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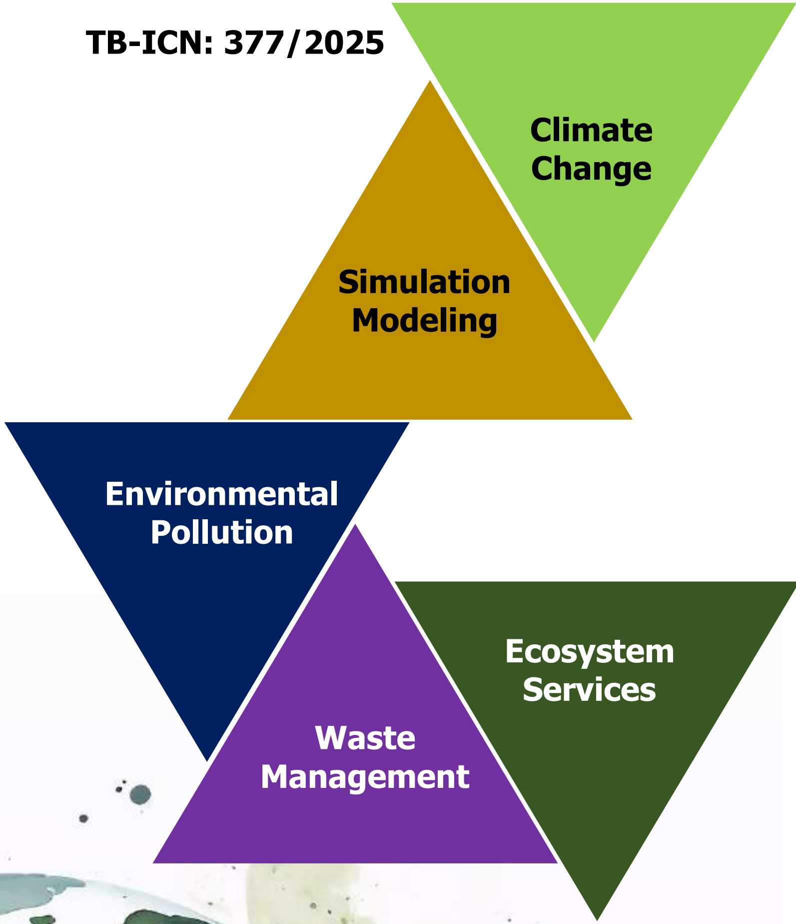
Annual Report 2024



Division of Environmental Sciences

ICAR-Indian Agricultural Research Institute, New Delhi 12

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December, 2024

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Preface

It is with great pride and satisfaction that I present the annual report 2024 of the Division of Environmental Sciences. Over the past three decades, our division has made exemplary contributions to the field of environmental sciences, addressing some of the most pressing issues of our time. The Division of Environmental Sciences was established on January 10, 1993 with a mission to advance the understanding of environmental processes and develop sustainable solutions to environmental challenges especially in agroecosystems. Since its inception, the Division has grown significantly, evolving into a hub of research and innovation. Our vision has always been to lead the way in environmental research, focusing on climate change, sustainable development, simulation modelling, environmental pollution, create wealth from waste and the preservation of ecosystem services.

Our division has been at the forefront of climate change research, with a focus on understanding the impacts of climate change and developing effective adaptation and mitigation strategies. We have conducted extensive research on the drivers of climate change, including greenhouse gas emissions and land-use changes. Our team has been actively involved in the development of policies and strategies aimed at reducing greenhouse gas emissions and impacts on agriculture through green adaptation technologies to promote sustainable development. In response to the growing challenges posed by climate change to agriculture, our division has pioneered research in climate-resilient agriculture. We have developed and tested various adaptation strategies to help farmers cope with the changing climate. This includes the improved nutrient and water management practices and the promotion of improved agronomic and agroforestry systems. Our work in this area especially under NICRA Project has been instrumental in enhancing the resilience of agricultural systems to climate variability.

The division has made significant advancements in the development of simulation models for crops. These models are used to forecast crop yields, assess the impact of climate change on agricultural productivity, and develop strategies for optimizing resource use. Our models have been widely adopted by policymakers and practitioners, providing valuable insights for planning and decision-making in the agricultural sector. A key area of our research has been the quantification of greenhouse gas emissions and the development of emission inventories. Our team has conducted comprehensive assessments of emissions from various sectors, including agriculture, energy, and waste management.

The climate change impacts, adaptation and vulnerability assessments on 11 crops and GHG inventory from agricultural soils, nitrogen fertilizer and crop residue burning have been reported by India as the BUR, Third National Communication to United Nations Framework convention on Climate Change (UNFCCC).

Recognizing the urgent need for sustainable waste solutions, the Division has significantly intensified its efforts in waste management, environmental remediation, and pollution control. Our research addresses critical issues such as the environmental fate of plastics, heavy metal contamination, air and water pollution, and the remediation of degraded lands. We are actively developing strategies for waste-to-wealth transformation, focusing on converting organic and industrial waste into value-added products such as compost, biochar, and biogas. A key thrust area of our Division is the quantification and valuation of ecosystem services, including carbon sequestration, biodiversity conservation, and climate regulation. Through this, we aim to promote the conservation and restoration of natural ecosystems as integral to achieving net-zero targets and ensuring ecological and economic sustainability.

Looking ahead, the Division remains committed to expanding its research on nature-based solutions, integrating renewable energy in agro-systems, and promoting sustainable production and consumption patterns. We envision our work contributing to the broader goals of environmental security, climate neutrality, and resilient rural livelihoods. Finally, the Division of Environmental Sciences has made remarkable progress in addressing some of the most critical environmental challenges of our time. Our achievements are a testament to the hard work and dedication of our scientists, staff, and partners. As we move forward, we remain committed to advancing our research, fostering innovation, and contributing to a more sustainable and equitable world. I would like to thank Dr. T.R. Sharma, Director, IARI, Dr. Viswanathan Chinnusamy, Joint Director (Research), Dr. Anupama Singh Jt. Director (Education) and Dr. R.N. Padaria**,** Jt. Director (Extension) for their constant support and guidance. I also thank Dr. Himanshu Pathak, Secretary (DARE) & Director General (ICAR) for constant support and encouragement for the inclusive growth of the Division. I acknowledge the funding agencies such as ICAR, DBT, DST, NASF (ICAR), NAHEP (ICAR), BARC and other national Instituitions as well as the Ministries viz., MoA&FW, MoEF&CC, MoSteel, MoS&T & SANH, FAO. Further I thank the support from the international agencies, such as AgMIP, FAO, SANH, IRRI for externally funded projects and studies for the financial year 2024 that immensely helped in meeting our research, teaching, and service goals. I express my sincere admiration to the Annual Report editorial team for bringing out the annual report. I look forward to more productive years ahead.

(Soora Naresh Kumar)

Contents

Division of Environmental Sciences: An Introduction

The Division of Environmental Sciences is a dynamic, interdisciplinary department at the forefront of tackling current and future environmental challenges. Our research extends to crucial areas such as climate change, simulation modeling, greenhouse gases emission quantification, waste management, environmental pollution and ecosystem services where innovative strategies are developed to mitigate the environmental impact. The Division of Environmental Science is actively engaged in cutting-edge research on a wide range of critical environmental issues. The research focuses on climate change, with particular emphasis on simulation modeling to predict future climate scenarios and their potential impacts. Additionally, the division is involved in quantifying greenhouse gas emissions to understand their sources better and mitigate their effects. Waste management practices are being studied to develop more efficient and sustainable solutions. The division also addresses various aspects of environmental pollution, including air, water, and soil contamination, and their impacts on human health and the environment. Furthermore, the division explores ecosystem services, assessing the benefits provided by natural ecosystems and how they can be preserved and enhanced to support biodiversity and human well-being. Moreover, we delve into the realm of ecosystem services, studying the benefits that ecosystems provide to society and farmers and devising strategies for their sustainable management and conservation. Finally, our division is actively engaged in studying the behavior and remediation of heavy metals in the environment (water, soil and plants), recognizing their significant impact on ecosystems and human health. Through innovative research and national and international collaboration, the Division of Environmental Sciences is committed to advancing knowledge and implementing practical solutions to safeguard our planet for future generations. Division of Environmental Sciences was established in 1993, has a mission for development of sustainable agriculture, climate change adaptation and mitigation strategies, management of environmental pollution, extension and teaching for the benefit of society and farming community.

The vision of this multi-disciplinary division is 'Enhancing resilience of Indian agriculture to environmental change'. A group of 16 scientists belonging to 7 different disciplines are working in this division with a mission of development and dissemination of efficient and economically viable technologies for climate-resilience, sustainable agriculture and environment protection.

Mandates of the Division

- To conduct basic and strategic research for environment resilient sustainable agriculture with a special emphasis on rainfed and small-scale farmers.
- To impart post-graduate education and training on agriculture-environment inter-relationships.
- To provide advisory and consultancy services on environment assessment and climate change in agriculture.

