TECHNICAL PROGRAMME

AICRP-RICE
(SOIL SCIENCE)

2023 – 24

ICAR - Indian Institute of Rice Research (IIRR)
Rajendranagar, Hyderabad - 500 030, Telangana.

Trial No-1: Long-term soil fertility management in rice-based cropping systems (RBCS) (Kharif and Rabi)

Objectives:

1. To study the potential of carbon sequestration in the soils in all the treatments, besides analysing soil for biological parameters like soil respiration, microbial biomass carbon, important enzyme activities and available sulphur and zinc status and contribution of irrigation water/silt to S nutrition. The methodology for C sequestration and enzyme studies will be provided later.
2. To evaluate the influence of liming (in acids soils only) on rice productivity and nutrient dynamics (treatment no. 7) and additional dose of vermicompost and oil cakes (treatment no. 13)

Treatment Details:

1	Control –1, No fertilizer or manure
2	100% PK (-N)
3A	100% NK in place of 100% N (-P)
3B	STCR recommended dose for target yield
4	100% NP (-K)
5A	100 % NPK + Zn + S
5B	100% NPK+ Zn + S + FYM / PM @ 5 t/ha (to be applied in *Kharif* and *rabi* seasons)
6	100% NPK –Zn
7A	100% NPK – S
7B	100% NPK – S + liming @1.0 t/ha (only in acid soils - Titabar)
8	100% N + 50% P + 50%K
9A	50% NPK
9B	50% NPK+ *Azospirillum* + PSB (both seasons in rice-rice and in *Kharif* in rice-CP system)
10	50% NPK + 50% GM – N (GM – N to be applied in both seasons)
11	50% NPK + 50% FYM – N (FYM – N to be applied in both seasons)
12	50% NPK + 25% GM-N + 25% FYM–N (GM and FYM–N applied in both seasons)
13A	FYM @ 10 t/ha (*Kharif*) ; FYM @ 15 t/ha (*Rabi* season)
13B	FYM@10t/ha + 3.0 t/ha Vermicompost + 200 kg/ha oil cakes as top dressing (In both *Kharif* and *Rabi* season)

At all locations, in treatment 9B, PSB is included additionally along with Azospirillum

Design: RBD; **Replications: 4**; Gross plot size: 100 m^2 surrounded by 1-2 m wide buffer zone.
Spacing: 20 x 10 cm (for rice) and for other crops as per recommendation.
Water management: Continuous submergence up to 5-8 cm depth for rice, and for other crops irrigation to be provided as per recommendations.

Experimental details:

1. NPK levels: The recommended levels of NPK for the respective zone, crop and season have to be applied. The levels of NPK applied should be reported for each crop/season.
2. Apply $ZnSO_4$ @ 40 kg/ha once either in *Kharif or Rabi* season depending on the local recommendations, uniformly to all the plots except in treatments 6 and 7.
3. In treatment No.6 Zn should not be applied while in treatment No.7, Zn is applied by dipping seedlings in 2.0% ZnO_2 suspension before transplanting rice.
4. In treatment No.7 phosphorus is applied through triple super phosphate (TSP) or Diammonium Phosphate (DAP) instead of Single Super Phosphate (SSP) to avoid application of S. In all other treatments P is supplied through SSP. This has to be followed for both the seasons continuously. In acid soils (Titabar only), liming treatment may be imposed in 50% of the plot area by applying lime @ 1 t/ha in *Kharif* season to assess the impact of lime on soil nutrient dynamics and rice productivity.
5. Treatment No. 3: One half of treatment 3 should be imposed with 100%NK treatment in place of 100% N treatment, and in the second half impose soil test based fertilizer recommendation for a yield target of *Kharif* and *Rabi* crops obtained at each location. Analyse the soil in treatment No. 3 for available N, P, and K and apply STCR fertilizer recommendation as per the equation developed for the district by STCR scheme. The yield target yield should be the one that is realisable at the location recorded in the STCR experiments or in progressive farmers' fields. Report the STCR recommended dose and the target yield fixed.
6. Treatment No.5: One half of the plot should be continued as per the old treatment. In the second half impose additionally FYM/poultry manure @ 5 t/ha. The nutrient composition (NPK) of the FYM/poultry manure applied should be furnished.
7. Treatment No 9: One half of the treatment area should be continued as per the old treatment i.e., 50% NPK. In the second half impose bio fertilizer treatment of applying *Azospirillum* mixed in suitable quantity of cow dung /FYM slurry at the rate recommended for the location for both *Kharif* and *Rabi* crops in rice – rice system, and for *Kharif* crop in rice –cowpea system. The quantity and the rate of bio fertilizer application and the procedure followed should be reported.
8. N and K, wherever necessary are applied through urea and muriate of potash (MOP). However, in treatment No.7, where DAP is the source of P, the N applied through DAP should be accounted for the total N dose.
9. For treatments 10 and 12, 8 weeks old Dhaincha (*Sesbania aculeata*) or leaves of *Glyricidia* sp. plants or any other green manure crop suitable to the location should be used in both the seasons (*Kharif and Rabi*) to supply the required amount of N. The quantity of green manure (fresh) incorporated and N content on ODB per hectare basis should be reported.
10. For the treatments 5, 11, 12 and 13, locally available, well-decomposed farmyard manure (FYM) should be applied. Analyse for C, N, P, K contents in the manure used and report the data on moisture and nutrient contents. Further, in treatment no. 13 as suggested during the annual workshop additional treatment of 3.0 t/ha of vermicompost plus 200kg/ha of oil cakes

over and above 10 t/ha of FYM should be applied as top dressing in 50% of the plot area (50 sq. m) in both the seasons to study its effect on the overall soil and crop productivity in view of reduced crop yields recorded in the treatment.

11. Before applying GM or FYM in both seasons (*Kharif and Rabi*), calculate quantity to be applied based on the N content and moisture percentage of the manures. Report the quantity of FYM applied. Raise the green manure *in situ* wherever possible.

12. All plant protection measures and other management practices must be followed as per recommendations.

13. Promising treatments should be validated in about five (5) farmers' fields of 0.5-1.0 acre (2000-4000 sq. meters) under FLDs around the location in comparison with current nutrient practices to demonstrate and transfer the technology. The results of the demonstration on yield, nutrient accumulation and basic soil data have to be reported.

Soil and Plant Sampling and Analysis:

- At the end of each cropping season (at the harvest) about 1 kg of composite soil sample (0 – 15 and 15 – 30 cm depth) should be drawn from each replicate and treatment, processed and preserved for analysis.
- Report grain and straw yields after harvest in **kg/ha** or **tonnes/ha.**
- Grain and straw samples at maturity should be collected, oven dried and processed for analysis to estimate crop removal of nutrients.

Observations (after each crop):

1. Moisture and nutrient (N, P, and K) content of organic manures on ODB.
2. Grain and straw yields for *Kharif* and *Rabi* crops.
3. Replicate-wise content of nutrients in grain and straw at harvest *viz*., N, P, K, S and Zn.
4. Replicate-wise soil analysis for available N, P, K, S, Zn and org. C.
5. Bulk density of the soil to be measured for evaluating changes in soil physical conditions.
6. S content in irrigation water and silt in water.
7. Microbial biomass carbon and dehydrogenase enzyme activity after harvest of *Kharif* rice (Procedure enclosed) *
8. Incidence of pest/disease and other observations on crop performance treatment wise.

