honey Dew and Pusa Dwarf are found suitable in the region. The production technology of these varieties technology has been standardized. Papaya gives economic crop upto 2 years and yield 60 – 75 tones/ha. The net returns of Rs.2.5-3.0 Lakh/ha made papaya cultivation a profitable venture for the farmers.

4. Sweet orange var Mosambi:

Cultivation of Sweet orange var Mosambi is a very suitable and profitable venture for the farmers producing a yield of 300-400 fruits/tree (30 – 40 tons/ha) fetching a price of Rs. 120-150/kg.

Integrated nutrient management of vegetable crops for higher yield

S. No	Crop	INM
1.	Tomato	FYM (5-7t/ha) + Vermi compost (2.5-3 t/ha) or equivalent commercial organic manures + mycorrhiza (10g/seedling) or 100g/m^2 in nursery + 75kg N + 37.5 kg/ha P_2O_5 + 37.5 kg/ha K_2O.
2.	Capsicum in Polyhouse	FYM (5-6 t/ha) + Vermi compost (2-2.5t/ha) or equivalent commercial organic manures + mycorrhiza (10g/seedling) or 100g/m^2 in nursery + 90kg N + 60 kg/ha P_2O_5 + 60 kg/ha K_2O.

S. No	Crop	INM
3.	Bottle gourd, Ridge gourd	Soil application of FYM @ 7.5-8.5t/ha + organic manures (2-2.5 t/ha) Urea:SSP:MOP: Bottle gourd: 110kg urea + 250kg SSP +65 kg MOP and Ridge gourd: 100kg urea + 150kg SSP +50 kg MOP iii. Foliar Spray of CaCl2 @ 0.5 % at fruit development stage. iv. Foliar Spray of Borax @ 0.3-0.4 % at fruit development stage. Application of Microbial Consortium @ 20 gm/L of water near to the root zone (20-50 ml/plant) after 10 days of transplantation. Application of micronutrient mixture and plant growth promoter @ 5 gm/L. Foliar spray of vegetable special solution in the evening time at the interval of 15 days. The first spray should be done after 30 days of transplanting of vegetable seedlings. vii. Use of pheromone trap for control of fruit fly and spray of suitable insecticides.
4.	Brinja, chilli and Okra	i. Seed treatment with Trichoderma @ 5gm/kg of seed ii. Soil application of FYM @ 7.5-8.5t/ha + organic manures (2-2.5 t/ha) iii. Fertilizer/ha: Brinjal : 325 kg Urea+450 kg SSP+100 kg MOP, Chilli: 200kg urea+ 300 kg SSP+ 85 kg MOP and Okra : 110kg urea + 375 kg SSP + 85kg MOP iv. Foliar Spray of CaCl2 @ 0.5 % at fruit development stage. v. Foliar Spray of Borax @ 0.3-0.4 % at fruit development stage.
5.		vi. Application of Microbial Consortium @ 20 gm/L of water near to the root zone (20-50 ml/plant) after 10 days of transplantation. vii. Application of micronutrient mixture and plant growth ppromoter @ 5 g/L. Foliar spray of vegetable special solution in the evening time at the interval of 15 days. The first spray should be done after 30 days of transplanting of vegetable seedlings. viii. Use of pheromone trap for brinjal fruit borer and application of suitable insecticides.

Livestock:

Production of feed grains for livestock feeds: Almost 8500 ha land under single crop can effectively be used to cultivate maize, mustard and pulse crops. Maize grain, and by-products of mustard and pulse besides rice bran could be used as feed ingredient while maize and pulse straw could be good source of dry fodder.

Formulation of low cost feed: There is a need to develop cheaper balance ration using locally available alternate feed resources so the farmers can afford to buy the feed for feeding as a minimum supplement to the animals and birds.

Development of organized marketing of Livestock and livestock products: Organized marketing of livestock and livestock products like milk, meat and eggs in Tripura remains relatively insignificant despite efforts in the past to develop and promote collective market mechanisms. It is very essential to develop market and marketing channel for selling of milk, meat, egg and their products.

Establishment of food Processing units: Development of food processing units like milk processing unit, meat processing unit etc for preparation of different milk, meat and egg products.

Development of cold storage infrastructure: Milk, meat, eggs and their products are highly perishable products. The shelf life of these products could be increased by using of these types of facilities.

Development of value added livestock products: So many value added products like sweet curds, lassi, and whey from (milk), meat products like sausage, nuggets, chicken samosa, egg pickle etc could be prepared. So that in surplus amount these are used as properly and demand of these value products are more and could be sold at very higher price.

Awareness programme for livestock farmers: Awareness programme should be organized on scientific dairy, pig, goat and poultry farming and their importance for farmers.

Training of Livestock farmers: Training to the farmers is required for the scientific management of the dairy, pig, goat and poultry farming. It will help in increasing production/ productivity of animals and reducing the animal diseases.

Human resource development- There is a need to update the knowledge and skills of the staff through exposure and providing opportunity to gain experience in practical aspects related to livestock farming.

Improve information dissemination mechanisms to reach wider population- Media can be effectively used to communicate information, gather ideas and issues that may help research community to initiate research. Besides traditional communication mechanisms like radio, TV, newspapers, etc., schools can be used for dissemination of essential messages that can bring transformation in different livestock farming.

Invest and promote research- It is time to take critical look and find ways on investing resources in research by creating adequate support structures that will stimulate research environment. Animal husbandry department should explore ways to strengthen research division and promote farmers participatory research to solve location specific problems and evolve new technologies.

Formulation of urea molasses block: Urea molasses block is could be important source of livestock feeding.

Increasing the number of cross breed population through intensification of Artificial Insemination (AI): In Tripura total population of cattle are 9, 88,004 out of which 8, 40,516 are nondescript and only 1, 47, 488 are cross bred cattle. The milk production in non-descript animals is very less as compared to cross bred animals. So it is need to increase the population of cross bred animals to increase the milk production and milk productivity of animals. To augment milk production of the state through introduction of improved germplasm of Sahiwal, Tharparker, HF, Jersy into the indigenous genetic pool of cattle by means of artificial insemination with frozen semen technology.

- Training of private AI workers and provision of logistic support for all AI service at farmers' door step.
- Mass vaccination and de-worming of different livestock species and supply of vaccines and mineral mixture to the farmers.
- Intensive epidemiological studies and timely disease control in different livestock species.
- Incentives to commercial dairy, piggery, goat and poultry farming through enhanced and easy credit arability.
- Provision of insurance coverage to livestock animals.
- Development of area specific mineral mixture for livestock.
- Popularization of castration to restrict the unwanted breeding. Organization of fertility camp for improving conception rate.
- Integrated like horticulture – livestock- fish, pig – fish and poultry – fish farming should be popularized among farmers to get additional yield of fish to minimize the production cost as well as to provide nutritional security and self-employment opportunity for the rural people.
- Extension service should be strengthened so that transfer of technology from lab to land can be properly disseminated in the farmers' field.

Poultry:

Supply of improved variety of poultry germplasm: There are so many improved germplasms of chicken, (Vanaraja, Gramapriya and BND Cross) duck (Khaki Campbell) are developed specially for backyard poultry farming, which have much better production performances like more egg production, faster growth and higher body weight than these native chicken and duck. The native chicken and duck have poor egg production, slow growth, small egg and body size. Egg production (50-70 eggs per chicken and around100 eggs/ duck per annum) is very less in these deshi/local chicken and ducks of Tripura as compared to improved variety of chicken and duck. If farmers rear these improved variety of chicken and duck it will be more productive than native chicken and duck. The improved quality of the chicks and duckling is one of the major critical inputs for the poultry production. However, availability of sufficient amount of quality chicks and ducklings is a major constraint in tribal villages which are mostly located in remote palaces and covered by hilly forests. Hence, there is a need to support the farmers by providing improved quality of poultry birds for augmenting rural poultry production to fulfil the deficiency gap in both poultry meat and egg sectors and to make the State self-sufficient.

Location specific Dual variety chicken (BND Cross) was developed by ICAR, Tripura Centre by crossing of Coloured Broiler, Tripura Black and Dahlem Red for backyard poultry farming. This newly developed dual type chicken has more egg production (more than 100 eggs/ annum), growth rate and body weight (2-2.5 kg) than native chicken (60-70 eggs/ annum). and well adapted in agroclimatic condition of Tripura.

Directorate on Poultry Research, Hyderabad has developed Vanaraja and Grampriya for backyard poultry farming. These breeds are well accepted in the Tripura condition. Vanaraja and Grampriya have more egg production (more than 160-180 eggs/ annum), growth rate and body weight than native chicken (60-70 eggs/ annum).

Fisheries

Capture Fisheries

- Development of fisheries in open water bodies: Ranching of 7-10 cm quality fish seeds in rivers and rivulets and reservoir as a part of conservation and awareness programme. This will enhance the fish population in the natural water bodies of the state which will lead to enhancement in the capture fish production of the state.
- Development of community based approach for cage and pen culture in the open water bodies:
- Better management practices should be enforced in the reservoir with intervention of appropriate stocking density, effective number of fishers, suitable candidate species, etc.
- Short term seasonal fish culture can be popularized in the seasonal open water bodies available in the state.
- Capacity building of fisher folk community on–a) scientific way of culture based fisheries in open water areas and big water bodies; b) sustainable and judicial fishing methods and optimum mesh size use
- Inclusion of women in fisheries activities through Self-help groups: Women community of the fisher community can be encouraged to take part in activities like fishing net fabrication and marketing activities.

Culture Fisheries:

Doubling Farmers Income in Culture Fisheries of Tripura: Fish is an important constituent in the diet of 95% population of Tripura. In spite of having sufficient aqua-resources which constitute 2.02% of the total geographical area of the State, the fish production of Tripura is much below the requirement. This necessitates its import from other parts of the country and drain-out of state funds. There is scope for enhancing fish production of Tripura in order to doubling the income of the farmers through either bringing down the cost of production or increasing the profitability. Following are some strategies in this context:

- Reclamation of depleted water bodies to enlarge effective area for fish cultivation.
- **Increasing profitability using seasonal ponds:** The seasonal ponds which retain water for 5-6 months can be utilized for addition fish production using medium carp which was assessed by the KVK North Tripura using *Cirrhinus reba*, popularly known as *Lachu*. The average growth in *lachu* was 83g/6 months and its contribution in composite culture was 237.5 kg in total fish yield of 1725 kg/ha. They also

demonstrated polyculture of prawn with IMCs with a production of 13 kg prawn and 3360 kg carps /ha. (Technology assessed/refined/both- KVK, North Tripura)

- Popularization of **Integrated fish farming** to reduce cost of production, enhance nutritional security and provide employment opportunity to rural people. Integration of livestock with aquaculture enhances productivity of fish ponds, generate additional revenue and employment for the fisher's family in one hand, and it reduces the cost of feed and fertilizer on the other. In general, either of 5-6 cattle, 30-40 pigs, 400-500 ducks or 500600 poultry is sufficient to fertilize one ha of pond size in Tripura. At ICAR Tripura Centre, in comparison to normal yield of 2.65 t fish/ha, the annual fish production was increased to 2.65-3.20 t/ha in Agri-horti fish culture, 3.47-4.12 t/ha in duck-fish and 4.44.5 t/ha in pig-fish and 4.25-5.12 t/ha in fish-pig-tuber crops systems (Santhosh et al., 2011). Similarly, multiple stocking and multiple harvesting in duck-fish system over 0.2 ha land annually produced 606 kg fish and 1230 eggs with a BC ratio of 3.42 at farmer's field
- in Bagma (South Tripura). Likewise, duck-fish system at KVK-North Tripura annually produced 3.2 t fish, 35 kg duck meat and 1200 eggs from one ha land (Technology assessed at KVK-North Tripura).
- **Stocking of advance fingerlings** in reservoirs and rivers has to be adopted as a continuous process to avoid depletion of catch to supplement of the stocking. Freshwater prawn culture should be popularized among the fish farmers.
- **Producing more fish through pond based cage culture:** There is scope of cage culture in the ponds of Tripura which is 1.90 Lakh. Low-cost cages can be fabricated using bamboo, woods etc and installed into the ponds for additional fish production. Carnivorous/ predatory fishes can be cultured with carps in the same ponds using cages. Beside, cages are easy to operate and maintain even by the women farmers. ICAR Tripura Centre has demonstrated a production of 6.3 kg fish /m^3 in Java puti (*Puntius sophore*) and 6.5 kg/m3 in red tilapia using bamboo-made cages [(Agrinews 2011 9(3): 6]
- **Reducing the feed cost:** Rice bran, mustard oil cake and meat meal are the three major ingredients of balanced fish feed. In Tripura rice is cultivated in 2.57 lakh ha area over all the three seasons, and thus rice husk/bran is sufficiently available. In addition, more than 84000 ha area under single cropping could easily bring under mustard cultivation, which could produce almost 50400 MT of mustard oil cake. Furthermore, almost 34759 MT meats are annually consumed in Tripura which produces almost equal amount of bone meal and meat meal. By creating a network of regulated slaughter houses across the state, locally processing the by-products of rice husk, MOC and bone meal and meat meal to prepare fish feed can effectively address the issues related to feed cost. In addition, it will generate secondary employment in oil mills, slaughter houses and feed industry. In addition there are about 16.00 sq Km of waterlogged seasonal ponds which are not used for any aquaculture purpose. These

ponds can be effectively used for Tilapia culture. Tilapia is a prolific breeder. The Tilapia thus produced from these ponds can be used in production of fish meal which will ensure further reduction of feed cost.

- **Disease management:** Epizootic ulcerative syndrome (EUS) caused by *Aphanomyces invadans* is one of the most dangerous, infectious and epidemic disease of fish in Tripura. Its outbreak could result poor yiels, lower market value and often complete loss of crops. CIFAX is the only registered medicine against EUS. Timely medicare not only reduce disease infestation by 72% but also ensures marketable produce upto 3175 Kg/ha (KVKNorth Tripura). However, the medicine is neither readily accessible to all fish farmers nor fully aware of the medicare options. Thus, awareness programme with enhanced availability of medicine at reasonable price needs to be ensured. In addition, supplementing fish feed with 2-3% Aswagandha (Withania somnifera) root powder could significantly improve the immunity level of fish (DARE-ICAR Annual Report 2016-17). Besides, Aswagandha could also be grown as soil binder in the dykes of the ponds with a complementary benefit of mixing root exudates with pond water. EUS mainly occurs due to drop down of water temperature during winter. For that, vegetable creepers can be planted around ponds or polythene shed can be made on pond to maintain temperature of pond environment. ·
- **Utilization of dikes for additional income:** The pond dikes could efficiently be used for organic cultivation of vegetable and fruit through life saving irrigation from the pond and thereby use underutilized land and manpower for additional revenue and employment generation. At Dhalai district of Tripura additional income of Rs. 4,815/ pond was generated from the cultivation of pineapples, ginger, turmeric and beans on dikes. Further, the intensification of aquaculture through recycling of crop residues minimized feed and fertilizer cost and improved fish production from 934-1545 kg/ha (5000 fingerlings/ha) to 2283-2473 kg/ha/yr (stocking density- 10000 fingerlings/ha) with a net benefit Rs. 2,08,725/- (Debnath et al., 2015).
- **Small indigenous fish:** The small indigenous species (SIS) like mola (*Amblypharyngodon mola*), darkina (*Esomus danricus*), puti *(Puntius spp.*), kanla (*Notopterus notopterus*) etc which are considered as 'fish of no importance to fisheries' or 'miscellaneous/ trash fishes' in other states, are highly demanded in Tripura due to their unique taste and deliciousness. They price higher than many major carps due to high protein and micronutrient content. A kilogram of mola cost Rs. 300-400/-, darkina Rs. 200-300/- and puti Rs. 400-500/- in Tripura markets. Earlier, all these fishes had no importance in aquaculture and eradicated during pond preparation. But now they are highly sort-out for regional aquaculture. Their presence in pond can be manipulated and stimulated to optimize pond production rather eliminate them, which is a common practice in aquaculture. They have the potential for making value-added fish products like smoked fish, fermented fish, fish pickle etc. Being self-recruiting species (SRS), they can be maintained in the composite/polyculture system through regular thinning for additional food production and income generation. Marginal and

small farmers if miss stocking of 'cash crops' in any season due to hardship, they can still earn some money by maintaining these SIS in their ponds. The production of seasonal ponds can be multiplied by using these fishes. But their culture has not yet popularized in Tripura despite of number of trials and success. Composite culture of mola with Indian major carps (IMCs) was demonstrated in the Dhalai district of Tripura which showed mola was non-competing with IMCs when thinned at 2-3 months intervals with a total production of 2034kg fish/ha/7 months of which mola contributed 475 kg. Mola was an additional income for the farmers (Debnath et al. 2013). Santhosh et al. (2011) demonstrated 278 kg additional fish production/ha using this fish. Mr. Subul Chowdhury was identified as the most progressive farmer of South Tripura in respect of mola culture. He is producing 500 kg mola/ha/yr additionally beside IMCs (4500 kg/ha) which gives him an extra income of Rs. 75000/yr. In his opinion, mola is giving additional income to him without any investment or serious management (Santhosh et al., 2011). Composite culture of *Puntius sophore* with IMCs was demonstrated that the fish was non-competing with IMCs when thinned at 2-3 months interval and it was an additional income for the farmers. Total production was 2115.23 kg/ha/7 months (Debnath et al., 2014).

- **Substitute source of lime:** The soil of Tripura is acidic therefore, it demands higher dose of lime (500-1000 kg/ha) during fish culture. But lime is not available in Tripura, it is mostly imported from main lands and become a costly affair in aquaculture. As an alternative, the ash of banana, mustard, paddy straw, fly ash from kilns etc can be used to minimize the cost of liming.
- **Periphyton base aquaculture** has to be promoted among the fish farmer to minimize the level of input in the culture practices.

Summary recommendations:

1. Improving pre-, farming, post farming activities to reduce cost of cultivation, increase access to inputs like quality seeds and planting materials in time and place and promoting future processing oriented cropping system for assured and enhanced income. Pre-farming activities especially land development, creation of adequate irrigation/drainage facilities, water harvesting, adequate plant protection measures along with mechanization will increase input use efficiency, diversify farming and income of the farmers.
2. Adequate credit facilities along with crop insurance and minimum support price are another area which need to be improved for enhancing income from farming. The whole concept should be to reduce cost of cultivation/production, increase productivity and income through efficient farming practices while mitigating risks in farming due to climate vagaries like floods, droughts etc.
3. Fish based farming system has the maximum potential in the state of Tripura. High value fish like Pabda, prawn, magur, tengra, etc. along with IMC (Katla, Common carp, Rohu etc.) and indigenous fish are of high demand among the local populations. Processed fish products (*Sidal, sutki* etc) are also in high demand in the state and in the region and

hence may be systematically promoted. Hence, organized production, marketing will help substantial increase in farmers income.

4. Upscaling and promotion of pulses and oil seed cultivation in rice fallow areas along with processing and marketing.
5. Promotion of value addition through food processing and marketing of following items with the objective of supporting processing/value addition industries for about 9 months in a year

i. Agricultural crops: Sticky and aromatic Rice and pulses

ii. Horticultural crops: Orange, Pineapple, Papaya, Banana, Mango, Litchi, etc.

iii. Vegetable crops: off-season vegetables

6. Promotion of secondary agriculture like Mushroom and bee keeping. Functional marketing channel with cold storage, small cottage industries etc. should be promoted for employment and income enhancement.
7. Diversification of rice based mixed Jhum farming with high value sustainable agro forestry system and remunerative legumes and pulses. Organic farming also has great scope on niche crops and vegetables for export promotion. The indigenous aromatic, fine grain and sticky rice cultivars like Kalikhasa, Harinarayana, Binni etc. are having very good demand within and outside the region and hence should be promoted through organized marketing.
8. Among the North Eastern hilly states, Tripura soils are low in Soil Carbon content (mostly less than 1%). Adequate soil management strategies including biofertilizers, organic manure, amendments and soil test based soil health management strategies should be promoted with emphasis on leguminous crops.
9. Adequate infrastructure for storage (Cold storage, ware houses) and transportation along with improvement of roads especially in villages/hilly areas should be created for enhancing market access and income of farmers for efficient management of ICT options like e-NAM etc.
10. Information & Communication Technologies (ICTs) should be strengthened to reach the farmers in a short time to give market information and help in proper decision making and planning by farmers to get adequate profit from farming.
11. Commercial and backyard goat and poultry farming should be promoted along with cultivation of feed crops such as corn, soybean, tuber crops to reduce investment on feed by the farmers.
12. Dairying is a highly profitable venture in and around City areas and hence, organized dairying along with need based credit facilities, technology support should be provided for dairying in the state for income enhancement of farmers. For promotion of dairying, adequate emphasis should be given on year round availability of fodder and quality feed in the state. Perennial fodder crops like napier, hybrid bajra, fodder tree species like parari etc. should be promoted in degraded lands, wastelands, farm fences etc. for assured

availability of quality fodder specially during dry season. This, would simultaneously also improve soil quality. 13. The State Department of Agriculture may formulate an action plan for doubling farmers' income in state of Tripura in collaboration with CAU, ICAR, KVKs, and allied Departments and adequate strategies may be worked out for proper implementation in a time scale.

13. Location specific technological options for climate resilient agriculture (farm diversification, integrated farming system, water harvesting, perennial trees, on-farm biomass recycling, processing and value addition etc) with adequate emphasis on farm mechanization for risk and drudgery reduction in farming.
14. Entrepreneurship and skill development for youths and women should be taken up. Trainers and farmers should be provided with adequate training and capacity building supports on handling improved technologies like ICTs, hi-tech poly houses, machines and processing facilities etc.
15. Medium, small and marginal enterprise programme strengthening agricultural post-harvest processing and value addition for enhancing household income should be emphasized.
16. Crop insurance scheme and minimum support price should be implemented in the state for assured income and mitigation of farmers' risks due to climate vagaries like drought, floods, cyclone etc.
17. Promotion of contract farming through a tripartite agreement with state as one party and farmer groups and buying houses as other parties. The state government can be represented by departments like State Agriculture Marketing Board, Cooperatives etc.
18. Adequate branding and GI tags will bring high remuneration to the producers for niche crops like aromatic rice, pineapple, etc.
19. Off-farm income will have to play a significant role in doubling farmers income. Hence, supports should be provided for promotion of non-farm activities like cottage industries, tailoring, weaving, village/highway shop etc.
20. Each KVK may adopt a village (about 50 ha) to demonstrate the model and appropriate MoU between State Govt, University, ICAR, other stake holders may be made. Subsequently the models may be replicated through the development departments.
21. Convergent program for all stake holders for effective implementation and relaxation and autonomy should be given while implementing such program in view of the difficulties for infrastructural facilities such as ICTs, credit facilities etc. Adequate policies and supports should be provided for landless farmers.
22. State coordination unit should be established and time bound monitoring and mid-term corrections should be taken up.

SUCCESS STORIES

1. Rice - Fish – Pig – Tuber Crop based Integrated Farming System:

Rice - Fish – Pig – Tuber Crop based Integrated Farming System was demonstrated on Mr. Karna Debbarma's field at Balramchaudhuripara, West Tripura. He has 0.736 ha land suitable for developing farming system model. The total farming land was allocated among the different components according the family need, profit maximization and efficient utilization of available resources. As rice is stable food of the family, therefore maximum land (0.32 ha) was allotted. Fish and pig come after rice, as these are main income generating enterprises of family. The adjoining upland to house used for kitchen garden and tuber crop cultivation and used as feed for pig. The whole system having area 0.736 ha require a total cost of production Rs 40000 during a year and provide the net income to farmers Rs 85120 under rainfed situation. Therefore, Rice - Fish – Pig – Tuber Crop based Integrated Farming System is most suitable farming system model for marginal farmers of Tripura under rainfed ecology.

2. Staggering technology in pineapple/Year round production of pineapple under Tripura condition:

It is one of the popular and widely accepted crops by the farmer due to its promising return. Besides doubling the grower's income, the fruit can be harvested almost round the year. There is no glut and the prices are stable over a longer period.

Staggered planting: Planting of suckers at one month interval from September to March. Planting of different grades of suckers or planting of slips, suckers and crowns. Staggering technology in pineapple has been successfully demonstrated which enables year round production of pineapple.

Chemical induction of flower**:** Ethephon (Ethrel) @100-150 ppm was identified as the most effective chemical to induce flowering in pineapple during different months at 30-32 leaves in Queen and 34-36 leaves in Kew under Tripura condition.

High density planting: High density planting is recommended to accommodate as many numbers of plants as possible while ensuring sufficient space to carry out cultural operations. It also increase the yield, less weed infestation, protection to fruits from sunburn and increased production of suckers and slips per unit area and non – lodging of plants. The yield of the first and second ratoon crops is to an extent of 50-60% and 40% of the plant crop in Tripura

Specification for high density planting

Plant population per hectare	Distance plant –plant within row (cm)	Distance row (cm)	row-	Distance Trench – Trench (cm)	Yield /ha
43,500	30	60		90	30-50 tones
53,300	25	60		90	50-60 tones
63,700	22.5	60 or 45		75 or 90	60 – 70 tones

The cost: benefit ratio is 1:4.84 during the main crop season with a net return of Rs. 4, 97, 198. And, in the second year (first ratoon) the benefit: cost ratio is 1:18.43

28

UTTARAKHAND

The State of Uttarakhand is located in the North-Western Himalayan region which spreads to an approximate area of 33.13 million ha, comprising of Himachal Pradesh (HP), Jammu & Kashmir (J&K) and Uttarakhand (UK), which is 10% of country's total geographical area. Uttarakhand is located between 28° 43' – 31° 27' N latitudes and 77° 34' – 81° 02' E longitudes. The Uttarakhand State has total geographical area (TGA) of 53,483 sq.km (5348.3 thousand ha), out of which about 86% is mountainous and the rest 14% is plain, comprising two districts of the State.

There are 1.046 million and 0.535 million main and marginal cultivators, respectively. Only 13.2% of the TGA of the State is cultivated, of which 53% is rainfed. The average size of land holding in Uttarakhand is 0.89 ha which less than the national average of 1.15 is ha. The average land holding is around 0.68 ha in hills and 1.77 ha in plains. Though the region is thinly populated, the actual pressure on agricultural land is high since the net cultivated area is low. The proportion of small and marginal farmers out of total farmers has increased in the State. The State accounts for only 0.93% of the total livestock population of the country. Livestock rearing is mostly with open grazing system. Dependency on forests and commonly owned grazing lands is very high. Cattle are the major components of livestock population of the State (42%), followed by sheep and goat (37%), and buffalo (21%). Poultry of the State accounts for 0.63% of the total population of the kind in the country. Fish production, being only inland kind, is only 0.04% of the country's production. The State has a unique climate which offers tremendous opportunities for production of high quality temperate fruits, vegetables and flowers, which have commercial significance besides distinct nutraceutical and medicinal properties. The area under fruit crops in the State accounts for 10.1% of the total area under these crops in the country.

The agro-climatic conditions of the State are suitable for growing temperate to sub-tropical fruits, such as apple, pear, peach, plum, apricot, persimmon, cherry, grape, almond, walnut, pecan nut, pistachio nuts, citrus, litchi, guava, kiwi, strawberry, banana, mango, olive, and aonla etc. The contribution of the State to the national fruit basket is very low as the cultivation is at a small scale. The productivity of fruits is low, considering the range of niche available for their cultivation in the State. The State is also suitable for cultivation of ancillary horticultural crops like flowers (orchids, gladiolus, marigold, chrysanthemum, cut flowers etc.), spices (ginger, saffron, chilly, cardamom, black pepper), mushroom, honey etc. The State also has the advantage for cultivation of off-season vegetables and flowers.

