IISS Newsletter

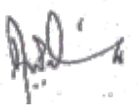
Director's Desk

It is an excellent opportunity for me to carry forward the legacy of Indian Institute of Soil Science (IISS) which has consistently contributed towards bringing up the national agricultural science to international level. IISS is fostering high quality research on basic, strategic and applied aspects of soil to make Indian agriculture sustainable keeping soil health as the core of its endeavour. Through green revolution Indian agriculture has witnessed continuous increase in agricultural production and reached self-sufficiency. However, declining natural resources, factor productivity, climate change and other environmental concerns are the emerging issues which needs careful assessment and technologies for providing suitable strategies to keep pace with increasing population and food grain requirement which may go up to a level of 300 million tons by the year 2025. In this context, it is important to ensure sustainability and profitability of agriculture by technology generation specifically designed to address the complex situation through integrated multidisciplinary research approaches supplemental to basic and strategic research and to carry the research output to the end users for effective adoption of technologies.

Soil resources serve as a basis for food security and nurture all forms of terrestrial life, the international community advocates for its sustainable and responsible use through conservation measures and governance. Soil organic matter (SOM) is at the heart of imparting sustainability as it induces a number of positive effects on soil physical and chemical properties and governs the soil's capacity to provide regulatory ecosystem services. SOM is regarded as being critical for soil function and soil quality, however its content is declining due to land degradation and in areas with unscientific use of inputs which in turn adversely affects and limits the capacity of the soil to undertake vital functions. Therefore, in the wake of such challenges we have to redefine our mission and ways of doing agriculture. In this respect, conservation Agriculture (CA) has emerged as a new way forward to achieve the goals of sustainable agriculture in response to these resource conservation challenges. A consortium research project involving a number of NRM institutes on conservation agriculture is being initiated at this institute to monitor efficiency of CA based practices on crops, soil and environment. Pradhan Mantri Gramin Krishi Yojna policy envisages two major components, distribution of Soil health

card to all farmers and irrigation facility to villages across the country. A farmer friendly soil testing kit that holistically tests soil properties along with biological quality is warranted. At IISS, efforts for developing a low cost effective portable soil health test kit is on its way to support the national need of generating soil health cards to the farmers of the country. It will assist farmers for profitable response of fertilizer application to various crops by providing precise fertilizer recommendations for a given crop based on soil test crop response equations to achieve the desired target yield.

Climate change and variability are posing serious challenges influencing the performance of Indian agriculture. Environmental degradation and the concomitant effects on crops, farm animals and man, unequivocally constitute one of the greatest challenges of man in the new millennium. There are evidences already of negative impacts on yield of wheat, rice and other crops in parts of India due to increased temperature & water stress, and reduction in number of rainy days which in turn would result in greater instability in food production. The country has been witnessing the impact of poor monsoons due to El Nino effect with adverse consequences on agricultural production, particularly in the rain-fed areas inducing severe drought conditions. A comprehensive adaptation and mitigation strategy for coping with the adverse impact of climate change is the need of the hour for developing climate smart agriculture through changes in land use management, development of multiple stress tolerant varieties, efficient cropping systems that match with the changed rainfall patterns, resource conservation technologies, water harvesting and supplemental irrigation for drought proofing in rainfed areas can help in mitigating the adverse impact of climate change and variability. Alternate land use system like agro-forestry system and other biological carbon capture systems can also help in both adaptation and mitigation. Reliable early warning system of climate effects and their spatial and temporal magnitude will be of great help to frame policies to support the diffusion of this information and to help interpret these forecasts in terms of their agronomic and economic implications are required to help farmers in a big way. The Director General, ICAR has already called upon the scientists to develop technologies that will improve water productivity and improve the per unit productivity of crops in the country. There is urgent need to optimize the resource use efficiency and produce more from the available resources to fulfill the national goals and meeting the global challenges. I am confident that we at Indian Institute of Soil Science will be able to contribute significantly towards meeting the challenges with scientific interventions and fulfill the national needs and responsibilities.



(A.K.Patra)

Dr. Ashok K. Patra did his early education at Bankura, West Bengal. He studied B. Sc. (Agri.) during 1979-1983 from Banaras Hindu University (Varanasi), and M.Sc. and Ph.D. in Soil Science & Agricultural Chemistry in 1985 and 1989, respectively, from IARI, New Delhi. He joined ARS (ICAR) in 1989 and started his career at IGFRI, Jhansi as a Scientist/Scientist Sr. Scale (1990-1998). Then as a Sr. Scientist he moved to CIFE, Mumbai (1998-1999), and to IARI, as Sr. Scientist (1999-2006) and Principal Scientist (2006-2014). He joined the ICAR- Indian Institute of Soil Science, Bhopal as Director on 1st May 2014. During his scientific career, he has also worked as a postdoctoral scientist (1991-1993) at ICRISAT, Hyderabad, and under Indo-UK Collaborative programme as Visiting Study Fellow (1996) at the Institute of Grassland and Environmental Research (IGER), Devon, UK. He was a recipient of the prestigious INRA Fellowship (2001-2003) of the French Research Ministry to work on molecular soil ecology in N cycling at the CNRS-Claude Bernard Université Lyon, France. For pursuing the frontier soil science research, DBT (GOI) awarded him the 'DBT Overseas Asssociateship'-2008 for which he visited USA during 2008-2009.

During his research career, Dr. Patra has made outstanding contribution on different aspects of nitrogen cycling, its ecology and biodiversity in different agro-ecosystems, and contributed more than 200 publications. He was a faculty of Post Graduate School, IARI, New Delhi and actively involved in teaching and guiding of postgraduate students at IARI for 15 years (1999-2014). He is a recipient of several awards/recognitions and fellowships, namely: British Council TCT Award 1996; DBT Overseas Associateship Award 2008; FAI Dhiru Morarji Memorial Award, 2011; ISSS Dr. G.S. Sekhon Memorial Lecture Award, 2012 of ISSS, New Delhi; Hooker Award of IARI (2013), New Delhi. Dr. Patra was Editor, Range Management and Agroforestry 1996-1998; Councillor, Indian Society of Soil Science (2005-2006); President (Delhi Chapter), Indian Society of Soil Science (2012-14); Member, Nature's Reader Panel (2009). He served as expert of several important committees and acted as reviewer for more than 25 international journals. Dr Patra is a Fellow of the National Academy of Agricultural Sciences, Indian Society of Soil Science and Range Management Society of India.