Thrust research areas

- Climate change, GHGs quantification, Inventory development, Emission factor refinement, adaptation and mitigation strategies
- Climate resilient agriculture
- Development of simulation models for crops, forecasting and vulnerability assessment
- Environmental Pollution (soil, air, and water pollution)
- Waste management, utilization and value addition
- Assessment of microplastics in soil and development of bioplastics
- Quantification of polyaromatic hydrocarbons (PAHs) in air and soil and their toxicity assessment
- Biogas production, enrichment and utilization
- Heavy metals contamination in soil, water, air and plants and their toxicity assessment
- Quantification of ecosystem services and their valuation
- Nutri-physiology and radio-ecological studies
- Development of nano and climate smart fertilizers
- Division also engaged in teaching, extension, capacity building and policy formulation

1. Scientific activities

Development of Machine Learning – RS-data based method for flood related crop loss estimation: Method for estimation of yield loss due to extreme flood events using remote sensing microwave data and machine learning algorithms is developed and applied for crop yield loss estimation in Himachal Pradesh. The efficiency of this method in estimating the croplands affected by the flash flood that occurred in July 2023 in Himachal Pradesh was found to be very good with Una, Hamirpur, Kangra, and Sirmaur districts identified as the most affected areas, with about 9%, 6%, 5.74%, and 3.61% of the respective districts' total geographical area under flood. Further, four machine learning algorithms (random forest, support vector regressior, k-nearest neighbour, and extreme gradient boosting) were evaluated to forecast maize and rice crop production and potential loss during the Kharif season in 2023. (Fig 1) A regression algorithm with ten predictor variables consisting of the cropland area, two vegetation indices, and seven climatic parameters was applied to forecast the maize and rice production in the state.

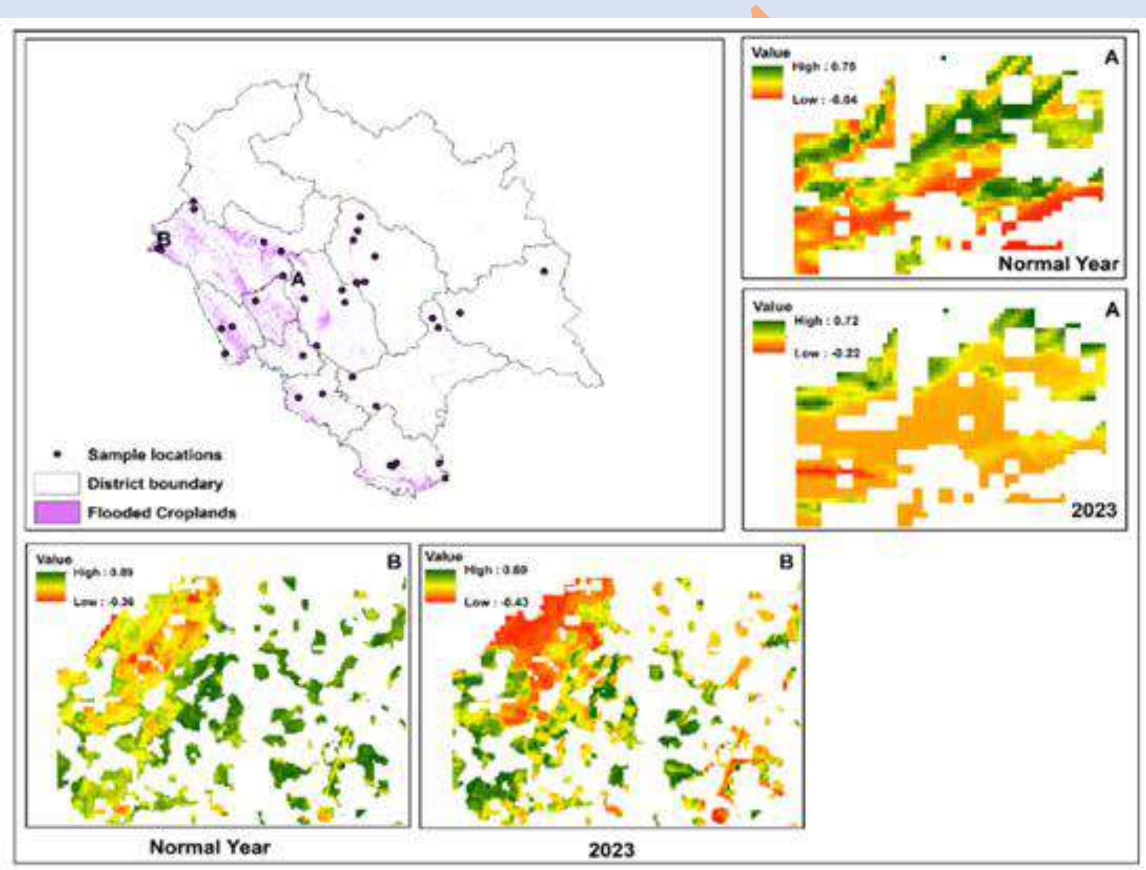


Fig 1: Variation in NDVI values at different locations in two years

Amongst the four algorithms, random forest showed outstanding performance compared to others. The random forest regressor estimated the production of maize and rice with R^2 more than 0.8 in most districts. The mean absolute error and the root mean squared error obtained from the random forest regressor were also minimal compared to the others. The maximum production loss of maize is estimated for Solan (54.13%), followed by Una (11.06%), and of rice in Kangra (19.1%), Una (18.8%) and Kinnaur (18.5%) districts. This indicated the utility of the proposed methodology for a quick in-season forecast on crop production loss due to climatic hazards. Research Paper is published in Environment Monitoring and Assessment (2024) 196:497.

The Global climate model (GCM) ensemble data are created for analysing the agricultural seasonal climate scenarios.

The 21 GCM historical simulated data on daily data on maximum and minimum temperatures and rainfall were analysed for bias identification with respect to Indian Meteorological Department gridded data for the 1980-2014 period. The models found to have cold bias in Northern latitudes and higher altitudes of Indian while the hot bias in the southern latitudes of India, when compared with. The models' data were bias corrected using quantile mapping method for the historical period (1951-2014) and then proceeded for the bias correcting the future climate scenarios for 2015-2100 period under Shared Socioeconomic Pathway (SSP)-Representative Concentration Pathway (RCP) combination of 2-2.4; 3-7.0 and 5-8.5. (Fig 2) This is being done to develop the climate scenarios for agricultural seasons in India.

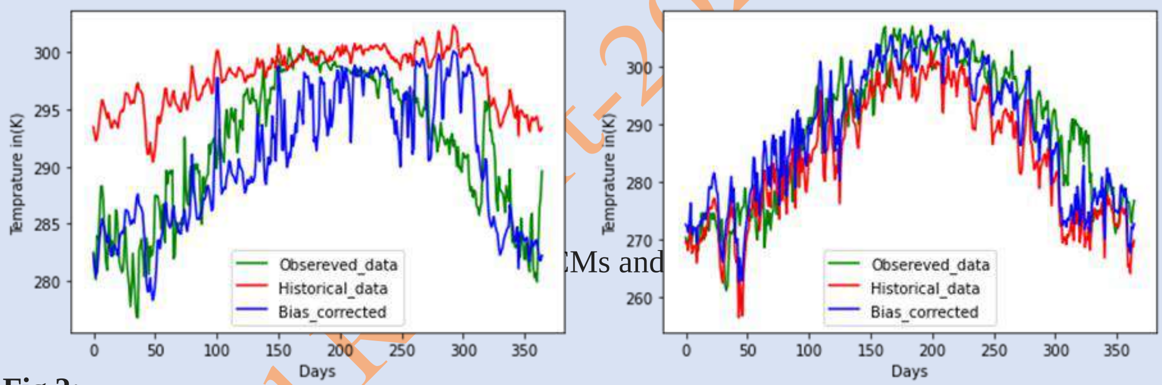


Fig 2:

Methane emission in different rice cultivated areas and water regimes

Rice cultivation in India occurs under different irrigated and rainfed water regimes and estimation of emissions under different water regimes is required for reducing the uncertainties in scaling factors for national inventory estimates. The methane and nitrous oxide emission under different irrigated water regimes of continuous flooded, single aeration and multiple aeration were quantified in rice-rice system in Aduthurai, Tamil Nadu and in rice-wheat system in Hazari Bagh, Jharkhand by close chamber technique and the GHG emissions are given in Table 1. The alluvial clay soil of Aduthurai site had a SOC content of 1.01% with a pH of 7.5, whereas the silty clay soil of Hazaribagh site had SOC of 0.64% and soil pH of 5.8. Methane and nitrous oxide were also measured in rice-rice system during kharif and rabi season at Aduthurai and Telangana field sites. The Rabi and Kharif season rice methane emissions in Aduthurai were 82.8 and 105.8 kg/ha respectively with flooding of 2-2.5 cm maintained during the crop growing stages on most days, under recommended fertilizer application. (Fig 3) At Aduthurai during the in kharif season the measurements were from (Sambha: Sept-Dec) and during the Rabi rice measurements were from (Navarai: Jan-April).