The Uttarakhand State lies mostly in the Agroclimatic Region No. 1, namely Western Himalayan Region. Within the State of Uttarakhand, there are two zones, namely the Hill Zone and Bhabhar&Terai Zone. Within an altitudinal variation ranging from 200 m to more than 8000 m above msl, the state comprises five lithotectonically and physiographically distinct subdivisions, namely, the Outer Himalaya comprising Tarai&Bhabhar, Sub-Himalayan belt of Shivaliks (300-1000 m), the Lesser/Mid Himalaya (1000-3000 m), the Great/Higher Himalaya (3000-7000 m), and the Trans-Himalaya or Tethys (> 7000 m).

The State's major natural resources are water, forests, floral and faunal biodiversity. The Ganga river basin, which originates in the form of Ganga and Yamuna rivers from the State, supports nearly 43% of India's population. The State, however, itself supports only 0.83% (10.1 million) human and 0.93% (4.7 million) livestock populations of the country. The State is rich with forest resources. About 61% of the State's total geographical area is under forests.

The area under permanent pastures is about 3%, which is a support to livestock production system. Area under trees and area as culturable waste are 7% and 6%, respectively leaving only a small amount of land i.e. 706 thousand hectares (12%) for cultivation out of the total reported area. Though yields of major cereals, pulses and foodgrains as a whole along with oilseeds have increased over the years, the areas under the same, except under pulses, have decreased.

28.1 Productivity Gaps and Major Constraints

In Uttarakhand, more than 69% of the population depends on agriculture for their livelihood. The average size of holding in the State is around 0.89 ha. The plains and hills present differing scenarios for agriculture. While commercial agriculture is practiced in the plains, the hill farmers mainly practice subsistence farming. The hills practice mixed cropping, while in the plains mostly a single crop is cultivated in a given season. Irrigated land is freely available in the plains, with over 88% of irrigated land as against a mere 12% in the hills. The seed replacement rate for the plains stands at 15-20 per cent, while for the hills it is 3-4 per cent. Productivity across same crops also differs greatly between the hills and plains. Another feature typical of hill farming is the small and scattered land holdings.

Rural livelihood security in north-western Himalayas has become a great challenge in recent years. The region has only 6% (2 m ha) land under agriculture, and due to increasing population, the per-capita availability of land in the region is approximately half of the national average. Unmanaged natural resources lead to drying up of water streams and eroded soils. Lack of growth in agriculture, increase in human population, depleting forest cover and increase in marginal and waste lands affected the development of allied sectors and progress of employment generation, which causes danger to livelihood security.

The crop production systems throughout the Uttarakhand hill region are based on agriculture (field crops), olericulture, and horticulture or agri-horticulture system. Livestock is an inseparable part of the system in the region. Wheat, rice, maize, finger millet and barnyard millet are the major cereal crops. Black gram, horse gram, ricebean, *rajma* and *bhat* (a variant of soybean, which is used as a pulse and has better quality fats and proteins and is more digestible than the common soybean) are the major pulse crops. Mustard and soybean constitute the major oilseed crops. Among vegetables - cole crops, cucurbits, capsicum, tomato, radish, pea, French bean, potato and onions are the major crops.

The region is riddled with many problems. From agriculture point of view, these can be categorized as regional and agriculture-related problems. Among regional problems, the major ones are – difficulty in access, low water retention capacity and high erodibility of soil, sloping terrain and thin soil cover leading to slow recovery of the ecosystem from natural and human disturbances, relatively low temperature throughout, and high rate of migration from villages.

The agriculture-related problems are - small and fragmented land holdings; low risk bearing capacity due to poor economic condition; largely rainfed agriculture (the net irrigated area in hills of Uttarakhand is only 40,822 ha compared to 2,96,874 ha area in plains, i.e. hills enjoy only 12% of the total net irrigated area in the state), modest soil fertility; age-old farming practices; low input use (the fertilizer consumption in hill districts ranges from 65 to 666 thousand tonnes against 31,851 and 73,768 thousand tonnes in Haridwar and Udham Singh Nagar, respectively, which are plain districts); negligible farm mechanization; relatively low awareness about improved technologies; High Yield Gap II; insufficient marketing base; etc. Livestock are one of the main components of hill farming, but there is a great paucity of green and dry fodder; poor transport facilities and processing units, etc.

The climate change has put forth an entirely different scenario of biotic and abiotic stresses, e.g. (i) heavy incidence of brown plant hopper (*Nilaparvata lugens*) was noticed for the first time in some rice-growing areas of Uttarakhand during 2010 (ii) high severity of yellow rust was observed during late-February to mid-March in wheat in 2011, (iii) a very low winter rainfall had resulted in a dismal wheat crop in many rainfed areas during past five years, (iv) adverse effect of increasing maximum temperature and sunshine hours of February months on wheat yield, and (vi) the damage caused by wild animals, like monkeys and boars, has assumed menacing proportions during recent years.

Yield Gap I & II in various crops are presented in Table 1. Among the field crops, Yield Gap I is highest in maize followed by rice. Yield Gap I is very high in vegetable crops, especially in capsicum and onion. Yield Gap II is more than 20% in all crops. Among the field crops, it is highest in maize (63.66%) followed by Finger millet (56.2%). It is lowest in Black soybean (23.01%) followed by rice (29.20%). However, it is worthwhile to mention here that Yield Gap II in upland rice is more than 50%. Among the vegetable crops, Yield Gap II is highest in garlic (933.33%) followed by onion (65.67%) and capsicum (63.33%). It is lowest in case of French bean (27.3%).

Uttarakhand, in spite of being a small state, has certain key features that make it distinct from other states of the country and highlight its potential for development. However, development has predominantly been in the plains, and the hill districts have been left behind. All the hill districts have subsistence farming as their main economic activity. Due to subsistence livelihood, migration and a remittance economy operate in the hill districts. They are land-locked with huge distances between markets and resources. Because of these constraints, traditional agriculture cannot be the lead sector for development. Thus, the state faces the challenge of promoting livelihoods to minimize migration through local employment and income generation, and to enhance the quality of life of people living in villages. The positive features of these hill districts are that they have an enormous potential for off-farm income through eco-tourism and a suitable climate for high-value agriculture. These must be harnessed for a development strategy.

Recently, the study conducted by ASSOCHAM jointly with the research firm RNCOS said, "The performance of Uttarakhand in agriculture and allied activities haves not been up to the mark as its share in the gross state domestic product (GSDP) had declined sharply from over 22% in 2004-05 to just over 9% in 2014-15," Therefore, Uttarakhand needs to promote a separate hill farming policy as the State has a meager 14% net sown area, more so as three-fifth of the State's total working population is engaged in agriculture. Low level of land holdings is a key challenge in the farm sector as 73.6% of the State's farmers hold less than one hectare of land.

The agriculture sector in the state recorded just about 3% Compound Annual Growth Rate between 2004-05 and 2014-15 (ASSOCHAM).

Table:1 Yield Gap – I and II in major crops of Uttarakhand

Crop	Yield Gap I (YG I in q/ha)	Yield Gap II (YG II in q/ha)	Yield Gap II (%)	Increase in income if YG II is bridged (Rs/ha)
Field Crops				
Wheat	6.1	11.24	42.58	15736
Rice	8.2	12.20	29.20	15982
Maize	15.0	22.28	63.66	29186
Soybean	6.10	8.89	43.75	22758
Bhat	Nil	2.98	23.01	7450
Finger Millet	8.8	9.10	56.20	13650
Vegetable Crops				
Garden pea	2.5	40.0	40.00	60000
Frenchbean	10.0	27.3	27.30	54600
Capsicum	100.0	95.0	63.33	190000
Tomato	12.5	175.0	58.33	262500
Onion	75.0	197.0	65.67	295500

Crop	Yield Gap I (YG I in q/ha)	Yield Gap II (YG II in q/ha)	Yield Gap II (%)	Increase in income if YG II is bridged (Rs/ha)
Garlic	25.0	136.0	933.33	544000

Yield Gap I = Average yield in AICRP – FLD yield

Yield Gap II = Average FLD yield – State average yield

Zone A (upto 1000m)

Strategy 1 : Productivity Enhancement

Introduction, adoption and popularization of high yielding varieties for increasing productivity

Recommended package and practices will be followed for the recommended crop varieties

Strengthening of traditional water storage structure

1. Creation of additional water storage tanks in Sult, Dwarahat, Syaldey and Tarikhet block for lean season.
2. Promotion of rain water harvesting and drip-fertigation system in vegetable clusters in this zone.
3. Creation of trenches for high percolation of water in slope/ terraces in all blocks of this zone.
4. Promotion of water conservation techniques like mulch, sprinkler and drip for juvenile plants in Dwarahat, Syaldey, Sult and Tarikhet blocks of this zone.
5. Popularisation of roof water harvesting system in all blocks of this zone.
6. Rejuvenation and popularisation of traditional water harvesting systems (Naula) in all blocks of this zone.

Adoption of cluster approach for holistic development

1. Strengthening of old fruit belt of Syaldey, Sult and Chaukhutia belts by introduction of new cultivars of stone fruits and pickling type mango (Late maturity).
2. Mass cultivation of Cinnamon plants at low hills in Sult, Dwarahat and Chaukhutia block.
3. Promotion of Ginger/Turmeric cultivation in rainfed areas in all blocks of this zone.
4. Promotion of off season vegetable such as tomato, capsicum, radish, potato, onion, garlic (protected/openfield) cultivation in all blocks of this zone.
5. Organic cultivation of chilli in Sult, Tarikhet, parts of Bhikiyasen areas of this zone.
6. Promotion of organic cultivation of traditional crops (finger millet, Barnyard millet, horse gram, bhatt) through the use of HYVs in Sult Block.
7. Fallow land development under agro-forestry in all blocks of zone.

8. Promotion of hybrid/basmati rice particularly in irrigated areas of Chaukhutiya, Bhaisiyachanna, Someswar valley, Dwarahat, Syaldey valleys and pulses, oilseeds in rainfed areas of all blocks.
9. Irrigated areas of Syaldey, Chaukhutia, Someswar valley and Seraghat should be used for seed production of rice and wheat.
10. Promotion of common minimum programme technology in vegetables to reduce the cost of cultivation and quality produce.

Management of wild animal problem

1. Promotion of lime/lemon in fruits, okra in vegetable, chilli, ginger or turmeric in spices, dual purpose varieties of barley, wheat and oats or Lemon grass at larger scale in cultivated field in all blocks to minimize the damage from wild boars, monkeys and cows.
2. Enacting legislative measures for protection of crop from wild animals.
3. Promotion of protected cultivation in all blocks.
4. Promotion of bio fencing on trench bunds.

Adoption of Farm mechanisation (Power tiller, thresher etc)

1. Promotion of serrated sickle, wheel hoe, handle fork, handle kutla, power tiller, small wheat thresher, winnowing fan, small reaper, Vivek Millet thresher cum pearler, VL Paddy thresher and Vivek small tool kit for reduction in drudgery of hill farmers.
2. Popularization of manually operated mini crop harvesters for rice, wheat and millets.
3. Popularization of multi crop thresher and Power Tiller/ Mini Tractor at Nyay Panchayat level in all the blocks.
4. Promotion of improved sickle, millet thresher & pearler for drudgery reduction of hill farmers in all the blocks of the zone.

Management of soil health in low or valley areas

1. Organic cultivation of traditional crop viz., fingermillet, barnyard millets, black soybean, horsegram, traditional rice in all blocks of this zone.
2. Promotion of Bio-fertiliser/soluble fertiliser based farming especially in rainfed areas of this zone.
3. Adoption of pulse based crop rotation and maximum use of value added compost/FYM in all blocks of this zone.
4. Making available the required recommended nutrients/ micro-nutrients at right time, place and quantity.
5. Adoption of integrated nutrient management in irrigated areas of rice and wheat for Chaukhutiya, Bhaisiyachanna, Someswar valley, Dwarahat, Syaldey valleys.
6. Popularization of soil and water conservation measures by pulse based intercropping, contour farming and shoulder bunds in particular rainfed areas of all blocks.

7. Promotion of soil testing kits in all blocks of this zone.

Adoption of efficient irrigation techniques

1. Surface irrigation in laser levelled land
2. Micro- irrigation system in Citrus, Mango, Litchi, Guava and in Vegetables
3. Drip Irrigation in Green House Cultivation for Cut Flowers and Vegetables.

Others

1. Cluster approach for holistic development.
2. Promotion of timely and local availability of high yielding varieties of all the cereal, pulse, High Value Crops like vegetable, fruits, spices, etc.
3. Cultivation of fodder crops & medicinal plants.
4. Adoption of only well decomposed FYM/ value added compost.
5. Promotion of efficient and timely use of IPM and IDM practices.
6. Compulsion of seed treatment through bio agent/ chemical in the cluster.
7. Adoption of moisture conservation practices.
8. Promotion to focus on timely weed management.

Strategy 2 : Livestock: Goatry, Poultry, Fisheries

1. Selection of high milk breeds in buffaloes (Murrah) and cattle (Jersey, Red Sindhi, Gir and Shaiwal).
2. Establishment of Fodder Bank in each block to meet fodder requirement of area.
3. Establishment of milk chilling plant at Sult/Syaldey block of this zone.
4. Establisment of Mollases/Multinutrient feed block at Tarikhet
5. Promotion of Urea, Mollasses, Multinutrient Blocks at Nyaypanchayt level.
6. Establishment of hatcheries for need of broilor or croilor at block level like at Sult and Chaukhutiya.
7. Introduction and promotion of cross Heiffer by Artificial Insemination (AI) for increasing income of marginal farmer in all blocks.
8. Improvement of cattle health through vaccination and proper feeding.
9. Strengthening of traditional water bodies/rivulets with Mahaseer or carps at Mohan areas and Gaggas areas.
10. Popularisation of green fodder crops ie sorghum, lobia, maize, oat, berseem in all blocks.
11. Community pasture development at village level.
12. Planning for establishment of Gaushala at block level to rear unproductive cattles to avoid the damage crops in cultivated areas.

Strategy 3 : Integrated Farming system

Promotion of different Integrated Farming System modules for 20 nali's or 0.4 ha such as :

Vegetable based – 18 nali protected cultivation + 2 nali composting and Goatry/ Poultry

1. 18 nali Protected cultivation (100 m^2 low cost polyhouse / shadenet/poly tunnel) Capsicum, cucumber, Tomato, nursey raising and cole crops/ off season vegetable/ growing vegetable seedling + 2 nali Composting (30 m^2) + Goatry (4F+1M) /backyard poultry (50 birds)

Live stock based- 10 nali green fodder + 5 nali Dairy, composting and Goatry/ Poultry+ 5 nali Protected cultivation

1. Fodder production (10 nali; Sorghum, lobia-Oat in rainfed or berseem in irrigated) + Mini dairy (Cross bred 05) + Composting (50 sqm) + Protected cultivation; 5 nali

Crop based- 15 nali crop and vegetable+ 5 nali Dairy, composting and Goatry/ Poultry.

1. 15 nali Truthfull seed production (Jethi rice, horsegarm,bhatt, Lentil, onion, radish, frenchbean, Pea); + Planting material supply 2 nali + Mushroom + Composting
2. Crop 14 nali (Gahat, madua, soyabean, lentil- 7 nali + vegetable- Cucurbits, French bean, veg pea, tomato, capsicum and leafy vegetables (7 nali) - 5 nali dairy/backyard poultry; +composting (50 sq.m).

Strategy 4 : Reducing post harvest losses and value addition

1. Establishment of processing units for pickle making in Chaukhutia/ Sult/ Sayldey/ Bhikiasein block of this zone.
2. Establishment of Food and Processing Units /Value addition centre at fruit/vegetable belt of the block Tarikhet, Sult and Syaldey
3. Establishment of procurement centre for efficient marketing of surplus fruit, vegetables in Chaukhutia, Sult,Saylde, Tarikhet block of this zone.
4. Establishment of marketing chain for efficient/timely supply of produce/product.
5. Promotion of common resources on custom hire basis viz. Mini thresher / mini tractor in Syaldey, Chaukhutia and Sult block of this zone.
6. Establishment of packaging infrastructure at village level with packaging, sewing, sealing and labeling facilities.

Strategy 5: Waste land development and waste water treatment

1. Contour making for arable purpose in waste land in Sult and other area.
2. Afforestation of plants and perennial grasses in steep slope of more than 40% sloppy area of this zone.

3. Popularization of plantation of mulberry, wild fruit plants and fodder trees (Grewia, Bauhinia, Alnus, Celtis, Quercus etc.).
4. Popularization of soil bunds to save excessive loss of nutrients in wasteland.
5. Popularization of trenches for percolation of water to avoid surface run off.
6. Construction of check dam and artificial structure to maximize water percolation rate in marginal and denudated areas.
7. Construction of tank/ poly tanks for storage of water for lean season.
8. Storage of rain water in monsoon season.
9. Development of silivi pastural/ pasture on waste land.
10. Plantation of improved grasses with legume.
11. Establishment of waste water treatment plants based on phycoremediation technique at sewer drainage points.

Strategy 6 : Reduced cultivation cost

1. Promotion of well decomposed FYM, vermi-compost and bio-fertilizers to minimize the use of costly chemical fertilizers.
2. Promotion of line sowing and recommended dose of fertilizers application in crops.
3. Promotion of recommended seed rate, spacing and depth.
4. Promotion of need based application of pesticides and other agricultural inputs.
5. Promotion of hand tools in agricultural and horticultural operations.
6. Promotion of use of Power tillers, Power weeders, Paddy threshers, Wheat threshers, Mandua/ Madira threshers, Maize Sheller, Wheel Hand hoe, Manual/ power operated Wheat/Paddy reapers in all blocks of this zone.
7. Adoption of mulching (bio or degradable plastic) in vegetable and fruit crops to maintain moisture and reduce intercultural operation cost.
8. Promotion of pressurized irrigation techniques in horticultural crops.
9. Promotion of tillers and other garden tools for reduction of drudgery.

Strategy 7 : Off-farm income

1. Promotion of subsidiary occupations like handicraft articles (aipen, jute bags, and woolen clothes), candle making, squash, pickles, mushroom production, home made/ value added products (bari, papad, namkeen, biscuit).
2. Promotion of apiculture for small and landless farmers in Chaukhutia and Sult block of this zone.
3. Promotion of sericulture in Chaukhutia and Sult block of this zone.
4. Promotion of cultivation and collection of medicinal plants.
5. Strengthening of SHG/ Federation for specific skill development in income generation activities in women and youth and also for better price realization.

Strategy 8 : Enabling Policies

1. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.
2. Labelling of organic inputs and certification mechanism for various crops.
3. Popularization of Udhyan and Krishak Cards for widespread use of government incentives/ subsidies to farmers.
4. Implementation of effective and workable Nursery Act to avoid spurious or unreliable planting material in the state.
5. Ensure sustainable agriculture through more efficient utilization of land, water and other resources.
6. Compulsion of Soil Health Card Scheme, Kisan Credit Card and Crop Insurance for all farmers.

Strategy 9 : Marketing and value addition in specific agro-ecological region

1. Creation of better transportation facilities with cool chain van at Block level.
2. Creation of direct linkages with food processing industries for better prices.
3. Establishment of strong linkages with various stake holders to furnish information on crop produce and surplus.
4. Establishment of procurement and collection centre at Nyaypanchyat level for agricultural surplus with proper labelling.
5. Installation of mini grading machines at village level.
6. Establishment of cold room in different clusters in Chaukhutiya and Sult.

Strategy 10 : Online Management and Evaluation

1. Strengthening of internet connectivity.
2. Development of Mobile apps/ software for online management and evaluation at district level.
3. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
4. Organization of monthly review meeting at district to solve the problems related with farmers.
5. Promotion of use of radio, TV talks and Whatsapp and other social networking media for effective implementation of program.

Zone: B (1000-1500m)

Strategy 1: Productivity Enhancement

Strengthening of traditional water storage structure

1. Creation of additional water storage tank for particular vegetable areas of Tarikhet, Hawalbagh, Takula, Lamgara, Bhaisiyachanna, Sult and Syaldey for lean season.
2. Promotion of rain water harvesting and drip-fertigation system in vegetable clusters in this zone.
3. Creation of trenches for high percolation of water in slope/ terraces in all blocks.
4. Promotion of water conservation techniques like mulch, sprinkler and drip in juvenile plants in particular vegetable growing areas viz. Tarikhet, Hawalbagh, Takula, Lamgara, Bhaisiyachanna, Sult and Syaldey.
5. Popularisation of roof water harvesting system in all villages.
6. Rejuvenation and popularisation of traditional water harvesting systems (Naula) in all blocks.

Adoption of cluster approach for holistic development

1. Strengthening of old fruit belt of Lamgara, Hawalbagh, Dunagiri, Dwarahat, Syaldey and Chaukhutia belts by introduction of new cultivars of stone fruits and pickling type mango (Late maturity).
2. Mass cultivation of Cinnamon plants at low hills in Sult, Syaldey, Dhauladevi and Dwarahat block.
3. Promotion of Ginger /Turmeric cultivation in shady areas in all blocks.
4. Promotion of hybrid/basmati rice particularly in irrigated areas of Takula, Chaukhutiya, Bhaisiyachanna, Syaldey, Hawalbagh and pulses, oilseeds in rainfed areas of all blocks.
5. Promotion of off season vegetable/protected cultivation (tomato, capsicum, radish, potato, onion, garlic cucumber, cole crops, leafy vegetable etc.) specially in Tarikhet, Hawalbagh, Lamgara, Deghat, some part of Takula, Dwarahat, Bhikiyasen, Sult, Bhasiachana etc).
6. Promotion of off season vegetable such as tomato, capsicum, radish, potato, onion, garlic (protected/openfield) cultivation in all blocks of this zone.
7. Organic cultivation of chilli in Tarikhet, Sult, Bhikiyasen areas.
8. Irrigated areas of Syaldey, Chaukhutia, Someswar, Seraghat, Barechina should be used for seed production of rice and wheat.
9. Fallow land development under agro-forestry in all blocks.
10. Promotion of common minimum programme technology in vegetables to reduce the cost of cultivation and quality produce.

Management of wild animal problem

1. Promotion of bio fencing on trench bunds especially in vegetable belts in all blocks.

2. Promotion of lime/lemon in fruits, lady finger in vegetable, ginger or turmeric in spices, dual purpose varieties of barley, wheat and oats or Lemon grass at larger scale in cultivated field in all blocks to minimize the damage from wild boars, monkeys and stray animals.
3. Enacting legislative measures for protection of crop from wild animals in all blocks.
4. Promotion of protected cultivation (low cost polyhouse, polytunnels etc.) in all blocks to ensure some income.

Adoption of Farm mechanisation (Power tiller, thresher etc)

1. Adoption of serrated sickle, wheel hoe, handle fork, handle kutla, power tiller, small wheat thresher, winnowing fan, Vivek mandua thresher for reduction of drudgery in practicing farmers and farm women in all blocks.
2. Popularization of manually operated mini crop harvesters, small wheat /paddy thresher in Takula, Chaukhutiya, Takula, Bhaisiyachanna, Syaldey, Hawalbagh.

Adoption of efficient irrigation techniques

1. Micro Irrigation (Drip and Sprinkler Irrigation) where water is available,
2. Drip Irrigation in integration with water harvesting structure where irrigation water is not available
3. Green House Cultivation for Vegetables

Management of soil health

1. Organic cultivation of traditional crop viz., fingermillet, barnyard millets, black soybean, horsegram, amaranths, traditional rice in all blocks of this zone.
2. Promotion of berseem after rice in marshy land of Takula, Chaukhutiya, Takula, Bhaisiyachanna, Syaldey, Hawalbagh.
3. Bio-fertiliser/soluble fertiliser based farming in rain fed areas of all blocks especially in Dhauladevi, Sult, Saldyey, Hawalbagh.
4. Adoption of pulse based crop rotation and maximum use of value added compost/FYM in all blocks.
5. Making available the required recommended nutrients/ micro-nutrients at right time, place and quantity.
6. Adoption of integrated nutrient management in irrigated areas of rice and wheat for Takula, Chaukhutiya, Takula, Bhaisiyachanna, Syaldey, and Hawalbagh.
7. Popularization of soil and water conservation measures by pulse based intercropping, contour farming and shoulder bunds in particular rainfed areas of all blocks.
8. Promotion of soil testing kits in all blocks of this zone.

Strategy 2 : Livestock: Goatry, Poultry, Fisheries

1. Selection of high milk breeds in buffaloes (Murrah) and cattle (Jersy, Sahiwal, Gir and Red Sindhi) in all blocks.

2. Establishment of Fodder Bank in each block to meet fodder requirement of area.
3. Establishment of milk chilling plant at Tarikhet and Dhauladevi (Danya).
4. Establisment of Molases/Multinutrient feed block at Dholadevi and someswar areas
5. Promotion of urea, molasses, multinutrient blocks at Nyaypanchayt level.
6. Establishment of three hatcheries for need of broilor or croilor at block level like at Dholadevi, Bhikiyasen and Dwarahat.
7. Introduction and promotion of cross Heiffer by Artificial Insemination (AI) for increasing income of marginal farmer in all blocks.
8. Improvement of cattle health through vaccination and proper feeding.
9. Strengthening of traditional water bodies/rivulets with Mahaseer or carps at Mohan, Kosi areas and carp at Gaggas, Vinod areas.
10. Popularisation of green fodder crops i.e. sorghum, lobia, maize, oat, berseem etc. in all blocks.
11. Community pasture development at village level.
12. Planning for establishment of Gaushala at block level to rear unproductive cattles to avoid the damage crops in cultivated areas.

Strategy 3 : Integrated Farming system

Promotion of different Integrated Farming System modules for 20 nali's or 0.4 ha such as :

1. Vegetable based – 18 nali protected cultivation/Offseason vegetable + 2 nali composting and Goatry/ Poultry
2. Protected cultivation (100sqm low cost polyhouse- Capsicum, cucumber, Tomato, nursey raising and cole crops)/ off season vegetable; 17 nali + Composting (30sqm) + Goatry (4F+1M) /backyard poultry (50birds)
3. Live stock based- 10 nali green fodder + 5 nali Dairy, composting and Goatry/ Poultry+ 5 nali Protected cultivation /Offseason vegetable
4. Fodder production (10 nali; Sorghum, lobia-Oat in rainfed or berseem in irrigated) + Mini dairy (Crossbreed05) + Composting (50sqm) + Protected cultivation; 5 nali
5. Crop based- 15 nali crop and vegetable+ 5 nali Dairy, composting and Goatry/ Poultry+ 2 nali Nursery raising Protected cultivation 5 nali
6. Truthfull seed production (Jethi rice, Lentil, onion, radish, frenchbean, Pea); 15 nali + Planting material supply 2 nali + Mushroom + Composting
7. Crop 14 nali (Gahat, madua, soyabean, lentil- 7 nali + vegetable- Cucurbits, French bean, veg pea, tomato, capsicum and leafy vegetables (7 nali)-dairy/backyard poultry; 5 nali +composting (50 sqm).

