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From the Director's Desk

Soil Physical Environment: A Link in the chain of Food Security

Soil -water, -air, -heat, -solid fractions etc. together constitute the physical environment of soil, which influence the productivity and environmental quality. A soil rich in all necessary chemicals is a desert if water is absent, a moist and fertile bottom land is a worthless swamp if inundation cut the oxygen supply that the roots need, the resources of the subsoil are inaccessible to the crops if a subsoil mechanical impedance inhibits the root penetration. These are a few examples illustrating the relationship of soil physical environment with productivity. Soil physical processes also influence the sources of environmental hazards such as soil erosion, translocation of solids and chemicals to water streams and emission of radioactive gases from the soil to the atmosphere.

Our forefathers realized the gravity of soil physical environment and soil physical processes and thus practiced judicious tillage, drainage, irrigation, crop rotation, manuring, liming etc. to increase and sustain the productivity without harming the soil. Ignoring the traditional wisdom, of late, has resulted in serious physical degradation of the land. Soil crusting, hardening, sub-surface mechanical impedance, shallow depth, temporary water logging etc. are some of the soil physical constraints that are being encouraged by the mismanagement of the soil that in turn is causing major yield losses. Fluffiness, desurfacing etc. are the other emerging new constraints. It is estimated that about 89.5 m ha of land in India is affected by one or the other form of soil physical constraints, and the area may increase considerably if physical degradation caused by water and wind erosion is also included.

Considering mankind's increased concern for food security, it is the high time to appreciate the fact that unless the soil physical environment is maintained at its optimum level, the genetic yield potential of a crop can not be realized even when all the other requirements are fulfilled. Poor-crop establishment; - root proliferation; - distribution, retention, supply and uptake of water, nutrients, air etc. attributable to sub-optimal soil physical environment does not allow efficient and economic output from important basic input resources namely seed, water, fertilizer and energy. On the other hand, the present trend towards intensification of agriculture and increased use of heavy farm machinery, chemicals etc. is bound to deteriorate soil physical environment in future. Decline in soil organic carbon status will also aggravate the problem . Should we allow this to happen incessantly or make persistent sincere efforts to arrest future growth of soil degradation, alleviate the soil physical constraints and also understand the respective causal processes for the sake of holistic, safe and resilient agricultural production systems ? The current scenario calls for appreciating the fact that once degraded it is very difficult, if not impossible, to restore the soil to its normal physical condition, and also that unlike solutions for fertility problems, corrective measure for soil physical problems is not available easily and cheaply in a bag in the market. Therefore, our sincere endeavour, while striving to enhance and sustain high productivity, must be to improve and maintain soil physical environment at its optimum condition with minimal risks to the environment. Let us keep this always in mind, lest our unconcerned attitudes and actions fail us to our future generation. All the institutions researching on soil physical environment need to respond to the challenges of the hour. The institution of AICRP on Soil Physical Constraints and their Amelioration for Sustainable Crop Production is a right step to take a lead holistically in this direction.

- C. L. Acharya

Farmers' Day

Farmers' day was organized in collaboration with IFFCO in a village Mugaliahat (Bhopal district) on September 27 to demonstrate the benefits of Integrated Plant Nutrient Supply (IPNS) System technology. About 100 farmers and agricultural extension workers participated and visited experimental trials on farmers' fields.

In This Issue

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Alleviating Soil Physical Constraints- a must for Sustainable Crop Production - Some Experiences

The main soil physical constraints affecting crop productivity and appropriate technologies developed to alleviate these constraints and to increase the crop yields are given in Table 1.