Research Highlights

Factors affecting potential carbon mineralization (PCM) in soil

Potentially organic carbon (C) mineralization (PMC) in soil is related to CO_2 produced from the labile organic carbon mediated by heterotrophic microbes. For better understanding such linkage, lab scale experiments were carried out using soil samples representing agriculture, fallow and forest located at Palampur, Jabalpur, and Ranchi. The 14 soil samples were used to determine potential carbon mineralization by conducting a long-term incubation study (247 days). The amount of C evolved in the form of CO_2 during different time intervals of incubation was used to estimate PMC. The cumulative C-CO_2 evolved were fitted to non-linear regression (least square) curve. PMC and decay constant were estimated for different soil types and land use parameters. PMC ranged from 61.9-146.1 mg C-CO_2 $100g^{-1}$ soil whereas, decay constant of PMC varied from 0.013 -0.041 per day. Subsequently, 12 variables including soil and climatic conditions were subjected to principal component analysis (PCA) for determining the factors responsible for PMC in soil. Results indicated that silt, clay and C: N ratio of soil were the main factors to influence potential carbon mineralization in the soil.

Nanoparticles influence plant growth and metabolism

The impact of nanoparticles (NP) on growth and metabolism of plants viz. wheat and maize was studied under hydroponic system using ZnO, CuO and Fe_3O_4 nanoparticles (Fig.1). Various plant growth parameters viz. plant height, root length, shoot biomass, root biomass and chlorophyll content were recorded during different period till 45 DAS (days after sowing). The level of antioxidant enzymes viz. super oxide dismutase (SOD), catalase (CAT) and peroxidase (POX) were recorded in plants treated with NPs to ascertain their impact on plant metabolism. It was observed that NP did not affect the root growth during 45 DAS but shoot growth was affected after 30 DAS. Plant height and biomass increased with CuO NP and decreased with Fe_3O_4 NP treatment. Antioxidant enzyme, SOD activity was observed after 30 DAS and CAT & POX activity was observed after 45 DAS. Fe NP / Zn NP treated plants showed moderate level of SOD/ CAT activities while Cu NP treated plants showed moderate POX, indicating lower level of stress in the plants. The NPs (ZnO and CuO) were analyzed in Transmission Electron Microscope (TEM) for characterization of size and shape (Fig. 2). Spherical and rod shaped particles were observed in case of ZnO NP and spherical shape was observed in case of CuO NP. Most of NPs were within 50 nm range.

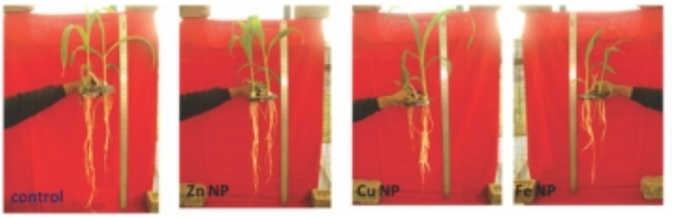


Fig. 1. Influence of nanoparticles on the shoot and root growth of maize plants.

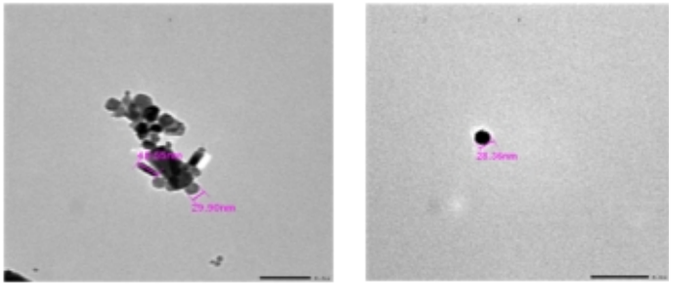


Fig. 2. Transmission electron microscopy of ZnO (left) and CuO (right) nanoparticles

Pore volume distribution of Clinoptilolite fractions

The pore size /volume distribution function of a porous medium is very important, since it influences the transport and equilibrium of molecules adsorbed in the structures. The pore volume distribution over pore diameter is expressed in terms of the distribution function f (v) = - (dV / d log D), where V is pore volume. The density functional theory based method for the calculation of pore size/volume distribution of zeolites from nitrogen adsorption isotherms has become a standard characterization procedure in recent years. Considering the micropore region of the fractions, differential pore volume distribution patterns for the three fractions have shown sharp

minima/parallel to the x axis between 1.6 nm and 6 nm (Fig. 3). There was no peak point of adsorption for the 1-2 nm region, which might be due to the artificial layering steps inherent to the theoretical isotherms causing artificial gaps on the calculated pore size distributions around 1 and 2 nm. In this region, there was no change in the adsorption for each incremental increase in the pore width, irrespective of the fraction. In the mesopore region, there were only two peaks at 35 and 40 nm with a zig-zag distribution pattern. In the macro pore region, upto 170 nm pore width, the pattern was zig-zag for all the fractions but thereafter it followed the exponential curve. However, from between 170 175 nm pore width, the fractions behaved differently. Z9 and Z10 exhibited a sigmoid curve with peaks at 230 and 280 nm, respectively. Z8 have a downward trailing curve which is unusual. It is concluded that when the particle diameter increases it loses the surface area, and may also affect the volume of the fractions

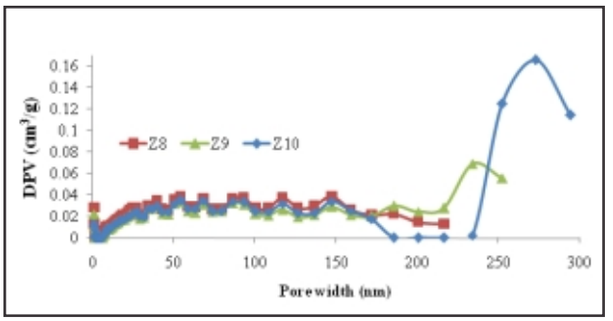


Fig 3. Differential pore volume distribution pattern for clinoptilolite fractions (DFT method)

Biochar effect on spinach performance

A pot study was conducted to assess the effect of biochar on spinach growth performance (Fig. 4 and 5). The treatments were T1 control, T2 biochar, T3 NPK 100%, T4 NPK + biochar, T5 NPK + FYM, and T6 NPK + FYM+ biochar. Spinach leaf yield (in weight) increased by about 63% with biochar application over control. Use of biochar and FYM along with NPK resulted in 40% and 25% increase over NPK application, respectively during first cutting. The effects were also visible during the second cutting of spinach leaves. The mean yield of the spinach increased by 49% with application of biochar along with inorganic fertilizers as compared to inorganic fertilizer application alone.

