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Proceedings
of the
Institute Research Council Meeting

held during

12th to 15th December 2011

Indian Institute of Soil Science
Nabibagh Berasia Road, Bhopal-462038

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P I - Nutrient Management and Fertility Improvement; ***P II*** - Management of Soil Physical components; ***P III*** - Soil Qualities for Sustainable Productivity ; & ***P IV*** - Minimizing Environmental Pollution

Proceeding of the IRC meeting held on
12th to 15th December 2011

The IRC meeting was held during 12th -15th December 2011 under the Chairmanship of Dr. A. Subba Rao, Director, IISS, Bhopal. Welcoming the members of IRC, Dr. S. Kundu requested all the members to sumarise their presentation in a brief manner so as to highlight the significant achievements. The Chairman in the opening remark pointed out that the ongoing research activity at this institute covers some important theme areas namely conservation agriculture, organic farming, soil pollution, biodiversity and nano-technology and therefore we need consolidation of research knowledge in those areas. In view of the forthcoming silver jublee celebration of this Institute we need to publish those information in the form of small bulletins booklets or pamphlets. The chairman urged upon the scientists to change their attitude towards research to excel and to achieve desired goals. He emphasized that we will have to develop inquisitive attitude and should be ready to take up challenging research.

Thereafter, the IRC proceeding started with the presentation by the individual principal investigators of the ongoing research projects. Out of 41 projects, the presentation of two research projects led by principal investigator namely, Ms. I. Rashmi and Dr. J. K. Saha could not be made as they were on leave. The specific comments of the house have been recorded in the succeeding part of the proceeding.

Thereafter, the IRC proceeding started with the presentation of five **new project** proposals and all the following five new research project proposals were approved by the house for implementation.

1. **Project title** :Metagenomic characterization and spatio-temporal changes in the prevalence of microbes involved in nutrient cycling in the rhizoplane of bioenergy Jatropha curcas crop"*

Funded by - Dept of Biotechnology, DBT India
PI : Dr S R Mohanty
Co-PI: Asit Mandal
Budget : 53 Lacs
Years : 3 years (started on Nov 2011)

Objectives :

- To define the microbial communities prevalent in the ectorhizopshere (rhizosplane) and endorhizosphere (endosymbionts) using molecular methods and finding out to what extent the community structure is determined by soil, agro-climate and rhizospheric attributes.
- To quantify nutrient cycling microbial groups prevalent in the ecto-endorhizosphere by real time PCR during various growth stages and cultural practices of Jatropha curcas to explore the plant microbial interaction for its sustainability in various agroecosystem.
- To isolate and characterize microbes from the rhizoplane and endorhizosphere (endosymbionts) of Jatropha curcas and identifying the potential nutrient (N & P) cycling species for using as microbial inoculants to enhance crop productivity and sustainability.

2. Project Title: Quantifying green house gases (GHGs) emissions in soybean-wheat system of M P.

Objective:

- To generate quantified information about emission level of three key GHGs.
- Identification of best management practice to mitigate GHGs emission in soybean-wheat system.

PI: Dr. Sangeeta Lenka.
CPIs: Dr. N. K. Lenka, Dr. S. R. Mohanty, Dr. S. Kundu, Dr. A. Subba Rao.

Funded by: MPCST, Bhopal (Rs. 11.62 Lakhs).
Duration: June 2011 to June June 2014.

3. **Project Title:** Evaluating conservation agriculture for stabilizing crop productivity and carbon sequestration by Resilient Cropping System / Sequences under aberrant Climatic Conditions in Black soils of Central India.

Objectives:

- To evaluate dominant cropping systems/sequences and conservation tillage for stabilizing crop productivity and its economics in black soils of Central India.
- To study the effect of conservation agriculture (CA) on energy, nutrient and water fluxes and green house gases (GHGs) emission under different cropping systems.
- To evaluate soil aggregation and carbon sequestration mechanisms under different tillage and cropping systems in black soils.

PI : Dr. J. Somsundaram.
Co-PI: Dr. R. S. Chaudhary, Dr. M. Vassanda Coumar, Dr. K. M. Hati, Dr. A. Subba Rao, Dr. Pramod Jha, Dr. K. Ramesh, Dr. Ajay.
Funded By: NICRA (ICAR) (Rs. 75 Lakhs).
Duration: 3 Years (2011-12 to 2013-14)

4. **Project Title:** Biochar on soil properties and crop performance.

Objectives:

- Standardization of pyrolytic conditions for preparation of biochar from different feed stocks
- Characterization of bio-char of different origins prepared under different pyrolytic conditions.
- To study the effect of biochar on soil properties and crop performance

PI: Dr. B. L. Lakaria,
Co-PI (IISS): Dr.Pramod Jha, Dr.A.K. Biswas, Dr.K.M. Hati, Dr.Jyoti Thakur, Dr. Vassanda Coumar,
Co-PI (CIAE) : Dr. A.K. Dubey and Dr.S. Gangil
Funded by: Institute
Duration: Jan, 2012- Jan 2017

5. Project Title: Interaction among tannery effluents constituents on heavy metals uptake by spinach.

Objectives:

- To study interaction among chromium, cadmium and zinc on their availability in soil and uptake by spinach.
- To study the effect of sodium, calcium, chloride and sulfate ions on chromium availability in soil and its uptake by spinach.
- To devise strategy for minimizing heavy metals uptake by plant from tannery effluent.

PI: Dr. M. L. Dotaniya.
CPIs: Dr. J. K. Saha, Mr. Rajendiran, S., Dr. M.Vassanda Coumar, Dr. S. Kundu.

Duration: 4 years (Jan., 2012 to Dec., 2016).

Projects concluded :

1. "Evaluation of efficiency of patentkali-PMS fertilizer for potash, magnesium and sulphur nutrition and yield of different crops in India" by Dr. A. K. Shukla (PI).

In response to the presentation of Mrs. Sangeeta Lenka, the house desired a detailed deliberation from Mrs. S. Lenka and it was decided that she will try to deliver a seminar on the methodology of estimation of GHGs and Indian scenario on any suitable date. Also on that seminar day, the PIs of two projects, namely, Miss I. Rashmi and Dr. J. K. Saha will also present the progress report of their ongoing projects and Dr. M. L. Dotania will make a detailed presentation of his new project.

In his concluding remark, the Chairman asked all the HOD's & PCs to start homework for the preparation of Silver Jubilee celebration of IISS. He also pointed out that an Institute, namely, "Virtual Fertilizer Institute" is coming up for funding research work related to development of new fertilizer materials. He suggested that our scientists should formulate suitable projects for such funding. The member secretary requested all the members to submit the soft copies of RPF II & III to the PME cell, as the cell be monitored by ADG during his visit at the time of RAC meeting. The meeting ended with the vote of thanks.

S. Kundu
(Member Secretary, IRC)

A. Subba Rao
(Chairman, IRC)

Programme I: Nutrient Management and Fertility Improvement

1. Long-term Evaluation of Integrated Plant Nutrient Supply Modules for Sustainable Productivity in Vertisol

Objectives:

1. To develop different integrated nutrient management (INM) modules for sustainable productivity.
2. To monitor changes in physical, chemical and biological properties of soil under different INM modules.
3. To study transformations of nutrients as influenced by continuous use of organic and/or inorganic sources.

Investigators:

PI: Dr. Muneshwar Singh
CO-PIs: Dr. K. Sammi Reddy, Dr. A. K. Biswas, Dr. A. B. Singh & Dr. R. S. Chaudhary

Date of Start: April 2002

Date of Completion: Long Term

Progress report to IRC (November, 2008):
Yield data of soybean (2008) revealed that IPNS modules involving 50% NPK with 5t FYM or 1t poultry manure or 5t urban compost/ha produced soybean grain yield at par with that of general recommended dose and STCR based dose. The IPNS modules involving recycling of wheat residue with FYM or PM produced lower soybean yields. During the seventh year, the complete organic manure treatment produced soybean yield similar to that of GRD or STCR based dose and IPNS modules involving 50% NPK with 5t FYM or 1t poultry manure or 5t urban compost/ha. The analysis of soil samples after six cropping cycles showed that the status of DTPA extractable Zn, Cu, Cd, Pb in soil increased in soils those received only inorganic fertilizers or combinations of fertilizers and various organic manures as compared to control.

Comment of the House:
The progress was satisfactory. The house suggested that total metal contents in FYM and compost should be determined. In addition to DTPA extractable metal contents of the soil, information on total metal contents in soil should also be estimated. The trend analysis of the crop yields should also be done.

Progress report to IRC (June, 2009):
The status of different fractions of Zn as influenced by continuous application of inorganic fertilizers, manures and fertilizers, manures alone in Vertisol after five years of soybean-wheat cropping has been investigated**.** Surface soil samples collected after 5 years have been analyzed for Zn fractions viz, CA-Zn, AAC-Zn, PYRO-Zn, AMOX-Zn, RES-Zn using sequential extraction method of McLaren and Crawford (1973).

The results showed that the 5-year continuous integrated use of NPK with FYM or poultry manure (PM) or urban compost (UC) and FYM alone significantly influenced only the PYRO-Zn, and AMOX-Zn fractions. The highest status of AMOX-Zn was observed in treatment that

received FYM alone @ 8t/ha to soybean and 16t/ha to wheat every year. This treatment also maintained the highest total Zn. Among other treatments, integrated use of NPK with FYM and NPK with urban compost maintained higher status of AMOX-Zn and PYRO-Zn in the soil. The influence on the status of other fractions (CA-Zn and AAC-Zn) was very little. The residual Zn in soil was not affected by different treatments even after 5 years. As suggested by the IRC, metal contents in FYM and compost were determined and presented. The data on total metal contents in soil and the trend analysis of the crop yields were presented in IRC.

Comment of the House:
The progress was satisfactory. The house suggested that other methods of Zn fractionation should also be done to make comparative assessment and total recovery of Zn in different zinc fractions. There is no report on changes in soil physical properties as well as biological properties and hence, the house suggested to undertake those studies.

Progress report to IRC (November 2009):
Yield data of 8th crop of soybean (2009) revealed that the IPNS module involving 50%NPK with 5 t FYM or 1 t Poultry manure or 5 t urban compost produced soybean grain yield at par with that of general or STCR based fertilizer dose. After 7 years of continuous cropping, sole application of high rate of FYM (24 t FYM/ha/year) started producing soybean yield at par with different IPNS modules and GRD or STCR based fertilizer recommendation. The progress was satisfactory. The total recovery of Zn in different zinc fractions in the fractionation scheme was presented and discussed. The data generated on changes in soil physical properties as well as biological properties were presented in IRC meeting.

Comment of the House:
The progress was satisfactory. The house recommended to carry out analysis on physical and biological properties after 4 years cycle and prepare nutrient balance sheet with standard methodology.

Progress report to IRC (June 2010):
Treatments using deviation method (Dalal and Molooney, 2000). Soil physical, chemical and biological indicators have been used for computing SQI. Soil aggregate stability, MWD, pH, EC, Soil Organic Carbon, Available Nutrients, DHA, MBC and Labile C were used for arriving SQI. The SQI values varied from 27 in plots those received STCR based fertilizer dose to 63 in plot those received 24 tonne FYM/ha/yr. Relative soil quality index with reference to sole organic treatment was 0.42 in STCR fertilizer based dose, 0.59 in INM with fertilizers plus FYM, 0.5 in INM with fertilizers plus crop residues. Continuous application of larger quantity of FYM alone maintained better soil quality under soybean-wheat system as compared to INM or fertilizer application alone. But availability of larger quantities of FYM is a major constraint. Therefore, INM involving fertilizers and FYM may be a better option for producing higher crop yields and maintaining better soil quality.

Comment of the House:
The progress was satisfactory and the house recommended that nutrient balance sheet may be worked out using standard methodology.

Progress report to IRC (January 2011):

The results of the 9th soybean crop shown that the grain yield level is very low due to flower drop. Therefore, the grain yield was not affected by the treatments. But there was a good vegetative growth. The straw yield of soybean was significantly affected by treatments and was higher in the treatment that received 50% NPK with 5 t FYM/ ha. This was at par with all other INM modules. I suggested in the previous IRC Meeting, the apparent nutrient balances after 5 cropping cycles were computed. The apparent potassium balance was negative in treatments those received only inorganic fertilizers but was positive in IPNS modules. The apparent balance of phosphorus and sulphur were positive in almost all IPNS modules. After 6 cropping cycles, micronutrient status in the surface soil was also assessed. The DTPA extractable zinc content of soil increased in soils those received different IPNS modules.

Comment of the House:
The progress was satisfactory. The house suggested that the PI may explore the possibility of changing the cropping system so as to have continuous double cropping system.

Progress report to IRC (June 2011):
As suggested by the IRC in the previous meeting, a meeting of the project investigators was held under the chairmanship of PI Dr. Muneshwar Singh to decide new cropping system and technical programme. All the investigators have agreed to change the existing cropping system (soybean-wheat) to Maize – chickpea cropping system. Accordingly, the fertilizer and manure doses were modified in all the 12 treatments and presented in the IRC.

Comment of the House:
In view of the regular failure of the wheat crop, the house suggested to continue the experiment with maize-chick pea rotation. During the first year both the crops should be raised as residual crops. Based on the earlier results, the PI should summarise the results and formulate suitable recommendation.

Progress report to IRC (Dec., 2011):
Technical Programme for maize-wheat system has to be discussed.

Comment of the House:
Technical programme may be presented in next IRC. Based on the earlier results the PI should summarize the and formulate suitable recommendation.

2. Transformation and Phyto-Availability of Zinc and Boron in Selected Bench Mark Acid Soils Amended With Lime and Farmyard Manure.

Objective:

1. To assess the dynamic of Zn and B in acid soil as a result of application of lime with and without FYM.
2. To study the effect of lime application with and without FYM on Zn and B nutrition of maize and changes in soil properties.

Investigators:

PI: Dr. Sanjib Kumar Behera
CO-PIs: Dr. M.V. Singh

Date of Start: June 2008
Date of Completion: May 2011

Progress report to IRC (November, 2008):

The values of pH, EC, organic carbon contents ranged from 3.90 to 6.45, 0.03 to 0.16 dSm^{-1} and 0.12 to 1.07 per cent, respectively in Bhubaneswar soil and from 4.11 to 5.89, 0.029 to 0.18 and 0.11 to 0.85 per cent, respectively in Ranchi soil. DTPA extractable Zn, Mn and Fe in soil varied from 0.04 to 1.26, 0.14 to 2.28, 0.94 to 68.58 and 3.92 to 61.08 mg kg^{-1}, respectively whereas, that ranged from 0.08 to 5.2, 0.16 to 1.94, 4.54 to 48.7 mg kg^{-1}, respectively in Ranchi soil. About 65 and 80 per cent of soil samples collected from Bhubaneswar and Ranchi, respectively were found to be having less than 0.6 mg kg^{-1} DTPA extractable Zn. The amount of cationic micronutrients extracted from soils of both the sites followed the order: Mehlich 3> Mehlich 1> DTPA. In general, organic carbon content of soil was positively and significantly correlated with extractable Zn, Cu and Mn in soils of both the sites.

Comment of the House:

Progress was satisfactory. However, the house made comments on usefulness of DTPA extractant for estimating available zinc in acid soils as the said extractant has been recommended for neutral and calcareous soils. Therefore, the PI was asked to pay more emphasis on refinement of methodology for estimating available zinc status in acid soils.

Progress report to IRC (June, 2009):

pH values ranged from 3.90 to 6.45, 4.11 to 5.89, 4.48 to 5.94 and 4.16 to 6.28 for Bhubaneswar, Ranchi, Palampur and Kasaragod soil respectively. For all the places, more than 90 percent collected soil samples are having pH values less than 5.5. Organic carbon content varied from 0.12 to 1.07, 0.11 to 0.85, 0.52 to 2.79 and 0.39 to 3.46 per cent for Bhubaneswar, Ranchi, Palampur and Kasaragod soil respectively. Majority of soil samples collected from Bhubaneswar and Ranchi are having low organic carbon content whereas organic carbon content of majority of soil samples collected from Palampur and Kasaragod is high. DTPA, 0.1 N HCl, Mehlich 1 and Mehlich 3 extracted Zn in Bhubaneswar soil ranged from 0.04 to 1.26, 0.40 to 3.76, 0.28 to 3.36 and 0.56 to 3.04 mg / kg respectively whereas that in Ranchi soil varied from 0.08 to 5.20, 0.28 to 14.88, 0.48 to 14.68 and 0.80 to 12.4 mg / kg respectively. In Palampur soil, DTPA, 0.1 N HCl, Mehlich 1 and Mehlich 3 extracted Zn varied from 0.28 to 9.12, 0.68 to 8.36, 0.48 to 8.08 and 0.88 to 8.08 mg / kg, respectively whereas that in Kasaragod soil ranged from 0.14 to 10.82, 0.80 to 14.24, 0.48 to 11.64 and 0.16 to 6.24 mg / kg, respectively.

Fertility status with respect to DTPA extractable Zn in Bhubaneswar and Ranchi soil is low and that in Palampur and Kasaragod soil is high. Extractable Zn in soil extracted by four extractants is well correlated among themselves for all the places.

Comment of the House:
The progress was satisfactory. The house suggested that there is need to conduct pot culture experiment for correlation studies for different extractants and suitability of of Melich – III extrectent. Also it was suggested that DTPA extractant without TEA may be tested for acid soils for Zn.

Progress report to IRC (November, 2009):
The value of exchangeable Ca ranged from 0.05 to 2.71, 0.06 to 1.84, 0.18 to 2.78 and 0.07 to 2.81 C mol/kg for Bhubaneswar, Ranchi, Palampur and Kasaragod soil respectively. Exchangeable Mg content varied from 0.05 to 2.57, 0.09 to1.15, 0.20 to 2.61 and 0.09 to 3.28 C mol/kg for Bhubaneswar, Ranchi, Palampur and Kasaragod soil respectively. Content of total Zn ranged from 8.8 to 67.5, 16.0 to 86.46, 33.8 to 179.2 and 13.75 to 121.64 mg/kg in Bhubaneswar, Ranchi, Palampur and Kasaragod soil respectively. It has been found that contribution of extractable Zn towards total Zn is higher in Bhubaneswar and Ranchi soil as compared to Palampur and Kasaragod soil. pH, EC and organic carbon content of bulk soils collected for pot experiment are 3.96, 0.14 dS/m, 0.87 per cent respectively for Ranchi soil whereas that are 6.07, 0.08 dS/m, 0.84 per cent respectively for Bhubaneswar soil.

Comment of the House:
The progress was good and the house suggested to check the measurements on calcium and magnesium saturation in the exchange complex.

Progress report to IRC (June, 2010):
ABDTPA extractable Zn ranged from 0.23 to 2.59 mg/kg (with mean value of 1.13mg/kg), 0.46 to 12.8 mg/kg (with mean value of 1.75 mg/kg), 0.59 to 6.65 mg/kg (with mean value of 2.14 mg/kg) and 0.34 to 7.33 mg/kg (with mean value of 1.69 mg/kg) for Bhubaneswar, Ranchi, Palampur and Kasaragod soil respectively. Considering all the soil samples collected from different places together, it was found that extractable Zn in these soils were significantly correlated soil properties like pH, organic carbon content, electrical conductivity, exchangeable potassium, calcium and magnesium. Correlation coefficient values, relating soil properties with extractable Zn by five different extractants are similar. R^2 values for DTPA-Zn vs Mehlich 1-Zn, DTPA-Zn vs Mehlich 3-Zn, DTPA-Zn vs 0.1 N HCl-Zn, DTPA-Zn vs ABDTPA-Zn were 0.68, 0.59, 0.73 and 0.57 respectively for all the soil samples combined together. On an average, Mehlich 1, Mehlich 3, 0.1 N HCl and ABDTPA extract 2.55, 2.81, 2.78, and 2.06 times more Zn than DTPA extraction. Contribution of soil pH towards the extractable and total Zn is very less. However, contribution of soil organic carbon towards DTPA extractable Zn is higher as compared to Mehlich 1, Mehlich 3, 0.1 N HCl and ABDTPA extractable Zn. Hot water soluble, Mehlich 1 and Mehlich 3 extractable boron in Bhubaneswar soil varied from 0.02 to 2.92 mg/kg (with mean value of 0.39 mg/kg), 0.72 to 5.72 mg/kg (with mean value of 2.70 mg/kg) and 1.36 to 6.96 mg/kg (with mean value of 3.26 mg/kg) respectively. No relationship was recorded among the extractable B in Bhubaneswar soil.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January 2011):

Hot water soluble boron in Ranchi, Palampur and Kasargod soils varied from 0.23 to 1.27 mg/kg (with mean value of 0.54 mg/kg), 0.26 to 1.24 mg/kg (with mean value of 0.57 mg/kg), and 0.10 to 2.14 mg/kg soil (with mean value of 0.37 mg/kg), respectively. Mehlich 1 extractable boron in Ranchi, Palampur and Kasargod soils ranged from 0.52 to 2.52 mg/kg (with mean value of 1.07mg/kg), 0.48 to 2.56 mg/kg (with mean value of 1.21 mg/kg), and 0.28 to 4.44 mg/kg soil (with mean value 1.28 mg/kg), respectively.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June 2011):

Work done:

1. Pot experiments have been conducted to study the effect of different levels of lime, farmyard manure, zinc and boron on plant nutrition and soil properties.
2. Analysis of soil and plant samples of the pot experiments has been carried out.

Salient research findings:

- Soil pH was significantly influenced by application of FYM and lime levels whereas, soil OC significantly increased by FYM application.
- DTPA extractable Zn in soil increased significantly with addition of FYM and zinc in both the soils.
- Biomass yield significantly affected by application of different levels of lime and zinc.
- Concentration of zinc in plant influenced by FYM, lime and Zn application. It increased with increased levels of FYM and Zn and decreased with increased levels of lime application.

Comment of the House:

Progress was satisfactory. In the place of Dr. M. V. Singh, Dr. A. K. Shukla's name may be included. The house recommended the extension of the project up to May 2012.

Progress report to IRC (Dec., 2011):

- DTPA, Mehlich 1, 0.1 M HCl and ABDTPA extractable Zn in soil increased significantly with addition of FYM and zinc in both the soils.
- Biomass yield in Ranchi soil was significantly correlated with DTPA, Mehlich 1, 0.1 M HCl and ABDTPA extractable Zn in post-harvest soil whereas in Bhubaneswar soil DTPA extractable Zn was not correlated with biomass yield.
- Zn concentration /Zn and uptake by maize was significantly correlated with DTPA, Mehlich 1, 0.1 M HCl and ABDTPA extractable Zn in post harvest soil.
- Correlation coefficient values indicated that both DTPA and ABDTPA extractants can be used for extraction of available Zn in acid soils; however ABDTPA has little edge over DTPA.

Comment of the House:

The progress was satisfactory.

3. Soil carbon saturation and stabilization in some soils in India.

Objectives:

1. To determine effect of soil carbon saturation level on stabilization efficiency of added carbon in some soils of India.
2. To understand the mechanism of carbon stabilization in different kinds of soils.
3. To determine the factors controlling mineralization kinetics of soil organic matter.
4. To determine effect of polyvalent ions on stabilization of carbon in soil.

Investigators:

PI: Dr. Pramod Jha

CO-PIs: Dr. Brij Lal Lakaria, Dr. Ritesh Saha, Dr. S.R. Mohanty, Dr. A.K. Biswas and Dr. Muneshwar Singh

Date of Start: March 2010

Date of Completion: February 2014

Progress report to IRC (June, 2010)

Soil samples from different land use systems have been collected from Palampur, Ranchi, Jabalpur and Bhopal. Project has been initiated from the samples collected from different land use systems of Bhopal.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January 2011):

For soils to act as a sink, organic C needs to be stabilized in stable pools. A laboratory incubation study was carried out by taking soil samples from Forest, agriculture & horticulture land use systems to determine the effect of soil initial carbon content on fate of added wheat straw carbon mineralization. Consumption of organic materials and subsequent respiratory release of CO_2 by microorganisms was used as an indicator of decomposition of wheat straw. As per soil carbon saturation theory, the stabilization potential of added wheat straw carbon should be more in subsurface plot and least in the forest & horticulture land use system because both these system are very near to their carbon saturation limit whereas, the subsurface plot which was having minimum carbon content should have maximum stabilization of wheat straw carbon since it was far away from soil carbon saturation level. Within agriculture land use, it followed the trend of soil carbon saturation theory. As per the hypothesis of soil carbon saturation, maximum decomposition of wheat straw should have been taken place in organic & RDF plots. The same happened in 97 days of incubation study. However, the amount of carbon evolved from wheat straw under forest & horticulture land use systems was at par with subsurface plot soil, where initial carbon was only 3.7 g kg^{-1}. The trend was similar under both the rates of wheat straw application (01 & 0.5%). After 97 days of incubation, amount of cumulative C evolved from soil amended with wheat straw @ 0.5% was minimum in subsurface plot (39.4 mg) which was at par with forest (41.1 mg) and agri-horti system (45.5 mg). Although, subsurface plot contains 4 to 6 fold lesser soil carbon than agri-horti and forest land use system. Similar observations were recorded in soil amended with 0.1% of wheat straw also. It was probably due to the prevalence of substrate specific soil heterotrophs population which may degrade only the native residue (SOM) or it may be due to high microbial population, where added residue carbon (wheat straw) might have been turned into microbial metabolites which may be released after the decay of microbial biomass provided the incubation study would have been for longer duration.

Another incubation study was carried out ascribed the effect of Ca salts on residue carbon mineralization. Effect of neutral salts on wheat straw carbon mineralization has been computed by the difference method. $CaCl_2$ and $CaSO_4$ either alone or in combination significantly affected soil and residue carbon mineralization. Residue carbon mineralized in un-amended soil was 24% whereas addition of $CaCl_2$ and $CaSO_4$ reduced the carbon mineralization to the extent of 8%. Chloride salt depressed carbon mineralization more than the sulphate. Water soluble carbon decreased significantly with the addition of calcium salts. Dehydrogenase activity was enhanced by the application of $CaSO_4$ whereas $CaCl_2$ had the opposite effect. The present investigation gave an insight that carbon stabilization could be enhanced by using the calcium salts.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June 2011):

We measured soil carbon pool sizes and decay constants of active and slow carbon pools for different land use systems (agriculture, forest and horticulture) of a vertisol of central India. Long term incubation study was carried out for quantification of active (C_a) and slow (C_s) carbon pools and MRT. Chemical fractionation technique (acid hydrolysis) was used for quantification of resistant carbon pool (C_r). The non hydrolysable carbon (C_r) expressed as a percentage of total C varied between 65% and 68% in the surface soil of different land use system whereas it was 78% in subsurface soil. Incubation study revealed that C_a pool in different land use system ranged from 3.3–10% of the total C and MRT varied from 25-67 days with an average value of 46 days. MRT of slow carbon pool of forest land use was 38.5 years. MRT of slow carbon pool (C_s) under the FYM (organic plot) increased by 4 fold (17.5 years) in comparison to inorganic treatment (RDF) plot.