Strategy 4 : Reducing post harvest losses and value addition

1. Establishment of mini fruit grading plant in Lamgara, Dhauladevi, Hawalbagh, Tarikhet.
2. Establishment of Food and Processing Units at fruit/vegetable Patti i.e. Lamgara, Tarikhet, Sult, Syaldey, Dehghat, Dhauladevi.
3. Establishment of Value addition centre at Takula, Hawalbagh, Dwarahat, Chaukhutiya and Bhaisiyachanna.
4. Promotion of cluster approach for efficient procurement and disposal of surplus fruits and vegetables in all blocks.
5. Establishment of marketing chain for efficient/timely supply of produce/product from nyaypanchayat level.
6. Promotion of common resources on custom hire basis viz. Mini thresher, mini tractor, power tiller etc. in Syaldey, Chaukhutia, Someshwar, Bhaisiyachanna.
7. Establishment of small processing units for tertiary and value addition of local mango in Bhikhiyasein.
8. Establishment of packaging infrastructure at nyaypanchayat level with packaging, sewing, sealing and labeling facilities.

Strategy 5 : Waste land development and waste water treatment

1. Contour making for arable purpose in waste land in all blocks including Sult, Tarikhet and Dhauladevi.
2. Afforestation of plants and perennial grasses in steep slope of more than 40% slope in all blocks.
3. Promotion of plantation of mulberry, wild fruit plants and fodder trees (Bheemal, Alnus, Celtis, Oak etc.) in all blocks.
4. Regular maintenance of soil bunds to save excessive loss of nutrients and minimize the water loss in wasteland in all blocks.
5. Popularization of V- notch, trenches or silages for percolation of water to avoid surface run off in all blocks.
6. Construction of Loose check dam in gullies/ nalas, check dams in rivers/nalas, and desired artificial structure to maximize water percolation rate in marginal and denudated areas in all blocks.
7. Construction of tank for storage of water for lean season in all blocks.
8. Development of pasture and drinking ponds for animals on waste land at nyaypanchayat level.
9. Establishment of waste water treatment plants based on phycoremediation technique at sewer drainage points.

Strategy 6 : Reduced cultivation cost

1. Promotion of different techniques to reduce cultivation cost in all blocks such as:
2. Promotion of well decomposed FYM, self prepared vermicompost and biofertilizers to minimize the use of costly chemical fertilizers.
3. Promotion of line sowing and recommended dose of fertilizers application in crops.
4. Promotion of recommended seed rate, spacing and depth.
5. Promotion of need based application of pesticides and other agricultural inputs.
6. Promotion of hand tools in agricultural and horticultural operations.
7. Adoption of Power tillers, Power weeders, Paddy threshers, Wheat threshers, Mandua/ Madira threshers, Maize Sheller, Wheel Hand hoe, Manual/ power operated Wheat/Paddy reapers.
8. Promotion of mulching (bio or degradable plastic) in vegetables and fruits to maintain moisture and reduce intercultural operation cost.
9. Promotion of pressurized irrigation techniques in horticultural crops.
10. Promotion of tillers and other garden tools (serrated sickle, wheel hoe, handle fork, handle kutla) for reduction of drudgery.

Strategy 7 : Off-farm income

1. Promotion of subsidiary occupations like handicraft articles (aipen, jute bags, bichhu grass articles, herbal gulal, natural colours from different flowers, squash, pickles, mushroom production, home made / value added products (bari, papad, namkeen, biscuit), sweets (Bal mithai), copper/ iron utensils.
2. Promotion of apiculture for small and landless farmers.
3. Promotion of sericulture in low hills or valley areas particularly in Takula (Someshwar), Saldye, Dhauladevi blocks.
4. Promotion of cultivation and collection of medicinal plants in all blocks.
5. Promotion of skill development in women and youth in all blocks.

Strategy 8: Enabling Policies

1. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.
2. Labelling of organic inputs and certification mechanism for various crops.
3. Popularization of Udhyan and Krishak Cards for widespread use of government incentives/ subsidies to farmers.
4. Establishment of wood bank at Dunagiri and Shaharphatak areas to meet the present and future demand of germplasm in horticultural crops.

5. Implementation of effective and workable Nursery Act to avoid spurious or unreliable planting material in the state.
6. Ensure sustainable agriculture through more efficient utilization of land, water and other resources.
7. Compulsion of Soil Health Card Scheme, Kisan Credit Card and Crop Insurance for all farmers.

Strategy 9 : Marketing and value addition in specific agro-ecological region

1. Creation of better transportation facilities with cool chain van at Block level (particularly vegetable/fruit/ floriculture).
2. Establishment of collection center of fruit/ vegetable processing unit (Tarikhet, Sult, Dhauladevi) and its direct linkage with food processing industries for better prices.
3. Establishment of strong linkages with various stack holders to furnish information on crop produce and surplus.
4. Establishment of procurement and collection centre at Nyaypanchyat level for agricultural surplus with proper labelling.
5. Installation of mini grading machines at village level.
6. Establishment of cold room in different clusters i.e Almora,
7. Deghat and Sult areas.

Strategy 10: Online Management and Evaluation

1. Strengthening of internet connectivity.
2. Development of Mobile apps/ software for online management and evaluation at district level.
3. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
4. Organization of monthly review meeting at district to solve the problems related with farmers.
5. Promotion of use of radio, TV talks and Whatsapp etc. for effective implementation of program.

Zone: C (1500-2400 m)

Strategy 1: Productivity Enhancement

Strengthening of traditional water storage structure

1. Creation of additional water storage tank/ polytank for particular vegetable areas of Tarikhet (Chaubatia), Hawalbagh (Shitlakhet, Kasardevi), Lamgara (Shaharphatak, Motiapathar) and Dhauladevi (Jageshwar) for lean season.

2. Promotion of rain water harvesting and drip-fertigation system in vegetable clusters in this zone in all blocks.
3. Promotion of water conservation techniques like mulch, sprinkler and drip in juvenile plants in particular vegetable growing areas viz. Tarikhet (Chaubatia), Hawalbagh (Shitlakhet, Kasardevi), Lamgara (Shaharphatak, Motiapathar) and Dhauladevi (Jageshwar)
4. Popularisation of roof water harvesting system in all villages.
5. Rejuvenation and popularisation of traditional water harvesting systems (Naula) in all blocks.

Adoption of cluster approach for holistic development

1. Strengthening of old fruit belt of Tarikhet, Dwarahat (Dunagiri), Lamgara and Hawalbagh by introduction of new cultivars of stone fruits.
2. Promotion of Ginger /Turmeric cultivation in shady areas in all blocks.
3. Promotion of off season vegetable/protected cultivation (tomato, capsicum, radish, potato, onion, garlic cucumber, cole crops,leafy vegetable etc.) specially in Tarikhet, Hawalbagh, Lamgara, Dunagiri, Jageshwar.
4. Fallow land development under agro-forestry in all blocks.
5. Promotion of recommended high yielding varieties and organic cultivation in all blocks.
6. Promotion of common minimum programme technology in vegetables to reduce the cost of cultivation and quality produce.

Management of wild animal problem

1. Promotion of bio fencing on trench bunds especially in vegetable belts in all blocks.
2. Promotion of Citrus/ nut fruits, lady finger in vegetable, ginger or turmeric in spices, dual purpose varieties of barley, wheat and oats or Lemon grass at larger scale in cultivated field in all blocks to minimize the damage from wild pigs, monkeys and cows.
3. Enacting legislative measures for protection of crop from wild animals in all blocks.
4. Promotion of protected cultivation (low cost polyhouse, polytunnels etc.) in all blocks to ensure some income.

Adoption of Farm mechanisation (Power tiller, thresher etc)

1. Adoption of serrated sickle, wheel hoe, handle fork, handle kutla, power tiller, small wheat thresher, winnowing fan, Vivek Millet thresher cum pearler Vivek small tool kit for reduction in drudgery of hill farmers.
2. Popularization of manually operated mini crop harvesters, small wheat /paddy thresher in Takula, Bhaisiyachanna and Hawalbagh.

Adoption of efficient irrigation techniques

1. Micro Irrigation (Drip and Sprinkler Irrigation) where water is available,

2. Drip Irrigation in integration with water harvesting structure where irrigation water is not available
3. Green House Cultivation for Vegetables.

Management of soil health

1. Organic cultivation of traditional crop viz., fingermillet, ugal, rice bean, barnyard millets, black soybean, horsegram, traditional rice in all blocks of this zone.
2. Bio-fertiliser/soluble fertiliser based farming in rain fed areas of all blocks.
3. Adoption of pulse based crop rotation and maximum use of value added compost/FYM in all blocks.
4. Making available the required recommended nutrients/ micro-nutrients at right time, place and quantity.
5. Popularization of soil and water conservation measures by pulse based intercropping, contour farming and shoulder bunds in particular rainfed areas of all blocks.
6. Promotion of soil testing kits in all blocks of this zone.

Strategy 2 : Livestock: Goatry, Poultry, Fisheries

1. Selection of high milk breeds in buffaloes (Murrah) and cattle (Jersy, Sahiwal, Gir and Red Sindhi) in all blocks.
2. Establishment of Fodder Bank in each block to meet fodder requirement of area.
3. Establishment of milk chilling plant at Lamgara block
4. Establisment of Molases/Multinutrient feed block at Lamgara.
5. Promotion of urea, molasses, multinutrient blocks at Nyaypanchayt level.
6. Establishment of hatcheries for need of broilor or croilor at block level like at Saharfatak area.
7. Introduction and promotion of cross Heiffer by Artificial Insemination (AI) for increasing income of marginal farmer in all blocks.
8. Improvement of cattle health through vaccination and proper feeding.
9. Strengthening of traditional water bodies/rivulets with Mahaseer or carps at Garurabajh and Vishvnathan river areas.
10. Popularisation of green fodder crops i.e. sorghum, lobia, maize, oat, berseem (Irrigated only) etc. in all blocks.
11. Community pasture development at village level.
12. Planning for establishment of Gaushala at block level to rear unproductive cattles to avoid the damage crops in cultivated areas in all blocks.

Strategy 3 : Integrated Farming system

Promotion of different Integrated Farming System modules for 20 nali’s or 0.4 ha such as :

1. Vegetable based – 18 nali protected cultivation + 2 nali composting and Goatry/ Poultry
2. Protected cultivation (100 sqm low cost polyhouse- Capsicum, cucumber, Tomato, nursey raising and cole crops)/ off season vegetable; 18 nali + Composting (50 sqm) + Goatry (4F+1M) /backyard poultry (50 birds)
3. Live stock based- 10 nali green fodder + 5 nali Dairy, composting and Goatry/ Poultry+ 5 nali Protected cultivation
4. Fodder production (10 nali; Sorghum, lobia-Oat in rainfed or berseem in irrigated) + Mini dairy (Crossbred 05) + Composting (50 sqm) + Protected cultivation; 5 nali
5. Crop based- 15 nali crop and vegetable+ 5 nali Dairy, composting and Goatry/ Poultry+ 2 nali Nursery raising Protected cultivation 5 nali
6. Truthfull seed production (Jethi rice, Lentil, onion, radish, frenchbean, Pea); 15 nali + Planting material supply 2 nali + Mushroom + Composting
7. Crop 14 nali (Gahat, madua, soyabean, lentil- 7 nali + vegetable- Cucurbits, French bean, veg pea, tomato, capsicum and leafy vegetables (7 nali)-dairy/backyard poultry; 5 nali +composting (50 sqm).

Strategy 4 : Reducing post harvest losses and value addition

1. Establishment of mini fruit grading plant in Saharfatak, Hawalbagh and Chaubatiya.
2. Establishment of Food and Processing Units at fruit/vegetable belt in Lamgara, Tarikhet, Jageshwar, Seharphatak and Bhikiasain.
3. Establishment of Value addition centre at Takula, Jainti, Jageshwar, Hawalbagh (kasardevi) and Bhaisiyachanna.
4. Promotion of cluster approach for efficient procurement and disposal of surplus fruits and vegetables in all blocks.
5. Establishment of marketing chain for efficient/timely supply of produce/product from nyaypanchayat level.
6. Promotion of common resources on custom hire basis viz. Mini thresher, power tiller etc. in all blocks.
7. Establishment of packaging infrastructure at nyaypanchayat level with packaging, sewing, sealing and labeling facilities.

Strategy 5 : Waste land development and waste water treatment

1. Contour making for arable purpose in waste land in all blocks.
2. Afforestation of plants and perennial grasses in steep slope of more than 35% slope in all blocks.
3. Promotion of plantation of mulberry, wild fruit plants and fodder trees (Griwia, Alnus, Celtis, Oak, Buransh, Kaafal etc.) in all blocks.

4. Regular maintenance of soil bunds to save excessive loss of nutrients and minimize the water loss in wasteland in all blocks.
5. Popularization of V- notch, trenches or silages for percolation of water to avoid surface run off in all blocks.
6. Construction of Loose check dam in gullies/ nalas, check dams in rivers/nalas, and desired artificial structure to maximize water percolation rate in marginal and denudated areas in all blocks.
7. Construction of tank for storage of water for lean season in all blocks.
8. Development of pasture and drinking ponds for animals on waste land at nyaypanchayat level.
9. Establishment of waste water treatment plants based on phycoremediation technique at sewer drainage points.

Strategy 6 : Reduced cultivation cost

1. Promotion of different techniques to reduce cultivation cost in all blocks such as:
2. Promotion of well decomposed FYM, self prepared vermicompost and biofertilizers to minimize the use of costly chemical fertilizers.
3. Promotion of line/cross sowing and recommended dose of fertilizers application in crops.
4. Promotion of recommended seed rate, spacing and depth.
5. Promotion of need based application of pesticides and other agricultural inputs.
6. Promotion of hand tools in agricultural and horticultural operations.
7. Adoption of Power tillers/ Power weeders, Mandua/ Madira threshers, Maize Sheller, Wheel Hand hoe, Manual/operated threshers.
8. Promotion of mulching (bio or degradable plastic) in vegetables and fruits to maintain moisture and reduce intercultural operation cost.
9. Promotion of pressurized irrigation techniques in horticultural crops.
10. Promotion of tillers and other garden tools (serrated sickle, wheel hoe, handle fork, handle kutla) for reduction of drudgery.

Strategy 7 : Off-farm income

1. Promotion of subsidiary occupations like handicraft articles (aipen, squash, Rambaans products, pickles, mushroom production, home made/ valueadded products (bari, papad, namkeen, biscuit), copper/ iron utensils.
2. Promotion of sericulture in all blocks.
3. Promotion of cultivation and collection of medicinal plants in all blocks.
4. Promotion of skill development in women and youth in all blocks.
5. Promotion of textile based articles.

Strategy 8 : Enabling Policies

1. Increasing institutional support by providing subsidises and incentives to small and marginal farmers.
2. Labelling of organic inputs and certification mechanism for various crops.
3. Popularization of Udhyan and Krishak Cards for widespread use of government incentives/ subsidies to farmers.
4. Establishment of wood bank at Shaharphatak and Chaubatiya areas to meet the present and future demand of germplasm in horticultural crops.
5. Implementation of effective and workable Nursery Act to avoid spurious or unreliable planting material in the state.
6. Ensure sustainable agriculture through more efficient utilization of land, water and other resources.
7. Compulsion of Soil Health Card Scheme, Kisan Credit Card and Crop Insurance for all farmers.

Strategy 9 : Marketing and value addition in specific agro-ecological region

1. Creation of better transportation facilities with cool chain van at Block level (particularly vegetable/fruit/ floriculture).
2. Establishment of collection center of fruit/ vegetable processing unit (Saharfatak, Tarikhet, Dhauladevi) and its direct linkage with food processing industries for better prices.
3. Establishment of strong linkages with various stack holders to furnish information on crop produce and surplus.
4. Establishment of procurement and collection centre at Nyaypanchyat level for agricultural surplus with proper labelling.
5. Installation of mini grading machines at village level.
6. Establishment of cold room in different clusters e.g. Shaharfathak, Chaubatia, Dunagiri, Jageshwar areas.

Strategy 10 :Online Management and Evaluation

1. Strengthening of internet connectivity.
2. Development of Mobile apps/ software for online management and evaluation at district level.
3. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
4. Organization of monthly review meeting at district to solve the problems related with farmers.
5. Promotion of use of radio, TV talks and Whatsapp etc. for effective implementation of program.

Zone: D (>2400 m)

Strategy 1 : Productivity Enhancement

Promotion of efficient water management

1. Promotion of efficient management of rain water harvesting with drip-fertigation system.
2. Creation of rain water harvesting structure in private and government buildings in all the villages of the zone.
3. Promotion of water conservation techniques like mulch, micro irrigation system in juvenile plants.

Management of wild animal problem

Promotion of plantation of wild fruits like Wild pear (Mehal) in Van Panchayat area for wild animal.

Strengthening of farmers through skill training

Organisation of regular trainings and feedback with experts regarding scientific methods of cultivation in each cluster.

Adoption of farm mechanization

1. Promotion of Power weeder, Fruit harvester for drudgery reduction in Upla-taknor, Arakot and Jakhol cluster.
2. Promotion of small hand tools like Secateurs, serrated sickle, hand wheel hoe and fork for drudgery reduction of farm women in all the clusters.

Adoption of efficient irrigation techniques

1. Micro Irrigation (Drip and Sprinkler Irrigation) where water is available,
2. Drip Irrigation in integration with water harvesting structure where irrigation water is not available
3. Green House Cultivation for Vegetables

Management of soil health

1. Popularization of soil testing in intensive mode and distribution of soil health cards to farmers for judicious use of fertilizers.
2. Adoption of well decomposed FYM and other compost.

Adoption of cluster approach for holistic development

1. Need to introduce new walnut, apricot, apple varieties with appropriate pollinizer variety especially in Joshimath block.
2. Promotion of production of vegetable pea, and French Bean in different cluster villages of Mirg, Parsari, Badgaon, Jhelam, Pandukeshwar, Mana & Mallari of Joshimath block.

3. Promotion of Seed production of local Razma, Cabbage & Potato at Auli Jhelum, Pandukeshwar of Joshimath block.
4. Promotion of bulbous flower like tuberose, lilium, gladiolus and other temperate bulbous flowering plants
5. Promotion of strong specially designed protected cultivation structures which can withstand heavy snow fall for the cultivation of vegetables (Capsicum, Cabbage, Cauliflower, leafy veg. like lettuce, Kale, Coriander) in all the blocks
6. Organic cultivation of Amranth, Razma & Pea in different village cluster in Joshimath block.

Strategy 2 : Livestock: Goatry, Poultry, Fisheries

1. Promotion of high milk yield breeds of cows Jersey, Red Sindhi and H.F, and goats (Gaddi, Chigu, Changthagi) and Sheep breed (Gaddi, Bhakarwal, Gurej, Kashmir Merino) in high alltitue areas of Auli, Niti, Mana, Kailashpur and Mirg area of Joshimath Block.
2. Establishment of milk processing plant at Joshimath block.
3. Promotion of Urea, Molasses, and Mineral mixer blocks at Nyaypanchayat level.
4. Strengthening of traditional water bodies/ rivulets with Mahaseer and trout at Joshimath block.

Strategy 3 : Integrated Farming system

Following Integrated farming system model may be developed:

1. Protected cultivation+ Composting+Goatry/backyard poultry/Dairy
2. Fodder production+ Mini dairy+Composting+ Protected cultivation
3. Seed production (Potato, Radish, Cabbage, Pea and Rajma

Cropping system
Rajma/Potato/Pea/Cabbage/Radish/Leafy vegetables
Horticulture
Apple/Apricot/Walnut (100 plants)
Livestock
Cow (01)/ sheep(50)/Goat (50) + Backyard Poultry (100)
Others
Vermi-composting (20m2)

Strategy 4 : Reducing post harvest losses and value addition

Establishment of mini fruit grading plant for Apple, Walnut and Apricot at Joshimath block

Promotion of common resources on custom hire basis viz. Power tiller, Potato Ridger, power sprayer and other horticultural tools and other equipments at Nyay Panchayat level in Joshimath block

Strategy 5 : Waste land development and waste water treatment

1. Contour bunding for arable purpose in waste land in Joshimath block.
2. Afforestation of plants and perennial grasses in steep slope of more than 40% slope in high altitudes of Joshimath block
3. Plantation of Sea buck thorn, at high altitudes of Joshimath block.
4. Construction of check dam and artificial structure to maximize water percolation rate Joshimath Blocks.

Strategy 6 : Reduced cultivation cost

1. Adoption of Power weeders, horticultural kits, power tree sprayers may provided through custom hiring centre at each Nyay Panchayat.
2. Promotion of specific fertilizers and micronutrients like Zink, Boron, Phosphorus, etc. may be provided at cluster level.
3. Promotion of timely availability of seeds, fertilizers, insecticides, pesticides etc. at Nyay Panchayat level.
4. Organisation of trainings to increase scientific Knowledge.
5. Promotion of practice of IPM and INM by farmers

Strategy 7 : Off-farm income

1. Encouragement to existing SHSs for collective farming, opening small scale enterprise like Pickle making, Jam & Jelly making, & packing, etc. may be provided for better performance at cluster level.
2. Establishment of distillation unit for medicinal & aromatic plants at Dharali and Sankari-Jakhol cluster.
3. Promotion to micro entrepreneur employment through Bee keeping, Processing of fruits, vegetables, Woollen knitting & Handicraft, Agri-clinic at each cluster

Strategy 8 : Enabling Policies

1. Promotion of crops like Lilium, carnation, gerbera, rose, orchids and other bulbous flowering plant.
2. Promotion and cultivation of Marigold for meeting the demand of religious places like Badrinath and other religious places in Karnprayag, Gairsain and Ghat blocks.

Strategy 9: Marketing and value addition in specific agro-ecological region

1. Installation of mini mandies to be established at Harshil & Sankari.
2. Strengthening of Cooperative societies may become a tool of marketing channels.
3. Promotion of better transportation facilities with cold chain van may be provided at Block level.
4. Creation of direct linkages with food processing industries for better prices.

5. Installation of Fruit & vegetable processing units in clusters.
6. Incorporation of Post harvest facilities including grading, packaging for Processed /raw fruits and vegetables in each clusters.

Strategy 10 : Online Management and Evaluation

1. Development of mobile apps/ software for online management and evaluation may be developed and farmers as well as concerned experts may be linked with it.
2. Formation of district level committees of State line departments with KVK experts for field and as well as online monitoring, evaluation and feedback.
3. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
4. Organization of monthly review meeting at district to solve the problems related with farmers.
5. Promotion of use of radio, TV talks and use of Whatsapp etc. for effective implementation of program.

Summary Recommendations:

Strategy 1: Productivity Enhancement

Introduction, adoption and popularization of high yielding varieties for increasing productivity

1. Promotion of high yielding varieties of major field crops, vegetable crops, fruit crops, medicinal crops, fodder crops and ornamental crops.
2. Promotion of high yielding milk, meat, wool, egg & meat breed of different cattle's, Buffaloes, Sheep, Goat and poultry birds.

Strengthening of traditional water storage structure.

1. Strengthening of existing water storage structures like ponds, Naula and Check dam in most of the villages.
2. Construction of water harvesting check bunds to harvest the rain water.
3. Construction of rain water harvesting structures (LDPE tank, Cemented tanks) in private as well as government buildings.
4. Construction of trenches for high percolation of water in valley area
5. Promotion of water conservation techniques like mulch, sprinkler and drip irrigation system in juvenile plants in low or valley areas.
6. Efficient management of rain water harvesting with drip-fertigation system.
7. Strengthening of existing Hydrum system of irrigation.
8. Popularization of low cost lining material to check seepage in the region.

9. Establishment of roof top water harvesting structures in all households.

Adoption of cluster approach for holistic development

1. Strengthening of old fruit belt by introduction of new cultivars of fruits crops.
2. Popularization and promotion of zero energy cool chamber among farmer group at Nyay Panchayat level.
3. Promotion of organic cultivation of Ginger/ turmeric in low valley areas.
4. Promotion the cultivation off season vegetables (tomato, potato, capsicum, cole crops etc.).
5. Promotion of production of major area specific field crops.
6. Promotion of irrigated areas for seed production of rice and wheat.
7. Promotion of production of major area specific vegetable crops (tomato, vegetable pea, okra, French bean, onion, garlic with the use of proper crop rotation.
8. Promotion of organic cultivation of different crops (basmati rice, finger millet, barnyard millet, horse gram, bhatt, ginger, turmeric).
9. Fallow land development under agro-forestry in the region.
10. Promotion of common minimum programme technology in vegetables to reduce the cost of cultivation and quality produce.

Management of wild animal problem

1. Promotion of live fencing of lime/ lemon at larger scale in fruit crops, ginger or turmeric in shady areas, Lemon grass to ward off wildlife in cultivated field.
2. Promotion of chilli, capsicum & okra as these are least affected by monkey menace.
3. Enacting legislative measures for protection of crop from wild animals.
4. Promotion of protected cultivation of vegetables (Tomato, Capsicum, Cabbage, Cauliflower and Cucumber) in the blocks of the state.
5. Promotion of cultivation of Kafal, Mango, Hishalu, wild walnut, Mahal and other wild fruits in different pockets in forest areas for wild animals.

Adoption of farm mechanisation

1. Popularization of multi crop thresher and Power Tiller/ Mini Tractor at Nyay Panchayat level in Uttarakhand.
2. Promotion of improved Naveen sickle, Dung collector, maize sheller& peeler for drudgery reduction of farm women in the state.
3. Popularization of manually operated mini crop harvesters for rice, wheat and millets.

Management of soil health in low or valley areas

1. Popularization of soil sampling and soil testing in intensive mode and distribution of soil health card to farmers for judicious use of Manure and fertilisers.

2. Promotion of vermi composting unit of this region and adoption of well decomposed FYM and other compost.
3. Promotion of cultivation of green manuring crops like Sesbania, Sunhemp, and lobia in Uttarakhand.
4. Popularization of biofertilizers like *Rhizobium, Azotobacter, Azospirillum*, PSB, PSM, K solubilising micro-organism and use of these biofertilizers with FYM at the time of sowing.
5. Fortification of FYM with *Pseudomonas* and *Trichoderma.*
6. Promotion of Bio-fertiliser/soluble fertiliser based farming especially in rainfed areas of Uttarakhand.
7. Adoption of integrated nutrient management in irrigated areas of rice and wheat.
8. Promotion of pulses crops in crop rotation to improve soil fertility and productivity.
9. Popularization of soil and water conservation measures by pulse based intercropping, contour farming and shoulder bunds in particular rainfed areas of Uttarakhand.
10. Organic cultivation of traditional crop viz., fingermillet, barnyard millets, black soybean, horsegram, traditional rice of state.
11. Promotion of soil testing kits in all blocks of the state.

Others

Cluster approach for holistic development.

1. Seed treatment through bio agent strictly in the cluster
2. Promotion of timely and local availability of high yielding varieties of all the cereal, pulse, oil crops, High value crops like vegetable, fruits, spices, etc.
3. Protected cultivation in vegetable crops.
4. Cultivation of fodder and forage crops & medicinal plants.
5. Adoption of only well decomposed FYM/ value added compost.
6. Promotion of efficient and timely use of IPM and IDM practices.
7. Adoption of moisture conservation practices.
8. Promotion to focus on timely sowing and weed management.
9. Promotion of biotic & abiotic stress resistance varieties and alteration in cropping pattern.
10. Promotion of Pusa Hydrogel technology in the cultivation of vegetables, pulses and cereals.
11. Compulsion of seed treatment through bio agent/ chemical in the cluster.