Table 1: Greenhouse gas emission from rice cultivation under irrigated water regimes

Water Regime	Aduthurai, Tamil Nadu	Hazari Bagh, Jharkhand
	Methane (kg/ha)	
Continuous Flooded	105.8 ± 8.6	65.2± 7.2
Single Aeration	73.3 ± 6.8	40.1± 2.9
Multiple aeration	29.2 ± 3.5	19.7± 3.7
	Nitrous oxide (kg/ha)	
Continuous Flooded	1.02±0.14	1.28±0.22
Single Aeration	1.45±0.32	1.52±0.18
Multiple aeration	1.88±0.26	2.01±0.37

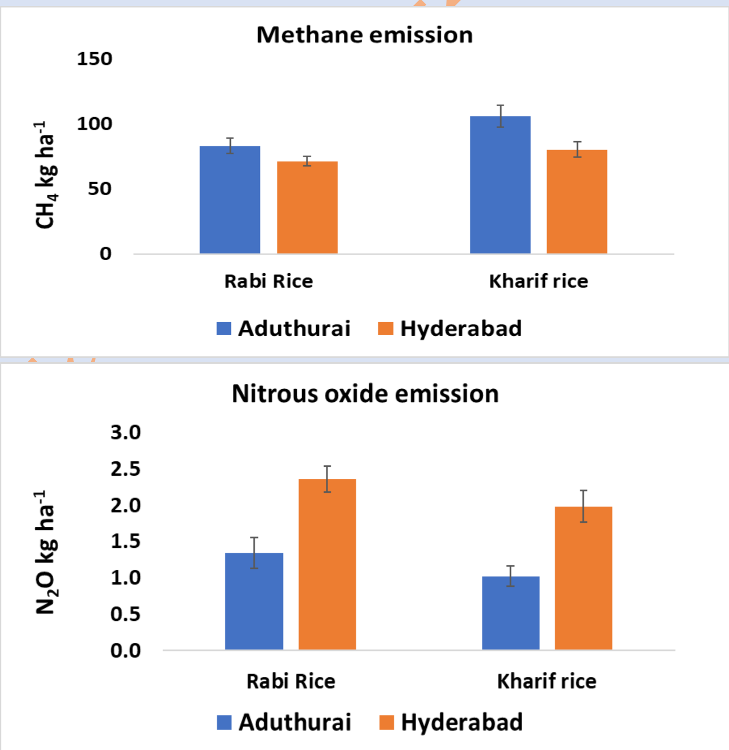


Fig 3: (a) methane (b) nitrous oxide emission from Rabi and Kharif rice growing seasons in rice-rice system

Dual inhibitors for reducing ammonia volatilization and greenhouse gas emissions in rice cultivation

The use of inhibitors retain nitrogen as ammonium in soil, giving plants ample time for its uptake. They can reduce nitrous oxide (N_2O) emissions, but extended retention may increase ammonia (NH_3) volatilization. This study assessed the efficacy of coated urea fertilizers in reducing greenhouse gas (GHG) emissions and NH_3 volatilization in rice fields. A field experiment for two kharif seasons growing Pusa 44 rice variety compared prilled urea (PU), nitrification inhibitors (NIs): neem oil-coated urea (NCU), karanj oil-coated urea, and dual inhibitor (DI: Limus + NCU). Compared to PU, DI reduced N_2O emissions by 23.7%, methane by 11.9%, and NH_3 by 29.8%. (Table 2) The application of DI significantly improved NUE of applied fertilizer (Fig 4.a). The EFs of N_2O ranged from 0.28 to 0.41% (Fig. 4.b), and the EF of NH_3 ranged from 6.5 to 11.8% (Fig 4.c) under the different treatments. DI also reduced NH_3 emissions by 36-39% compared to other NIs. Based on our estimates, the GWP of rice fields in India, calculated by combining the seasonal N_2O emissions (including both indirect and direct sources) and CH_4, reduced by 11.09% with the application of NCU as compared to PU. Overall, these enhanced efficiency fertilizers such as dual inhibitor (DI) coated urea can lower the global warming potential of rice cultivation in trans Indo-Gangetic plains region by 17.1% for both direct and indirect emissions, suggesting its significant potential to reduce India's contribution to total agricultural GHG emissions.

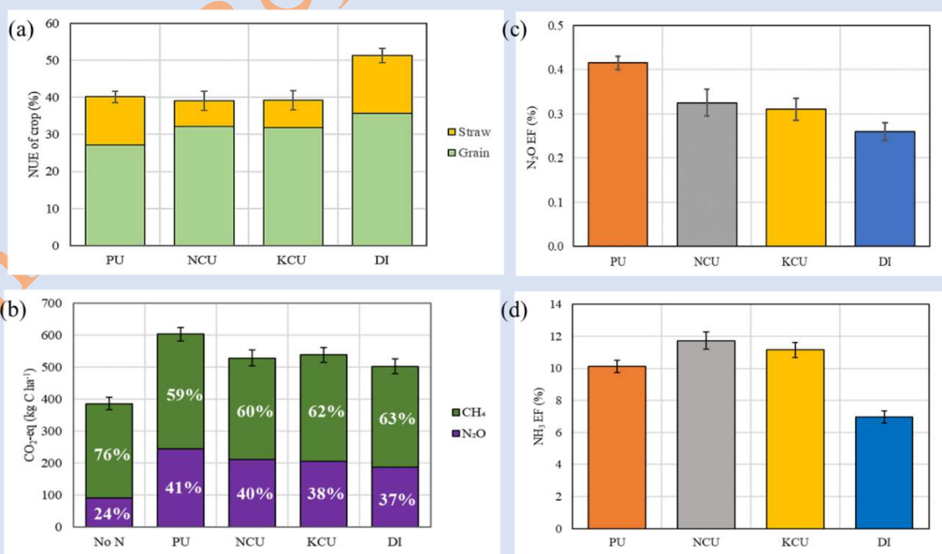


Fig 4: (a) NUE of crop (%), (b) CO_2-eq (kg C ha^{-1}), (c) N_2O EF (%) and (d) NH_3 EF (%) observed for the different treatments.

Table 2: Estimates of reduction in GHG, NH_3 and overall GWP from RCWS in IGP in India

		Prilled urea	Neem Coated Urea	Double Inhibitor (NCU+UI)
Reduction (%)	Direct N_2O		15.4	23.7
	CH_4		9.1	11.9
	NH_3		-12.6	29.8
Emission (Gg)	N_2O	8.35	7.06	6.35
	CH_4	178.76	162.51	157.55
	NH_3	132.72	149.42	93.19
	Redeposition of NH_4^+-N (@ 74%)	98.21	110.57	68.96
	Indirect N_2O (@ 0.5%)	0.49	0.55	0.34
	Total N_2O (Direct + Indirect)	8.84	7.61	6.70
	GWP (Gg CO_2 eq.)	6494.0	5773.2	5384.8

Emission coefficient of nitrous oxide under different drip irrigation practice-greenhouse gas inventory refinement

The emission of nitrous oxide and carbon dioxide was quantified under surface drip and conventional furrow irrigation in potato vegetable crop. Three treatments were taken for the experiment growing potato (variety- Kufri Neelkanth) under drip and furrow irrigation. In T1 treatment furrow irrigation with conventional broadcast NCU application @18:4:4 g/m^2 (N:P:K) was carried out. In T2 treatment under drip irrigation (100% field capacity), the same fertilizer as in T1 was applied. In T2 the fertilizer N was applied with five fertigation. In T3 treatment, initially two fertigation of customized fertilizer (19:19:19) was applied at planting and then 50% NCU was applied through three drip fertigation. Under T4, no nitrogen control P and K was applied as in T1 treatment with furrow irrigation. In all eight irrigations were applied in 120 days of potato crop. The measurement of N_2O and CO_2 was carried out by close chamber technique from both ridge and furrow region and analyzed by gas chromatography. The cumulative GHG emitted during the potato growth period is shown in Table 3. The N_2O emission reduced significantly under drip fertigation, however marginal increase was observed in CO_2 emissions under drip fertigation. The EF of N_2O reduced from 0.59% of applied N to 0.41% with drip fertigation on NCU application. Drip irrigation significantly increased the potato yield and reduced the greenhouse gas intensity of potato cultivation. (Fig 5)

Fig 5: Sampling of nitrous oxide emission with drip fertigation in potato crop

Table 3: GHG emission and tuber yield of potato under different irrigation practices

S. No	Treatment	Nitrous oxide kg/ha	Carbon Dioxide kg/ha	Global warming potential	Tuber Yield kg/m^2	EF% N2O	GHG intensity
T1	Furrow irrigation + conventional broadcast application (100% NCU)	2.198^a	3904^b	4487^a	3.58^c	0.586^a	0.125^a
T2	Drip irrigation + conventional broadcast application (100% NCU)	1.705^b	4316^a	4768^a	4.31^a	0.413^b	0.111^b
T3	Drip fertigation 2*(19+19+19) + 50% NCU (three fertigation)	1.572^c	4221^a	4650^a	3.98^b	0.366^c	0.116^b
T4	Furrow irrigation (No N)	0.538^d	3033^c	3176^b	1.15^d		0.275^c

Development of nitrous oxide emission factor from vegetable and oilseed cultivation

Agriculture sector ranks second contributing 14% to total GHG emission of the country. Agricultural soils are the second largest source of GHG emission mainly N_2O. Synthetic fertilizer application contributes app 75% of the total emissions from managed soils. However, there are large uncertainty. Country specific emission factors for N_2O is important to reduce the uncertainty in emission inventory of N_2O.Field experiment was conducted growing vegetables (potato, tomato, brinjal and onion) and oilseed (Soybean) under different fertilizer doses to quantify the emission of N_2O. The emission factor for N_2O-N ranged from 0.42-0.62% of applied N (table 4). The mean emission factor was estimated as 0.51±0.060% of applied N with an uncertainty of 11.7%.

Table 4: Emission factor for N2O-N from vegetable and oilseed crops

Crop	N applied (kg/ha)	Total N_2O emission (kg/ha)	Emission factor (%)
Onion (Bhima dark red)	125	1.596	0.498
	150	1.775	0.491
Potato (Kufri badshah)	150	1.386	0.429
	220	2.211	0.531
	280	3.11	0.622
Tomato (Pusa rohini)	120	1.707	0.560
	150	1.935	0.545
Brinjal (Vaibhav)	150	1.648	0.490
Soybean (9712)	30	0.674	0.441

Fig 6: Measurement of nitrous oxide from vegetable and oilseed crops

Open windrow composting of lignocellulosic crop residues and neem litter: Accounting for reactive nitrogen and greenhouse gas emissions

Crop residue management plays a key role in reducing the environmental impact of agriculture, particularly through composting. Compost application to soil replenishes organic matter. A study was conducted to quantify the greenhouse gas emissions (GHG) (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N2O)) and reactive nitrogen (Nr) losses (ammonia (NH_3) and oxides of nitrogen (NOx)) from the open windrow composting of crop residues from three cereal crops (rice, maize and pearl millet) and neem litter. The windrow moisture was maintained between 50 and 60% with mechanical turning every 25 days. Compost maturity was reached after 137 days, indicated by a germination index (GI) > 80% and the ratio of initial to final C/N ratio, which was <0.4. CO_2 and N_2O emissions increased after turning, while CH_4 emissions declined. The global warming potentials of the composts were 169.71, 184.13, 200.15, and 217.3 g CO2 eq. kg^{-1} initial dry matter (DM) for rice straw, maize stover, pearl millet stover, and neem litter, respectively. NH3 emissions ranged from 1.13 to 2.13 mg kg^{-1} initial DM, with neem litter producing more NH_3 and less N_2O due to its lower C/N ratio and nitrification inhibitory properties. Rice straw emitted the highest NOx (75.48 mg kg^{-1} DM), while maize stover had the lowest (28.39 mg kg^{-1} DM). Nitrogen losses from compost ranged from 8.16% in paddy straw to 0.53% in neem compost, with carbon losses ranging from 82.35% to 85.57%. The study concluded that careful management of moisture and aeration is critical for minimizing gaseous emissions from open windrow composting.