Estimation of microbial biomass:

i) Fumigation and extraction method for measuring soil microbial biomass: Chloroform is used as fumigant for measuring biomass as it is an effective biocide, and does not solubilizing or predispose non-microbial soil organic matter. The increase in extractable organic C following soil fumigation is used to estimate C held in the soil microbial biomass.

Procedure:

- Weigh 20 g (dry weight) of moist sieved soil in duplicate into glass beakers.
- Fumigate one set with ethanol free $CHCl_3$* leaving the other set non-fumigated by placing the beakers in a large vacuum desiccator that is lined with moist filter paper.

- A beaker containing 50 ml of alcohol-free $CHCl_3$, and anti-bumping granules is placed in the desiccator.
- The desiccator is then evacuated with the help of vacuum pump till the $CHCl_3$ starts boiling. Allow the $CHCl_3$ to boil for 1 – 2 min, seal the desiccators and incubate the samples under $CHCl_3$ vapor for 18 to 24 h at 25^{o}C.
- Then break the vacuum in the desiccators slowly, open it, and remove the moist paper and $CHCl_3$ vapors by repeated evacuations.
- Non-fumigated control soil samples are also kept in a desiccators lined with moist paper for 18 to 24 h at 25^{o}C.
- After fumigation, extract the soil with 0.5*M* K_2SO_4 (1:4 soil: solution ratio) for 1 h.
- Filter the extracts through Whatman no. 1 filter paper and store the extracts at 4 -5^{o}C till further assay.
- An aliquot of the K_2SO_4 soil extract is used for measuring organic C in the extracts.

Microbial biomass C (mg C/kg dew of soil) = (C content in extracts of fumigated soil - C content in extracts of non-fumigated soil) / 0.411 (K_c)

ii) Spectrophotometric method:

Pipette out 5 ml portions of the extract into digestion tubes, add 5 ml of 0.07 N $K_2Cr_2O_7$, add 10 ml of 98% K_2SO_4, add 5 ml of 88% H_3PO_4 and mix well. Use 0.5 M K_2SO_4 as blank. Boil samples in a digestion block for 30 minutes at 150^{0}C. Cool samples before reading absorbance at 440 nm. **Standard:** 1000 mg/l carbon in sucrose (0.2377g sucrose in 100 ml of 0.5 M K_2SO_4. **Working standards:** 0, 20, 40 60, 80, 100 and 150 mg/l carbon (dilute 0, 2, 4, 6, 8 10 and 15 ml of stock to 100 ml with 0.5 M K_2SO_4) Purify by shaking (3x) 5 ml chloroform with 5 ml of 5% H_2SO_4 and then wash 3x with distilled water and dry over K_2CO_3.

II. Eestimation of dehydrogenase enzyme activity in soil (Casida *et al.,* 1964**)**

Reagents:
1) Calcium carbonate ($CaCo_3$), reagents grade.
2) 2, 3, 5-Triphenyl-tetrazolium chlorides (TTC), 3%: Dissolve 3g of TTC in about 80 ml of water and adjust the volume to 100 ml with water.
3) Methanol, analytical reagent grade.
4) Triphenyl formazan (TPF) standard solution: Dissolve 100 mg of TPF in about 80 ml of Methanol, and adjust the volume to 100 ml with methanol. Mix thoroughly.

Procedure:

Thoroughly mix 20 g of air-dried soil (<2mm) and 0.2 g of $CaCO_3$, and place 6 g of this mixture in each of three test tubes. To each tube add 1 ml of 3% aqueous solution of TTC and 2.5 ml of distilled water. This amount of liquid should be sufficient that a small amount of free liquid appears at the surface of the soil after mixing. Mix the contents of each tube with a glass rod, and stopper the tube and incubate it a 37^{0}C. After 24 h, remove the stopper, add 10 ml of methanol, and stopper the tube and shake it for 1 min. Un-stopper the tube, and filter the suspension through a glass funnel plugged with absorbent cotton, into a 100 ml volumetric flask. Wash the tube with methanol and quantitatively transfer the soil to the funnel, then add additional, methanol (in 10-ml portions) to the funnel, until the reddish colour has disappeared from the cotton plug. Dilute the filtrate to a 100 ml volume with methanol. Measure the intensity of the reddish colour by using a spectrophotometer at a wavelength of 485 nm and a 1-cm cuvette with methanol as a blank. Calculate the amount of TPF produced by reference to a calibration graph prepared from TPF standards. To prepare this graph, dilute 10 ml of TPF standard solution to 100 ml with methanol (100 mg of TPF ml^{-1}), make up the volumes with methanol, and mix thoroughly. Measure the intensity of the red colour of TPF as described for the samples. Plot the absorbance readings against the amount of TPF in the 100 ml standard solutions.

Important decisions in the group meeting: (All centres are requested to follow the below instructions)

- It was decided to select the most popular and high-yielding variety for this trial.
- It was decided to leave a buffer zone of at least 1 meter on all sides.
- Any additional observations viz., Pest and disease occurrence may be collected.
- It was decided to study the microbial properties in selected important treatments at NRRI by a microbiologist.
- It was decided to study the temporal and spatial yield stability.
- Critical analysis of buildup of P, S and Zn to be analyzed from selected LTFE treatments over the years
- Any other important soil parameters can be studied in detail in the following treatments,

Trt. No.	Treatment details
1	Control –1, No fertilizer or manure
5A	100 % NPK + Zn + S
5B	100% NPK+ Zn + S + FYM / PM @ 5 t/ha (to be applied in *Kharif* and *Rabi* seasons)
9A	50% NPK
12	50% NPK + 25% GM-N + 25% FYM–N (GM and FYM–N applied in both seasons)
13A	FYM @ 10 t/ha (In both *Kharif* and *Rabi* seasons)

Locations (3): Mandya, Maruteru, Titabar

Trial No 2: *Soil quality and productivity assessment for bridging the yield gaps in farmers' Fields (Kharif)*

Rice production must increase to meet future food requirements amid strong competition for limited resources. Large variations in yield are a major impending problem for rice sustainability in India. Yield gap analysis is a useful method to examine how large the ranges are between potential, desirable rice yields and those actually realized in farmers' fields. Balanced nutrient application is a must to meet the growth requirements of a genotype for realizing the yield potential of several contemporary genotypes. Current fertilizer management practices, in general, are not tailored to site specific soil nutrient supply capacities and crop demand. Blanket fertilizer recommendations are still being followed in large domains with less importance being given management-induced site variations of soil nutrient supply capacities, and crop demand more so when new high yielding cultures with increasing yield potential are being regularly introduced. In view of this, an existing old trial is modified and reported here.

Objectives:

1. To identify the soil related and management constraints limiting the productivity in farmers
   Fields
2. To give site specific recommendations to the farmers for higher productivity.

Note: The fertilizer recommendations given below in the table will be tested in the low yielding farm sites in *Kharif*-2022.

