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FORTHCOMING EVENT

Regenerative Agriculture: For Enhanced Crop Production, Soil Health and Ecosystem Services

Agriculture and pasture land use systems occupy > 40% of earth's land surface. Farming in those land use systems is mainly reliant on climate as well as edaphic factors. Of late, farming is under tremendous pressure due to extreme climatic events, large scale land use conversion and associated land degradation. Land degradation via soil erosion and loss of fertile top soil is recognized the most significant factor impacting productivity, livelihood and soil health. Thus, we need to protect our natural resources through resource conservation technologies (RCTs), conservation agriculture (CA), precision farming (PF), sustainable soil management (SSM) practices, and regenerative agriculture (RA). Lately, RA has been advocated to sustain higher crop productivity and income from arable lands through restoring soil's organic carbon (SOC) along with reducing environmental footprint. In addition, RA concept aids in reverting land degradation; maximizing crop productivity per unit area; enhancing soil biodiversity, improving soil health; that eventually enhances overall soil functions and ecosystem services.

RA is a system of farming principles and practices that seek to rehabilitate and enhance the entire ecosystem of the farm by placing a heavy premium on soil health with greater attention also paid to water management, fertilizer use, and more. These practices largely depend on both natural and/or traditional farming practices and also on modern research and innovations in sustainable agriculture. RA is a system-based approach reconciling the needs of producing adequate and nutritious food along with restoring the environment. Under the RA umbrella, various practices/approaches including conservation agriculture/no-till farming in with residue retention, cover cropping, integrated farming system (IFS), integrated nutrient (INM/IPNS) and pest management, and agri-horti/agroforestry-systems have been promoted. No-till farming reduces soil erosion and favours water to infiltrate into the soil. However, excess use of herbicide for weed control is against principles of regenerative agriculture. Inclusion of cover crops in cropping system bring multiple benefits such as reduce soil erosion, water pollution, improves soil properties and C. Maintaining soil fertility by enhancing soil organic matter content, biological N fixation (growing legumes/ green manure), and recycling of nutrients through crop residues, site-specific nutrient management (using 4Rs nutrient management) are some of the most important principles of regenerative agriculture. Other practices such as diverse crop rotations, recycling of organic wastes, and integration of crop-livestock-grazing should be promoted.

Future perspectives of RA demands evidence-based approach in regenerative farming trials necessary to understand the inconsistencies between the scientific literatures and the experience of farmers. Some of the current practices of cultivation may be replaced or modified to minimize the mechanical, chemical and physical field treatments. Mass awareness programmes can be arranged to promote nature friendly best agricultural practices to protect and enhance soil biodiversity, health and sustainability and to protect them from conversion and degradation. In addition, there is a need for policy implementation to provide incentives and rewards to adopters of RA for carbon credits/ecosystem services.

ASHOK K PATRA

Sardar Patel Outstanding ICAR Institution
FAO King Bhumibol World Soil Day Awardee

RESEARCH HIGHLIGHTS

Exploring Plant Growth Promoting Potential of the Thermophilic Bacteria Isolated from Anhoni Hot springs of Central India

A study demonstrated thermophilic bacterial isolates exhibited plant growth promoting properties in pigeon pea (Figure1). Thus, it could serve as efficient biofertilizer candidates for improving plant growth under stress conditions

Figure 1. Exploring PGP attributes of the Thermophilic Bacteria Isolated from Pigeon Pea (CajanusCajan)

Endophytic and Rhizoplane Microbial Diversity in Wheat

Total of 27 morphologically distinct endophytes based on nutrient fixation/solubilization ability were screened from the rhizoplane of Wheat (Cultivar:Tejas) crop grown on Alfisols, Vertisols and Inceptisols (Figure 2). Out of these, 6 were N fixers, 19 solubilized P from Fe-Phosphate, 15 solubilized P from Ca-Phosphate, only 1 isolate solubilized P from Al-Phosphate, 9 isolates are positive for K solubilization from Glauconite and 5 isolates were found to be Zn-solubilizers. The diversity of the isolated endophytes studied by Amplified Ribosomal DNA Restriction Analysis using HaeIII restriction endonucleaseindicated that the isolates which strongly colonized the rhizoplane could also establish themselves as effective endophytes.

Figure 2. Some endophytes screened from the wheat rhizhoplane

Compost Quality Assessment

The compost samples were tested for the presence of nematode by Baermann funnel method. No nematode was observed in the samples of compost suspension whereas rhizospheric soil suspension showed presence of active nematodes (Figure 3). Here, rhizosphere soil was taken as positive control. Likewise, mature compost was also found to be free from coliform bacteria and Escherichia coli and no pathogenicity was detected as all the composts showed germination index more than 75

Nematode in Rhizosphere soil (Positive Control) | No nematode in compost sample

Figure 3. Microscopic observation of compost samples to detect nematodes

Exploring Enzymatic Stoichiometry: Indicator of Nutrient Limitation in different LTFE Soils

Hydrolytic enzymes for obtaining carbon, nitrogen, phosphate and their stoichiometric ratios were used to reveal the transitions in nutrient limitations for microorganisms. A higher vector length and vector angle (calculated from plotting of C:N versus C:P ratios) indicated higher C demand relative to soil nutrients (N and P) and higher P demand compared with N, respectively (Figure 4). Results indicated that significantly higher C and P limitation under imbalanced fertilizer application.

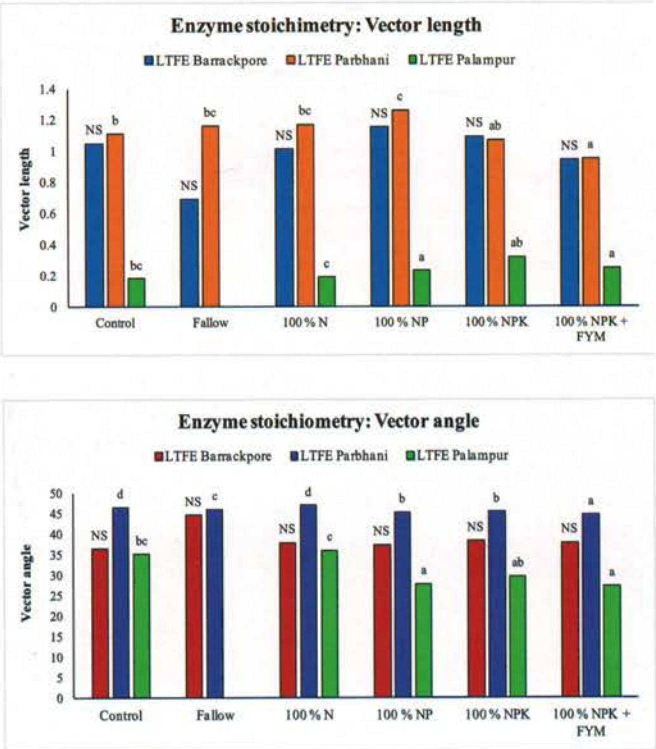


Figure 4. Enzyme stoichiometry in LTFE soils

Decomposition of Crop Residues as Affected by Placement Method

A field trial has been conducted to investigate the decomposition of wheat, maize and soybean residues at surface and subsurface (incorporated) soil under soybean-wheat cropping system using the nylon mesh bag technique. It was observed that decomposition of wheat, maize, and soybean residue occurred at 46.8%, 51% and 68%, respectively in surface placed condition. Whereas, decomposition of these crop residues was 68.9%, 73% and 80% respectively, under incorporated condition. Carbon residue was mineralized at 64%, 58% and 69% respectively for wheat maize, and soybean under surface retained condition and 75%, 74% and 79%, respectively under incorporation (Figure 5). Nitrogen concentration in surface retention of wheat and maize residues increased throughout the decomposition period due to microbiological immobilization. In case soybean residues, nitrogen immobilization occurred only during first three months, followed by nitrogen mineralization. While in case of subsurface incorporated wheat and maize residues, nitrogen mineralization occurred during initial five months followed by net mineralization.