Another study was carried out with the hypothesis that aggregates having different carbon content might affect the mineralization of added residue carbon. The results demonstrated that cumulative soil carbon mineralization from different aggregates had significant ($r=0.60$, $p=0.05$) and positive relationship with their oxidisable soil carbon content whereas residue carbon mineralization in different aggregate size classes were inversely related to their oxidisable soil carbon content ($r=-0.95$, $p=0.01$), cumulative soil carbon mineralization ($r=-0.89$, $p=0.01$) and resistant soil carbon pool ($r=-0.80$, $p=0.01$). Residue carbon mineralization in different aggregate size classes were also inversely ($r=-0.61$, $p=0.05$) related to their active carbon content ($KMnO_4$ oxidizable carbon) of the aggregates. Water soluble carbon and active carbon (alkaline $KMnO_4$ oxidisable C) were significantly higher in macro-aggregates than in micro-aggregates.

Comment of the House:

Progress was satisfactory.

Progress report to IRC (Dec., 2011):

Long-term fertilizer experiments (>37years) conducted at several locations of India provide an opportunity for assessing the influence of chemical fertilizer and manuring on soil carbon stability and nitrogen dynamics. Long-term application of either NPK+ farm yard manure (FYM) or FYM alone increased the carbon content of resistant pool (bio-chemically stabilized carbon) of soil organic matter (SOM) with concomitant increase in total carbon content of soil in both Vertisol and Alfisol. Long-term application of chemical fertilizer (NPK) alone did not influence the carbon content of resistant pool of SOM in Alfisol whereas it was significantly increased in Vertisol. Chemical fertilization significantly increased the carbon content of slow pool of SOM in Alfisol. Long-term fertilization had variable effect on soil carbon stability. Carbon stability affected the N dynamics in soil. We observed that availability of N in soil is governed by the amount of carbon in acid hydrolysable pool rather than total soil organic carbon content.

Globally, there is problem of computing soil carbon stock due to prevalence of Walkley-Black method which gives only an approximation of soil organic carbon content. Till now, no universal

relationship between Walkley-Black carbon (WBC) and total soil organic carbon (TOC) has been developed which could be applicable in all kinds of soil. We developed relationship between Walkley-Black carbon (WBC) and soil total organic carbon (TOC), which would be applicable in all kinds of agricultural soil. The present study gives an easy approach to measure TOC by easily available data sets thereby eliminating the use of sophisticated instrument like TOC/CHNS

Comment of the House:
The progress was satisfactory.

4. Study on nanoporous zeolites for soil and crop management.

Objectives:

1. To characterize natural and commercially available zeolites in the country.
2. To study the material release kinetic of N and P using nano-porous zeolites.
3. To study the utilization of fertilizer nutrient with and without zeolites.

Investigators:

PI: Dr. K. Ramesh
CO-PIs: Dr. K. Sammi Reddy and Dr. I.Rashmi

Date of Start: March 2010
Date of Completion: March 2012 (3 years)

Progress report to IRC (June, 2010):

Three commercial natural zeolite samples from GM Chemicals, Ahmedabad were procured. The pH of the samples were found to be 8.51, 8.1 and 7.68 for sample A,B and C respectively. Sample D (commercial natural zeolite) has been procured from Neelkanth Minechem, Jodhpur. Two zeolite samples viz. E and F have been procured from Zeolitews ans allied Products P Ltd, Mumbai. Initial analytical studies have been initiated. Collection of natural samples from niche areas at Sagour and Chhindwara are being attempted in association with Department of Applied Geology, Sagar.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January 2011):

The commercial natural zeolite samples from GM Chemicals, Ahmedabad were studied. The pH of the samples was found to be 8.51, 8.1 and 7.68 for sample A, B and C respectively. Sample D (commercial natural zeolite) has been procured from Neelkanth Minechem, Jodhpur. Two zeolite samples viz. E and F have been procured from Zeolites and allied Products P Ltd, Mumbai. Analytical studies have been initiated. During the reporting period, three more additional natural zeolites were collected from the Maheshwar district of Madhya Pradesh and characterization is in process. Zeolite 'C' sample was analyzed for its capacity to adsorb soil urease enzyme, ostensibly to slow down urea dissolution and dissipation process in a laboratory study. It was found that zeolite addition was inversely proportional to soil urease activity. In addition the N release kinetics was also studied and the results are presented. Collection of natural samples from niche areas at Chhindwara will be done during Feb –Mar 2011.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June 2011):

As per the suggestions in the last IRC, characterization of zeolites was concentrated. Although extensive discussions were held at AMPRI (CSIR), Bhopal and Indian Institute of Technology, Mumbai, there was no headway in the characterization. Meanwhile SASTRA University (Tamil Nadu) has quoted rates for the characterization of zeolites materials viz., for morphology (SEM), elemental analysis (EDAX), surface area & pore size (BET) and crystallanity (XRD). The process is underway and samples will be sent shortly.

A commercial zeolite sample was studied for ammonium sorption characters. A set of different concentration of ammonium chloride and ammonium sulphate were incubated with 2 g zeolite sample. The results indicated that zeolites can hold 15-237 µg of N/g of zeolites. Nitrogen concentration to adsorption showed a sigmoid curve.

Comment of the House:
Progress was satisfactory.

Progress report to IRC (Dec., 2011):

The PI visited Ohio State University under USDA Norman E Borlaug Fellowship program during 14th July – 10 Sep 2011 and got trained in "organo-zeolitic mixtures". Ten no of zeolites samples have been sent to SASTRA University (Tamil Nadu) for the characterization of zeolites materials viz., for morphology (SEM), elemental analysis (EDAX), surface area & pore size (BET) and crystallanity (XRD). The results are awaited. Clinoptilolite samples collected from New Mexico, US were sieved for different particle sizes viz., <125 µ, 125-250 µ and >250 µ. The pH of the sample was found to be 8.96-9. The CEC of the samples were 47.26, 40.19 and 37.39 meq/100 g for the different particle sizes respectively.

Comment of the House:

The progress was satisfactory.

5. Efficacy of soil sampling strategies for describing spatial variability of soil attributes.

Objectives:

1. To describe spatial variability of soil attributes using geostatistical tools.
2. To compare efficacy of various sampling strategies for describing spatial variability of soil attributes.

Investigators:

PI: Dr. Neenu S

CO-PIs: Dr. S. Srivastava, and Dr. Y. Muralidharudu

Date of Start: August 2010

Date of Completion: July 2012

Progress report to IRC (June, 2010):

Review of literature related to the project was carried out. I also underwent two training programmes namely "*Enhancing input application efficiency for seeds, fertilizers and chemicals using precision farm machinery, decision support systems and electronic controllers for precision agriculture in Vertisols*" at CIAE, Bhopal and "*Geospatial knowledge management for sustainable livelihood security*" at NAARM, Hyderabad to acquire necessary knowledge and skills for usage of GIS softwares to carry out the project. Technical program of the project was finalized in consultation with the project team members. Two farmers' fields of minimum 20 acre size will be selected and yield recording of the Kharif crop will be carried out first and then soil sampling based on various strategies will be conducted on those selected fields.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January 2011):

Two farmers' fields (one in village Dhamarrah and another in Pipaliyabaaz khan) were selected. In both the fields Soybean-wheat cropping system is followed. Sampling of the Kharif crop (Soybean) was carried out in the first field by taking 28 random points within the field. The crop was air dried and yield of the grain was taken. A yield map of the crop was prepared using ArcGIS. The field was then divided into 5 zones based on yield map and 5 samples were collected from each of the zones. Grid based soil sample collection was performed for both the fields. For this purpose, soil samples were collected based on ½ acre, 1 acre, 2 acre and 5 acre grids. Collected samples were air dried and grinded and ready for laboratory analysis.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June 2011):
Two farmers' fields (one in village Dhammarrah and another in Pipaliyabaaz khan) were selected. In both the fields soybean-wheat cropping system is followed. Sampling of the kharif crop (soybean) was carried out in the first field by taking 25 random points within the field. The crop was air dried and yield of the grain was taken. A yield map of the crop was prepared using ArcGIS. The field was then divided into 5 zones based on yield map and 5 samples were collected from each of the zones. Grid based soil sample collection was performed for both the fields. For this purpose, soil samples were collected based on half acre, 1 acre, 2 acre and 5 acre grids. Collected samples were air dried and grinded and ready for laboratory analysis. There were a total of 177 samples. The samples were analyzed for pH, EC, Organic carbon, available N, P, K and micronutrients like boron and zinc. Almost all analyses were completed except zinc due to the inaccessibility of the instrument. The data will present in the coming IRC.

Comment of the House:
Progress was satisfactory. Dr. B. N. Mandal's name may be included.

Progress report to IRC (Dec., 2011):

The soil sample analyses were completed and send for statistical analysis. The statistical analysis is going on. The chemical analysis data were already presented in the last IRC. The results of statistical analysis completed till now will be presented in the coming IRC.

Comment of the House:
The progress was satisfactory.

6. Participatory Integrated Nutrient management for improving the productivity and fertility of soils of Nagaland.

Objectives:

1. To evaluate the effect of balanced and integrated nutrient supply on crop yield and profitability
2. To study the changes in soil properties due to integrated nutrient management.

Investigators:

PI: Dr. Brij Lal Lakaria

CO-PIs: Dr. N.K. Lenka, Dr. R.H. Wanjari, Dr. A.K. Biswas.

Date of Start: May 2010

Date of Completion: April 2013

Progress report to IRC (January, 2011):

All over the state about 108 soil samples covering 22 sites were collected by the State Department of Agriculture. These have been analysed for soil physico-chemical properties, soil organic carbon and available nutrients. The soil test report along with the memorandum of understanding has been submitted to the state department of Agriculture, Nagaland. Yet the duly signed memorandum of understanding has not been obtained from the department.

The soil mean soil pH among different sites varied 4.5 and 6.7 and the soil electrical conductivity ranged between 0.06 and 0.37 dS/m among different sites. About 43% samples has pH between 4-5, 39% between 5-6 amd rest only 18% had pH between 6-7 indicating a existence of acidic soils in the region. The soil organic carbon is in medium to very high category in most cases. It ranged between 0.44 and 4.62 per cent. The available N, P and K varied from 188-552, 1.1 – 27.4 and 60 – 730 kg ha^{-1}.

To start with, the project was launched during May 2010 at different locations in the State of Nagaland with five major sites under the direct supervision of the IISS. Site selection for the paddy plantation was done at five places although the same would be replicated by the State Department of Agriculture at many locations. Also, fertilizer recommendations were provided. Schedule of activities/observations to be carried out was also provided to concerned SAO/ SADOs.

As per plan, the observations on crop performance and yield were to be collected at harvest of paddy crop by the scientists. As agreed upon, The state department of Agriculture would bear the travel expenses in respect of the visiting scientists. However, they did not agree to our proposal and assured that the they themselves would collect the desired observation on crop parameters, yield data as well as collection of soil and plant samples after harvest of paddy crop. So far they have not sent any data/sample despite regular requests.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

The study was initiated during kharif 2010 with rice as test crop. Various modules of INM were tested at about 10 locations in Nagaland State. Rice crop was transplanted during June-July and grown with standard package of practices involving various INM modules. At maturity crop growth parameters were recorded. During first year, most of sites recorded good yield of rice

crop at different locations especially under WRC system of rice cultivation. Highest yield of rice was obtained in the Singrijan village at Dimapur. Among different modules, 50% NPK+5 t FYM+ green manuring resulted in the maximum yield at various locations. The first year cropping did not reveal much significant variations in yield except at one site (Tannag Valley).

Comment of the House:
Progress was satisfactory.

Progress report to IRC (Dec., 2011):

Paddy crop was raised at different locations in Nagaland and crop has been harvested. Data for most of the locations is awaited from State Department of Agriculture, Nagaland. Nutrient removals and probable organic nutrient input to crops has been worked out.

Comment of the House:
The progress was satisfactory.

7. Studies on soil resilience in relation to soil organic matter in selected soils.

Objectives:

Investigators:

PI: Dr. N. K. Lenka

CO-PIs: Dr. Sangeeta Lenka, Dr. B. L. Lakaria, Dr. Asit Mandal, Dr. S. K. Bahera, Dr. A.K. Biswas and Dr. A. Subba Rao.

Date of Start: July 2010
Date of Completion: July 2015
Progress report to IRC:

Progress report to IRC (Dec., 2011):

Two types of soil, viz., coarse textured, low carbon and medium textured, high carbon, collected from Ranchi (Jharkhand) and Aizawl (Mizoram) were put to oxidation treatment to yield three levels of organic carbon status for each soil type. The treated soil was sun dried and then leached thoroughly for two flushes to minimize the risk of chemical residues. The pot experiment was started taking soybean in kharif. Even though data analysis is not completed, the visual observation shows that growth of crops was affected with reduction in level of SOC and also affecting the root growth and soil aggregation particularly in the high carbon soil of Aizawl. The reduced growth in the lowest C level however got improved under the management practice with addition of 20 t FYM/ha. The latter also improved the soil physical properties of the low C treatment in Aizawl soil. Observations on photosynthesis, stomatal conductance and nodule parameters were taken during the maximum crop growth period. After harvest of the crop, soil penetration resistance and bulk density measurements were taken from individual pots. Wheat has been taken as the next rabi crop.

Comment of the House:
The progress was satisfactory.

8. Changing climatic factors' influence on the nutrient acquisition, utilization and recovery by soybean and wheat/gram germplasm lines/genotypes on black soils of central India.

Objectives:

1. To identify the genotypes/germplasm having better nutrient uptake, utilization and use efficiency in soybean and wheat under changing temperature and drought.
2. To identify and characterize the higher nutrient use efficiency adaptive traits of plants under drought and high temperature.
3. To find out the best nutrient management practices for different soybean and wheat genotypes/germplasm for optimum yield under drought and high temperature scenario.

Investigators:

PI: Dr. Neenu S.
CO-PIs: Dr. K. Ramesh, Dr.. I. Rashmi, Dr. J. Somasundaram

Date of start: June 2010,
Date of Completion: June 2012

Progress report to IRC (January, 2011):

During the Kharif season (2010), 10 varieties of soybean collected from NRC, Indore. 10 varieties were raised in the field in miniplots in three replications. Two dates of sowing were given. Recommended dose of fertilizer was given to all the plots. Field observations were taken. The crop was harvested in the month of October-November. Soil and plant analysis were done. For rabi season 12 chickpea varieties were collected from Agricultural Colleges, Sehore and Indore. All the 12 varieties were sown in the field during the month of November, 2010. Here also the recommended dose of fertilizer was applied to all the varieties.

The results of first experiment were presented in the last IRC. The second crop (chickpea) is in the field and first sown crop is about to harvest. The observations in the flowering season were taken. The plant and soil samples during flowering is collected and processing is going on. The results will present on the next IRC.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

During the rabi season (2010-11) 12 varieties of chick-pea were sown in the field on two dates of sowing with 3 replications. Two dates of sowing were given. Recommended dose of fertilizers were given to all the plots. Field observations were taken at flowering and harvesting time. The crop is harvested in the month of March-April. Soil and plant samples were collected for analysis. Soil analysis was done and plant analysis is still going on.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (Dec., 2011):

During the Kharif season (2011), 4 varieties of were raised in the field in miniplots in three replications. Two dates of sowing were given. There were 4 fertilizer treatments. Field observations were taken. The crop was harvested in the month of October-November. Soil and plant analysis are going on. For rabi season 4 varieties were collected from research stations. The field preparation is also going on. The results of second crop in the first experiment were presented in the last IRC. The results of the second year (Kharif season) experiment will be presented in the coming IRC.

Comment of the House:
The progress was satisfactory.

9. Biofortification of grain sorghum & finger millet varieties with Zinc through agronomic measures.

Objectives:

1. To study the variability among grain sorghum and finger millet varieties for Zn content in seed and feed.
2. To understand the plant physiological, biochemical and root characteristics responsible for the variability of Zn among selected varieties.
3. To find out the efficient agronomic measures of Zn enrichment in seed and Stover.

Date of start: July 2010
Date of Completion: July 2010
PI: Dr. Ajay
Co-PI: Dr. M. V. Singh, Dr. Vassanda Coumar, Dr. J. K. Saha, Dr. S. Kundu, Dr. S. K. Bahera.

Progress report to IRC (January, 2011):

The initial soil values have been analyzed, before sowing the crops and application of treatments. The pH 7.69 , EC (ds/m) 0.63 , Available N 186.5 , Available P 11.5 , Available K 412 in (kg/Ha), Organic Carbon % 0.55 and DTPA Zn (ppm) 0.36 – 0.41 were estimated. The initial root exudates studies have also been initiated with seeds of sorghum and finger millet through pH indicator. The results will be correlated with Zn content after digestion of the samples. The enzymatic studies and chlorophyll contents including photosynthesis have been completed with different growth stages. Overall, the T5 treatment (0.5% $ZnSO_4$ for spray at three growth stage (300liter/ha/spray) was found to be effective in the terms of physiological and biochemical indicators. However, the final data will be analyzed after Zn estimation in the digested sample, which is going on.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

The major activity for this period is estimation of Zn content in the grain, vegetative parts and in soil after harvest. The activity is still running for the estimation. However, the Zn content of the grain has shown the wide variability in the Zn content. The Foliar application was found to enhance the Zn content in grain in finger millet, while soil and foliar application both enhance in the Sorghum. By analyzing the Zn content, the variety with low, medium and high Zn content in the sorghum are PC 5, Pant chari series and CSV216R, respectively. Similarly, in the raagi, though the variation was not high, the varieties are HR 911, GPU 28 and Paiyur 1, respectively.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (Dec., 2011):

The major activity for this period is crop sowing and harvesting. The observation regarding growth, zinc content, photosynthesis, and enzymes analysis has been taken at three growth stages. The data analysis will be completed after analysis. Just now harvesting process is on. In this period the zinc content in different plant parts has also been completed. The data analysis incorporation and analysis is under process. Only activity will be presented in this IRC.

Comment of the House:

The progress was satisfactory.

10. Development of phosphorus saturation indices for selected Indian soils.

Objectives:

1. To evaluate different extractant for measuring Phosphorus Saturation Index (PSI) in some major soils of India
2. To evaluate environmental thresholds of PSI in these soils.

Date of start: April, 2011,
Date of Completion: April, 2014
PI Dr. I. Rashmi
Co-PI: Dr. J. S. V. Tenshia, Dr. K. S. Reddy, Dr. A. K. Biswas, Dr. A. Subba Rao

Progress report to IRC (June, 2011):
Soil samples were collected from IISS, Bhopal and DWSR, Jabalpur. Soil samples are processed and initial analysis of the samples is in progress. Soil samples from other places will be collected in the following months.

Comment of the House:
The progress was satisfactory. In place of Mrs. J. S. V. Tenshia, Ms. Neenu may be included in the said project.

Progress report to IRC (Dec., 2011):
Soil samples from three sites Bhopal, Jabalpur and Delhi were collected. Soil samples were processed for initial analysis. Phosphorus sorption isotherm was determined for all the three soils. The phosphorus sorption maxima were fitted in different equations. Based upon these sorption maxima soils are incubated with different levels of phosphorus.

Comment of the House:
The progress was satisfactory.

Programme II: Management of Soil Physical Component

11. Study of long-term tillage management with differential nitrogen on soybean-wheat cropping systems in Vertisols.

Objectives:

1. To evaluate performance of different tillage systems on soil quality and crop productivity on long term basis
2. To find out the appropriate implement for tillage practices and residue incorporation.

Investigators

PI: Dr. K. M. Hati
CO-PIs: Dr. R. K. Singh

Date of Start: June 1999
Date of Completion: Long-term
Progress report to IRC (November, 2008):

The data recorded on soybean grown during the rainy season are presented, results showed that the seed and biomass yield of soybean were not different significantly among the tillage treatments. However, the seed and biomass yield of soybean recorded at 150% and 100% recommended dose of nitrogen was significantly higher than that recorded at 50% recommended dose of N treatment. The average seed yield among the various treatments varied between 880 to 1420 kg/ha. Addition of biomass to the plots in the form of leaf fall and crop residues addition was recorded after soybean harvest. On an average, 680 kg/ha residues were added to the soil surface. The total rainfall received during the rainy season was 754 mm, which is 25% lower than the long-term average rainfall. Imposition of tillage treatments and variations in nitrogen levels significantly influenced the bulk density of the top 5 cm soil recorded during the pod filling stage of soybean. The BD was minimal in RT-RoT (1.20 Mg/m3) and MB-RoT (1.21 Mg/m3) treatments while it was the highest in CT-CT treatment (1.29 Mg/M3). Among the nitrogen levels, BD was maximal at 50% N level and it was significantly higher than the BD recorded at 100% and 150% N levels.

Comment of the House:

Progress was satisfactory. However, the house suggested that PI should make some yield trend analysis so as to depict the effect of tillage practices.

Progress report to IRC (June, 2009):

Due to shortage of irrigation water wheat in the winter season could not be grown in the experimental plots. To evaluate the effect of long-term imposition of different tillage treatments and nitrogen levels on soil physical properties, infiltration rate, bulk density of the surface soil were determined during the fallow period. The result showed that imposition of tillage treatments and variations in nitrogen levels significantly influenced the bulk density of tillage treatments and variations in nitrogen levels significantly influenced the bulk density of the top 5 cm soil. The BD was minimal in RT-Rot (1.20 Mg/m^3) and MB-Rot (1.21 Mg/m^3) treatments while it was the highest in CT-CT treatment (1.29 Mg/m^3). Among the nitrogen levels BD was maximum at 50% N level and it was significantly higher than the BD recorded at 100% and 150% N level. The steady state infiltration rates of plots under no tillage (NT-NT), mouldboard tillage (MB-Rot) and reduced tillage (RT-Rot) treatments were significantly higher than that under conventional tillage (RT-Rot) treatment. Among the nitrogen levels, $N_{100\%}$ and $N_{150\%}$ level recorded significantly higher infiltration than $N_{50\%}$ level. Besides this, a study was

conducted to evaluate the effect of changing soil moisture content on bulk density of soil under no tillage and conventional tillage system. The data clearly showed that with decrease in moisture content from near saturation to below permanent wilting point the bulk density of the Vertisol decreased at both 0-7.5 and 7.5-15 cm depths. The BD and moisture content relationship (as expressed through coefficient of determination) was stronger at 0-7.5 cm depth than that at 7.5-15 cm depth. The trend in the increase of BD with depletion of moisture content was similar in CT-CT and NT-NT treatments.

Comment of the House:
The progress was satisfactory. The house recommended that there is need to synthesize all the results obtained during last 10 years so as to generate information on optimization of soil physical conditions.

Progress report to IRC (November, 2009):
To evaluate the effect of long-term imposition of different tillage treatments and nitrogen levels on soil physical properties, infiltration rate, bulk density of the surface soil were determined during the fallow period after harvest of soybean. The results showed that imposition of tillage treatments and variations in nitrogen levels significantly influenced the bulk density of the top 5 cm soil. The BD was minimal in RT-RoT (1.20 Mg/m3) and MB-RoT (1.21 Mg/m3) treatments while it was highest in CT-CT treatment (1.29 Mg/m3). Among the nitrogen levels BD was maximum at 50% N level and it was significantly higher than the BD recorded at 100% and 150% N level. The steady state infiltration rates of plots under no tillage (NT-NT), mouldboard tillage (MB-RoT) and reduced tillage (RT-RoT) treatments were significantly higher than that under conventional tillage (CT-RoT) treatment. Among the nitrogen levels, N100% and N150% level recorded significantly higher infiltration than N50% level.
A relationship between bulk density and moisture content was developed for soils of no tillage and conventional tillage at 0-7.5 and 7.5-15.0 cm soil depths. The bulk density decreased with increase in moisture content and the second-degree polynomial could explain 63 to 88 per cent of total variation. Though the minimum bulk density was at soil wetness of more than 25 per cent, the bulk density increased at higher rate below 15 per cent soil moisture. The bulk density values were relatively high in subsurface soil (7.5-15.9) at drier range of moisture and the effect of tillage was not apparent in the relationships. The study suggested that bulk density of Vertisols be taken in the moisture range of about 20-25 per cent.

Comment of the House:
The progress was very good.

Progress report to IRC (June, 2010):

The performance of different tillage systems and nitrogen rates on soil quality and crop productivity in Vertisols has been assessed. Soybean was grown with four tillage treatments namely, mould board plough (MB), conventional tillage (CT), reduced tillage (RT) and no tillage (NT) as main plot and three nitrogen levels (50%, 100% and 150%) as subplots. The seed yield of soybean were not different significantly among the tillage treatments. However, the seed yield of soybean recorded at 150% and 100% recommended dose of nitrogen was significantly higher than that recorded at 50% recommended dose of N treatment. The average seed yield among the various treatments varied between 1333 to 1704 kg/ha.

