All India Coordinated Research Project
On
Long -Term Fertilizer Experiments to Study Changes in Soil Quality, Crop Productivity and Sustainability (AICRP on LTFE)

LONG-TERM FERTILIZER EXPERIMENTS have generated enormous and valuable information which could be used for sustainability of high input intensive agriculture. Introduction of high yielding varieties, irrigation and high analysis fertilizer accelerated the mining of nutrient other than supplied eternally from soil. To sustain the productivity it was essential to maintain the supply of nutrients. Since large amount of nutrient has to be applied to soil in chemical form which may have impacted soil properties and soil productivity in long run. Changes in soil fertility, as a result of imbalanced fertilizer use and faulty management practices take few years for appearance of disorders in soil but needs more time for rejuvenation. Long-term fertilizer experiments provide the best possible platform to study the changes in crop productivity, soil properties and processes, identifying emerging nutrient imbalances and deficiencies and overall impact on quality and health of soil. Therefore, to study the impact of chemical fertilizer on productivity and soil quality, the Indian Council of Agricultural Research decided to launch the **"All India Coordinated Research Project on Long-Term Fertilizer Experiments (AICRP-LTFE)"** in September 1970 at 11 centres. The work carried out at different centres of LTFE was reviewed by QRT during 1997 and recommended to enlarge the mandate and objectives of the project and changed the title as **AICRP on "Long-Term Fertilizer Experiments to Study Changes in Soil Quality, Crop Productivity and Sustainability"**. The purpose of conducting long term fertilizer experiments at fixed sites in different agroecological zones (AEZ) with important cropping systems was not only to monitor the changes in soil properties and yield responses and soil environment due to continuous application of plant nutrient inputs through fertilizers and organic sources but also to develop strategies and policies for rational use and management of fertilizers to improve soil quality and to minimize environmental degradation. Thus, the thrust of AICRP-LTFE is on productivity, sustainability and environmental safety.

MISSION

- Soil Fertility Management through Integrated Plant Nutrient Supply for Enhancing and Sustaining Crop Production and Maintaining Soil Quality

MANDATE

- To conduct coordinated long term fertilizer experiments in different soil types under diversified cropping systems
- To collate information on long term soil fertility trials

OBJECTIVES

- To study the effect of continuous application of plant nutrients, singly and in combination, in organic and inorganic forms including secondary and micronutrient elements (as per the need) on crop yield, nutrient composition and uptake in multiple cropping systems

- To study the effect of application of secondary and micronutrients (as per the need) on crop yield and also on the assessment of the need for these elements under an intensive cropping programme.
- To work out the amount of nutrient removal by the crops
- To monitor the changes in soil properties as a result of continuous manuring and cropping with respect to the physical, chemical and microbiological characteristics of the soil in relation to its productivity
- To investigate the effect of intensive use of biocidal chemicals (weedicides and pesticides) on the build up of residues and soil productivity
- To make an assessment of the incidence of soil borne diseases and changes in pests and pathogens under the proposed manuring and cropping programme
- To assess impact of changing climate on crop productivity and soil health.

TREATMENT DETAILS

T_1 : 50% optimal NPK

T_2 : 100% optimal NPK

T_3 : 150% optimal NPK

T_4 : 100% optimal NPK + hand weeding

T_5 : 100% optimal NPK + Zinc or lime

T_6 : 100% optimal NP

T_7 : 100% optimal N

T_8 : 100% optimal NPK + FYM

T_9 : 100% optimal NPK (Sulphur free source)

T_{10} : Unmanured (Control)

COORDINATING CENTRES UNDER AICRP-LTFE:

The ICAR-Indian Institute of Soil Science, Bhopal is a headquarter and acts as Project Coordinating Unit for following centres of AICRP-LTFE.