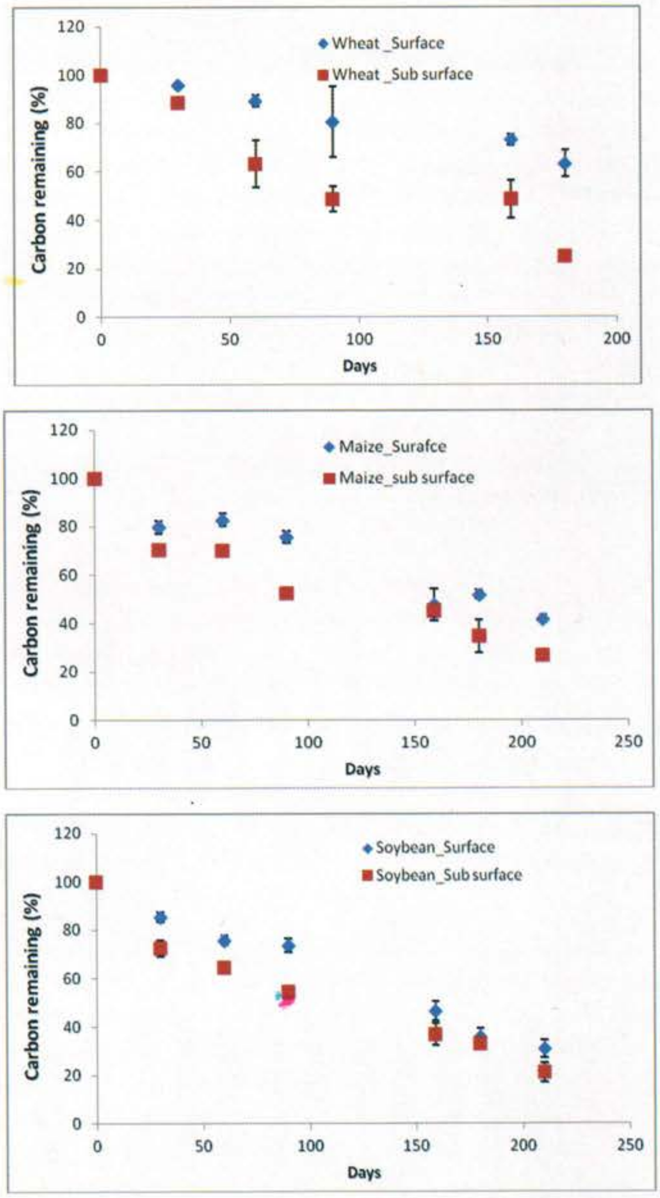


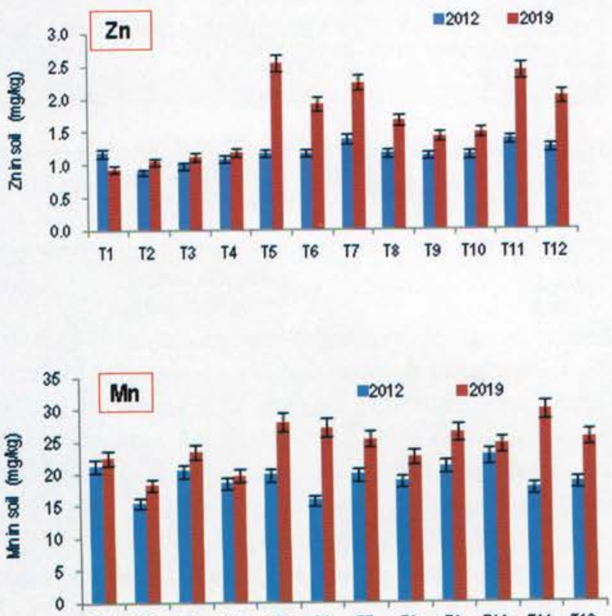
Figure 5. Carbon mineralization dynamics under different crop residue placement methods

Status of Potassium Fractions in the LTFE Soils

No application of K fertilizer for long term reduced Non Exch-K storage and increased Exch-K in 100% N treatment in both LTFE sites of Parbhani and Palampur. Likewise, the water soluble K (WSK) was highest in Integrated Nutrient Management (INM) treatment in both sites. Microbial biomass K (MBK) correlated significantly with WSK under INM treatment in LTFE Parbhani, however, no correlation found in Palampur.

Long-term Fertilization Impacts on Soil Micro-nutrient Availability under Maize-Chickpea Cropping System

Integrated nutrient management (INM) modules were evaluated and results showed considerable changes in the status of available Zn, Mn, Fe and Cu in soils (Figure 6). Highest availability of micronutrients recorded in FYM @ 20 Mg ha^{-1} and STCR based 75% NPKZn + FYM at 5 Mg ha^{-1} and the lowest under plot receiving chemical fertilizer as per general recommended dose. Integration of poultry manure, urban compost with STCR based 75% NPKZn had higher Zn, Mn, Fe, and Cu content than the chemical and control plots. Results indicated that integration of pure organic manures (urban compost, maize residue and Glyricidia loppings) influenced the micronutrient availability in maize-chickpea cropping system.



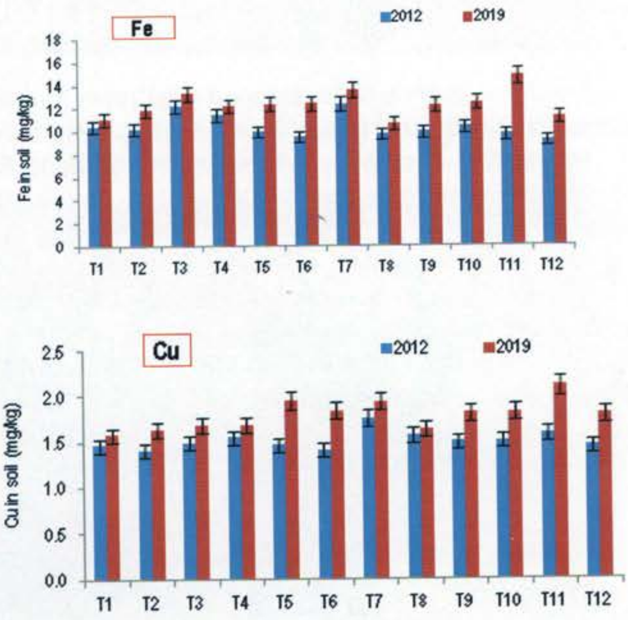


Figure 6. Status of available Zn, Mn, Fe and Cu in soils under LTFE

Spatial distribution of Phyto-available second ary and micronutrients in Soils of India

Analysis of 2,42,827 soil samples collected from 615 districts of 28 Indian states showed widespread deficiencies of S and micronutrients. The mean available nutrient concentrations (mg kg^{-1}) were as follows; S: 27.0 (±29.9), Zn: 1.40 (±1.60), B: 1.40 (±4.70), Fe: 31.0 (±52.2), Cu: 2.30 (±3.50) and Mn: 17.5 (±21.4) (Figures 7 & 8).

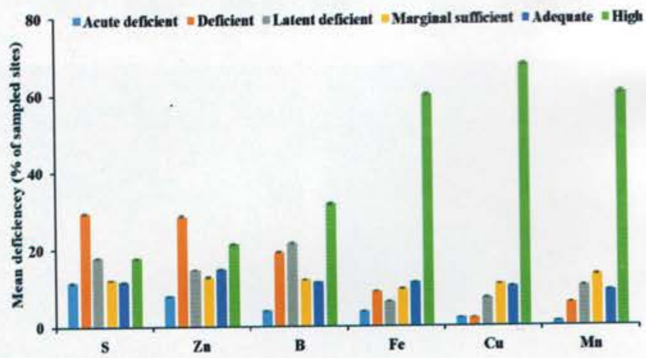


Figure 7. Available S and micronutrients in agricultural soils of India

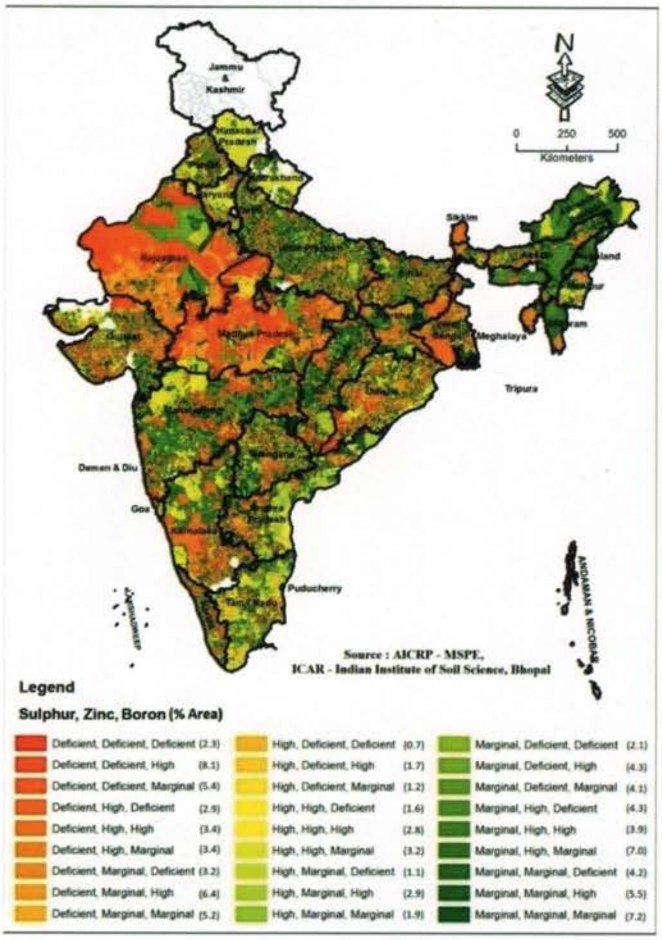


Figure 8. Spatial distribution of S,Zn,B deficiency in different states of India.