The pooled analysis showed that the seasonal variation of soybean yield was highly significant and the distribution of weekly temperatures and rainfall during reproductive stage from year to year could not explain the seasonal variation in soybean yield.
The specific volume and soil wetness at 0-7.5 and 7.5-15.0 in CT-CT and NT-NT showed a definite relationship. The specific volume showed negligible change with moisture ratio up to 0.16-0.25 and after these ratios the specific volume increased with increase in soil wetness. The specific volume at 7.5-15.0 cm in both tillage treatments increased after moisture ratio of 0.25 whereas at 0-7.5 cm these moisture ratios were 0.16 in NT-NT and 0.20 in CT-CT.
The infiltrability values varied with season. Tillage effect on steady state infiltration rate was measured during March and October to study temporal variability of infiltration rate. The steady state infiltration rate was significantly higher under conservation tillage treatments (no tillage and reduced tillage treatments) than that under the conventional tillage treatment during both seasons. The infiltration rate after the rainy season (October) was lower than the infiltration rate during March.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
Soybean was grown under four tillage treatments and three nitrogen levels. The biomass growth of soybean during the season was adequate in all the treatments but due to poor pod setting and inadequate grain filling in the pods, the average seed yield of soybean was very poor. Analysis of the yield and yield attributes showed that the pod number per plant was very less and the seed test weight was also less. Due to shortage of irrigation water wheat in the winter season could not be grown in the experimental plots. To evaluate the effect of long-term imposition of different tillage treatments and nitrogen levels on soil physical properties, infiltration rates both cumulative and steady state, and bulk density of the soil up to 30 cm depth at 7.5 cm increment were determined after the harvest of soybean. The results showed that **i**mposition of tillage treatments and variations in nitrogen levels significantly influenced the bulk density of the top 15 cm soil, while below 15 cm depth the bulk density difference among the treatments were not significant. The BD in most of the plots increased with increase in depth. The BD at 0-7.5 cm depth minimal was in reduced tillage (1.20 Mg/m^3) while it was highest in conventional tillage treatment (1.30 Mg/m^3). In mouldboard tillage and no tillage treatments, the BD was 1.24 Mg/m^3 and 1.25 Mg/m^3, respectively. At 7.5-15 cm depth the BD in mouldboard treatment was significantly less than other three tillage treatments. Among the nitrogen levels BD was maximum at 50% N level and it was significantly higher than the BD recorded at 100% and 150% N level. The steady state infiltration rates of plots under no tillage (NT-NT), mouldboard tillage (MB-NT) treatments were significantly higher than that under reduced tillage (RT-RoT) and conventional tillage (CT-CT) treatment. Among the nitrogen levels, $N_{100\%}$ and $N_{150\%}$ level recorded higher infiltration than $N_{50\%}$ level but the treatment difference was not significant. The cumulative infiltration up to 300 minutes was significantly higher in no tillage, mouldboard tillage treatments than that in reduced tillage and conventional tillage treatments. Cumulative infiltration recorded in $N_{100\%}$ and $N_{150\%}$ level was significantly higher than that in $N_{50\%}$ level treatment.

Comment of the House:
The progress was satisfactory. The house suggested that the PI may change the cropping systems in view of the continuous failure of the winter crop. Also the PI may explore the possibility to change the number of treatments to reduce the size of the experiments.

Progress report to IRC (June, 2011):

Due to shortage of irrigation water wheat could be grown during the winter season. Soil samples were taken during the fallow period for their analysis of soil properties. In this project changes in soil physical properties due to tillage differences were studied regularly but the effect of conservation tillage and nitrogen levels on soil nutrient availability, its dynamics and stratification in the soil layer were not studied. It was decided by the house that after the end of next crop cycle soil samples will be collected for study of nutrient dynamics and stratification. Dr. Brij lal Lakaria, Principal Scientist, Soil Chemistry division will be associated in the project and will carry out the chemical analysis and interpretation of the data.

Comment of the House:

The progress was satisfactory. House suggested that after 2011 soybean crop and 2011-12 wheat crop the project may be declared as closed.

Progress report to IRC (Dec., 2011):

Soybean was grown under four tillage treatments and three nitrogen levels. Data on soil water content, and crop growth parameters were monitored regularly. The bulk density of the soil and soil moisture retention of undisturbed cores at field capacity were determined during the season. The biomass growth of soybean during the season was adequate in all the treatments but due to continuous and heavy rainfall during the reproductive stage pod setting and filling was poor which resulted in very low average seed yield of soybean. Analysis of the yield and yield attributes showed that the pod number per plant was very less and the seed test weight was also less. The results showed that **i**mposition of tillage treatments significantly influenced the bulk density of the soil, but nitrogen level effect on soil bulk density was not significant. The BD in most of the plots increased with increase in depth. The BD at 0-7.5 cm depth minimal was in mouldboard (1.18 Mg/m^3) and reduced tillage (1.20 Mg/m^3) treatments while it was highest in no tillage treatment (1.26 Mg/m^3). At 7.5-15 cm depth the BD in mouldboard treatment was significantly less than other three tillage treatments. Soil moisture retention at field capacity was relatively higher in conservation tillage treatments compared to the conventional tillage treatment. Soil samples from the profile were collected after harvest of soybean for estimation of soil physical and chemical properties under different tillage and nitrogen level treatments. Wheat crop is sown after imposition of tillage and nitrogen treatments in the 3rd week of November.

Comment of the House:

The progress was satisfactory.

PROGRAMME II: MANAGEMENT OF SOIL PHYSICAL COMPONENTS

12. Tillage and manure interactive effects on soil aggregate dynamics, soil organic carbon accumulation and bypass flow in vertisols.

Objectives:

1. To assess the SOC stock dynamics, SOC pools and their role in soil structural stability in response to quality and frequency of manure-C inputs and tillage practices.
2. To determine the influence of tillage and manure on bypass flow of water in vertisols.
3. To find out relationship between some physical, chemical and biological soil attributes and soil aggregate dynamics.
4. To evaluate and assess energy of zero till slit drill in surface managed crop residues in the field following controlled traffic measures.

Investigators:

PI: Dr. Sangeeta Lanka

CO-PIs: Dr. R. K. Singh, Dr. K.M. Hati, Dr. M.C. Manna, Dr. B.L. Lakaria and Dr. R. C. Singh (CIAE).

Date of Start: June 2008

Date of Completion: 2014

Progress report to IRC (November, 2008):

Field experiment started with soybean crop (JS-335) from July 2008. Soil sampling for moisture content was done from 0-15, 15-30 and 30-45 cm soil depths at 54 DAS and 90 DAS. The crop was harvested on 14th October. 2008. After harvest biomass and grain yield were recorded. Soil sample were collected from 0-15 cm depth for analysis of NPK and biological properties. Wheat variety HI-1531 was sown on 18th November 2008 after presowing irrigation. Potculture experiment was done to study the effect of roots on soil aggregation. It started in the month of July 2008 and harvested in the month of October. Soil sample were collected from 0-5 and 5-15 cm soil depth at 45 and 90 DAS for analysis of SOC, SMBC, SR, DHA and alkaline phosphates. Wheat variety HI-1531 was sown on 19th Nov. 2008 after presowing irrigation.

Grain yield ranged from 6-7.6 q/ha and biomass yield from 20-34 q/ha. Both grain and biomass yield was found to be more in conventional tillage (CT) as compared to no tillage (NT). Initial NPK decreased with depth, BD and moisture retention was found to increase with depth from surface to 45 cm. In pot culture experiment it was found that C content is more in pots without crop as compared to with crop pots. Biological activity, basal respiration and DHA is relatively greater in pot with crop as compared to without crop pots soil at higher levels of FYM.

Comment of the House:

Progress was satisfactory. It was suggested that the PI should compute the total nutrient supply to the soil through FYM under different treatments.

Progress report to IRC (June, 2009):

Different levels of FYM had significant effect on grain and biomass yield of wheat 2008-09. Grain yield ranged from 3.4 to 4.0 Mg/ha. The effect of FYM-C levels 2 (T4) and 2.5 (T5) t/ha on grain yield was the highest and also found to be at par. Biomass yield ranged from 6.0 (T1) to 7.3 (T7) Mg/ha. After harvest of wheat, no tillage resulted in higher available N than

conventional tillage at both soil depths (0-5 and 5-15 cm). Reverse trend was observed in available P and K at both soil depths with respect to village. Available N, P and K were found to increase significantly with increase in levels of FYM. TOC percent was found to vary from 0.89 (T1) to 1.48 (T7) after wheat harvest. However levels of FYM, tillage and manure interaction had significant effect on TOC at 9-5 and 5-15 cm soil depths. In soybean at 90 DAS in pot culture experiment it was found that SOC, SMBC and basal respiration is more in without crop as compared to with crop pots at 0-5 and 5-15 cm soil depth. However alkaline phosphatase and dehydrogenase activity were relatively greater in cropped than non-cropped pots. In the field experiment tillage did not have any significant effect on biological activity. Whereas biological activity increased significantly with increase in levels of FYM. Fluorescein di acetate was found to have highest correlation of 0.45 and 0.52 with water soluble carbon and acid hydrolysable carbohydrate respectively.

Comment of the House:
The progress was satisfactory. The PI was asked to check all the results presented by her in consultation with HOD (Soil physics division). Dr. Brijlal Lakaria may be associated in place of Dr. D. D. Reddy.

Progress report to IRC (November, 2009)
The PI was absent.

Progress report to IRC (June, 2010):
Soybean grain yield varied from 21 to 26.7 q//ha in 2009. There is no significant effect of tillage, FYM-C and their interaction on soybean grain and biomass yield. However no tillage was found to have 13% and 19% greater grain and biomass yield respectively as compared to conventional tillage in soybean 9-10% increase in soil moisture content at surface 0-5 cm soil depth in no tillage than conventional tillage. There is no significant effect of tillage, FYM-C and their interaction on soil moisture content.

Comment of the House:
The PI was absent as she was on deputation for training at U.S.A.

Progress report to IRC (January, 2011):
Soybean is sown on 4^{th} and 5^{th} July 2010 in field and pots respectively. Intercultural operations were carried out as per schedule. Soybean is harvested on 5^{th} October 2010 in field and pots. Root weight and volume were taken at flowering in Soybean by core method from 0-7.5, 7.5-15, 15-22.5, 22.5-30, 30-37.5 and 37.5-45.0 cm soil depth. After soybean harvest biomass and grain yield are recorded. Bulk density measurements were done after soybean harvest. Wheat crop (HI-1531) is sown on 10^{th} and 11^{th} Nov. 2010 in field and pots respectively. Aggregate fractionation, SOC and soil biological properties determination were done in post harvest soil of wheat 2009-10. Loss of water through Bypass flow was also assessed after harvest of wheat in April 2010.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Wheat grain yield ranged from 4.1-4.5 Mg/ha in Conventional Tillage (one pass rotavator and sowing by seed drill, residue incorporated) and 4.0-4.9 Mg/ha in No Tillage (residue on soil

surface). No tillage was found to have significantly higher grain and biomass yield as compared to conventional tillage. Soil resistance to penetration was more in conventional tillage compared to no tillage.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Soybean grain and biomass yield varied from 0.79-1.35 Mg/ha and 3.31-4.28 Mg/ha. There was no significant effect of tillage and FYM-C on yield and biomass of soybean. Analysis of post harvest soil samples after wheat showed that soil aggregation and aggregate stability was more in no tillage compared (NT) to reduced tillage (RT). Mean weight diameter and water stable aggregate was found to be more in NT by 15% and 5% respectively over RT. No tillage showed more organic carbon in surface 0-5 cm soil depth. However total organic carbon, permanganate oxidizable carbon, available N, P, K and biological activity (FDA, dehydrogenase, SMBC, hot water soluble carbon) was found to be more in reduced tillage at 0-5, 5-15, 15-30 and 30-45 cm soil depth. Effect of no tillage (direct sowing with no till slit drill) and reduced tillage (one pass rotavtor and sowing with seed cum fertilizer drill) was evaluated on loss of water through bypass flow after third year of experiment in soybean-wheat system in vertisols. Loss of water beyond 60 cm soil depth as recorded were 37% and 56% in RT and NT respectively. The depth and width of cracks in no tillage was also significantly more than reduced tillage. Lower crack width and intensity could have resulted in less loss of water through bypass flow in reduced tillage.

Comment of the House:
The progress was satisfactory.

13. Tillage effect on weed dynamics in soybean-wheat system on Vertisol.

Objective:

1. To determine the influence of tillage methods on weed seed stratification.
2. To study the tillage management effects on weed abundance.
3. To determine the relationship between soil properties and weed populations.

Investigators:

PI: Dr. Blaise D'Souza
CO-PIs: Dr. R. H. Wanjari and Dr. R. K. Singh

Date of Start: June 2009
Date of Completion: July 2012

Progress report to IRC (November, 2009):
The main purpose of the project was to understand the effects of long-term tillage practices on weeds, their densities and distribution in soybean-wheat crop sequence. At the time of first sampling, 25 days after sowing, weed density was the least in the reduced and no-tillage treatments followed by moldboard ploughing. Weed density was the highest in the conventional tillage treatment. Although, total weed density was not different among the treatments at 45 DAS, significantly fewer grassy weeds were recorded in the reduced and no-tillage treatments. Effective weed control was achieved in the reduced and no-tillage treatments by applying pre-plant herbicides resulting in significantly higher soybean grain yield than the conventional tillage treatment.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010):
Among the tillage treatments (Conventional tillage: CT, reduced tillage: RT, mould board tillage: MB and no tillage: NT), weed abundance was significantly greater in the CT treatments and the least in the MB. Studies on seed bank (germination assay technique) indicated that the top 0-5 cm soil layer had significantly more weed seeds than the 5-15 cm soil depth. In the 0-5 cm soil depth, weed seed bank was the least in the MB, both for monocot (grassy weeds) as well as dicot (broad leaf) weeds. A low weed seed bank in the MB ploughed plots was because the plots had a low initial weed biomass than the RT and NT plots. Differences among the CT, RT and NT treatments were not significant. With regard to the 5-15 cm soil depth, the trend was the reverse with the MB treatment having the highest weed seed density. The MB treatment did not differ with the CT. The NT and RT treatments had the least number of weed seeds. Weed species and density were recorded during December 2009. A total of 21 weed species were recorded in the experimental field. Number of weed species was greater in the CT (avg. 7 species) compared to the RT and NT treatments (5-6 weed species). The CT treatment had higher weed abundance than the RT and NT and was the least in the MB ploughed plots during the soybean cropping season.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
During the second season of the field experiment, observations on weed abundance were recorded twice and at harvest of soybean, weed species diversity was also recorded. Weed biomass was also quantified. Weed density was the least in the MB plough treatment and the highest in the CT treatment. At a later stage, the NT treatment had a higher weed density and biomass accumulation. Expectedly, soybean grain yields were the lowest in the weedy check. Grain yields were determined by the time of weeding. The first thirty days were the most crucial with highest grain yield with two weeding compared to one and no weeding done. Weed seed stratification was monitored in a laboratory study with the highest weed seed population in the MB plough in the 20-30 cm soil depth. The trend followed was MB > CT = RT > NT. Weed sample analysis for nutrient content is in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Germination assays were conducted to assess the quantum of weed seeds present in the soil. Soils collected from the 0-5 and 5-15 cm soil depth were incubated at field capacity under ambient conditions and weekly emergence of monocot and dicot weeds were noted. Weed seed stratification was observed with the soil depth. The trend followed for the 0-5 cm was CT > RT = NT > MB whereas in the 5-15 cm soil depth it was CT = MB > RT = NT. however, the weed numbers recroded were lower than those for the samples collected in the previous year. This could be attributed to three probable reasons (i) physical protection offered by the aggregates, (ii) dormancy and/or (iii) lower weed biomass left at the end of the previous season. The soils were disrupted and ground to pass the 2-mm sieve. After disruption, the weed emergence increased by >80% in the RT and NT plots. These plots also had aggregates of larger mean weight diameter than the other two tillage treatments, namely mold board and conventional tillage.
Weed samples were also analysed for micronutrient (Zn, Fe, Mn and Cu) and macro-nutrients (P and K) content of the first season and P and K for the second season. P removal by weeds was 6.1 kg/ha during the crop season in the CT treatment and ranged from 3.0 to 3.4 kg/ha in the MB, RT and NT treatments. K removal was also greater in the CT treatment (19 kg K/ha) mainly because of a large proportion of grassy weeds. K removal in the MB, RT and NT treatments did not differ and ranged from 7.1 to 8 kg K/ha.
Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

The predominant weeds observed in soybean (Kharif, 2011) were *Echinochloa colona*, *Cyperus rotundus*, *Saccharum spontaneum*, *Cynodon dactylon*, *Euphorbia hirta*, *Digera arvensis*, and *Tridex procumbens*. The weed abundance and biomass was highest in NT (no tillage) followed by RT (reduced tillage), CT (conventional tillage) and MB (MB plough tillage) during crop growth stages. However, at harvest lowest weed biomass was recorded in NT and RT. The weed control efficiency was lowest in NT followed by RT. Tillage treatments (NT, RT, CT and MB) did not influence average soybean yield, however, it was in the ascending order as NT< RT< CT< MB. Response to tillage treatments in soybean was not significant due to low soybean yield level (317-369 kg ha^{-1}) compared to its potential yield. However, yield was significant for weed control conditions. Physical properties i.e. bulk density (BD), penetration resistance (PR),

moisture content (MC) were recorded at different crop growth stages. Comparatively high BD, PR and MC were recorded in NT plots compared to other tillage treatments.

Comment of the House:
The progress was satisfactory. Dr. R.H. Wanjari will be the PI of the project.

14. Detection of water and nitrogen stress and prediction of yield of soybean and maize using hyper-spectral reflectance and vegetation indices.

Objectives:

1. To develop soil line for Vertisols to separate crop signature from soil background noise.
2. To identify hyperspectral narrow-wavebands and formulate vegetation indices that are best suited for early detection of crop N stress under varying water status situations.
3. Development of model for prediction of crop yield using narrow-band vegetation indices.

Investigators:

PI: Dr. K. M. Hati
CO-PIs: Dr. R. K. Singh, Dr. Blaise D'Souza, Dr. A. K. Misra,

Date of Start: June 2009
Date of Completion: 2012
IRC Comments:
New Project

Progress report to IRC (November, 2009):
For studying the water and nitrogen stress effect on maize, a field experiment has been initiated in *kharif* 2009. Maize crop (cv. Kanchan101) was grown at four nitrogen and two irrigation levels on a split plot design. Due to rainfall in later part of crop season moisture stress was not very apparent and so the irrigation treatments could not be imposed. During the cropping season leaf area, biomass, profile moisture content and spectral reflectance from crop as well as from the bare soil was recorded during important growth stages. The LAI, biomass values showed significant variations between the nitrogen levels. From the spectral reflectance common vegetation indices like NDVI, green-NDVI, ratio index, normalized difference red index (NDRE), modified spectral ratio (MSR) were calculated and they were correlated with the LAI and biomass. The NDVI showed a good correlation with the LAI and biomass at the initial stages but during the full vegetation stage (when LAI value exceeded the value 2) GNDVI was found to be a better predictor for LAI and biomass. Preliminary results gave an indication that ratio vegetation indices at 550 and 785 nm wavelength bands are sensitive to the nitrogen stress in maize. Average maize yield at N0 level was 3039 kg/ha while at N150% it was 5827 kg/ha.

Comment of the House:
The progress was satisfactory.
Progress report to IRC (June, 2010):
Wheat crop (cv. WH-147) was grown under four nitrogen and two irrigation levels on a split plot design. During the cropping season leaf area, biomass, profile moisture content and spectral reflectance from crop as well as from the bare soil was recorded at important crop growth stages. The LAI, biomass values showed significant variations between the nitrogen levels and irrigation regimes. Both the LAI and biomass were higher at higher nitrogen doses. From the spectral reflectance data vegetation indices like NDVI, green-NDVI, ratio index, normalized difference red index (NDRE), modified spectral ratio (MSR) were calculated and they showed good correlation with the LAI and biomass during the vegetation stage of crop growth. Highest grain yield of wheat (5389 kg/ha) was recorded in $N_{150\%}$ nitrogen with three irrigation treatment.

Wheat yield increased with increasing irrigation and nitrogen level. Irrigation X nitrogen interaction effect was significant on wheat grain and biomass yield.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
For studying the water and nitrogen stress effect on maize, a field experiment has been conducted in *kharif* 2010. Maize (cv. Kanchan101) was grown at four nitrogen and two irrigation levels on a split plot design. During the cropping season leaf area, biomass, and spectral reflectance from crop as well as from the bare soil was recorded during important growth stages. The nitrogen content of the maize leaf collected during the maximum vegetative stage was estimated and the nitrogen content was correlated with the spectral reflectance recorded during that period. The LAI, biomass values showed significant variations between the nitrogen levels. From the spectral reflectance common vegetation indices like NDVI, green-NDVI, ratio index, normalized difference red index (NDRE), were calculated and they were correlated with the LAI and biomass. The NDVI showed a good correlation with the LAI and biomass at the initial stages but during the full vegetation stage (when LAI value exceeded the value 2) GNDVI was found to be a better predictor for LAI and biomass. Red edge position (REP) from the spectral reflectance was calculated and it was found to shift towards higher value with increase in nitrogen content in plant. Average maize yield at $N_{0\%}$ level was 2153 kg/ha while at $N_{150\%}$ it was 5625 kg/ha.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
For studying the water and nitrogen stress effect on maize and wheat crops, a field experiment is being initiated during the rainy season of 2009. Due to the paucity of irrigation water wheat could not be grown in the experimental area. During the rainy season of 2011 maize will be raised for the third year. Detailed analysis and some interpretation of data collected during the previous cropping seasons were carried out. Vegetation indices were calculated for prediction of yield and nitrogen stress in maize and wheat. The reflectance characteristics of Vertisols under varying moisture level were studied and a soil reflectance line were generated for this soil.
Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):
For studying the water and nitrogen stress effect on maize, a field experiment has been conducted in *kharif* 2011. Maize (cv. Kanchan101) was grown at four nitrogen and two irrigation levels on a split plot design. During the cropping season leaf area, biomass, and spectral reflectance from crop as well as from the bare soil was recorded during important growth stages. The moisture content of the soil profile was also recorded four times during the cropping season. Maize leaf samples and soil samples were collected for estimation of nitrogen content in leaf and soil under different nitrogen treatments. The nitrogen content will be correlated with the reflectance bands for finding relationship between them. The LAI, biomass values showed significant variations between the nitrogen levels. From the spectral reflectance common vegetation indices like NDVI, green-NDVI, ratio index, normalized difference red index (NDRE), were calculated and they were correlated with the LAI and biomass. Average maize

yield at level $N_{0\%}$was 833 kg/ha while at $N_{150\%}$ it was 4132 kg/ha. Maize yield difference between $N_{0\%}$ and $N_{50\%}$ was not significant

Comment of the House:
The progress was satisfactory.

Programme II: Management of soil physical components

15. Participatory assessment of qualitative parameter for categorizing different degrees of soil quality to enhance the soil health and productivity.

Objectives:

1. Qualitative assessment of soil parameters (physical, biological and chemical) for categorizing various degrees of soil quality.
2. To develop a soil health card with focus on above parameters.
3. Validation of soil health card under varying soil management practices.

Investigators:

PI: Dr. R. S. Chaudhary

CO-PIs: Dr. J. Somasundaram, Dr. Brij Lal Lakaria, Dr. Santosh R. Mohanty, Dr. A. B. Singh.

Date of Start: March 2010

Date of Completion: August 2013 (3.5 years)

Progress report to IRC (June, 2010):

Planning for selection of the study area and methodology to be adapted have been finalized.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January, 2011):

In the first year of experiment (2010-11) two villages viz. Parwalia (Distt.Bhopal) and Vaidakhedi (Distt. Sehore) MP were selected for the project. From each village 15 farmers were selected. In single village, three farming systems Viz. i)organic manure based farming: ii) Inorganic farming and: iii) Integrated farming systems were identified under soybean – wheat cropping system. From each farming system 5 farmers were selected for the project.

Total 12 parameters of soil quality assessment comprising of soil physical, biological and chemical parameters were determined in selected farmer's fields using low cost farmer friendly tools. The weighted average values of thee parameters as assessed in the field, placed organic manure based farming in 'Good' category of soil health followed by integrated farming system that recorded 'Fair' category overall. These field assessed values were backed up by quantitative values of these parameters as determined in the laboratory using scientific instruments, and the results supported the inferences drawn by field tools.

Using these values the "Soil health cards" for the 30 selected farmers have been prepared and kept ready for printing and distribution.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

During the period under report, two training camps were organized in the selected villages to further train the farmers. Farmers were apprised of the low cost methods of soil health assessment alongwith the kit meant for soil chemical analysis in the field.

The wheat yield data recorded under three farming systems Viz. i)organic manure based farming: ii) Inorganic farming and: iii) Integrated farming systems revealed that in Parwali village, the wheat yield (Var. Malwa Shakti) was significantly higher under integrated farming (5068 kg/ha) followed by organic Farming (4490 kg/ha) and least under inorganic farming (4300 kg/ha).

Similarly in Baidakhedi village the wheat yield (var. Sujata), recorded significantly higher yield under integrated farming (3100 kg/ha) followed by organic Farming (2645 kg/ha) and least under inorganic farming (2320 kg/ha). The soil samples were drawn for chemical analysis before the fertilizer application for second year soybean.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

During the period under report, soil physical parameters like penetration resistance and infiltration rate were determined in the field in both the selected villages. The soil sampling too was carried out in both the villages for parameters like organic carbon, mean weight diameter and water stable aggregates. The analysis of the samples revealed that the infiltration rate was higher in organic farming systems (1.14 to 1.15 cm /h) followed by integrated one (0.83 to 0.88 cm/h) and minimum among three systems in inorganic farming systems (0.67 to 0.86 cm/h) .Similarly the WSA %, MWD, and SOC were higher in organic farming followed by integrated and minimum in inorganic one.The penetration resistance was lesser at surface (0-15 cm) in organic farming systems (1100kPa) followed by integrated (1175 kPa) system and higher in inorganic system(1200-1300 kPa). However at lower depths the Soil Penetration resistance tended to be higher and almost equal among various farming systems. The Soybean yield data recorded under three farming systems Viz. i)organic manure based farming: ii) Inorganic farming and: iii) Integrated farming systems revealed that in Parwalia village, the Soybean yield was significantly higher under integrated farming (1860 kg/ha) followed by organic Farming (1752 kg/ha) and least under inorganic farming (1656 kg/ha). Similarly in Baidakhedi village the soybean yield recorded significantly higher yield under integrated farming (1282 kg/ha) followed by organic Farming (1136 kg/ha) and least under inorganic farming (1018 kg/ha).

Comment of the House:
The progress was satisfactory.

PROGRAMME II: MANAGEMENT OF SOIL PHYSICAL COMPONENTS

16. Evaluating conservation tillage on various sequences/ rotations for stabilizing crops productivity under erratic climatic conditions in black soils of Central India.

Objectives:

1. To identify the potential dynamic cropping sequences/rotations* and conservation tillage for stabilizing crops productivity under erratic climatic conditions.
2. To study the effect of crop rotations and/or sequences on soil organic carbon and soil properties.
3. To evaluate the economics under different crop rotations and conservation tillage.

Investigators:

PI: Dr. J. Somasundaram
CO-PIs: Dr. R. S. Chaudhary

Date of Start: March 2010
Date of Completion: June 2012

Progress report to IRC (June, 2010)

Planning for selection of the study area and methodology to be adapted have been finalized.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January, 2011):

This is the first year of experimentation. The study was laid out in split – plot design with 2 tillage treatments namely conventional tillage (CT) and reduced tillage (RT) along with 6 cropping systems i) Soybean- Fallow, ii) Maize- Gram, iii) Soybean- Fallow, iv) Soybean + Pigeon pea, v) Soybean+ Cotton and vi) Soybean– Wheat.

