Soil Sciences Education: Global Concepts and Teaching

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6.2. Challenges in soil science education in India and way forward

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6.2.1. Introduction

Education is not just accumulation of information through learning but essentially about enhancing one's ability to perceive the facts. Education should aim to provide a sense of responsibility and vision to students for service to society. Here, the role of teacher is in motivating and pushing their students to achieve the best and emerged as self-motivated flag bearers with strong nature connect. Education for one which recruits waves of new generation, converting them into productive members of society by imparting creative kinds of knowledge and instilling notions of order, obedience and discipline without conflicting with culture and mother language (Prasad 2016). This can be achieved through better course content and form, better method and manner of teaching, and through better goal system setting. But sometime it happens when reality clashes with rigidity held belief, reality is generally the loser. There are some social factors, such as, caste, creed, religion, language, region, etc. which sometimes come in the way of education that need to be properly tackled so that new generation get equal opportunity to blossom themselves under the umbrella of nature and mentor with government support.

In India, after independence, separation of teaching and research was a mistake that created vacuum for excellence in teaching and/or research. The best education happens in places that combine teaching and research, like it used to happen in Takshashila and Nalanda from 5th Century in India and soil science education is not an exception. Recently Government has introduced National Education Policy, 2020 focussing on transformation of curriculum and pedagogy in order to minimize rote learning: encouraging holistic development and skills such as critical thinking, creativity, scientific temper, communication, collaboration, multi-lingualism, problem solving, ethics, social responsibility, and digital literacy.

6.2.2. Importance of soil in ancient Indian scriptures

According to Indian mythology, our body is the result of five tatva (element) namely Prithvi (earth/soil), Sameer (air), Agni (fire), Gagan (sky) and Jal (water). The Atharva Veda (12.1. 26-28) appeals to mankind not to falter mother earth. Earth is held together and bound firm with rock, soil, stone and dust. The greatest contribution that we can do to remain in touch with wonderful gift of nature, i.e. soil in serving the society and human being. We all have encumbered the earth, thanks to our wretched existence and hence it has to be legacy for prosperity, even dawn of civilization was rooted in the soil. If we have any love for our children, we have to love the soil and its fragrance and leave our soil and water in better condition than they are now (Fig. 6.2.1). In Indian culture, earth is worshipped as mother earth [Vishwagarbha – World's womb (Prithvi Sukta, Atharva Veda, AV 1000 BC)], which provide everything (life existing in every particle of

Mother Soil

Soil is like our mother,
beautiful and caring.

It grows gifts for us,
Delicious fruits and flowers are charming.

Soil takes care of our hunger,
Gives us energy, rich corn and vegetables.

But we are not so kind full.
Don't care our mother soil.

Dump garbage and throws polythene,
Domestic and Industrial waste to spoil

Please be thankful to our mother soil.
It is my humble request
Take care of our priceless resource

Arya Pathak (Grade IV)

Fig. 6.2.1. A little girl is singing a song about soil during 84th Annual Convention of Indian Society of Soil Science, held at Banaras Hindu University, Varanasi (Courtesy: Varanasi Chapter, ISSS).

soil) and grow crop using embedded knowledge and wisdom gained from experience over many generations. These farming practices were suited to local conditions; operations such as planting, irrigation, input application, harvesting etc. done manually and gene pool was highly localized. Traditional methods *viz.* use of animal excreta, urine, bone and fish washings, and various kinds of mixtures as fertilizers; biological pesticides and insecticides, and the produce was somewhat organic without knowing much about the details of soil properties but later on it got intensified owing to advancement in scientific knowledge, innovative technologies *vis-à-vis* population pressure resulting in transformation in agriculture, and soil as base for production system (Katyal 2015). The survival of human will depend upon how serious we are in managing the soil resources as soil health is linked to climate change, human health, biodiversity and economic growth.