Developed Protocol for Estimation of Nitrate and Potassium in Soil by Ion Selective Field Effect Transistors (ISFET)

Protocols for the estimation of soil pH, nitrate-nitrogen), and potassium were developed using ISFET. Models/functions for these parameters were validated for different soils of India. It has been found that nitrate and potassium could be successfully estimated by using 0.1 M copper sulphate ($CuSO_4$) through ISFET. Soil nitrate and potassium were also directly estimated in the soil suspension. Soil : copper sulphate suspension (0.1 M) (5 g soil + 15 ml copper sulphate) at 1:3 ratio could be used for the estimation of nitrate and potassium by directly dipping the ISFET in the suspension. ISFETs connected through a circuit with Laptop were used to measure NO_3^-, K^+, and H_3O^+. Software to calibrate and calculate the concentration of ions in unknown sample was also developed (Figure 9).

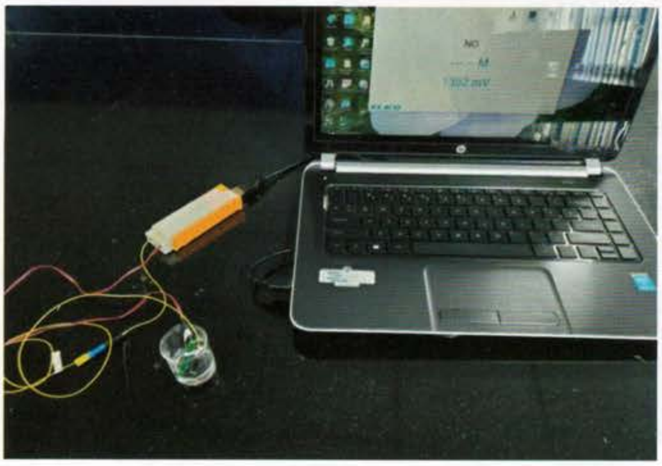


Figure 9.Estimation of soil nitrate through ISFET.

Potassium fractions in different benchmark soil series of Vertisols in Central and Western India

Results of nine benchmark soil series revealed that the soil pH varied from 7.7 to 8.4, increased with depth in all sites. The water soluble potassium (WSK) ranged between 6 and 1139 kg ha^{-1} where the maximum value was found in Sarol series followed by Jalawara series. Similarly, Exchangeable K (Exch K) varied from 193 to 5365 kg ha^{-1} where Sarol series had the higher Exch K, followed by Nabibagh series. The non-exchangeable K (Non Exch K) content of soil ranged from 286 to 6433 kg ha^{-1}. Similar to WSK, Sarol series registered higher Non Exch K followed by Nabibagh series. However, Junagad serieswas found to be low in all K fractions. Irrespective of soil series, pristine soils showed higher amount of K in all the fractions.

Nitrogen Use Efficiency (NUE) of selected wheat genotypes grown under different levels of Phosphorus in Vertisols

Twelve genotypes of wheat were evaluated under three different doses of phosphorus (P) fertilizer viz. control, sub-optimal P (half dose; 30 kg ha^{-1}) and normal dose of P (full dose; 60 kg ha^{-1}) during rabi season. . Results showed that P levels significantly increased the yield attributes of genotypes viz. plant biomass, grain yield, nutrient uptake, use efficiencies, harvest index and P harvest index (Figure 10). Among the 12 varieties NARMADA14 exhibited highest plant biomass (10696 kg ha^{-1} and 9480 kg ha^{-1} under normal and sub-optimal P fertilizer doses) whereas, the yield was highest in HI8713 (8217 kg ha^{-1}) under control conditions. The variety HI8713 generated highest grain yield under normal (4555 kg ha^{-1}) doses followed by sub-optimal P fertilizer doses (3985 kg ha^{-1}) and control (3055 kg ha^{-1}) conditions. The highest mean total P uptake was observed in HI8713 (11.70 $kgha^{-1}$) followed by NARMADA14 (11.40 $kgha^{-1}$) and the lowest total P uptake was in LOK1 (9.80 $kgha^{-1}$). P harvest index ranged between 82.84 - 80.68% for normal dose of P; 83.19 - 78.96% for sub-optimal dose of P; and 82.38 - 76.39% for control irrespective of the varieties.

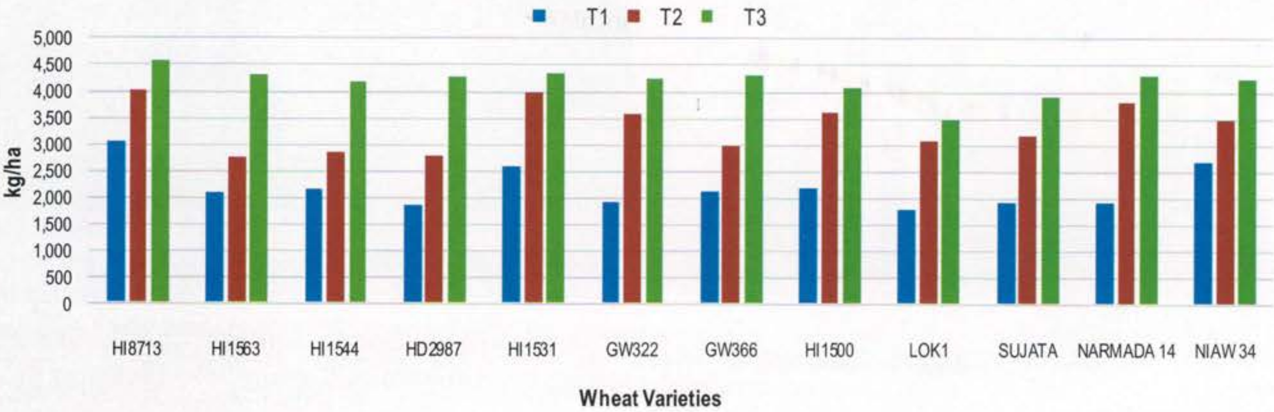


Figure 10. Grain yield of twelve wheat genotypes under different treatments

Brick-kiln Activity impacts Soil Fertility

A study on the impact of brick kiln activities on soil fertility indicated that there has been considerable decrease in the contents of organic matter (by 40%), available N (by 14%), P (by 70%), K (by 26%) and Zn (by 39%) in the surface soil due to removal of top fertile soil causing significant reduction in soil productivity in Bhopal and adjoining districts (Figures 11 & 12).

Figure 11. Brick kiln unit in Raisen district

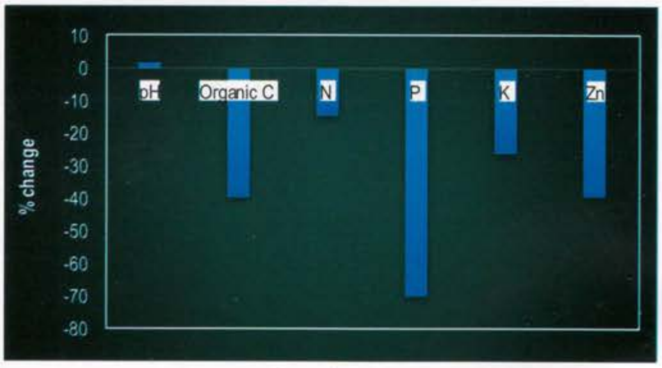


Figure 12. Change (%) in average soil fertility parameters due to top soil removal for brick making

Nitrogen Mineralization and Immobilization under Different Management Regimes

N mineralization under different crop residue, soil moisture and nutrient management was investigated. The content of soil NO_3^-N in various residue incorporation was in the trend of wheat < soybean < rice < maize < control soil (no residue) at 57 days of incubation and wheat < rice < maize < control soil < soybean at 87 days of incubation. Application of N, P, K through organic (manure / biochar) and inorganic sources minimized the N immobilization rate. Besides, application of wheat and rice residues resulted in N immobilization, while soybean and maize residues resulted in N mineralization (Figure 13). Application of biochar @ 5 Mg ha^{-1} along NPK fertilizers increased the NH_4^+N in control and residue amended soil. However, soil mineral N decreased significantly with reduction in the soil moisture content.