Kharif season crops namely sole soybean and maize, Soybean + Pigeon pea and Soy bean + cotton was sown on 1 – 2 & 3.07.10, respectively. Soybean and Maize were harvested and recorded biometric and yield parameters. Long duration crops namely pigeon pea and cotton are yet be harvested.

Rabi season crops namely wheat and gram was sown (15.11.10) in six experimental plots, respectively. Biometric observation and initial soil samples and yield analysis are in progress. However, long-duration crops namely pigeon pea and cotton and Rabi season crops are yet to be harvested for compilation of one year crop rotation data.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

The study was laid out in split – plot design with 2 tillage treatments namely conventional tillage (CT) and reduced tillage (RT) along with 6 cropping systems i) Soybean- Fallow, ii) Maize- Gram, iii) Soybean- Fallow, iv) Soybean + Pigeon pea (2:1), v) Soybean+ Cotton (2:1) and vi) Soybean– Wheat.

Kharif season crops namely sole soybean and maize, soybean + pigeon pea (2:1) and soybean + cotton (2:1) was sown on 2-3.07.10, respectively. Soybean, maize and long duration crops namely pigeon pea and cotton crops were harvested and recorded yield parameters. *Rabi* season crops namely gram and wheat was sown on 27.10.10 and 15.11.10, respectively. Yields of six

cropping system were calculated and converted into soybean grain equivalent yield (SGEY). Among the various cropping systems, maize–gram recorded highest SGEY of 5420 kg/ha followed by soybean-wheat, soybean+ cotton (2:1), soybean + pigeon pea (2:1). The soybean-fallow system recorded the lowest yield under both CT and RT. From the one year crop data reveals that crop yields were relatively higher in conventional tillage as compared to reduced tillage except wheat yield. However, moisture percent in gram crop was slightly higher in reduced tillage than conventional tillage.

Comment of the House:
The progress was satisfactory. The house recommended that Ms. Neenu and Dr. Ajay may be included in this project.

Progress report to IRC (Dec., 2011):

The study was laid out in split – plot design with 2 tillage treatments namely conventional tillage (CT) and reduced tillage (RT) along with 6 cropping systems i) Soybean- Fallow, ii) Maize- Gram, iii) Soybean- Fallow, iv) Soybean + Pigeon pea (2:1), v) Soybean+ Cotton (2:1) and vi) Soybean– Wheat. *Kharif* season crops namely sole soybean and maize, soybean + pigeon pea (2:1) and soybean + cotton (2:1) was sown on 2.07.10, respectively. Soybean, maize and long duration crops namely pigeon pea and cotton crops were harvested and recorded yield parameters. *Rabi* season crops namely gram and wheat was sown on 27.10.11 and 15.11.10, respectively. Yields of six cropping system were calculated and converted into soybean grain equivalent yield (SGEY). Among the various cropping systems, maize–gram recorded highest SGEY of 5420 kg/ha followed by soybean-wheat, soybean+ cotton (2:1), soybean + pigeon pea (2:1). The soybean-fallow system recorded the lowest yield under both CT and RT. From the one year crop data reveals that crop yields were relatively higher in conventional tillage as compared to reduced tillage except wheat yield. However, moisture per cent in gram crop was slightly higher in reduced tillage than conventional tillage.

Comment of the House:
The progress was satisfactory.

PROGRAMME II: MANAGEMENT OF SOIL PHYSICAL COMPONENTS

17. Impact of crop covers on soil and nutrient losses through runoff in Vertisol.

Objectives:

1. To determine the soil and nutrient losses through run off under different crop covers.
2. To assess the effect of run off, soil and nutrient losses on soil properties.

Investigators:

PI: Dr. R. K. Singh

Co-PIs: Dr. R. S. Chaudhary, Dr. J. Somasundaram, Dr. I. Rashmi

Date of Start: June 2010

Date of Completion: June 2012 (4Years)

Progress report to IRC (June, 2010)

Planning for selection of the study area and methodology to be adapted have been finalized.

Comment of the House:

The progress was satisfactory

Progress report to IRC (January, 2011):

The present study is carried out at Indian Institute of Soil Science, Bhopal to asses the impact of crop covers on soil and nutrient losses through run off in vertisol. There are seven treatments with three replications under randomized block design. The treatments were consisted with three sole (Soybean, maize and pigeon pea) and three intercrops viz, Soybean + Maize (1:1), Soybean + Pigeon pea (2:1) and Maize + Pigeon pea (1:1) with cultivated fallow as a control. Crops were sown on 2 July, 2010. Run off, soil moisture and weed observation were recorded.

The run off and soil loss was recorded greater in sole crops namely soybean, maize and pigeon pea as compared to intercrops namely soybean + maize (1:1), soybean +pigeon pea (2:1) and maize +pigeonpea (1:1) but maximum run off and soil loss was recorded in uncultivated fallow plot (control). In case of sole crops, the weed biomass was less in maize crops and more in soybean crop but in case of intercrop, weed biomass was more in pigeon pea + soybean crops and less in maize + Soybean. The soil moisture content was higher in uncultivated fallow followed by soybean plot in all three soil depth (0-15,15-30 and 30-45) and less in soybean + maize except 0-15 cm soil depth at 52 day after sowing of crops. However, more soil moisture content was recorded in uncultivated fallow plot as compared to crop plots in 0-15 cm but higher in lower soil depth 15-30 after harvesting of soybean and maize crops.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

The study was laid out in split – plot design with 2 tillage treatments namely conventional tillage (CT) and reduced tillage (RT) along with 6 cropping systems i) Soybean- Fallow, ii) Maize-Gram, iii) Soybean- Fallow, iv) Soybean + Pigeon pea (2:1), v) Soybean+ Cotton (2:1) and vi) Soybean– Wheat.

Kharif season crops namely sole soybean and maize, soybean + pigeon pea (2:1) and soybean + cotton (2:1) was sown on 2.07.10, respectively. Soybean, maize and long duration crops namely pigeon pea and cotton crops were harvested and recorded yield parameters. *Rabi* season

crops namely gram and wheat was sown on 27.10.11 and 15.11.10, respectively. Yields of six cropping system were calculated and converted into soybean grain equivalent yield (SGEY). Among the various cropping systems, maize–gram recorded highest SGEY of 5420 kg/ha followed by soybean-wheat, soybean+ cotton (2:1), soybean + pigeon pea (2:1). The soybean-fallow system recorded the lowest yield under both CT and RT. From the one year crop data reveals that crop yields were relatively higher in conventional tillage as compared to reduced tillage except wheat yield. However, moisture per cent in gram crop was slightly higher in reduced tillage than conventional tillage.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

The experiment is being conducted to assess the impact of crop covers on soil and nutrient losses through run off in vertisol at Indian Institute of Soil Science, Bhopal. There are seven treatments with three replications under randomized block design. The treatments were consisted with three sole (Soybean, maize and pigeon pea) and three intercrops viz, Soybean + Maize (1:1), Soybean + Pigeon pea (2:1) and Maize + Pigeon pea (1:1) with cultivated fallow as a control. Crops were sown on 3 July, 2010 with optimum soil moisture content .During crop growth period, the observations on rainfall, plant growth, soil moisture content, dry matter production, run off and soil loss and crop yield were recorded. The maximum run off and soil loss was recorded in cultivated fallow over sole as well as intercrops. Among the sole crops, the maximum run off and soil loss was recorded under pigeon pea and lowest was in soybean sole crop. In case of intercrops, the maximum run off and soil loss was in maize and pigeon pea and lowest in soybean + pigeon pea. The overall , the soybean as sole recorded minimum runoff and soil loss followed by soybean+ pigeon pea (2:1), soybean + maize, (1;1) maize +pigeon pea, (1:1) and sole crops namely maize and pigeon pea. Weed biomass and crop residue was significantly higher in soybean as compared to maize and pigeon pea but in case of intercrops, soybean + pigeonpea recorded higher as compared soybean + maize and maize +pigeon pea to others treatments. Rests of treatments were significantly similar. The soil penetration resistance was in 0-15 cm soil depth as compared to 15-10 cm soil depth at harvest stage. The soil moisture content was recorded during the crop period in different soil depths. The soil moisture content was higher in cultivated fallow followed by soybean plot in and less in soybean + maize at harvest stage.

Comment of the House:
The progress was satisfactory.

18. Characterizing rooting behaviors, soil water patterns and nutrient uptake of soybean-chick pea under different tillage and water regimes in Vertisols.

Objectives:

- To study the effect of different tillage and water regimes on root characteristics.
- To quantify uptake and partitioning of nutrients under different rooting behaviors in soybean-chick pea as affected by different tillage and water regimes.
- To model soil water extraction pattern in soybean – chickpea cropping systems under different tillage and water regimes.

Investigators:

PI: Dr. N. K. Sinha

CO-PIs: Dr. M. Mohanty, Dr. K. M. Hati, Dr. R. Saha, Dr. J. Somsundaram and Dr. I. Rashmi.

Date of Start: June 2011

Date of Completion: June 2014

Progress report to IRC (Dec, 2011):

The project was initiated with sowing of two cultivars of soybean (cv JS 335 and JS 9305) during *kharif* season of 2011 under the conventional and No-tillage. Soil, plant and root sample at different vegetative and reproductive stage has been taken, and processed. Analysis of root and soil is completed, and plant sample is being analyzed. The result showed that root length distribution across different diameter classes shift to lower diameter classes. Maximum root length density (RLD) was observed at flowering stage (R1) for both the cultivar under both the tillage. Long duration cultivar (JS335) is having higher RLD compare to shorter duration cultivar (JS9305); it is because that RLD is the function of vegetative growth, so that a variety having longer vegetation will have higher RLD. An exponential model was also used to get the profile distribution of RLD.

Comment of the House:

The progress was satisfactory.

19. Assessing impact of climate change on different cropping systems in Central India and evaluating adaptation studies through crop simulation models.

Objectives:

- To calibrate and validate crop growth simulation models for dominant crops of central India.
- To predict the yield of different crops and cropping systems in central India.
- To evaluate the performance of different cropping systems under various climate change scenarios.
- To explore the possibilities of employing different adaptation strategies to alleviate the climate change impacts on performance of different cropping systems.

Investigators:

PI: Dr. M. Mohanty

CO-PIs: Dr. K. M. Hati, Dr. N. K. Sinha, Dr. S. Lenka, Dr. K. S. Reddy, Dr. Pramod Jha, Dr. S. Neenu, Dr. R. S. Chaudhary and Dr. A. Subba Rao..

Date of Start: June 2011

Date of Completion: June 2016.

Progress report to IRC (Dec., 2011):

Comment of the House:

Progress report to IRC (Dec., 2011):

The soybean (cv JS 9560) and maize (cv K 101 and K 103) were sown during kharif season of 2011 under this project. Observations and on plant growth and development according to model requirements were collected in different vegetative and reproductive stages. The data analysis is completed. However, calibration of the APSIM, DSSAT and Crop Syst models for the crop cultivars cannot be completed at this stage due to incomplete of the weather data for this growing season. Calibration of the models will be presented in the next RAC. However, the well calibrated and validated APSIM model for soybean cultivar JS 335 was used for climate scenarios analysis under different temperature and CO_2 concentration. The increase in temperature reduced the grain yield of soybean while increase in CO_2 concentration increased on soybean yield as predicted by the model. The changes in soybean yield under different GCM models scenarios were also predicted.

Comment of the House:

The progress was satisfactory.

Programme III: Soil Qualities for Sustainable Productivity

20. Project Title: Quality assessment of crops under different nutrient management systems in long-term experiment

Objectives:

1. To evaluate the nutritional quality of seed/grain of soybean, wheat and chickpea crops grown under different nutrient management systems and
2. To estimate the accumulation of anti-nutritional constituents in seeds/grains under different management systems in long term experiments of the Institute.

Investigators:

PI: Dr. A.B. Singh

CO-PIs: Dr**.** P. Ramesh, Dr. Muneshwar Singh, Dr. A. K. Tripathi and Dr. A Subba Rao

Date of Start: May 2008

Date of Completion: May 2013

Progress report to IRC (November, 2008)

In the on-going experiment, we assessed the nutritional quality constituents of wheat and chickpea crops grown under different nutrient management practices. Quality constituents (protein, minerals, tryptophan, methionine, cysteine and NPN contents and mineral elements (NPK, Cu, Fe, Mn and Zn) in wheat and chickpea grain have been analyzed. It has been observed from the data that the highest total minerals (1.77%), protein 12.24%) and tryptophan contents (1.58 g/16gN) were recorded with the application of 100% NPK + FYM. Similarly, highest methionine (1.68 g/16gN), cysteine contents (1.66 g/16gN) were recorded in 100% NPK + S application in LTFE Jabalpur Centre. The lowest value in respect of these constituents was recorded in control. The analysis of other nutritionally important constituents (carbohydrate, sugar, chemical score value of sulphur containing amino-acids and wheat protein fractions) and anti-nutritional constituents (total phenol and nitrate content) in wheat and chickpea grains is in progress. The samples of soybean seeds from organic farming experiment, Jabalpur and Ranchi LTFE Centres have been received and are being analysed for nutritional and anti-nutritional quality parameters.

Comment of the House:

Progress was satisfactory. Since the PI is associated with network project on organic farming and LTE on INM, he was advised not to include the results of these projects under this project and make comparative studies on quality attributes of the crops grown under AICRP-LTFE centres only.

Progress report to IRC (June, 2009):

In the on-going experiment, we assessed the nutritional quality constituents of wheat, chickpea and soybean crops grown under different nutrient management practices. Quality constituents (protein, tryptophan, mehtionine, cysteine, carbohydrates and mineral contents (total minerals, NPK, Cu, Fe, Mn and Zn) in wheat, chick pea and soybean grains have been analyzed. Anti-nutritional constituents viz; NPN, total phenol and nitrate content in seed/ grains of wheat, chickpea and soybean have also been analysed. It has been observed from the data that the highest minerals, protein and tryptophan contents were recorded with the application of 100% NPK + FYM. Similarly, highest methionine and cysteine contents were recorded in 100% NPK + S application at LTFE Jabalpur Centre. The lowest value in respect of these constituents was recorded in control. The analysis of different protein fractions in wheat grains is in progress. The

wheat grain samples from Jabalpur and Ranchi LTFE Centres will be analysed for nutritional and anti-nutritional constituents for second year of the experiment.

Comment of the House:
The progress was satisfactory. The PI was asked to analyze soil sulphur content of the experimental soils.

Progress report to IRC (November, 2009):
Wheat grain samples from long term fertilizer experiments (LTFE) at Jabalpur and Ranchi centers were collected and analysed for various chemical and biochemical constituents of nutritional significance. Biochemical constituents such as protein, true protein, amino-acids, mineral and mineral elements have been analysed in wheat grains of LTFE Jabalpur and Ranchi Centres. These constituents were recorded highest with the application of balance fertilization compared to other nutrient treatments and control. Different protein fractions and chemical score values of amino- acids were also recorded highest under balance fertilization treatment compared to imbalanced use of nutrient. On the basis of the results obtained in the study, it can be concluded that balanced application of nutrient not only resulted in improvement in mineral contents in grains but also improve the different protein fractions, amino-acids contents and its chemical score value. The analysis of other constituents (carbohydrates, total phenol and lysine content in wheat grains is in progress. Soybean seed samples from Jabalpur and Ranchi LTFE Centres will be collected for the analysis of nutritional and anti-nutritional constituents for second year of the experiment.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010):
Soybean seeds from LTFE Jabalpur and Ranchi centres were collected and analyzed for nutritional quality parameters of the seed. It was observed from the study that the 100-seed weight was recorded highest with the application of 100% NPK + FYM compared to other treatments and was the lowest in control. Moisture, carbohydrates and oil percentage in soybean seeds did not vary significantly due to different nutrient treatments but the higher values of above mentioned parameters were recorded in all the nutrient treatments compared to control. Similar results were also recorded in Ranchi LTFE centre. Higher values of S-containing amino-acids (methionine and cysteine) and tryptophan contents in soybean were recorded due to different nutrient treatments compared to control in both the LTFE soybean samples. Analysis of antinutritional constituents in soybean is in progress. Wheat grain samples from LTFE Jabalpur and Ranchi centres for the year 2009-2010 crops will be collected for nutritional quality parameters analysis.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
Wheat grain samples from long-term fertilizer experiments at Jabalpur and Ranchi centres were collected for the year 2010-11 and analyzed for nutritional and anti-nutritional constitutes in the grains. It was observed that the 100-grain weight and moisture content was recorded highest with the application of 100% NPK + FYM followed by 150% NPK and 100% NPK and the lowest in control. Protein, true protein, minerals and amino-acid content in the wheat grain did not vary

significantly due to different nutrient treatments but the higher values of above mentioned parameters were recorded in all the nutrient treatments compared to control. Similar results were also recorded in Ranchi LTFE centre. Tryptophan content (g/16gN) varied significantly in wheat grain due to different nutrient treatments compared to control. Similarly, micronutrient (Fe, Mn, Zn and Cu) contents were also recorded higher in all the nutrient treatments compared to control in both the LTFE wheat grain samples. Total phenol and nitrate content in grain did not vary significantly due to different nutrient treatments. Analysis of chemical score value of amino-acids, amino-acid and carbohydrate content in wheat grain is in progress. Soybean seed samples from LTFE Jabalpur and Ranchi centres will be collected for the analysis of nutritional quality constituents.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Collected soybean seeds samples from LTFE Jabalpur and Ranchi centers have been analyzed for nutritional and anti-nutritional quality parameters. The results indicated that the 100-seed weight (g) was increased significantly with the application of different nutrient treatments. The highest 100-seed wt was recorded with the application of 100% NPK + FYM compared to other treatments and the lowest in control. Oil, total minerals and protein content in soybean seeds did not vary significantly among different nutrient treatments but compared to control, the higher values of above mentioned parameters were recorded in all the nutrient treatments. Tryptophan amino-acid content in soybean seed was also recorded higher due to different nutrient treatments compared to control in both the LTFE soybean samples. The NPK, Zn and Cu content in soybean seed was found to be non-significant but the highest NPK, Zn and Cu content were recorded in 100% NPK along with FYM application compared to other nutrient treatments. Anti-nutritional constituents such NPN and total phenol content in soybean seed did not vary significantly with the application of different nutrient treatments. Wheat grain samples from LTFE Jabalpur and Ranchi centres for the year 2010-11 crops have been collected for nutritional and anti-nutritional quality parameters analysis.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):
Wheat grain samples collected from LTFE at Jabalpur and Ranchi centres were analyzed for nutritional and anti-nutritional constitutes. It was observed that the 100-grain weight and moisture content was recorded highest with the application of 100% NPK+ FYM followed by 150% NPK and 100% NPK and the lowest in control. Protein and minerals content in the wheat grain did not vary significantly due to different nutrient treatments but the higher values of above mentioned parameters were recorded in all the nutrient treatments as compared to the control. These constituents were recorded highest with the application of balanced fertilization as compared to other nutrient treatments and control. Different protein fractions and chemical score values of amino acids were also recorded highest under balanced fertilization treatment as compared to imbalanced use of nutrients. Similar results followed for Ranchi LTFE centre. Similarly, micronutrient (Fe, Mn, Zn and Cu) contents were also recorded higher in all the nutrient treatments as compared to control in both the LTFE wheat grain samples. Total phenol and nitrate content in grain did not vary significantly due to different nutrient treatments.

Soybean seed samples for the year 2011 from LTFE Jabalpur and Ranchi centres will be collected for the analysis of nutritional quality constituents.

Comment of the House:
The progress was satisfactory.

21. Project Title: On farm Production and evaluation of vermi-compost and enriched compost

Objectives:

1. To assess various methods of preparation of vermin-compost and enriched compost in farmer field situations using local resources.
2. To assess the quality of the composts in terms of physical, chemical and biological parameters.
3. To work out the economic of production and use of the various composts under different cropping systems.

Investigators:

PI: Dr. A. K. Tripathi
CO-PIs: Dr**.** M.C. Manna, Dr. A.B. Singh, Dr. Ranjit Kumar

Date of Start: May 2008

Date of Completion: May 2010

Progress report to IRC (November, 2008):

Farmers, on whose farms work to be carried out, have been selected from the villages of Parwalia, Misrod and Jatakhedi. Crop residues for the preparation of Vermicompost and compost has been procured. Jhabua Rock Phosphate from Jhabua (M.P.) to be procured in the month of Dec. 2008. The prepration of Vermicompost and compost on the farmer's field will start from the month of Feb. 2009, which will be applied in Kharif soybean.

Comment of the House:

Progress was not so satisfactory and the PI was advised to make sincere efforts to carry forward his project work. The rock phosphate, to be procured from Jhabua should be analysed for P content prior to use for composting and vermi-composting. He should also make proper records of the chemical composition of the residues before and after composting.

Progress report to IRC (June, 2009):

Rock phosphate from Meghnagar (Jhabua) has been transported to our institute and distributed to the farmers as per their requirement. Two farmers each from the Misrod and Parwalia villages have been finally selected for the experimentation. Preparation of phosphocompost and vermicompot have been started on the farmers' fields itself. Composts so prepared will be applied in the kharif season crop. i.e. soybean. The big farmers those who are having resources are not showing interest and small farmers facing the problem of resources. Shortage of water in the villages it self. Small farmers also not having crop residues for compost preparation.

Comment of the House:

The progress was satisfactory and PI was asked to make complete analysis of the pre and post compost materials so as to indicate the benefit of composting.

Progress report to IRC (November, 2009):

Soil samples collected from both the villages before sowing of the soybean crop have been analyzed for various physico-chemical properties. Soil samples from Misrod villages are rich in available nutrients status compared to Parwalia village. Vermicompost and enriched compost

prepared on the farmer's field have been analysed for various physical, chemical & biological properties. Based on the phosphate contents in the vermicompost and enriched compost imposition of treatment were done in soybean crop. Soybean crop was sown in the month of July and harvested in the month of October. Soil samples have been collected after harvest of the crop for further chemical analysis. Analyses of seed yield data are in progress. Wheat crop has been sown after harvesting of soybean.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2010):

Seed yield of soybean at different farmer's field varied significantly among various treatments. Highest seed yield of soybean was recorded with vermicompost treatment followed by enriched compost, farmer's practice and 100% NPK treatments at all the farmer's field. Straw yield of soybean followed the similar trend. Wheat was grown on the same plots after harvest of soybean with 100% recommended dose of fertilizers. Seed yield of wheat did not vary significantly between vermicompost and enriched compost treatments but it did vary significantly between farmer's practice and 100% NPK treatment. The lowest seed yield of wheat was recorded with 100% NPK treatment compared to all other treatments. Straw yield of wheat followed the similar trend as that of grain yield. Preparation of vermicompost and enriched compost at the farmer's fields are in progress and is near to completion. The compost so prepared will be applied in the coming soybean crop.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January, 2011):

Vermi-compost, enriched compost and conventional compost prepared on the farmer's field have been analyzed for various physical, chemical & biological properties. Based on the phosphate contents in the vermin-compost and enriched compost imposition of treatment were done in soybean crop. Soybean crop was sown in the month of July and harvested in the month of October. Soil samples have been collected after harvest of the crop for further chemical analysis. Seed yield of soybean at different farmer's field varied significantly among various treatments. Highest seed yield of soybean was recorded with vermin-compost treatment followed by enriched compost, farmer's practice and 100% NPK treatments at all the farmer's field. Straw yield of soybean followed the similar trend. Wheat was grown on the same plots after harvest of soybean with 100% recommended dose of fertilizers.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

Wheat crop was grown on the same plots wherein compost treatments were applied after harvest of soybean crop with 100% recommended dose of fertilizers. Grain yield of wheat did not vary significantly among different treatments but the grain yield of wheat in the enriched compost and vermicompost treated plots were significantly higher compared to farmer's practice and 100% NPK treated plots. Straw yield of wheat followed the similar trend as that of grain yield. Soil samples were collected after two years of cropping were analysed for different physico-chemical properties. On perusal of data very less variation was observed on these physico-chemical properties.

Comment of the House:
The progress was satisfactory. The house recommended that the PI may re check the statistical analysis of his yield data. The field experiment should be continued for one more cycle of soybean wheat rotation.

Progress report to IRC (Dec., 2011):

Vermicompost, enriched compost and conventional compost prepared on the farmers' fields have been analyzed for various physical, chemical & biological properties. Based on the phosphate contents in the vermicompost and enriched compost imposition of treatment were done in soybean crop. Soybean crop was sown in the month of July and harvested in the month of October. Soil samples have been collected after harvest of the crop for further chemical analysis. The seed yield of soybean this year is quite low in Misrod village compared to Parwalia Village due to stagnation of water in standing crop. However, Seed yield of soybean at different farmer's field varied significantly among various treatments. Highest seed yield of soybean was recorded with vermicompost treatment followed by enriched compost, farmer's practice and 100% NPK treatments at all the farmer's field. Straw yield of soybean followed the similar trend. Wheat was grown on the same plots after harvest of soybean with 100% recommended dose of fertilizers.

Comment of the House:
The progress was satisfactory.

22. Project Title: Structural and functional diversity of microbes in soil and rhizosphere.

Objectives:

1. Soil types
2. Crops and cropping systems
3. Agricultural practices (fertilizer, water management, pesticides)
4. Root Exudates and their influence on rhizospheric microbial community structure.