S. No.	Location (State)	Year of start	Taxonomic Class	Existing cropping system
1.	ICAR-CRIJAF Barrackpore (West Bengal)	1971	*Typic Eutrochrept*	Rice-wheat-jute fibre
2.	PAU Ludhiana (Punjab)	1971	*Typic Ustochrept*	Maize-wheat
3.	ICAR-IARI New Delhi (Delhi)	1971	*Typic Ustochrept*	Maize-wheat
4.	TNAU Coimbatore (Tamil Nadu)	1971	*Vertic Ustopept*	Fingermillet-maize
5.	GBPUA&T Pantnagar (Uttarakhand)	1971	*Typic Hapludoll*	Rice-wheat
6.	JNKVV Jabalpur (Madhya Pradesh)	1972	*Typic Chromustert*	Soybean-wheat
7.	UAS GKVK Bangalore (Karnataka)	1972	*Kandic Paleustalf*	Fingermillet-maize
8.	BAU Ranchi (Jharkhand)	1972	*Typic Haplustalf*	Soybean-wheat
9.	CSKHPKV Palampur (Himachal Pradesh)	1972	*Typic Hapludalf*	Maize-wheat
10.	JAU Junagadh (Gujarat)	1996	*Vertic Ustochrept*	Groundnut-wheat
11.	Dr PDKV Akola (Maharashtra)	1996	*Typic Haplustert*	Sorghum-wheat
12.	KAU Pattambi (Kerala)	1996	*Typic Haplustalf*	Rice-rice
13.	IGKV Raipur (Chhattisgarh)	1996	*Typic Haplusterts*	Rice-wheat
14.	MPUA&T Udaipur (Rajasthan)	1996	*Typic Ustochrept*	Maize-wheat
15.	VNMAU Parbhani (Maharashtra)	1996	*Typic Chromustert*	Soybean-safflower
16.	PJTSAU RRS Jagtial (Telangana)	2000	*Typic Tropaquept*	Rice-rice
17.	OUAT Bhubaneswar (Odisha)	2002	*Aeric Haplustalf*	Rice-rice
B	**Voluntary centre**			
18.	ICAR-IASRI New Delhi	1972	-	-

SALIENT ACHIEVEMENTS

THE LONG–TERM FERTILIZER EXPERIMENTS conducted across the country clearly brought out that balanced and integrated nutrient management sustained the crop productivity, soil quality and overall soil health. The findings emanated from AICRP LTFE are highlighted hereunder:

- The crop yield trends in the long term fertilizer experiments (LTFEs) are in the order of 100% NPK+FYM > 150% NPK > 100% NPK+Zn / lime >100% NPK > 50% NPK > 100% NP > 100% N>Control at most of the LTFE locations. The balanced fertilizer use sustained the crop productivity across almost all the locations. The integrated nutrient management (100% NPK+FYM) further improved the crop productivity and soil quality under LTFEs.
- Balanced fertilizer use as well as integrated nutrient management (100% NPK+FYM) improved physical, chemical and biological state of soil.
- Crop yield data for Alfisols of Palampur, Ranchi and Bangalore indicated that soil amended with FYM found to be superior to lime as far as crop productivity is concerned. Application of organic manure helps in moderating soil condition in addition to supply nutrients whereas lime merely increases soil pH.
- Balance application of nutrients (fertilizers and manure) resulted in increase of the population of soil microorganisms. Increase in application of nutrient from 100 to 150% also had positive effect on soil microbial count and also enzymatic activities.
- In Vertisols of Raipur, yield can be sustained with balance application of fertilizer nutrients as well as integrated nutrient management (INM) in rice and wheat.
- In Vertisols of Akola, results indicated that exclusive application of nutrients through organic manure (FYM) even after 34 years could not keep the pace with 100% recommended NPK. It is advised that there is need to increase the dose of organic manure (FYM) to optimize the yield and to keep the pace with inorganic nutrient application.
- In Alfisols, results indicated that application of only urea (i.e. 100% N alone) had deleterious effect on crop productivity of maize and wheat at Palampur, soybean and wheat at Ranchi, finger millet and maize at Bangalore. This is due to decline in soil pH which reduces the availability of P and K to a large extent.
- Irrespective of soil and crop, incorporation of farm yard manure (FYM) or green manure not only resulted in increase in productivity but also increase microbial count and their enzymatic activities.
- Application of FYM continuously along with balanced fertilizers found to decrease soil bulk density, compared to imbalance and unmanured treatments. Similarly, hydraulic conductivity, mean weight diameter, water stable aggregates, infiltration etc. got remarkably improved under balance and INM (100% NPK+FYM) practices under LTFEs.
- Soil biological parameters such as microbial count, dehydrogenase activity, biomass C and N, urease activity, phosphatase enzymes found to be encouraged with balanced and INM (100% NPK+FYM) nutrient options across soil types under LTFEs.
- Nutrient dynamics studies carried out at LTFE sites suggests both macro and micronutrient fractions were found to be highest in 100% NPK+FYM. The water soluble, exchangeable and non-exchangeable K were recorded higher in balance nutrient application and INM treatments at most of the LTFEs.