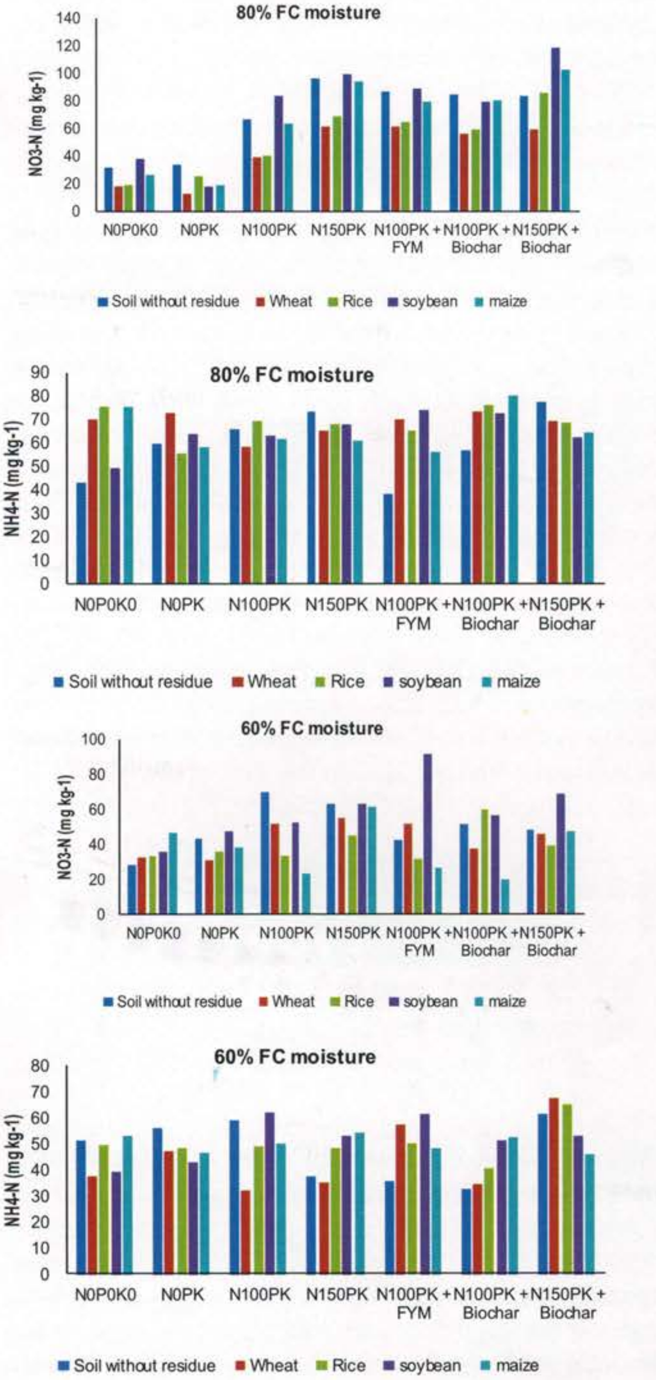


Figure 13. The NO_3^-N and NH_4^+N (mg kg^{-1} soil) in soil as influenced by crop residues, moisture and nutrient regimes

Effect of Industrial Sludge on Heavy Metal Concentration and Crop Productivity

A field study evaluated the potential utilization of industrial sludge on maize crop after critical analysis of benefits and contamination risks @ 2 t ha^{-1} (T_4), 5 t ha^{-1} (T_5), 10 t ha^{-1} (T_6), 20 t ha^{-1} (T_7), and 50 t ha^{-1} (T_8) showed sludge application @ >20 t ha^{-1} enhances crop growth and grain yields compared to RDF (Figure 14&15). Higher concentration of heavy metals in biomass was the result of trade-off between their 'increasing entry in soil-plant system' and 'dilution in biomass' due to enhanced crop growth. The study concludes that conjoint application of lower rates of both sludge and N fertilizer can minimize risk of heavy metals contamination while ensuring higher crop yields.

Figure 14. Effect of industrial sludge application on maize crop growth

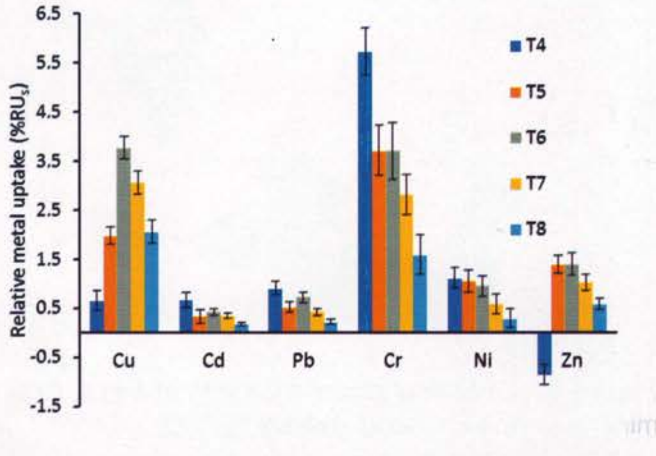


Figure 15. Relative uptake (%RUs) of heavy metals by maize biomass from their added quantity through sludge

Evaluation of Different Fertilizer Management in Wheat and Chick Pea Productivity under Farmer Field Conditions

Twelve farmers from four different villages were selected for imposition of three nutrient management treatment viz balanced use of fertilizer (BF), integrated nutrient management (INM) and farmers practice (FP). In wheat, highest biomass and grain yield were noticed under BF followed by FP. The lowest biomass and grain yield was found in INM. In chick pea, highest biomass as well as grain yield was attained in BF and lowest in the FP (Figure 16).

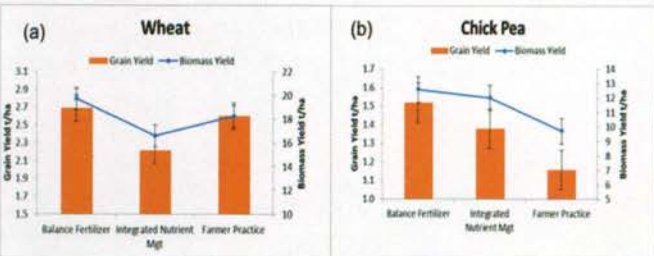


Figure 16. Effect of fertilizer management on yield of Wheat (A) and Chick Pea (B) in the farmer field under SCSP Program

Assessment of Acid Mine Drainage Affected Areas in Madhya Pradesh

Geo-referenced top layer (0-15 cm) soil samples were collected from the open cast coal mines (Sharda mine) and nearby agriculture as well as forest areas of Amlai mine (viz. Bargaon, Kelauhri and New Amlai) of Madhya Pradesh (Figure 17).

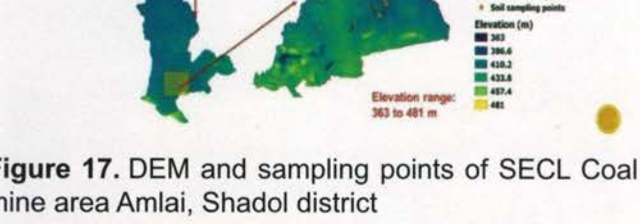


Figure 17. DEM and sampling points of SECL Coal mine area Amlai, Shadol district

Preliminary study of coal mine soils (Amlai) were strongly acidic (pH 4.51-5.45) whereas the nearby agricultural fields pH ranged between 5.30 to 6.58. Total and exchangeable acidity of mine soils were in the range of 6.92 to 10.53meq/ 100 g soil and 1.04 to 1.58meq/ 100 g soil, respectively. In nearby agricultural soils total and exchangeable acidity was in the range of 3.88 to 7.41 and 0.58 to 1.11meq/ 100 g soil, correspondingly. EC of mine and nearby agricultural soils were in the range of 105 – 210 µS/cm and 105-876 µS/cm, respectively.