6.2.3. Soil science education and research in India

Soil science got recognized as scientific discipline in 19th Century and soil was studied and researched independently as natural body. However, in India ancient farmers knew about suitability of soils for different crops by trial and error practices. There are numbers of old records at different places about soils and their use and traditional groupings for different uses. However, greater emphasis was laid out on teaching and research of soil by opening few colleges at Shibpur (Bengal), Saidapet (Madras), Cawnpore (United Province) and Poona (Bombay) in last quarter of 19th Century. With the establishment of Imperial Institute of Agricultural Research (IIAR), the research and education got accelerated. Later on extensive investigation on salt affected soils (*usar* and *reh*) and *regur* (black earth) was carried out for reclamation and conservation followed by groups of scientist who had worked on genesis, soil resources and survey, and soil map of India, soil chemistry, electro chemical-properties of soil clays, problem soils, soil fertility, soil-water relationship.

Later on, organizational set up were undertaken and consequently many state, central and deemed universities were established. In India, soil science education is pursued as a part of agricultural research in the department of soil science and agricultural chemistry and in basic science department/division of other non-agricultural universities or research organizations. In addition of these, there are many private unaided /aided colleges imparting the teaching and research in soil science. The soil-based institute namely ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur; ICAR-Indian Institute of Soil Science, Bhopal; ICAR-Indian Institute of Soil and Water Conservation, Dehradun; ICAR-Central Soil Salinity Research Institute, Karnal also cater the need of research and teaching in soil science. Although, Indian Council of Agricultural Research has made uniform course curricula across the country for teaching of soil science but it is not strictly adhered mainly due to lack of trained staff in a specific field, poor infrastructure facilities, multitasking by teaching staffs, opening of new colleges without having laid down norms and facilities, inbreeding of staffs, appointment of research managers *via* hidden factors etc., criteria for selection and promotion of staffs, non-appointment of skilled teachers against vacant posts, lack of re-skilling of teachers in view of advancement in communication and technology, knowledge and innovation and lack of coordination for interdisciplinary and trans-disciplinary research and education and thus affecting soil science education (Prasad 2015, Abrol 2015).

6.2.4. Soil science at elementary, middle and high school level

The education, in general, at school level is to get good marks rather than understanding the basic through hands on experiments. There is also a severe learning crisis, failing to recognize the elephant in room – owing to poor school and absenteeism and low teacher effort, private tuition, demand for note of the subject, scanning the course material by high power mobile cameras and voluntary retirement and non-appointment of teachers due to different reasons are adding to the agony of learning of subject. Teaching and awareness about soil in course curriculum of state/central school are documented.

At elementary school level, students are exposed to different indigenous implements like *Khunti* and *Khurpi* (local names), spade for loosening/digging of soils for sowing of seeds or removing of weeds; sickles for harvesting and ploughs for ploughing. Students are also shown to practice kneading of clay (soil) with water and preparation of boll. The students should also be asked to visit garden and bare field to observe the variation in colour of soil and faunal activity (say earthworm casts etc.).

At the early age of the curriculum after the primary level children's were exposed to the importance of soil in agriculture and human survival, soil teaming with life, weathering of rocks and formation of soils, soil profile, horizonation, texture, stickiness/plasticity for preparation of earthen pots, percolation and absorption of water, soil moisture and soil erosion, soil pollution, soil and crop and these got explained by illustrations and at places through case study/story. Before the middle school i.e., primary school level, the students are exposed to various soil textures i.e., clayey soil, sandy soil, loamy soil and silty soil and pH (Soil reaction) etc. (Figs 6.2.2 and 6.2.3). In the pre-college level (i.e., in grade XI and XII) all the soil formation processes to its relationship with landform, soil survey, cartography, bio-climate based classification, different types of soil and its formation process were explained elaborately in the geography subject, which is an elective one (http://ncert.nic.in/textbook/textbook).

A chapter on management of natural resources explains about soil, air and water and how various components are cycled over and over again in nature, and how these resources (a preliminary idea) are to be managed for sustainable development and ways to grow food crops to feed

Fig. 6.2.2. Student examining soil consistence and texture through feel method (Courtesy: Kendriya Vidyalaya, Gomtinagar, Lucknow).