Type of data collection : By Survey in the new farm sites

Methodology: A Survey will be conducted in nearby villages during *Kharif* -2022 involving data collection from around 20-30 farmers regarding Variety, sowing time, manures and fertilizer application, management practices, Yield, weather parameters, soil conditions as per their knowledge and other details. The farmers will be grouped into Low and high categories based on their yields. Soil and plant samples will be collected from field after harvest and analyzed for their nutrient contents. The data will be analyzed critically and the reasons for low yield will be identified in comparison with high yielders. For next season crop, site specific recommendations to the farmers will be given for higher productivity and soil health improvement.

Observations: 1. Soil type. 2. Variety and seed rate 3. sowing time 4. Manures and fertilizer application 5. Management practices followed 6. Harvesting time 7. Yield 8. Rainfall 9. Insect Pests 10. Diseases 11. Initial/post-harvest soil analysis data 12. Nutrient uptake at harvest

Note: Interested cooperators **FROM AGRONOMY** discipline can take up this trial.

Rice productivity in relation to internal supply capacity of nutrients in farmers' fields, *Kharif* 2022

Site-specific fertilizer recommendation (kg/ha) for target yields for *Kharif* season of 2022

Site /centers	**Current yield low yielders group (kg/ha)**	**Current yield High Yielders group (kg/ha)**	**Per cent increase in yield over low yielders groups**	**Fertilizer recommendation for the target yield (t/ha)** Chinsurah, 5. Titabar-3.5, Ludhiana-3.5, Moncompu-4.5, Pantnagar-6.5 Kaul -8.0, Kanpu-6.5		
				N (Urea)	**P_2O_5 (SSP)**	**K_2O (Potash)**
Chinsurah	2.38	5.00	52	100	25	55
Titabar	2.48	3.43	28	70	21	38
Ludhiana	2.90	3.50	17	70	21	38
Moncompu	2.40	4.32	44	65	33	77
Pantnagar	4.39	5.94	26	49	19	82
Kaul	1.44	8.80	84	159	65	170
Kanpur	4.76	6.59	28	70	19	138

Important decisions in the group meeting:

- **Potential yield of the location to be recorded**
- **Soil health indices to be calculated and related with yield gap**

Locations (4): Chinsurah, Cuttack, Kanpur, Pantnagar

Soil Science coordinated trial No. 2 (Questionnaire)

Soil quality and productivity assessment for bridging the yield gaps in farmers Fields

Details of crop management practices followed by the farmers (Season- *Kharif* -----------):

Name of the farmer :

Village : **Mandal / Tehsil :**

District : **State :**

Land holding / cultivated area (ha):

GPS coordinates (Longitude/ latitude) of the site:

Soil type : Soil fertility status (kg/ha) : N: ______ P_2O_5: _____ K_2O:_____

Zn: ___________

Rice ecosystem: Irrigated / Rain fed low land

Variety: _______________ Duration (days): ___________________

Date of sowing: ____________ Date of Planting: ____________

Water source: Canal / Tank / Bore well / Water quality: _______________

Crop management:

Organic manures applied (t/ha) ____________ (FYM / Compost / Poultry manure / Green manure / crop residue)

Fertilizer recommendations for the site (kg ha); N___, P_2O_5____K_2O ___ Any other nutrients: ______

Farmer's fertilizer practice: N: ____, P_2O_5: _____, K_2O _____ Any other nutrients: ______

Fertilizer sources used: _________________________

Top dressing (Qty. kg / ha) and source including stage of crop (days after planting) :

1.________ at stage (DAT); 2 __________ at stage (DAT); 3, ____________at stage (DAT)

Pest management: Major pests : ____________________

Control strategies : ____________________

Soil related problems: Salinity / alkalinity / acidity ____________________________________

Any other problems: ____

Observations:
Crop data at harvest:

Yield (3 replication): Gross plot (m^2) _______ Net plot (m^2):______________ **of each farm**

Soil data (pre sowing or post harvesting)

Soil Texture : ______________

pH (1:2 ratio: soil/water) : ______________

EC (1:2 ratio: soil/water) : ______________

OC (%) : _____________

Available N (kg/ha) :_______________

Available P_2O_5 (kg/ha) : _______________

Available K_2O (kg/ha) : ________________

Available Zn: _________________________

<u>Note</u>: Please identify any specific soil related/management related constraints that are limiting the yields and mention in the excel sheet

Trial No.3: ***Management of Sodic soils using nano Zn formulation***

Objectives:

- To study the direct, residual and cumulative effects of Zn formulations on nutrition and productivity of rice based cropping system and to evaluate germplasm in sodic soils.
- To study the influence of Zn formulations on sodic soil properties
- To study the effect of nano Zn formulations on grain Zn content and its effective translocation.

Lay out: Fixed plot (undisturbed) layout;
Varieties: Rice - varieties will be sent by IIRR (IIRR)
Design: Split plot design
Main plots: Treatments: 6
1) Control (NPK alone)
2) $ZnSO_4$ @ 0.5 % foliar spray, One at tillering and other at PI stages
3) Nano Zn (20 ppm; 2ml/L), One at tillering and other at PI stages
4) Nano Zn (50 ppm; 5ml/L), One at tillering and other at PI stages
5) Soil application of $ZnSO_4$ (50 kg /ha)
6) Silicic acid 40 ppm – Four sprays at 15 days' interval starting from 15 DAT (days after transplanting)
7) Silicic acid 80 ppm – Four sprays at 15 days' interval starting from 15 DAT (days after transplanting)
Subplots: Génotypes**;** Génotypes (CSR 23 and DRR Dhan 48) and products will be sent by IIRR.
(Please use the seed of your previous *kharif* season)

Cropping system: Rice in *Kharif* followed by rice in *Rabi* season to be grown with standard package of practices and recommended fertilizer dose.

Plot size: At least 25 m^2 (Undisturbed layout); Replications**:** 4

Spacing: Rice – 20 cm x 10 cm.

Water management: Frequent irrigation to shallow submergence for wetland rice. Drainage facility should be provided for the experimental plots

Experimental details:

❖ Select experimental field with high pH soil. Bulk soil sample (0-15 cm depth) representing the experimental area should be collected before the imposition of treatments and analysed for pH, OC, EC, ESP, exch. Ca and Mg, SAR, available N, P, K, S, Zn, Fe, Mn

❖ Plough the land dry, puddle the soil block wise and layout the plots.

- ❖ Apply recommended dose of fertilisers for the location and crop. N through urea in 3 split doses (1/3: 1/3: 1/3). Report the fertilizer dose.
- ❖ All Basal application of N, P, K and S should be incorporated into the soil up to 15 cm depth before transplanting rice.
- ❖ *Rabi* crop also has to be grown following standard package of practices. Report the nutrient doses applied, yield of grain, straw/shoot weight.

Observations:

- ❖ Grain and straw yield, yield parameters of *Kharif* rice and *Rabi* crops. Report grain and straw yields after harvest in kg/ha or tonnes/ha.
- ❖ Initial soil analysis for soil pH, OC, texture, CEC, ESP, EC, SAR, Soluble Na, Ca, Mg, K, exchangeable Ca, Mg, Available N, P, K, Zn, Fe, Mn and S before amendments are applied.
- ❖ Analyse plant samples (grain and straw) for Zn content drawn from each plot. Report all data replicate wise.
- ❖ Post-harvest soil properties to be reported
- ❖ Care should be taken to avoid contamination of grain/straw samples from dust/metals, etc. Before analysing the grain samples, the material should be washed with tap water followed by 2% HCl, tap water, distilled water (in sequence) for few minutes, dried with filter paper immediately and oven dried in containers at 50-60^{o}C to uniform weight.