Table 1. Effect of alleviation of soil physical constraints on crop yield

Soil type (Location)	Constraint	Technology	Crop (yield increase %)
Deep Loamy Sand (Jobner)	High Permeability	Compaction	Cowpea (280)
Black soil (Nizamabad))	High Subsurface mechanical impedance	Chiselling	Sugarcane (31)
Red soil (Hyderabad)	Hardening	Residue Incorporation	Castor (23)
Loamy Sand (Hisar)	Crusting	Seed line Mulch	Pearl millet (34)
Black soil (Jabalpur)	Slow Permeability	Raised bed & Sunken bed	Pigeon pea (1210)
Red soil (Hyderabad)	Shallow Depth	Ridge & Furrow	Castor (30)
Red soil (Hyderabad)	Sloppy + Shallow Depth	Ridge & Furrow + *Khus* barrier	Sorghum+ Redgram; 2:1 (25 +23)
Sandy clay Loam (Hisar)	Desurfacing	Chiselling	*Raya* (42)

Compaction near Proctor moisture increases yield in soils with relatively low percentage of finer fractions and which exhibit high permeability. Soils that are very low in clay respond more to clay addition followed by compaction. Breaking layers by deep cultivation (chiselling / ploughing) in soils offering high sub-surface mechanical impedance up to 40 cm depth has been found beneficial and economical if done at 50 - 60 cm interval, particularly for deep rooted crops. Addition of organic and inorganic amendments such as gypsum along with deep cultivation / chiselling is more beneficial. Black soils self – compact again due to rapid swelling. Addition of slow decomposing residues as well as gypsum to alleviate rapid and irreversible hardening of red *chalka* soils upon drying has been found to result in yield advantage up to 3rd successive crops. Application of seed line mulch of organics such as wheat *bhusa,* rice husk, FYM has been most effective in increasing the yield. Various soil management practices viz. ridges and furrow, broad bed and furrow, and raised and sunken beds of different widths were found effective on slowly permeable black soils of relatively low (Parbhani) and high (Jabalpur) rainfall areas to avoid water logging during rainy season. On sodic soils, gypsum as well as organics have been beneficial. The construction of about 10 cm high ridges has been found effective in shallow soils to mitigate the depth related constraints. A combination of ridge plus live barriers viz. *khus* (Vetivar) has been more effective than only ridge and furrow for conserving natural resources of soil and water and producing sustainable higher yields on soils of rolling topography. A combination of chiselling, disc ploughing and organic matter incorporation has been found beneficial on desurfaced soil. The economic analysis undertaken (calculated on the basis of yield alone and that too for a single crop / cropping sequence) in the project also suggests that these technologies are economically viable (Table 2).

Table 2. Economic evaluation of technologies under field condition

Technology	Cropping sequence/ Crop	Location	Benefit: Cost Ratio
Compaction	Wheat	Delhi	3.13
Clay mixing (2% clay) + compaction	Pearlmillet	Jobner	5.28
Chiselling	Groundnut	Coimbatore	3.20
Residue incorporation	Sorghum – Castor	Hyderabad	3.09
Raised and sunken beds	Soybean	Jabalpur	3.94
Ridge + *khus* barrier	Castor	Hyderabad	2.00

D.K. PAINULI
Project Coordinator (SPC), IISS, Bhopal

RESEARCH HIGHLIGHTS

Effect of long-term cropping with fertilizer and farmyard manure applications on sulphur transformations in a Kandic Paleustalf

The results of 13-year old long-term field experiment involving a fixed rotation of finger millet - maize – fodder cowpea at UAS, Bangalore indicated that continuous application of NPK (+S) at 50%, 100% and 150% of optimum recommended rates and 100% NPK (+S) with FYM increased the organic C and total N status of soil. Intensive cropping with continuous use of 100% NPK without S resulted in depletion of total, organic and inorganic S contents by 10.7%, 10.3% and 19.4%, respectively over control.

Plant availability of soil zinc fractions

Studies on the effect of zinc (Zn) application on the Zn distribution among various pools in two Alfisols under wheat revealed that the addition of Zn with and without FYM increased Zn concentration in different fractions except the residual forms. Path coefficient analysis showed that organically (PYR-Zn) and inorganically (AAC-Zn) bound forms of Zn play the most important role in contributing Zn to the plant-available pool.