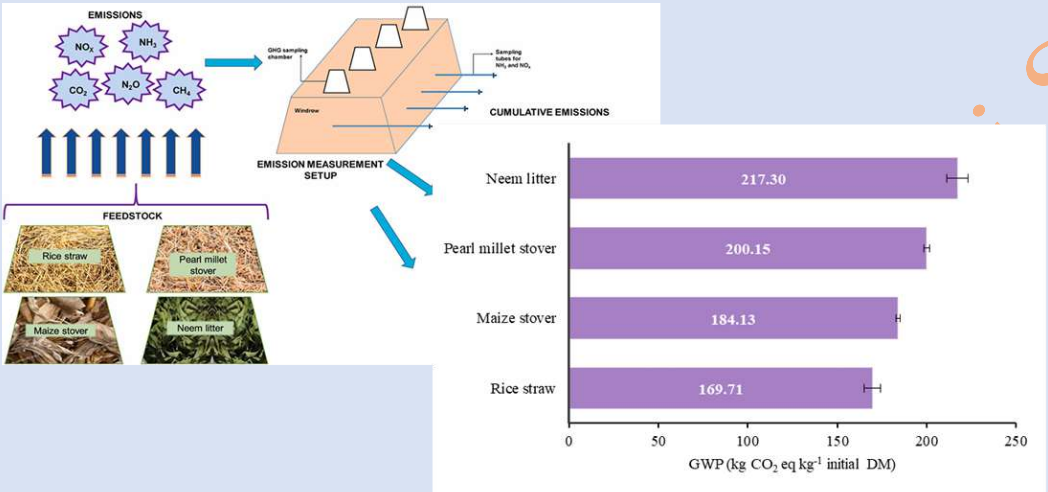


Fig 7: Global warming potential of Open windrow composting of lignocellulosic crop residues and neem litter

Fig 8: Ammonia N losses from composting of crop residues

Greenhouse gases and particulate matter emission due to sugarcane residue burning using measurements and remote sensing

Sugarcane is another major crop, apart from wheat and rice, whose residue is burned on-farm globally. In India, the dry leaves of sugarcane obtained after the harvesting of canes are subjected to on-farm burning. The study was conducted in the Shamli district in Uttar Pradesh. A field survey was conducted in five locations (60 farmers) in the district to know the cropping pattern, the method of sugarcane harvesting, cane and biomass yield and various usage of residue, to estimate the harvest index (HI), Residue to crop ratio (RCR), fraction of biomass burned and moisture content in the residue. The crop area map of sugarcane in Shamli was prepared with an overall accuracy of 88% using ground truth sites and the random forest classifier. The burning events of sugarcane were monitored for spatio-temporal variation in the district between November 2023 and March 2024 using active fire count data from AQUA, TERRA, and S-NPP satellites. A total 200 burning event were detected in Shamli district. The burnt area map of sugarcane in Shamli was prepared using Sentinel-2A L2A images obtained with an overall accuracy of 89%. The burnt area (30.1%) obtained was used to calculate the amount of residue burnt in the district in the year 2023-24. The sugarcane residue burned on farm in five different locations to monitor the emission of GHGs and particulate matter (PM) and develop the emission factors (EFs). The average concentration of various GHGs, CH_4, CO_2, and N_2O monitored on-farm was 2.79 ± 0.13 ppm, 652.33 ± 39.52 ppm, and 394.98 ± 45.21 ppb, respectively. The average particulate matter concentrations of 0.3, 0.5, 1, 2.5, 5, and 10 µm were 108.13 ± 62.11 µg/m3, 456.58 ± 286.70 77 µg/m3, 675.33 ± 507.00 µg/m3, 512.00 ± 300.09 µg/m3, 489.00 ± 297.55 µg/m3, and 401.00 ± 241.75 µg/m3, respectively. The emission factors were calculated in the present study for CO_2, CH_4, N_2O, CO, and PM2.5. The emission factors were also collected from published literature as well as default IPCC EFs for comparison with the factors developed in the present study. Approximately, 51.66% of N and almost 99% of carbon is lost in the environment due to on-farm burning of sugarcane residue. The study highlighted the need for continued research to estimate the burned area based on remote sensing along with validation with primary survey and development of region-specific emission factors, enabling more precise estimates of GHG and air pollutant emissions from agricultural residue burning.

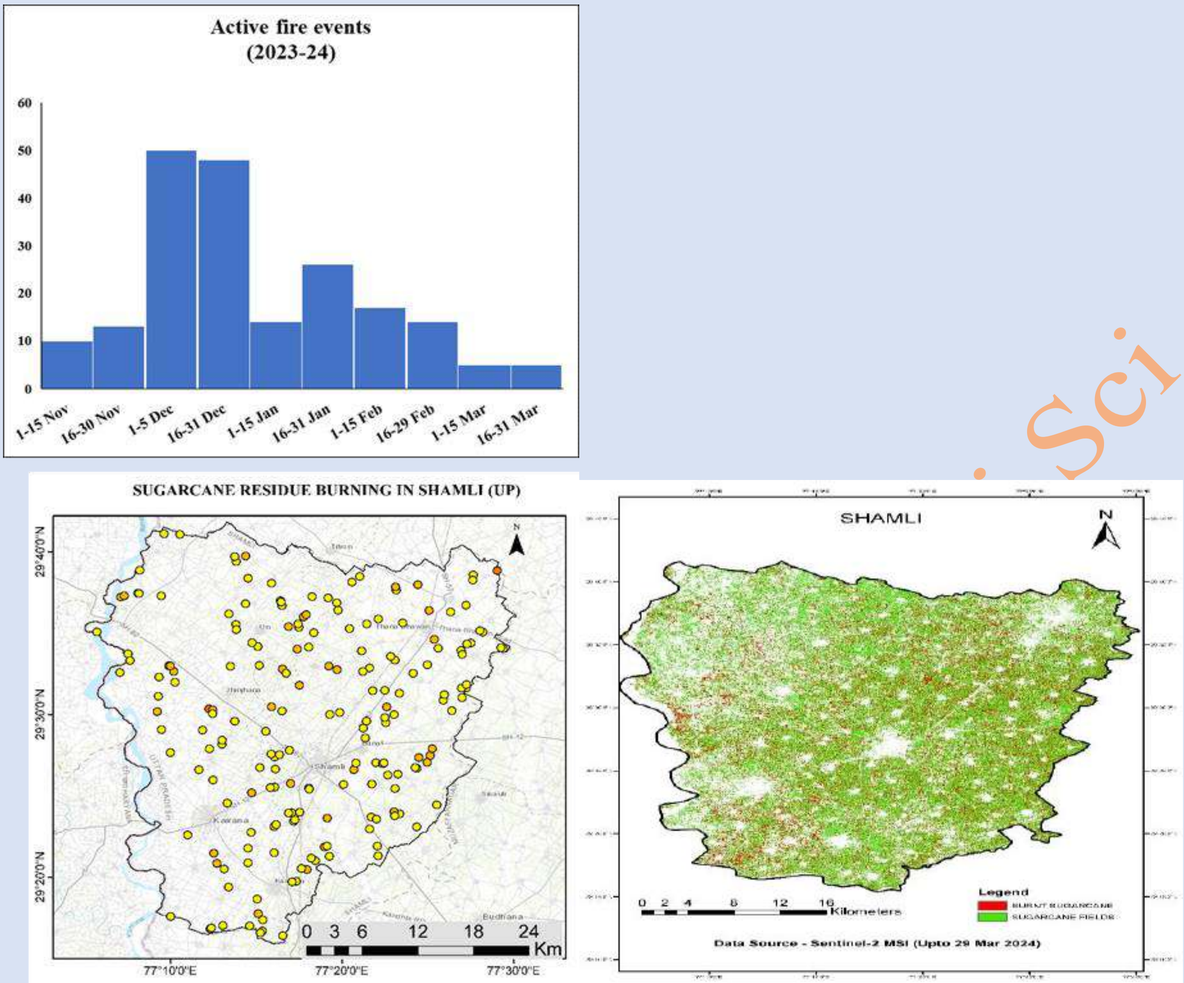


Fig 9: Number of active fire event, cumulative active fire events map and sugarcane area burning map

Nitrogen and water footprints of tomato cultivation under different irrigation and nitrogen management practices

Tomato is one of the popular vegetable in India with a total area of 28.04 million ha and 351.91 million tons' productivity. Vegetable fields are characterized by intensive production and high N application rates. Excessive use of N fertilizer leads to loss of N to the environment in different forms. Ammonia volatilization, leaching, nitrous oxide emission are different pathways for N loss. All the N losses are significantly influenced by irrigation and nitrogen management practices, making it essential to optimize these factors for sustainable production. Therefore, a field experiment was conducted to quantify nitrogen losses, nitrogen foot print and water footprint from tomato under different irrigation and nitrogen treatments. The treatments include two irrigation method ridge & furrow irrigation and drip irrigation and five different N sources namely no