Strategy 2: Livestock, Goatry, Poultry, Fisheries

1. Promotion of high milk breeds of cows, buffaloes and goats while promotion of wool yielding breeds of sheep.

2. Introduction and promotion of cross Heiffer by Artificial Insemination (AI) for increasing income of marginal farmerat block level in the state.
3. Development of good nursery of fishes and availability of good species of fingerlings is required; fisheries should be promoted through favourable policies.
4. Establishment of Fodder Bank at *each block /Nayay Panchayat* level to meet fodder/feed block and mineral blocks requirement particularly during lean period.
5. Establishment of milk chilling plant at block level in the state.
6. Development of grass land in different villages of state.
7. Selection of more numbers of veterinary experts at *Nyay panchayat* level.
8. Promotion of urea, molasses, and mineral mixer blocks at *Nyaypanchayat* level.
9. Establishment of hatcheries for need of broilor / layer at block level in the state.
10. For need of broilor or croilor at district level to meet out the requirement of chicks to the farmer's.
11. Strengthening of traditional water bodies/ rivulets with Mahaseer or carps at block level in state.
12. Availability of feed material with low prices & timely health check-ups of animals.
13. Introduction and promotion of Cross bred milch breed of animal for increasing income of marginal farmer.
14. Planning for establishment of *Gaushala* at block level to rear unproductive cattles to avoid the damage crops in cultivated areas.

Strategy 3: Integrated Farming system

1. Following Integrated farming system model may be developed:
2. Protected cultivation+ Composting+Goatry/backyard poultry/Dairy
3. Fodder production+ Mini dairy+Composting+ Protected cultivation
4. Seed production (Lentil, Radish, Pea)+ Planting material supply+Mushroom
5. Vegetable based –protected cultivation + composting and Goatry/ Poultry
6. Live stock based- green fodder + Dairy, composting and Goatry/ Poultry+ Protected cultivation
7. Crop based- crop and vegetable+ Dairy, composting and Goatry/ Poultry.

Strategy 4: Reducing post harvest losses and value addition

1. Establishment of mini fruit grading plant for fruits at block level in Uttarakhand.
2. Establishment of Food and Processing Units/ Value addition centre at fruit/vegetable belt for pickle, jam and jellies making.
3. Establishment of procurement centre for efficient marketing of surplus fruit, vegetables.
4. More refrigerating van/Reefers for quick transportation for perishable commodities like

flowers and vegetables.

5. Promotion of cluster approach for efficient procurement and disposal of surplus fruits and vegetables in all the blocks.
6. Promotion of common resources on custom hire basis viz. Power tiller, Mini Thresher and other equipments at *Nyay Panchayat* level.
7. Establishment of packaging infrastructure at village level with packaging, sewing, sealing and labeling facilities.
8. Establishment of marketing chain for efficient/timely supply of produce/product.
9. Creation of larger facilities of infrastructure for reducing post harvest losses in horticultural commodities viz. Long term storage, warehouses.
10. Development of cottage industries at village level for unfinished products.
11. Cluster approach is useful for small and marginal farmers to procure input and disposal of surplus in areas.
12. Establishment of storage facilities like warehouses, cold storage and cold chamber at each block level.
13. Gravity ropeways to be constructed to provide road head access to the farm produce need to be taken to be taken at a larger scale.
14. Private investment must also be encouraged in post harvest technology and infrastructure to bridge the gap in agricultural marketing.

Strategy 5: Waste land development and waste water

1. Contour bunding for arable purpose in waste land in high hills areas.
2. Afforestation of plants and perennial grasses in steep slope of more than 40% slope.
3. Need to develop more forest nurseries to supply fodder plants to farmers in rainy season.
4. Plantation of Mulberry plants, Wild fruit plants, Fodder trees (Bheemal, Utees, Oak etc.) may be promoted.
5. Popularization of soil bunds to save excessive loss of nutrients in wasteland of Uttarakhand.
6. Popularization of trenches or silages for percolation of water to avoid surface run off in Uttarakhand.
7. Construction of check dam and artificial structure to reduce run off and maximize the water percolation rate.
8. Construction of tank for storage of water for lean season.
9. Establishment of storage system for rain water in monsoon season.
10. Popularization of roof water harvesting system in different villages in the state.

Strategy 6: Reduced cultivation cost

1. Judicious application specific fertilizers and micronutrients like Zink, Boron & Phosphorus etc. after soil testing in every block.

2. Promotion of Custom Hiring Centre (CHC) for the use of Power tillers, Power weeders, Paddy threshers, Wheat threshers, Mandua/ Madira threshers, Maize Sheller, Wheel Hand hoe, Manual/ power operated Wheat/Paddy reapers etc.) Power sprayer, mechanical fruit harvester at cluster or Nyaypanchayat level.
3. Establishment of sales and community centres at each cluster for easy and timely availability of seeds, seedlings, fertilizers.
4. Promotion of Zero tillage method of sowing in cereals.
5. Promotion of well decomposed FYM, Vermicompost and Biofertilizers to minimize the use of chemical fertilizers.
6. Promotion of line sowing and fertilizers application in crops.
7. Promotion of recommended seed rate, spacing and depth.
8. Promotion of timely availability of seeds, fertilizers, insecticides, pesticides etc. at Nyaay Panchayat level.
9. Promotion of hand tools in agricultural and horticultural operations.
10. Promotion of mulching (bio or degradable plastic) to maintain moisture and reduce intercultural operation cost.
11. Promotion of need based application of pesticides and other agricultural inputs.
12. Promotion & use of trichocard, light trap & pheromones trap for control of inspect-pest in different horticulture/vegetable/cereal.
13. Promotion of pressurized irrigation techniques in horticultural crops.
14. Implementation of*Chakbandi* of scattered land.
15. Minimization of Rain fed condition.
16. Organisation of trainings to increase scientific Knowledge.
17. Facilitation of farmers with weather updates.
18. Promotion of practice of IPM and INM by farmers.
19. Increase in number of sales and community centres for easy and timely availability of seeds, seedlings, fertilizers and required information in each block.
20. Avoid broadcasting of seeds and fertilizers in crop production program.
21. Use of modern techniques to use water use efficiency in horticultural crops.

Strategy 7: Off-farm income

1. Promotion of subsidiary occupations like poultry, fish farming and mushroom production.
2. Promotion of apiculture for small and landless farmers.
3. Promotion of sericulture in low hills or valley areas in Uttarakhand.
4. Promotion of cultivation and collection of medicinal aromatic plants in the state.
5. Emphasis on promotion of religious tourism for PanchKedarYatra to serve organic and local delicacy.

6. Promotion of skill development for Nursery raising techniques in fruits and vegetables, Handicraft, commercial dairy business, Orchard Management, Processing methods for women and youth.
7. Encouragement to existing SHGs for collective farming, opening small scale enterprise like Candle making, Pickle making, Jam & Jelly making, Spice cultivation, Ghee making & packing, aipen, jute bags, Woolen clothes, candle making, squash, pickles, mushroom production, homemade/ value added products (bari, papad, namkeen, biscuit) etc. may be provided for better performance.
8. Promotion of SHGs for value addition and primary processing and linking them to market (Buy back system).
9. Increasing awareness towards education which is helps in getting employment to the rural youth, farm women.
10. Development of online advisory centres by trained youths.

Strategy 8: Enabling Policies

1. Consolidation of land holding either forcefully implementation by govt or by mutual understanding at *village level*
2. Increasing institutional support by providing subsidises and incentives to *small and marginal farmers.*
3. Labelling of organic inputs and certification mechanism for various crops/fruits and vegetables.
4. Popularization of Udhyan and Krishak Cards for widespread use of government incentives/ subsidies to farmers.
5. Establishment of mother orchard to meet the present and future demand of germplasm in horticultural fruit crops.
6. Implementation of effective and workable Nursery Act to avoid spurious or unreliable planting material/seedlings in the state.
7. Ensure sustainable agriculture through more efficient utilization of land, water and other resources.
8. Promote mechanization through small implement suitable for hills, provide maximum subsidy for sprinkler and drip irrigation facility and protected cultivation of vegetables.
9. Creating new market for purchase of farm produce specially horticulture crops at block level and providing facilities for maintaining cool chain for sending the produce from the state to distant market with in the country and abroad.
10. Floriculture has immense potential to boost the economy of farmers as well as the state therefore potential floriculture crops like Lilium, carnation, gerbera, rose, orchids and other bulbous flowering plant should be promoted in *all t*he blocks.
11. Promotion and cultivation of Marigold for meeting the demand of religious in religious places of Uttarakhand.

12. Implementation of Soil Health Card Scheme at gram panchyat level.
13. Implementation of policies for control of wild animal menace in agricultural areas.

Strategy 9: Marketing and value addition

1. Establishment of cold storage in all blocks of Uttarakhand.
2. Creation of better transportation facilities with cold chain van at block level in Uttarakhand.
3. Creation of direct linkages with food processing industries for better prices.
4. Establishment of strong linkages with various stack holders to furnish information on crop produce and surplus.
5. Establishment of procurement and collection centre at Nyaypanchyat level for agricultural surplus with proper labelling.
6. Formation of district level committees of State line departments with KVK experts for field and as well as online monitoring, evaluation and feedback.
7. Installation of mini grading machines at village level in Uttarakhand.
8. Establishment of mini mandies at block level in the state.
9. Creation of direct linkages with food processing industries for better prices.
10. Establishment of strong linkages with various stack holders to furnish information on crop produce and surplus.
11. Promotion of localHatt at Tahsil level in the blocks.
12. Development of proper marketing network to check the interference of middle men in marketing of agricultural produce of the farmers.

Strategy 10: Online Management and Evaluation

1. Development of Mobile apps/ software for online management and evaluation at district level.
2. Development of e-Marketing and kiosk at district level to have information of surplus commodities at block level.
3. Organization of monthly review meeting at district to solve the problems related with farmers.
4. Promotion of use of community radio, TV talks and mobile app etc. for effective implementation of programme. Weather forecasting and contingency plan.

SUCCESS STORIES

Success Story of Sugarcane Production Technology (U.S. Nagar)

Name of farmer : Chaudhary Satendra Singh
Village : Shahdora Farm (Kichha)
District : U.S.Nagar
State : Uttarakhand
Mob. No. : 09690458006
Crop : Sugarcane
Variety : Co0238, Co0239, CoS88230

Cultivation Practice : Trench Method
Intercropping : Chick pea
Cane Length : 18 feet
Cane weight : 3.5 kg
Yield : 2225q/ha
Award :कृषि पंडित, उत्तरा खण्ड सरकार, 2016

Component	Farmer Practice	Trench method
Yield (q/ha)	1000	2225
Cost (Rs/ha)	150000	215000
Gross return (Rs/ha @ 317/q)	317000	705325
Net Return	167000	490325
Net Return from inter crop	20000	30000
Total Profit (Rs/ha)	187000	520325
Change in income (Trench: Farmer practice)		2.78

Ginger Cultivation: An Alternative to Organic Farming in Rudraprayag

Brief about the study area major technological interventions		
1.	**Village (Rudraprayag distt)**	**Narayankoti**
2.	**No. of farm families targeted (beneficiaries)**	**120**
3.	**Net cultivated area targeted families (ha)**	**5**
4.	**No. of small farm families involved**	**250**
5.	**Total area under ginger cultivation after 2 years intervention**	**150 ha**
6.	**Total production of the distt (approx)**	**150 tonnes**

Impact of organic packages of practices in ginger

S. No.	Parameter (s)	Before intervention	After intervention	Percentage increase
1	Area (Ha)	25	150	600
2	Productivity (q/ha)	60	100	60

Treatments	Yield with Unit (q/ha)	% change in Yield	Incidence of rot (%)	% change in Parameter	Net Income (Rs)	BC Ratio
Farmer's practice	85.0	-	22.5	-		
Use of organic mulch and Bioagents + Pant Bioagent 3 as soil and seed treatment	100.0	17.64	8.0	64.44	1,82,540	2.22

29

UTTAR PRADESH

Uttar Pradesh is the fourth largest state with 75 districts. UP is the most populated state in India (16.5% of total population) with 19.95 crores population (2011 Census) with an area of 24.09 million hectares covering large part of the highly fertile and densely populated upper Gangetic plain with the state average population density of 828 persons per km^2.

Uttar Pradesh is located between 23052'-31028'N Latitudes and 7704'-84o38'E longitudes. Geographically it is situated in one of the most fertile tracts of the country i.e. Ganga and Yamuna basin. The state is divided in 9 Agro Climatic Zones. The area of 13 districts fall in two agro-climatic zones and62 districts are covered in single zones. The area of 13 districts fall in two agro-climatic zones and62 districts are covered in single zones.

Uttar Pradesh with diverse agro-climatic conditions and cropping systems has high potential for agricultural development. However, lack of optimal infrastructure (like roads, electricity, marketing, processing, transportation, irrigation, *etc.* has been the limiting factor in realizing the requisite potential of the agricultural sector in the state. Uttar Pradesh is a state where opportunities in agriculture sector outnumber the constraints in the productivity improvement. There is tremendous scope to bring the state among the best performing states if targeted technological interventions are equally supported by required infrastructure and relevant policy framework. Scaling up and strengthening farm mechanization with low-cost small equipments for field operations and also for on-farm post-harvest processing, value added product development, cold chain development for perishable agricultural produce for reducing post harvest losses, effective surplus management and enhancing higher profit returns.

Six out of nine zones possess better irrigation facilities and soil fertility status where rice-wheat, rice-sugarcane cropping systems are most popular and these zones mainly contribute to rice, wheat and sugarcane production.

Three zones viz, South Western Semi Arid zone, Bundelkhand and Vindhyan zones possess relatively low irrigation facilities and soils are also average-to-medium in fertility and contribute major share of pulses and oilseeds production in the state.

Uttar Pradesh has huge diversity with 9 agro-climatic zones characterized by

- Dryland areas of Bundelkhand with an annual rainfall of about 65 cm.

- North-Eastern parts of the state receiving 140 cm annual rainfall.
- Temperature varies from 1.50C recorded in Western Plain zone to 47.80C in Bundelkhand zone.
- The cropping intensity varies from 111% (Bundelkhand region) to 157% (Western region).

Major limitations of different agro-climatic zones are

- Sodic soils in Central Plain.
- Brackish water, alkalinity and undulating ravines in South Western Semi Arid zone.
- Rainfed situation in Bundelkhand.
- Flood-prone area in North Eastern Plain zone.
- Saline & alkaline soils and *diara*lands in Eastern Plain zone.
- Undulating and rocky area in Vindhyan zone.
- Salinity & alkalinity, water logging in Western Region.
- Problem of drainage in Bhabar & Tarai zone.
- Six out of nine zones possess better irrigation facilities and soil fertility status where rice-wheat, rice sugarcane cropping systems are most popular and these zones mainly contribute to rice, wheat and sugarcane production.

Three zones viz, South Western Semi Arid zone, Bundelkhand and Vindhyan zones possess relatively low irrigation facilities and soils are also average-to-medium in fertility and contribute major share of pulses and oilseeds production in the state.

The major crops of the State are rice, wheat, maize, sugarcane, chickpea, urdbean and pigeonpea. The major crops of the State are rice, wheat, maize, sugarcane, chickpea, urdbean and pigeonpea, pulses chickpea, urd and pigeonpea occupied 1.82%,2.21% and 1.12%, rapeseed & mustard and sesamum (Til) are the two major oil seeds crops of the state. Of the gross cropped area mustard occupied 2.44% followed by 1.51% under sesamum and cropping intensity is 156%.

The productivity gap in Uttar Pradesh in different crops compared to national average ranges between 7.6 % to 47.5%.Majority of the state population depends upon farming activities. Uttar Pradesh is a major contributor to the national food grain stock.

It has been observed that the productivity enhancement during last five years in most of the crops have almost been decimal in the State.

This indicates that livestock is a potential source of income and its integration with other economic activities, making value added products and retail trading can play important role in doubling farmers' income. Uttar Pradesh ranks first in sugarcane, potato area and production and the state ranks first in milk production and contributes about 17% (26.4 million tonnes) to the total national.

29.1 Productivity Gaps and Major Constraints

Rice

Constraints

- Continuous use of traditional varieties and lack of awareness among farmers about high yielding varieties/hybrids specially in upland, rainfed, lowland and deep water areas.
- Poor plant population in case of direct seeding resulting in uneven germination (upland and direct seeded lowlands). Delay in onset of monsoon often results in delayed and prolonged transplanting and sub-optimum plant population (Mostly in rainfed lowlands).
- Iron and Zinc deficiency in low-rainfall regions and disease outbreak particularly sheath blight and bacterial leaf blight and also khaira disease due to Zinc deficiency.
- Inadequate area coverage under improved production technologies (for example SRI).
- Heavy infestation of weeds and insects/pests such as blast and brown spot and poor attention towards integrated pest management.
- Submergence and flash flood in rice particularly in eastern region.
- Occurrence of dry spell during crop growth period.

(i) Wheat

Constraints

- Late sowing of wheat resulting in exposure to higher temperature during the reproductive stage.
- Inadequate area coverage by using ferti-seed drill giving low fertilizer use efficiency.
- Infestation of diseases like yellow rust, leaf blight and loose smut and poor adoption of plant protection measures. Among the diseases, yellow rust, leaf blight and loose smut are the major constraints.
- Declining water table, inadequate labourer availability, imbalance fertilizer use, lack of knowledge about recent technologies and frequent disruption in electricity supply.

(ii) *Sugarcane*

Constraints

- Late planting mostly after wheat harvest with inadequate spacing.
- Cultivation of obsolete cane varieties on large areas.
- Limited availability of quality seed cane of improved varieties.
- Excessive use of urea.
- Non-adoption of scientific ratoon management practices.

- Occurrence of red rots and stem borer.
- Inadequate adoption of improved mechanization practices recommended for sugarcane cultivation

Pulses

Constraints

- Cultivation of pulses under rainfed condition (Chickpea 82% and pigeonpea 87% rainfed).
- Inadequate availability of quality seed of improved varieties.
- Pod borer infestation in pigeonpea and chickpea.
- Weed infestation and lack of proper weed control measures.
- Infestation of yellow mosaic virus disease particularly in urd and mungbean.

Oilseeds

- Cultivation under rainfed condition.
- Preference for the cultivation of cereals by small and marginal farmers to meet their family demand.
- Poor seed replacement rate particularly in sesamum (Til).
- Exposure to aberrant weather situation leading to incidence of pest and diseases like Sclerotinia disease, aphid and white rust infestation in rapeseed & mustard, white grub and collar rot infestation in groundnut, phyllody and Bihar hairy caterpillar infestation in sesamum and infestation of linseed bud fly and boll worm.
- Lack of adequate market facilities.

(vii) Fodder

- Competition of fodder crops with grain crops, vegetables and pulses.
- General tendency of the farmers to use sugarcane tops as green fodder which leads to nutrient deficiency in milch animals (e.g., Calcium deficiency).
- Poor seed chain of improved fodder varieties and inadequate training on seed production..
- Farmers not fully aware about role of quality fodder in milk production
- Inadequate intervention on fodder production by the State Animal Husbandry Department.
- Inadequate database on fodder in the State.

(vii) Potato

- Poor seed replacement rate.
- Excessive use of fertilizer especially urea.

- Traditional post-harvest practices.
- Adverse effect on production if temperature is more than 300C at the time of tuberization.
- Inadequate value chain.

(viii) Vegetables, Fruits & Flowers

Constraints in vegetable production

- Inadequate availability of quality seeds/hybrid seeds.
- Inadequate soil management and reduced soil organic matter content like green manuring, addition of compost/FYM etc. as vegetable crops require fertile soil.
- Lack of adequate storage, transport and market facilities.
- Inadequate agro-based industries in vegetable cluster areas.

Constraints in fruit production

- Cultivation of seedling varieties.
- Limited availability of quality planting materials.
- Lack of awareness about production technologies including IPM technologies.
- Poor management practices/predominance of unmanaged orchards.
- Declining yield of existing old orchards.
- Exorbitant post-harvest losses during harvesting, storage and transport.
- Poor infrastructure for processing/value added products.
- Inadequate market intelligence.

Constraints in flower production

- Lack of synchronization of flower production with its market demand during different festive seasons, marriage occasions, other occasions etc.
- Poor adoption of improved production technology.
- Inadequate availability of quality seeds and planting materials.

Constraints in livestock production

- Infertility problem of cow and buffalo.
- Lack of availability of quality green fodder and area specific mineral mixture.
- Low success rate in AI in rural areas.
- Low level of technical skills, entrepreneurship of the farmers and poor success in crossbreeding programme.
- Unorganized cooperatives and restricted flow of credit in the context that most of the technologies advocated to farmers are costly.
- Old breeding policy (2002) which needs to be revisited.

- Lack of preference for Goat/Sheep husbandry by small holder.
- Lack of slaughter facilities in the domestic trade especially in rural and remote areas is leading to production of unhygienic and poor quality meat. Further the byproducts obtained during slaughter remain unutilized or underutilized and causing environmental pollution.
- Inadequate Veterinary Infrastructure and livestock services delivery system.

Poultry

Constraints in Poultry

- Low availability of good quality poultry germplasm.
- Loss of poultry birds due to pathogenic diseases particularly New castle disease, Fowl cholera etc.
- Poor input delivery system.
- Inadequate cold chain facilities.
- Inadequate capacity for proper hatchery management and feed formulation.
- Lack of new marketing strategies for augmenting sale of poultry and poultry products.
- Lack of organised cooperatives and cluster farming for better utilization of resources.

(xii) Inland Fish

Constraints in aquaculture

- Aquaculture is not used as primary farming and entrepreneurship activity.
- The large water bodies are not in use for fish farming due to poor quality.
- Adoption of traditional practices, low input and with limited use of quality seed and feed formulation by the fish farmers.
- Lack of capacity building/awareness of farmers for best aquaculture practices including disease management.
- Fisheries sector not getting equivalent status like agriculture, facing difficulties in getting loans and rate of electricity being very high.

29.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

	Strategy	Action Plan
1.	Low productivity of crops as compared to national average and efforts are required to improve the productivity /situation	Crop diversification, varietal intervention, intercropping and crop establishment techniques like SRI (System of rice intensification), SWI (System of Wheat Intensification). On-farm and In situ moisture conservation and water management, increasing water use efficiency through micro-irrigation e.g. drip/sprinkler system, bed planting, spaced sugarcane planting techniques (SPAT) for quick multiplication, cultivation of short-duration summer mungbean after wheat and its intercropping with sugarcane, increasing cropping intensity in rice-fallow areas by promoting cultivation of short-duration lentil, linseed and mustard for higher returns. ❖ Adoption of SRI technology using high yielding varieties/ hybrids leading to enhancing production by 20-25%. Green manuring before rice cultivation for improving soil organic matter content and foliar spray of micronutrients for correcting Zinc and Iron deficiency. ❖ Popularization of Swarna Sub-1 rice variety in waterlogged areas. ❖ Adoption of input use efficient high yielding varieties for improving production by 10-15% over traditional low productive varieties. The potential varieties are listed in Table 32, Table 33, Table 34, Table 35, Table 36 and Table 37. ❖ Immediate distribution and dissemination of leaflets and bulletin containing information about promising varieties, recent technologies, system intensification models, several Government schemes, success stories etc. ❖ Promoting fertilizer management in different crops based on soil health card/soil test values for reducing excessive application of fertilizers especially urea.
2.	Promotion of drip, sprinkler irrigation system and water saving technologies for increased water use efficiency	Replacement of tradition flood method of irrigation with furrow method of irrigation in Broad Bed Furrow (BBF), Bed Planting and Furrow Irrigated Raised Bed (FIRB) systems for improving irrigation efficiency by 40-50% and production by 20 to 25% over flat method of crop establishment.

	Strategy	Action Plan
3.	Incentivise protected/ polyhouse cultivation with micro- irrigation for high value off-season vegetables and flower production.	Promoting micro-irrigation like drip irrigation with fertigation concept in high value crops like protected vegetables and flowers cultivation, orchard and sprinkler irrigation in undulating topography for improving irrigation efficiency by 60 to 80%. Incentivization of improvised low-cost drip irrigation system to the small land-holders. ❖ Adoption of spaced sugarcane planting techniques (SPT) for quick multiplication for increasing production by 25-30% by saving the canes normally used for seed purpose. ❖ Adoption of bud-chip/cane node technology and deep trench method (up to 1m) of planting technique which may increase production by 20-30%.
4.	Target to achieve 175% cropping intensity from existing 150%	❖ Popularizing short duration summer mung after wheat as catch crop for increasing cropping intensity, total system production by 10-15% and soil health. ❖ Inclusion of short duration lentil, linseed and rapeseed & mustard as a rotation crop in rice-fallow areas under Eastern Plain zone for increasing cropping intensity and total system production by 15-20%.
5.	Crop diversification and intensification as risk mitigating mechanism.	❖ Promotion of crop diversification with fruits, vegetables, oilseed and pulses and crop intensification through adoption of intercropping for risk mitigation, providing complementary advantages and increase system production by 15-20% Promising Inter-cropping systems are listed in **Table 38.**
6.	Rejuvenation of senile orchards for increasing productivity of fruit crops.	Rejuvenation of senile orchards for increasing productivity in mango, guava, ber and aonla as most of the orchard in Uttar Pradesh is old.

	Strategy	Action Plan
7.	Strengthening seed chain of quality seeds of promising varieties and increasing seed replacement rate. Production of vegetable seeds and disease/pest free planting materials by public sector for reducing cost	Rigorous monitoring of seed supply chain to provide good quality seeds at cheaper rates, especially seeds of vegetable crops, by enhancing seed production at public institutions and Universities to minimize the cost of cultivation and increased seed replacement rate (SRR). ❖ Ensuring availability of quality seeds of the improved varieties particularly in case of chickpea, lentil, barley, bajra, Pigeonpea and groundnut in seed chain for which Universities and public institutions will have to share the responsibility in popularizing the improved varieties by seed production and making them available to the farmers at reasonable rates and also for rigorous monitoring in seed supply chain for increasing seed replacement rate. ❖ Creation of sugarcane seed village hubs with rapid seed multiplication technique for seed production and promotion of seed production at sugar mill farms. ❖ Creation of community-based low energy vegetable seed village hubs to increase availability of quality seed materials. ❖ Fodder seed production particularly in Western Plain zone in order to cater the needs of fodder seed, particularly Berseem and Lucerne to the other parts of the State.
8.	Crop residue management	Abolish crop residue burning, promote conservation agriculture, utilization of farm waste by adoption of low- cost technology for ermin-compost preparation, emphasis on soil microbial inoculants development by the rural youths. ❖ Promotion of combine bailing technology through mobile feed block technique and urea treatment of crop residue for producing quality dry fodder and adoption of zero tillage technology for handling crop residue. ❖ Adoption of conservation agriculture for improving soil organic matter and reducing production cost by 25-30% by reducing the number of tillage operations, combining several operations together and increasing production by 15-20% through placement of seeds and fertilizer. Crop residue to be used as mulch to reduce water losses. ❖ Entrepreneurship development among rural youth for establishing low-cost compost unit and soil microbial inoculant-cum-bio-fertilizer unit through the intervention of KVKs and State Department of Agriculture.