Impact of FYM along with recommended dose of NPK on soybean production and soil physical health

Integrated use of FYM (10 t ha^{-1}) with 100%NPK ($N:P_2O_5:K_2O::25:60:20$ Kg ha^{-1}) resulted in higher

evapotranspiration, water use efficiency and soybean seed yield. Bulk density of the surface soil after three years of experimentation at 100%NPK+FYM treatment was significantly lower than that of 100%NPK and control treatments. The saturated hydraulic conductivity up to 10cm depth was highest under 100%NPK+FYM treatment and lowest in control. Cone penetration resistance up to 14 cm depth at a particular moisture content was lowest in FYM treated plots and increased with increase in soil depth.

Effect of spent wash on soil biological health and seed quality of soybean

The enzymatic activities viz., dehydrogenase activity in a Typic Haplustert treated with spent wash was significantly higher than that observed in control and found further enhanced when spent wash applied in combination with rockphosphate and wheat straw. Seed quality parameters, viz. methionine, cystine, oil and ash contents were also observed to be higher by spent wash application @ 5 ha-cm compared to control and NPK treatments.

Effect of intercropping on soil biological activity in a Typic Haplustert

Soil biological activity in terms of soil microbial biomass, dehydrogenase activity, alkaline phosphatase activity and soil respiration were higher under intercropping system (soybean-sorghum) than that under the respective sole crop. The VAM infection was about 10% more under intercropping system over those of monocrops.

Refinement of fertilizer adjustment equations for Typic Ustropepts

Studies under AICRP (STCR) carried out for rice crop in Tamil Nadu revealed that the soil nutrient efficiency (Cs) and fertilizer nutrient efficiency (Cf) did not change appreciably due to variation in soil properties in a new site but they were higher under plant population level of 80 hills m^{-2} compared to 66 hills m^{-2} population. This resulted in a change in the coefficients of already developed adjustment equation. The refined equation is: FN = 5.06 T - 0.81 SN (80 hills m^{-2}), where FN = fertilizer N (kg ha^{-1}), T = yield target (q ha^{-1}),SN = $KMnO_4$-N (kg ha^{-1}).

Current micronutrient stocks in different Agroecological zones of India, AICRP (MN)

Recent studies on the current micronutrient stocks of soils carried for different agro-ecological zones (AEZs) revealed that the deficiency of zinc is declining in many areas due to regular use of zinc fertilizers by the farmers. However, deficiencies of iron, manganese and boron are increasing in soils of various AEZs as compared to their deficiencies reported till eighties. Currently 45, 41, 33, 8.3, 4.5, and 3.3 per cent of 1.48 lakh soil samples analysed were found to be deficient in zinc, sulphur, boron, iron, manganese and copper, respectively.

Biofertilizer responses in Tamilnadu

A mixed biofertilizer formulation 'Azophos" developed by the Coimabatore centre of the AICRP (BNF) has shown its promise even when applied along with recommended dose of NPK for rice, cotton and other crops. Surveys conducted in farmers' fields in Tamilnadu revealed that the Azophos application not only resulted in 5-10% higher rice yield but also helped in saving of N by 25%.

Other activities

1. Plantation of nitrogen fixing trees viz., *Gliricidia* (2000) and *Leucaena leucocephala* (5500).

2. Development of 3 international training programmes for trainees of Afro-Asia Region.

AWARDS & HONOURS

Dr. D. L. N. Rao, Project Coordinator (BNF) has been awarded the 12th International Congress Commemoration award and gold medal for the year 2000 by the Indian Society of Soil Science.

Dr. Anand Swarup, Project Coordinator (LTFE) received Dhiru Morarji Memorial award of the FAI (2nd prize) for his article published in Fertliser News.

Dr. A. Subba Rao, Project Coordinator (STCR) selected as fellow of the National Academy of Agricultural Sciences, New Delhi for the year 2001.

Dr. D. K. Painuli, Project Coordinator (SPC) elected councillor of the Indian Society of Soil Science for the year 2001 and year 2002.

Dr. C. L. Acharya, Director, IISS, Chief Guest in a seminar at Dr.Punjabrao Deshmukh Agricultural University, Akola, December 8 – 9.

Dr. R. B. R. Yadav, Principal Scientist, Guest lecture at TNAU, Coimbatore on December 19, 2000.