Investigators:

PI: Dr. Santosh R. Mohanty

CO-PIs: Dr. M. C. Manna and Dr. Muneshwar Singh

Date of Start: January 2010

Date of Completion: January 2012 (4 years)

IRC Comments:

Planning for selection of the study area and methodology to be adapted have been finalized.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January, 2011):

Greenhouse gas methane (CH_4) production and oxidation reflecting microbial activity to regulate global climate change in long term fertilizer experiment (LTFE) sites were investigated. Soils from Pantnagar and Ranchi were incubated under flooded and 60% MHC conditions to stimulate methanogenic and methane oxidizing microbial metabolic processes. CH_4 regulating microbes were differentially influenced by the soil factors as well the fertilizer components. Both soils exhibited similar CH_4 production potential while varied in CH_4 oxidizing activity. Rate of CH_4 oxidation (k) was higher in Pantnagar than Ranchi soil. Fertilizer input like N alone stimulated CH_4 production while applied along with P and K alleviated this process. CH_4 oxidation activity in Pantnagar soil stimulated by P and K application than that of only N. Results revealed the differentially effect of N, P, K fertilizers on methane production and oxidation in tropical soils under long term application process.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

Application of NIRS technology for assessing soil quality and predicting microbial responses offers a rapid mechanism to acquire biogeochemical information in terrestrial ecosystem. Here we report application of NIRS to predict the CH4 oxidation potential in a range of tropical soils varying widely in the physico-chemical properties. Soils from three agro-ecological regions (Bhopal, Pantnagar, and Ranchi) were collected and NIRS spectra were obtained. CH4 oxidation potential were measured using the gas chromatography by laboratory incubation method. Methane oxidation potential of the Ranchi, Pantnagar, and Bhopal varied significantly at 60% MHC. Rate of CH4 oxidation in vertisols was about 2.2 ug/g soil while that of Pantnagar and Ranchi soil exhibited about 1.5 and 0.04 ug/g soil. Using partial least square (PLS) global calibration NIRS spectrums were modeled and could differentiate the CH4 oxidation activities among the three different soils. However the CH4 oxidizing activities in different treatments of each soil were not significantly correlated with that of the GC estimated values. Therefore PLS local calibration will be carried out along with the existing PLS global prediction model.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Methanogenesis (CH_4 cycling) in vertisols was explored in vertisol under organic, inorganic and integrated fertilizer management studied. Population dynamics of methanotrophs, nitrifiers were estimated by culture dependent techniques. Experiment provided explicit information on the CH_4 cycling process under different fertilizer management practices. CH_4 oxidation was higher in organic amended soil followed by integrated and inorganic treatments. Methanotrophs i.e methane oxidizing bacterial population, ammonium oxidizers were higher in organic fertilized soil and were correlated to the CH_4 oxidation potential. Methanotrophs possessing both particulate and soulable methane monooxygeanses are responsible for atmospheric CH_4 oxidation and were stimulated by C sources. The inherent soil C are doesn't play any role in methanotrophs population dynamics as they use CH_4-C as C source, therefore further experiments needed to verify the role of soil C on this microbial groups. In addition to C (CH_4) cycling in vertisol, experiment conducted to predict microbial mediated CH_4 oxidation in soil Near Infrared Reflectance Spectrophotometer (NIR) was used for first time. Methanotrophic activity in vertisol were estimated by incubation method followed by GC analysis. CH_4 oxidation potential was calibrated with the NIR spectrum of vertisolscollected from various agricultural fields located at the IISS campus. With the help of multifactorial principal component (PCA) and regression analysis (Local and Global) predicted and estimated values were evaluated.

Comment of the House:
The progress was satisfactory.

23. Project Title: Consequences of transgenic crops on soil health.

Objectives:

1. To assess the cultural and functional diversity of soil beneficial microorganisms under Bt and non-Bt cotton.
2. To assess the soil beneficial microorganisms such as Nitrogen fixers, P solubulisers, Cellulose decomposers under Bt and non-Bt cotton.
3. To quantify microbial processes like soil respiration, N-mineralization, microbial C, N, P and soil lipids and glomalin content under Bt and non-Bt cotton.

Investigators:

PI: Dr. Asit Mandal.
CO-PIs: Dr. J. K. Thakur, Dr.. Asha Sahu, Dr. M. C. Manna, Dr. D. L. N. Rao and Dr. A. Subba Rao

Date of Start: March 2011
Date of Completion: March 2014
Progress report to IRC (June, 2011):
I have initiated my project program with made a contact with Director, CICR and one extension personnel and one microbiologist. I have gone for survey of Bt-cotton growing areas of Nagpur. I went for survey at Bouruzwada village and interaction with the farmers collected some information (questionnaires) about their Bt-cotton cultivation package of practices and their problems at Nagpur district throughout the survey program. We have collected also soil samples from their respective fields of Bt cotton areas and non Bt-cotton areas for initial biological analysis. The details of the same will be presented in the coming IRC.

Comment of the House:
The progress was satisfactory. The house suggested that soil sampling should also be done from the farm of CICR Nagpur under long term cultivation of Bt and non Bt cotton.

Progress report to IRC (Dec., 2011):

Rhizospheres soil sample was collected in the month of July, 2011 from bt and non-bt cotton from CICR as well as from farmers field. Soil samples processed in the laboratory and kept for 4^0C for biological analysis. The rhizosphere soil samples of bt and non bt cotton were analyzed for soil microbial biomass carbon and soil respiration. The same soil also studied for enzymatic activities soil dehydrogenase, acid and alkaline phosphatase and FDA. The samples also studied for microbial counts like total heterotroph, bacterial, fungal and actinomycetes counts using media by serial dilution technique. Total heterotrohic population was also done using Nutrient agar media. Isolation of Phosphate Solubilizing bacteria was carried out using Pikovaskaya's medium (1948).
Comment of the House:
The progress was satisfactory.

24. Project Title: Actinomycetes diversity in Daccan plateau, hot, arid region and semi arid eco-sub-region (AER 3 and 6) and evaluation of their PGPR activity.

Objectives:

1. To characterized the culturable diversity of actinomycetes in the rhizosphere of dry land crops (Sorghum, Pearl millet, Pigeon pea, Finger millet, Groundnut).
2. To identify the promising isolates with growth promoting and bio-control ability.
3. To evaluate the effect of inoculation of efficient actionmycete isolates on growth and yield of selected crops.

Investigators:

PI: Dr. Radha T.K.
CO-PIs: Dr. D. L. N. Rao

Date of Start: August 2010
Date of Completion: August 2013

Progress report to IRC (June, 2011):

Collected 9 soil samples from rhizosphere of different dryland crops like Sorghum, Pearl millet, Pigeon pea, Finger millet, Groundnut (at Koundal, Hubli, Honaganahalli, Honaganahalli Railway gate, Tumkur in Karnataka; Anantpur in Andhra Pradesh and Jaisalmer, Rajasthan) and 2 soil samples from pristine forested sites in Karnataka (Kegdal, Vibuthi). Soil samples were air dried and used. Four different media were used for isolation of actinomycetes like actinomycetes isolation agar, starch casein agar, arginine glycerol salts medium and humic acid vitamin agar. Among all the media used, Humic acid vitamin agar was found better for enumeration of actinomycetes and gave about 2.5 times higher counts than other standard media like actinomycetes isolation agar and starch casein agar. More than 100 isolates have been purified by repeatedly streaking on fresh media containing actidione antibiotic (50 µg/ml) and preserved in yeast extract malt extract agar. Purified actinomycetes were further screened based on morphology and selected about 17 isolates from actinomycetes isolation agar, about 11 isolates from starch casein agar, 17 isolates from arginine glycerol salts medium, and 5 isolates from humic acid vitamin agar. Totally 50 isolates were selected for gram staining, acid fast staining, biochemical characterization and to screen for beneficial traits. Among all the isolates one isolate was showing polysaccharide production on starch casein agar was observed.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Forty one isolates of actinomycetes were short-listed from the isolates (100 no.) made earlier on four different media. Morphological characterization was done by light microscopy. Highest proportion of the isolates belonged to the genus *Streptomyces* (61%), followed by *Nocarida* (29%) while the rest 10 % isolates belonged to *Micromonospora* and *Saccharopolyspora.* In screen house experiments in paper cups using maize as test crop, of the 41 isolates, 8 were highly effective (> 35% increase in plant DW), 10 strains were moderately effective (25-35%), 9 strains were effective (15-25%) and 14 strains were in effective (<15%. Biochemical characterization of the isolates and screening against chickpea is in progress

Comment of the House:

The progress was satisfactory.

25. Project Title: Developing technique for acceleration of decomposition process using thermophilic organisms.

Objectives:

- Isolation and identification of thermo-philic bacteria, fungi and actinomycetes.
- Evaluation of selected thermo-philic decomposers in municipal solid waste and agricultural waste compost at different stages of decomposition.
- Evaluation of physico-chemical properties of compost and economics of composting.
- Develop an appropriate technique/protocol to enhance the decomposition process mediated by microbes and its possible application in agriculture.

Investigators:

PI: Dr. Asha Sahu

CO-PIs: Dr**.** J. K. Thakur, Dr. Vinod Kumar Bhargav (CIAE), Dr. H. L. Kushwah (CIAE), Dr. Asit Mandal, Dr. M. C. Manna and Dr. A. Subba Rao

Date of Start: June 2011

Date of Completion: June 2014.

Progress report to IRC (December 2011):

Progress report to IRC (Dec., 2011):

To accelerate the process of recycling of agricultural and city waste, the efficient microbial inoculation during decomposition (thermophilic) is of prime importance during composting process. For that different wastes from rural and city wastes have been collected for isolation and identification of fungi, Bacteria and actinomycetes. To examine the isolated organisms wastes were kept at temperature more than 50^0 C in BOD. The work is in progress

Comment of the House:

The progress was satisfactory.

26. Project Title: Chemical and Microbiological Evaluation of Biodynamic and Organic preparation.

Objectives:

- To assess the microbiological and chemical properties of different biodynamic products available.
- To evaluate the biodynamic formulation for its PGPR activities *in vitro* and *in vivo.*

Investigators:

PI: Dr. J. K. Thakur.
CO-PIs: Dr**.** Asha Sahu, Dr. Asit Mandal and Dr. A. B. Singh.

Date of Start: June 2011.
Date of Completion: June 2013.
Progress report to IRC (December 2011):

Progress report to IRC (Dec., 2011):

The project has been initiated with microbiological analysis of panchagavya. Total viable microbial count was estimated for bacteria, fungi, actinomycetes, aerobic nitrogen fixers and pseudomonads. Purified bacterial isolates from panchagavya were studied for their PGPR activities *viz.*, P solubilization, IAA production, ammonia production, HCN production, Antifungal activites *etc.* These isolates are preserved for further study. Seed germination test was also conducted with undiluted Panchagavya. Total microbial count from BD500 is also completed. The isolates are being purified for studying their PGPR activities.

Comment of the House:
The progress was satisfactory.

27. Project Title: Developing database on extent of soil and water contamination in India.

Objectives:

1. Collection of secondary information related to extent of soil and water pollution in India with special reference to pollutant element.
2. Identify the hotspots and highlighting the environmental problems with special reference to agriculture
3. To make user friendly information system for access of data on extent of soil and water contamination

Investigators:

PI: Dr. J.K. Saha
CO-PIs: Dr. Tapan Adhikari , Dr. S. Ramana, Dr. A.K. Biswas, Dr. S. Srivastava, Dr. S. Kundu and M.L. Dotaniya

Date of Start: April 2008
Date of Completion: 31 March 2012

Progress report to IRC (November, 2008):

During the period under report, the major industrial locations in different parts of India were compiled in the form of Maps (Macromedia), depicting the major industrial areas. Secondary information regarding some major industrial location where pollution is a major problem was also collected and compiled. A geo-referenced survey was undertaken during the period from Korba (Chhattisgarh) and Pithampur, Dhar (Madhya Pradesh) industrial areas. The collected soil and effluents/water samples were analyzed for some metals and the result showed that there is a problem of Cr and Na toxicity in soil as well as effluent due to disposal of waste (solid/liquid) materials from existing industries in surrounding areas.

Comment of the House:

The collected and compiled information is very interesting. Progress was satisfactory.

Progress report to IRC (June, 2009):

During the period under report, the major industrial locations in different parts of India were compiled in the form of Maps (Macromedia), depicting the major industrial areas. Secondary information regarding some major industrial location where waste water is a major problem was also collected and compiled (Punjab). A geo-referenced survey was undertaken during the period from Upper Lake, Lower Lake and Shahapura Lake, Bhopal. The collected water samples were analyzed for some metals and the result showed that this water is not suitable for drinking because of high concentration of Fe, Mn and Pb in waters at selected points. The water of these points is not suitable for pisciculture (bottom feeder fishes).

Comment of the House:

The progress was satisfactory. The PI was asked to indicate possible areas of heavy metal contaminations and project some researchable issues from case studies.

Progress report to IRC (November, 2009):

A geo-referenced survey was undertaken during the period from Patancheru Industrial Area, Medak district and Musi River, Hyderabad. Soil, effluent, sewage and groundwater samples were collected from various villages (07) where industrial sewage water is used for irrigation i.e. Pattancheru, Isnapur, Mutangi, Bachiguda, Chitkul, Ismailgandpet and Narsapura. This sewage/effluents nallas from study area forms a stream namely Peddavagu which ultimately joins Nakkavagu stream, a tributary of the Manjira River. Sewage water and sediment samples from Musi river from its starting point to end point in Hyderabad i.e. Osmansagar, Balajinagar, Ramdevguda, Bapu Ghat, Karwan, City college, Salarjung Museum, Chadarghat, Old bus stand, Mushrabagh bridge and Uppal were also collected.

The collected water samples were analyzed and the result showed that this water is of neutral to alkaline/basic in nature except few samples. pH does not show significant positive correlation with any trace element in surface and groundwater, while it shows negative correlation with Fe, Pb and Zn in surface water and Mn in groundwater. It was observed that there are some high values of Fe, Mn, Pb and Zn due to point and non-point sources, which may be attributed to the industrial and agricultural activities. During the period under report, the major industrial locations in different parts of India were compiled in the form of Maps (Macromedia), depicting the major industrial areas. Secondary information regarding some major industrial location where waste water is a major problem was also collected and compiled.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2010):

A geo-referenced survey was undertaken during the period from Pali Marwar Industrial Area and near Bandi and Luni River, Pali district and Udaipur Industrial Area, Udaipur. Soil, effluent, sewage and groundwater samples were collected from various villages (10) where industrial sewage water is used for irrigation i.e., Mandia, Javadia, Kerla, Gadhwara, Phekaria, Sukarlai and Nehada in down stream of Bandi river and Hemavas, Iycea and Sonai Maji in upstream of Bandi river, Pali. These sewage/effluents from Pali industrial area is directly coming to Bandi river which is a tributary of Luni river. Soil, effluent, sewage and groundwater samples were also collected from Udaipur industrial area where industrial sewage water or ground water is used for irrigation i.e. Debari hejlai, Gorla, Bichhri, Gadwa, Sihala, Dabok, Ordi, Nandwel and Toos Dangi villages. In these villages the underground water is also polluted due to effluents from Hindustan Zinc Ltd., Rose Zinc Ltd. and other ancillary industries of HZL, Udaipur. The collected water samples were analyzed and the result showed that the underground near Bandi river (Pali Marwar) is highly saline in nature. The soils became saline where this water is used for irrigation. It was also observed that in some villages the groundwater is having high values of Cu, Pb, As, Cr and Zn due to point and non-point sources, which may be attributed to the industrial and agricultural activities. While in Udaipur the concentration of heavy metals is higher in well waters as well as in effluent irrigated soils nearer to the discharge point (Gorla and Bichhari village) while the concentration of these heavy metals decreased with the distance from the effluent discharge point increases. Secondary information regarding some major industrial location where waste water is a major problem was also collected and compiled. During the period under report, the major industrial locations in different parts of India were compiled in the form of Maps (Macromedia), depicting the major industrial areas.

Comment of the House:

The progress was satisfactory and the PI was asked to prepare a bulletin based on the information generated before the ISSS convention.

Progress report to IRC (January, 2011):

A geo-referenced survey was undertaken during the period from Tiruppur Industrial Area and near Nayyal River, Tirrpur district, Coimbatore Industrial area and Coca-cola Plant, Palachimada, Pallakad. Soil, effluent, sewage and groundwater samples were collected from various villages (10) where industrial sewage water is used for irrigation *i.e.*, Santhapuram, Nallure, Kangayam, Thottipalayam, Anaipallayam, Thangaman Koil and Orathupallayam in down stream of Noyyal river and Ammapallayam, Virapandi in upstream of Noyyale river, Tiruppur. These sewage/effluents from Tirrupur industrial area is directly coming to Noyyale river which is a tributary of Cauveri river. Soil, effluent, sewage and groundwater samples were also collected from Coimbatore industrial area where industrial sewage water or ground water is used for irrigation *i.e*. Thelumgupallayam, Selvapuram, Karapudur, Thillaipalayam and Reddypalayam villages.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

In the pursuit of creating database, information generated by CPCB was analyzed for identifying critically polluted industrial clusters of the country. Based on available information, CPCB computed comprehensive environmental pollution index (CEPI) for 88 industrial areas of the country. CEPI was calculated for land pollution, air pollution and water pollution. On the basis of CEPI values, different industrial clusters were ranked for severity of pollution. The top 20 highly polluted industrial clusters, identified according the decreasing order of severity, were Ankleshwar (Gujarat), Vapi (Gujarat), Ghaziabad (Uttar Pradesh), Chandrapur (Maharashtra), Korba (Chhatisgarh), Bhiwadi (Rajasthan), Angul Talcher (Orissa), Vellore (North Arcot) (Tamilnadu), Singrauli (Uttar Pradesh), Ludhiana (Punjab), Nazafgarh drain basin, Delhi, Noida (Uttar Pradesh), (Jharkhand), Dombivalli (Maharashtra), Kanpur (Uttar Pradesh), Cuddalore (Tamilnadu), Aurangabad (Maharashtra), Faridabad (Haryana), Agra (Uttar Pradesh), Manali (Tamilnadu). Presence of carcinogenic toxins in land and groundwater and scale of industrial activities were higher Ankleshwar, Ghaziabad and Ludhiana. Pollutant concentration in land and groundwater as well as their adverse impact on people and eco-geological features were reported high in Ankleshwar, Vapi, Delhi and Dhanbad. Number of people potentially affected within 2 km boundary from the pollution source and level of exposure were reported high in Korba, Vapi, Angul Talcher, and Chandrapur.

Comment of the House:

The progress was satisfactory. The house recommended that Dr. Dotania may be included in this project.

Progress report to IRC (Dec., 2011):

Comment of the House:

The progress was satisfactory.

28. Project Title: Phytoextraction of chromium by some floriculture plants

Objectives:

1. To screen some floriculture plant species for Cr accumulation
2. To understand the physiological and biochemical mechanisms of Cr accumulation and tolerance

Investigators:

PI: Dr. S. Ramana
CO-PIs: Dr A. K. Biswas, Dr. A. B. Singh, Dr. Ajay

Date of Start: June, 2009 (4 years)
Date of Completion: June, 2013
Comment of the House: New Project

Progress report to IRC (November, 2009):

A pot culture experiment was conducted in kharif season in the screen house to screen some floriculture plant species (Tuberose, Gladiolus, Marigold, Chrysanthemum, Dahlia, Aster, Calendula, Sunflower, Rose and Nerium) for their tolerance to different levels of Cr (0,5,10,25,50,100and 200 ppm). Beyond 25 ppm, chromium was highly toxic to all the plant species except varieties some of tuberose and gladiolus. In tuberose the emergence of the plants was not affected by the application of chromium up to 10 ppm. But the emergence was delayed by 10 days in 25 ppm and by 30 - 40 days beyond 50 ppm. Similarly, the emergence was also delayed by one week in gladiolus at higher concentrations.

The photosynthesis of tuberose was determined in all the three tuberose varieties. The photosynthesis rate declined with increase in the level of chromium. The soil was analyzed for initial DTPA extractable Chromium, pH, dehyrogenase activity, alkaline phosphatase activity and soil respiration. The pH was not affected by the chromium but there was a slight increase in EC. The activity of dehydrogenase, alkaline phosphatase and soil respiration decreased with the applied chromium. The work progressing well in the right direction.

Comment of the House:

The progress was very good.

Progress report to IRC (June, 2010):

Comment of the House:

PI was absent as was on deputation for training in Australia.

Progress report to IRC (January, 2011):

The experiment was conducted in the screen house to screen some floriculture plant species(Tuberose, Xenia, Navaranga, Gladiolus, Marigold, Chrysanthemum, Dahlia, Aster, Calendula and Sunflower) for their tolerance to different levels of Cr (0,5,10,25,50,100and 200 ppm). The plants were harvested at flowering stage and analyzed the Cr content in different plant parts. The data revealed that among the different plant parts, the highest concentration of Cr was found in roots followed by shoots and the lowest in flowers. Among the different plant species, the highest concentration was found in Xenia and was followed by navaranga, sunflower, marigold, chrysanthemum, aster, calendula and dahlia. In tuberose, beyond 50 ppm, the

application of chromium inhibited flowering. Among the different varieties of tuberose, highest concentration of Cr was found in Prjwal and in the remaining two varieties, the concentration was more or less similar. As advised by RAC, an experiment on two fibre crops i.e. mestha and frakaria is under progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
In the previous year, the pot culture experiment was conducted in the screen house to screen some floriculture plant species(Tuberose, Gladiolus, Marigold, Chrysanthemum, Dahlia, Aster, Calendula, Sunflower, Rose and Nerium) for their tolerance to different levels of Cr (0,5,10,25,50,100and 200 ppm). The growth of the plants was satisfactory up to 10 ppm and beyond that level i.e, 25 ppm, chromium was highly toxic to all the plant species except varieties some of tuberose and gladiolus. But it was not clear up to what level of Cr, the plant species will tolerate. Therefore, another experiment was conducted with different levels of Cr below 25 ppm (0,5,10,15,20, and 25 ppm) to find out the critical level.
The plant species selected were calendula, chrysanthemum, aster, dahlia, mesta. The results revealed that, there was mortality in calendula, chrysanthemum,dahlia and aster at 25 ppm. There was a drastic reduction in growth of plants. The number and size of the flowers also decreased beyond 10 ppm. In dahlia there was inhibition of flowering at 20 ppm.
In mestha, a fibre yielding crop, the plants survived up to 25 ppm. In this crop initially there was a drastic reduction in growth of the plants beyond 10 ppm but at harvest stage the plants recovered and the growth was more or less similar to that of lower levels of Cr i.e, 5 and 10 ppm. The plants have been harvested and the chemical analysis is underway.

Comment of the House:
The progress was satisfactory. The house recommended that mechanisms need to be studied.

Progress report to IRC (Dec., 2011):
An experiment was conducted to screen different floriculture plant species (calendula, chrysanthemum, aster and dahlia) for their tolerance to different levels of Cr (0,5,10,15,20, and 25 ppm). In all the four plant species, beyond 10 ppm, chromium was toxic to the plants and there was a drastic reduction in growth and of plants. In 20 and 25 ppm, there was negligible growth and mortality of the plants. In calendula, chrysanthemum and dahlia the application of chromium beyond 10 ppm inhibited flowering. The chromium content in different plant parts of calendula, chrysanthemum, dahlia, aster was determined. It was found that in all the plant species, the highest concentration o f Cr was found in the roots and was followed by shoots and flowers. Dahlia recorded the highest concentration of chromium among the plant species and calendula the least.The proline content increased upto Cr_{50} but declined at Cr_{100}. The photosynthesis rate decreased with applied Cr in both nerium and frakaria.

Comment of the House:
The progress was satisfactory. The work so far done on objective 2 may be elaborated and presented in the next IRC.

29. Project Title: Soil Resilience and its Indicators under Some Major Soil Orders of India.

Objectives:

1. To characterize the soil resilience in relation to the basic soil properties (indicators) under some major soil orders.
2. To study the effects of management practices on recovery rate of soil resilience in some major soil orders.

Investigators:

PI: Dr. Ritesh Saha

CO-PIs: Dr. K.M. Hati, Dr. Pramod Jha, Mr. M. Mohanty, Dr. Vassanda Coumar, Dr. R.S. Choudhary, Dr. A. Subba Rao and Dr. Badegaonkar (Scientist From CIAE)

Date of Start: March 2011
Date of Completion: - February 2013
Progress report to IRC (June, 2011):
Bulk soil samples from Ranchi (*Alfisol*) and from Bhopal (*Vertisol*) have been collected and the samples are under process for further laboratory analysis. Study at compaction laboratory in CIAE, Bhopal initiated and necessary arrangements made. Duly filled RPF-I has already been submitted to the competent authority. Simultaneously, on-line RPF data has been entered/updated in the ICAR Project Information and Management System (PIMS-ICAR) as per the guidelines.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):
During the period under report, soil samples from Delhi (*Inceptisol*) have been collected and the samples from major soil orders were analyzed for initial physico-chemical characterization. Soil properties varied considerably across different soil orders and locations. Results revealed that SOC is closely correlated with liquid limit (correlation coefficient, r=0.94, $P \leq 0.05$), plastic limit (r=0.97, $P \leq 0.05$) and gravimetric water contents at -33 kPa (r= 0.89, $P \leq 0.05$). The clay type and its amount along with organic matter control the soil specific surface and this subsequently determines the plastic and liquid limits. Simultaneously, an incubation study was carried out ascribed the recovery rate of *Vertisol* under various doses of fully decomposed FYM application after applying Cu stress. Study suggests that Cu stress significantly (17.98- 29.30%) reduced the soil microbial biomass C (SMBC) as compared to untreated soils. After 2^{nd} weeks of incubation study, the SMBC ranged from 169.69 to 259.61 µg/g of soil under Cu stress and 240.00 to 384.05 µg/g of soil under untreated soil. Among the various FYM treatments, the percent reduction in SMBC due to Cu stress fluctuated from 7.38 to 17.36%. The study is still under progress.

Comment of the House:
The progress was satisfactory.

30. Project Title: Non point sources of phosphorus loading to upper lake, Bhopal.

Objectives:

a) Survey and collection of secondary data on land use patterns, cropping systems, fertilizer usage and soil types of catchments area of upper lake.

b) To asses the relative magnitude of non point source of phosphorous loading to upper lake.

Investigators:

PI: Dr. M. Vassanda Coumar

CO-PIs: Dr. M. L. Dotaniya, Dr. J. Somasundaram, Dr. J. K. Saha, Dr. K.S. Reddy, Dr. S. Kundu.

Date of Start: April 2011

Date of Completion: March 2014

Progress report to IRC (June, 2011):

The water and sediment samples were collected from different sampling points of Upper Lake, Bhopal. The secondary data related to land use pattern, soil type and drainage pattern maps were also collected from Madhya Pradesh council of Science and Technology (MPCST). The water and sediment sample were processed and analyses for Total and Dissolved phosphorus is under progress.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Geo-referenced Sediment and Water samples from 11 sampling points for pre-monsoon stage were collected from Upper Lake, Bhopal. The pre-monsoon sediment samples were analyzed for Total P and the water samples were analyzed for different fractions of P. The results shows that the total P in the sediment of pre-monsoon stage samples ranges from 0.03% to 0.07% with a mean value of 0.04%. The total P value in the water samples ranges from 0.28 to 0.47mg/L with a mean value of 0.39mg/L. The total Dissolved P, Total Reactive P and Dissolved Reactive P ranges from 0.08 to 0.17 mg/L, 0.05 to 0.09mg/L and 0.008 to 0.04 mg/L with a mean value of 0.13, 0.08 and 0.03 mg/L, respectively. The survey for identifying sampling point of catchment area is initiated. The post monsoon samples of sediment and water were also collected from 15 sampling point from the Upper Lake, Bhopal. The post monsoon samples (water & sediment) analysis for different P fractions is in progress.