Note 1**:** The evaluation of varieties will be done for sodic and saline soils with a minimum of 6 – 10 centres. Management aspects also can be included. Wherever sodic and saline soils exist and that centre does not have Soil Scientist, Agronomists can take up this trial.

- **<u>Note:</u> Same set of genotypes should be tested for two years**
- **Plant Physiologist can be associated and observations to be taken by him/her**
- *Zinc analysis in plant/soil samples will be done at one place (NRRI) (Processed and extracted sample will be sent to NRRI for analysis)*

Locations (4): Faizabad, Mandya, Kanpur, Pusa

Trial No 4: Management of Acid soils *(Kharif)*

Objectives:

- To evaluate the germplasm/genotypes for tolerance to soil acidity related nutrient constrain in typical locations
- To identify the better management practice for high productivity under soil acidity.

Ecosystems: The experiment can be laid out either in **Rain fed/irrigated conditions** in a soil of pH less than 5.5 (Soil: water 1: 2).

Design: Split plot design

Main plots: Treatments

1) RDF (Control)

2) RDF +Silixol spray 3 times 1. Vegetative stage – 50 ml per Knap sack sprayer
2. 500 ml/acre at booting stage
3. 500 ml/acre at grain filling stage

3) RDF + Rice husk ash @ 500 Kg/ha; 300 kg/ha basal and 200 kg/ha 30 days after transplanting

4) RDF + Dolomite @ 500 Kg/ha; 300 kg/ha basal and 200 kg/ha 30 days after transplanting

5) RDF + Silixol spray as in T2 + Dolomite @ 250 Kg/ha 30 days after transplanting

6) RDF + RHA @ 250 Kg/ha during land preparation + Dolomite @ 250 Kg/ha 30 days' after transplanting

7) RDF+ Potassium Silicate Solution- Four sprays at 15 days' interval starting from 15 DAT (days after transplanting)

8) RDF + Dolomite + Silicate solution (Four sprays at 15 days' interval starting from 15 DAT (days after transplanting)

Génotypes : Vasundhara from Titabar and Uma from Moncompu will be sent by IIRR.

(Please use the seed of your previous *kharif* season)

Plot size: At least 25 m^2 (Undisturbed layout); Replications**:** 4; Design: Split plot design

Spacing: Rice – 20 cm x 10 cm.

Water management: Frequent irrigation to shallow submergence for wetland rice. Drainage facility should be provided for the experimental plots

Observations:

- Grain and straw yield, yield parameters of *Kharif* rice and *Rabi* crops. Report grain and straw yields after harvest in kg/ha or tonnes/ha.
- Initial soil analysis for soil pH, OC, texture, CEC, ESP, EC, SAR, Soluble Na, Ca, Mg, K, exchangeable Ca, Mg, Available N, P, K, Zn, Fe, Mn and S before amendments are applied.
- Analyse plant samples (grain and straw) for N, P, K, Zn, Fe, and Mn drawn from each plot. Report all data replicate wise.
- Post-harvest soil properties to be reported

- Care should be taken to avoid contamination of grain/straw samples from dust/metals, etc. Before analysing the grain samples, the material should be washed with tap water followed by 2% HCl, tap water, distilled water (in sequence) for few minutes, dried with filter paper immediately and oven dried in containers at 50-60 ^oC to uniform weight.
- Silicon content and uptake to be reported

Silicon estimation in plants (Saito et al, 2005)

- Dried rice plant samples are milled or cut to small pieces. Place 0.5 g DW of plant sample in a 50 mL plastic bottle. Add 10 mL of the HF solution, stopper the bottle, stir the content of the bottle to immerse the plant tissues in the HF solution, and let it stand for 30 min at 30°C (1 h at 18°C) with occasional stirring (roughly every 10 min). Add 40 mL of distilled water, stir to homogenize the content, and let plant materials settle for 20 min. For example, immersing 100 mg of plant samples in 2 mL of the HF solution for 1 h, and then, diluting with 8 mL of distilled water. The aliquot (0.1 mL) of the clear supernatant is taken for the spectrometric determination with the molybdenum yellow method.
- The working Mo standard solution is prepared prior to use. Plastic tubes (20-mL volume) and micropipettes with plastic tips are used. Each aliquot, 0.100mL, of standards of 0-3,000 mgL^{-1} SiO_2 or of the sample extract solutions is transferred to a plastic tube. Add 2.0 mL of the 0.1 M B solution, rinsing any droplets of the extract solution inside the tubes. Add 2.0 mL of the Mo working solution and mix the contents. Allow 3 min (not more than 15 min) for the formation of molybdenum yellow to be completed, and then, add 4.0mL of the 0.1 M citric acid solution, stopper the tube and mix the content. Measure the absorbance at 400nm with a spectrophotometer, from 4 to 10min after the addition of citric acid.
- **HF solution preparation**: The extraction solution consisting of 1.5 M HF-0.6 M HCl solution (HF solution) was prepared under a ventilated hood by combining 1 v of concentrated hydrochloric acid (36%), 1 v of concentrated hydrofluoric acid (49%), and 18 v of distilled water.
- **Preparation of silica standards in HF solution**: Amorphous silica, prepared by wet ashing from 5 g of $Na_2SiO_3.9H_2O$, was pulverized, and completely dehydrated by heating at 950'C for 2 h. The standards in the 0.3 M HF-0.12 M HCl solution (3,000, 1,500. 750, 300, and 0 mg L-' SiO_2) were prepared in plastic bottles by dissolving the amorphous silica (300, 150, 75, 30, and 0 mg) with 20 mL of the HF solution for about 3 h and finally diluting with 80mL of distilled water to 100 mL
- **Preparation of reagents for spectrometric determination of silicon:**
  The molybdenum yellow method was derived from the molybdenum blue method (Weaver et al. 1968) with some modifications, like the addition of boric acid to mask the fluoride interference. 1) Silicon standard solution with 50 mg L^{-1} Si was prepared by the dilution of 1,000 mg L^{-1}Si standard, with the addition of 2.5 mmol L^{-1} HC1 to adjust the pH of the solution in the range between 2 and 4. 2) 0.5 M B solution and 0.1 M B solution were prepared using H_3BO_3 and stored in plastic bottles. 3) 0.5 M Mo (stock Mo) solution was prepared from N%Mo04.2H20 and, stored in a polypropylene bottle. 4) 0.8 M H_2SO_4-0.5 M B (stock H2S0,) solution was prepared by dissolving $H_3BO_3$and adding concentrated H_2SO_4. 5) 0.25 M Mo-0.4 M H_2SO_4-0.25 M B (working Mo) solution was prepared, before use, by combining 1 v of the stock H_2SO_4 and 1 v of the stock Mo. The working Mo solution had a H_2SO_4/ Mo molar ratio of 1.6 and was stable for about 1 month at 5°C. 6) 0.25 M Mo-0.4 M H_2SO_4 was prepared from the stock Mo and 0.8 M H_2SO_4 solution. 7) 0.5 M citric acid (stock citric) solution was prepared with 250 mg L-' of benzoic acid as antiseptic.