Impact of tillage, crop residue addition, nutrient doses on Soil organic carbon

Soil Organic Carbon: Impact of tillage, crop residue addition and nutrient doses on soil organic carbon and active C evaluated after five crop cycles. Results (Figure 18) indicated that tillage system and nutrient doses had a significant impact on SOC at end of kharif season. Surface soils (0-10 cm) registered significant higher value of SOC (0.78%) observed under NT with 30 (T1) and 60 cm (T2) residue height. Lower value (0.66 and 0.52%) of SOC was found under T5 (Conventional tillage) at both of the soil depths, respectively. Among the nutrient doses, the higher values of SOC (0.80 and 0.82%) were recorded under N2 (100% RDF) and N3 (STCR) compared N1 (75% RDF). The interaction of tillage system x nutrient dose, nutrient dose x depth and tillage system x nutrient dose x depth have not shown significant effect on SOC in the end of kharif.

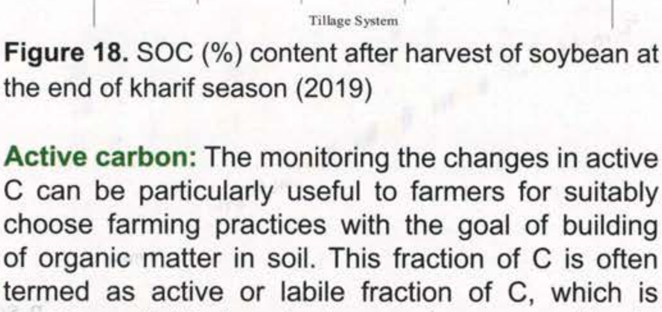


Figure 18. SOC (%) content after harvest of soybean at the end of kharif season (2019)

Active carbon: The monitoring the changes in active C can be particularly useful to farmers for suitably choose farming practices with the goal of building of organic matter in soil. This fraction of C is often termed as active or labile fraction of C, which is readily available to microbes and very sensitive to management practices. The active C fraction (835.7 mg C kg^{-1}) was found significantly higher under RT with 60 cm residue height compared to NT (829.4 mg C kg^{-1}) and CT practices in the end of kharif sampling (Figure 19). This was mainly due to better mixing of residue with minimum soil disturbances under reduced tillage, which provided more substrate for microbes to decompose the fresh residue resulting in higher labile carbon under these treatments. Lower values of active C under NT over RT was due to less opportunity for mixing of crop residue. Minimum active C content was recorded under CT (682.8 mg C kg^{-1}). Nutrient management practices had significant ($P < 0.05$) effect on labile carbon at both of the samplings. STCR dose was significantly higher active C (824.86 mg C kg^{-1}) than other nutrient doses. The interaction effects between tillage system and nutrient dose was non-significant ($P > 0.05$) on active C.

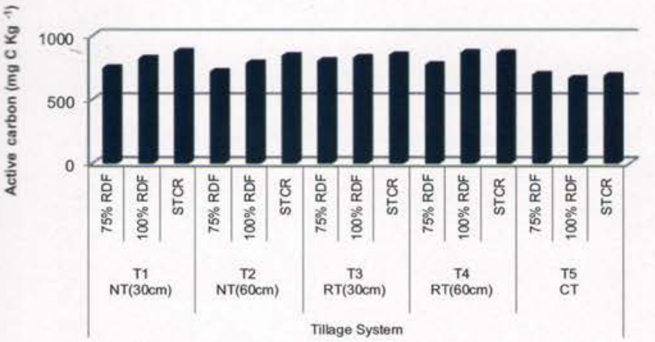


Figure 19. Active carbon content at the end of kharif and rabi season (2019-20)

Evaluation of Different Satellite-derived Soil Moisture Data

The satellite-derived daily volumetric soil moisture content data was acquired from Soil Moisture Active Passive (SMAP), European Space Agency Climate Change Initiative Soil Moisture (ESA CCI SM), and Advanced Microwave Scanning Radiometer 2 (AMSR2).The surface and root zone soil moisture product layer from SMAP L4_SM, surface soil moisture at both AM and PM pass from SMAP L3_SM_P_E, both active and passive combined surface soil moisture from ESA CCI SM, surface soil moisture content from C1 (6.9GHz), C2 (7.3GHz) and X (10.7GHz) bands from both ascending and descending pass of AMSR2 was downloaded and processed to derive the soil moisture for Bhopal, Shajapur and Sehore districts of Madhya Pradesh (Figure 20). There was good correlation among SMAP L4 surface and root zone soil moisture, SMAP L3 SMPE AM pass, SMAP L3 SMPE PM pass, and ESA CCI soil moisture, but comparatively weak correlation with AMSR-2 products.

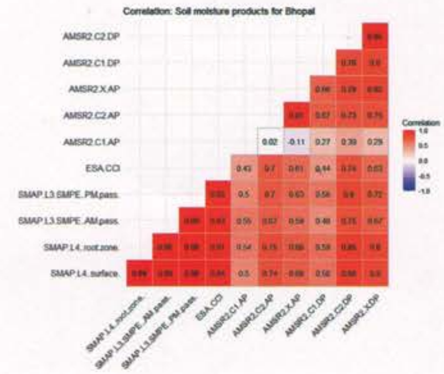


Figure 20. Correlation between different satellite-derived soil moisture products for Bhopal

Prediction of SOC Stock using RothC model

The RothC model was calibrated and validated to study the impact of different residue levels on SOC stock in the rice-wheat growing area of India. Soil and weather information of Hisar and Ludhiana districts were used to parameterise the RothC model. Increment residue incorporation from 1 t/ha to 7 t/ha of rice residue was considered during simulation study. The initial total organic carbon (TOC) Stock in Hisar and Ludhiana were 21.49 t/ha and 16.73 t/ha, respectively. Results showed an increase in TOC stock with an increase in the amount of residue incorporation at both locations (Figure 21).

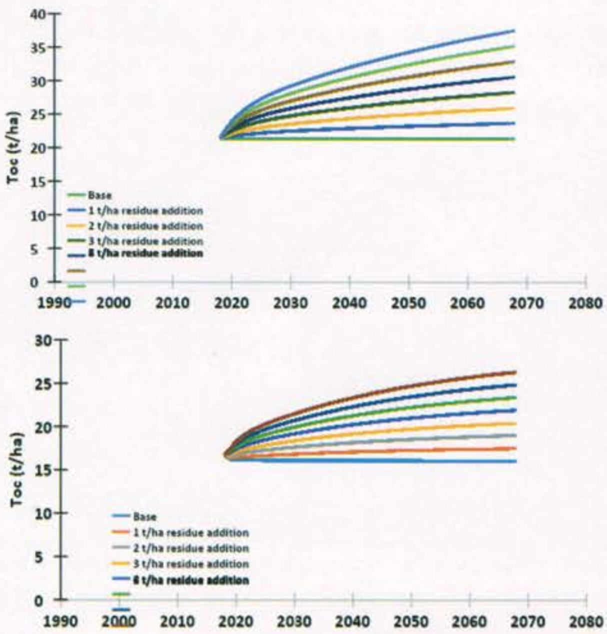


Figure 21: Effect of residue incorporation on TOC stock (a) Haryana (b) Ludhiana

APSIM Model for Rice- Wheat Cropping System under Long Term Fertilizer Experiments

The APSIM crop model was recently enhanced to simulate rice-wheat cropping systems and environmental dynamics of ponded systems at LTFE-Raipur center. Results (Figure 22) showed a good correlation between observed and simulated rice (R^2 = 0.75) and wheat (R^2= 0.65) yield. The observed soil carbon stock was closely related with the predicted SOC with modelling efficiency, EF, 0.76 in the upper 30 cm of soil depths. It indicates that model is performing satisfactorily well for future scenario.

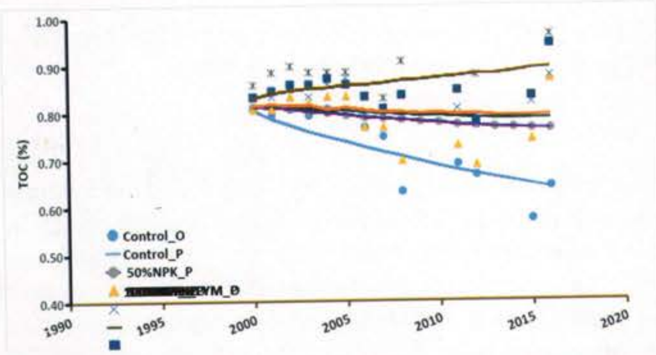


Figure 22 : Evaluation of APSIM model in simulating SOC stock in rice-wheat system

Management Interventions to Improve Productivity of Orchard

In guava plantation, nearly 90% of the total plants were infested with stem borer followed by bark eating caterpillar. Those plants were rejuvenated by inserting cotton soaked with petrol in the holes (Figure 23). Fruit fly was also a major issue in guava orchard which caused 80-90% losses of mrigbahar in crops. To control this pest, pheromone traps were installed in the guava orchards (Figure 24).In lime plants, mulching was done to conserve soil moisture and Bordeaux mixture was applied on the main trunk. The orchard was restored by planting about 80 lime plants and 100 drumstick saplings on the bunds surrounding the lime and guava plantations. Light pruning in mango resulted in good flowering and fruiting that resulted Rs.13525/- as revenue from mango.