	Strategy	Action Plan
9.	Adoption of integrated farming system (IFS) models involving crop horticulture, livestock and fisheries to enhance farm income and ensure risk mitigation mechanism, particularly for small/marginal farmers and also Incentivization to cluster based farming.	❖ Adoption of integrated farming system models for recycling of resources and by-products, reducing dependence of inputs like fertilizer from external sources and generating round the year employment for farmers' family members. ❖ Promotion of IFS models among small land holders for increasing on-farm income by 50-60% and mitigating risk against the aberrant weather conditions and biotic stresses. ❖ IFS models for different zones have been listed in Annexure VII.
10.	Speedy delivery system of inputs and agricultural produce.	Mechanism to ensure right time availability of inputs/resources to the farmers including good quality seeds, fertilizers and electricity for irrigation, infrastructural development to improve road connectivity for quick delivery of inputs and agricultural produce. ❖ Develop mechanism to ensure right time availability of quality inputs like seeds, fertilizers, bio-fertilizer, other agro-chemicals for facilitating sowing of seeds at optimum time and adoption of crop management practices at proper time. Ensuring availability of sulphur in oilseeds producing areas. ❖ Ensuring supply of electricity for irrigation at critical stages of crops for improving production by 30-35%. Development of infrastructure in terms of road connectivity for speedy delivery of inputs and transportation of agriculture products for minimising transportation losses up to 4% and maintaining better marketing quality for higher market price. ❖ Joint linkage between public sectors like State Departments, KVKs, ATMA, SAUs, ICAR institutes and private agencies like seed agencies, fertilizer agencies etc. for sharing information and right time availability of inputs to the farmers. ❖ Policy initiative by the State Government for improving road connectivity and road networking for speedy movement of inputs and agricultural produces.

	Strategy	Action Plan
11.	Promotion of low-cost improved farm implements and incentivise farmers for designing and manufacturing of low-cost farm machineries and implements and custom hiring of implements	Scaling up and strengthening farm mechanization with low-cost small equipments for field operations and also for on-farm post-harvest processing, value added product development, cold chain development for perishable agricultural produce for reducing post-harvest losses, effective surplus management for enhancing higher profit returns. ❖ Promotion of low-cost small implements already available in the market for sowing, weeding, irrigation and harvesting operations to the small land holder for reducing cost of cultivation. ❖ Adoption of laser based land levelling system as water saving technology (saving of water by 10-15%), use of harvester/ reaper, multi-crop thresher, transplanted of rice and vegetable seedling, multi-crop planter with vertical inclined seed metering devices for reducing production cost and enhancing productivity. Encourage energy use in Agriculture in view of reducing agricultural workforce in Uttar Pradesh. ❖ Surplus management through promotion of small equipment for packaging, grading of fruits and vegetables in post-harvest processing for increase self- life of product and getting higher market price.

	Strategy	Action Plan
12.	Creation of Special Agriculture Zone (SAZ) for potato, vegetables and fruits, cluster zone development, development of food processing parks and creation of cold chain facilities	Creation of Special Agriculture Zone (SAZ) and cold chain facilities at potato growing belt located at Agra, Firozabad, Hathras, Kannauj, Farrukhabad, Aligarh, Budaun, Etawah, Mathura, Mainpuri and Faizabad, vegetable growing belt at Varanasi, Budaun, Moradabad, Jaunpur and fruit growing belt at Lucknow, Saharanpur, Bulandshahr, Muzaffarnagar, Banda, Allahabad, Gorakhpur, Kanpur, Sitapur, Hardoi for handling excess production, prevent market price fluctuation and easy disposal of perishable product for higher market return. ❖ Framing enabling policies to encourage on farm processing, creating agri-export zones to promote export of agri-commodities from the state and developing strategies for market driven production system in the specific fruit growing belts like Dasheri mango in Malihabad, Chausa in Saharanpur-Meerut, guava in Allahabad and aonlain Pratapgarh. The commercial mango varieties grown in the state are Dasheri, Langra, Chausa, and Bombay Green and the major mango producing belts in the state are Saharanpur, Sitapur, Hardoi, Meerut, Bulandshahr, Lucknow, Faizabad and Varanasi. Major guava producing belts in the state are Allahabad, Farrukhabad, Aligarh, Varanasi, Kanpur and Budaun and have different ripening periods. ❖ Establishing vegetable Agro-Processing industries for producing processed vegetable products like green chilli powder, instant soup of moringa, bitter gourd chips, bottle gourd kheer mix, etc. in vegetable growing cluster areas located at Varanasi, Budaun, Moradabad, Jaunpur and creating linkages between processing industries and SAUs/ICAR-IIVR for utilizing post-harvest technologies developed by the Universities/Institutes. ❖ Replacement of obsolete refrigeration system in cold stores by technologically sound refrigeration system for improving efficiency of cold storage. ❖ Policy initiative by State Government to execute the creation of SAZ, creation of cold chain facilities and replacement of obsolete refrigeration system.

	Strategy	Action Plan
13.	Efficient water harvesting, ground water recharge technologies	Emphasis on rejuvenation of water bodies, surface water harvesting, desalting and ground water recharge and development of sustainable natural farming models at block level. ❖ Renovation of "Haveli" cultivation and renovation of old "Haveli" structure in Bundelkhand region for conserving rain water & growing crops in Rabi season. ❖ Rejuvenation of water bodies, desilting of ponds for water harvesting and ground water recharge for enhancing cropping intensity to 200%, crop productivity by 20-60% and reducing number of dry wells to 26% from 95%, at present. ❖ Micro algae culture for waste water treatment to remove heavy metal and toxic organic compound to make water enable for irrigation purpose. ❖ Development of sustainable natural farming models at block level through participatory mode for empowering farming community. ❖ Thrust on maintenance of existing irrigation projects to reduce the gap between Irrigation Potential Created (IPC) and Irrigation Potential Utilized (IPU).
14.	Promote honey bee production to enhance pollination, develop mechanism to sustain honey bees survival during hot summer and promote household micro-processing of honey.	Promotion of bee keeping in mustard, vegetable and orchard growing tracts for harnessing mutual complementary effect by increasing production of crops (15-20%) and orchard (10-15%) through enhanced pollination and increasing honey production with overall increase in income by 60-70%. ❖ Capacity building and entrepreneurship development of orchard growers on honey bee keeping and household micro-processing techniques. ❖ Developing suitable mechanism on community basis for sustaining survival of honey bees during hot summer months by transporting honey bees to the cooler places like Himachal Pradesh.

	Strategy	Action Plan
15.	Training, Capacity Building, Entrepreneurship development and Women Empowerment	Capacity building of rural youth and farmers on specific areas like seed production, promotion of high value crops, livestock, poultry and fisheries, good quality silage preparation, rapid dissemination of improved technological interventions to minimize cost and maximize net returns, developing entrepreneurship skills, check migration to urban areas and convergence of KVK, ATMA, extension functionaries of State Line Department, SAUs and ICAR Institutes for strengthening extension education programme and also creating awareness about Pradhan Mantri Kaushal Vikas Yojana (PMKVY) and Pradhan Mantri Yuva Yojana. ❖ Capacity building and skill development on different crops and agricultural commodities listed in Table 39. ❖ Entrepreneurship development of different agricultural commodities and off-farm sector listed in Table 40. ❖ Creating Incubation Centres for experiential learning and Training Centres for providing training to the rural youth in livestock/poultry/fish farming. Expedite integrated industrial township projects in Auraiya and Jhansi. ❖ Creation of 100 crore corpus to promote incubators and start-ups. ❖ Introduce district specific skill & livelihood generation policy. ❖ Encourage non-conventional use of energy in agriculture like solar pump, solar fencing. ❖ Provide broad band services in rural and distant areas via cable TV network.

	Strategy	Action Plan
16.	Creating awareness for the adoption of various Central/State Government Schemes like Pradhan Mantri Fasal Bima Yojana (PMFBY), Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), e-marketing, e-extension strategies, e-NAM portal, e-Pashuha at portal etc.	ICT, E-Extension (E-Farming, E-Trading and E-Learning) ❖ Promotion of e-marketing strategies through electronic communication technologies (ICT), such as internet, mobile phones and digital television, to accomplish marketing objectives by active involvement of functionaries engaged in agricultural development. ❖ Adoption of E-extension programme for facilitating networking with institutions and departments for agricultural crops and commodities. It is basically comprised by e-farming (Online farm and business advisor), e-trading (Online trading place) and e-learning (Online learning place for technologies and marketing). It maximizes the use of Information and Communication Technology (ICT) to attain a modernized agriculture. E-NAM Portal ❖ Capitalizing the benefits of E-NAM (National Agriculture Market) portal which provides a single window service of all Agricultural Produce Marketing Committee (APMC) related information and services. This includes commodity arrivals & price, buy & sell trade offers, provision to respond to trade offers, among other services. While agricultural produce marketing continues to happen through mandis, an online market reduces transaction cost and information asymmetry. E-Pashuhaat ❖ Utilizing the benefits of E-Pashuhaat portal which was launched by the Hon'ble Minister of Agriculture & Farmers Welfare for the first time in the country to connect the breeders and farmers for sale and purchase of germplasm. Through the portal breeder and farmers can sell and purchase breeding stock, access information on all forms of germplasm including semen, embryos and live animals with all the agencies and stakeholders in the country. Through this portal, farmers will know about the availability of quality disease free bovine germplasm with different agencies in the country. The portal will lead to propagation of high genetic merit germplasm.

	Strategy	Action Plan
17.	Popularization of Goat and Popularization of goatary and poultry among small Poultry among small farmer's including landless and innovative farmers' including landless practices for better income.	❖ Promotion of goatary in South Western Semi-Arid zone and Bundelkhand region for increasing goat population and maintaining goat unit at 5:1 (Male: Female) ratio. ❖ Development of kid nursery or Buck Mother Farm and establishing nucleus flocks of goat through PPP mode. ❖ Major thrust to promote poultry production and backyard poultry production (Dual purpose breed- CARI-Debendra, CARI-Nirbheek, CARI- Shyama, Layer breed-RIR (exotic), Ankleshwar (Desi), Pure Desi Breed-Aseel, Kadaknath, Nicobari-for hilly and Tarai areas), Turkey and Duck (Duck-Khaki Campbell, White Pekin and Desi breeds like Indian Runner) having immense potentiality to increase farmers' income by increasing egg and poultry meat production. ❖ Adoption of improved poultry production system like integrated duck-fish pond combination in which excreta of the poultry dropped into the pond to be used as feed for fish.
18.	Engaging mass media channels like FM radio, TV, newspapers, mobile phones, Face book and WhatsApp and Kisan Call Centres for rapid technology awareness, timely interventions and adoption at least cost.	Improve Coordination and convergence among KVKs, Agricultural Technology Management Agencies (ATMA), Extension Education Directorates & Departments in SAUs/SVUs, Extension education/Technology Transfer Divisions of ICAR institutes.
19.	Constitution of Agriculture Cabinet for coordination, reporting and periodical review under the chairmanship of Hon'ble Chief Minister.	Proposal for creating effective coordination mechanism by establishing a coordination cell with an empowered nodal officer including Agriculture and Home Science Scientist at district level linked with Agriculture Cabinet for reporting and periodical review of technology adoption and dissemination strategies of the respective districts with broad band connectivity and Video Conferencing facilities and being directly responsible to the Hon'ble Chief Minister/Agriculture Cabinet.

	Strategy	Action Plan
20.	Parampragat Krishi Vikas Yojana (PKVY) and Participatory Guarantee System (PGS) towards organic farming	Skilling farmers on organic farming by implementing Participatory Guarantee System (PGS) and creating awareness among the farmers about Parampragat Krishi Vikas Yojana (PKVY) implemented by Government of India. ❖ Decentralized Organic Farming Certification system, generally seen as precursor to third party certification required for exporting organic products from India. The small scale farmers in groups on cluster basis may be trained on PGS, while large farmers may be facilitated for third party certification in high value export oriented crops like Basmati rice, turmeric, ginger, medicinal and aromatic plants. Cluster based farming and formation of organic cluster be encouraged for ensuring mutual benefits. ❖ Educating farmers about the benefits of **Paramparagat *Krishi Vikas Yojana (PKVY)*** in which model organic cluster demonstration is organised in farmers' field in the area of 20 hectares for boosting/promoting organic farming among the rural youth/farmers/consumers/traders and disseminating the latest technology of organic farming in one or more clusters approved under PKVY scheme.
21.	Strengthening linkages between farmers and research institutions and promotion of Agri-Clinics/Agri-innovation hubs at block level and Agri/Rural tourism to supplement the income of farmers.	Agri/Rural Tourism ❖ Development of Agri/Rural-tourism at the outskirt of the selected cities like Varanasi, Mathura, Faizabad, Allahabad etc. on protected cultivation, micro irrigation system, milking devices, model cattle shed, natural farming, technology park, genetic garden with biofortified crop etc. ❖ Development of strong linkage between farmers and research institution for mutual sharing of expertise for empowerment, capacity building and entrepreneurship development of the farmers like honey bee keeping, household micro-processing of honey, household processing of fruits and vegetables, seeds and seedlings production, low-cost compost technology, farm mechanization, natural farming etc. by creating Agri-Clinics/Agri-innovation hubs.

	Strategy	Action Plan
22.	Technical backstopping to the private sector companies by agri-research institutions and SAUs to channelize their funds under corporate social responsibility (CSR) for agricultural development.	❖ Increasing funding to the SAUs for improving research & development infrastructure for generating location specific need based technologies for demonstration to the farming communities in different zones. ❖ Technological backstopping by these institutions to farmers via extension networks for raising agricultural production.
23.	Mass vaccination and regular deworming in livestock and poultry for increasing productivity.	Improving livestock and poultry health by mass vaccination against important diseases, deworming on regular basis, production of quality green fodder round- the-year, infertility management of cow and buffalo through availability of area-specific mineral mixture and broiler buffalo rearing for export quality meat production. ❖ Ensuring timely vaccination with the vaccines already available in the market against the major diseases like Foot-and-Mouth disease (FMD), Peste des Petits Ruminants (PPR), Black Quarter (BQ), Haemorrhagic Septicaemia (HS) in animals and Newcastle disease in poultry and regular deworming in animals against the major worms. This intervention can be implemented by the State Department of Animal Husbandry, SAU (Animal Science) in joint collaboration with ICAR-IVRI and ICAR-CARI. ❖ Promotion of mineral mixture supplementation, immuno-modulatory treatment for repeat breeders (low cost techniques) and use of crystoscope (detection of oestrus) for detection of right time of AI at field level can be executed by the State Department of Animal Husbandry in collaboration with ICAR-IVRI. ❖ Adoption of growing Bajra Napier Hybrid/Guinea grass and other perennial grasses on the bunds of field boundaries, irrigation channels and community farm land and other non-competitive land areas. ❖ Adoption of round the year green fodder production and food-fodder production models.

	Strategy	Action Plan
24.	Formulation of new State Livestock policy including review of the existing Livestock breeding policy formulated long back in 2002. These policies need to be revisited in view of the current National Livestock and animal breeding policies.	❖ The State Livestock Development Board should be proactive and take lead in improving productivity of the native cattle and buffaloes. The local cattle breed needs to be upgraded by selective breeding. ❖ In peri-urban areas, where crossbreds are maintained and breeding with exotic blood is adopted, the level of exotic blood should be maintained between 50-62.5% and not more than this limit in any case keeping in view the climatic condition of state. ❖ Under the breed improvement programme, local male which are not reared for breeding purpose must be castrated and their subsequent replacement (as per availability) by elite male in a phased manner to reduce the number of non-descript livestock and check indiscriminate breeding. ❖ Improving livestock producers' access to animal health services by strengthening and restructuring the public delivery system and forging private sector participation. ❖ Enable more rural and peri-urban households to use and enhance livestock production as a viable livelihood option which can ensure improved income, balanced family diets and generate employment.

	Strategy	Action Plan
25.	Conservation of indigenous cattle, popularization of milch goat breed, ensuring availability of vaccines, creating cold chain facilities in rural areas for effective vaccination and successful AI	Promoting conservation of Sahiwal, Hariyana, Gangatiri and Tharparkar breeds of cattle in Uttar Pradesh (Tharparkar in Bundelkhand Region) for improving milk productivity of indigenous cattle through selective breeding. ❖ Popularization of improved goat breeds (Jamunapari, Barbari, Beetal, Jakhrana or Sirohi) as milch goat having medicinal values in South Western Semi-Arid and Bundelkhand zones for getting higher market price. ❖ Shaping the veterinary hospital as complete health management, knowledge and resource service centres for providing single window service to the stakeholders in vaccination, deworming, infertility management, detection of proper time of AI including creating awareness about Government schemes, loan facilities etc. ❖ Creating cold chain facilities in rural areas for storing and maintaining quality of semen for successful AI and maintaining quality of vaccines for effective vaccination. ❖ Ensuring timely availability of vaccines for effective control of diseases.
26.	Community based cattle management, creation of Go Sambardhan Kendras, Natural Farming and development of Adarsh Clean Village.	Promotion of community approach for managing stray animal in Go Sambardhan Kendras at Panchyat level and the concept to be used for tackling Annapratha problems particularly in Bundelkhand region. Promotion of community-based bio-gas model for fuel, use of bio-gas slurry (by-product) as organic manure, cattle urine for crop protection, crop residue and tree leaves for mulching, Use of Trichoderma, Pseudomonas as bioagent for controlling soil borne diseases, Nuclear Polyhedrosis Virus (NPV) for controlling insects, bio-pesticides/bioherbicide (Streptomyces hygroscopicus, Colletotrichum gloeosporioides) for controlling weeds, Azadirachtin/ Neem oil for controlling insects and diseases. Use of pheromone traps for controlling adult population of insects in natural farming for harnessing several advantages in the form of adding organic matter in soil, controlling weeds and reducing chemical load in the system. Promotion of Adarsh Clean Village for converting chemical based farming to natural as well as organic farming.

	Strategy	Action Plan
27.	Management of wild animals for reducing menace in crop fields. Bio fencing/ natural fencing at field boundaries with agro-forestry plantation.	Policy formulation for controlling population of wild animals like Boselaphus tragocamelus (Nilgai) through community approach by mass castration of the wild animals and creating bio-fencing/ natural fencing at field boundaries with agro-forestry plantation for restricting invasion into crop fields.
28.	Creating off-farm income opportunity in rural areas like formation of farmers' producers companies and marketing of products developed in rural areas.	❖ Strategies to be adopted for organizing the producers, especially small and marginal farmers into producer organisation for addressing accessibility to investments, technology, inputs and markets. ❖ Linking producer groups directly to market opportunities for integration in the agriculture value chain and creation of direct producer consumer supply chains. ❖ Assisting farmers by the ICAR institutes, SAUs and State Line Departments to form groups, deal with marketing issues and link up, for example, with a wide range of service providers and finally linking with nodal officer of the districts for proper coordination, reporting and periodical reviewing of technological advancement by the Agriculture Cabinet.
29.	Harnessing potential for fisheries development	❖ Encouraging rural youth / farmers / entrepreneurs through different schemes to dig fish ponds on their private lands for enhancing fish rearing activities. ❖ Engaging private sector for quality fingerlings production, establishment of improved hatcheries, processing and marketing. ❖ Entrepreneurship development among rural youth on ornamental fisheries having potential, for which capacity building and handholding support be extended to set up ornamental fisheries units.

	Strategy	Action Plan
30.	Empowerment, capacity building and entrepreneurship development of Mahila Kisan	❖ Empowerment and capacity building of Mahila Kisans about household micro-processing, post-harvest value addition etc., creating Gram Panchyat Mahila Funds, creating awareness about the several National Schemes for Mahila Kisans, making inventory of the farmers who doubled their income and establishment of Farm School. ❖ The awareness of several National Schemes for Mahila Kisan like Support for Women Food Security Group (FSGs), Support for Gender Coordinator, Representation of Women Farmers in Decision Making Bodies, Outreach to Women Farmers, Promoting Women Groups like SHGs/ FIGs/FPOs/ Women groups/Co-operatives etc. for distribution of certified seed, leas out seed garden, installation of Pre-processing, Processing and oil extraction equipment/devices under Mini Mission –III, Back-ended composite subsidy towards cost of project to Women etc. by the State Department of Agriculture/ Horticulture, KVKs, ATMA in collaboration with ATARI and Farm School headed by Mahila Kisans.

Summary recommendations:

1. Growth rate of different economic activities reveals that cultivation/crop husbandry recorded fluctuating growth rate with the negative values during 2013-14 and 2014-15, whereas, Livestock/animal husbandry maintained a stable growth rate almost 5% during last five years. This indicates that livestock is a potential source of income and its integration with other economic activities, making value added products and retail trading can play important role in doubling farmers' income.
2. In Integrated Farming System models livestock sector especially dairy enterprise play an integral role in augmenting farm income as it requires least space to contribute maximum to the income. As per the IFS modules/models stated in role of technologies reveal that by utilizing 8% of the total land resources the dairy enterprise contributes maximum to the tune of 38.7 to 47.7% to the total farm income. Combination of crossbreed and indigenous will be more appropriate against the heat stress due to climate change.
3. In order to harness the genetic potential to the maximum extent of the livestock in dairy enterprise feeding and health management are very important to maintain the productivity of animals. Shortfall in management significantly affect the productivity of animals and animals take certain period to reach to the previous productivity level once proper management is restored. Regular and timely vaccination against the major diseases like Foot-and-Mouth disease (FMD), *Peste des Petits Ruminants (PPR),* Black Quarter (BQ), Haemorrhagic Septicaemia (HS) and feeding management for which regular supply of

quality green fodder, concentrate and mineral mixture are very important. In the context of quality green fodder, 1/3rd portion of crop land can be converted for perennial fodder production in which Bajra Napier Hybrid has huge potential to maintain the supply of green fodder especially during lean period.

4. The by-product of dairy sector can be taken to the business model of vermi-compost production which has tremendous potential of increasing non-farm income and side by side rural youth can be attracted to take up the venture.

5. Promoting food processing and setting up agro processing centre (APC) at farm level and retail trading of the products at farm outlet can have significant effect in augmenting farm income side by side increasing job opportunity especially Mahila Kisan in rural areas and also changing the orientation of farming community and households towards food processing.

- Uttar Pradesh is holding highest production in agriculture commodities like total food grain, potato, green pea, sugarcane, milk, meat and higher productivity in mango and guava. There is large scope of promoting food processing and value addition and setting up agro processing centre in the production catchment area, however, for which skill and scheme are essentially required for entrepreneurship and infrastructure development. Government can play role in framing policy and scheme for minimizing the cost of various machines through providing incentives in its purchases and providing financial support in the form of loan and subsidy in capital investment for infrastructure development, procurement of raw material and transportation of goods at selling, initiating protection policy to reduce competition in selling goods, reduction in the rate of various taxes etc. Government Departments can establish linkage with ICAR and AICRP to utilize expertise in setting up agro processing centre.
- Timely execution of Green Field Expressway project connecting to the State Capital and NCR (National Capital Region) will enhance transportation of inputs to the production catchment areas and speedy delivery of agricultural produce (raw and processed) from the production catchment area to the market. The farmers of the districts Agra, Firozabad, Mainpuri, Etawah, Auriya, Kannuaj, Kanpur, Unnao, Hardoi and Lucknow will be benefitted from this project.

6. Potato and sugarcane are the two major crops contributing farm income and sustaining livelihood security of farming community. Setting up potato processing industries at potato growing hub of Agra division can give more return to the farmers as price of processing potato is comparatively higher than table purpose potato. Government initiatives in procuring potato from farmers can boost their income, however, price variation at different zones should be minimised. Developing pest free cluster potato zone and contract/corporate farming venture can increase export potential of potato to the country like Russia which has great demand of Indian potato.

7. Like potato, sugarcane also the source of potential income of the farmers. Government role in modernizing farm mechanization like sugarcane cutter planter and sugarcane harvester

by creating hubs of these machines at selected cluster area and providing training to the farmers at the centre can change the orientation of sugarcane cultivation and farmers' income by increasing production, speedy supply of raw material to the sugar mills and increasing sugar recovery. Government initiatives by directing sugar mills to make faster payment to the farmers improves purchasing capacity, investment potential of the farmers and timely intervention to the other economic activities.

8. Promoting bee keeping into business model by orchard and vegetable growers, house hold micro-processing of honey, making inventory of bee keeper within the State and establish networking among the bee keeper within the State and outside the State especially Uttarakhand for sharing technologies, bee boxes, survival mechanism of honey bees during hot summer and market intelligence can augment farmers' income.

9. Popularization of Goat and Poultry among small farmers including landless

- Promotion of goatary in South Western Semi-Arid zone and Bundelkhand region for increasing goat population and maintaining goat unit at 5:1 (Male: Female) ratio. Development of kid nursery or Buck Mother Farm and establishing nucleus flocks of goat through PPP mode.
- Major thrust to promote poultry production and backyard poultry production (Dual purpose breed-CARI-Debendra, CARI-Nirbheek, CARI-Shyama, Layer breed- RIR (exotic), Ankleshwar (Desi), Pure Desi Breed- Aseel, Kadaknath, Nicobari-for hilly and Tarai areas), Turkey and Duck (Duck-Khaki Campbell, White Pekin and Desi breeds like Indian Runner) having immense potentiality to increase farmers' income by increasing egg and poultry meat production.
- Adoption of improved poultry production system like integrated duck-fish pond combination in which excreta of the poultry dropped into the pond to be used as feed for fish.
- Replicate success story of cold storage in Agra division into other areas like vegetable growing belt at Varanasi, Budaun, Moradabad, Jaunpur and fruit growing belt at Lucknow, Saharanpur, Bulandshahr, Muzaffarnagar, Banda, Allahabad, Gorakhpur, Kanpur, Sitapur, Hardoi for handling excess production, prevent market price fluctuation and easy disposal of perishable product for higher market return.
- Ensuring availability of quality seeds/planting materials of the improved varieties.
- Particularly in case of chickpea, lentil, barley, bajra, pigeonpea and groundnut in seed chain for which Universities and public institutions will have to share the responsibility in popularizing the improved varieties by seed production and making them available to the farmers at reasonable rates and also for rigorous monitoring in seed supply chain for increasing seed replacement rate.
- Creation of community-based low energy vegetable seed village hubs to increase availability of quality seed materials.
- Crop diversification and intensification as risk mitigating mechanism-Agricultural

diversification towards high-value crops can potentially increase farm incomes as demand for high-value food products has been increasing more quickly than that for staple crops. The non-traditional areas may include shifting orientation from cereal dominance to high value crops like horticulture and livestock. Even, as pulses are becoming a high value commodity, shift in favour of pulses can meet the nutritional as well as income security.

- Promoting pulse production as high value crops as Central Government has lifted curbs on export of pulses to protect farmers' income. India has produced a record 22.95 million tonnes of pulses in 2016-17 crop year (June-July) and Government is targeting to repeat this performance this year also. The Cabinet Committee on Economic Affairs has given its approval for removal of prohibition on export of all type of pulses to ensure that farmers have greater choice in marketing their produce and in getting better remuneration. Export of pulses will provide an alternative market for surplus production. Pules production can be enhanced into the respective zone with potential varieties and management practices.
- Replacement of tradition flood method of irrigation with furrow method of irrigation in Broad Bed Furrow (BBF), Bed Planting and Furrow Irrigated Raised Bed (FIRB) systems for improving irrigation efficiency by 40-50% and production by 20 to 25% over flat method of crop establishment.
- Promoting micro-irrigation like drip irrigation with fertigation concept in high value crops like protected vegetables and flowers cultivation, orchard and sprinkler irrigation in undulating topography for improving irrigation efficiency by 60 to 80%.
- Rejuvenation of senile orchards for increasing productivity in mango, guava, ber and aonla as most of the orchard in Uttar Pradesh is old.
- Promotion of Sahiwal, Hariyana, Gangatiri and Tharparkar breeds of cattle in UP (Tharparkar in Bundelkhand Region), popularization of goat breeds (Jamunapari, Barbari, Beetal, Jakhrana or Sirohi) as milch goat breed including for medicinal values, strengthening service centres and micro-level interface services for cow and buffalo management, ensuring timely availability of quality semen, developing semen sexing facility for increasing number of female calf/heifer, maintenance of cold-chain for vaccination and artificial insemination (AI) especially in rural areas.
- 150,000 ha community ponds in the State are considered suitable for fish culture and only 70,000 ha are presently used for aquaculture and there is scope for adding nearly 80,000 ha of community ponds after undertaking renovation and improvement. Though such areas will continue to be used as low input production, however, still the production from the community pond areas can be doubled. This will need availability of quality seed and awareness of the farmers towards management against major diseases.
- About 60,000 ha of additional fish culture ponds can be developed in water logged areas including 10,000 ha for culture of new species, under private sector. Adoption

of aquaculture and integrated farming system in these areas will enhance farmers' income through productive use of such land, with production of fish, crops and fodder. This can be useful opportunity in the areas of Lucknow, Barabanki, Raebareli and Sitapur especially along the canal command area.