Comment of the House:

The progress was satisfactory.

31. Project Title: Soil quality assessment for enhancing crop productivity in some tribal districts of Madhya Pradesh.

Objectives:

- To assess soil quality and generation of soil quality index maps for Jhabua, Alirajpur and Dhar districts of Madhya Pradesh.
- To identify and validate promising technologies for enhancing crop productivity and farmer's income.
- To create awareness among the tribal farmers on soil quality and improved management practices for sustainable crop production.

Investigators:

PI: Dr. Rajendiran, S
CO-PIs: Dr. M. L. Dotaniya, Dr. M. Vassanda Coumar, Dr. N. K. Sinha, Dr. S. Srivastava, Dr. A. K. Tripathi, Dr. S. Kundu.

Date of Start: April 2011
Date of Completion: March 2014
Progress report to IRC (Dec., 2011):

The secondary data related to land use pattern, soil type, and general agricultural informations and block level informations were collected from District Agricultural Deportments and KVKs of Alirajpur, Dhar and Jhabua districts. Collection of soil sample from Alirajpur, Dhar and Jhabua districts was initiated.

Comment of the House:
The progress was satisfactory.

Externally funded projects

1. Project Title: Nano-Technology for Enhanced Utilization of Native Phosphorus by Plants and Higher Moisture Retention in Arid Soils

Funding agency: NAIP

Project cost: Rs 29.4 lakhs (for IISS Centre)

Objective:

1. Enhancing the utilization of native phosphorus by plants using nano-particles of Mg, Zn and Fe.
2. Enhancement of gum production for soil binding and moisture retention by microbes through nano-particle (Mn, Zn, Fe, P) stimulation
3. Synthesis and application of nano-granules of phosphorus from rock phosphate for enhancing its utilization.

Major activities:

Objective 1.

Characterization of synthetic and biologically developed nano-particles

Effect of nano-particles on nutrient use efficiency, plant metabolism and enzyme exudation

Objective 3

Removal of toxic heavy metals from rock phosphate

Assessing potential of nano-granules for its use an nano-fertilizers in selected test plants

Effect of nano-material coated fertilizers on plant growth

Investigators:

PI: Dr. Tapan Adhikari

CO-PIs: Dr**.** A.K. Biswas and Dr. S. Kundu

Date of Start: 18 July 2008

Date of Completion: 31 March 2012

Project location: Division of Environmental Soil Science

Progress report to IRC(November, 2008)

As per work schedule, recruitment of staff completed and different nano-particles (ZnO, Fe_2O_3, Cu_2O and Hydroxy apatite) were procured. Rock phosphate samples from different sites of India were collected.

Comment of the House:

Progress was satisfactory.

Progress report to IRC (June, 2009):

Rock phosphate samples (P content ranged from 1.6 % to 15.3%) were used to prepare ultra fine particle size by grinding and sedimentation method. The procured nano particles are highly unstable in water (except Hydroxy apatite <200nm) because of their zeta potential (range of zeta potential for stable suspension is –30 mv to +30 mv zeta potential). Results revealed that zinc oxide nano particle had no toxic effect (up to 2000 ppm) on gram seed germination where as, it prevented the germination of mustard seed at the level of greater than 500 ppm. Solution culture study showed that 0.27 ppm Zn (as nano zinc oxide particle) enhanced the growth of maize plant in comparison to conventional 0.5 ppm Zn (as $ZnSO_4$).

Comment of the House:
The progress was satisfactory.

Progress report to IRC (November, 2009):
A combination of pulverization, ultra sonication (100 watt) and sedimentation process was followed for the preparation of ultra-fine rock phosphate particle and HGRP3 Rock phosphate (Udaipur) was taken as a test sample. This rock phosphate was characterized by XRD and found that it mainly consisted of calcium apatite, hydroxy apatite, flour apatite, plumbogonite, quartz, crystobolite, strengite, veriscite etc. It was observed that in finer particle (with longer sedimentation time) the prominent peaks of variscite and strengite were disappeared. Nano particle of HGRP3 Rock phosphate (Udaipur) was also prepared by high energy ball milling. The average size was 28.20 nm. Solution culture study showed that 0.27 mg/L Zn (as nano zinc oxide particle) enhanced the growth of maize plant in comparison to conventional 0.5 mg/L Zn (as ZnSO4). The plant parameters like, plant height, root length, root volume, dry matter weight were all improved due to application of zinc oxide nano particle. A series of experiments were carried out to know the effect of Cu oxide -nanoparticles on germination and growth of seeds of soybean and gram. In both the crops, germination was not checked up to 2000 mg/L Cu (applied through Cu oxide –nanoparticles), but the root growth was prevented above 500 mg/L Cu. In many cases root necrosis was occurred. Investigation was also carried out to know the effect of copper sulphate solution on seed germination, above 200 mg/L Cu, it restricted the germination of seeds, because of high salinity.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010):
Rock phosphate (HGRP3 and Sagar rock phosphate) nano particle was prepared by grinding it in a high-energy ball mill. Rock phosphates were ball milled at ambient temperature and high-energy intensities, which induces phase changes through solid-solid reactions. During this milling process repeated collisions between ball and powder continuously exposes new reactant surfaces. After ball milling these rock phosphate particles (HGRP3 and Sagar rock phosphate) were analyzed by Photon Collision Spectroscopy (Dynamic light scattering techniques) and Scanning Electron Microscope (SEM) to know the size distribution of the particles. The obtained results pointed out that produced rock phosphate powder is a highly disperse, nano- scaled mixture of small particles, that is crystallites with sizes in the range of 80-150 nm. Experimental results revealed that recovery of P from nano rock phosphate particles (45%) particularly at lower concentration (2ppm) is higher than the KH_2 PO_4 source (29.8%) in Aridisol. An experiment on microbial solubilization of rock phosphate nano particles showed that 82.61% solubilization occurred after 72 h by *Pseudomeonas streata.* Estimation of P in nano rock phosphate particles was also carried out in laboratory by spectrophotometer and ICP-OES and it was found that although estimated value was higher in case of ICP-OES than spectrophotometer, still ICP-OES underestimated the P content in solution.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
Under the project activity to know the effect of nano particles on growth of crop, a solution culture experiment was conducted. Maize (*Zea mays* L.) crop was taken as a test crop.

Phosphorus was applied through different rock phosphate particle SRP II (110 nm), SRP (14 µm), HGRP3 (71nm), HGRP3 (13 µm) and also through KH_2PO_4.Results showed that nano rock phosphate particles of SRP II (110 nm) recorded highest dry matter yield of maize plant. The other plant parameters like, plant height, root length, root volume, root dry matter weight were all improved due to application of rock phosphate nano particle. Application of nano rock phosphate particles also enhanced the enzyme activity like Nitrate reductase. A laboratory experiment was conducted for the decontamination of rock phosphate to remove toxic heavy metals from rock phosphate. The content of heavy metals (Cd, Pb, Ni, Co) in treated rock phosphate was very less in comparison to untreated rock phosphate. Complete removal of heavy metals from rock phosphate is not possible by this method. A pot culture (10 kg capacity) experiment was carried out to the effect of nanorock phosphate (HGRP-3 and SRP II) on growth of maize on four different soils viz. Vertisol from Bhopal, Alfisol from Betul (MP), Inceptisol from Ludhiana and Aridisol from Jodhpur. Results depicted that the biomass yield of crop harvested after 60 days of sowing was higher in nano rock phosphate applied soil in comparison to micron sized rock phosphate.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Under the project activity to know the effect of nano particles on growth of crop, a solution culture experiment was conducted. Barley (*Hordeum vulgare L.*) crop was taken as a test crop. Phosphorus was applied through different rock phosphate particle SRP II (110 nm), SRP (14 µm), HGRP3 (71nm), HGRP3 (13 µm) and also through KH_2PO_4.Results showed that nano rock phosphate particles of SRP II (110 nm) recorded highest dry matter yield of barley plant. The other plant parameters like, plant height, root length, root volume, root dry matter weight were all improved due to application of rock phosphate nano particle. Application of nano rock phosphate particles also enhanced the enzyme activity like Nitrate reductase. A field study (Preliminary Trial) was conducted to know the effect of nano rock phosphate on sorghum-wheat and finger millet-wheat cropping sequence in a Vertisol. Results showed that application of nano rock phosphate particles enhanced the yield of the crop. It may be attributed to higher P use efficiency in nano form of rock phosphate. A perusal of the data depicted that the biomass yield of crop harvested after 120 days of sowing was higher in nano rock phosphate applied soil in comparison to control. Three rock phosphate-solubilizing fungi (Black, Green, Yellow) have been isolated from the IISS, farm soil and sent to IMTECH, Chandigarh for their identification. In another experiment nano zinc oxide and rock phosphate particles were coated with oleic acid and their effect on plant growth will be studied in the next experiment. Bulk sample of SRP and Udaipur were collected to synthesize nano rock phosphate particle in bulk amount.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Under the project activity to know the effect of nano particles on growth of crop, a solution culture experiment was conducted. Rice (*Oryza sativa* L.) crop was taken as a test crop. Phosphorus was applied through different rock phosphate particle SRP II (110 nm), SRP (14 µm), HGRP3 (71nm), HGRP3 (13 µm) and also through KH_2PO_4.Results showed that nano rock phosphate particles of SRP II (110 nm) recorded highest dry matter yield of rice plant. The other plant parameters like, plant height, root length, root volume, root dry matter weight were all

improved due to application of rock phosphate nano particle. Application of nano rock phosphate particles also enhanced the enzyme activity like Nitrate reductase. Phosphatse and phytase enzyme activities were also estimated and found that both the enzyme activities were more in case phosphorous deficient situation. A laboratory experiment was conducted to know the mechanism of nano particle entry into the soybean seed. Experimental results revealed that Zn nano particles both from the metallic zinc (<50 nm) and the ZnO nano particles (<100nm) could enter inside the soybean seed. A bulk amount of rock phosphate has been collected from Sagar, M.P. and Udaipur, Rajasthan to prepare the nano rock phosphate particles and will be used for field trial after coating it.

Comment of the House:
The progress was satisfactory.

2. Project Title: Understanding the mechanism of variation in status of a few nutritionally important micronutrients in some important food crops and the mechanism of micronutrient enrichment in plant parts. (NAIP).

Objective:

1. To study the variability across locations in the cultivars of some important crops viz., rice, wheat, maize, pigeon pea and bengal gram, for the content of nutritionally important micronutrients viz., zinc, iron, manganese and copper in seed and fodder.
2. To investigate the plant physiological, anatomical and rhizospheric factors responsible for the observed variability in micronutrient uptake, absorption and translocation in seed and fodder of the crops under study.
3. To study the mechanism of micronutrient enrichment of seed, straw and stover through foliar application of micronutrients.
4. To conduct a preliminary study to relate the micronutrient content in seeds of the crops under study and their bioavailability in model laboratory animals, mouse and rabbit.

Investigators:

PI: Dr. A. K. Shukla
CO-PIs: Dr. S. K. Behera, Dr. Muneshwar Singh, Dr. P. C. Mishra and Dr. Tapan Adhikari

Date of Start: February 2009
Date of Completion: March 2012

IRC Comments:
New project

Progress report to IRC (June, 2009)
Launching workshop and first CAC meeting has been organized from 08-09th May 2009 at NBSSLUP, Nagpur. The technical programme for the year 2009-10 has been finalized for implementation.
Comment of the House:
The PI was absent.

Progress report to IRC (November, 2009)
The experimental soil has pH 7.82, EC 0.17 dS/m, organic carbon content 0.46%, DTPA Zn 0.22 mg/kg, DTPA Cu 1.07 mg/kg, DTPA Mn 11.78 mg/kg, DTPA Fe 8.43 mg / kg,
exchangeable K 256 mg/kg, exchangeable Ca 140 mg/kg, exchangeable Mg 458 mg/kg and Olsen P 5.88 mg/kg.

Twenty varieties of pegion pea namely C-11, ICPL-87119, AKT-8811, PKV-Trombay, Hisar-Manak, Hisar-Paras, Hisar-HO2-60, Pusa-9, BDN-2, JKM-7, Virsa Arhar-1, SKNP-05-05, GAUT-93-17, DT-23, AAUT-2007-4, GT-101, T-15-15, BSMR-853, GT-1, AAUT-2007-10 were grown in kharif season of the year 2009.
Parameters like plant height, leaf area, and dry weights of shoot, leaf and root were recorded at flowering initiation stage.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010)
The varieties of pigeon pea differed from one another with respect to grain as well as stover yield. On an average, highest yield of 2891 kg/ha of pigeon pea grain was obtained from ICPL 87119 whereas that of lowest was recorded from PKV Trombay across the treatments. Almost all the varieties responded positively, with respect to grain yield to soil as well as soil + foliar application of Zn. Twenty wheat varieties of wheat also differed from one another with respect to grain as well as stover yield. On an average, highest yield of 4145 kg/ha of wheat grain was obtained from HI-8627 whereas that of lowest was recorded from HI-1500 across the treatments. Almost all the varieties responded positively, with respect to grain yield to soil as well as soil + foliar application of Zn. Zinc use efficiency, on grain yield basis of pigeon pea varieties ranged from 67 to 97 and that of wheat varieties varied from 80 to 97.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
Zinc concentration and uptake by grains of pigeon pea and wheat varieties have been estimated. Field experiments of pigeon pea and wheat for the year 2010-11 have been initiated.

Comment of the House:
The progress was satisfactory.
Progress report to IRC (June, 2011):
Work done:

- The field experiments for the pigeon pea and wheat crop for the year 2010-11 have been conducted and biomass yield have been recorded.
- Grain samples collected from the experiments have been analyzed for micronutrient content.
- Zn uptake by pigeon pea and wheat grain, Zn efficiency index and Zn efficiency of the cultivars have been calculated

Salient research findings:

- The cultivars of pigeon pea as well as wheat responded to Zn application like the previous year.
- Concentration as well as uptake of Zn by different cultivars of pigeon pea as well as wheat varied widely.
- Based on Zn efficiency index and Zn efficiency of cultivars for both the years, it was found that pigeon pea varieties like ICPL-87119, T-15-15 and Virsa Arhar 1 and wheat varieties like GW-322, JW-3211 and HI-8627 were efficient. Whereas as pigeon pea varieties like Pusa-9, Hisar-Paras and Hisar-HO2-60, and wheat varieties like HW-2004, AKW-4627 and JW-17 were found to be inefficient.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

- Zn concentration in grain, leaf and stem of efficient and inefficient cultivars of pigeon pea was higher under soil + foliar application of Zn as compared to control and soil application only. Cu concentration in grain and stem was higher under control. Mn and Fe concentration did not follow any specific trend under different treatments.
- Zn and Cu concentration in leaf and stem of efficient and inefficient varieties pigeon pea decreased from pre-flowering stage to maturity whereas Mn and Fe concentration of leaf increased.
- Like pigeon pea, Zn concentration in grain and stover of efficient and inefficient cultivars of what was higher under soil + foliar application of Zn as compared to control and soil application only. Whereas, higher Cu concentration was recorded under control treatments for both categories of the varieties.
- Higher Mn concentration in stover of both efficient and inefficient cultivars of wheat was obtained with Zn application.

Comment of the House:
The progress was satisfactory.

3. Project Title: **Evaluation of allwin wonder (aw) and allwin top (at) for their effects on maize productivity and soil fertility (sponsored by sree ramcides chemicals p ltd, chennai)**

Objective:

To evaluate the effect of allwin wonder and allwin top on growth and yield of Maize and to assess the effect of allwin wonder and allwin top on soil nutrient status under Maize cropping

Investigators:

PI: Dr. K. Ramesh
CO-PIs: Dr. S. Ramana

Date of Start: April 2009
Date of Completion: April 2012

IRC Comments:
New project

Progress report to IRC (November, 2009)

1. The first trial was sown on 30.06.2009 and harvested on 30.09.2009. At 60 DAS the combinations of AW & AT along with 100% recommended NPK has recorded higher plant biomass (8% higher than 100% fertilizer) and the same treatment has shown early tasselling and silking. Besides, chlorophyll content (13.78% higher than 100% fertilizer) and leaf area (around 20% higher than 100% fertilizer) of this treatment was also higher than other treatments.

2. The PI visited the firm and has observed the production process (including the raw materials).

3. Production protocol: Allwin wonder: Triazine (commercial name: Melamine) 30 kg (contains 18-25% heterocyclic aromatic N) is initially loaded in a ball mill. To this 5 kg of wetting agent is also added and allowed to mix evenly. As a next step 30 kg rock phosphate after through drying and thorough homogeneity is obtained. Thereafter, 15 kg potassium chloride added and allowed to mix. Further 20 kg humic acid is added and allowed to mix and the final product is packed for sale. Melamine and humic acid are imported from China.

4. Production protocol: Allwin top: Cyanuramide (commercial name: Melamine) 40 kg (contains 18-25% heterocyclic aromatic N) is initially loaded in a ball mill. To this 5 kg of wetting agent is also added and allowed to mix evenly. As a next step 10 kg potassium chloride is added. Thereafter, 10 kg mono ammonium phosphate added and allowed to mix. Further 20 kg octoborate is added and allowed to mix and then15 kg humic acid is added and the final product is packed for sale. Melamine and humic acid are imported from China.

5. Four field experiments/demonstrations in three villages at Kancheepuram district of Tamil Nadu was seen in Paddy crop for Allwin wonder. The paddy crop was at active tillering/maximum tillering phase and a close view of the control and Allwin wonder applied plot has shown robust growth of root system in the treated fields.

6. Soil and plant analysis are in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010)

The first trial was sown on 30.06.2009 and harvested on 30.09.2009 and the results were presented in the last IRC held on 23.11.2009. Analysis of Allwin wonder and allwin top have been completed for Nitrogen, phosphorus and Potassium, besides organic matter. Soil and plant analysis have been completed and it was noted that there is nutrient mining in the best performing treatment and the yield improvement might be due to hormonal effect rather than nutrient effect since the amount of nutrients added through the products are bare minimum. Second year crop will be sown by the end of June month and confirmative results could be obtained.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January, 2011):

The second trial was sown on 30.06.2010 and harvested on 30.09.2010. Results of the second year trial indicated that combination of Allwin wonder as soil application and Allwin Top as foliar spray recorded higher yield than other treatments. Analysis of Allwin wonder and allwin top have been completed for Nitrogen and organic matter. Post harvest soil and plant analysis are underway. Third and final year crop will be sown by the end of June 2011.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (June, 2011):

Two trials have been completed. Results of the second year trial indicated that combination of Allwin wonder as soil application and Allwin Top as foliar spray recorded higher yield than other treatments. Post harvest soil analysis has been completed. Analysis of Allwin wonder and allwin top have been completed for micronutrients. Third and final year crop will be sown by the end of June 2011.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Third trial has been completed and compilation of results is underway. Although the crop was very poor due to incessant rains during the crop growing season, results of the third year trial also indicated that combination of Allwin wonder as soil application and Allwin Top as foliar spray along with 100% recommended dose of fertilizers have recorded higher yield than other treatments. The same treatment recorded higher leaf chlorophyll a and b as well as nitrate reductase activity. The quantity of nutrients supplied through the products are bare minimum, but the products contain humic acid which might have helped in improving the maize yield.

Comment of the House:

The progress was satisfactory.

4. Project Title: GPS and GIS based model soil fertility maps for selected districts for precise fertilizer recommendations to the farmers of India.

Funding agency: Department of Agriculture and Cooperation,
Ministry of Agriculture,
Govt. of India, New Delhi-110 001

Project cost: 10 crores, for 3 years (2009-12).

Objective:

1. To develop database related to soils, crops and cropping systems, organic manure, primary, secondary and micronutrients fertility status.
2. To prepare soil fertility maps using GIS and N, P, K, Se, Fe, Mn, Cu, Zn, B
3. To interlink the soil fertility status with soil test crop response data and to generate site specific IPNS recommendations.
4. Validation of Geo referenced fertility maps and their refinement for farmers' friendly fertilizer recommendations.
5. To prepare policy guidelines for the planners, administrators for allocation, distribution of all required plant nutrients carriers for improved nutrient use efficiency, which helps in larger savings of the economy of the country.
6. Transfer of generated technology to the farmers through govt. agencies and NGO's

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Investigators:

PI: Dr. A. Subba Rao

CO-PIs: Dr. Y. Muralidharudu, Dr. M. V. Singh, Dr. Muneshwar Singh, Dr. K. N. Singh, Dr. R. H. Wanjari, Dr. S. K. Behera and Dr. A. Rathore

Date of Start: June 2009

Date of Completion: June 2012 (3 years)

Project location: Indian Institute of Soil Science, Bhopal

Progress report to IRC (June, 2010):

At IISS, Procured the C.D containing village level directory including village statistics for the whole country, from census office, Bhopal, M.P.

Using the multistage random sampling technique, 8 to 10 % of the villages of each district, have been selected for all districts based on village population and area. The selected villages of 50 districts to different cooperating centres were sent directly to centres enable them to go to villages and collect samples using GPS. In many states, GPS based sampling started and some of the details are as follows:

GPS Based sample collections were made in the following States

State	Villages	Total	No. of Samples	District	No. of districts
Coimbatore	90	74	540	Thanjavur	1
Kanpur	125		750	Farukhabad } Kanpur }	2
Punjab	75		400	Ludhiana } Nawashaha } Jalandhar }	1
West Bengal	435		2600	Jalpaigudi West Dinachpur Nadia	3
Bihar	83		500	Samastipur	1
A.P	150		900	Mahaboobnagar Kurnoor	1 21
Kerala	40		250	Thrissur	1
Karnataka	130		780	Mandya	1
Akola	140		850	Akola Bhandara	2
Rajasthan	83		500	Bikaner	1
Assam	-		60	--	
M.P.	-		-	-	
Haryana	-		-	-	
Orissa	50		300	Puri } Khurda }	1
H.P	115		690	Hamirpur	1
Gujarat	333		2000	Anand Khera Baroda	4
		TOTAL	**11120/-**		**41**

Purchase of equipment and recruitment of manpower different centres is in progress.

Comment of the House:

The progress was satisfactory.

Progress report to IRC (January, 2011):

An interaction meeting was held at IISS during 17th to 18th April 2010 and 13th -14th Oct., 2010 with both representatives of Ministry of Agriculture and scientists from all seventeen cooperating centres including scientists from IISS. Various issues were deliberated for two days.

Each centre proposed 4 to 5 districts during 1st year for collecting samples and analysis of all nutrients. Thus, Totally, seventy districts have been proposed for 1st year and accordingly funds were allotted to centres immediately and work is going on.

At IISS, Procured the C.D containing village level directory including village statistics for the whole country, from census office, Bhopal, M.P.

Using the multistage random sampling technique, 8 to 10 % of the villages of each district, have been selected for all districts based on village population and area. The selected villages of 50 districts to different cooperating centres were sent directly to centres enable them to go to villages and collect samples using GPS.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
During the year 2010-2011, 18 Cooperating centres of 17 states have collected GPS based soil samples using multistage random Sampling technique from70 **districts** as per target and the analysis for nutrients has been completed for 50 districts and the data from different cooperating centres has been received for **42 districts**. However, the fertility maps for macronutrients have been prepared for **24districts** and for micronutrients for 13 districts. Soil Sample have been received from **34** districts of **15** States for validation purpose and analysis for macro, micro and secondary nutrients have been completed for 230 samples in referral laboratory at IISS, Bhopal. The data of both the centres and referral laboratory have been compared and correlated. Some parameters are well compared and some are not

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

About 770 soil fertility maps (macro and micro-nutrients, organic C, pH, EC etc) based on GPS and GIS have been prepared for 62 major districts using soil testing data of 30000 geo-referenced soil samples. These maps showed that almost all soils of different districts of North, South, East and West zones are deficient in available N. In **North zone,** majority of the soils are medium to high in available P and available K status. Only few soils (1-8%) in 3-4 districts are low in P and K. In **West Zone**, majority of the soils are low to medium in available P except Gujarat. About 92-100% area in Gujarat is high in available P. Altogether only 10-33% area in west zone is low in available K. Most of the soils in Gujarat and Maharashtra are high and Rajasthan are in medium in available K. In **East Zone**, most of the area in Orissa (73-97%) is low in available P. Majority of the soils of Assam and West Bengal are medium to high in available P status of soils. Majority of the soils in East Zone are medium in available K except Kurda district in Orissa where 58% of the area is low in available K. In **South Zone**, majority of the soils in Andhra Pradesh, Tamil Nadu and Kerala are high in available P. In Karnataka, most of the soils are medium in available P. Regards to available K, majority soils of Tamil Nadu, Karnataka and Kerala are medium and majority of the soils of Andhra Pradesh are high in available K. Micronutrient fertility maps of 62 districts showed that almost all soils of Punjab, Haryana, and Himachal Pradesh in **North zone** are high in available Zn whereas majority of Uttar Pradesh soils are medium in available Zn. Majority of soils of this zone are high in available Fe, Cu and Mn with minor exceptions. Other-wise, majority of soils are sufficient in available Zn, Fe, Cu and Mn.

Comment of the House:
The progress was satisfactory.

5. Project Title: Efficiency of Bio-release micronutrient fertilizer Zinc (Micromac) on yields and zinc nutrition of different crops in India.

Funding agency: M/s Sowbhagya Amino Inputs Pvt. Ltd., Hyderabad.

Project cost: Rs. 10.31015 lakh.

Objective:

To evaluate the efficiency of Bio-release micronutrient fertilizer – Zinc (Micromac) for zinc nutrition and yield of different crops in India and their effect on soil fertility in India

Investigators:

CPI:	Dr. A. K. Shukla
CCPIs:	Dr. S. K. Behera
Associates:	Dr. R. H. Wanjari
	Dr. B. L. Sharma

Date of Start: August 2010

Date of Completion: July 2011

Project location: Project Coordinating Unit Micronutrients.