Fig. 4. Biochar effect on performance of spinach

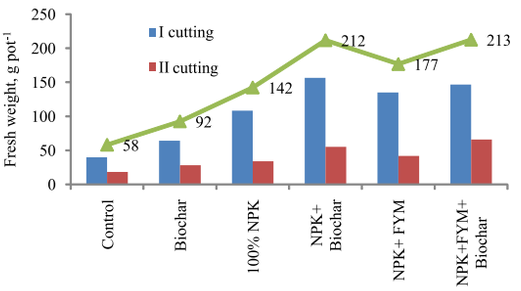


Fig. 5. Effect of biochar on fresh leaf yield of spinach

Wheat root architecture as influenced by soil compaction levels in a Vertisol

In a laboratory study, the root systems of wheat cvs Sujata and Malwa Shakti were assessed in response to soil compaction levels (Fig. 6). There was significant difference in the root architecture of both the cultivars with increase in bulk density (BD) from 1.2 Mg m^{-3} to 1.6 Mg m^{-3}. Between the two cultivars, the main axis length was greater in Malwa Shakti than Sujata at 1.2 and 1.4 Mg m^{-3}, whereas, there was not much difference in main axis length at 1.5 and 1.6 Mg m^{-3} BD levels. However, the main axis length of the both the cultivars decreased significantly with increase in soil compaction levels. By increasing the BD, the number of primary axis decreased significantly in both the cultivars. Higher number of primary roots was observed in Malwa Shakti than Sujata. On an average, there was 30% and 36% reduction in number of primary root in Malwa Shakti and Sujata with increase in BD from 1.2 Mg m^{-3} to 1.6 Mg m^{-3}, respectively. Result highlighted that increasing soil compaction

levels may negatively influence root architecture of wheat.

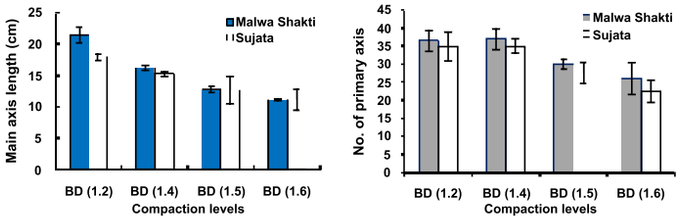


Fig. 6. Effect of soil compaction levels on main axis length & number of primary axis of wheat

Effects of change in temperature and CO_2 concentration on wheat yield

In a simulation study, it was revealed that temperature played a negative role; while CO_2 played a positive role on grain yield of wheat under future climate change scenarios (Fig. 7). Increasing the temperature by 1 °C from the base, there was decrease in grain yield by 8.4% of the wheat cv Sujata. On an average, there was 5% decrease in wheat grain yield per increase in 1 °C in temperature. Increase in CO_2 concentration from the base (350 ppm) to 850 ppm, the wheat grain yield increased. By doubling the CO_2 concentration from 350 ppm to 700 ppm, the grain yield was increased by 26%. The combination of a 450 ppm CO_2 and a 1 °C temperature rise stimulated wheat grain yield by 2.6% compared to base. However, the combination of a 450 ppm CO_2 and a 2°C temperature rise reduced wheat yield by 5.4% over base. This trend continued to follow with increasing the temperature to 5°C. With increasing the CO_2 level from 400 ppm to 700 ppm and corresponding increase in temperature to 5°C the negative effect of temperature on wheat yield was diminished. The result shows that an increase in temperature and elevated CO_2 concentration had an interactive effect on wheat yield in the sub-humid part of central I

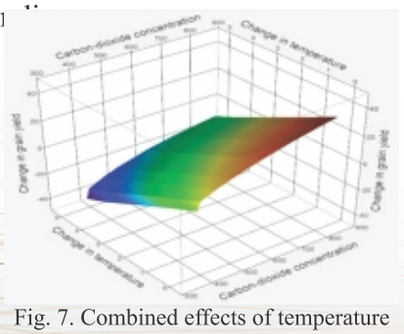


Fig. 7. Combined effects of temperature & CO_2 concentration on wheat yield

Global warming potential of soybean-wheat under different fertilizer management

Experiment carried out to compare the greenhouse gas emission from soybean-wheat cropping system in Vertisols of central India. The gas samples were collected at frequent intervals from sowing to harvest and during the fallow period using static chamber placed between crop rows. It was observed that integrated nutrient management (organic manures combined with NPK fertilizers) stimulated N_2O and CO_2 emissions more than other fertilizer practices. Soil temperature, air temperature, and precipitation correlated positively with CO_2 emissions. The global warming potential of different nutrient management practices followed as INM > Organic > Inorganic. The carbon equivalent emission from soybean-wheat system varied from 3112 and 4260 kg C ha^{-1}. Integrated fertilizer management increased the global warming potential by 37% than inorganic treatment.

Effect of Chromium on soil enzyme activities

A laboratory experiment was conducted to evaluate the impact of chromium (Cr) application on soil enzyme activities *i.e.,* dehydrogenase activity, alkaline phosphatase and fluorescein diacetate hydrolyzing enzymes. Graded doses of Cr (0, 5, 10, 15, 20, 40, 80 and 100 ppm) were applied through $K_2Cr_2O_7$, and enzyme activities were measured at 7, 15, 30 and 45 days after incubation. Preliminary results showed that increasing the concentration of Cr (0 to 100 ppm) reduced the dehydrogenase activity (70%), alkaline phosphatase (68%) and fluorescein diacetate (41%) over control. The inhibitory effect of Cr on soil enzymatic activity was significant from 20 ppm onwards. It can be concluded, that Cr contamination (from tannery effluent) has significant adverse effect on soil enzymes activities.

Soil quality status of tribal dominated Jhabua district of M.P.

Geo-referenced surface soil samples (top 15 cm) were collected from the farmers' field of tribal dominated Jhabua district (MP). About 540 samples were collected from 90 randomly selected villages. The samples were analyzed for their physico-chemical properties. Fifteen soil quality indicators were identified for soil quality calculation. Soil parameters influenced crop productivity were clay content, soil depth, soil organic carbon (SOC), pH, available N, P, K, S and Zn. Soil quality index (SQI) was calculated and a SQI map was prepared for the Jhabua, Rama, Meghnagar and Tandla blocks of Jhabua district (Fig. 8). Mostly, these soils exhibited moderate to poor soil quality. About 65% soil samples were categorised as poor and 35% soils were of medium quality.