Figure 23. Management of stem borer in guava

Figure 24. Pheromone trap in guava orchard to control fly flies

PRODUCTS DEVELOPED

Formulation of IISS-EKCEL Decomposer Capsule for in-situ and Ex-situ Crop Residue Decomposition

EKCEL decomposer consisting of four lignocellulolytic fungi (each capsule contains one fungal species) has been formulated in gelatin capsules (Figure 25). These capsules can be activated in 0.1 % bran-sugar solution. For in-situ decomposition, five capsules of each culture (4 fungi × 5 capsules = 20 capsules) are required to be activated in 50L bran-sugar solution whereas for ex-situ applications four capsules (one of each culture) are required to be activated in 10L solution. The activated cultures can be sprinkled on pit (pit 10x4x3 ft) or sprayed in field (0.5 acre).

Figure 25. EKCEL Decomposer

Low-cost Liquid Media Formulated for Mass Culturing of Fungal Bioinoculum for Composting

A low-cost media containing jaggery and wheat bran christened as "IISS-mycoF" has been developed for mass multiplication of fungal cultures. The media supported the growth and sporulation of Trichoderma asperellum isolate IISS-F1, Aspergillus niger isolate IISS-F2, Rhizopus oryzae isolate IISS-F3 and Aspergillus flavus isolate IISS-F4 (Figure 26). However, the medium needs to be tested for more fungal species having importance in agriculture.

Figure 26. Fungal growth in IISS-mycoF

EXTENSION ACTIVITY

Demonstrations under the Farmer FIRST Programme

Demonstrations were carried out on balanced nutrient application and need based pesticide application (Figure 27), conservation agriculture to promote best bet crop management techniques, soil health and disposa l of crop residues (Figure 28), vermicomposting for recycling of farm waste (Figure 29), along with backyard rearing of dual purpose poultry birds to enhance income of marginal and land less farmers (Figure 30).

Figure 28. Demonstration of balanced nutrient application in wheat

Figure 27. Demonstration of balanced nutrient application in vegetable crops

Figure 29. Demonstration of composting technique

Figure 30. Backyard poultry for improved net farm income

Demonstration of in-situ Decomposition of Wheat Residue in Soybean -Wheat Cropping System

In-situ crop residue decomposition technology was demonstrated at village Bagoniya on 22 June, 2021 for decomposition of wheat residue. Consortia of ligno-cellulolytic microorganism consisting of 3 Bacteria, 4 Fungi and 2 actinomycetes were used. For one acre of land, 1.6 tonnes of fresh cow dung, 2 kg molasses, 1 kg curd, 30 kg urea was mixed with microbial consortia, and sprinkled over the residue. The residues and ingredients were incorporated into the soil by tractor drawn rotavator (Figure 31). One irrigation was given immediately after incorporation of these residues.

Figure 31. In-situ crop residue decomposition technology

Frontline Demonstrations (FLDs) on Balanced Fertilizer Use in Wheat and Chickpea in Tribal Areas of Madhya Pradesh

Under STC (TSP) project of Indian Council of Agricultural Research FLDs were conducted in wheat (50) and chickpea (66) crops in the tribal villages of Barwani district (MP) during the rabi seasons of 2020-21 (Figure 32). In wheat, HYV seeds (cv Pusa Tejas i.e. HI-8759) with balanced recommended dose of fertilizers (RDF) @ 100:60:40 kg $N:P_2O_5:K_2O$ ha^{-1} generated average wheat yield of 3757 kg ha^{-1} whereas that was 2681 kg ha^{-1} under farmers' practice as they have been growing local cultivars and imbalanced fertilizer (@ 9:23:0 kg N:P2O5:K2O ha-1). Thus, improved variety along with balanced nutrient management recorded 40.1% higher yield over farmers' practice in wheat. In chickpea, two interventions such as farmers' practice (Variety: Local; Fertilizer @ 9:23:0 kg N:P2O5:K2O ha^{-1}) and improved variety (cv RVG-202) with RDF of @ 20:60:20 kgha^{-1} $N:P_2O_5:K_2O$ with package of practices and plant protection measures in chickpea generated maximum yield of 1580 kg ha^{-1} and a minimum 1080 kg ha^{-1} under balanced nutrient management. On the contrary, under farmers' practice the maximum yield was 1070 kg ha^{-1} and minimum 840 kg ha^{-1}. However, the average chickpea yield with improved variety and RDF was 1334 kg ha^{-1} whereas 970 kg ha^{-1} under farmers' practice. Thus, improved variety with balanced nutrient application recorded 37.5% higher chickpea yield over farmers' practice.

Figure 32. Performance of Wheat and chickpea under FLDs in Tribal Areas of BarwaniMicrobial Culture for Accelerating Composting Process

Microbial Culture for Accelerating Composting Process

Use of microbial consortia for accelerating the composting process was demonstrated in Ratibad village (Figure 33). The farmers were made aware about the importance of organic manure in sustenance of soil health, human health and environmental security. Farmers were also provided with portable vermibed and process for preparation of vermicompost using farm waste and cattle dung was explained.

Application of microbial culture

Layering with cow dung & waste

Heap preparation

Vermibed distribution to farmers

Figure 33. Demonstration of preparation of compost using microbial consortia and vermicomposting technology

Major Events

Input Distribution Programmes

Under the SCSP scheme, different agriculture inputs such as soybean and maize seeds, chemical fertilizers and farm implements (sickle, spade, pickaxe and manual weeder) were distributed to scheduled caste farmers of different villages adopted by the institute in connection with the MGMG programme.

ICAR-IISS, Bhopal, TSP-AICRP on MULLaRP, Raipur and Krishi Vigyan Kendra Rajnandgaon jointly organised Krishi Mela-Krishak Sangosthi on 02 March 2021 at the Gidhali Village of Rajnandgaon district, Chhattisgarh. Around 350 tribal farmers attended the events. 75 animals were vaccinated for 'Foot and Mouth disease' in the animal camp organized in the Krishi Mela. Also, agriculture inputs such as paddy and green gram seeds, portable vermibeds etc. were distributed to tribal farmers.

Training-cum input distribution program "Biofertilizers for Improving Soil Health & Crop Production" for the tribal farmers of Betul district (M.P.) was organised during 15-16 March, 2021. Liquid formulations of twelve biofertilizers were distributed to 200 tribal farmers from six tribal villages of the district viz., Charban, Chhata, Selagaon, Kahnegaon, Ghisibagla.

Farmers-Scientist Interaction Meeting

An interaction meet on "Climate-smart Agriculture for Improving Soil Health" was organized on 1st February, 2021 at Bagoniya village, Bhopal, M.P. under the SCSP scheme and nearly 100 farmers of the locality participated in the programme. (Coordinators: Drs. Dolamani Amat, M. Mohanty, Jitender Kumar, Asit Mandal, J.K. Thakur and A.B. Singh)

A field visit -cum- farmers scientist interaction meet was organized at the Mogra village of Rajnandgaon district (Chhattisgarh) on 3rd March, 2021 in connection with TSP programme of the institute.

Training Programmes Organized

ICAR-IISS, Bhopal with collaboration with State Institute of Agricultural Extension and Training (SIAET), Bhopal organised three days online training on "Integrated Nutrient Management" during 5-7 January 2021. (Coordinators: Drs. Pradip Dey, R.H. Wanjari, and M. Vassanda Coumar of ICAR-IISS Bhopal and Dr. Madhuri Wankhede of SIAET, Bhopal).

ICAR-IISS Bhopal and SIAET Bhopal jointly organized an online training programme on 'Soil Health Management' during 19-22 January, 2021 (Co-coordinator Drs. J. Somasundaram, Nishant K Sinha, Jitendra Kumar)

ICAR-IISS Bhopal in collaboration with SIAET, Bhopal organized three days online training on "Integrated Nutrient Management" during 23-25 February, 2021 (Co-coordinator Drs. A.B. Singh, A.K. Tripathi, Pradip Dey and Sudeshna Bhattacharjya).

Skill Training Programme on "Soil and Water Testing Lab Analyst (NSQF Level- 5)"was organized at the institute during 15 Feb to 16 March, 2021. The training was sponsored by Agriculture Extension Division, Indian Council of Agricultural Research, New Delhi, India (Coordinators: Drs. A.O. Shirale, A.K. Tripathi, B.P. Meena, Priya P Gurav and A.K. Biswas).