Progress report to IRC (January, 2011):
Salient research findings:

1. The values of soil pH, EC and OC initial soil samples were 7.97, 0.11, and 0.46% respectively.
2. The maize grain and stover yield under various treatments differed significantly and varied from 4.19 to 6.01 t/ha and from 8.05 to 11.70 t/ha respectively.
3. The treatments had no effect on the soil pH, EC and OC content in post harvest soils.
4. Concentration of Zn in grain and stover of maize ranged from 22.16 to 31.75 mg/kg and 26.84 to 41.38 mg/kg respectively.
5. Zinc uptake by grain and stover varied from 92.4 to 189.4 g/ha and 216.3 to 460.7 g /ha respectively.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Salient research findings:

1. Concentration of Cu, Mn and Fe in maize grain ranged from 1.63 to 2.72, 3.60 to 4.73 and 20.03 to 23.53 mg kg-1, respectively whereas, that in maize stover varied from 7.80 to 9.83, 37.67 to 44.83 and 189.44 to 211.57 mg kg-1, respectively, under different treatments.
2. Total uptake of Cu, Mn and Fe by maize crop ranged from 74.31 to 110.93, 342.52 to 506.61 and 1604 to 2532 g/ha respectively, under different treatments.
3. The grain and straw yield of wheat crop varied from 4.20 to 5.11 t/ha and 5.19 to 5.93 t/ha respectively, under treatments respectively.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

Analysis cationic micronutrients in plant samples of wheat trial conducted during Rabi 2010-11 has been completed. Assessment of post harvest soil properties has been carried out. Six monthly progress report has been prepared and submitted to sponsoring authority.

Comment of the House:
The progress was satisfactory.

6. Project Title: Improving yields and nutrient uptake of selected crops through microbial inoculants in Vertisols of Central India

Funding agency: AMAAS (ICAR)
Project cost: Rs. 35.03 Lakhs
Objective:

1. To study the culturable microbial diversity of vertisols for selection of promising rhizobial and plant growth promoting rhizo-bacterial strains for soybean, chickpea and wheat.
2. To develop the best consortia of rhizosphere competent and compatible strains of N fixers, P solubilizers, PGPR and PGP-B for inoculation of above crops.
3. To study the microbial interaction in the crop rhizosphere in relation to CNP transformations and bio-availability of nutrients.
4. To test the best performing combination of inoculants for soybean, chickpea and wheat in farmers fields.
5. To make multiple-repositories of the elite strains microorganism.

Investigators:

PI: Dr. D. L. N. Rao
CO-PIs: Dr. M. C. Manna

Date of Start: 2006
Date of Completion: 2011
Project location: Network project on BNF
Progress report to IRC (November, 2008)

Sixty effective PGPR for soybean, chickpea and wheat and 36 effective rhizobial strains for soybean and 9 for chickpea have been short-listed (total 105 isolates) after preliminary screening of 603 isolate of PGPR and rhizobia in green-house. Second stage screening of 27 soybean rhizobia yield and promising strain which will be taken up in further studies. Obligate copiotrophs and obligates formed formed only a small proportion of the isolate (3.7%) but they also exhibited facultative mode of nutrition on long stotage at 4^{o}C. Rhizobia and non-rhizobia contaminants showed differential resistance patterns to some antibiotics, of which Carbencillin, rifampicin and ciprofloxacin proved to be most discriminatory. Non-rhizobia were sensitive to all three antibiotics. A modified method for more sensitive detection of HCN production by bacteria is under development.

Comment of the House:
Progress was satisfactory.

Progress report to IRC (June, 2009)

A data base of 50 promising PGPR based on physiological and biochemical attributes prepared. Oligotrophic soil bacterial isolates (10 no.) could be maintained in viable state in distilled water upto 4 months(10^5-10^6 cells/ml). Intrinsic antibiotic resistance (IAR) pattern of 35 nod+ rhizobial isolates of soybean showed a lot of diversity and clustering into 5 distinct groups at 67% level of similarity. 63 % of the total isolates fell in cluster 3. MPN of soybean rhizobia ranged from 100-4000 cells/g in M.P. 40 promising rhizobia and 45 PGPR strains based on green house screenings short-listed for field testing in AINP-BF- Jabalpur.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (November, 2009)
Passport Data of 103 soil bacterial strains was generated and entered into a database. The oligotrophic soil bacteria could be maintained in double distilled water upto 6 months. Out of 19 antibiotics used, 6 were identified as suitable for competition studies of inoculated rhizobia in Bhopal Soil. In diversity studies it was found that soybean bradyrhizobia of M.P. fell into 5 clusters w.r.t IAR) and 6 clusters w.r.t carbon sources. The most probable number of soybean rhizobia in M.P. soils ranged from 100-4000. Field trials with liquid formulations of 40 Rhizobium and 45 PGPR strains for soybean completed at AINP Network Centre, Jabalpur.. Yield increase of 35.6 % with oligotrophic PGPR and 72.6 % (max) for rhizobia recorded. Collaborative farmer field Trials with BIOMIX (Rhizobium +PGPR) were conducted in soybean - 100 trials ; TATA-ICRISAT: 1000 trials. Soybean seed yield increase in INM was 54% over FP and 18% over balanced Fertilization. Bradyrhizobium japonicum! and Bacillus megaterium mother culture supplied to JNKVV Biofertilizer productioncentre.
In vertisols of Hoshangabad, M.P., improvement in soil biological properties was found in soils under grasses as compared to trees. Natural farming practicesimproved biological activity.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010)
Fifteen elite PGPR and 15 elite rhizobial strains strains increased the grain yield of soybean in vertisol field by 30-55 % at Jabalpur. PGPR could survive in oligotrophic environment upto one year, suggesting possible mode of long term storage of cultures. Three PGPR isolates showed early promise for checking *Fusarium* wilt in `sick plots' in vertisol field at Sehore. Soil health of inoculated chickpea rhizosphere soils showed clear improvement in terms of increased population of nitrogen fixers, nitrifiers (at early stage), and soil enzymes (acid phosphatase and dehydrogenase). Intrinsic Antibiotic Resistance and Carbon sources utilization showed 5 clusters of soybean rhizobia and were robust criteria for diversity studies and selection of strains for competitiveness. There was 98% mortality of soybean rhizobia during summer in surface soil reinforcing need for regular inoculation. *Bradyrhizobium japonicum*- ISR-33 and *Bacillus megaterium*-ISP-3 increased grain yield with INM option by 18% over balanced fertilization and 54% over farmers practice in 100 demonstrations in M.P. During 2009, 2.13 lakh inoculant packets were prepared with the IISS strains by JNKVV and supplied all over M.P.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
Database of 108 soil bacteria isolated from vertisols and composts has been prepared. 23 gene sequences of PGPR were deposited in NCBI. Of these, 10 sequences were of oligotrophs. The oligotrophs showed high catabolic diversity and shared 44% similarity among themselves. 15 PGPR strains for soybean gave an average increase of 18% in grain yield in field. Oligotrophs were effective as PGPR for soybean, chickpea and wheat in vertisols. 10 soybean Rhizobium strains gave an average increase of 15 % grain yield in field.

Comment of the House:
The progress was satisfactory.
Progress report to IRC (June, 2011):
Database of 108 soil bacteria in vertisols. PGPR-50; rhizobia- 58 prepared. 23 gene sequences of PGPR (including 10 oligotrophs) deposited in NCBI. 17 PGPR cultures deposited in NBAIM collection. In rabi 2011 in vertisol field, inoculation of two effective PGPR strains Bacillus subtilis gave significant grain yield increase (av of 15 strains: 12.0%). Similarly inoculation of two effective rhizobia in vertisol field gave significant chickpea grain yield increase of 9-15%. Inoculation of five effective PGPR on wheat gave significant grain yield increase of 11-25%. (av of 15 strains: 7.3 %).

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):

In cross nodulation studies under controlled conditions, soybean was nodulated by both soybean and chickpea strains. But chickpea was nodulated by only its homologous strains. Neither soybean nor chickpea strains nodulated (berseem, methi or pea plants). Soybean rhizobia also did not nodulate moong but they nodulated cowpea. Chickpea local strain nodulated both moong and cowpea hosts. Based on intrinsic antibiotic resistance as a marker, (neomycin) soybean rhizobia R 33 showed nodule occupancy of 56%. Chickpea Rhizobium (R 40) showed nodule occupancy of 52% (nalidixic acid). Various combinations of the best performing PGPR cultures, viz., P3 (Bacillus megaterium), P10 (Bacillus subtilis), P25 (Lysinibacillus fusiformis) and rhizobial cultures R 33, R35, of soybean and R40 of chickpea were found to be compatible in vitro and hence suitable for consortia preparation for field use. Of 15 PGPR strains tested in field, PGPR- P10 (B. subtilis) and P33 (B. amyloliquefaciens) gave significant 16-25% increase in wheat yield. PGPR- P10 and P68 (both B. subtilis) gave highly significant 40-43% increase in chickpea yield. Six more PGPR strains have been deposited in NMAIM, Mau (total 23). The final part of the work on sequencing the 16s r DNA of soybean and chickpea rhizobia, their homology, phylogenetic studies is under progress**.**

Comment of the House:
The progress was satisfactory.

7. Project Title: Soil organic carbon dynamics and climatic changes and crop adaptation strategies.

Funding agency: NAIP

Project cost: 54.01 Lakhs (for IISS center)

Objective:

1. To evaluate the interactive effect of elevated greenhouse gases, temperature and hydrological relations on SOC decomposition and nutrient release, and their impact on climate change
2. To monitor in situ gaseous-C and N emission in three major cropping system (rice-wheat, soybean-wheat and sugarcane-wheat) and related them to soil physico-chemical and microbiological parameters.
3. To study intervention points for devising adaptation strategies to manage–C flux in three major cropping systems.

Investigators:

PI: Dr. M.C. Manna

CO-PIs: Dr. S. Ramana, Dr. K.Sammi Reddy, Dr. A.K. Tripathi, Dr. Muneshwar Singh, Dr. K.N.Singh and Dr. S. R. Mohanty

Date of Start: May 2008

Date of Completion: 31 March 2012

Project location: Division of Soil Biology

Progress report to IRC (November, 2008):

Soil Sample of selected treatments have been collected at 0-15 and 15-30 cm soil depths from ongoing long-term field experiments conducted at Indian Institute of Soil Science, Bhopal under Integrated Nutrient Management (INM) trial. The soil samples have been processed with three sieve size classes i.e., 4000 µm, >2000 µm and 2000 µm and stored at 4^0C for analysis of soil biological parameters and sub-samples were dried at 70 ^{0}C for various physical and chemical analysis. During this period SRF and RA have been recruited. Research work is in progress.

Comment of the House:

Progress was satisfactory.

Progress report to IRC (June, 2009):

Soil samples of selected treatments from ongoing trial under Integrated Nutrient Management (INM) at IISS research farm have been used for C-mineralization with three hydrological regimes (50 %MHC, 100 %MHC and under submerged condition) and three temperature conditions i.e., 25, 35 and 45^{o}C. C-Mineralization in terms of CO_2 evolution was recoded at different days after incubation (DAI) i.e., 3, 10, 20, 40, 60, 80,120, 160, 180, 240 and 365 DAI. Active pools of C- fraction were also recorded at initial, 40 DAI, 180 DAI and 365 DAI. For fungal and bacterial structural diversity were recorded at initial and 40 DAI. Various microbiological and biochemical parameters was reported here up to 60 DAI under three hydrological regime at 35 ^{0}C temperature.

After 5 cycles of soybean-wheat in rotation, the higher concentrations of C pools such as soil microbial biomass carbon (SMBC), water soluble carbon (WSC) and acid hydrolysable carbohydrates (AHC) were observed in FYM treated plots followed by 50% NPK+CR,

50%NPK+FYM and 100%NPK in surface layer (0-15 cm). The slow pool of carbon i.e., particulate organic carbon POM-C varied from 14.7 to 28.4 % of TOC in these treatments and it was lowest in unfertilized control. Therefore, 71.6 -85.3 % of TOC was present in terms of mineral associated organic matter (<0.053 mm) in these soils. In all the treatments, rewetted sand free mass aggregate size distributions at 0-15 cm depths were dominated by small macro aggregates (25-2000 µm) accounting for 55.5-70.6% of dry soil weight followed by micro aggregates (53- 250 µm), accounting for 18- 37%) . The sand free macro-aggregate carbon was greater in 250-2000 µm size classes followed by micro-aggregates. The maximum FDA was observed (7.9 µg Fluorescein /g/h) in the FYM treated plots due to greater biological activities. After 60 days of incubation, it was observed that the CO_2 evolution increased maximum up to 40 days in these treatments. Among these three hydrological regimes, the higher amount of CO_2 evolution was observed in 100 %MHC followed submerged condition and least was observed in 50 % WHC at 35 ^{o}C in vertisol. Further it was observed that the CO_2 evolution was maximum (192 mg CO_2/100) by the application of 100 % FYM at 100 % MHC followed by NPK +CR, 100% NPK and 50% NPK+ FYM possibly due to greater release of water soluble phase of carbon and acid hydrolysable carbohydrates, which acted as source of bio energy for higher amount of exogenous micro organisms. Under submerged condition bacterial substrate induced respiration was greater than fungal-SIR and it was reverse under 100 %MHC at 35 ^{0}C temperature. The work is in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (November, 2009):
Soil Sample of selected treatments of Integrated Nutrient Management (INM) trail at IISS research farm have been used for C-mineralization and cultural biodiversity with three hydrological regimes (50 %MHC, 100 %MHC and under submerged condition) and three temperature conditions i.e., 25, 35 and 45oC. C-Mineralization in terms of CO2 evolution was recoded at 210 days after incubation. It was observed that CO2-evolution was initially increased with temperature up to 40 days of incubation but at later stage, it was substantially decreased with increased in temperature. It was also noted that CO2-evolution was decreased with increased in moisture holding capacity of soil and under water logged soil it was substantially decreased at 210 days after incubation. The heterotrophs population was ten fold decreased with temperature at 90 days of incubation. Similarly ammonifiers population was abruptly reduced as incubation was pronounced up to 210 days. Under submerged condition bacterial substrate induced respiration was greater than fungal-SIR and it was reverse under 100 %MHC at 350C temperature.
The C-mineralization rate constant increased with increase in temperature. The Q10 values were increased with increased in moisture content of soil and it was relatively greater under 100 % moisture holding capacity of soil. In this experiment data reveled that larger emission of gaseous-C was due to exhaustion of the labile pools of carbon under 100 % MHC than submerged condition. The work is in progress.

Comment of the House:
The progress was satisfactory. The PI was asked to recheck the data and present the same in proper form. Dr. Mohanty may be included in this project.

Progress report to IRC (June, 2010):
Soil Sample of selected treatments of Integrated Nutrient Management (INM) trail at IISS research farm have been used for C-mineralization and cultural biodiversity with three hydrological regimes (50 %MHC, 100 %MHC and under submerged condition) and three temperature conditions i.e., 25, 35 and 45^{o}C. C-Mineralization in terms of CO_2 evolution was recoded at 210 days after incubation. It was observed that CO_2-evolution was initially increased with temperature up to 40 days of incubation but at later stage, it was substantially decreased with increased in temperature. It was also noted that CO_2-evolution was decreased with increased in moisture holding capacity of soil and under water logged soil it was substantially decreased at 210 days after incubation. The heterotrophs population was ten fold decreased with temperature at 90 days of incubation. Similarly ammonifiers population was abruptly reduced as incubation was pronounced up to 210 days. Under submerged condition bacterial substrate induced respiration was greater than fungal-SIR and it was reverse under 100 %MHC at 35^{0}C temperature.
The C-mineralization rate constant increased with increase in temperature. The Q_{10} values were increased with increased in moisture content of soil and it was relatively greater under 100 % moisture holding capacity of soil. In this experiment data reveled that larger emission of gaseous-C was due to exhaustion of the labile pools of carbon under 100 % MHC than submerged condition. The work is in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
Soil Sample of selected treatments of long-term field experiments at Jabalpur research farm have been used for C emission, C pools and cultural biodiversity with two hydrological regimes (60 %MHC, and under submerged condition) and three temperature conditions i.e., 25, 35 and 45^{o}C. C-emission in terms of CO_2 evolution was recorded at 90 days after incubation. It was observed that CO_2-evolution was increased with increase in temperature and decreased with submerged condition up to 90 days of incubation. CO2 efflux increased with increased in temperature ranging from 25 to 45^{o}C and it was relatively greater at 60 % MHC as compared to submerged condition. The active pool of carbon such as SMBC varied 156 to 598mg/kg, FDA varied from 3.92 to 6.13 ug/g/h. Slow pools of C was varied from 624 to 1650 mg/kg in these treatments. The most recalcitrant fraction of carbon (HA) was varied from 34.25 to 51.4 % and it was maximum in 100 % NPK+ FYM treatment. The heterotrophs population was relatively greater than N_2 – fixers and ammonium oxidizers. The bacterial respiration was greater than fungal respiration. After 90 days of incubation the active pools of carbon i.e., acid hydrolysable carbohydrates substaintially decreased as compared to initial. The slow pools of carbon was decreased ranging from 5.5 -36.9 % at 25^{o}C and 4- 15 % under submerged condition. In this study it was observed that soil biological activities were substantially improved in 100 % NPK + FYM treated plots and decreased with advancement of temperature under 60 % MHC in Vertisol. The work is in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Soil Sample of selected treatments of long-term field experiments at Jabalpur research farm have been used for C emission. C-emission was studied at 60 % MHC with three temperature

conditions i.e., 25, 35 and 45^{o}C at 1,2,4,6,8, and 10 weeks of incubation from different aggregate size classes such as macroaggregate (250-2000 µm), microaggregate (53-250µm) and mineral associates (<53µm) in terms of CO_2 evolution. It was observed that CO_2-emission was relatively greater in macroaggregate (250-2000 µm) followed by microaggregate (53-250µm) and least was observed in mineral associates (<53µm) at all these three temperature conditions. Further it was observed that the CO_2 emission from macroaggregates was increased with increase in temperature but the consistency was not followed for micro aggregates and mineral siassociates. The methanotrophic activities was increased with increased in temperature from 25 to 35^{o}C and decreased with increased in temperatureat 45^{o}C. It was observed that methanogenic production potential decreased with increase in temperature from 25 oc to 45^{o}C. After 90 days of incubation of whole soil (2 mm size) the heterotrophic population was 2 fold greater (cfu x 10^6), followed by N_2 fixers(cfu x 10^5) , ammonium oxidizers (cfux 10^4) and nitrite oxidizers (cfux 10^4). The elevation CO_2 was maintained at 650-700ppm ppm to study the elevated CO_2 on soil biodiversity. The work is in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (Dec., 2011):
Soil Sample of selected treatments of long-term field experiments at Jabalpur research farm have been used for C emission. C-emission, N mineralization and composition of soil biota were studied at 60 % MHC with three temperature conditions i.e., 25, 35 and 45^{o}C at 1, 2, 4, 6, 8, and 10, 12, 14 and 16 weeks of incubation from different aggregate size classes such as macroaggregate (250-2000 µm), microaggregate (53-250µm) and mineral associates (<53µm) in terms of CO_2 evolution and N mineralization. It was observed that the microbial respiration rate in most recalcitrant pools (<53 µm) was increased by 5- to 13.9 % at 45 ^{o}C as compared to 25^{o}C in all those treatments. The data revealed that the labile pool increased with increase in temperature from 4.9 to 55.4 % at 25 to 45^{o}C in N, N-P, N-P-K and N-P-K plus FYM under 250-2000 µm size classes. The hydrolysable carbohydrates was decreased by 23 to 37% of SOC from 25 to 45^{o}C temperature and POM-C was decreased by 12 to 23 % of SOC from 25 to 45^{o}C in whole soil. Microbial respiration increased dramatically with soil temperature due to apparent increase in the pool size of C and N metabolized by soil microbes at higher temperature in all these aggregates. We found that the largest microbial respiration rate was observed at 45^{o}C in all aggregate size classes probably resulted from greater availability of labile substrate in soil organic C and N must be accounted for when attempting to predict the effects of soil warming on soil microbial respiration and N mineralization. The bacterial/fungal SIR ratio was decreased with increase in temperature. The elevation CO_2 was maintained 150 days at 650-700ppm ppm to study the elevated CO_2 on soil biodiversity. The work is in progress

Comment of the House:
The progress was satisfactory.

8. Project Title: Network Project on Organic Farming.

Funding agency: Network Project on organic farming (ICAR)

Project cost: 20 Lakhs

Objective:

1. To study the impact of organic, chemical and integrated management practices on productivity and soil health of different cropping systems.
2. To study the impact of various organic manures on nutrient supply capacity, soil health and produce quality.

Investigators:

PI: Dr. A.B. Singh
CO-PIs: Dr. S. Ramana and Dr. K. Ramesh and Dr. B.L.Lakaria

Date of Start: July 2004
Date of Completion: July 2007
Project location: Division of Environmental Soil Science

Progress report to IRC (November, 2008):

In the fifth year of field experiment (Kharif 2008), 100% organic treatment recorded 20.7% higher soybean seed yield (2009 kg/ha) compared to 100% inorganic treatment (1664 kg/ha). This was due to better nutrient availability which resulted in higher biomass accumulation and more number of pods/plant in organic compared to inorganic treatment. Soil organic carbon, available N, P and K of soil were also higher in organic treatment. Soybean seed quality parameters like protein, oil and ash content were slightly higher in organic but were on par with other treatments. In the second experiment, highest soybean seed yield (1910 kg/ha) was recorded in the treatment receiving cattle dung manure for the present crop preceded by the application of CDM + VC + PM combination during the previous rabi crops. Straw yield and number of pods/plant were significantly affected whereas, harvest index, seeds/pod and 100 seed weight were not affected among the treatments. Application of organic manures improved the soybean seed quality parameters, soil organic carbon, available N, P and K compared to the control.

Comment of the House:

Progress was satisfactory.

Progress report to IRC (June, 2009):

A survey was conducted in five states *viz*. Maharashtra, Karnataka, Tamil Nadu, Kerala and Uttarakhand and Pondicherry involving 35 certified organic farms. The objectives of the survey were to compare the production potential and economics of organic farming and to evaluate the soil quality in comparison to the conventional farming. The productivity of crops under organic farming is less in most cases and the reduction in yield varies from 1.3 to 25.0 %. In few cases (Cashew, Mango in Tamil Nadu and Coconut in Kerala), the productivity is higher in case organic farming. The economics of organic farming is also less in organic farming except in cases where the farmers are getting premium price for their produce. The soil samples collected from both organic and conventional farms were analyzed for physical, chemical and biological

parameters. In general, there is an improvement in the soil quality parameters in organic farms compared to conventional farms in all the 5 states surveyed.

Comment of the House:
The progress was satisfactory. The PI was asked to associate one microbiologist to see the microbial populations in the collected soil samples. Also the PI was asked to analyze punchagobya and different biodynamic preparations so as to throw some light on the efficacy of those preparations.

Progress report to IRC (November, 2009):
In the sixth year of the field experiment (Kharif 2009), organic manure treatment recorded 26 % higher soybean seed yield (2377 kg/ha) compared to the chemical treatment (1879 kg/ha). This was due to higher biomass, more number of pods/plant and 100-seed weight observed in organic treatment compared to chemical treatment. Soil organic carbon, available N, P, K and biological activity of soil (dehydrogenase, phosphatase and FDA activity) were also higher in organic manure treatment compared to the chemical alone treatment.
In the second experiment, application of panchgavya along with organic manures recorded the highest seed yield of both soybean (2238 kg/ha) and maize (5682 kg/ha) compared to control or the application of manures alone. Application of biodynamic preparations was not shown any significant affect on yield attributes and yield of both soybean and maize.

Comment of the House:
The progress was satisfactory. In view of the transfer of Dr. P. Ramesh, the chairman recommended that Dr. A. B. Singh will act as a PI.

Progress report to IRC (June, 2010):
In the sixth year of the field experiment (Rabi 2009), organic manure treatment recorded higher yield of wheat, chick pea, linseed and mustard in Soybean-wheat, Soybean-Chick Pea, Soybean-linseed and Soybean-mustard cropping systems as compared to either chemical or integrated nutrient management. This was due to higher yield attributes of the said crops in the cropping system studied. Soil bulk density, soil aggregate analysis, soil organic carbon, available P, K and biological activity of soil (dehydrogenase, phosphatase and FDA activity) have been completed.
In the second experiment, application of panchgavya along with organic manures and biodynamic preparations recorded the higher seed yield of wheat as compared to other management methods. Soil organic carbon, biological activity of soil (dehydrogenase, phosphatase and FDA activity), bulk density, and soil aggregate analysis have been completed. Analysis of nutritional quality parameters such as amino-acids, minerals and oil content is in progress and will be presented in next IRC meeting.
Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
In the seventh year of the field experiment (Kharif 2010), organic manure treatment recorded higher yield of soybean as compared to 100% inorganic treatment. This was due to better nutrient availability which resulted in higher biomass accumulation and more number of pods/plant in organic compared to inorganic treatment. Soil organic carbon, available N, P and K of soil were also higher in organic treatment. Soybean seed quality parameters like protein, oil and minerals content were slightly higher in organic but were on par with other treatments. In the second experiment, application of panchgavya along with organic manures and biodynamic

preparations recorded the higher seed yield of soybean as compared to other management methods. The rabi session crops i.e. wheat, mustard, linseed and chickpea have been sown in the experiment.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
In the seventh year of the field experiment (Rabi 2010), there was no significant differences among the different nutrient management treatments in wheat crop. In chickpea crop, integrated nutrient management showed significant superiority over organic and was followed by inorganic management In mustard crop, integrated nutrient management and organic management were statistically similar. In Linseed crop, there was poor yield recorded during year 2010-11 due to poor germination in the field. Chemical and biological analysis of soil have been completed.
In the second experiment, various organic manures, biodynamic formulations and Panchagavya, which are being used in the experiment, were analyzed prior to field application. The data of the study clearly indicated that the application of panchgavya along with organic manures and biodynamic preparations recorded the higher grain yield of wheat as compared to other management methods. In respect of chickpea, the treatments did not affect the yield significantly. The soil analysis data clearly show the effect of Panchagavya with Organic Manure and also with Organic Manures + Biodynamic formulations on soil quality. The soil organic carbon, available N, P and K were higher in OM + BD + PG treatment. The soil biological acticity (dehydrogenase) was higher in these treatments as compared to the control and bio-dynamic alone. Analysis of other soil chemical and biological parameters as well as nutritional quality parameters in wheat, chickpea and mustard crop is in progress and will be presented in next IRC meeting.
Comment of the House:
The progress was satisfactory. The house suggested that yield data of wheat, mustard and chick pea may be rechecked with agronomist, Dr. K. Ramesh.
Progress report to IRC (Dec., 2011):

In the eighth year of the field experiment (kharif 2011), overall there was reduction in soybean seed yields due to continuous cloudy weather along with incessant rains during the vegetative growth phase that accelerated vegetative growth. The data of the study clearly indicated that the organic manure treatment recorded higher soybean seed yield (326 kg/ha) compared to the chemical & INM treatments and the same registered higher no of pods/plant. Soil chemical analysis (after harvest of rabi crops) showed that soil available nitrogen varied between 214 and 222 kg/ha among various management options and 208 and 236 kg/ha among the cropping systems. Different cropping systems behaved differently (75.3-101.8 kg/ha), the organic carbon content varied 0.52 % (control) to 0.91% (organic nutrient management). DTPA extractable micronutrient content after harvest of wheat 2010-2011, showed that Fe, Mn, Zn and Cu content varied from 8.50 – 8.21; 13.1- 14.7; 0.88-1.30; 7.63-7.72 ppm, respectively, under different organic nutrient management options. The higher soil biological activity evidenced though dehydrogenase, phosphatase and microbial biomass carbon were recorded under various organic nutrient managements compared to control.
In the second experiment, various organic manures, biodynamic formulations and Panchagavya, which are being used in the experiment, were analyzed prior to field application. Application of panchgavya along with organic manures + BD yielded better than other treatments. Higher soil analysis data clearly showed the effect of Panchagavya with Organic Manure and also with

Organic Manures + Biodynamic formulations on soil quality. The soil organic carbon, available N, P and K were higher in OM + BD + PG treatment. Higher soil biological parameters (dehydrogenase, phosphatase and microbial biomass carbon) were recorded in these treatments as compared to either control or bio-dynamic alone. Sowing of rabi crops in both the experiments was taken up on 15th November 2011.