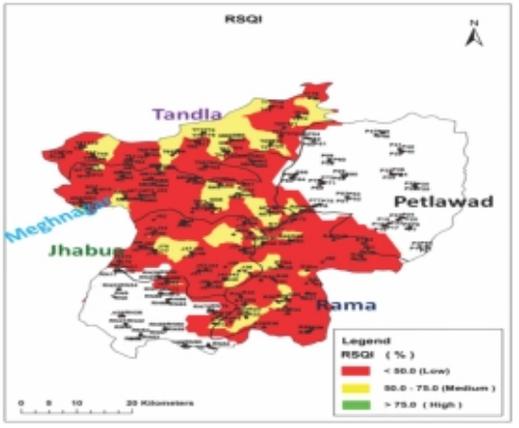


Fig. 8. Relative soil quality index map for Jhabua, Rama, Meghnagar and Tandla blocks of Jhabua district

Balanced nutrient management to enhance rice yield in tribal farmers' of Chhattisgarh

Productivity in tribal belt of our country is generally poor due to lack of knowledge of technology and resources. To enhance and sustain the productivity of rice in Chhattisgarh, field demonstrations were conducted in Durg, Dhamtari, Mahasamund and Janjgir-Champa (Fig. 9) districts. Field demonstration were carried out with (i) Farmers' practice (FPD), (ii) application of sole N source, (iii) application of recommended dose of fertilizer (RDF), and (iv) application of RDF + FYM. Data indicated that use of fertilizers in less quantity and imbalanced way is responsible for less yield (Table 1). Survey further revealed that majority of the farmer's are using only urea which further declined the productivity of rice. The use of fertilizer in balanced amount resulted substantial increase in rice yield. On an average 15 to 20 quintal increase in productivity can be achieved by optimum fertilizer application. In all the three targeted districts 31 to 49 percent increase in rice productivity over farmers' practice was obtained. Incorporation of 5 t FYM further increased the rice productivity by 13 to 20 %. Study clearly showed Adopting nutrient based fertilizer management practice will increase the crop productivity and improve the economic condition of farmers' of the region.

Table 1. Effect of balanced fertilizer on rice yield (t ha^{-1}) in Tribal farmers' field of Chhattisgarh

Treatments	Durg district		Dhamtari district		Janjgir-Champa district	
	Yield	Increase (%)	Yield	Increase (%)	Yield	Increase (%)
FPD (65:40:15)	3.51	-	3.63	-	3.00	-
N 120 kg ha^{-1}	2.60	(-)25.69	2.67	(-)26.43	2.56	(-)14.46
120:60:40 N:P:K kg ha^{-1}	4.60	31.23	4.93	36.00	4.42	47.36
120:60:40 N:P:K kg ha^{-1} + 5 t FYM	5.08	44.84	5.50	51.62	5.03	67.90

Fig. 9. Field demonstrations conducted on farmers' fields in Tribal areas of Chhattisgarh

Bioremediation of heavy metals

Biofilter is an important tool to remove heavy metals from contaminated municipal solid waste. In the present study six mesophilic fungi were used to remove contaminated heavy metals from MSW compost (Fig.10). The highest heavy metals removal efficiency of fungi was observed for Pb that varied from 18-52% with a mean of 31.5% followed by Ni, which was varied from 16-42% with a mean of 34% (Table 2).

Fig. 10. Bioremediation of heavy metals using biofilter

Table 2. Heavy metal removal efficiency of the fungal isolates

Heavy metals	Removal efficiency (%)
Zn	5-32
Cu	6-22
Cr	4-19
Cd	7-35
Ni	19-42
Pb	18-52

Crop production under organic, inorganic and integrated fertilizer practice

Productivity of soybean evaluated in organic, inorganic and integrated (INM) fertilizer management system. Soybean production was higher in organic nutrient management than INM and inorganic nutrient management. Higher yield of soybean was found in 100% organic nutrient management practice than 75% organic + innovative practices. With respect to integrated nutrient management, 75% organic + 25% inorganic treatment was better than 50% organic + 50% inorganic treatment. Among the cropping systems, the yield of soybean was higher in Soybean-Mustard under 100% organic treatment than 75% organic + 25% innovative treatment. Similarly, in rabi season the crops including wheat, mustard, chickpea and linseed performed better under organic management followed by INM as compared to inorganic management. In organic management, the yield of all rabi season crops were found to be higher in 100% organic nutrient management practices than 75% organic + 25% innovative practices. With respect to integrated nutrient management, 75% organic + 25% inorganic treatment performed better than 50% organic + 50 % inorganic treatment. Highest count of bacteria, fungi and actinomycetes was found in the organic system compared to INM and inorganic systems. Among different cropping systems, the total count of soil microbes was higher in chickpea than wheat.

Metagenomic diversity of rhizospheric microbes associated with bioenergy crop

Diversity of bacteria and archaea in the rhizosphere of bioenergy crop *Jatropha curcas* was estimated by terminal restriction fragment length polymorphism (TRFLP), to define how the bioenergy crop interacts with ecosystem through rhizospheric microbial population dynamics. Genomic DNA from the rhizoplane was extracted, purified and amplified using the primers targeting 16S rRNA gene of archaea and bacteria. Both forward primers were labeled with 6-FAM dyes at the 5' end. PCR products of archaea (105F/915R) were digested with Alu (AG^CT), while that of eubacteria (8F/535R) were digested with RsaI (GT^AC). Data revealed that both bacteria (Fig. 11) and archaea associated with bioenergy crop were mostly uncultured type. Terminal restriction fragments (TRFs) representing uncultured archaea, crenoarcheota, and ferroplasma contributed 20-25% of total fluorescence. Study provided insight into the spatial variability of the microbial community in response to growth of *J. curcas*.

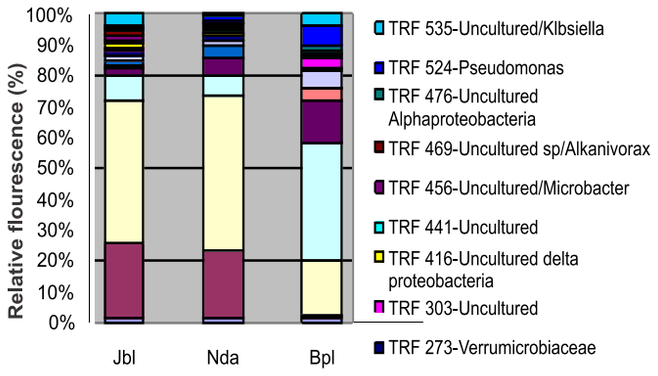


Fig. 11. Metagenomic diversity of bacteria associated with rhizosphere of bioenergy crop *Jatropha curcas*.

Microbial succession in the rhizosphere of soybean

Experiment carried out to reveal microbial succession in the rhizosphere of soybean in response to fertilizer and crop growth stage. Root samples of soybean plant were collected at 7, 15, 30, 45, 60, and 80 days after germination. TRFLP analysis carried out with the labeled amplicons (Fig. 12). Data revealed that there were 20 major T-RFs (bp 42, 51, 64, 81, 90, 95, 117, 169, 234, 273, 303, 417, 426, 441, 469, 486, 494, 524, 529, and 532) found in the rhizospheric samples. The major TRFs assigned tentatively were Delta proteobacteria, uncultured bacteria, uncultured *actinobacteria, Fusabacterium, Delta proteobacteria/ Geobacter, Acidobacteria, Azorhizobium/ Spingomonas, Streptomyces, Delta proteobacteria-Shewanella ,Verrumicrobiota, uncultured bacteria, Desulfobacterium /Methylosinus, Acidophilum, Clostridium acetobutylicum*. Relative fluorescence of TRF's 42, 81, 303, and 417 were in the range of 30-42%. Association of delta proteobacteria was more prominent, while the association of alpha proteobacteria with soybean was during early growth phase of soybean.