Skill Training Programme on "Vermicompost Producer (NSQF level-4)" was organized during 17 February-18 March, 2021. The program was sponsored by Agriculture Extension Division, Indian Council of Agricultural Research, New Delhi (Coordinators: Drs. A.K Tripathi, A.O Shirale, A.B Singh, A.K. Vishwakarma, A. Mandal, J.K. Thakur, Dolamani Amat and Pradeep Dey)

ICAR-IISS and Centre for Agriculture and Rural Development (CARD) jointly organized a Training and Exposure Visit on "Integrated Nutrient Management" for the Extension Officers of Uttar Pradesh during 19-25, February, 2021. (Coordinators: Drs. A.B. Singh, A.K. Tripathi, Asha Sahu)

ICAR-IISS organized one day training program on "Vermicomposting and Organic Farming" for Scheduled Caste farmers under the SCSP sub plan at Parwalia Sadak, Bhopal on 06 March, 2021. (Co-coordinator Drs. Dolamani Amat, Asit Mandal, J.K. Thakur, Kollah Bharati, Asha Sahu and A.B. Singh).

Women cell of ICAR-IISS organized a training programme on "Corona kaal me Gramin Mahilayon ki Krishi me Bhumika avam Sashaktikaran" at village Parwalia Sadak on 6 March, 2021

Women cell members of ICAR-IISS organized one day training for farm women under ATMA at ICAR-IISS, Bhopal on 8 March, 2021.

Women Cell celebrated International women's day on the theme "Women leadership in Agriculture: Achieving an equal future in Covid-19 World". Keeping in line with this theme, various events on Women Leadership in Agriculture, Entrepreneurship, Equity and Empowerment (3E) were organized.

Three days Kisan Pathshala on "Climate-Smart Agriculture and Soil health management" for SC farmers was organized under SCSP sub plan from 8-19 March, 2021 and coordinated by Drs. Dolamani Amat, Jitender Kumar, Asit Mandal, J.K. Thakur, A.K Tripathi and A.B. Singh.

Three Farmer Field Schools (FFS) were organized in Kanera, Parwalia Sadak and Raipur Panchayats of Bhopal district during 4-6, 6-8 and 16-18 March, 2021 respectively under NICRA Project. A total of 180 farmers (60 in each FFS) had participated. The FFSs imparted knowledge on conservation agriculture with minimum crop residue burning, integrated nutrient management, and integrated farming system for doubling farmer's income.

Farmers Field Day programme at the village Bhairopur was also organised under the Farmer FIRST Programme on 26.03.2021.

Republic Day 2021 Celebration

ICAR-IISS Bhopal celebrated Republic Day on 26 January 2021. Dr. Ashok K. Patra, Director hoisted the flag and addressed the employees of the institute.

National Science Day Celebration

ICAR-IISS Bhopal and Bhopal Chapter of the National Academy of Agricultural Sciences jointly organized a webinar on "Future of Science & Technology on Natural Resources Management in Agriculture" on 28 February 2021.In this event, two lead presentation by, Dr. R.T. Patil, former Director, ICAR-CIPHET, Ludhiana and Dr. D.K. Pal, former Visiting Scientist, ICRISAT were made followed by a panel discussion.

World Water Day Celebration

Institute celebrated World Water day on 22 March 2021 by organizing a series of programmes like quiz competition on 'Valuing Water' farmer-scientist interaction meet in the Raipur village of Bhopal district with the objectives of creating awareness on valuing water among farming communities in which about 200 farmers and students had participated. Mrs. T.S. Raji Jain, Chief General Manager, NABARD, Bhopal graced the event as Chief Guest.

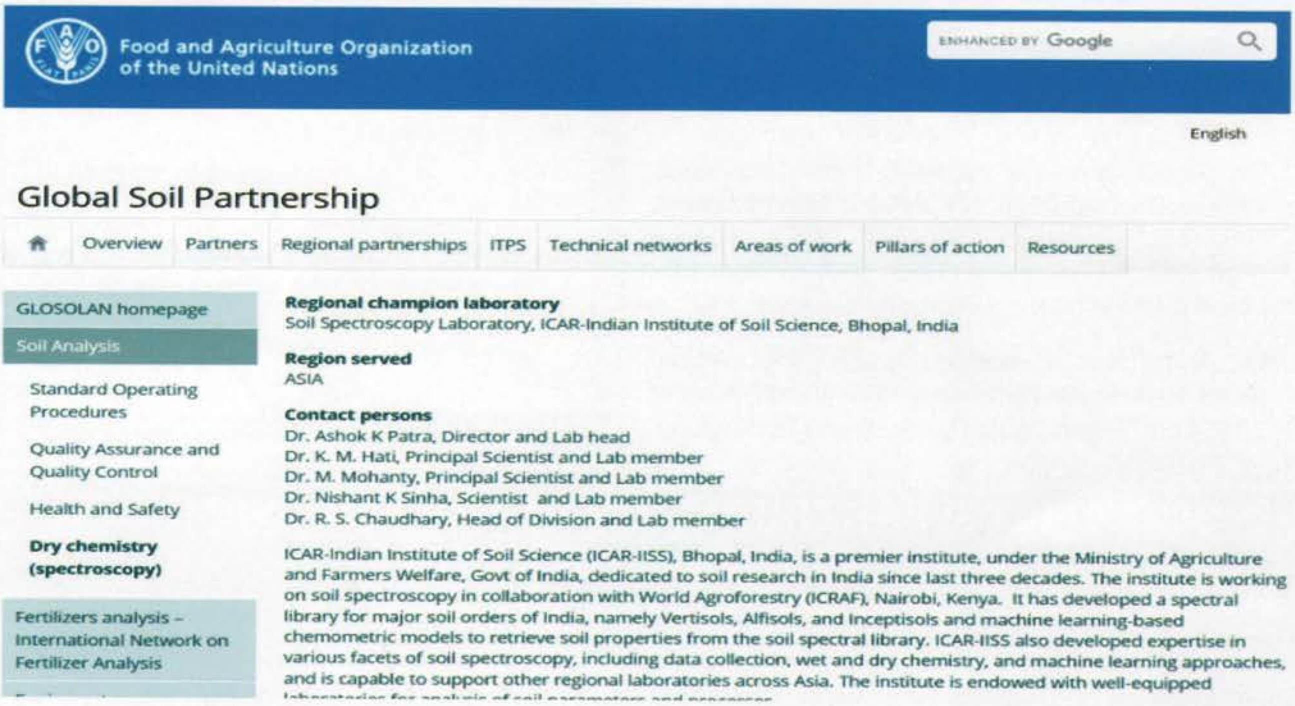
Swachhta Awareness Camps

Four swachhta awareness camps were organized in the villages Beenapur, Khujari, Rasulia Pathar and Ratibad adopted for taking up the activities of swachhata action plan.

World Environment Day Celebration

A webinar on "Ecosystem Restoration for Sustainable Food Production and Human Health" was organized on 5th June 2021. On this occasion, Dr. S. K. Chaudhari, DDG (NRM), ICAR was the chief guest. Dr. K.S. Rao, Professor and Head, Department of Botany, University of Delhi, Dr. Pinaki Sar, Professor, Department of Biotechnology, IIT Kharagpur, and Dr. T.J. Purakayastha, Principal Scientist, Division of Soil Science and Agricultural Chemistry, IARI delivered lectures in this webinar.