Nitrogen Control (0:60:60), farmers practice (150: 60:60), recommended dose of fertilizer (120:60:60) with micronutrient (RDF) , customized slow release fertilizer (CF1), customized fertilizer with micronutrients (CF2). The cumulative emission of N_2O was significantly higher in ridge & furrow (1.55 kg/ha) compared to drip irrigation (1.24kg/ha). The trend of cumulative N_2O emission from different N sources was Farmers practice >RDF> CF1> CF2 > no N control. The seasonal accumulated flux of NH_3-N was 6.58kg/ha in ridge & furrow and 2.9kg/ha in drip irrigation. The seasonal accumulated flux of NH_3-N emission was maximum in farmers practice (9.07 kg/ha) and minimum in no N control treatment (0.20 kg/ha). Drip irrigation shows negligible leaching losses of nitrate-N, ammoniacal-N and total mineral N from soil compared to ridge and furrow method. Leaching losses of nitrate N ranged from 0.04 to 1.68 kg/ha, ammoniacal N losses from 0.34 to 2.36 kg/ha, and total mineral N losses from 0.38 to 4.04 kg/ha under different N treatments. The average GWP of drip irrigation (329.6±24.8 kg CO_2 eq/ha) was significantly lower than ridge & furrow method (411.2±22.2 kg CO_2 eq/ha). The trend of GWP from different N sources was Farmers practice >RDF> CF1> CF2 > no N control. The mean fruit yield was significantly high in drip irrigation compared to ridge & furrow among the different irrigation methods and was maximum in CF2 and lowest in no N control among the N treatments. The lycopene content ranged from 3.25 mg/100g to 5.61 mg/100g among different irrigation and N treatments. The Lycopene content was statistically at par in RDF and CF2 treatments. Drip irrigation was able to reduce the nitrogen and water footprint by 68.55% and 43% compared to ridge & furrow method. RDF, CF1 and CF2 reduced N footprint by 28%, 35 % and 43%, respectively compared to farmer practice treatment. No N control showed highest green and blue water footprint 26.33 m3/t and 368 m3/t, respectively. Present study revealed that combining drip irrigation with improved nitrogen management practices can substantially lower nitrogen losses through N_2O emissions, NH_3 volatilization, and mineral N leaching.

Emission inventory of non-CO2 gases from crop residue burning

The total crop biomass generated in the year 2020 was 801.86 million tons on dry weight basis. Out of the total crop biomass generated 13.79% (110.6 million tons) was burnt on farm leading to emission of 298.59 million tons of CH_4 and 7.74 million tons of N_2O. Rice, wheat and sugarcane biomass contributed 80.76% to the total biomass burnt related emissions (Fig 10).

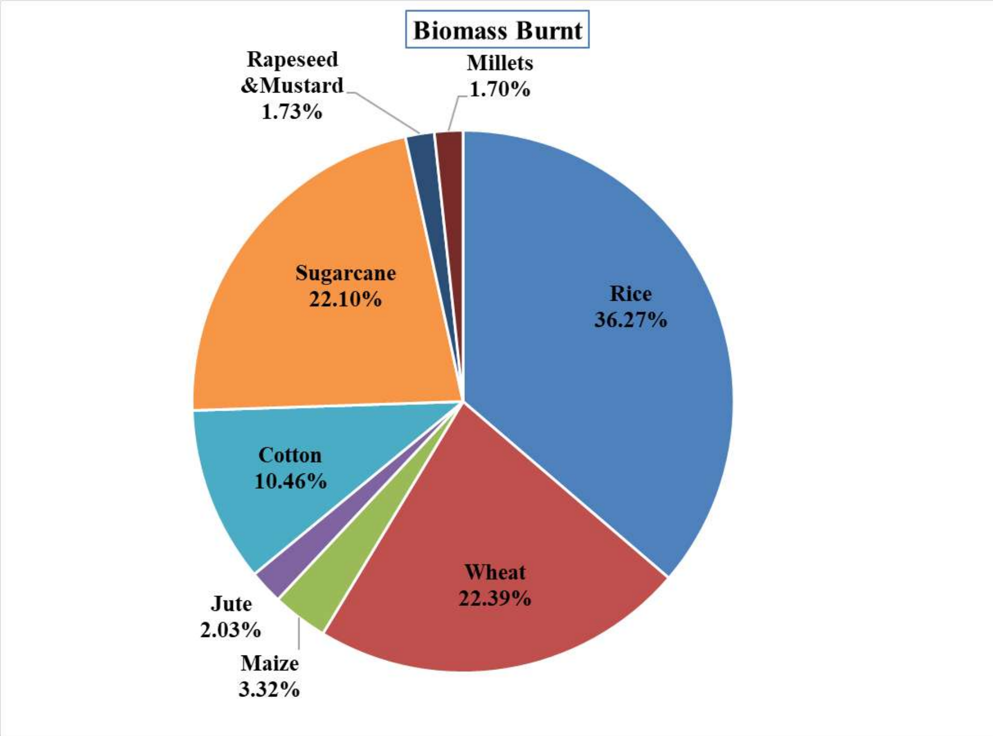
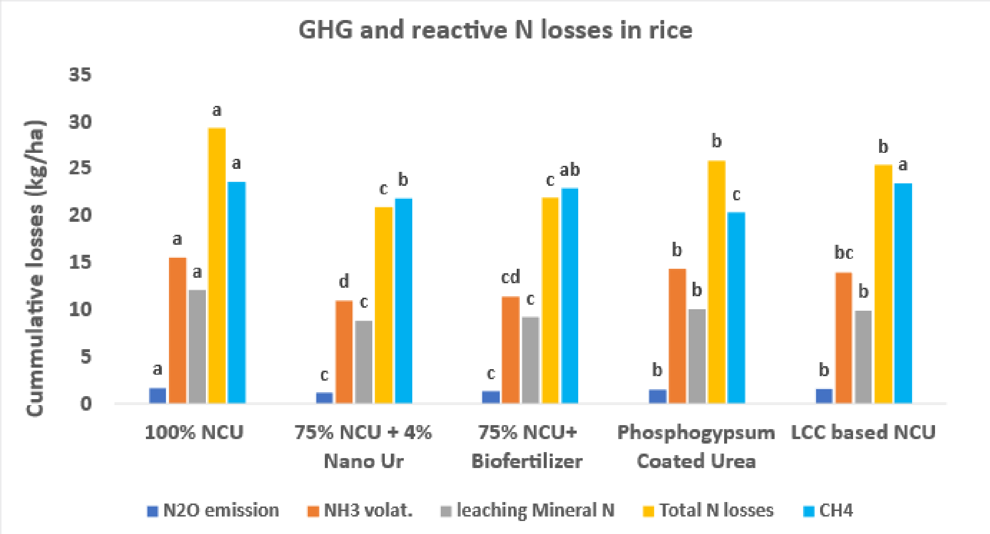


Fig 10 : Contribituion of different crops to total crop biomass burned

Reducing greenhouse gas intensity of rice-wheat cultivation with different agronomic N management practices in a farmer field experiment

Different nitrogen management practices were evaluated for reducing greenhouse gas intensity and improving nitrogen use efficiency in farmer field experiment in rice-wheat system. A field experiment was conducted in Mumtazpur village, Pataudi block growing Pusa 1847 variety of rice in kharif and HD 3226 wheat variety in Rabi with phosphogypsum coated urea, LCC based neem coated urea (NCU), NCU 75%+ Biofertilizer, NCU 75%+1 spray of Nano urea, and conventional 100% NCU application @120 kgN/ha. A 5% coating of Phosphogysum was coated onto prilled urea with guar gum to make it a slow-release fertilizer (PGCU 5% w/w), BGA and azospirillum biofertilizer were used in rice and wheat along with 25% reduced N application. (Fig 11)



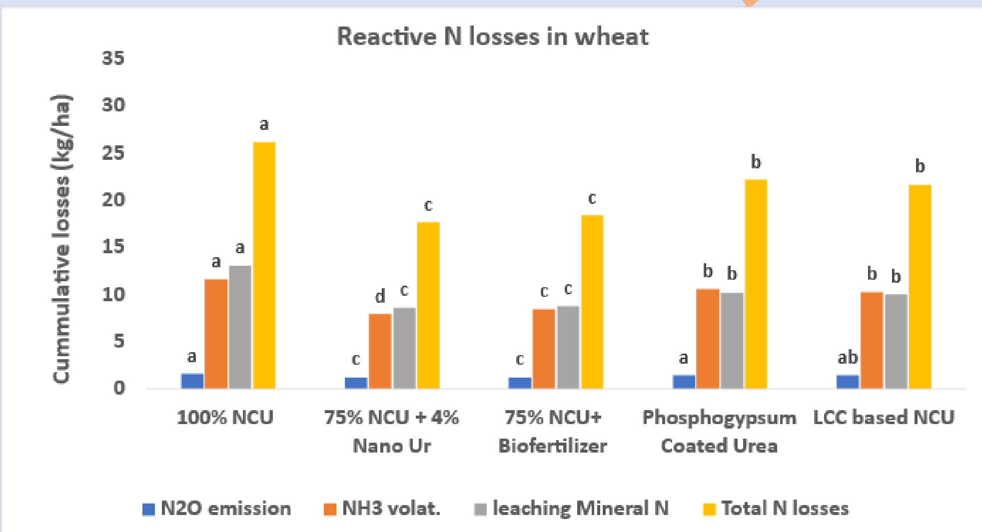


Fig 11: (a) Reactive N losses and GHG emission in (a) rice (b) wheat in rice-wheat system under different N management practices

Measurements of emissions of methane, nitrous oxide, ammonia volatilization and leaching losses of mineral N and yield parameters, plant and soil nitrogen were made. The water regime in rice was multiple aeration under transplanted puddled conditions, whereas six irrigations were applied in wheat crop. Results reveal that PGCU significantly ($p<0.05$) improved yield parameters, reduced reactive N losses of cumulative NH_3, mineral N leaching, and CH_4 emissions, thereby reducing the GHG intensity (GHGi) of rice-wheat system compared to NCU. Nitrous oxide emissions were significantly reduced with application of PGSU in rice only. Biofertilizer and Nano urea application along with 75%N led to a significant lowering in GHGi, though with a slight decline in the crop yields. More long-term trials with PGCU need to be carried out for evaluating impact on environmental and crop productivity.