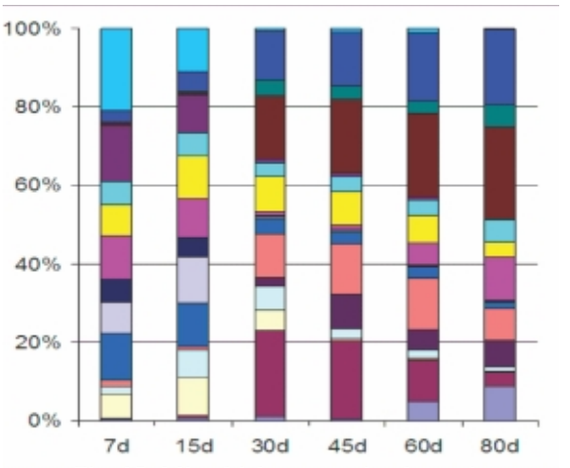
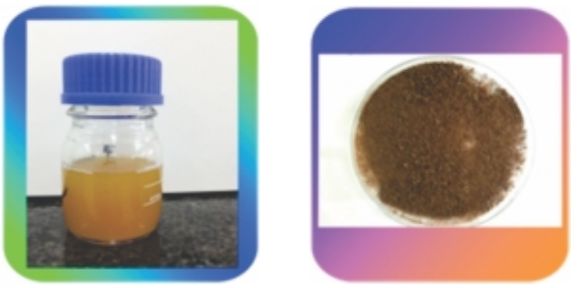


Fig. 12. Microbial community dynamics in the rhizosphere of soybean

Bioactive products developed from bioenergy crop *Jatropha curcas*

Biomass of *J. curcas* based bioproduct was prepared through an extraction and processing method. Two kinds of final products (aqueous and granular) were developed (Fig. 13). Product was evaluated by testing its potential to enhance nutrient use efficiency, soil biological activity and mitigation of global cliamte. Bioproducts stimulated soil enzymatic activities (FDA). Amendment of the product to soil increased abundance and activity of N_2 fixers, P solubilizers, heterotrophs, and methanotrophs. The product minimized N loss (low N_2O-N loss) and aided in C storage (CH_4 mediated C sequestration). These functionalities rendered by the product opened new scopes for its use to enhance agriculture production and mitigation of global climate.



Aqueous Granular

Fig. 13. Bioproduct (Aqueous - left and Granular-right) developed from biomass of bioenergy crop *Jatropha curcas*.

Greenhouse gases (GHG) emissions from static pit of poultry manure

Greenhouse gas (CO_2, CH_4, and N_2O) emission from poultry compost sites located at Parwalia village near Bhopal was measured using static chamber techniques (Fig. 14). Poultry manure samples were also collected and were characterized periodically during composting to correlate with GHG flux values. N_2O emission was initially high with flux ranging from (2.05-29.15 mg m^{-3} d^{-1}). CH_4 emission from poultry manure reached high at 30 days. CO_2 emission which indicates microbial respiration decreased in its value over time indicating the maturity of compost. Greenhouse gas losses during composting of poultry manure were 0.37 CH_4-C mg kg^{-1} and 1.86 N_2O-N mg kg^{-1}.

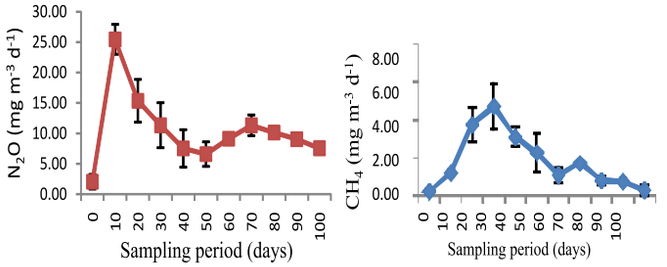


Fig 14. Nitrous oxide (N_2O) and methane (CH_4) emission from poultry manure (Pit) during different composting period.

Soil phosphorus kinetics in organically managed tea cultivation

Soil samples were collected from the organically (Jalinga tea estate) and conventionally (Rose candy tea estate) managed tea plantations located at Barrack valley of Assam. Phosphorous from these soil samples were extracted with six different extractants (Table 3). The extractants varied in their potential to extract organic P fractions. Conventional tea gardens supported relatively resistant organic P fractions. Organic phosphorus mineralization kinetics was evaluated by 1st order kinetics. Mineralization co-efficient (k), half-life ($t_{½}$) and well mean residential times (MRT) of residual organic P fractions were calculated. First order model fitted significantly with the P, extracted by basic EDTA. Organically managed soils exhibited faster mineralization with shorter half-life ($t_{1/2}$) and mean residence time (MRT) with different extractants tried.

Table 3. Organic P mineralization parameters under AICRP (STCR)

Treatment	k(day^{-1})	$t_{1/2}$ (day)	MRT(day)
Jalinga Tea Estate			
0.125(M) NaOH + 0.05 (M) EDTA	0.041^{a}	16.90^{b}	2926.82^{b}
0.25 (M) NaOH + 0.05 (M) EDTA	0.037^{ab}	18.72^{ab}	3243.24^{ab}
0.375(M) NaOH + 0.05(M) EDTA	0.036^{b}	19.26^{ab}	3333.33^{ab}
0.5(M) NaOH + 0.05 (M) EDTA	0.032^{ab}	21.65^{ab}	3750^{ab}
0.75(M) NaOH + 0.05(M) EDTA	0.035^{ab}	19.8^{ab}	3428.57^{ab}
1(M) NaOH + 0.05(M) EDTA	0.04^{a}	17.32^{b}	3000^{b}
Rose Candy Tea Estate			
0.125(M) NaOH + 0.05 (M) EDTA	0.031^{b}	32.26^{a}	3870.968^{a}
0.25 (M) NaOH + 0.05 (M) EDTA	0.031^{b}	32.26^{a}	3870.968^{a}
0.375(M) NaOH + 0.05(M) EDTA	0.038^{ab}	26.32^{a}	3157.895^{a}
0.5(M) NaOH + 0.05 (M) EDTA	0.039^{ab}	25.64^{a}	3076.923^{a}
0.75(M) NaOH + 0.05(M) EDTA	0.031^{ab}	32.26^{a}	3870.968^{a}
1(M) NaOH + 0.05(M) EDTA	0.033^{a}	30.30^{a}	3636.364^{a}

Livelihood improvement through Biofertilizer usage in coastal acid soil in Odisha