Fig. 6.2.3. Students testing the pH of soil from Field and Garden using pH paper (Courtesy: Kendriya Vidyalaya, Gomtinagar, Lucknow).

Fig. 6.2.4. Soil museum visit by students of grade xii (Courtesy: ICAR-NBSS&LUP, Nagpur).

the burgeoning populations. The education in soil science, soil awareness should not be left to student/school alone but parents too have an equally important role towards their wards learning by taking them to sites having fertile land, eroded land and problems soils and associated land use so that their wards are exposed to different types of soils supporting different land use (specific crop/vegetation) and erosion sculptured landscape, weathering of rocks, formation of soil pillar etc. The students should also be encouraged for participation in debates, quiz and poster competitions on different themes and hands on experiments on soil, its use and management.

The retention cards having questions on one side and answers on the other side may help students to memorize the facts much better than rote learning/teaching (broadcasting or transmission). However, the learning and understanding of soils and its relevance in society/nature should be acquired by foundational learning skills. But what are of paramount importance is political will, community participation and nationwide mobilization, prioritizing the soil science education in the country. There should be social interaction among students and teachers, student to learn discipline group activities, sharing etc. The importance of soil, its dynamic and ecosystem services has to be communicated and demonstrated in public domain at nook and corner (school/college and other professionals) through audio-visuals and good slide show by teachers/researchers/spokesperson to attract the citizen to come forward and sponsor the cause for soil studies for betterment of society. The use of voice assistant may be encouraged to provide a resource to help teachers.

The students should be taken to soil museum, geological museum and research institutes carrying research work on soil and food production and to be explained science of soil and its role in ecosystem science, culture and sociality of soil (Fig. 6.2.4). They should be taught about environmental sensitive hygiene by doing sorting of waste materials, etc. (Say no to plastic and hazardous materials). The watershed based farming system approach should also be demonstrated through models and by visit to site (Fig. 6.2.5) to understand soil variability, suitability of

Fig. 6.2.5. College students observing the watershed model (Courtesy: ICAR-NBSS&LUP, Nagpur).

sites for various uses on sustainable basis. There should be no hard separation of learning areas in terms of curricular, co-curricular and extracurricular areas at foundation stage. Soil education through graphic syllabus, visual and experimental activities, soil-landscape relationship, illustration and maps (e.g., soil map prepared by Japanese Society of Soil Science on balloon) to be encouraged. It may also be informed to students that many of the civilization got perished due to misuse/abuse of soils by citing the examples from India and abroad, and its cultural signature/heritage.

There is an urgent need today to ensure quality education in primary grades and high school level, or else our demographic advantage may very soon turn to demographic burden. Language experts (possibly region specific) must be involved in the development of a broad literary frame work based on scientific pedagogical principles that provides scalable sustainable inputs within built flexibility. Based on the framework, early grade curriculum needs to be reworked on the chapter on soils, agriculture and to be fully revised. It is also important to make early interventions in child progress as adequate education at young age make significant impact on their cognitive ability and simultaneously interest towards science, thus determining the future productivity. Teacher education courses and in-service training need to be made more relevant and closely linked to ground realities.

6.2.5. Soil science education at college level

Soil science and its education at college and university level are facing problem in bringing out the solutions to be challenges in soil science and ecosystem services of soils. These challenges can be addressed by 1) a student pursuing Master degree should have science background in physics, chemistry, geology, mathematics at graduate level; 2) at graduate level, basics of soil science should be taught by senior professor to create interest and inquisitiveness among stu-

dents to know more about soil resource management and to attract them for furthering the education and research in soil science; 3) establishing connectivity with kindred disciplines (including social science and economics etc.,) for better understanding of river-scape, erosion (harvesting of potable water, tapping the sediments going to sea, river, etc.), prevention of eutrophication, bioremediation of degraded lands, alternate sources of nutrients *e.g.* municipal waste water, residue management, bio-fertilizers, etc.; gas emission through industry, indiscriminate cutting of vegetation, wet land ecosystem, residue burning linking to global warming (smogging in Indian context) and ways to mitigate; rice-wheat cropping in N-W India, sugarcane cultivation in semi-arid deep and shallow shrink-swell soils, shifting cultivation and at places rabbing (Prasad 1992) and we have to address these issues for the conservation of soil but for water resources also, alarming situation in our country.