Emission factor of nitrous oxide from rice and wheat crop growing regions of India using IPCC Tier 3 methods

Synthetic fertilizer application is the major source of nitrous oxide (N_2O) emissions from cropped soils in India. Approximately 5.3 and 3.2 MT of synthetic nitrogenous fertilizer is consumed in rice and wheat crops annually contributing significantly to the annual N_2O emissions from agricultural soils. Rice and wheat crops are grown across the Indian subcontinent with different agronomic practices in diverse agro-climatic conditions, leading to uncertainties in N_2O emission factors. InfoCrop simulation model was used to quantify spatially disaggregated N_2O emissions from the different rice and wheat growing regions of India using IPCC Tier 3 methodology. The crop growth model was calibrated and validated for crop yields and N_2O emissions using published studies in different agro-climatic regions. The N_2O EF ranged from 0.25 to 1.25 % of applied fertilizer N in Kharif rice. (Fig 7) The N_2O EF ranged from 0.36 to 1.14 % of applied N fertilizer in Rabi rice. In wheat crop the N_2O EF ranged from 0.2 to 0.88 % of applied N fertilizer.

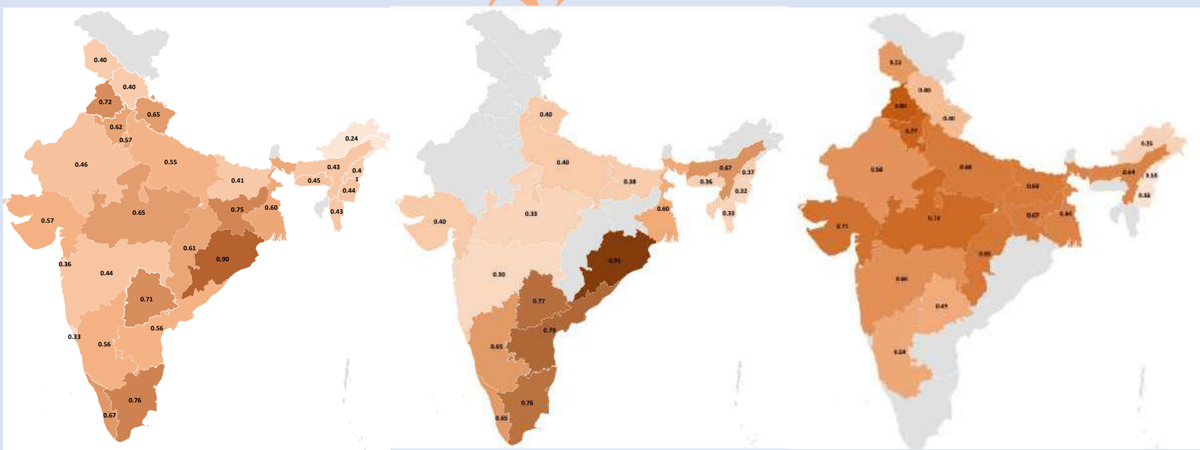


Fig 12: Emission factor of nitrous oxide from rice and wheat cropped soils using Infocrop simulation model

Reactive nitrogen losses from tomato cultivation under open field and polyhouse conditions

This experiment was conducted from November 2023 to May 2024 at two experimental sites, viz. Polyhouse, Vegetable Science Division, and Open

Field, Environmental Sciences Division, IARI, New Delhi, aims to quantify the reactive nitrogen losses from tomato cultivation under different nitrogen management practices in open field and polyhouse conditions. The key findings reveal that the bulk density of soil in the open field ranged from 1.43 to 1.45 g/cm³, while in the polyhouse, it ranged from 1.38 to 1.41 g/cm³. The soil pH averaged 8.00 in the open field and 7.78 in the polyhouse. Electrical conductivity (EC) indicated higher salinity in the polyhouse, measuring between 503 to 526 µS/cm, compared to 465 to 510 µS/cm in the open field. Biological activities, such as dehydrogenase and urease, were significantly higher in polyhouse soils, attributed to the controlled environment favouring microbial growth.

Cumulative N_2O emissions were 21.22% higher in polyhouse cultivation than open field treatments, which indicates more significant greenhouse gas emissions under protected conditions. Ammonia volatilization was highest from T2 plots (RDF @ 120 kg N/ha) in both environments, with emissions being 30.7% greater in polyhouses. Moreover, NH_4^+ and NO_3^- leaching losses were recorded 12.93% and 14% higher, respectively, in open fields than in polyhouses, suggesting better nitrogen retention in polyhouse conditions. The study concludes that while polyhouse cultivation may lead to higher reactive nitrogen losses compared to open-field cultivation, it also provides a more controlled environment that can reduce certain forms of nitrogen loss and enhance crop yields. To maximize the benefits and minimize environmental impacts, careful management of nitrogen inputs is essential in polyhouse systems.

Carbon footprint of rice-wheat system with different rice residue and tillage practices

Greenhouse gas emission was quantified in rice-wheat system with different rice residue management practices for estimating the carbon footprint. The treatments were transplanted puddled rice (TPR) followed by conventional tilled wheat (CTW) with burning of the rice residue (T1). In treatment T2, the conventional practice of rice-wheat cultivation along with rice residue incorporation (RI) and in the third treatment (T3) transplanted puddled rice was followed by zero-tilled wheat (ZTW) with retention of rice residue (RR). The alternately wetting and drying irrigation regime was followed during rice crop growth period. The greenhouse gas emissions due to on field burning of rice residue were quantified under the conventional treatment.

Table 5: Greenhouse gas emission under tillage and residue management in rice-wheat system

S.No.	Treatment	CH_4 (kg/ha) Rice	N_2O (kg/ha) Rice	N_2O (kg/ha) Wheat	CO_2 (kg/ha) Rice	CO_2 (kg/ha) Wheat	CO_2 eq. Emission (kg/ha) Rice-residue burning	Carbon footprint kg CO_2 eq./ha
T1	TPR-CTW(RB)	18.44±1.4	1.78±0.26	1.44±0.18	3451±126	3143±124	6325 ± 373	12919
T2	TPR-CTW(RI)	17.66±1.1	1.67±0.31	1.78±0.23	3547±143	4155±168	-	7702
T3	TPR-ZTW(RR)	19.05±0.92	1.81±0.19	2.14±0.23	3633±98	2668±142	-	6321

Cumulative methane emissions ranged from 17-19 kg/ha. The incorporation of rice residue in conventional tilled wheat significantly increased the CO_2 emissions, whereas the residue retention in zero tilled wheat led to a significant decline in CO_2 emission with a non-significant increase in N_2O emissions (Table 5). The crop residue burning was the highest contributor of GHG emission in the conventional treatment accounting for ~49% of the total carbon footprint. The total carbon footprint reduced by 40% and 51% with residue incorporation and residue retention as compared to the conventional treatment of rice-residue burning.

The changes in concentration of GHGs during the rice burning event is shown in Fig. 13. The earlier part of the fire (5-10 minutes) was flaming with higher CO_2 emission and the later part was smouldering (15-20 minutes) with higher CH_4 emission. The excess CO_2 concentration during the fire event over the non-fire period ranged from 42-1135 ppmv, whereas excess methane concentration ranged from 0.01 to 0.23 ppmv during the 30 minutes burning period. Not much variation in nitrous oxide emissions was observed and an excess from 2-13 ppbv was recorded. The emission factors of CH_4, N_2O and CO_2 during the field burning of rice residue were 2.56±0.52 gkg^{-1}, 0.3±0.05 gkg^{-1} and 1035±44 g kg^{-1}, respectively (Fig 9)

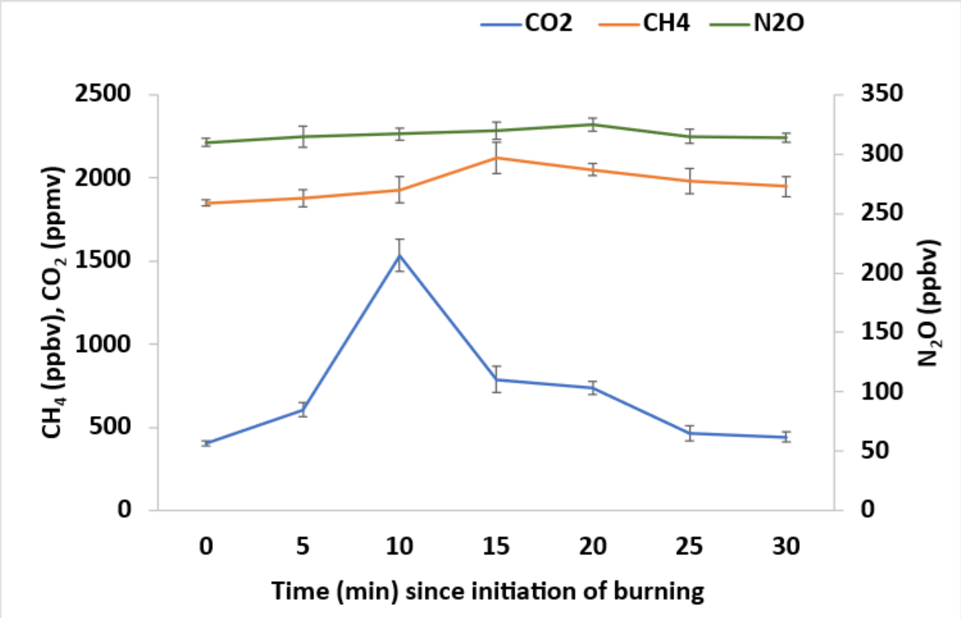


Fig 13: Change in concentration of methane, nitrous oxide during rice residue burning event