Improved methods of farming including the regular use of bio-fertilizers resulted in improved livelihoods as illustrated by the experience of a subsistence farmer Sh. Kamal Pradhan, tilling one ha in village Nilkanteswar in Gop block in district Puri, Odisha (Fig. 15). He was unable to manage his five member family two years ago, but is now in a position to earn his livelihood by adopting technology transferred by the All India Network Project on Soil Biodiversity-Biofertilizers, IISS, Bhopal of OUAT, Bhubaneswar centre. This included acid soil amelioration with paper mill sludge, use of new crop varieties, vermicomposting and biofertilizers. He is cultivating 0.2 ha mid-upland for vegetables and 0.8 ha of medium land for cereals, pulses and oil seeds. Using BF input, the farmer is getting yield advantage ranging from 10-19.4 % in different crops. There was also savings in chemical fertilizers use to the extent of 30 % in his farm. The total yearly income from his farm was ₹1,08,860/- against an investment of ₹33,270/-. So he

earned ₹3.27 per rupee invested. The yearly benefit was ₹75,590/- of which the bioinoculation benefit was ₹8,300/- (over the expenditure of ₹600/ annum on BF) thus representing 11 % of the total benefit. In terms of input cost the B:C ratio of Biofertilizer was 14.8. Overall B: C ratio of cultivation increased from 2.08 without BF's to 2.46 with BF's.

Fig. 15 Knolkhol crop in coastal acid soil of Nilakantheswar, Puri district using biofertilizer as a component of INM in livelihood improvement programme

Integrated software for soil health assessment and STCR based crop nutrient management

User friendly soil information based decision support system is being developed at the Indian Institute of Soil Science, Bhopal for crop planning. It is integrated with soil test crop response (STCR) equations to generate target yield based on the crop nutrient requirements, fertilizer requirements and soil amendments. Software is based on the soil information for different states and major growing areas. The decision support system may be utilized as a ready reckoner for any problem that may emerge upon soil auditing. Solutions may be generated immediately and will be a one stop solution for various soil related crop management problems. Software is useful to assess the current status of soil quality and when updated over time, will also help determining changes in soil quality affected by field management.

Forth Coming events

1. ICAR sponsored short course entitled "Advances in Nutrient Dynamics in Soil-Plant-Atmosphere System for Improving Nutrient Use Efficiency" during 02-11 Sept., 2014 at IISS, Bhopal

2. MTC on Best Nutrient Management Practices for Major Crops and Cropping Project of India on Oct 7-14th , 2014 at IISS, Bhopal

3. Winter Schools: Waste Recycling and Resource Management through Rapid Composting technique during 3-23rd December, 2014.

4. MTC on Climate Change and Conservation Agriculture from Jan 28th to Feb,4th 2015 at IISS, Bhopal

Books published

- Subba Rao, A., Singh, A. B., Wanjari, R.H., Ramesh, K., Vassanda Coumar, M. and Shinogi, K.C. (2014). Glimpses of IISS contribution in Technology generation and dissemination. Indian Institute of Soil science Bhopal, 123p.

- Somasundaram, J., Chaudhary, R.S., Rao, S. A., Hati, K.M. Sinha, N.K and Vassanda Coumar, M. (2014). Conservation Agriculture for Carbon Sequestration and Sustaining Soil Health. Published by New India Publishing Agency (NIPA), New Delhi, pp 1-528 (ISBN: 978-93-83305-32-2).

International cooperation

- Dr. A. Mandal participated in 20th World Congress of Soil Science at ICC Jeju, Korea during 8-13th June 2014.

- Dr. P. Jha attended NAIP-ICAR funded training in the area of Carbon Trading/Carbon Sequestration /Climate Change at Ohio State University, USA from 20.12.2013 to 15.03.2014 under the supervision of Dr. Rattan Lal.

Awards and honours

- Dr. A. K. Biswas has been nominated by ICAR as Vigilance Officer for the institute since 2014.

- Dr. N. K. Lenka received the Young Scientist Award of the Indian Association of Soil and Water Conservationists at the National Conference on Farmers' First at Dehradun during 22-24 March, 2014.

- Dr. R. Saha has been selected as Associate Fellowship of NAAS for the year 2014.

- Dr. A. K. Vishwakarma has been awarded with Distinguished Scientist Award by Society for Extension Education and Management in Agriculture, during National Conference on emerging problems and recent advances in applied science: Basic to molecular approaches, held at Ch. Charan Singh University, Meerut (U.P.) during February 8-9, 2014.

- Dr. P. Dey elected as Vice President of Indian Society of Agrophysics, New Delhi.

- Mr. S. Siddiqui received best technical support award of AICRP-MSN during 27th AICRP-MSN workshop at PDKV, Akola on March 8, 2014.

- Dr P. Dey, Project Coordinator (STCR) was Guest of Honour in Brain Storming session on Soil testing and fertilizer use. Organized at ANGRAU, Hyderabad on January 24, 2014.

Extension activities

Dr. A. B. Singh had given training on Vermicomposting and Vermiculture technique during June 27-29, 2014, arranged by Bihar Agriculture Management and Extension Training Institute (BAMETI) Patna, Bihar.

Dr. A. B. Singh organized five days three Farmers Training in the institute during January 9-13, 2014, March 10-14 and March 24-28, 2014, sponsored by ATMA, Distt. Hoshangabad and Morena Distt. Madhya Pradesh.

Drs. A. B. Singh, S. Srivastava, R. H. Wanjari, R. K. Singh participated in farmer scientist interaction meeting in Krishi Vasant -2014. In this meeting around 200 farmers were participated in the interaction meeting.

Drs. A. B. Singh, S. Srivastava attended State Level Krishi Vigyan Mela as resource person, during 25-27, June, 2014 at Rajgarh, Madhya Pradesh. Around 2000 farmers were present in the sangosthi on organic farming and soil health.

Drs A. B. Singh and S. Srivastava, participated in farmer scientist interaction

Farmers' participation during interaction

Dr. R. H. Wanjari, Dr. R. K Singh, Shri Vinod Chaudhary and Shri Sanjay Gharde attended the 'Krishi Vasant -2014', at Central Institute of Cotton Research, Nagpur, held during Feb 9-13, 2014. At the IISS stall (No. A-69) model on 'Vermicomposting", nano-fertilizer, and publications were exhibited.


Distinguished visitors visited institute

- Dr. Rattan Lal, Distinguished University Professor, Ohio State University & the Director, Carbon management and sequestration centre, Columbus, USA, visited the Institute during 10-12 March, 2014.

• Dr. A. K. Sikka, DDG (NRM), Dr. S. S. Khanna former member of Planning Commission, and Dr. S. K. Chaudhari, ADG (SWM) visited the institute during February 26-27, 2014 to attend the National Consultation meeting on Soil Health

Workshop/training programme organized

- A Training Programme on "Soil health management, leaf analysis and soil analysis" to Officers of Soil testing Labs under the Department of Agriculture, Kerala at IISS, Bhopal during Jan. 14-18 and Feb. 10-14, 2014 (Course Director – Dr. A. K. Biswas and Course Co-Director – Drs. B. L. Lakaria & I. Rashmi).