Dr. Sanjay Srivastava and Dr. T.R. Rupa, Scientists elected councillors of the Central Zone of the Clay Minerals Society of India.

Events

Independence Day: Independence day celebrated with great enthusiasm by all the staff members and their families.

IMC Meet: The Institute Management Committee (IMC) met on September 23.

Farmers' Day: A Farmers' day organized in a village Mugaliahat, Bhopal (M.P.) on September 27.

SRC Meet: The Staff Research Council met to review the progress of the *kharif* experiments of on-going projects on 2nd, 4th and 5th December.

Workshops Held

1. Workshop of AICRP on Microbiological Decomposition and Recycling of Farm and City Wastes inaugurated by Dr. J.S. Samra, DDG (NRM), ICAR was held at UAS, Bangalore during November 10-11.

2. Training workshop on STCR for personnels working in soil testing laboratories in the Northern region was held at Hisar, Haryana on December 1-2.

Participation in Seminars/Symposia/Meetings/ Conferences/Workshops/Training programmes

Dr. T.R. Rupa: "Research programme on Water and Soil Towards Sustainable Land Use" at University of Applied Sciences, Nordostniedersachsen, Suderburg, Germany, July 15 – October 15.

Dr. C. L. Acharya: Task Force on Bio-Geo database on ecological medeling for Himalayas at DST, New Delhi, July 18; XVI meeting of the ICAR Regional Committee No. V at Indira Gandhi Agricultural University, Raipur, September 8-9; Planning meeting for a NATP project CRIDA, Hyderabad, September 14–15.

Ms. K. Alivelu: 71st Foundation Course for Agricultural Research Scientists Service (FOCARS) at NAARM, Hyderabad, August 25 – December 12.

Dr. Kiran P. Raverkar: Travelling Workshop cum Field Visit to Benchmark Watersheds located in Vietnam, Thailand and India, August 27 – September 12.

Dr. D. K. Painuli: Training Programme on "Development and Validation of Simulation Models to Predict Long-Term Consequences of Tillage and Residue Management Strategies" at Department of Crop and Soil Science, Michigan State University, East Lansing, Michigan, USA, September 25 – October 17.

Dr. R. B. R. Yadav: National Seminar on Plant Physiology at IISR, Lucknow, November 7 - 9.

Drs. C. L. Acharya, A. Subba Rao, D. L. N. Rao, Mohan Singh, J. K. Saha, K. Sammi Reddy, Sanjay Srivastava, T. R. Rupa, K. M. Hati, K. K. Bandhopadhyay and R. H. Wanjari: 65th Annual Convention of Indian Society of Soil Science at NBSS&LUP, Nagpur, December 27 – 30.

Distinguished Visitors

M. Phil students from IIFM, Bhopal on August 25.

Dr. V. L. Chopra, Former – Secretary, DARE and DG, ICAR, New Delhi on August 31.

Study Group – I of Estimates Committee of Parliament headed by Prof. Umareddy Venkateshwarlu, Member of Parliament along with 10 other team members on September 6.

Dr. P. D. Sharma, ADG (Soils), ICAR, New Delhi on September 23.

Dr. G. B. Singh, Ex-DDG (NRM), ICAR, New Delhi on Spetember 30.

Group of students from Guru Nanak Dev University, Amritsar on December 23.

Staff News

New staff joined

Smt. Kushal Suri, Assistant, September 2.
Smt. Manju Lohani, UDC, September 2.

Staff left

Shri M. M. Tiwari, Assistant, August 31.
Shri C. P. Mishra, UDC, August 31.
Dr. S. Kundu, Senior Scientist, October 28.
Dr. S. P. Singh, T– 4 (Technical Assistant), October 12.

Sports event

In the ICAR Zonal Tournament held at CSWRI, Avikanagar during November 16–20, 2000, Shri Sukhchain Das secured second position in cycling event while Dr. K. N. Singh, Shri M. Mohanty, Shri K. P. Singh and Shri M. S. Hedau constituting badminton team of the Institute stood runners-up.