INTERNATIONAL COOPERATION



Food and Agriculture Organization of the United Nations

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Global Soil Partnership

Overview | Partners | Regional partnerships | ITPS | Technical networks | Areas of work | Pillars of action | Resources

GLOSOLAN homepage
Soil Analysis
Standard Operating Procedures
Quality Assurance and Quality Control
Health and Safety
Dry chemistry (spectroscopy)
Fertilizers analysis – International Network on Fertilizer Analysis

Regional champion laboratory
Soil Spectroscopy Laboratory, ICAR-Indian Institute of Soil Science, Bhopal, India

Region served
ASIA

Contact persons
Dr. Ashok K Patra, Director and Lab head
Dr. K. M. Hati, Principal Scientist and Lab member
Dr. M. Mohanty, Principal Scientist and Lab member
Dr. Nishant K Sinha, Scientist and Lab member
Dr. R. S. Chaudhary, Head of Division and Lab member

ICAR-Indian Institute of Soil Science (ICAR-IISS), Bhopal, India, is a premier institute, under the Ministry of Agriculture and Farmers Welfare, Govt of India, dedicated to soil research in India since last three decades. The institute is working on soil spectroscopy in collaboration with World Agroforestry (ICRAF), Nairobi, Kenya. It has developed a spectral library for major soil orders of India, namely Vertisols, Alfisols, and Inceptisols and machine learning-based chemometric models to retrieve soil properties from the soil spectral library. ICAR-IISS also developed expertise in various facets of soil spectroscopy, including data collection, wet and dry chemistry, and machine learning approaches, and is capable to support other regional laboratories across Asia. The institute is endowed with well-equipped

AWARDS & HONOURS

- Dr. R.S. Chaudhary: Member, Advisory Board for new generation watershed projects, Panchayat& Rural Development Department, Govt. of Madhya Pradesh from 2021 and onwards.
- Dr. R.S. Chaudhary: Nodal Officer, State Level Dynamic Decision Support System-Green Platform, Govt. of Madhya Pradesh-An initiative of Department of Land Resources, Ministry or Rural Development, Government of India.
- Seema Bhardwaj: Received "Research Excellence Award 2020 "by Institute of Scholars for year 2020.
- Dr. Asha Sahu received reviewer certificate from European Journal of Soil Science on 26/02/2021
- Dr. Sudeshna Bhattacharjya received reviewer recognition certificate from PLOSOne on 18/02/2021
- Best Popular article award (Institute Award) conferred to Lal Chand, Dhiraj Kumar, Asha

Ram, Naresh Kumar, SukumarTaria and HirdayeshAnuragi on the occasion of (26 January) Republic Day 2021 from ICAR-Central Agroforestry Research Institute, Jhansi (U.P).

- Dr. Sangeeta Lenka received Science and Engineering Research Board-POWER- fellow, Department of Science and Technology, Government of India in the March 2021.
- Dr. Bharat Prakash Meena received Best Oral paper Presentation (virtually) award in the 4thInternational Conference Global Approaches in Natural Resource Management for Climate Smart Agriculture (GNRSA-2020) During Pandemic Era of CoVID-19 (26 -28 Feb., 2021).
- Dr. Priya Gurav received the Best Young Scientist Award, EET CRS 10th Science and Technology Awards -2021, Bangalore.
- Dr. Dinesh K Yadav received "Seth Lachhiram Chudiwal Award-2020" of ICAR-Indian Agricultural Research Institute for Best PhD Thesis (Agricultural Chemicals) during 59th convocation of the institute held on February 12, 2021.
- Dr. Abhijit Sarkar received Augmenting Writing Skills for Articulating Research (AWSAR) Award 2020 from Department of Science and Technology (DST), Government of India on the occasion of National Science Day, 28 February 2021.

SCIENTISTS' PARTICIPATION IN TRAINING/SEMINAR/ WORKSHOP/MEETING

Name	Program Attended/Participated	Venue/Organizer	Date/Duration
Dr. Asit Mandal	Online Group Monitoring Meeting of Expert Committee	Science and Engineering Research Board (SERB)-DST	11-13 January, 2021
Dr. Jitendra Kumar	online training programme on Hyper spectral Data for Land and Coastal Systems	NASA's Applied Remote Sensing Training Program, USA	19, 26 January & 2 February, 2021
Dr. Asit Mandal	7th Annual Review Meeting of NASF of the Strategic area "Precision agriculture and management of natural resources; and application of sensors in crops, animals and Fisheries"	ICAR-National Agricultural Science Fund	21 January, 2021
All Scientists	IPR enabling of technologies and processes involved	ICAR-Indian Institute of Soil Science Bhopal	22 January, 2021

Name	Program Attended/Participated	Venue/Organizer	Date/Duration
Drs. Bharat Prakash Meena, Priya P Gurav	2nd Asian Web Conference on Managing Hill Resources and Diversities for Zero Hunger and Climate Resilience	Soil Conservation Society of India, Meghalaya chapter, Barapani, India	12-13 February, 2021
All Scientists	Webinar on 'Future of Science and Technology on Natural Resource Management in Agriculture'	ICAR-Indian Institute of Soil Science and Bhopal Chapter of the National Academy of Agricultural Sciences	28 February, 2021
All Women Scientist	International Women's day celebration	Parwalia Sadak, Bhopal, M.P.	08 March, 2021
Drs. Elanchezhian, Asit Mandal	International Plant Physiology Virtual Symposium 2021 (IPPVS -2021) "Physiological Interventions for Climate Smart Agriculture"	ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu & Indian Society of Plant Physiology (ISPP), New Delhi, India	11-12 March, 2021
All Scientists	World Water Day	ICAR-Indian Institute of Soil Science Bhopal	22 March, 2021
Ms.Seema Bharadwaj	Iinternational Symposium on Water Sustainability: Challenges, technologies and opportunities March 22-25th 2021	Amrita Vishwavidyalaya, Peetham, Kerela, India and WAPCOS Ltd.	22-25 March, 2021
Dr. Bharat Prakash Meena	Global Symposium on Biodiversity	Food and Agriculture Organization	10-12 April, 2021
All Scientists	Webinar on "Ecosystem Restoration for Sustainable Food Production and Human Health"	ICAR-Indian Institute of Soil Science Bhopal	05 June, 2021
Dr. Narayan Lal	Webinar"Challenges and opportunities for developing new cultivars in fruit crops	Faculty of Agriculture Science and Technology, Mansarover Global University, Sehore, MP	14 June,2021
Drs. R.H. Wanjari, Dhiraj Kumar, Narayan Lal and Jitendra Kumar	Farmer's Awareness Campaign on "Balanced Use of Fertilizer"	ICAR-Indian Institute of Soil Science Bhopal	18 June, 2021
All Scientists	National webinar on "Nanotechnology in Agriculture: Opportunities and Challenges	NAAS-Bhopal Chapter and ICAR-IISS, Bhopal	21 June, 2021
All Scientists	Brainstorming Session on "Regenerative Agriculture for Soil Health, Food and Environmental Security Program	Trust for Advancement of Agricultural Sciences, New Delhi	26 June, 2021

STAFF NEWS

JOINING

- Mr. Rahul Mishra, Scientist (Soil Sciences) joined ICAR-IISS Bhopal on 11.01.2021
- Dr. Dinesh Kumar Yadav, Scientist (Agricultural Chemicals) joined ICAR-IISS Bhopal on 12.01.2021
- Ms. Khushboo Rani, Scientist (Soil Sciences) joined ICAR-IISS Bhopal on 13.01.2021
- Mr. Abhinash Das, Scientist (Soil Sciences) joined ICAR-IISS Bhopal on 13.01.2021
- Mr. Prashant Gour, LDC joined ICAR-IISS Bhopal on 15.01.2021

PROMOTION

- Dr. Sanjib Kumar Behra, Senior Scientist promoted from academic level 13A to 14 (Principal Scientist) w.e.f. May 02, 2018
- Dr. Sangeeta Lenka, Senior Scientist promoted from academic level 12 to 13A w.e.f January 08, 2019
- Dr. Asit Mandal, Senior Scientist promoted from academic level 11 to 12 w.e.f June 20, 2018
- Dr. Vassanda Coumar Senior Scientist promoted from academic level 11 to 12 w.e.f November 03, 2018
- Dr. Hiranmoy Das, Scientist promoted from academic level 10 to level 11 w.e.f September15, 2016
- Dr. Vasudev Meena, Scientist promoted from academic level 10 to level 11 w.e.f September15, 2016
- Dr. Dhiraj Kumar, Scientist promoted from academic level 10 to level 11 w.e.f January 01, 2019
- Dr. Sudeshna Bhattacharjya, Scientist promoted from academic level 10 to level 11 w.e.f January 01, 2019
- Dr. Shirale Abhay Omprakash, Scientist promoted from academic level 10 to level 11 w.e.f January 01, 2019
- Mr. D.R. Darwai, Technical Officer promoted Sr. Technical Officer w.e.f January 23, 2018
- Mr. Venny Joy, PA promoted through MACP w.e.f
- Mr. Bansilal Sarsodia, Assistant promoted through MACP w.e.f
- Ms. Geeta Yadav, PS promoted through MACP w.e.f

TRANSFER

- Dr. Vasudev Meena, Scientist transferred to ICAR-DRMR Bharatpur, Rajasthan on January 23, 2021.

DECEASED

Mr. Vinod Chaudhary, Senior Technical Assis tant, departed to heav enly abode on 14 April, 2021.

Dr. S. Ramana, Principal Scientist (Plant Physiol- ogy) departed to heav enly abode on 18 April, 2021.

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