Glimpses of the training program

- Workshop on "Management of Intellectual Property rights in Public Research" at IISS, Bhopal on 7 February, 2014 wherein 62 scientists and research scholars from IISS, CIAE, HSADL, Bhopal, DWSR, Jabalpur and Barkatullah University, Bhopal participated. Dr. Sanjeev Saxena, Principal Scientist, Agrinnovate India, New Delhi, presented a lecture on Intellectual Property Management. (Organized by Dr. S. Srivastava, Dr. K. C. Shinogi, and Mr. Hiranmoy Das).
- National level consultation meeting on soil health assessment was organized at IISS, Bhopal on February 26, 2014 (Organizing secretary: Dr. A. K. Biswas).

- A Training-cum-Workshop on Soil Health and Fertility Management for KVK personnel of M. P., Chhattisgarh and Odisha was organized in collaboration with Zonal Project Directorate, Zone- VII, Jabalpur during on May 7-9, 2014 at IISS, Bhopal. (Organizing secretary: Drs. S. Srivastava & A. K. Biswas).

- Drs. A Subba Rao, Mrs. Sangeeta Lenka and N. K. Lenka organized the NAAS Brainstorming session on "Carbon Economy in Indian Agriculture" at NASC complex, New Delhi on 01 February, 2014 as Convener and Co-conveners.
- Technical programme workshop of AICRP LTFE was organized at CSK HPKV, Palampur during June 2-3, 2014.

- 27th Biennial Workshop of All India Coordinated Research Project on Micro - and Secondary Nutrients and Pollutant Elements in Soils and Plants (AICRP-MSPE) was organized at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 7–9 March, 2014. The workshop, inaugurated by Dr. S. K. Chaudhari, Honb'le ADG (SWM), ICAR.

- An Interaction Meet of Micronutrient Researchers, Extension Scientists and Entrepreneurs was organized for collaborative roadmap on Micro and Secondary Nutrients in India on 9th March 2014 at Akola. The meet was held in the leadership of Dr. K. D. Kokate, Honb'le DDG, Extension and Dr. S. K. Chaudhari, Honb'le ADG (SWM), ICAR, New Delhi. Personnel from ZPDs, KVKs, and micronutrients Entrepreneurs and Scientist from all the cooperating centres of the AICRP-MSPE discussed the roadmap for collaboration between AICRP-MSPE and KVKs to increase the use of micronutrients and technology dissemination to the farmers.

- Field day cum capacity building programme under TSP was organized by AICRP (STCR) to popularize the soil test based balanced fertilizer application among the tribal farmers of Jharkhand, Odisha, and Chhattisgarh. The beneficiary farmers from Aturgaon village of Kanker district, Bhagdeva and Bade Bendri villages of Kondagaon district and Narayanpur, Sulenga and Karlakha villages of Narayanpur district of Chhattisgarh. Similarly 60 farmers of Rukunapur and Balibandh villages of Keonjhar district, Odisha were benefited by this program. Programme also conducted at Nagarabera village, Angara block, Jharkhand. About 40 farmers participated in the programme.

January 11, 2014; Nagarabera village, Angara block, Jharkhand

March 7, 2014; Balibandh villages Keonjhor district, Orissa

March 9, 2014; Kanker district, Chattisgarh

- Training programme was organized by AICRP (STCR) in collaboration with State Department, Govt. of Telangana, June 24 2014. STCR based fertilizer recommendations and GPS & GIS based soil fertility mapping demonstrated to the officials and progressive farmers from 9 districts of Telangana.

International women's day celebration

International women's day was celebrated on 14th March, 2014 at IISS. The3 chief guest of function was Dr. Sonia Gupta, Professor, Hospitality at Leeds Metropolitan University, U.K., India Campus at Bhopal. Guest of honor was Smt. Bhulaxmi Devi.

Survey and agro advisory for, Hailstorm affected areas in MP

Drs. R. S. Chaudhary, K. M. Hati, A. K. Vishwakarma, R. K. Singh, S. Rajendran, B. P. Meena and N. K. Sinha conducted the Survey of hailstorm affected districts of MP as assigned by the DDG, NRM. They visited the affected areas, contacted the farmers and consulted KVKs, State Agricultural departments and submitted a preliminary report on areas and extent of damage. In continuation of this exercise, three teams of scientist have visited the affected areas for assessment of actual loss to the farmers in the 25 villages of four districts viz.Vidisha, Bhopal, Raisen, and Sehore. After sample analysis, survey data and triangulation with State Agril. Deptt., a rigorous estimate of the area damaged was provided to the DDG, NRM and suitable agro advisories were given.

PERSONNEL		
S.No.	**Name**	**Wef**
1	Dr. M. Vassanda Coumar, Scientist from RGP 6000 to RGP 7000	04.11.2013
2	Dr. Neenu. S, Scientist from RGP 6000 to RGP 7000	21.04.2013
3	Dr. A. Mandal, Scientist from RGP 6000 to RGP 7000	23.06.2013
4	Dr. M. Mohanty, RGP 7000 to RGP 8000	10.11.2010
5	D. N. K. Lenka, Senior Scientist to Principal Scientist	30.09.2012
STAFF PROMOTED		
S.No.	**Name**	**Wef**
1	Smt. Seema Sahu, Sr. Tech. Officer to Asstt. Chief Tech. Officer	01.04.2012
2	Shri D. R. Darwai, Sr. Technical Assistant to Technical Officer	23.01.2013
3	Shri Pramod Kumar Chouhan, Sr. Technical Assistant to Technical Officer	05.02.2013
EMPLOYEES PROBATION CLEARED		
S.No.	**Name**	**Wef**
1	Shri P. S. Sunil Kumar, Asstt. Administrative Officer	18.09.2012
2	Shri Sunny Kumar Stenographer Gr.III	21.12.2013
3	Shri Sanjay Kori, Stenographer Gr.III	03.01.2014
NEW STAFF JOINED THE INSTITUTE		
S.No.	**Name**	**Wef**
1	Dr. J. K. Saha, Pr. Scientist joined as Head of Division Environmental Soil Science	02.01.2014
2	Dr. A.K. Patra, Joined as Director, IISS, Bhopal	01.05.2014
3	Dr. N. S. Bhogal, Senior Scientist (Soil Chemistry/ Fertility/Microbiology)	26.05.2014
STAFF TRANSFERRED/RESIGNED FROM THE INSTITUTE		
S.No.	**Name**	**Wef**
1	Shri Saurav Kumar, Assistant resigned from IISS	13.06.2014
EMPLOYEE RETIRED FROM THE ICAR SERVICE		
S.No.	**Name**	**Wef**
1	Dr. A. Subba Rao, Director IISS, Bhopal	30.04.2014
2	Shri T. Ayodhya Ramaiah, P.A.	30.04.2014

Dr. A S Rao, Director IISS, Bhopal superannuated on Apr 30, 2014. Dr Rao served this institute as principal scientist (1989-1997), project coordinator of STCR (1997-2004), and Director (2004-April 2014). Dr Rao was given a warm farewell in a function on Apr 30 2014. His scientific laurels and leadership legacy will remain in this institute forever. IISS fraternity wishes Dr Rao and his family a happy, healthy and prosperous future life.