8) 0.1 M citric acid (working citric) solution was prepared from 0.5 M citric acid. 9) 1 M tartaric acid was prepared.

Note: Plant Physiologist can be associated and observations to be taken by him/her
Locations (4): Moncompu, Mizoram, Ranchi, Titabar

Trail 5: *Residue management in rice based cropping systems (Kharif and Rabi)*

Recycling of residues, especially rice and wheat straw, by returning them directly to fields, plays a significant role in ecological protection and sustainable agricultural production as it helps to enhance soil quality and increasing crop productivity. Straw incorporation is effective in situ residue management strategy that solves the problem of excess residue while simultaneously improving soil fertility, promoting crop growth and yield, and enhancing soil quality. It also can lead to a reduction in the burning of straw/residues, which is practiced to clear the field for the next crop due to the short turnover period between *Kharif* rice and Rabi rice/non-rice crops and has become a major source of greenhouse gas emissions and air pollution. Keeping these aspects in view, this trial proposes to study the effect of straw incorporation along with microbial decomposers (Pusa Decomposer) and green manure/green leaf manure on straw decomposition, and crop productivity and soil quality.

Objective:

1. To study the influence of rice/wheat residue on rice crop productivity, soil health and grain quality in rice based cropping systems
2. To develop efficient residue management practices with a view to avoid adverse environmental effects of residue burning

Treatments:

T1	100% RDF (Recommended Dose Fertilizer)
T2	50% Residue + 50% RDF
T3	50% Residue + 50% RDF + Pusa decomposer
T4	50% Residue + 50% GM/GLM
T5	75% RDF + 25% residue + Pusa Decomposer
T6	Absolute control

**** The organics (residue/Green Manure/Green Leaf Manure) should be analysed for their N content and then quantity of organics to be applied should be decided based on N equivalent basis.**

Note: The experiment should be conducted in the same field every year in an undisturbed field layout

Design : Randomized Block Design

Replications : 4

Plot size : 30 – 50 m² plot/treatment

Variety : Local popular variety (Zone specific)

Preparation of Pusa Decomposer (PD) inoculum

1. Take 150 g jaggery/gud and add in 5 litres of water
2. Boil jaggery vigorously and remove all the dirt with sieve
3. Cool the solution in a deep square tray/tub till it is slightly warm
4. Add 50 g of chickpea flour/besan and mix
5. Break four capsules of PD inoculum and mix thoroughly
6. Cover with thin cloth and keep in warm place

7. Growth will start in two days. A mat of different colours will start to grow
8. After 10 days, mix well again and use for inoculation as described below

(If upscaling is necessary for more inoculum production, after full growth another 5 liters of jaggery/gud solution can be added, mixed and allowed to grow for 7 days and then used)

•10L of the liquid PD inoculum has to be diluted into 200 L water and then sprayed on the straw/GM/GLM lying in one acre (approx 2.5 tons). Calculate as per your plot size and amount of straw

Method of treatment of residue with PD inoculum (*Kharif* and *Rabi*)

- After puddling/ leveling/land preparation and laying out the experiment, spread the required quantity of straw (rice/wheat)/GM/GLM in plots (T2—T7)
- Spray PD inoculum on the straw/GM/GLM as per treatment (T3, T5, T6, T7)
- After spraying immediately incorporate the residues into the field. Ensure sufficient moisture in the field before incorporation during Rabi
- Wait for 2-4 days before transplanting seedlings/sowing

Observations to be recorded:

Soil analysis:

- Initial analysis of field soil for **pH, EC, OC, available NPK status, micronutrient status** and important physical properties**,** soil enzymes (**soil dehydrogenase and alkaline phosphatase**) and microbial counts (**bacteria and fungi**)
- Record and report the **NPK** content of **straw, green manure, green leaf manure and the quantity** (kg) of **straw, green manure, green leaf manure applied in plots**
- Soil (all plots) to be sampled 25 days after the spraying of Pusa Decomposer (0-15cm depth soil) and analyzed for Organic C, available N and soil enzymes (soil dehydrogenase, alkaline phosphatase) and microbial counts (bacteria and fungi)
- Final analysis of soils after harvest for all important properties
  (**Note**: If facilities are not available, freshly collected samples may be sent to IIRR for analysis. Soil in labeled zip lock covers can be packed along with plastic covered cool/ice packs in a thermocol box and sent to ICAR-IIRR for analysis of microbiological properties)

Plant analysis:

- Grain and straw yields at harvest. Report grain and straw yields after harvest in tonnes/ha.
- Grain and straw analysis for its nutrient content especially N, P, K, Zn, Fe, Mn and Cu.
- Grain analysis for quality parameters (in brown rice and polished rice) along with hulling, milling and head rice recovery.
  Note: If quality analysis is not available at the centers, send 200 g of grain samples to IIRR immediately after harvesting.

Locations (09): Faizabad, Hazaribagh, Kanpur, Karaikal, Khudwani, Maruteru, Moncompu, Pantnagar, Pusa

Trial 6: Nano-fertilizers for increasing nutrient use efficiency, yield and economic returns in transplanted rice (New trial)- (Collaborative with Agronomy and IFFCO)

Since the industrial revolution, the use of synthetic N fertilizers has led to the increase of atmospheric N_2O, one of the most important anthropogenic greenhouse gases causing global warming. Despite previous efforts, the Nitrogen Use Efficiency (NUE) in agricultural systems has remained low; meaning that on a global scale, more than 50% of the N applied to agricultural soils is potentially lost into the environment. One of the major challenges of modern agriculture is to satisfy actual and future global food demands efficiently. The current NUE needs to be improved substantially by increasing the efficiency of agricultural systems, adopting environmentally sound agronomic practices, and exploring disrupting technologies. Nano-fertilizers possess unique features which enhance plants' performance in terms of ultra-high absorption, increase in production, rise in photosynthesis, and significant expansion in the leaves' surface area. Besides, the controlled release of nutrients contributes in preventing eutrophication and pollution of water resources. Replacement of traditional fertilizer by nano-fertilizer is beneficial as upon application, it releases nutrients into the soil steadily and in a controlled way, thus preventing the water pollution. It would be very helpful if we use nano-fertilizer for specific crops such as rice to minimize the potential negative effects brought about by the extensive use of chemical inputs without compromising production and nutritional benefits.

Objectives: Based on the previous study and present status the trial is constituted with the following objectives:

1. To study the efficiency of nano-fertilizer in increasing the growth and yield of rice crop and
2. To find out nutrient use efficiency of nano-fertilizers in rice crop.