- Empowerment and capacity building of Mahila Kisans about household micro-processing, post-harvest value addition etc., creating Gram Panchyat Mahila Funds, creating awareness about the several National Schemes for Mahila Kisans, making inventory of the farmers who doubled their income and establishment of Farm School.
- Majority of the strategies already framed for doubling farmers' income have been included into Central and State Government Schemes. Creating awareness, timely execution and rigorous monitoring by implementing agencies of the Schemes can assure income security to the beneficiaries directly related to the Schemes.
- Proposal for creating effective coordination mechanism by establishing a coordination cell with an empowered nodal officer including Agriculture and Home Science Scientist at district level linked with Agriculture Cabinet for reporting and periodical review of technology adoption and dissemination strategies of the respective districts with broad band connectivity and Video Conferencing facilities and being directly responsible to the Hon'ble Chief Minister/Agriculture Cabinet

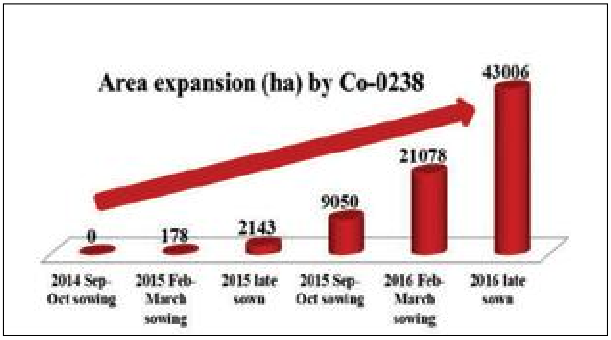
SUCCESS STORIES

1. Potential of doubling the farmers' income through high yielding sugarcane variety Co-0238 in Saharanpur (Bhabar and Tarai Zone)

Issues: Sugarcane is grown in large area of 79634.00 ha and farmers was growing disease susceptible and low yielding varieties like CoSa 767, CoSa 8436, Coj-64 etc. which gave poor yield and low net income.

Intervention: KVK, Saharanpur conducted varietal demonstration in Bedvi village through the farmer Shri. Sudhir Kumar.

Output and Economics: The average yield 1375.00 q/ha and the average net return Rs 2.61 lakh/ha

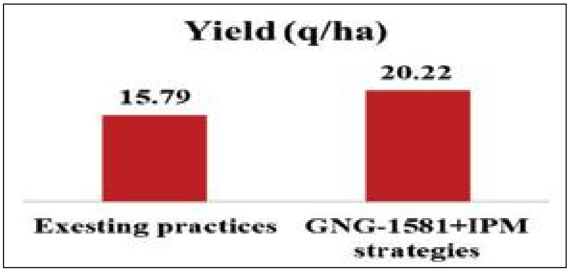


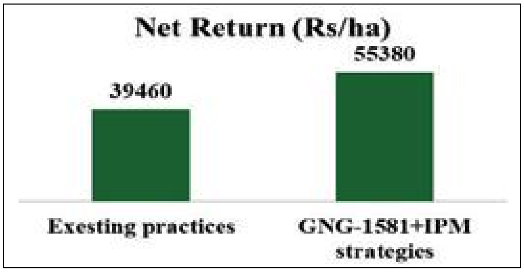
2. Varietal replacement (GNG-1581) & adoption of IPM strategies enhanced Chickpea Productivity & Net Income in Ghazipur District (Eastern Plain Zone)

Issues: Gram pod-borer is a major pest accounting for 21% yield losses and 50-60 % pod damage Intervention: KVK Ghazipur assessed IPM strategies under farmer's conditions 37 trials in 15 ha on varietal replacement (GNG 1581) with IPM strategies during 2016-17.

Outcome and Economics: IPM practice with variety GNG 1581recorded 20.22 q/ha and net return of Rs 55,380/ha whereas existing practice recorded 15.79 q/ha and net return of Rs 39,460/ha.

IPM strategies: proper tillage, line sowing seed treatment with Carbendazim 50% WP @2g/kg seed for management of collar rot, Profenophas 50%EC 2litre/ha at 50% flowering and Spinosad 45% SP @150ml/ha at 50% pod filling.





30

WEST BENGAL

West Bengal is on the eastern bottleneck of India, stretching from the Himalayas in the north to the Bay of Bengal in the south. The state has a total area of 88,752 square kilometres (34,267 sq mi).The Rarh region intervenes between the Ganges delta in the east and the western plateau and high lands. The Darjeeling Himalayan hill region in the northern extreme of the state is a part of the eastern Himalayas mountain range. he narrow Terai region separates the hills from the North Bengal plains, which in turn transitions into the Ganges delta towards the south. A small coastal region is in the extreme south, while the Sundarbans mangrove forests form a geographical landmark at the Ganges delta.

West Bengal's climate varies from tropical savanna in the southern portions to humid subtropical in the north. The main seasons are summer, the rainy season, a short autumn, and winter. While the summer in the delta region is noted for excessive humidity, the western highlands experience a dry summer like northern India, with the highest daytime temperature ranging from 38 °C (100 °F) to 45 °C (113 °F).

West Bengal (21° 25' 24" and 27°13' 15" north latitudes and 85°48' 20" and 89°53' 04" east longitudes) is predominantly an agrarian State, comprising of only 2.7% of India's geographical area. West Bengal is located in Eastern India stretching from the Himalayas in the north to the Bay of Bengal in the south. It has an area of 88,752 sq km.

The centre is an extension of India's fertile Gangetic plain. It is one of the world's largest populated cities and is well connected with the rest of the world by road, rail, air and sea. It is one of the world's largest populated cities and is well connected with the rest of the world by road, rail, air and sea. It is one of the world's largest populated cities and is well connected with the rest of the world by road, rail, air and sea.

Agriculture is the leading economic sector in West Bengal. Years after independence, food production remained stagnant, and the Indian green revolution bypassed the State. However, there has been a significant increase in food production since the 1980s, and the State now has a surplus of grains. A major agricultural producer, West Bengal is the 6th biggest contributor to India's net domestic product. Agriculture is the leading economic sector in West Bengal. Years after independence, food production remained stagnant, and the Indian green revolution bypassed the State. However, there has been a significant increase in food production since the 1980s, and the State now has a surplus of grains. A major agricultural producer, West Bengal is the 6th biggest contributor to India's net domestic product. Agriculture is the leading economic sector in West Bengal. Years after independence, food production remained stagnant, and the Indian green revolution bypassed the State. However, there has been a significant increase in food production since the 1980s, and the State now has a surplus of grains. A major agricultural producer, West Bengal is the 6th biggest contributor to India's net domestic product.

30.1 Productivity Gaps and Major Constraints

- The State is rich in human resources with 70% of its population engaged in agriculture. There are 733 lakh farm families of whom 90 per cent of the cultivators being small and marginal farmers (less than 1 ha land holding). Large holdings (above 10 ha) are almost absent. Small and marginal farming communities hold 84% of the State's agricultural lands as against 69.8 percent at all India level. Incidentally, this is the second highest in the country after Kerala. Thus, agriculture in the State is small farmer centric. The average size of land holding is only 0.77 ha. The per capita cultivable land holding is highly fragmented. This has resulted in uneconomic holding size to sustain a farmer's family.
- Agriculture is the leading economic sector in West Bengal. There has been a significant increase in food production since the 1980s, and the State now has a surplus of grains. Cropping pattern in the State is dominated by food crops which account for about 78 percent of the area under principal crops, in particular, rice. Per hectare yield in rice is higher in the State than at all India level.
- West Bengal contributes 3% of pulse production in India. The early vigour and duration of local varieties of pulse crops are generally slow and long respectively, thus the farmers are reluctant to grow pulses in their fields. The availability of high yielding varieties with efficient plant type for different situations can provide 3-2.0 tons/ ha stable seed yield to compete with other crops. Major biotic stresses in West Bengal are wilt, root rot and BGM. These biotic stresses reduce the productivity of the crop by 30-50%. Other important constraints are terminal moisture and heat stress, non-availability of quality seeds of improved varieties, non-adoption of improved production technologies, inadequate and unbalanced use of fertilizer, delayed sowing, poor plant population due to low seed rates and weed infestation.
- West Bengal has been the highest producer of jute and produces nearly 70% of the country's raw jute fibres. With its insignificant coverage, it plays a predominant role in the country's economy by generating employment, using in the textile as well as paper industries, improving soil fertility, earning foreign exchange etc. Jute is cultivated by small and marginal farmers. Thus, the investment capacity is poor. Technically, there is poor adoption of technology, imbalance fertilizer application, poor plant protection measure in jute cultivation. There is shortage of improved variety seed. Jute cultivation is labour intensive for weeding, thinning, extraction of fiber cutting / soaking, stripping, washing and drying.

- Potato production in West Bengal has witnessed a five -fold increase in the last 40 years. The State is second largest producer of potato with high yield (19.73 t/ha) second only to Uttar Pradesh (22.8 t/ha) and produces 30% of the total potato in the country. The importance of potato cultivation has increased day by day and the farmers have shifted from traditional rice -based cropping system to high value cash crops like potato in the rabi season. Per hectare yield in potato is higher in the Statethan at all India level. However, the State is totally dependent on other States like Punjab for meeting the seed potato requirements. Absence of exclusive cold storage facilities for seed potato is affecting seed quality and viability. Potato in the West Bengal is grown mainly by small and marginal farmers who face problems of getting remunerative market price, sufficient credit/bank loans and cold storage facilities.
- The horticulture sector in West Bengal is wide ranging and produces considerable amounts of vegetables, fruits and nuts, spices, medicinal plants, aromatic plants, mushroom etc. under different agro-climatic conditions. West Bengal is the leading vegetable growing State in India. The State has immense potential for development in horticulture sector both through horizontal (area expansion) and vertical integration (productivity improvement). Despite the impressive achievements, still low productivity of vegetables in the State is a challenge and matter of concern. The phenomenon of climate change and aberrant weather conditions are major issues to be tackled with new innovations in crop improvement and production systems. Apart from these, the challenges are many, namely, nutritional security, need for new plant genotypes for diversified end uses, degradation of soil health, production deficit and gluts, lack of infrastructure in commodity value-chain, retail chains and organized market systems, farmer producer companies, and export promotion.
- There is only 22% crossbred/ up-graded cattle and the rest 78% cattle are indigenous and low-productive in West Bengal.
- Average milk yield of dairy animals available in West Bengal is below than the national average.
- Lack of adequate scientific post-harvest storage facilities both for perishable and nonperishable agriculture produce is one of the problems associated with the agriculture production in the State. The storage capacity is considered to be grossly inadequate. Similar situation prevails in respect of cold storage facilities for perishable horticulture produce.
- The annual post-harvest fruit and vegetable losses incurred by West Bengal, which is facing a 12 lakh metric-ton shortfall as far as cold storage capacity is concerned. Though 90 per cent cold storage facilities of the State is for potato crop and located in the potato growing regions, still it falls far below the requirement. At present 20-25 % of horticultural produce is wasted prior to reaching the consumer in the State and during the periods of rains losses of produce increased further.
- There are many climate-related problems that people in West Bengal are already

facing, such as diminishing water resources and frequent natural disasters, which are likely to be further aggravated by the impending changes in the climate. In the present situation, a heavy rainfall lead to flood and a deficient rainfall could lead to drought. The paradox of flood and drought occur simultaneously almost every year, making agriculture highly vulnerable and unstable in many districts of the State. Every summer many parts of Purulia, Bankura, Paschim Medinipur, and Birbhum suffer water shortage with respect to the entire State. About 42% of the State area is flood prone and is manifested across the State by various modes. The devastating impact of natural calamities that we experienced in the recent past – Cyclone Aila in West Bengal, is fresh in our mind, and perhaps, are the warning signals of what is imminent in the future on account of climate change. With over 70% of Indian agriculture being rain fed and totally dependent on vagaries of monsoon and an equal percent of population depending agriculture for subsistence, the consequences of climate change could be to say the least, disastrous. There may be adverse impact of sea-level rise on coastal agriculture and settlements in the State. There is a direct impact on human health due to the increase in vector and water-borne diseases such as malaria.

- The Temperature Humidity Index (THI) relates animal stress with temperature and humidity. Livestock animals are comfortable at THI between 65 and 72, under mild stress when THI is between 72 to 78 and under severe stress when it is above 80. The livestock in West Bengal is already experiencing medium to high stress levels. Increase in temperature levels in the future may make the entire West Bengal region with THI > 80. Livestock and poultry birds are likely to suffer from heat stress impacting their productivity. Crossbreds are more sensitive to rise in THI than indigenous varieties. Rising temperatures negatively impact growth and time to attain puberty of livestock species. There is normally a decrease in milk production for animals under heat stress. This decrease can be either transitory or longer term depending on the length and severity of heat stress. These decreases in milk production can range from 10 to >25%. An average adult cow or buffalo producing 10-15 lit milk per day requires about 40-45 lit/day as drinking water on hot days and about 40- 60 lit for other related work thus requiring a minimum of 100 lit/ day/ animal. An organized animal farm following standard management practices and disposal of animal wastes requires additional water about 50- 100 lit/day/animal. Any loss in water availability will certainly lead to decline in milk productivity.
- Production cost of an egg in WB is about ` 4/- whereas, eggs supplied from AP cost about ` 3.5 to 3.8 per egg. This is due to high feed cost. Due to unavailability of feed ingredients like Maize, Fish Meal etc., the cost of poultry feed is much higher than Andhra Pradesh and other poultry developed States. Most agri-developed districts in the State are high humid zone which is not suitable for layer farming. It is not possible to make the state self-sufficient in respect of egg production unless special attention is paid for the establishment of big organized commercial layer farms.
- Major poultry companies have vertically integrated operations which comprise

approximately 60-70 percent of the total chicken production. Entire market is controlled by middleman. Thus, base level farmers are exploited.

- The State is a fodder deficit State. There are certain limitations such as non-availability of land for fodder cultivation and acute shortage of availability of quality fodder seeds in the State are responsible for the shortfall of fodder production. There is acute shortage of good quality fodder seeds in the State. The two main feed ingredients viz., maize and soybean are required to be imported from other States, as the production of maize and soybean in West Bengal is meagre.
- The problem again is the lack of organized infrastructure in terms of automated and hygienic processing units. With its tropical climate and proximity to ports, Bengal has the potential to develop into one of the largest producers of processed fish, value added fish and meat products in the country.
- Hilsa is mostly available in the eastern part of Bay of Bengal, especially in West Bengal and Bangladesh coastal waters and in the rivers and estuaries of the region. A trend on hilsa catch and import from across the border is given here to understand the dwindling nature of this important fishery vis-a-vis its demand in the market. The visible decline in hilsa catch in the estuarine and riverine stretch of Hooghly-Matla system is a matter of serious concern for the State. Indiscriminate capture of juveniles is further causing damage to already disturbed fishery.

30.2 Strategy and action plan for enhancing production, cost reduction, quality improvement, generating additional income

1. Availability of quality certified seeds/ planting materials

Being an agrarian State with relatively high level of cropping intensity and diversified crop production, the production and productivity has a direct correlation to the availability of quality seed which forms the critical production input. It is well documented that improved seed quality alone can increase 20% crop yield. The most important component in increasing crop production and productivity resulting in increase in farmers' income is 'quality seed'.

At present approximately 50% of seed requirement in the State is being sourced from other parts of the country. The diverse agro climatic conditions in the State offer good scope for seed production of different crops. Production of certified seeds should be sectorized based on best suitable area for production of seed of a particular crop and knowledge of seed producer, instead of trying to produce seeds of all crops throughout the State.

There is need of providing supports to the farmers for region specific, short duration varieties of paddy, drought and disease resistant varieties of paddy, location specific varieties of fine quality rice, location specific scented rice varieties, different pulse varieties with early vigor and profuse branching and short duration and high Harvest Index input. There is need of developing some rice varieties resistant to arsenic for some districts like North 24 Parganas, Nadia etc.

Production of certified seeds should be de-centralized. Emphasis needs to given on decentralized production through "seed village concept" with active involvement of progressive farmers, farmers' clubs, PACs/ societies. Active involvement of KVKs both in production as well as extending technical support to farmers/ other agencies is needed.

The State is emphasizing for self sufficiency in quality seed production. Production of certified seed should be continued in the Government Farms as well as in farmer's field with proper seed testing, seed processing, and storage facilities. The concept of quality seed is complex one. Evaluation of physical and genetic purity, germination capability, moisture, seed health etc. as per prescribed standard of I.S.T.A (International Seed Testing Association is considered as hallmark of judging the quality of seed). Seeds and planting material certification arrangements of the state is running through state seed certification agency. Seed certification wing has to be strengthened by means of laboratory support and HR support. Accredited seed testing laboratories should come up in both private sector and/ or PPP mode to cope up with the tight time schedule and demand for quality.

There is a need for standardization of location specific potato seed production technologies in the State to ensure timely availability of quality seed on long term basis.

Training needs to be imparted to generate awareness among the farmers about the benefit in the use of quality seed/ planting materials.

2. Soil health and nutrient management

The soil is home to a large proportion of the world's biodiversity. In a balanced soil, plants grow in an active and steady environment. The mineral content of the soil and its healthful structure are important for their well-being, but it is the life in the earth that powers its cycles and provides its fertility. Soil health depends on the physical and biological properties of soil. The content of soil organic matter (SOM)/ organic carbon is the crucial indicator. The soil health can be deteriorated because of poor organic carbon content, land degradation, soil erosion, increase or decrease of soil pH etc. The impressive growth of consumption of fertilizer in India as well as West Bengal in the post-green revolution period ensured increase in food grain production. But because of imbalances in use of chemical fertilizers and non-use of organic manure and bio-fertilizers, the adverse effect on soil fertility has been noticed. Restoration of soil fertility is the need of the hour all over the world, especially in the context of food security.

Even though different soils have some properties that cannot be changed, such as texture, soil quality can be improved by implementing good management strategies. A good management strategy includes the use of nutrient plans by which nutrients to the soil at the required level can be very effectively be added.

Soil testing and issue of 'Soil Health Card' to all farmers has to be done to take stock of the soil health status at a regular interval. Scheme like 'Swasth Dhara- Khet Hara' has been launched to maintain the soil health fertility where in Soil Health Cards are being issued to the farmers.

Based upon soil test results (pH of lands), chemical fertilizers have to be used and necessary liming programme should be taken.

Balanced and optimum use of fertilizers will be promoted together with use of organic manures and bio-fertilizers to optimize the efficiency of nutrient use.

The concept of INM practices in rice, pulse, oilseeds production needs to be popularized.

Use of organic manure in the soil would be the effective step in maintaining the health of the soil. Composting, vermicomposting, use of Farm Yard Manure, use of green manure crops, green leaf manuring etc., would be promoted as part of it. The availability of these types of natural organic manures is to be assured by employing effective mechanisms and logistic networks so that the organic content of the soil is increased to the level ideal for shifting towards 'Organic Farming' without affecting the returns.

Amelioration of acidic soils through soil ameliorants to be undertaken and side by side acid tolerant crops are also to be included in the cropping system approach, where amelioration would not be profitable.

Adequate and timely supply of fertilizers at reasonable rate to farmers shall be the endeavour of the Government.

Farmers should be convinced for growing green manure crop and planting organic matter supplying trees on his land.

Training on skill development is to be imparted for vermicompost preparation from manures of cattle, pigs, poultry and goat along with various sorts of crop/ vegetables refuse.

3. Technologies for conservation and management of natural resources

- A database of the soils as well as water resources of West Bengal State is to be available to the farming community indicating the different characteristics of the soils, water resources and the crops suited for them with the corrective measures needed for introducing alternate crops. Farmers should get these details at their fingertip through the web and facilitated by Agricultural officer who is the grass root functionary of the system. The database on soils, water resources and the crops suited for the area along with technological modules should be at Panchayat level and treated as baseline for any agricultural development programmes.
- Effective use of land and water is fundamental to growth and sustainable development. Soil and water conservation, agriculture development and allied activities like animal husbandry, pisciculture, etc, will be carried out in an integrated manner with a full involvement and participation of the farmers.
- Water budgeting could be defined as 'an estimate of harvest of water resources and its utilization for a set period of time'. The requirement of water in a watershed is assessed scientifically and a plan is to be made. The water available from rains, irrigation requirement, water holding capacity of the soil, irrigation frequency, method of irrigation, crop duration etc., should be taken in to account and a water budget is to be formulated with the help of irrigation engineers, NGOs, farmers and Agricultural

Officers. This would not only help to regulate the water use but also in improving the per unit productivity per drop of the available water.

- The programmes should aim at improving water, soil, biomass and other natural resources which would help the rural livelihoods and institutionalizing and scaling up participatory approaches and processes in natural resource management with a focus on livelihoods.
- It is important to preserve and promote traditional varieties of crops.
- Low water intensive, location specific crops and cropping sequences under command areas are to be identified and promoted.
- Intervention is needed for increasing productivity of land by mixed cropping, cover cropping, crop rotation, conservation tillage and leveling.
- Promotion of pulses (rabi, summer & kharif) and Dhaincha in cropping system should be incorporated for better soil health.
- On farm production of bio fertilizer should be encouraged in a big way.
- Different types of plant protection chemicals are being used by the farming community in West Bengal. These plant protection chemicals severely affect the bio resources available in soil and water. Pesticide residues are being found increasingly in our farm produces posing a threat to human health. Use of chemical pesticide needs to be declined. Use of bio-pesticide and botanical pesticide is being emphasized.
- The programme needs to be designed to suit the specific local conditions of the State and to help re-orient its development in conformity with environmental perspectives so as to make the development sustainable.
- Awareness, training and capacity building of the farmers are to be organized on use and management of natural resources.

4. Utilization of rice fallow area

There is a huge scope for increasing the rice fallow area for pulse production in West Bengal. As per the estimates of the Department of Agriculture, Government of West Bengal, the total available area under rice fallow is 8.53 lakh ha. The present area under pulses is 2.19 lakh ha and additional pulses area covered under rice fallow is only 0.96 lakh ha during 2016-17. Pulses in rice fallow may also be promoted in the districts like Birbhum, West Medinipur, Bankura and Purulia.

It is to be mentioned that under National Food Security Mission (NFSM) more than 60% of the budget has been allocated for pulse production.

A very/ super early pulse crop (lentil/ green gram) should be sandwiched between early/ medium kharif paddy and boro paddy in the cropping sequence.

Location specific 2nd crop (pulse/ oilseed/ maize) should be selected in the rice fallow area so as to cover entire 8 lakh ha of rice fallow in West Bengal. It may be grown as poira crop or as sole crop sown by zero/ minimal tillage method.

Where late kharif paddy is in practice or where high residual moisture is retained up to the end of November, sunflower/ summer green gram can be a good alternative to cover the fallow.

5. Integrated Farming System (IFS) approach

For the small and marginal farmers of the State, IFS approach involving integration of crops + goat + poultry for irrigated midland situation may be promoted to augment the farmers' income.

For the small and marginal farmers of the State, IFS approach involving integration of crops + cattle + fish + duck for lowland situation may be promoted to augment the farmers' income.

IFS model needs to be promoted involving synergic blending of crops, horticulture, dairy, fisheries, poultry, etc. which is a viable option to provide regular income and at site employment to small land holder, decreasing cultivation cost through multiple use of resources.

Integrated fish farming especially poultry/duck/pig/dairy/paddy-cum-pisciculture with horticulture and seasonal vegetables on the embankments may be encouraged. This will encourage organic fish farming and simultaneously utilize a number of organic wastes including domestic sewage thus enabling eco-restoration.

Production of vermin compost needs to be integrated with the production of bio gas and the use of its slurry in the agricultural field.

In-situ crop residue incorporation should be encouraged

6. Crop diversification

Adaptation of rice based profitable crop sequence; preferably including one leguminous pulse crop can be an additional source of income. Cereal or other crops in the prevailing rice- wheat cropping systems may be replaced with high yielding varieties of pulses. Short duration varieties of pulses as catch crop may be included. Cultivation of pulses in the irrigated area in rabi season may be increased. The cropping intensity by incorporating short duration forage crops in rice based cropping sequence (e.g. Rice- Grass pea- Vegetables) may be improved. Pigeonpea may be cultivated on bunds.

Crop diversification such as pulses, oilseeds, potato, vegetables, tuber crops may be brought under massive programme.

Cultivation of grass pea (Lathyrus) as dual purposes (green forage + pulse seed production) to utilize residual moisture and nutrients may be undertaken, particularly in Western part and coastal/ saline areas of West Bengal.

Inter-cropping with the growing of two or more crops simultaneously in the same field may be encouraged. Generally, individual crop yield slightly less when intercropped, but total productivity is higher than in monoculture. Enhancement of cropping intensity uniformly from 184 % to 200 -250 % in all sorts of land and training to the farmers for accepting the need of intercropping in various area should be organized.

In North Bengal, nearly 68341 ha fallow land might be a good resource to initiate desired crop diversification programme.

7. Reduction of cost of production

Increase in use of farm power through farm mechanization should be targeted. Promotion of use of Power tillers, Power weeders, Paddy threshers, Wheat threshers, Maize Sheller, Wheel Hand hoe, Manual/ power operated Wheat/Paddy reapers may reduce the cost of production.

Use of small farm tools will reduce the cost of production.

Use of recommended seed rate, spacing and depth will reduce the cost of cultivation.

Need based application of agricultural inputs is essential reduce the cost of cultivation.

Promotion of mulching to maintain moisture and reduce intercultural operation cost.

In house production and use of organic manure/ compost/ vermin compost need to be promoted.

Promotion of tillers and other garden tools can reduce drudgery.

In house production and use of low cost animal feed may reduce the cost of production of milk, meat and eggs.

8. New and innovative technologies for crop husbandry practices

Water saving technologies under irrigated rice (boro/ aus crops) like System of Rice Intensification (SRI) where feasible may be introduced. The technology has the potential to reduce the irrigation requirements by 30%.

Cultivation of rice following SARP technology may be undertaken.

There are some short and medium grained traditional aromatic rice varieties in different agro-climatic zones of the state. Some of this promising scented rice cultivar are Gobindabhog, Tulaipanji, Kalonunia, Radhunipagal, Kataribhog, etc. The State Agriculture Department may make a plan for promotion of these potential aromatic rice varieties.

Development of multiple disease and pest resistant varieties for all major pulses is urgently needed.

Zero tillage technique of sowing of a number of crops including rice may be undertaken.

There is need of district-wise technology policy for minimizing the yield variation and thus increasing the overall jute productivity in the state. Value addition of jute, recycling of jute waste e.g. use of jute stick for charcoal may give extra return to the farmers. An acceptable retting technology, involving minimum use of water and keeping the jute sticks intact need to be developed.