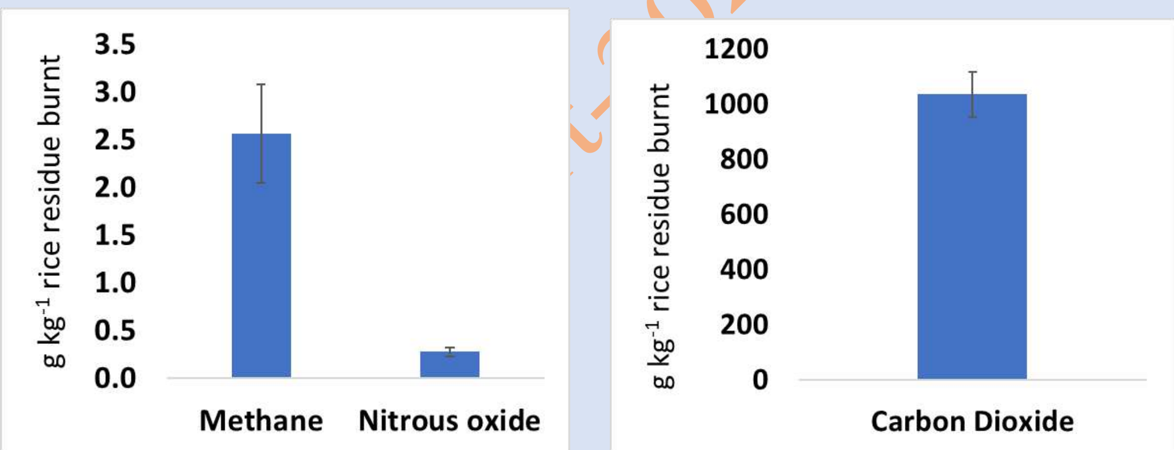


Fig 9: (a) methane and nitrous oxide (b) carbon dioxide emitted during on field rice residue burning event

To evaluate the effect of engineered nano-particles on plant growth and soil health under elevated CO2 condition

During the year, the effects of zinc oxide nanoparticles (ZnO NPs) on rice (*Oryza sativa* L. cv. PB1509) plant growth were assessed in soil microcosm under ambient and elevated CO_2 condition. This study suggests a dose of up to 10 mg kg^{-1} ZnO as basal dose and 10 mg/L as foliar spray at tillering and anthesis stage significantly increased rice grain yield in ambient and elevated CO_2 condition. However, grain yield was found to be higher in elevated CO_2 condition.

To evaluate the impact of metal oxide nanoparticles amendments on remediation of metal contaminated soils

Effects of biochar alone and biochar modified with ZnO nano particles (NP) (BioCh-ZnONP) on the immobilization and bioavailability of Pb, Cd, Zn, and Ni in soil under mustard cultivation were investigated. The results showed that BioChar, and BioCh-ZnONP treatments significantly increased shoots and roots dry weight of mustard compared to the control. The maximum dry weight of root and shoot (1.5 g pot^{-1} and 5.1 g pot^{-1}, respectively) was reached at 1% BC@MnO_2. The heavy metals uptake by mustard roots and shoots decreased significantly after addition of amendments. The lowest Pb, Cd, Zn and Ni uptake in the plant shoot (11.2, 20.1, 30.1, and 46.9 µg pot^{-1}, respectively) was obtained in the 1% BioCh-ZnONP treatment. Modified biochar was more successful in reducing HMs uptake by mustard and improving plant growth than pristine biochar and can therefore be used as an efficient and cost-effective amendment for the remediation of HMs contaminated soils.

To study phosphorus stratification under different agriculture practices

Impact of tillage, residue, and nitrogen management on crop growth and soil health under maize-wheat cropping system studied under field condition. The experiment was conducted in split-split plot design with two level of tillage as main plot of conventional tillage (CT) and no tillage (NT), two level of residue as sub plot of residue (R+) and without residue (R0) and three level of nitrogen as sub-sub plot of 50%, 100% and 150% recommended dose of nitrogen (RDN) for both maize and wheat crop. The results showed that the combination of wheat residue with SSP at a rate of 30 kg P ha^{-1} significantly increased maize yield by 40 % when compared to the control. Similarly, the same treatments as indicated above showed higher P uptake (19. 1 kg P ha^{-1}) than the control). The plant residues quality such as C:N ratio, total plant N, and P significantly Influenced the maize grain yields.

Biochar preparation and utilization from agri-waste as soil conditioner

The biochars prepared from plant biomass included woody species like lantana and pine needles and herbaceous species like wheat straw. Biochars of woody species like lantana and pine needles had higher mass yield and the contents of C, N, humin-like C component, B, Mo and carbonyl group compared to herbaceous biochar like wheat straw. Within the low-temperature range, pyrolysis at 300°C gave a higher mass yield of biochar along with higher content of humin-like C component and O-containing functional groups, as compared to 450°C. Thus, biochars prepared from farm/forest wastes by low temperature (300°C) pyrolysis with low specific density but higher content of humin-like C component and O-containing functional groups appeared to be suitable as a potential soil conditioner to improve soil health.

Zinc- and Magnesium-Doped Hydroxyapatite Nanoparticles Modified with Urea as Smart Nitrogen Fertilizers

Three variants hydroxyapatite−urea, magnesium-doped hydroxyapatite−urea, and zinc-doped hydroxyapatite−urea nanohybrids have been synthesized in a two-step method and characterized as slow-release nitrogen fertilizers. Doping with Zn and Mg reduces the hydroxyapatite nanoparticles' size and accommodates a higher amount of urea molecules. The urea molecules were slowly released from the nanohybrids for up to two weeks in the soil environment. With zinc and magnesium integrated into hydroxyapatite, the synthesized nanohybrids serve as a multinutrient complex of nitrogen, calcium, phosphorus, magnesium, and zinc nutrients. We found that nanohybrids containing 50% nitrogen doses-maintained wheat crop yield and nitrogen nutrient uptake equivalent to a urea fertilizer containing 100% nitrogen doses, which helped mitigate ammonia emissions from the agricultural fields. The nanohybrid-supplemented soil enhanced the soil dehydrogenase and urease enzyme levels, suggesting no adverse impact of nanohybrids on soil health.

Seed priming with *Trichoderma asperellum* and aloe vera leaf extract enhances seedling performance of chickpea subjected to osmotic and temperature stress

The cultivation of chickpea is often hampered by drought and extreme temperatures, especially during early growth stages, that are intensifying with climate change. Two separate investigations were conducted to assess the impact of seed priming with aloe vera leaf extract (AvLE), Trichoderma asperellum, and their combination in enhancing chickpea seedling performance under osmotic and temperature stresses. Seeds were subjected to polyethylene glycol-induced osmotic stress (0.0 MPa, -0.15 MPa, and -0.50 MPa) and germination at varying temperatures (high-30°C, optimum- 20°C and low- 15°C). Seed priming with AvLE and *T. asperellum* significantly improved chickpea performance under osmotic and temperature stress in comparison to hydro-primed seeds. Under osmotic stress, AvLE seed priming increased germination, seedling length, seedling dry weight, vigour index I, and vigour index II by 18.40%, 53.98%, 25.60%, 50.81%, and 64.66% respectively (Fig.14). Similarly, under temperature stress, AvLE enhanced the germination and vigour index I by 12.00% and 22.90% respectively, while *T. asperellum* treatment resulted in 15.78% increase in seedling length (Fig.11). The findings suggest that AvLE priming enhances chickpeas' resilience to adverse environmental conditions.

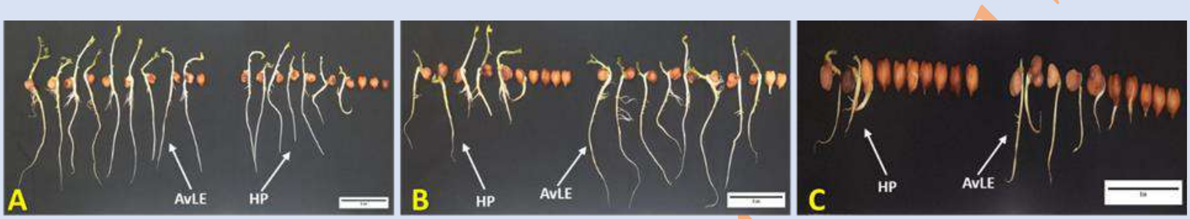


Fig 14: Effect of seed treatments with biostimulants on germination of chickpea (Cicer arietinum L.) seeds under osmotic stress. Osmotic stress A: 0.0 MPa, B: 0.15 MPa and C: 0.50 MPa. AvLE: Alo vera and HP: Hydro-priming. Scale bar = 5 cm.