Treatments:

T_1: Recommended dose of nitrogen (RDN) through urea (recommended P and K)- Urea in three splits (50% Basal + 25% active tillering (AT) + 25 % Panicle initiation (PI)

T_2: T1 + 2 sprays of Nano urea (4 ml/L of water) (AT and PI)

T_3: 50% of RDN (Urea) as total N as basal + Two foliar spray Nano-Urea at active tillering and panicle initiation stages (4ml /L of water)

T_4: 75 % of RDN (66% Basal + 17 % active tillering (AT) + 17 % at Panicle initiation (PI))

T_5: 75% of RDN (66% Basal + 17 % active tillering (AT) + 17 % at Panicle initiation (PI)) + Two foliar spray Nano-urea (4ml/L of water) (AT and PI)

T6: Nano Urea spray alone (4 sprays @ 4 ml/L) (15 days' intervals- 15, 30, 45 and 60 DAT)

T_7: Control (no application of N)

Fertiliser application method

If the Recommended Nitrogen dose is 100 kg Nitrogen /ha

Treatment	Basal (kg/ha)	First split at tillering (kg/ha)	Second Split at PI (kg/ha)
T1	50	25	25
T2	50	25+ Nano (4ml/L)	25 + Nano (4ml/L)
T3	50	0 + Nano application	0+ Nano application
T4	50	12.5	12.5
T5	50	12.5 + 1st spray Nano urea	12.5 + 2nd spray Nano urea
T6-(Four Sprays)	**0**	**0**	**0**
T7-Control	0	0	0

Spray volume: 200 litres of water/acre

Design: Randomized Block Design **Replication**: 3

Note:

**Rice crop will be grown in transplanted condition. Recommended package and practices of transplanting rice should be followed. All varieties duration should be same. In all treatments recommended dose of P_2O_5 and K_2O will be applied.*

**Trial will be conducted in fixed plot for studying nutrient depletion in soil.*

Soil Science centres: (08) Chiplima, Cuttack, Faizabad, Kanpur, Karaikal, Khudwani, Maruteru, Moncompu

Observations

1. Initial soil N, P and K status
2. Growth and yield parameters of rice crop at active tillering, panicle initiation and harvest stages
3. Total tillers/m^2
4. Total panicles/m^2
5. Filled grains/panicle
6. Unfilled grains/panicle
7. 1000 grain weight
8. Grain yield (kg/ha) and Straw yield (kg/ha)
9. Quality parameters of the seed
10. Post-harvest Soil nutrient status
11. Pests and Disease infestation (Collaboration with Entomology and Pathology)
12. Plant Nitrogen uptake at Harvest (Straw + Grain)
13. Grain quality parameters to be assessed
14. Nutrient use efficiency indicators
15. Cost of cultivation and net returns

Trial 7: ***Yield maximization of rice in different Zones (collaborative trial – Agronomy, Soil Science)***

Rice (*Oryza sativa* L.) is grown in India over a gross area of 44 million hectares (ha). Total production of Rice during 2021-22is estimated at record 127.93 million tonnes. It is higher by 11.49 million tonnes than the last five years' average production of 116.44 million tonnes. However, India would need to produce at least 200 million tonnes of paddy to meet its ever-growing population requirements. Rice occupies a pivotal position concerning food security in India. The future of food security in this region will depend on its ability to improve rice productivity continuously on an ecologically sustainable basis.

One of the main reasons for low rice productivity in India is the variation in fertilizer usage between the country's different agro-climatic zones and between states in each region. Low input use in general is a further factor accounting for the plateau or declining trend of grain yields.

Objectives:

1. To maximize the yield in different zones
2. To compare yield and economics of the best management practices

Locations :

Agronomy and Soil science collaborators are requested to conduct in collaborative mode and supply data together as decided in the workshop meeting

Design	**:**	Randomized Block Design
Replications	**:**	3
Season	:	*Kharif and Rabi*
Variety (Rice)	**:**	High yielding variety
Seed rate	:	20-25 kg/ha (20 x 15 cm)

In *rabi*: Rice or any other rotation crops with same nutrient combinations

Maintain the plot and take big plot size (50 m^2 per treatment)

 # Yield target*:* 6 t/ha and above.

Treatments:

T_1: Location specific recommended dose of fertilizer (RDF)

T_2: T_1 + FYM@ 5t/ha

T_3: T_1 + Sampoorna (KAU) @10 g per litre of water twice in the cropping season (250 litre/hectare/application), *i.e*., one week prior to maximum tillering stage and one week prior to panicle initiation (1% foliar application of 'Sampoorna KAU Multimix' @ 2.5 kg/ha each at the above two stages).

T_4: 125% RDF of T_1

T_5: 125% RDF of T_1 + FYM@5 t/ha

T_6: T_1+ Application of micro nutrient (deficient to that location)

T_7: T_1+ Geoxol.COM @ 40 kg/ha during basal fertilizer application (Geoxol will be sent by IIRR)

T_8: Optional (According to location- any best treatment of location)

Details on Multi nutrient foliar mix 'Sampoorna KAU Multimix' for application in rice fields

Wide spread occurrence of micronutrient deficiencies observed in the paddy fields can be corrected by the application of 'Sampoorna KAU Multimix' @10 g per litre of water twice in the cropping season (250 litre/hectare/application), ie., one week prior to maximum tillering stage and one week prior to panicle initiation (1% foliar application of 'Sampoorna KAU Multimix' @ 2.5 kg/ha each at the above two stages).

Nutrient Content in 'Sampoorna KAU Multimix' as revealed by KAU

Zinc- 4- 6.5%, Boron – 3.5 - 4.5%, Copper – 0.3 - 0.5%, Iron - less than 0.2%, Manganese - less than 0.2%, Molybdenum - less than 0.02%

Cost of 'Sampoorna KAU Multimix' is Rs 230/kg

Details of Geoxol. COM: It is,a compressed granulated organic manure and a viable alternative for Farm Yard Manure. Nutrient Composition of Geoxol. COM: Total carbon content – 15 %, Total nitrogen – 1.50 %, Total phosphorus – 1.00%, Total potassium – 0.5%.

Note: The state-wise fertility maps are available and all the fertilizer recommendations in the AICRP trials should be based on the fertility level suggested by these maps in different states. This is for strict compliance and provides RFD as per the recommendation

*Avoid manual labour involvement as much as possible to minimize cost of cultivation

*The goal of this trial should be reducing the cost of cultivation as much possible along with maximization of yield o rice

Observations:

1. Total tillers/m^2	7. Grain yield/20 m^2 (mention t/ha also)
2. Total panicles/m^2	8. Straw yield/20 m^2 (mention t/ha also)
3. Filled grains/panicle	9. Initial and Final Soil nutrient status
4. Unfilled grains/panicle	10. Plant uptake NPK at Harvest (Straw + Grain) if soil scientist is associated
5. 1000 grain weight	11. Cost of cultivation
6. Pests and disease infestation	

Note:

- *Wherever facilities are available and involve soil scientists for analysis of soil and plant samples and send the analyzed the data for report preparation*
- *Contact PI of Agronomy for LCC charts (R. Mahender Kumar, PI Agronomy kumarrm21364@gmail.com – 94404 76493)if needed*
- *Contact Drs. Gobinath and Manasa, ICAR-IIRR regarding chemical analysis*

Centres (14):

Bankura, Chinsurah, Chiplima, Faizabad, Kanpur, Karaikal, Khudwani, Mandya, Maruteru, Moncompu, Pantnagar, Puducherry, Pusa, Titabar

Trial 8: Enhancing productivity of Organic rice cultivation and Natural farming (collaborative trial – Agronomy, Soil Science and Crop protection) *permanent trial for 5 years and in permanent plot and system-based approach Zones*

(Collaborative trial – Agronomy and Soil Science)