Integrated pest and disease management practices in different crops through popularization of different kinds of traps, botanical pesticides, bio-agent and other natural enemies along with balanced and optimum use of pesticides should be undertaken.

Integrated weed management practices by popularizing cultivation crops in rows and use of small implements wherever possible, mechanical weeding and need based use of herbicides should be undertaken.

Various research studies have shown that water saving, electricity saving, irrigation efficiencies and yield of crops using drip irrigation are substantially higher than crops irrigated by the conventional flood irrigation method. Steps may have to be taken to promote and propagate drip irrigation system as an effective measure for conservation of water in the dry and water scarce tracts of Purulia, parts of Birbhum, Paschim Medinipur and Bankura districts.

Water harvesting in 10%/ 20% model field ponds and utilizing it as life saving irrigation may be beneficial.

“Ail” [bund] cultivation following land shaping may be popularized.

Multitier cropping system needs to be popularized to augment farm income.

Promotion of gender friendly mechanization for reduction of drudgery in farm women (Nail weeder, ground nut decorticator, maize sheller, fertilizer broad caster, Chaff cutter)

9. Application of climate resilient technologies to address climate change challenges

Climate Change resilience can be built in through assessing vulnerability of a cluster of villages/ sub-region to climate change, stabilisation and management of the natural resource base with an ecosystems-based approach.

Bio diversity within the species and among the species must be restored. Diversification among enterprises and diversification of varieties will have an important role to play in the coming times to mitigate the adverse impact of climate change.

There is a need of integrating a package of climate smart agriculture practices into ongoing programmes such as weather-based locale specific agro-advisories, contingent crop planning, promotion of low-external input technology, agricultural diversification toward enhanced climate resilience, water budgeting, and livelihood diversification.

Resource Conservation Technologies (RCTs) need to be promoted for farming such as “no tillage” as it saves water, labour and energy, helps early sowing, improves soil organic C, reduces soil compaction, increases fertilizer use efficiency, and reduces soil erosion.

Development and cultivation of climate resilient crops need to be promoted.

Protected cultivation may be one option.

Crop insurance is must to avoid economic loss out of crop failure due to climate related disastrous.

10. Generation of additional income

Some non-farm activities such as bee keeping, sericulture, mushroom production, carpentry, tailoring, etc in order to uplift the financial status of the farming community need to be undertaken among the vast farming community.

There is need to promote women SHGs for preparation of home-made low cost weaning food for malnourished children at home and making marketing network for the same.

Promotion of young girls, unemployed women for handmade jute handicraft at their surplus time and marketing them.

Processing of fruits and vegetables may be advocated.

Strengthen capacity of the farmers through skill training

Skill development training on crop husbandry, livestock rearing, fisheries, home science and other areas would benefit the farmers for farming in a better way and thus bring a change in more income generation.

Development of agro-ecological zone specific, district specific and farmer centric technological modules

Zone II: Eastern Himalayan Region

1.1. Northern Hill sub region

1.1.1. Darjeeling District

Need based technology should be provided for rice-maize based cropping system.

- There is need for the promotion of Darjeeling mandarin orange, peach, pear, plum and pineapple, strawberry, kiwi fruits by proper nutrient management as well as disease management.
- Rejuvenation of old mandarin orchards with intercropping of large cardamom is suggested.
- Technological backup should be there for the cultivation of large cardamom, ginger and turmeric which are the main cash crop of the region.
- Availability of quality planting materials of fruits (pineapple, strawberry, lime etc.) and flowers (rose, gladiolus, gerbera, anthurium and orchids) need to be ensured.
- Promotion of agro forestry plantation in wasteland for improvement of organic carbon in the soil.
- Cultivation of broom stick may be promoted.
- Dried preservation of mustard leaf, rai sag, soybean and radish and radish leaf needs to be undertaken.
- Promotion of hill specific farm implements to minimize manual labour.
- Making of wall decorative/ craft using locally available dried flowers and other

materials may be encouraged.

1.2. Teri and Teesta sub region

1.2.1. Jalpaiguri District

- This district has rich bio-diversity in both flora and fauna and has immense natural beauty.
- Promotion is required for huge cultivation of local scented rice namely Kalo Nunia and its marketing in the entire State.
- There is a need to promote soil amendments in reclamation of problematic and degraded soil in Terai zone.
- Promotion is required for organic cultivation of local scented rice and high value crops.
- There is a need to promote areca nut based cropping model (Areca nut + Citrus +Black pepper), (Areca nut + Vegetables + Black pepper), (Areca nut+ Turmeric /ginger + Black pepper).
- It is required to practice vegetable based multitier cropping model (cucurbitaceous vegetables+ leafy vegetables+ turmeric/ ginger).
- Acid tolerant crop (pineapple) may be included in the cropping system.
- Promotion of different Integrated Farming System modules such as:

A. Crop based- (Crops+ Composting + Dairy + Goat farming / backyard poultry)

B. Pond based-(Fish+ Vegetables + Duck), (Crops+ Fish+ Vegetables +Duck),

C. Cattle based- (Mini dairy + Composting+ Protected cultivation+ Fodderproduction).

- Bay leaf, citrus, tuber crop like colocasia, EFY and spices like turmeric, ginger may be brought under forest villages.
- Conservation and propagation of high value local Ghungroo breed of pig need to be undertaken among the farmers in general and tribal farmers particular.

1.2.2 Uttar Dinajpur District

- It is one of the most backward districts of India. The Dinajpur region has traditionally been known for cultivating a large variety of indigenous aromatic rice strains, of which the Tulaipanji variety is native to the Raiganj region and has got geographical indicator. Promotion is required for huge production of such local scented rice and its marketing in the entire State.
- Replacement of old and traditional varieties with high yielding varieties in grains, pulses, oilseed and also horticultural crops.
- Promotion of different Integrated Farming System modules such as:
- Crops + Livestock + Backyard Poultry + Mushroom cultivation + Honey Bee + Fodder production + Vegetable cultivation.
- Crop losses are a frequent feature during the season of rains, because of the location

of large parts of the district along the active floodplains of the rivers Mahananda and Nagar. Adequate technological back up needs to be extended to help the farmers out of crop losses due to flood. Technology is needed for protected cultivation of crops.

- Conservation and propagation of high value local Ghungroo breed of pig need to be undertaken among the farmers in general and tribal farmers particular.

1.2.3 Coochbehar District

- Promotion of suitable mixed cropping (jute+amaranthus, lentil+mustard), inter cropping (potato+maize, elephant foot yam +amaranthus) is suggested.
- Integration of crops+goat+poultry for irrigated medium land is suitable
- Integration of crops+cattle+fish+duck for low land situation is suggested
- Integration of vegetables+fruits+cattle+fish+duck+poultry for pond based land is recommended.
- Promotion of agro-forestry system in uncultivable wasteland and unfertile fallow land is suggested.
- There is good prospect for dairy farming with cross breed or up-graded breed of cattle with high genetic potential
- Cultivation of perennial fodder crops in selected fallow land, ails or bunds is needed.
- There is a need for conservation and breeding of high value fish species.

Zone III: Lower Gangetic Region

2.1. Old Alluvial sub region

2.1.1. Dakshin Dinajpur District

- Promotion of different Integrated Farming System modules such as:

A. In Medium to Up land: Jute / Mesta – Rice – Mustard/Wheat, Fishery, Livestock, Poultry

B. In Medium to Low land: Fallow – Rice – Rice, Fishery.

C. In Medium land: Jute – Rice – Vegetable / Potato, Fishery.

D. In Upland: Vegetable – Vegetable – Vegetable, Fishery, Livestock, Poultry.

E. In Lowland: Fallow – Rice – Fallow, Fishery.

- Promotion of cultivation of fibre crops like jute.
- Plantation of quick growing crop like custard apple, drumstick, fig, biel and other economically viable plants in waste land.
- Promotion of ghungroo pig in farmers in general and tribal farmers particular.

2.1.2. Malda District

- Mango, jute and silk are the most notable products of this district.
- The special variety of mango produced in this region, popularly known by the name of the district, is exported across the world and thus it is suggested to promote various mango cultivars like Fazli, Ashwina, Gopalbhog, Langra, Lakshanbhog, Himsagar,

Amrapalli and Guti.

- Rejuvenation of age old Mango orchard and plantation of new orchard with export quality varieties of mango and litchi are required.
- Establishment of new orchard with high density planting is recommended.
- Improve technique of harvesting i.e. use of mango harvester to reduce the loss due to damage during harvesting of the fruits is required.
- Proper grading and packaging of mango need to be promoted.
- There is a need of intercropping of pulses, turmeric, ginger, elephant foot yam, etc under shady and partial shady condition.
- Promotion of cultivation of fibre crops like jute and also jute based processing facilities are required.
- Integration of adequate cropping system with inclusion of cereals, pulses, horticultural crops like, guava, banana, citrus, papaya & fodder crops is required.
- While 4.03 per cent cropped area of the district is drought prone, 7.55 per cent has been earmarked to be flood prone area. Alternative option is required in drought prone area of the district. Adequate technological back up needs to be extended to help the farmers out of crop losses due to flood.
- Dairy farming needs to be promoted.

2.2. Gangetic New Alluvial sub region

2.2.1. East Medinipur District

- Development and promotion of area specific and resource specific IFS model for maximizing profit and reducing risk of mono-cropping.
- There is a scope for increasing productivity of oilseed through cultivation of sunflower and groundnut.
- The district has a long coastline of 65.5 km along its southern and south eastern boundary. Thus, there is a tremendous scope for fish farming.
- There is huge potentiality to develop composite fish culture, fish based farming system with vegetable in bank and orchard in pond side area.
- The district has a 899 hectare forest cover. The farmers need to be popularized for agro forestry.
- Normally floods occur in 21 of the 25 Blocks in the district. Adequate technological back up needs to be extended to help the farmers out of crop losses due to flood.

2.2.2. Bardwan District

- The district of West Bengal leads the table in the country so far as rice production is concerned and among its' districts Bardwan is on top which is why the district is known as the 'Rice bowl of India'. Proper care and management need to be extended to the farmers for the production of short duration, high yielding rice varieties.

- Short duration, high yielding oilseed and pulse crops to be taken up in rice fallow areas with ensured irrigation.
- Integrated farming system needs to be scaled up.
- There is a huge prospect of dairying in the district.

2.2.3. Hooghly District

- With highly fertile alluvial soils, well developed irrigation infrastructure, the district can safely be called as an agriculturally advanced district. The following cropping system needs to be promoted.

A. Rice- Rice- Jute

B. Rice- Potato- Sesame

C. Rice-Vegetables- Rice

D. Rice- Potato- Rice + Livestock and Fisheries

- The district is well known for jute cultivation, jute industry, and jute trade hub in the state. Need based technological back up for jute cultivation need to be extended to the farmers.
- Potato is one of the cash crops in the district. Emphasis should be given for potato seed production in the district.
- There is a good scope for vegetables production, particularly onion. Adoption of improved package of practices for increasing onion productivity and dissemination of improved seed production technology of onion are recommended.
- There is scope for livestock farming and fisheries in the district.

2.2.4. Howrah District

- Diversification in rice based farming system is required.
- Howrah district has huge low lying areas where cultivation of paddy is the only option. That area can be brought under land shaping programme by formation heaps for planting of fruit crops where crop diversification can be possible.
- Cultivation of Swarna Sub-I under waterlogged condition is suggested. Sowing of short duration paddy variety like IET- 4786, IET- 4094 etc. in seed bed for flood affected areas of Howrah district is also recommended.
- Short duration, high yielding oilseed and pulse crops to be taken up in rice fallow areas with ensured irrigation.
- Ground nut varieties TAG-24, TG-51 may be introduced as an alternative crop in Summer.
- Integrated farming system needs to be scaled up.
- Production of flowers may be undertaken in the farming system.
- Poultry and duck farming may be promoted for the farmers belonging to SC, ST and backward classes.

- There is a huge prospect of dairying in the district.

2.2.5. Murshidabad District

- The economics of the district is based on agriculture, handicrafts and sericulture. The Murshidabad Silk for making saris and scarves, is world famous.
- Crop diversification needs to be promoted from low value crop to high value crop in rice based farming system.
- Promotion of different Integrated Farming System modules such as:

A. Cereals/Vegetables/fruits/Pulses/Spices/Medicinal plants + Dairy + Fishery + Backyard Poultry+ Duckery + Biogas unit + Composting unit.

B. Cultivation of vegetables at pond bunds + Composite fish culture + Goatery/ Backyard poultry/ Duckery.

C. Fodder production+ Mini dairy + Composting + Vegetables.

- Technological inputs are needed for the promotion of jute, wheat, pulses, oilseeds, vegetables and mangoes.
- Promotion of green gram intercropping with jute to increase per unit land productivity and profitability is required.
- Fodder production is in practice in the district. It is necessary to promote the cultivation of green fodders rich in digestible proteins viz. rice bean, cowpea and berseem as well as napier and dinanath as fast growing grass for lean season.
- Murshidabad district is known for the breeding tract of pure Black Bengal goats. The conservation and propagation pure Black Bengal goats should be a thrust area of work.
- There is a good scope of dairying and poultry farming in the district.

2.2.6. Nadia District

- Crop diversification to high value crops in rice based farming system needs to be promoted.
- Agriculture and Horticulture-based farming system is encouraged.
- Adoption of pulse based cropping system is suggested.
- Nadia district is known for vegetable growing district. Promotion of off season vegetable cultivation like summer cauliflower, cabbage, leafy vegetables like spinach, coriander, radish, winter gourds, ladies finger etc is suggested.
- There is scope for promotion of protected cultivation of capsicum, strawberry, gerbera, orchid etc.
- Promotion of integration with horticultural crops like mango, litchi, guava, banana, citrus, papaya with intercrop of vegetables like gourds, turmeric, ginger, chilli etc as intercrop.
- Dairy based farming system needs to be promoted.
- There is good scope for goat and poultry farming in the district.

2.2.7. North Parganas District

- Crop diversification to high value crops in rice based farming system needs to be promoted.
- Agriculture and Horticulture-based farming system is encouraged.
- Promotion of off season vegetable cultivation like French bean, pea, Kharif onion, bottle gourd, summer cauliflower, cabbage, leafy vegetables like spinach, coriander, radish, winter gourds, ladies finger etc is suggested.
- Promotion of cultivation of flower crops like tuberose, Chrysanthemum, rose, gladiolus, foliage plant etc is suggested.
- There is need for promotion of integration with horticultural crops like mango, litchi, guava, banana, citrus, papaya with intercrop of vegetables like gourds, turmeric, ginger, chilli etc as intercrop.
- Integration with livestock, fishery (composite fish culture) and horticultural crops is recommended.
- Adoption of Land shaping model for coastal area is suggested.
- Dairy based farming system needs to be promoted.
- There is good scope for goat and poultry farming in the district.

2.3. Costal Saline sub region

2.3.1. South Parganas District

- Nimpith KVK developed Land shaping and rain water harvesting technology for augmenting production per unit area by converting mono-cropped low lying areas into multi-cropped and assured irrigation throughout the year.
- There is a scope for cultivation of sunflower and cotton.
- Pisciculture is the major economical support of this district. Promotion in multiple cropping through paddy cum fish + vegetable in ails during kharif + vegetable in land embankment is recommended.
- Diversification in vegetable farming through land embankment cultivation
- Creation of upland in low-lying areas
- Creation of vegetable cultivable areas through reclamation of saline soils
- Distillation of derelict water bodies and proper utilization of water bodies through culture of air-breathing fish species.
- Promotion of integrated fish cum duck cum vegetables cultivation is suggested.
- Optimization of profitability by stocking at least 30 different freshwater fish species in carp ponds is advocated.
- Triple cropping in a year through promotion of mono-sex tilapia and climbing perch farming in shallow water bodies is recommended.
- Promotion of backyard hatcheries of high demand fish like carps, catfish, etc. to

enhance farmers' income is promising option.

- There is a prospect of culture of high value species like freshwater giant prawn, sea bass , feather back, indigenous catfish, butter fish, climbing perch, etc. in mono culture or poly-culture systems
- Promotion of commercially profitable brackish water fish and prawn species like sea bass, mullets, shrimps, crabs etc is required.
- Bee keeping may be promoted.
- There is enough scope for goat and poultry farming in the district.

3. Zone VII: Eastern Plateau and Hill Region

3.1. Undulating Red and Laterite sub region

3.1.1. Bankura District

- Intermittent gaps of precipitation and moisture stress during the monsoon gives rise to serious setback in production during the Kharif, which is the main stay of agriculture in the district.
- Integration of adequate cropping system with inclusion of cereals, pulses, oilseeds and forage is suggested.
- It is recommended to promote integration with horticultural crops like mango, guava, citrus, papaya with intercrop of vegetables like turmeric, ginger, chilli, elephant foot yam etc.
- Plantation of different economically important minor fruit plants, such as bael, amla, custard apple etc and vegetable crops like drumstick, green papaya etc in wasteland should be undertaken.
- Promotion of different Integrated Farming System modules such as:

A. Crop based backyard poultry – goat rearing/ seasonal fish farming,

B. Crop based – dairy husbandry – goat rearing,

C. Crop based backyard pig rearing and backyard poultry rearing / goat rearing,

D. Crop based backyard poultry rearing and goat rearing

- Drought constitutes a major hazard in the district. Promotion of sericulture, apiculture, poultry, and mushroom production will harness the potential of improved technology in farming occupation.

3.1.2. Birbhum District

- Birbhum District is often called as "the land of red soil. Major crops produced in the district include rice, legumes, wheat, maize, potatoes and sugar cane.
- The following farming systems may be promoted.

A. In Upland- Paddy, red gram, fruit crops.

B. In Medium land- Paddy, mustard, potato, sugarcane, sesame, black gram, vegetables and fruit crops.

C. In Lowland- Paddy, sugarcane, wheat, potato and vegetables.

- It is suggested to promote commercial cultivation of demand specific medicinal plants like kaempheria etc in rainfed area.
- Production of cotton, lac and sericulture should be promoted.
- In waste land Tree Plantation with year-round drumstick, hybrid amloki, hybrid ber, different perennial cereal and legume fodder crops may be promoted.
- Promotion of different Integrated Farming System modules such as:
  - Integration of fishery with inclusion of pulses and vegetable,
  - Integration of duck and poultry farming with fish based farming system,
  - Integration of fruit trees with fish and poultry based farming system.
- Birbhum is a major centre of cottage industries. Thus, some notable cottage industries like cotton and locally harvested tussar silk, jute works, batik, kantha stitch, pottery and terracotta, solapith, woodcarving, bamboo and cane craft, metal works and tribal crafts should be promoted.
- Promotion of rural tourism in different tourist spot of the district is suggested.

3.1.3. Purulia District

- Due to the rough weather and soil, Purulia lags behind in agricultural arena from the other districts of West Bengal. However, cultivation of silk and lac are the main agricultural products. Hence, cultivation of lac and sericulture should be the priority area of development.
- Kharif rice based cropping system should be followed with the cultivation of suitable pulses/ oilseeds.
- Digging of trenches for high percolation of water, construction and regular maintenance of check dams in the district are required.
- Storage of rain water in monsoon season by pond lining is suggested.
- Development of orchards in waste land may be promoted.
- Promotion of effective use of mulch, sprinkler and drip irrigation in the existing orchards as well as vegetable cultivation is required.
- Conservation of Black Bengal Goat and Aseel breed of poultry in context to Purulia district is required for maintaining the bio-diversity as well as the income generation programme.
- Pig farming among the tribal people may be promising option.
- To promote the income generation amongst the rural youth through, broiler poultry as well as duck farming and mushroom production may be high remunerative option.
- Tourism is another source of income for this district. Promotion of rural tourism in

different tourist spot of the district is suggested.

3.1.4. West Medinipur District

- Rice based cropping system should be followed with the cultivation of suitable pulses/ oilseeds.
- Construction of watershed structures and artificial structure to maximize water percolation rate in marginal and denudated areas are suggested.
- Cultivation of Swarna Sub-I under waterlogged condition is suggested. Sowing of short duration paddy variety like IET- 4786, IET- 4094 etc. in seed bed for flood affected areas of West Medinipur district is also recommended.
- Ground nut varieties TAG-24, TG-51 may be introduced as an alternative crop in Summer.
- Integrated farming system needs to be scaled up.
- Wasteland development through orchard development eg mango, cashewnut, mosumbi etc.
- Afforestation with agroforestry and cultivation of fodder plants are suggested.
- Fisheries and duck farming may be promoted.
- West Medinipur district is subject to both floods and drought. Adequate technological back up needs to be extended to help the farmers out of crop losses due to flood as well as drought. Promotion of sericulture, apiculture and mushroom production will harness the potential of improved technology in farming occupation.

30.3 Summary recommendations

Agriculture has been the way of life and continues to be the single most important livelihood of the rural masses in West Bengal. So, all the stakeholders of West Bengal need to work in a mission mode for development of Agriculture and Allied sector in a holistic manner with the vision of “Doubling farmers’ income by 2022”.The members of SCC suggested the following recommendations to fulfil this vision.

i. There is a basic need of quality certified seeds and good animal breeds which should be addressed on priority.

ii. The cost of cultivation needs to be reduced for augmenting the farm income.

iii. Minimum Support Price (MSP) and remunerative price in the market must be ensured to avoid distress sale.

iv. Terms of trade for agriculture need to be improved.

v. The farmers need to be linked with the market intelligence.

vi. There is need to develop agro-ecological zone specific, crop specific and the farmer centric technological modules.

vii. Conservation of our basic agricultural assets such as land, water and biodiversity and application of technologies for natural resource management are required.

viii. Farm mechanization and irrigation facilities need to be expanded.

ix. Integrated Farming System (IFS) approach needs to be encouraged.

x. Rice fallow area is to be utilized fully.

xi. Soil fertility, nutrient management and crop response are to be integrated.

xii. Crop diversification and cultivation of high-value crops are to be promoted.

xiii. New and innovative technologies for crop cultivation, animal husbandry practices and fish production are to be identified for the transfer to the farmer's field.

xiv. Technologies towards the use of solar energy need to be used. The largest share of energy is utilized for pumping of irrigation water. Micro/ precision irrigation system could be installed with solar energy system to utilize available ground water/ surface water to the maximum possible extent for increase in horizontal coverage as well as cropping intensity.

xv. The facilities/ infrastructures are to be established for post-harvest technologies/ food processing/ value addition/ preparation of by-products.

xvi. Capacity through skill training is to be strengthened.

xvii. Application of climate resilient technologies to address climate change challenges like drought, excess rainfall etc.

xviii. Public Private Partnership (PPP) mode involving the FPOs and NGOs etc needs to be fostered.

xix. Some specific programmes need to be undertaken for the betterment of farmers belonging to SC, ST and backward classes; empowerment of women in agriculture.

xx. ICT based agri-extension portal, a dynamic platform is to be used massively to disseminate crop, livestock and fishery related solution to the farmers at farm-gate level.

SUCCESS STORIES

1. Mandarin Orange Cultivation-A Valuable and Profitable Source of income

A farmer named Mrs Anita Sharma, Age 40 years from village Bong busty, Dist.-Kalimpong, switched from a homemaker to a farmer. Motivated by 4 days training on Mandarin cultivation during year 2007 in Darjeeling Krishi Vigyan Kendra, she started with 150 Darjeeling Manadarin seedlings and is now a successful owner of 500 trees Orchard. FLD on nutrient management in Darjeeling Mandarine was successfully conducted on her field due to which the farmer earned high profit.

Economic analysis of mandarin crop per hectare:

Type of cultivation	Yield (q/ha)	Cost of cultivation/ ha	Gross income/ha	Net income/ha	B:C ratio
Farmers practice	180	1,05,900/-	2,66,700/-	1,60,800/-	2.5:1
After nutrient application	370	1,84,100/-	5,48,000/-	3,63,900/-	2.9:1

2. Livelihood development through diversified farming

After taking training from KVK, Jalpaiguri, a 45 years old energetic and informative small farmer Mr. Arup Bhattacharya, who possesses 2.7 acre of cultivated land at Sobhabari, Jalpaiguri district of West Bengal started practising diversified farming system from last 18 years along with his family members. By doing so, he has achieved to earn his annual income from Rs. 69,600 to Rs. 2,86,850.00.