The teaching and research on micromorphology of soil; colloidal chemistry including humus- metal/metalloid complexes; hydroxyl-interlayering and layer charge of clay minerals; hydropedology; medical pedology; paleopedology; land evaluation and land use planning; soil nano-technology; soil quality; C-sequestration; solute transport in relation to pore size, tortuosity, contact angle; unsaturated flow, vadose zone; site/region specific PTF; sensor based fertigation; real time erosion assessment; diffuse spectroscopy, remote sensing and GIS; use of artificial intelligence, neural network and deep learning in modelling, microwave remote sensing, soil-landscape modelling and digital soil mapping; soil taxonomy for Indian soil; conservation agriculture; desertification, and land degradation and reclamation strategies; rhizosphere biology and biochemistry including persistence and breakdown of pesticides by soil microbes; critical level of nutrients, nutrient use efficiency in different eco-zones, etc. have to be strengthened with advanced laboratory facilities and manpower (Prasad 2016). The comprehensive information about soil (standard nomenclature/ethnic name in vernacular language) and its land use potential to be put on web portal for easy retrieval and use by different organizations/agencies/farmers. At present syllabus of soil science at college level is not comprehensive to resolve the issues of sustainable productivity and soil health.

6.2.6. Challenges before soil science education

Many of the traditional agricultural practices of the early period gave way to modern agricultural techniques which emphasized upon increased production per unit areas and resulting in self-sufficiency on food front but later it was realized that gain in production resulted in pain because large tract of land area started showing decline trend in factor productivity owing to faulty agro-managements, economic consideration by stakeholders and Govt. policy etc.

The emerging issues in India are burning of residues, unscientific digging of canals leading to clogging of aquifers, compaction of sub-soils, sale of top soils for brick kilns and filling for construction of roads; flattening of dunes, salinity, sodicity, acidity, water-logging, heavy metal, pesticides and other contaminants, nutrients deficiency, toxicity, shifting cultivation, erosion and landslide etc. The teachers and researchers have to work hard in their domain to bring out the solutions of issues through teaching, research, awareness and visionary road map.

Thus, it is necessary to create awareness about soil in society and broad educational process that goes beyond formal education, including the subjectivities of art and spirituality, where values and attitudes towards soil can be reviewed and rebuilt. Education should not be confined to four walls of classroom. It should be vibrant and continuous enhancement in course curriculum and learning process, improvement in infra-structure and methodology in evaluation. There is a need to have good environment in classroom for creating awareness, encouraging students to ask questions, developing analytical mind, logic and scientific reasoning. Our education and course

curriculum have to be relooked in view of advancement in soil science and societal need so that we can stand on our own in justifying ourselves as a true soil scientist and our ethical attitude in caring the mother earth. This is high time to religiously connect and judiciously conserve the soil otherwise the planet will not be conclusive for human beings to live upon it. Further, if exploitation of Mother Earth will continue the pandemics like Covid19 are nature's way of balancing things.

Lastly, it is the duty of the Government to prevent malpractices in education and compromised publications, ensure quality products (through accreditation), protect the interest of citizen, ensure access and opportunity to the deserving – not to control, over regulate, stifle, even strangulate the creative genius of the society. The Government must facilitate the process of society's capacity to meet its own educational needs dealing with soil and its ecosystem services rather than straggle its ability to improvise, invent and innovate (Prasad 2016) and thus it requires change in mind sets at policy level and eco-friendly life style at individual level.

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