Organic farming and natural farming is rapidly gaining recognition worldwide as a promising means to offer healthier food and to ensure environmental sustainability. Currently, organic produce including organic rice is in huge demand owing to its potential to fetch premium prices in the global market. Use of diverse organic nutrient sources including the split application of fast mineralizable nutrient-rich manures (vermicompost, poultry manure), green manures and bio-fertilizers can supply optimum nutrients in organic rice system. In parallel, development and deployment of rice varieties having a response to organic nutrient inputs, resistance to diseases/insects and the ability to compete with weeds can help minimize the risk of crop failure. Natural farming (NF) is purported to be a disruptive farm practices addressing major concerns of farmers of rising cost of production. It basically envisages ecological or regenerative agriculture approaches and any kind of chemicals to soil systems are strictly prohibited. This practice does not involve any external Chemical or Organic Fertilizers. It is also known by various names like; Zero Budget Natural Farming, Prakrithik Krishi, Cow Based Natural Farming, Shashwat Kheti, Chemical Free Agriculture, etc. The addition of formulation made up of cow dung and urines to trigger the microorganisms in the soil system and enhance the nutrient availability

Even though rice performs well under organic production system/natural farming system, a set of constraints including nitrogen stress at critical growth stages, unavailability of rapidly mineralizable organic amendments, lack of appropriate varieties and intense crop–weed competition pose major challenges to realize the potential yield.

However, a substantial research gap still exists demanding a deeper understanding of the organic rice system to register higher yield gains. There is an urgency for the alignment of modern agricultural techniques with organic rice production to improve both the system productivity and the product quality along with effectively avoiding the risks associated with indiscriminate use of chemicals in agriculture.

Objectives:

1. To maximize the yield in rice through organic and natural farming practices
2. To compare yield and economics of the different organic and natural farming practices
3. To assess the soil health, Pest dynamics and seed quality parameters in organic and natural farming practices

Locations:

Soil Science Centres (09): Chinsurah, Karaikal, Khudwani, Mandya, Moncompu, Pantnagar, Puducherry, Pusa, Titabar

Note: Agronomy and Soil science collaborators are requested to conduct in collaborative mode and supply data together as decided in the workshop meeting

Design : Randomized Block Design

Replications : 4

Season : *Kharif and Rabi*

Variety (Rice) : High yielding variety

Seed rate : 20-25 kg/ha (20 x15 cm)

Treatments details

Treatmen	**Details**
T1	Control (No addition of any inputs except labour for operations including
T2	Complete NF (1. Beejamrit +Ghanjeevamrit + Jeevamrit; 2. Crop residue mulching; 3 Intercropping) ***[***Pre-monsoon dry sowing (PMDS) / Muti-variate cropping (MVC) with multiple crops during fallow + Prophylactic/preventive method of application of Neemaster, Dashparni ark, Brahmaster, Neem seed kernel extract, border crop, trap crop, seed treatment with ***Trichoderma, Pseudomonas*** and Curative application of leaf extracts of Datura, vitex, Agniaster, sour butter milk, 2 G/3G extract and use of bio-control agents and mechanical traps***]***
T3	AI-NPOF package- State wise package can be adopted (Link is provided) **(https://iifsr.icar.gov.in/icar-iifsr/npof/index.php?id=package_of_practices)**
T4	Integrated Crop Management (50 % nutrient application through organic manures and 50% nutrient application through inorganic sources with pre-monsoon dry sowing / *Muti-variate cropping (MVC)* with multiple crops during fallow + Prophylactic/preventive method of application of Neemaster, Dashparni ark, Brahmaster, Neem seed kernel extract, border crop, trap crop, seed treatment with Trichoderma, Pesudomonas and Curative application of leaf extracts of Datura, vitex, Agniaster, sour butter milk, 2 G/3G extract and use of bio-control agents and mechanical traps
T5	Integrated Crop Management (50 % nutrient application through organic manures and 50% nutrient application through inorganic sources with application of need based pesticides for pest management)

T3: AI-NPOF package- State wise package can be adopted (Link is provided):
Punjab: Basal application of organic Source Quantity/ha Source Quantity/ha manures including soil FYM (1% N) 10 t/ha FYM (1% N) 6.75 t/ha application of bio-fertilizers, VC (1.5% N) 2.25 t/ha bio-control agents etc. Irrigation practices
(State wise variation will be there which need to be mentioned while sending the data)

Note:

- *Maintain permanent plot for 5 years*
- *Initial and post-harvest soil nutrient status to be recorded*
- *Nutrient uptake and utilization efficiency to be calculated*

Observations:

1. Total tillers/m^2
2. Total panicles/m^2
3. Filled grains/panicle
4. Unfilled grains/panicle
5. 1000 grain weight
6. Pests and disease infestation
7. Lodging resistance
8. Grain yield/20 m^2
9. Straw yield/20 m^2
10. Quality parameters of the seed
11. Initial and Final Soil nutrient status
12. Soil organic carbon and microbial properties after harvest
13. Pests and Disease infestation (Collaboration with Entomology and Pathology)
14. Plant uptake NPK at Harvest (Straw + Grain) by associating soil scientist of the center

Trial 9: Assessment of bio fortified rice genotypes response to Zn application and assessing agronomic bio fortification potential

"Bio fortification" or "biological fortification" refers to nutritionally enhanced food crops with increased bioavailability to the human population that are developed and grown using modern biotechnology techniques, conventional plant breeding, and agronomic practices, involving the use of biotechnology, crop breeding, and fertilization strategies, respectively. Bio fortification is an upcoming, promising, cost-effective, and sustainable technique of delivering micronutrients to a population that has limited access to diverse diets and other micronutrient interventions. Unfortunately, major food crops particularly rice is poor sources of micronutrients required for normal human growth. So far, our agricultural system has not been designed to promote human health; instead, it only focuses on increasing grain yield and crop productivity. This approach has resulted in a rapid rise in micronutrient deficiency in food grains, thereby increasing micronutrient malnutrition among consumers. Now agriculture is undergoing a shift from producing more quantity of food crops to producing nutrient-rich food crops in sufficient quantities. This will help in fighting "hidden hunger" or "micronutrient malnutrition" especially in poor and developing countries, where diets are dominated by micronutrient-poor staple food crops. In recent years several varieties have been released which are rich in Zn. These varieties and other newly developed genotypes are needs to be tested for their response to the applied Zn fertilizers so as to develop the nutrient management strategy and also to find out their potential for agronomic bio fortification.

Objectives:

- To evaluate the response of the fortified rice genotypes/varieties to the zinc application
- To study the agronomic bio fortification potential of the rice genotypes/varieties

COMPLETE TREATMENT DETAILS:

Design – Factorial RBD **Replications –** 3

Plot Size – 5x4 sq. m

Treatments:

Factor 1 – Rice genotypes/varieties (4 or 5)

Factor 2 – Zn doses

1. Control with no Zinc
2. Soil test-based Zinc application (STBZ)+ Foliar spray of 0.5% Zinc at PI stage and 1 week after flowering
3. Foliar spray of 0.5% Zinc at active tillering (AT) stage, panicle initiation (PI) stage and 1 week after flowering

Note: Recommended dose of NPK will be applied in all the treatments. For foliar spray, depending on the treatment aqueous solution of $ZnSO_4.7H_2O$ will be sprayed on the plants until the solution started to run-off from the leaves.