Comment of the House:
The progress was satisfactory.

Externally funded projects

9. Project Title: Assessment of quality and resilience of soils in diverse agro-ecosystems

Funding agency: NAIP

Project cost: Rs. 276.65 lakhs (Rs. 95.42 lakhs for IISS center)

Objective:

1. To identify key indicators for assessment of soil quality and their validation for predominant soil groups and cropping systems in major agro-ecological regions.
2. To determine threshold levels of soil organic carbon pools and other screened indicators for soil quality under diverse agro-ecosystems
3. To investigate into the resilience of some degraded soils with appropriate remedial interventions for identifying its key indicator and restoration.
4. To develop a decision support system for good land care practices linked to a geo-referenced digitized database based on the result/information generated.

Investigators:

PI: Dr. S. Kundu

CO-PIs: Dr. A. Subba Rao, Dr. Muneshwar Singh, Dr. J.K. Saha Dr. A.K. Biswas, Dr. A.K. Tripathi, Dr. K. Sammi Reddy, Dr. R.H. Wanjari, Dr. K.M. Hati, Dr. T. Adhikari and Dr. M. Vassanda Coumar.

Date of Start: 17 July 2008
Date of Completion: 31 March 2012
Project location: Division of Environmental Soil Science

Progress report to IRC (November, 2008):

Recruitment of project staffs completed and specification of approved equipments have been finalized for tender notification. District maps of Vidisha and Sehore have been procured and villages were identified for sampling. From Sehore district soil samplings were completed from 20 villages covering 5 Tehsils and from Vidisha district soil samplings were completed from 28 villages covering 7 Tehsils. Soil samples are being processed for different analysis.

Comment of the House: Progress is satisfactory.

Progress report to IRC (June, 2009):

Soil sampling was completed before start of winter season crops in all the centres. All the identified sites were geo-referenced using GPS. The target districts for soil sampling were Vidisha & Sehore (under AESR 10.1), Rupnagar & Ludhiana (under AESR 4.1), Warangal & Nalgonda (under AESR 7.2) and Hoogly & Bankura (under AESR 15.1).

The preliminary soil analysis results of IISS, Bhopal centre indicated that due to cultivation of crops, the soil organic C (SOC), available Fe and Mn from the surface (0-15 cm) soil layer were decreased by 31.03, 44.6 and 35.8%, respectively in Sehore district; while the SOC, available K and available Fe were decreased by 46.3, 47.6 and 19.9% respectively in Vidisha district as compared to pristine soil.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (November, 2009):
Soil sample collected from Sehore and Vidisha district were analyzed for all the chemical, physical and biological properties as per the approved programme. The distribution of different pools of soil organic carbon (SOC), namely vary labile, labile, less labile and non labile C content were 27.9, 16.4, 36.9 and 18.9 % of the TOC (0.73%) in soils under soybean- wheat cropping in Sehore district, as against 33.4, 21.4, 30.1, 17.8% of the TOC (1.08%) of the pristine soil, respectively. Similar trend was also observed in Vidisha district. Both the district showed increase in less labile C pool in soil due to cultivation over the years. The soils of Sehore district also showed higher content of total N, available N, available P, total P, available K, non-exchangeable K, available S, and available micronutrients as compared to soils of Vidisha district. Considerable decrease in organic P and inorganic P contents were observed in Sehore district due to cultivation over the years where as soils of Vidisha district didn't show any change in both organic and inorganic P content. Based on the measurements made upto Aug. 2009, the mean loss of C from soil under wheat-soybean and chickpea-soybean cropping in AESR 10.1 were 237.2 and 214.6 mg C/ha/year, respectively.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2010):
The principal component analysis was carried out to screen the indicator of soil quality of the district Vidisha and Sehore. The results indicated that Oxidizable C and Oxidizable C/orgne phosphorus were identified as indicator of soil quality in Vidisha whereas TOC, TOC/OP, total Cu, Non-exchangeable – K and silt content were identified as indication of soil quality for Sehore district. The master indicators of explained 43.7% and 52.3% of the yield in Vidisha and Sehore, respectively. The SQI value of Sehore district ranged from 1.31 to 3.92 (with mean value of 2.57) whereas the SQI value in Vidisha varied from 1-4 (with mean value 2.19). The optimum and threshold level of Oxidizable C were 9.72 and 5.14 g/kg soil in Sehore district and 13.07 and 3.23 g/kg were the values for the same in Vidisha district.

Comment of the House:
The progress was satisfactory and PI has asked for inclusion of Dr. M. Vassanda Coumar as scientist in this project.

Progress report to IRC (January, 2011):
During the period under report, field investigation war carried out on 10 farmers field (5 each from Sehore and Vidisha) from Kharif season of 2010, to study the soil resilience after imposing treatment with graded level of charcoal (0, 5.4, 10.8 and 16.2 t/ha). The wood charcoal was characterized in term of nutrient contents (pH – 8.5, C – 65.95%, N – 1.04%, K – 0.80 g/kg, P – 0.609 g/kg, S - 0.315 g/kg, Ca – 1.12 g/kg, Mg – 0.97 g/kg, Fe – 73.75 mg/kg, Mn – 54.06 mg/kg, Zn – 27.71 mg/kg and Cu – 12.5 mg/kg). The CEC of the wood charcoal varied widely depending upon the fineness of the charcoal. The CEC of the charcoal particles having sizes 1 – 2 mm had CEC 19.90 C mol/kg whereas the CEC increased to 51.60 C mol/kg as the particle size decreased to less than 53 μm. In the finer fraction (< 53 μm), 23.8% of the total C was found oxidizable by wet oxidation process, whereas in the coarser fraction (1-2 mm size), only 6.2% of the total C was found oxidizable by Walkly & Black method. There was marked improvement in

Soybean yield due to charcoal application and the yield improvement was more pronounced in soil having low SQI value. In Sehore district, the mean yield of Soybean increased from 1621 kg/ha to 1818, 2005 and 2143 kg/ha due to 5-4, 10.8 and 16.2 t/ha charcoal addition where as in Vidisha district, the mean yield increased from 1636 kg/ha to 1724, 2000 and 2169 kg/ha due to 5-4, 10.8 and 16.2 t/ha charcoal addition, respectively. Soil analysis for recovery of indicators of soil quality is in progress.

Comment of the House:
The progress was satisfactory.

Progress report to IRC (June, 2011):
Yield of wheat crops from 11 farmers field under soil resilience studies was recorded. Application of wood charcoal to the preceding soybean crops was found to have marked residual effect on the succeeding wheat crop. The soils having low SQI value responded well to charcoal application whereas yield improvement was marginal in soils having higher SQI values. For example, at SQI value 1.38, application of 10.8 and 16.2 t/ha charcoal resulted yield improvement by 51.80 and 70.25% over the yield of control plot while in plots having SQI value 3.31, the yield improvement was marginal. Out of the total 276 soil samples collected from farmer's field from Sehore and Vidisha district (AESR-15.1), 42.75, 31.88 and 12.69 % soils were found deficient in 1, 2 and 3 nutrients respectively, while 9.06% soil samples were found to have no deficiency in respect of 9 nutrient elements. The relative SQI values, computed on the basis of 15 known indicators, indicated that in AESR 15.1 (Vidisha and Sehore), 11.23% soils was found to have RSQI values > 70% (very good quality soil), 30.93% soils was found to have RSQI values 60-70% (good quality) 47.10% soils was found to have RSQI values 50-60% (Average quality) and 11.24% soils was found to have RSQI values less than 50% (Poor quality) based on the observed crop yield record.

Comment of the House:
Progress was Satisfactory.
Progress report to IRC (Dec., 2011):

A research investigation was carried out in the farmer's fields to study resilience capacity of Vertisol of AESR 10.1 The resilience index (RI) of the soils of each of the ten sites due to application of charcoal @ 5.4 t/ha (I_1), 10.8 t/ha (I_2) and 16.2 t/ha (I_3) was computed using the following expression

$$RI = \frac{SQI(I) - SQI(d)}{SQI(p) - SQI(d)} \text{ X } 100,$$

Where, SQI (I): The computed SQI value of soil after management intervention (I)
SQI (d): The computed SQI value of soil before the management intervention (I)
SQI (p): The computed SQI value of pristine soil near the corresponding site.

The result showed that the loss of soil quality as compared to respective pristine soil are different in different sites and the values ranged between 0.114 unit (site no. 9) to as high as 0.650 unit (site no. 2). After imposition of interventions, there was improvement in SQI values in each site, however, magnitude of improvement in SQI value varied from site to site. Under intervention I_1 (5.4 t charcoal/ha), I_2 (10.8 t charcoal/ha) and I_3 (16.2 t charcoal/ha) the improvement in SQI values ranged from 0.026 unit (site no. 10) to 0.246 unit (site no. 4), 0.051 unit (site no. 9) to 0.287 unit (site no. 2) and 0.067 unit (site no. 9) to 0.392 unit (site no. 2), respectively. Similarly, under intervention I_1, I_2 and I_3 the resilience index ranged from 10.97 % (site no. 10) to 58.01 %

(site no. 4), 28.27 % (site no. 10) to 65.09 % (site no. 4) and 45.14 % (site no. 10) to 87.95 % (site no. 3), respectively. It was further observed that out of the ten sites the value of resilience index ranged from 28.12 to 68.78 % which resulted in gain in soybean yield ranging from 264 to 442 kg/ha and gain in succeeding wheat yield ranging from 103 to 815 kg/ha. The soil analysis carried out after the harvest of wheat crop showed that out of the eight key indicators identified for vertisol, only two indicators, namely, TOC and Alkaline Phosphatase activity showed significant improvement due to application of wood charcoal. Also we observed significant improvement in microbial biomass C content in the soil due to charcoal application. It could be concluded that improvement in TOC and alkaline phosphatase activity were responsible for the increased resilience in the vertisol.

Comment of the House:
The progress was satisfactory.

10. Project Title: Impact assessment of continuous fertilization on heavy metals and microbial diversity in soils under long-term fertilizer experiment.

Funding agency: Ministry of Forest and Environment, New Delhi
Project cost: Rs. 19.03986 lakhs.
Objective:

1. To estimate build up of cadmium, lead and other toxic metals in soil profile due to continuous application of chemical fertilizer and organic manures under long term fertilizer experiment.
2. To assess the diversity of microbial population in soils as influenced by heavy metal accumulation in soils under long term fertilizer experiment.
3. To investigate the heavy metals contamination in crops as affected by continuous fertilization under long term fertilizer experiment.

Investigators:

PI:	Dr**.** T. Adhikari
CO-PIs:	Dr. R.H. Wanjari, Dr.A. K. Biswas, Dr.Muneshwar Singh, Dr. (Mrs.) S. Singh (CIAE), Dr. S. Kundu and Dr. A. Subba Rao

Date of Start: 1st October 2009

Date of Completion: 1st October 2012

Project location: Division of Environmental Soil Science

Progress report to IRC (June, 2010):
The soil samples were collected from different depths in selected treatments from different centres of All India Coordinated Research Project on Long Term Fertilizer Experiments under different agroecological zone in India like HPKV, Palampur, GBPUAT Pantnagar, BAU, Ranchi, JNKV Jabalpur, and IARI, New Delhi. From these LTFE centres plant samples and fertilizers/organic manures were also collected. From each treatment, soil and plant samples were collected from 3 replications. For microbiological studies soil samples were collected from 5 depths (0-5, 5-15, 15-30, 30-45, 45-60cm) from palampur, Ranchi, Jabalpur while for other centres for heavy metal analysis soil samples were collected from 4 depths (5-15, 15-30, 30-45, 45-60cm). The collected soil and plant samples are properly labeled, processed and being used for analysis.
Comment of the House:
The progress was satisfactory.

Progress report to IRC (January, 2011):
As per approved activity chart of the project, the assigned work for the stipulated period of one year was completed. Administrative work such as SRF Recruitment and purchase of equipments were completed within this year. Under the research work like collection of soil samples from different depth (0-15 cm, 15-30 cm, 45-60 cm) of the treated plots of the selected centres of AICRP (LTFE) viz. Barrackpore, Jabalpur, Bangalore, Ranchi, Palampur, Pantnagar and New Delhi, was completed and for microbial study (0-5 cm, 5-15cm,15-30 cm, 45-60 cm) soil samples were collected from Barrackpore, Jabalpur, Ranchi, and Palampur centre. Besides that different fertilizer samples and plant samples were also collected for laboratory analysis. Soil pH is sensitive to management practices like fertilizer and manure application. Application of

NPK+FYM moderated the soil reaction. pH of NPK+FYM treated plot of Jabalpur centre was recorded 7.44. Electrical conductivity of soil indicates the soluble salts status of the soil. The EC value for most of the soils irrespective of treatments is below 0.25 mmhos cm^{-1} through out all the soil depths viz. 0-15, 15-30, 30-45 and 45-60 cm. The highest value of acid phosphatase activity was recorded in surface horizon of the 100% NPK + FYM. Acid phosphatase activity decreased with an increase in soil depth. As compared to control (unfertilized plots) acid phosphatase activity was increased up to 87 and 111 % in 100% NPK, and 100% NPK +FYM, respectively. The highest FDA values were observed in 0 – 5 cm soil depth as compared to other soil profile. The maximum value of FDA was recorded in 100 % NPK + FYM (48.7 µg Fluorescein g^{-1} soil hr^{-1}). As compared to control (unfertilized plots) FDA was increased up to 46 and 71 % in 100% NPK, and 100% NPK +FYM, respectively. Heavy metal content (<1 ppm) were recorded in soybean grain of Ranchi centre.

Comment of the House:
The progress of the project is not upto the expected level. He has to expedite analysis of the soil samples for heavy metal content.

Progress report to IRC (June, 2011):
The risks of contaminants accumulating in soils and crops due to inadvertent addition of impurities in agricultural fertilizers and soil amendments were assessed in this project work. Elements considered of concern were cadmium (Cd), lead (Pb), chromium (Cr), Nickel (Ni) etc. Results showed that build up of heavy metals in those soils are not alarming after 40 years of cultivation. Amongst the treatment addition of fertilizer at higher doses (150% NPK, 100% NPK+ Zn, 100% NPK+FYM), increased the DTPA Pb content from 0.8 to 1.35 ppm, DTPA Ni content from 0.2 to 0.38 ppm, DTPA Co content from 0.15 to 0.25 ppm in Jabalpur centre.Amongst the fertilizer sample of Jabalpur centre (MOP, Urea, ZnSO4, FYM, SSP and DAP), DAP, SSP, FYM, ZnSO4 content varying amount (mg/kg) of cadmium (Cd), lead (Pb), chromium (Cr), and Nickel (Ni) which may increase the build up of metal in soil. Microbial parameters of Jabalpur centre (DHA, FDA, Acid phosphatase activity, Alkaline phosphatase activity etc.) were not affected by heavy metal content of soil. But with the application of fertilizer and farmyard manure (FYM) enzyme activity was increased as compared to unfertilized plot. To assess the quality of food grain, heavy metal content in wheat and soybean grain was estimated and it has been found that all the heavy metals like Cd, Cr, Pb, Ni, Co were present in the food grain in minute quantity (ppm) (Cd: 0.5 to 1.15, Cr: 4 to 11, Pb: 2to 5, Ni: 2.5 to 4 etc.).
Comment of the House:
The progress was satisfactory.
Progress report to IRC (Dec., 2011):
As per approved activity chart of the project, under the research work like collection of soil samples from different depth (0-15 cm, 15-30 cm, 45-60 cm) of the treated plots of the selected centres of AICRP (LTFE) viz. Barrackpore, Jabalpur, Bangalore, Ranchi, Palampur, Pantnagar and New Delhi, was completed and for microbial study (0-5 cm, 5-15cm,15-30 cm, 45-60 cm) soil samples were collected from Barrackpore, Jabalpur, Ranchi, and Palampur centre. Besides that different fertilizer samples and plant samples were also collected for laboratory analysis. During this period, samples collected from two centres like Bangalore and Barrackpore were analyzed. Results showed that build up of heavy metals in those soils are not alarming after 40 years of cultivation. Amongst the treatment addition of fertilizer at higher doses (100% NPK , 150% NPK, 100% NPK+ lime), increased the DTPA Pb content from 0.9 to 3.5 ppm, DTPA Ni content from 0.2 to 0.89 ppm, DTPA Co content from 0.08 to 0.20 ppm, DTPA Cd content from 0.07 to 0.20 ppm in Bangalore centre. Amongst the fertilizer sample of Bangalore centre

(MOP, Urea, Lime, FYM, SSP and DAP), DAP, SSP, FYM, Lime content varying amount (mg/kg) of cadmium (Cd), lead (Pb), chromium (Cr), and Nickel (Ni) which may increase the build up of metal in soil. To assess the quality of food grain, heavy metal content in maize and fingermillet grain was estimated and it has been found that all the heavy metals like Cd, Cr, Pb, Ni, Co were present in the maize grain in minute quantity (ppm) (Cd: 0.75 to 1.00, Cr: 2.38 to 5, Pb: 2.63 to 7.50, Ni: 1.63 to 1.95 etc.).Microbiological study of Barrackpore centre revealed that the highest value of acid phosphatase activity was recorded in surface horizon of the 100% NPK + FYM. Acid phosphatase activity decreased with an increase in soil depth. As compared to control (unfertilized plots) acid phosphatase activity was increased up to 34 and 145 % in 100% NPK, and 100% NPK +FYM, respectively. The highest FDA values were observed in 0 – 5 cm soil depth as compared to other soil profile. The maximum value of FDA was recorded in 100 % NPK + FYM (48.21 µg Fluorescein g^{-1} soil hr^{-1}). As compared to control (unfertilized plots) FDA was increased up to 51 and 93 % in 100% NPK, and 100% NPK +FYM, respectively.

Comment of the House:
The progress was satisfactory.

Scientist-wise number of Research Projects at IISS, Bhopal (As on 10/12/2011)

SNo.	Name of Scientist	On-going Project		Total
		PI	Co-PI	
1	Dr. Muneshwar Singh	1	8	9
2	Dr. A.K.Shukla	2	3	5
3	Dr. D.L.N. Rao	1	1	2
4	Dr. M.C. Manna	1	6	7
5	Dr. S. Kundu	1	8	9
6	Dr. K. Sammi Reddy	-	8	8
7	Dr. A.K.Biswas	-	12	12
8	Dr. Ajay	1	3	4
9	Dr. J.K. Saha	1	5	6
10	Dr. R.S. Chaudhary	1	4	5
11	Dr. A.K. Tripathi	1	4	5
12	Dr. A.B. Singh	2	4	6
13	Dr. Sanjay Srivastava	-	3	3
14	Dr. Kuntal M. Hati	2	7	9
15	Dr. Tapan Adhikari	2	3	5
16	Dr. S. Ramana	1	5	6
17	Dr. R.H.Wanjari	-	7	7
18	Sh. M.Mohanty	1	2	3
19	Dr. Brij Lal Lakaria	2	5	6
20	Dr. K.Ramesh	2	3	5
21	Dr. Pramod Jha	1	4	5
22	Dr. N.K. Lenka	1	2	3
23	Dr. J.Somasundaram	2	5	7
24	Dr.(Mrs.) Sangeeta Lenka	2	2	4
25	Dr. Ritesh Saha	1	2	3
26	Dr. S.R.Mohanty	2	3	4
27	Dr. R.K.Singh	1	4	5
28	Dr.S. K. Behera	1	5	6
29	Ms. I.Rashmi	1	4	5
30	Ms. Neenu S	2	4	6
31	Dr. Vasanda Coumar	1	7	8
32	Dr. Asit Mandal	1	4	5
33	Dr. M.L. Dotaniya	1	3	4
34	Dr. Jyoti Kumar Thakur	1	4	5
35	Dr. Asha Sahu	1	2	3
36	Ms. T.K. Radha	1	-	1
37	Dr. J.S.V. Tenshia	-	1	1
38	Dr. N.K. Sinha	1	2	3
39	Dr. S. Rajendiran	1	1	2
40	Dr. K. Bharti	-	-	-
41	Dr. Shinogi	-	-	-
42	Dr. Abhishek Rathore (On deputation)	-	1	1
	Scientists from other institute			
1	Dr. B. Mandal	-	1	1

Annexure-1

Scientists who attended the IRC meeting

S.N.	Name of Scientist	Date			
		12.12.2011	13.12.2011	14.12.2011	15.12.2011
1.	Dr. A. Subba Rao	P	P	P	P
2	Dr. Muneshwar Singh	P	A	A	A
3.	Dr. A. K. Shukla	P	P	P	A
4.	Dr. D.L.N. Rao	P	P	A	P
5.	Dr. K. Sammi Reddy	P	P	A	P
6.	Dr. S. Kundu	P	P	P	P
7.	Dr. M.C. Manna	A	P	A	P
8.	Dr. A.K. Biswas	P	P	P	P
9	Dr. R.S. Chaudhary	P	P	P	P
10	Dr. J. K. Saha	A	A	A	A
11.	Dr. A.B. Singh	P	P	P	P
12.	Dr. Ajay	P	P	P	A
13.	Dr. A.K. Tripathi	P	P	P	A
14.	Dr. Tapan Adhikari	P	P	P	P
15.	Dr. Brij Lal Lakaria	P	P	P	P
16.	Dr. Sanjay Srivastava	P	P	P	P
17.	Dr. Kuntal M. Hati	P	P	P	P
18.	Dr. S. Ramana	A	P	P	A
19.	Dr. N. K. Lenka**	-	-	-	-
20	Dr. J. Somasundaram***	A	A	A	A
21.	Dr. R.H. Wanjari	A	A	A	A
22	Dr. K. Ramesh	P	P	P	P
23.	Dr. Pramod Jha	P	P	P	A
24.	Dr. Ritesh Saha	P	P	P	P
25.	Dr. S. R. Mohanty	P	P	P	A
26	Dr. Mrs. K. Bharti	P	P	P	P
27.	Dr. M. Mohanty	P	P	P	P
28.	Dr. Abhishek Rathore**	--	--	--	--
29.	Dr. R.K. Singh	P	P	P	P
30	Dr. Sangeeta Lenka	P	P	P	P
31.	Dr. S. Kumar Behera	P	A	A	A
32.	Dr. Asit Mandal	P	P	P	P
33.	Dr. Asha Sahu	P	P	P	P
34.	Dr. M. Vassanda Coumar	P	P	P	P
35.	Dr. Radha T. K.	P	P	P	P
36.	Dr. I. Rashmi*	A	A	A	A
37.	Dr. Neenu S.	P	P	P	P
38.	Dr. J. S. Virgine Tenshia***	A	A	A	A
39.	Dr. N. K. Sinha	P	P	P	P
40.	Dr. Jyoti Thakur	P	P	P	P
41.	Dr. M. L. Dotania	A	A	A	A
42.	Dr. Rajendran S.	P	P	P	P
43.	Ms. K.C. Shinogi	P	P	P	P

* On study leave, ** On deputation, A: Absent, P: Present; *** On leave;

Scientist-wise number of Research Projects at IISS, Bhopal (As on 10/12/2011)

SNo.	Name of Scientist	On-going Project		Total
		PI	Co-PI	
1	Dr. Muneshwar Singh			
2	Dr. Y. Muralidharudu			
3	Dr. A.K.Shukla			
4	Dr. D.L.N. Rao			
5	Dr. M.C. Manna			
6	Dr. S. Kundu			
7	Dr. K. Sammi Reddy			
8	Dr. A.K.Biswas			
9	Dr. Ajay			
10	Dr. K.N. Singh			
11	Dr. J.K. Saha			
12	Dr. R.S. Chaudhary			
13	Dr. Blaise Desouza			
14	Dr. A.K. Tripathi			
15	Dr. A.B. Singh			
16	Dr. Sanjay Srivastava			
17	Dr. Kuntal M. Hati			
18	Dr. Tapan Adhikari			
19	Dr. S. Ramana			
20	Dr. R.H.Wanjari			
21	Sh. M.Mohanty			
22	Dr. Brij Lal Lakaria			
23	Dr. K.Ramesh			
24	Dr. Pramod Jha			
25	Dr. N.K. Lenka			
26	Dr. J.Somasundaram			
27	Dr.(Mrs.) Sangeeta Lenka			
28	Dr. Ritesh Saha			
29	Dr. S.R.Mohanty			
30	Dr. R.K.Singh			
31	Dr.S. K. Behera			
32	Ms. I.Rashmi			
33	Ms. Neenu S			
34	Dr. Vasanda Coumar			
35	Dr. Asit Mandal			
36	Dr. M.L. Dotaniya			
37	Dr. Jyoti Kumar Thakur			
38	Dr. Asha Sahu			
39	Ms. T.K. Radha			
40	Dr. J.S.V. Tenshia			
41	Dr. N.K. Sinha			
42	Dr. S. Rajendiran			
43	Dr. K. Bharti			
44	Dr. Shinogi			
45	Dr. Abhishek Rathore (On deputation)			
	Scientists from other institute			
1	Dr. B. Mandal			