Scientists' participations in Conferences/ Seminars/ Trainings/ Workshops/ Group Discussion			
Name	Program	Venue	Period
Drs. A. K. Shukla & P. Dey	Conferences of Vice-Chancellors and Directors	NIASM, Baramati	Jan 19-20, 2014
Drs. A. K. Biswas & S. Srivastava	Farmers' meeting organized by PRII, Gurgaon	Vidisha, MP	Jan 21, 2014
Dr. P. Dey	Seminar on Soil Health : A Key to Food Security	MPKV, Rahuri	Jan 21-22, 2014
Dr. K. Ramesh	CAFTA training on "Organic farming approaches and applications"	TNAU, Coimbatore	Jan 22–Feb 11, 2014
Dr. S. Srivastava	Training cum workshop on "Technology Management for Researchers"	NAARM, Hyderabad	Jan 27-31, 2014
Drs. R. K. Singh and M. L. Dotaniya	2nd International conference on "Agriculture & Horticultural Sciences"	Hyderabad	Feb 03-05, 2014
Dr. T. Adhikari	101th Indian Science Congress	University of Jammu, Jammu	Feb 03-07, 2014
Dr. S. Lenka	National conference on "Recent trends in Environmental Science"	Jiwaji University, Gwalior	Feb 04-05, 2014
All Scientists	Workshop on "Management of Intellectual Property Rights in Public Research"	IISS, Bhopal	Feb 07, 2014
Dr. A. K. Vishwakarma	National conference on "Emerging problems and recent advances in applied science: Basic to molecular approaches"	Ch. Charan Singh University, Meerut	Feb 8-9, 2014
Dr. P. Dey	Conference on "Diversification led agricultural transformation towards green economy"	NBPGR, New Delhi	Feb 14, 2014
Drs. A. B. Singh, S Srivastava, R. H. Wanjari, R. K. Singh, Mr. V. Choudhary and Mr. S. Gharde	Krishi Vasant-2014	Central Institute of Cotton Research, Nagpur	Feb 9–13, 2014
Dr. A. K. Vishwakarma	Meeting on weed control, AICRP	DWSR, Jabalpur	Feb 12-14, 14
Dr. S. Rajendran	Training programme on "Management of Soil Health and Degraded Lands for Sustainable Productivity"	RVSKVV, Gwalior	Feb 14-Mar 06, 2014
Dr. A. K. Vishwakarma	Biennial conference of ISWS on "Emerging challenges in weed management"	DWSR, Jabalpur	Feb 15-17, 2014
Drs. D. L. N. Rao, A. B. Singh, K. Ramesh, N. K. Sinha J. Somasundaram and S. Neenu	International Soybean Research Conference "Soycon-2014"	Directorate of Soybean Research, Indore	Feb 22-24, 2014
Drs. R. S Chaudhary, K. M. Hati, N. K Sinha	Aquifer Mapping and Management	Central Ground Water Board, Bhopal	Feb 25-26, 2014
All Scientists	National Level Consultation Meeting on "Soil Health Assessment"	IISS, Bhopal	Feb 26, 2014
Dr. S. Neenu	National Training on "Sensors and Actuators for Precision Farming"	CIAE, Bhopal	Mar 03-12, 2014
Drs. M. Singh and P. Dey	International Symposium on "Potassium nutrition and crop quality"	BAU, Ranchi	Mar 4-5, 2014
Dr. A. K. Shukla Mr. P. K. Tiwari	27th Biennial Workshop of AICRP-MSPE	Dr. PDKV, Akola	Mar 07-09, 2014

Scientists' participations in Conferences/ Seminars/ Trainings/ Workshops/ Group Discussion			
Name	Program	Venue	Period
Dr. D. L. N. Rao	Workshop of the AICRP on "Micro and Secondary Nutrients and Pollutant elements in Agriculture"	PDKV, Akola	Mar 8, 2014
Dr. R. Elanchezhian	National training program on “Application of nanotechnology in agriculture”	CAZRI, Jodhpur	Mar 10-19, 2014
Dr. A. K. Shukla	Terminal workshop of NAIP project Comp. 4	ICAR, New Delhi	Mar 18-20 2014
Dr. A. K. Biswas	Attended the Council Meeting of ISSS	New Delhi	Mar 22, 2014
Dr. N. K. Lenka	National Conference on "Farmers' First for Conserving Soil and Water Resources held at The Institute of Engineers"	Dehradun	Mar 22-24, 2014
Dr. S. Neenu	National Seminar on “Innovations in Science and Technology for Inclusive Development” at MP Council of Science and Technology	Vigyan Bhawan, Nehru Nagar, Bhopal	Mar 26-27, 2014
Dr. A. K. Biswas	Attended meeting of the Editorial Board of ISSS	New Delhi	Apr. 5, 2014
Dr. D. L. N. Rao	Participated as an expert panelist in the Indo-German workshop on “Microbial Ecology and Application of Inoculants in Biocontrol”	NASC, New Delhi	Apr 9, 2014.
Dr. P. Dey	Interactive Conference of NARES India and Interactive Meeting of Vice Chancellors of AUs and ICAR Directors	NASC, New Delhi	Apr 28, 2014
Dr. P. Jha	Workshop on “Development of Greenhouse Gas Emission Inventory and carbon budget for Indian Agriculture”	CESCRA, IARI New Delhi	May7-8, 2014
Dr. D. L. N Rao	Meeting on "Seed coating with biologicals" organized by National Seeds Corporation Ltd.	Pusa, New Delhi	May 15, 2014
Dr. B. L. Lakaria	Sensitization workshop of PME cell Incharges	NASC, New Delhi	May 27, 2014
Dr. S. Srivastava	Zonal Institute Technology Management Committee (ZITMC) meeting	CIRCOT, Mumbai	Jun 2, 2014
Drs. P. Dey, A.K. Shukla, A. K. Biswas and P. Jha	Annual Workshop of AICRP (LTFE)	CSKHPKV, Palampur	Jun 2-3, 2014
Dr. P. Dey	National Workshop on ICT Applications in Agriculture	Vigyan Bhawan, New Delhi	Jun 20, 2014
Dr. A. K. Shukla Mr. P. K. Tiwari	27th Biennial Workshop of AICRP-MSPE	PDKV, Akola	Mar 07-09, 2014

Editors : S. R. Mohanty, A. K. Vishwakarma, M. L. Dotaniya

For feedback please contact,

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