Observations:

1. Initial soil analysis (pH, EC, SOC, Texture, Available N, P, K, S, Zn, Fe, Mn and Cu)
2. Plant height (30, 60, 90 DAP and at harvesting)
3. Total tillers/m^2 (30, 60, 90 DAP and at harvesting)
4. Days to 50% flowering
5. Total panicles/m^2
6. Panicle weight
7. No. of filled grains/panicle
8. No. of unfilled grains/panicle
9. 1000 grain weight
10. Grain and straw yield
11. Content and uptake of Zn (grain and straw)
12. Care should be taken to avoid contamination of grain/straw samples from dust/metals, etc. Before analysing the grain samples, the material should be washed with tap water followed by 2% HCl, tap water, distilled water (in sequence) for few minutes, dried with filter paper immediately and oven dried in containers at 50-60^oC to uniform weight. After that ground the samples (grain and straw) to make it powder before sending.

Centres (04): Cuttack, Pusa, Maruteru, Varanasi

Note:

- Contact Dr. Shahid, ICAR-NRRI regarding further details of the trial (shahid.vns@gmail.com Mobile-9439638083). For zinc analysis, please send 200 g each of soil, harvested grain and straw (14% moisture) to NRRI, Cuttack.

List of cooperating centres of Soil Science and allotment of trials: 2023-24

Sl. No	Locations	Trial 1		Trial 2		Trial 3		Trial 4	Trial 5		Trial 6		Trial 7		Trial 8		Trial 9		Intended
		K	R	K	R	K	R	K	K	R	K	R	K	R	K	R	K	R	
1	**Kanpur (F)**			x		x	x		x	x	x	x	x	x					9
2	**Karaikal (F)**								x	x	x			x		x			5
3	**Kaul (F)**																		No Indent
4	**Mandya (F)**	x	x			x							x		x				5
5	**Maruteru (F)**	x	x						x	x	x	x	x	x			x	x	10
6	**Moncompu (F)**							x	x	x	x	x	x		x	x			8
7	**Pantnagar (F)**			x					x	x			x	x	x	x			7
8	**Pusa (F)**					x			x				x		x		x		5
9	**Titabar (F)**	x	x					x					x		x				5
10	**Ludhiana (F)**																		No indent
11	Chinsurah (V)			x	x								x	x	x	x			6
12	Faizabad (V)					x			x		x		x						4
13	Hazaribagh (V)								x	x									2
14	Khudwani (V)								x		x		x		x				4
15	Puducherry (V)												x		x				2
16	Bankura (V)												x	x					2
17	Ranchi (V)							x											1
18	NRRI, Cuttack			x							x	x					x		4
19	Mizoram (V)							x											1
20	BHU, Varanasi (V)																x		1
21	Chiplima (V)										x		x	x					3
Total trials allotted		**3**	**3**	**4**	**1**	**4**	**1**	**4**	**9**	**6**	**8**	**4**	**13**	**7**	**8**	**4**	**4**	**1**	

K – Kharif; R- Rabi; F- Funded centre, V= Voluntary Centre

Trial No.1: **Long-term soil fertility management in rice-based cropping systems (RBCS): 03 (**Mandya, Maruteru, Titabar)

Trial No.2: **Soil quality and productivity assessment for bridging the yield gaps in farmers' fields: 04** (Chinsurah, Cuttack, Kanpur, Pantnagar)

Trial No.3: **Management of sodic soils using nano Zn formulation: 04** (Faizabad, Kanpur, Mandya, Pusa)

Trial No.4: **Management of acid soils: 04 (**Mizoram, Moncompu, Ranchi, Titabar)

Trial No.5: **Residue management in rice-based cropping systems: 09** (Faizabad, Hazaribagh, Kanpur, Karaikal, Khudwani, Maruteru, Moncompu, Pantnagar, Pusa)

Trial No 6: **Nano-fertilizers for increasing nutrient use efficiency, yield and economic returns in transplanted rice: 08** (Cuttack, Chiplima Faizabad, Kanpur, Karaikal, Khudwani, Maruteru, Moncompu)

Trial No.7: **Yield maximization of rice in different Zones: 14** (Bankura, Chinsurah, Chiplima, Faizabad, Kanpur, Karaikal, Khudwani, Mandya, Maruteru, Moncompu, Pantnagar, Puducherry, Pusa, Titabar)

Trial No.8: **Enhancing the productivity of Organic Rice cultivation & Natural farming: 09** (Chinsurah, Karaikal, Khudwani, Mandya, Moncompu, Pantnagar, Puducherry, Pusa, Titabar)

Trial No.9: **Assessment of bio-fortified rice genotypes response to Zn application and assessing agronomic bio fortification potential: 04** (Cuttack, Maruteru, Pusa, Varanasi)

List of Soil Science Cooperators – 2023-24

S. No	Centre	Scientist	Mail Id & Mob. No
FUNDED			
1.	Kanpur	**Dr. Devendra Singh,** Jr. Soil Scientist**,** AICRIP on rice, C.S. Azad University of Agriculture and Technology, Kanpur**.**	dsyadu@gmail.com +91-9450136063
2.	Karaikal	**Dr. L. Aruna**, Scientist in charge cum Associate Professor, P.J.N College of Agriculture& Research Institute, Karaikal-609603	marunassac@gmail.com +91-9487731178
3.	Kaul	**Not Filled**	
4.	Mandya	**Dr. Savitha** H.R., Assistant professor, AICRP on Rice, ZARS, V.C. Farm, Mandya - 571 405	savitha2094@gmail.com +91-9964072409
5.	Maruteru	**Dr. Ch. Sreenivas**, Principal Scientist (SSAC), APRRI, Maruteru - 534 122, W. Godavari, A.P	csvasu@yahoo.com +91-9440415303
6.	Moncompu	**Dr. Biju Joseph,** Assistant Professor (SSAC), RRS (KAU), Thekkekara, Monocompu	biju.joseph@kau.in 9847375249
7.	Pusa	**Dr. Vipin Kumar,** Scientist cum Assistant Professor (Soil Science), RPCAU (Pusa), Samastipur, Bihar.	drvipinkumar72@gmail.com +91-9431841476
8.	Titabar	**Dr. Sanjib Ranjan Borah,** Jr. Scientist (Soil Science), College of Agriculture, RARS, AAU, Titabar.	srborah@gmail.com +91-6002588722
9.	Pantnagar	**Dr. A.K. Pant,** J.R.O., Dept. Of Soil Science, College of Agriculture, Pantnagar, Uttarakhand -263145.	akpsoil@yahoo.com 9412419872
10.	Ludhiana	**Not Filled**	
VOLUNTARY			
11.	Chinsurah	**Dr. Kaushik Majumdar**, Junior Soil Scientist, Rice Research Station, Hooghly, WB-712 102,	kaushikiari@gmail.com +91-9564124443
12.	Ranchi	**Dr. Purnendu B. Saha**, Soil Scientist, Birsa Agricultural University, Zonal Research Station, Ranchi, Jharkhand-814 101	saha_purnendu@yahoo.com +91-9934525212
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