- Imbalance nutrient application resulted in low yield of major crops in LTFEs. On the contrary, balance nutrient application sustains crop productivity as well as nutrient uptake. The INM through 100% NPK+FYM further improved nutrient uptake.
- Results revealed that decline in P dose to half in the plots/fields, wherein P accumulated as in case of soils of Ludhiana (Punjab), Bangalore (Karnataka) and Jabalpur (Madhya Pradesh) did not have any adverse effect on crop productivity. Thus, it can be inferred that P accumulated over the years can be reutilized in these areas.
- Application of balanced use of fertilizer catalyzed the enzymatic activities such as dehydrogenase activity in soil which resulted in evolution of more CO_2. Thus, observations clearly demonstrated that balance application of fertilizer is essential for not only sustaining the crop productivity but also to maintain or enhance microbial population in soil.
- Rice yield at Pantnagar (Mollisols) indicated that combined application of Zn and S had additive effect. Thus, Zn and S need to be supplied simultaneously for enhancing/maintaining crop productivity in Mollisols of Uttarakhand.
- The increase in productivity on use of balanced fertilizer resulted increase in carbon and microbial population in soil and thus ruled out the assumption that chemical fertilizer deteriorate soil carbon and adversely affects the growth of microorganisms.
- The Carbon Management Index (CMI) was maximum with 100% NPK+FYM. Soil with higher CMI values are considered as better managed soil. The CMI significantly enhanced by 100% NPK+FYM compared to balanced or imbalanced nutrient application.
- The technology demonstration on farmers' field under Tribal Sub Plan (TSP) and Scheduled Caste Sub Plan (SCSP) clearly demonstrated the yield advantage and also monetary gain on adoption of balanced and integrated nutrient management (INM) doses of nutrients over imbalance and farmers' practice.
- Balance nutrient application gives greater sustainable yield index (SYI) and integrated nutrient management (INM) had further improved SYI. In Alfisols, application of N alone gave lower values of SYI compared to balance and INM treatments.
- Soil quality index (SQI) was derived by taking into account 30-35 soil parameters (chemical, physical and biological) and it was found that SQI was higher in balanced nutrient application. Further, SQI improved with an application of NPK along with FYM/Lime.
- Developed and updated AICRP LTFE database i.e. Information System on Long Term Fertilizer Experiments (ISLTFE) by Indian Agricultural Statistics Research Institute (ICAR-IASRI), New Delhi. Data has been uploaded on ISLTFE for various centers with the support of KRISHI project. The data updates are in progress.
- A soil carbon (C) and nitrogen (N) turnover model has been developed by ICAR-Indian Institute of Soil Science, Bhopal by using the dataset on soil as well as crop over the years under long term fertilizer experiments in India.

Aerial view of Soybean LTFE site at VNMAU, Parbhani (Maharashtra)

A field layout for rice at the LTFE site
at PJTSAU RRS, Jagtial (Hyderabad) (Telangana)