Income level before and after adopting diversified farming:

Crop/ Livestock/ Fish/ Enterprise	Area (acre)/ No.	Cost of production* (Rs. per unit)	Return(Rs. per unit)	Net income (Rs. per unit)
Crop- Rice, Areca nut, Livestock-Cow, Goat, Sheep	24 10	88,600	1,58,200	69,600
Crop-Rice/green fodder, areca nut Livestock-Cow, Buffalo, Sheep, Enterprise-Vermi compost unit Bio-gas unit, Paneer Making, Azolla Unit	1.5 31	3,74,200.00	6,61,050.00	2,86,850.00

ANNEXURE:

State Wise Coordination Committees for Doubling Farmers' Income by March 2022

1. Andhra Pradesh:

i) Vice Chancellor, Acharya N.G. Ranga Agri. Univ., Guntur Hyderabad: Chair
ii) Director ATARI Zone V CRIDA Campus, Hyderabad: Convener
iii) Director, CTRI Rajahmundry: Member
iv) Indian Institute of Oil Palm Research, Pedavegi: Member
v) One Nominee of the DG ICRISAT: Member
vi) Director CRIDA, Hyderabad- Member
vii) Director, IIRR, Hyderabad: Member
viii) Director, IIMR, Hyderabad: Member
ix) Director IIOR, Hyderabad: Member
x) Director, Directorate of Poultry Research, Hyderabad: Member
xi) Director, Agriculture, Govt. of Andhra Pradesh: Member
xii) Director, Horticulture, Govt. of Andhra Pradesh: Member
xiii) Director, Animal Husbandry, Govt. of Andhra Pradesh: Member
xiv) Director, Fisheries, Govt. of AP: Member
xv) Nominee of Secretary DAC&FW: Member
xvi) Nominee of Secretary, DAHDF: Member
xvii) Nominee of Secretary, Ministry of Food Processing Industries: Member
xviii) Nominee of Secretary, Ministry of Water Resources: Member

2. Bihar:

i) Vice Chancellor: BAU, Sabaur: Chair
ii) Director, ICAR Regional Station for Eastern Region Patna: Convener
iii) Vice Chancellor, Dr. Rajendra Prasad CAU, Pusa, Samastipur: Member
iv) Vice Chancellor, Bihar Veterinary and Animal Science University, Patna: Member
v) Director, NRC Litchi, Muzzafarpur: Member
vi) Director, NRC Integrated Farming System, Motihari: Bihar
vii) Director, Agriculture, Govt. of Bihar: Member

viii) Director, Horticulture, Govt. of Bihar: Member
ix) Director, Animal Husbandry, Govt. of Bihar: Member
x) Director, Fisheries, Govt. of Bihar: Member
xi) Director ATARI, Kanpur: Member
xii) Nominee of Secretary DAC&FW: Member
xiii) Nominee of Secretary, DAHDF: Member
xiv) Nominee of Secretary, Ministry of Food Processing Industries: Member
xv) Nominee of Secretary, Ministry of Water Resources: Member

3. Chhattisgarh

i) Vice Chancellor, IGKV, Raipur: Chair
ii) Director, ATARI Zone IX, Jabalpur: Convener
iii) Vice chancellor, Chhattisgarh Kamdhenu University, Durg: Member
iv) Director, National Institute of Biotic Stress Management, Raipur : Member
v) Director, Agriculture, Govt. of Chhattisgarh : Member
vi) Director, Horticulture, Govt. of Chhattisgarh: Member
vii) Director, Animal Husbandry, Govt. of Chhattisgarh: Member
viii) Director, Fisheries, Govt. od Tripura: Member
ix) Nominee of Secretary DAC&FW: Member
x) Nominee of Secretary, DAHDF: Member
xix) Nominee of Secretary, Ministry of Food Processing Industries: Member
xx) Nominee of Secretary, Ministry of Water Resources: Member

4. Delhi (NCT):

i) Director, Indian Agriculture Research Institute, New Delhi: Chair
ii) National Inst.of Agril. Economics & Policy Research, New Delhi: Convener
iii) Director, Indian Agricultural Statistical Research Institute, New Delhi: Member
iv) Director, National Bur eau of Plant Genetic Resources, New Delhi: Member
v) Director, NRCPV, New Delhi: Member
vi) Director, NRCIPM, N. Delhi: Member
vii) Director, Agriculture, Govt. of Delhi: Member
viii) Director, Horticulture, Govt. of Delhi: Member
ix) Director, Animal Husbandry, Govt. of Delhi: Member
x) Director, Fisheries, Govt. of Delhi: Member
xi) Nominee of Secretary DAC&FW: Member

xii) Nominee of Secretary, DAHDF: Member
xiii) Nominee of Secretary, Ministry of Water Resources: Member
xiv) Nominee of Secretary, Ministry of Food Processing Industries: Member

5. Goa:

i) Director, Central Coastal Agricultural Research Institute Goa: Chair
ii) Director, ARATI, Zone VIII, Pune: Convener
iii) Director, Agriculture, Govt. of Goa: Member
iv) Director, Horticulture Govt. of Goa: Member
v) Director, Animal Husbandry, Govt. of Goa: Member
vi) Director, Fisheries, Govt. of Goa: Member
vii) Director, CMFRI, Cochin, Member
viii) Director CIFT, Cochin: Member
ix) Nominee of Secretary DAC&FW: Member
x) Nominee of Secretary, DAHDF: Member
xxi) Nominee of Secretary, Ministry of Food Processing Industries: Member=
xxii) Nominee of Secretary, Ministry of Water Resources: Member

6. Gujarat:

i) Vice Chancellor, JunagarhAgrl. University, Junagarh: Chair
ii) Director, Directorate of Groundnut Research, Junagarh: Convener
iii) Vice Chancellor, AAU, Anand: Member
iv) Vice Chancellor, Kamdhenu University, Gandhinagar: Member
v) Vice Chancellor, Navsari Agricultural University, Navsari: Member
vi) Vice Chancellor, SKDAU, Sardarkrishinagar, Dantiwada.
vii) Director, Directorate of Medicinal and Aromatic Plants Research, Anand: Member
viii) Director, ATARI Zone VIII Pune: Member
ix) Director, Agriculture, Govt. of Gujarat: Member
x) Director, Horticulture Govt. of Gujarat: Member
xi) Director, Animal Husbandry, Govt. of Gujarat: Member
xii) Director, Fisheries, Govt. of Gujarat: Member
xiii) Nominee of Secretary DAC&FW: Member
xiv) Nominee of Secretary, DAHDF: Member
xv) Nominee of Secretary, Ministry of Water Resources: Member
xvi) Nominee of Secretary, Ministry of Food Processing Industries: Member

7. Haryana:

i) Vice Chancellor, CCSHAU Hisar: Chair
ii) Director, National Dairy Research Institute, Karnal : Convener
iii) Vice Chancellor, LUVAS, Hisar: Member
iv) Vice Chancellor, University of Horticultural Sciences, Uchani, Karnal: Member
v) Director, Indian Institute of Wheat and Barley Research, Karnal: Member
vi) Director, Central Soil Salinity Research Institute, Karna: Member
vii) Director, National Bureau of Animal Genetic Resources, Karnal: Member
viii) Director, Central Institute for Research on Buffaloes, Hisar: Member
ix) Director, NRC on Equine, Hisar: Member
x) Director, Agriculture, Govt. of Haryana, Member
xi) Director, Horticulture, Govt. of Haryana: Member
xii) Director (DG), Animal Husbandry, Govt. of Haryana: Member
xiii) Director, Fisheries, Govt. of Haryana: Member
xiv) Nominee of Secretary DAC&FW: Member
xv) Nominee of Secretary, DAHDF: Member
xvi) Nominee of Secretary, Ministry of Water Resources: Member
xvii) Nominee of Secretary, Ministry of Food Processing Industries: Member

8. Himachal Pradesh:

i) Vice Chancellor, Dr. Y. S. Parmar Univ. of Hort.& Forestry, Solan: Chair
ii) Director, Central Potato Research Institute, Shimla: Convener
iii) Vice Chancellor, CSK, HPKV, Palampur: Member
iv) Director, Directorate of Mushroom Research, Solan : Member
v) Director, Agriculture, Govt. of HP: Member
vi) Director, Horticulture, Govt. of HP: Member
vii) Director, Fisheries, Govt. of HP: Member
viii) Director, Animal Husbandry, Govt. of HP: Member
ix) Nominee of Secretary DAC&FW: Member
x) Nominee of Secretary, DAHDF: Member
xi) Nominee of Secretary, Ministry of Water Resources: Member
xii) Nominee of Secretary, Ministry of Food Processing Industries: Member

9. Jammu and Kashmir:

i) Vice Chancellor, Sher e Kashmir Univ. of Agricultural Sciences, Jammu: Chair
ii) Director: Central Institute of Temperate Horticulture, Srinagar: Convener
iii) Vice Chancellor, Sher e Kashmir University of Agricultural Sciences, Srinagar: Member
iv) Director, Agriculture, Govt. of J&K: Member
v) Director, Horticulture, Govt. of J&K: Member
vi) Director, Animal Husbandry, Govt. of J&K: Member
vii) Director, Fisheries, Govt. of J&K: Member
viii) Director, ATARI Zone I, Ludhiana: Member
ix) Nominee of Secretary DAC&FW: Member
x) Nominee of Secretary, DAHDF: Member
xi) Nominee of Secretary, Ministry of Water Resources: Member
xii) Nominee of Secretary, Ministry of Food Processing Industries: Member

10. Jharkhand:

i) Vice Chancellor, Birsa Agriculture University, Kanker, Ranchi: Chair
ii) Director, Indian Institute of Natural Resins and Gums, Ranchi: Convener
iii) Director, National Institute of Biotic Stress Management, Raipur: Member
iv) Director, Indian Institute of Agricultural Biotechnology, Ranchi: Member
v) Director, ATARI, Zone IV, Patna: Member
vi) Director, Agriculture, Govt. of Jharkhand: Member
vii) Director, Horticulture, Govt. of Jharkhand: Member
viii) Director, Animal Husbandry, Govt. of Jharkhand: Member
ix) Director, Fisheries, Govt. of Jharkhand: Member
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

11. Karnataka:

i) Vice Chancellor, University of Agricultural Sciences, GKVK, Bangaluru: Chair
ii) Director, ATARI Bangaluru: Convener
iii) Vice Chancellor, University of Agricultural; Sciences, Dharwad: Member

iv) Vice Chancellor, University of Agricultural Sciences, Raichur: Member
v) Vice Chancellor, Karnataka Vety., Ani. & Fisheries Sci. Univ., Bidar: Member
vi) Vice Chancellor, Univ. of Agri. and Horticultural Sciences, Shimoga: Member
vii) Vice Chancellor, University of Horticultural Sciences, Bagalkot: Member
viii) Director Indian Institute of Horticultural Research, Bangalore: Member
ix) Director, National Institute of Animal Nutrition and Physiology, Bangalore: Member
x) Director, NIVEDI, Bangalore: Member
xi) Director, National Bureau of Agriculturally Important Insects, Bangalore: Member
xii) Director Directorate of Cashew Research, Puttur: Member
xiii) Director Agriculture, State of Karnataka: Member
xiv) Director Animal Husbandry, State of Karnataka: Member
xv) Director Horticulture, State of Karnataka: Member
xvi) Director, Fisheries, Govt. of Karnataka: Member
xvii) Nominee of Secretary DAC&FW: Member
xviii) Nominee of Secretary, DAHDF: Member
xix) Nominee of Secretary, Ministry of Water Resources: Member
xx) Nominee of Secretary, Ministry of Food Processing Industries: Member

12. Kerala

i) Vice Chancellor, Kerala Agricultural University, Trissur: Chair
ii) Director CMFRI, Cochin: Convener
iii) Vice Chancellor, Kerala University of Fisheries and ocean Studies, Kochi: Member
iv) Vice Chancellor, Kerala University of Veterinary & Animal Sc., Wayanand: Member
v) Director, Indian Institute of Spices Research, Calicut: Member
vi) Director CIFT, Cochin: Member
vii) Director, CTCRI, Thiruvananthapuram, Kerala: Member
viii) Director, CPCRI, Kasargod: Member
ix) Director, ATARI, Zone XI, Bangalore: Member
x) Director Agriculture, State of Kerala: Member
xi) Director Animal Husbandry, State of Kerala: Member
xii) Director Horticulture, State of Kerala: Member

xiii) Nominee of Secretary DAC&FW: Member
xiv) Nominee of Secretary, DAHDF: Member
xv) Nominee of Secretary, Ministry of Water Resources: Member
xvi) Nominee of Secretary, Ministry of Food Processing Industries: Member

13. Madhya Pradesh

i) Vice Chancellor, JNKVV, Jabalpur: Chair
ii) Director, ATARI Zone IX, Jabalpur: Convener
iii) Vice Chancellor Nanaji Deshmukh, PashuChikitsaVishvavidyalaly, Jabalpur
iv) Vice Chancellor, RajmataVijayaRajeSchindia Krishi Vishwavidyalaya, Gwalior
v) Director, Directorate of Soybean Research, Indore: Member
vi) Director, Indian Institute of Soil Science, Bhopal: Member
vii) Director, Directorate of Weed Research, Jabalpur: Member
viii) Director, Central Institute of Agricultural Engineering, Bhopal: Member
ix) Director, National Institute of High Security Anim. Diseases, Bhopal: Member
x) Director Agriculture, State of MP: Member
xi) Director Animal Husbandry, State of MP: Member
xii) Director Horticulture, State of MP: Member
xiii) Nominee of Secretary DAC&FW: Member
xiv) Nominee of Secretary, DAHDF: Member
xv) Nominee of Secretary, Ministry of Water Resources: Member
xvi) Nominee of Secretary, Ministry of Food Processing Industries: Member

14. Maharashtra

i) Vice Chancellor, MPKVV, Rahuri: Chair
ii) Director, Natl. Inst. of Abiotic Stress Mgmt., Baramati, Maharashtra: Convener
iii) Vice Chancellor, VNKMKVK, Parvani: Member
iv) Vice Chancellor, PDKV, Akola: Member
v) Vice Chancellor, MAFSU, Nagpur: Member
vi) Vice Chancellor, Dr. B.S. Konkan Krishi Vishwavidyalaya, Ratnagiri: Member
vii) Director, Central Institute of Cotton Research, Nagpur: Member
viii) Director, Central Institute on Fisheries Education, Mumbai: Member
ix) Director, Central Citrus Research Institute, Nagpur: Member
x) Director, NRC Grapes, Pune: Member
xi) Director, NRC Pomegranate, Solapur, Maharashtra: Member

xii) Director, Directorate of Onion and Garlic Research, Rajgurunagar, Pune: Member
xiii) Director, Directorate of Floricultural Research, Pune: Member
xiv) Director, National Bureau of Soil Survey and Land Use Planning, Nagpur: Member
xv) Director, Central Institute of Research on Cotton Technology, Mumbai: Member
xvi) Director, ATARI, Zone VIII, Pune: Member
xvii) Director Agriculture, State of Maharashtra : Member
xviii) Director Animal Husbandry, State of Maharashtra : Member
xix) Director Horticulture, State of Maharashtra : Member
xx) Director, Fisheries, Govt. of Maharashtra: Member
xxi) Nominee of Secretary DAC&FW: Member
xxii) Nominee of Secretary, DAHDF: Member
xxiii) Nominee of Secretary, Ministry of Water Resources: Member
xxiv) Nominee of Secretary, Ministry of Food Processing Industries: Member

15. Odisha:

i) Vice Chancellor, OUAT, Bhubneshwar: Chair
ii) Director, National Rice Research Institute, Cuttack: Convener
iii) Director, Indian Institute of Water Management, Bhubaneshwar: Member
iv) Director, Central Institute of Freshwater Aquaculture, Bhubaneshwar: Member
v) Director, Central Institute for Women in Agriculture, Bhubaneshwar: Member
vi) Director Agriculture, State of Odisha: Member
vii) Director Animal Husbandry, State of Odisha: Member
viii) Director Horticulture, State of Odisha: Member
ix) Director, Fisheries, State of Odisha: Member
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

16. Punjab:

i) Vice Chancellor, PAU, Ludhiana: Chair
ii) Director, Central Inst. on Post Harvest Eng. and Tech., Ludhiana: Convener
iii) Vice Chancellor, GADVASU, Ludhiana : Member
iv) Director, ATARI, Zone V, Ludhiana: Member
v) Director, IIMR, Jalandhar, Punjab: Member

vi) PC, AICRP on Plasticulture Engineering and Technology, Ludhiana: Member
vii) PC, AICRP on Post Harvest Engineering and Technology, Ludhiana: Member
viii) Head, CIRB, Regional Station, Nabha, Patiala: Member
ix) Director, Agriculture, Govt. of Punjab: Member
x) Director, Animal Husbandry, Govt. of Punjab: Member
xi) Director, Horticulture, Govt. of Punjab: Member
xii) Director, Fisheries Development: Govt. of Punjab: Member
xiii) Nominee of Secretary DAC&FW: Member
xiv) Nominee of Secretary, DAHDF: Member
xv) Nominee of Secretary, Ministry of Water Resources: Member
xvi) Nominee of Secretary, Ministry of Food Processing Industries: Member

17. Rajasthan:

i) Vice Chancellor, MPUAT, Udaipur: Chair
ii) Director, Central Arid Zone Research Institute, Jodhpur: Convener
iii) Vice Chancellor, Swami Keshawanand RAU, Bikaner : Member
iv) Vice Chancellor, Jodhpur Agricultural University, Mandore, Jodhpur: Member
v) Vice Chancellor, Agricultural University, Borkhera, Kota: Member
vi) Vice Chancellor, RAJUVAS, Bikaner: Member
vii) Vice Chancellor, Shri Karan Narendra Agri. University, Jobner: Member
viii) Director, ATARI, Zone II, Jodhpur: Member
ix) Director, Directorate of Rapeseed - Mustard Research, Bharatpur: Member
x) Director, Central Institute of Arid Horticulture, Bikaner: Member
xi) Director, NRC Seed Spices, Ajmer: Member
xii) Director, Central Sheep and Wool Research Institute, Avikanagar: Member
xiii) Director, NRC on Camel, Bikaner: Member
xiv) Director, Agriculture, Govt. of Rajasthan : Member
xv) Director, Animal Husbandry, Govt. of Rajasthan: Member
xvi) Director, Fisheries, Govt. of Rajasthan: Member
xvii) Director, Horticulture, Govt. of Rajasthan: Member
xviii) Nominee of Secretary DAC&FW: Member
xix) Nominee of Secretary, DAHDF: Member
xx) Nominee of Secretary, Ministry of Water Resources: Member
xxi) Nominee of Secretary, Ministry of Food Processing Industries: Member

18. Tamil Nadu:

i) Vice Chancellor, TNAU, Coimbatore: Chair
ii) Director, Sugarcane Breeding Institute, Coimbatore: Convener
iii) Vice Chancellor, Tamil Nadu Fisheries University, Nagapattanam: Member
iv) Vice Chancellor, Tamil Nadu Vety. and Anim. Sci. University, Chennai: Member
v) Central Institute Brackish-water Aquaculture, Chennai: Member
vi) Director, NRC, Banana, Tiruchirappalli: Member
vii) Director, Agriculture, Govt. of Tamil Nadu: Member
viii) Director, Animal Husbandry, Govt. of Tamil Nadu: Member
ix) Director, Horticulture, Govt. of Tamil Nadu: Member
x) Director, Fisheries Development: Govt. of Tamil Nadu: Member
xi) Nominee of Secretary DAC&FW: Member
xii) Nominee of Secretary, DAHDF: Member
xiii) Nominee of Secretary, Ministry of Water Resources: Member
xiv) Nominee of Secretary, Ministry of Food Processing Industries: Member

19. Telangana

i) Vice Chancellor, Prof Jaishankar, Telangana Agri. University, Hyderabad: Chair
ii) Director CRIDA, Hyderabad: Convener
iii) Vice Chancellor Sri Konda Laxman Telangana State Hort. Univ., Hyderabad: Member
iv) Vice Chancellor, Shri P.V. Narsimha Rao Telangana State University of Veterinary & Anim. Sciences, Rajendra Nagar, Hyderabad: Member
v) Director, IIRR, Hyderabad: Member
vi) Director, IIMR, Hyderabad: Member
vii) Director IIOR, Hyderabad: Member
viii) Director, Directorate of Poultry Research, Hyderabad: Member
ix) Director, ATARI, Zone V, Hyderabad: Member
x) Director Agriculture, State of Telangana: Member
xi) Director, Horticulture, State of Telangana: Member
xii) Director Animal Husbandry & Fisheries State of Telangana: Member
xiii) Director, Fisheries, Govt. of Telangana: Member
xiv) Director, NRC. Meat, Hyderabad: Member
xv) One Representative of DG, ICRISAT: Member

xvi) Nominee of Secretary DAC&FW: Member
xvii) Nominee of Secretary, DAHDF: Member
xviii) Nominee of Secretary, Ministry of Water Resources: Member
xix) Nominee of Secretary, Ministry of Food Processing Industries: Member

20. Uttarakhand

i) Vice Chancellor, GBPUAT, Pantnagar: Chair
ii) Director, IISWC, Dehradun: Convener
iii) Director, PD FMD, Mukteshwar: Member
iv) Director, Directorate of Cold Water Fisheries Research, Bhimtal
v) Director, Agriculture, Govt. of Uttarakhand: Member
vi) Director, Animal Husbandry, Govt. of Uttarakhand: Member
vii) Director, Horticulture, Govt. of Uttarakhand: Member
viii) Director, Fisheries, Govt. of Uttarakhand: Member
ix) Director, Vivekananda, Parvatiya Krishi Anusandhan Sansthan, Almora: Member
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

21. Uttar Pradesh

i) Vice Chancellor, Rani LaxmiBai Central Agricultural University, Jhansi: Chair
ii) Director, Indian Veterinary Research Institute, Izatnagar: Convener
iii) Vice Chancellor, CS Azad University of Agric& Technology, Kanpur: Member
iv) Vice Chancellor, ND Univ. of Agric& Technology, Faizabad: Member
v) Vice Chancellor, SVBP Univ. of Agriculture & Technology, Modipuram: Member
vi) Vice Chancellor, Banda Univ. of Agriculture & Technology, Banda: Member
vii) Vice Chancellor, UP Pt. DDU Pashu Chikitsa Vishwavidyalaya, Mathura: Member
viii) Director, Indian Institute of Pulses Research, Kanpur: Member
ix) Director, Indian Grassland and Fodder Research Institute, Jhansi: Member
x) Director, Indian Institute of Sugarcane Research, Lucknow: Member
xi) Director, Directorate of Seed Research, Mau: Member
xii) Director, National Bureau of Agri. Important Microorganisms, Mau: Member
xiii) Director, Central Institute of Sub Tropical Horticulture, Lucknow, Member

xiv) Director, Indian Institute of Vegetable Research, Varanasi: Member
xv) Director, Indian Institute of Farming System Research, Modipuram: Member
xvi) Director, Central Agroforestry Research Institute, Jhansi: Member
xvii) Director, Central Institute for Research on Goats, Makhdoom : Member
xviii) Director, Central Institute for Research on Cattle, Meerut: Member
xix) Director, Central Avian Research Institute, Izatnagar: Member
xx) Director, National Bureau of Fish Genetic Resources, Lucknow: Member
xxi) Director, Agriculture, Govt. of UP: Member
xxii) Director, Animal Husbandry, Govt. of UP: Member
xxiii) Director, Horticulture, Govt. of UP: Member
xxiv) Director, Fisheries, Govt. of UP: Member
xxv) Director, ATARI, Kanpur: Member
xxvi) Nominee of Secretary DAC&FW: Member
xxvii) Nominee of Secretary, DAHDF: Member
xxviii) Nominee of Secretary, Ministry of Water Resources: Member
xxix) Nominee of Secretary, Ministry of Food Processing Industries: Member

22. West Bengal

i) Vice Chancellor, BCKVV, Mohanpur: Chair
ii) Director, ATARI, Zone V Kolkata: Convener
iii) Vice Chancellor, UttakBanga Krishi Vishwavidyalaya, Cooch Behar: Member
iv) Vice Chancellor, West Bengal, University of Veterinary & Anim. Sci. Kolkata: Member
v) Director, Central Research Institute for Jute and Allied Fibres, Barrackpore: Member
vi) Director, Central Inland Fisheries Research Institute, Barrackpore: Member
vii) Director, Agriculture, Govt. of West Bengal: Member
viii) Director, Animal Husbandry, Govt. of West Bengal: Member
ix) Director, Horticulture, Govt. of West Bengal: Member
x) Director, Fisheries, Govt. of West Bengal: Member
xi) Nominee of Secretary DAC&FW: Member
xii) Nominee of Secretary, DAHDF: Member
xiii) Nominee of Secretary, Ministry of Water Resources: Member
xiv) Nominee of Secretary, Ministry of Food Processing Industries: Member

23. Arunachal Pradesh:

i) Vice Chancellor: AAU, Jorhat: Chair
ii) Director, NRC on Yak, Dirang: Convener
iii) Vice Chancellor: AAU, Jorhat : Co-Chair
iv) Director, ICAR Res Complex for NEH Region, Shillong: Member
v) Director, ATARI, Shillong: Member
vi) Director, Agriculture, Govt. of Arunachal Pradesh: Member
vii) Director, Horticulture, Govt. of Arunachal Pradesh: Member
viii) Director, Animal Husbandry, Govt. of Arunachal Pradesh: Member
ix) Director, Fisheries, Govt. of Arunachal Pradesh: Member
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

24. Assam:

i) Vice Chancellor: AAU, Jorhat : Chair
ii) Director, NRC Pigs, Rani, Guwahati : Convener
iii) Vice Chancellor, CAU, Imphal : Member
iv) Director, ICAR Res Complex for NEH Shillong: Member
v) Director, ATARI, Shillong : Member
vi) Director, Agriculture, Govt. of Assam: Member
vii) Director, Animal Husbandry, Govt. of Assam: Member
viii) Director Horticulture, Govt. of Assam: Member
ix) Director, Fisheries, Govt. of Assam: Member
xiv) Nominee of Secretary DAC&FW: Member
xv) Nominee of Secretary, DAHDF: Member
xvi) Nominee of Secretary, Ministry of Water Resources: Member
xvii) Nominee of Secretary, Ministry of Food Processing Industries: Member

25. Meghalaya:

i) Vice Chancellor: AAU, Jorhat: Chair
ii) Director, ATARI, Shillong: Convener
iii) Vice Chancellor: CAU Imphal: Member

iv) Director, NRC on Yak, Dirang: Member
v) Director, ICAR Res Complex for NEH Region, Shillong: Member
vi) Director, Agriculture, Govt. of Meghalaya: Member
vii) Director, Horticulture, Govt. of Meghalaya: Member
viii) Director, Animal Husbandry, Govt. of Meghalaya: Member
ix) Director, Fisheries, Govt. of Meghalaya: Member
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

26. Sikkim:

i) Vice Chancellor: AAU, Jorhat : Chair
ii) Director, NRC on Orchids, Paykyong, Sikkim: Convener
iii) Vice Chancellor, CAU, Imphal: Member
iv) Director, ICAR Res Complex for NEH Shillong: Member
v) Director, ATARI, Shillong: Member
vi) Director, Agriculture, Govt. of Sikkim: Member
vii) Director, Animal Husbandry, Govt. of Sikkim: Member
viii) Director, Fisheries, Govt. of Sikkim : Member
ix) Director Horticulture, Govt. of Sikkim:
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

27. Tripura:

i) Vice Chancellor: CAU, Imphal : Chair
ii) Director, ICAR Res Complex for NEH Shillong: Convener
iii) Vice Chancellor, CAU, Imphal: Member
iv) Director, ATARI, Shillong: Member
v) Director, Agriculture, Govt. of Tripura: Member
vi) Director, Animal Husbandry, Govt. of Tripura: Member
vii) Director, Fisheries, Govt. od Tripura: Member
viii) Director Horticulture, Govt. of Tripura:

ix) Nominee of Secretary DAC&FW: Member
x) Nominee of Secretary, DAHDF: Member
xi) Nominee of Secretary, Ministry of Water Resources: Member
xii) Nominee of Secretary, Ministry of Food Processing Industries: Member

28. Manipur

i) Vice Chancellor, CAU, Imphal : Chair
ii) Director, ICAR Res. Complex, NEH Region: Barapani: Convener
iii) Vice Chancellor, AAU, Jorhat: Member
iv) Director, ATARI Zone VII: Member
v) Scientist I/C, ICAR RC for NEH Region, Manipur, Lamphelpat, Imphal: Member
vi) Director Agriculture, State of Manipur : Member
vii) Director Animal Husbandry, State of Manipur : Member
viii) Director Horticulture, State of Manipur : Member
ix) Director, Fisheries, State of Manipur: Member
x) Nominee of Secretary DAC&FW: Member
xi) Nominee of Secretary, DAHDF: Member
xii) Nominee of Secretary, Ministry of Water Resources: Member
xiii) Nominee of Secretary, Ministry of Food Processing Industries: Member

29. Mizoram:

i) Vice Chancellor: CAU Imphal: Chair
ii) Director, ICAR Res Complex for NEH Shillong: Convener
iii) Vice Chancellor, AAU, Jorhat: Member
iv) Director, ATARI, Shillong: Convener
v) Director, Agriculture, Govt. of Mizoram: Member
vi) Director, Animal Husbandry, Govt. of Mizoram: Member
vii) Director, Fisheries, Govt. od Mizoram : Member
viii) Director Horticulture, Govt. of Mizoram:
ix) Nominee of Secretary DAC&FW: Member
x) Nominee of Secretary, DAHDF: Member
xi) Nominee of Secretary, Ministry of Water Resources: Member
xii) Nominee of Secretary, Ministry of Food Processing Industries: Member

30. Nagaland:

i) Vice Chancellor: CAU, Imphal: Chair

i) Director, ICAR Res Complex for NEH Shillong: Convener

ii) Vice Chancellor, AAU, Jorhat: Member

iii) Director, NRC Mithun, Medziphema, Nagaland: Member

iv) Director, ATARI, Shillong: Member

v) Director, Agriculture, Govt. of Nagaland: Member

vi) Director, Animal Husbandry, Govt. of Nagaland: Member

vii) Director, Fisheries, Govt. of Nagaland : Member

viii) Director Horticulture, Govt. of Nagaland: Member

ix) Nominee of Secretary DAC&FW: Member

x) Nominee of Secretary, DAHDF: Member

xi) Nominee of Secretary, Ministry of Water Resources: Member

xii) Nominee of Secretary, Ministry of Food Processing Industries: Member

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