Fig 11: Effect of seed treatments with biostimulants on germination of chickpea (*Cicer arietinum* L.) seeds under temperature stress condition. Seed germination temperature A: 15°C, B: 20°C and C: 30°C. AvLE: Aloe vera and HP: Hydro-priming. Scale bar = 10 cm.

Utilization of green synthesized Metal Oxide nanoparticles for Arsenic removal from contaminated water

Water is a vital and essential natural asset for sustaining life and environment. However, different ecological, natural and anthropogenic factors have resulted in the increase of toxic contaminants in groundwater, making it unsuitable for human consumption. The contamination of groundwater by poisonous Arsenic is a significant environmental concern that requires immediate attention. This study investigated the synthesis of ZnO and CuO nanoparticles from the agricultural byproducts such as maize husks and banana peels (Fig.15). Batch adsorption experiments were performed using these synthesized nano adsorbents by following Box-Behnken Design (BBD). ZnO nanoparticles, obtained from banana peel and maize husk extracts, exhibited their highest Arsenic removal efficiencies of 94.7% and 97.7% respectively whereas the CuO nanoparticles derived from banana peel and maize husk extracts shown a maximum removal efficiency of 96.6% and 98.6 % respectively, when subjected to a combination of variables consisting of an adsorbent dosage of 30, a pH level of 6, and a contact time of 60 minutes.

Fig 15: ZnO and CuO nanoparticles from Banana Peel Extract and Maize Husk Extract (BPE, MHE)

Productivity and nutrient in wheat under elevated ozone and carbon dioxide interaction under varying N management

Global food security is challenged by the increasing levels of air pollutants like ozone (O_3). A study was conducted in IARI during the rabi season, to quantify the impact of elevated O_3 and CO_2 interaction on growth, productivity, macro and micro nutrient status of wheat under different N management practices. Elevated O_3 level significantly decreased crop growth parameters and yield attributes in wheat crop. In elevated O_3 plus CO_2 interaction treatment grain yield was more by 7.8% than that of ambient with recommended dose of N. Grain and straw N concentration in wheat significantly reduced in elevated O_3 plus CO_2 treatment than ambient. Application of one additional spray of nano urea along with recommended dose of N was able to compensate the reduction in grain N by 9.1%.

Soil organic carbon sequestration as affected by conservation agriculture in a rice-wheat system

Conservation agriculture (CA) has been promoted for sustainable agriculture, limited information is available on the long-term effect on CA on carbon stabilization, soil carbon pools, temperature sensitivity of soil organic carbon (SOC) decomposition, soil aggregation and aggregate-associated C and C cycling enzyme activities in rice (*Oryza sativa* L.)- wheat (*Triticum aestivum* L.) cropping system. These findings revealed that under long-term CA, the physical stabilization of SOC in microaggregates within macroaggregates was the major mechanism of carbon sequestration in rice-wheat cropping system in an Inceptisol of the Indo-Gangetic plains. Thus MBR+ZTDSR-RR+ZTW-WR+ZTMB (ZT plot with rice, wheat and mungbean residue retention) can be a viable option for rice-wheat cultivation in the Indo-Gangetic plains that can enhance carbon sequestration and carbon stabilization in soils by mitigating climate change.

A nine year CA field experiment was selected with seven treatments namely, zero tilled direct seeded rice (ZTDSR)-zero tilled wheat (ZTW), Wheat residue (WR) + ZTDSR – rice residue (RR) + ZTW, WR + ZTDSR + brown manuring (BM) – RR + ZTW, ZTDSR – ZTW – ZT mungbean (MB), Mungbean residue (MBR) + ZTDSR – RR + ZTW – WR + ZTMB, Puddled transplanted rice (TPR) – ZTW, TPR – conventionally tilled wheat (CTW) laid out in a randomized block design with three replications. Results revealed that after nine years of CA practices, the MBR+ZTDSR-RR+ZTW-WR+ZTMB plots had around ~29.9% more total SOC concentrations in the topsoil (0-5 cm) than TPR-CTW plots (7.77 g kg^{-1}). In the topsoil (0-5 cm), the MBR+ZTDSR-RR+ZTW-WR+ZTMB plots had ~23.0% more total SOC stock than CT plots (6.07 Mg C ha^{-1}). The MBR+ZTDSR-RR+ZTW-WR+ZTMB had ~27.9% higher labile C than TPR-CTW plots (4.55 g kg^{-1}) in bulk soil. The MBR+ZTDSR-RR+ZTW-WR+ZTSOC plots had ~31% higher macroaggregate-associated carbon than TPR-CTW plots and ~46.3% higher labile C within macroaggregates than TPR-CTW plots (5.21 g kg^{-1}) showing that residue retention had positively influenced the SOC pool. The MBR+ZTDSR-RR+ZTW-WR+ZTMB had ~35.5% higher recalcitrant C concentrations than TPR-CTW plots (3.14 g kg^{-1}) in the 0-5 cm soil layer. The highest Ct value was recorded in the MBR+ZTDSR-RR+ZTW-WR+ZTMB plots in all the three temperatures for bulk soil, macroaggregates and microaggregates. Higher Kc values were observed in TPR-CTW plots, while CA plots had lower decay rates in the topsoil due to higher recalcitrant C to total SOC concentration. The Q_{10} values revealed that SOC in TPR-CTW plots was more sensitive to temperature changes than ZT plots with residue retention (CA plots). The plots under TPR-CTW were more sensitive to temperature rise in bulk soils, macroaggregates and microaggregates. The ZT plots with residue retention had a higher proportion of macroaggregates and lower microaggregates than TPR-CTW plots in both soil depths, indicating the positive effect of CA practices on soil aggregation. The MBR+ZTDSR-RR+ZTW-WR+ZTMB plots had ~31% higher macroaggregate-associated carbon than TPR-CTW plots and ~46.3% higher labile C within macroaggregates than TPR-CTW plots (5.21 g kg^{-1}) in the 0-5 cm soil depth, showing that residue retention had positively influenced the SOC pool. The MBR+ZTDSR-RR+ZTW-WR+ZTMB plots had higher proportions of coarse particulate organic matter within macroaggregates (cPOM_M) and lower silt+clay within macroaggregates (s+c_M) than TPR-CTW plots in the 0-5 and 5-15 cm soil depths, indicating the positive impact of CA on organic matter retention within aggregates. The MBR+ZTDSR-RR+ZTW-WR+ZTMB plots exhibited higher total organic carbon concentrations within coarse-particulate organic matter in macroaggregates (cPOM_M), light fractions in microaggregates inside macroaggregates (LF_mM), intraaggregate particulate organic matter in microaggregates inside macroaggregates (iPOM_mM), and silt+clay in microaggregates inside macroaggregates (s+c_mM) fractions compared with TPR-CTW plots, indicating improved carbon retention and stabilization in CA soils. The MBR+ZTDSR-RR+ZTW-WR+ZTMB plots showed maximum C stabilization (2.42 g C/1000 g bulk soil) within iPOM_mM which was 95% higher than TPR-CTW plots in top soil. About 0.183 Mg C ha^{-1} yr^{-1} was stabilized inside microaggregates within macroaggregates in the MBR+ZTDSR-RR+ZTW-WR+ZTMB over control.

Empirical observation of natural farming inputs on nitrogen uptake, soil health and crop yield of rice-wheat cropping

Natural Farming represents an agro-ecological methodology for farming that emphasizes regenerative practices to promote holistic ecological balance and reduce the dependence on external inputs and financial resources. Substantial concern has recently arisen over the need to encourage agroecosystems that are more sustainable to improve the deteriorating soil health as well as reversing the yield plateau of crop. So, the current on farm field experiment was executed comprising of 8 treatments with different combination of natural farming inputs (Ghanjeevamrit, Jeevamrit, Beejamrit), organic fertilizer (such as FYM), integrated nutrient management (NPK, FYM, Azotobacter and Azolla) and in- organic(NPK) to examine and compare the consequence of natural farming inputs, organic fertilizer and in-organic dosage of fertilizer on soil nitrogen uptake, soil physicochemical properties, soil biological properties, soil microbial population and crop yields in a rice-wheat cropping system over two crop seasons 2021-23 [rice (Pusa-1509) and wheat (HD-3086)]. The study results demonstrated that there was significant ($p<0.05$) increase in the soil's nitrogen availability and nitrogen uptake with the use of natural farming inputs as compared to control treatment, whereas natural farming treatments (TNF1, TNF2, TNF3, TMNF) were inferior to integrated nutrient management (TINM). They recommended doses of fertilizer (TRDF) treatment in case of nitrogen uptake by both rice and wheat crops. The soil enzymatic activity (Dehydrogenase, β-glucosidase, and urease), soil microbial biomass carbon and nitrogen, and soil microbial population (Bacteria, fungi, and actinomycetes) were significantly ($p<0.05$) higher in treatment receiving natural farming inputs compare to inorganic fertilizer and organic fertilizer. A positive and significant correlation was observed between potential mineralization nitrogen and soil enzymatic activity (Dehydrogenase, β-glucosidase and urease), soil microbial biomass carbon, nitrogen, and soil microbial population (Bacteria, fungi and actinomycetes. The crop yield at the end of experiment recorded to be highest in treatment TINM (75 % RDF (In-organic) + 25% RDF (FYM) + BGA) i.e., (Rice- 4.76 t/ha and Wheat- 5.82 t/ha) compared to TRDF and TNF. A crop yield reduction of 14.2% was observed in treatment receiving natural farming inputs compare to TINM. A significant increase in crop yield was observed in TMNF (Jeevamrit (25%) + Ghanjeevamrit (25%) + 50% RDF through FYM + Beejamrit) compare to Tc (Control) and TFYM (Farmyard manure). (Fig 16) Therefore, our study suggests that adoption of natural farming inputs over time can facilitate the enhancement of soil biological health.

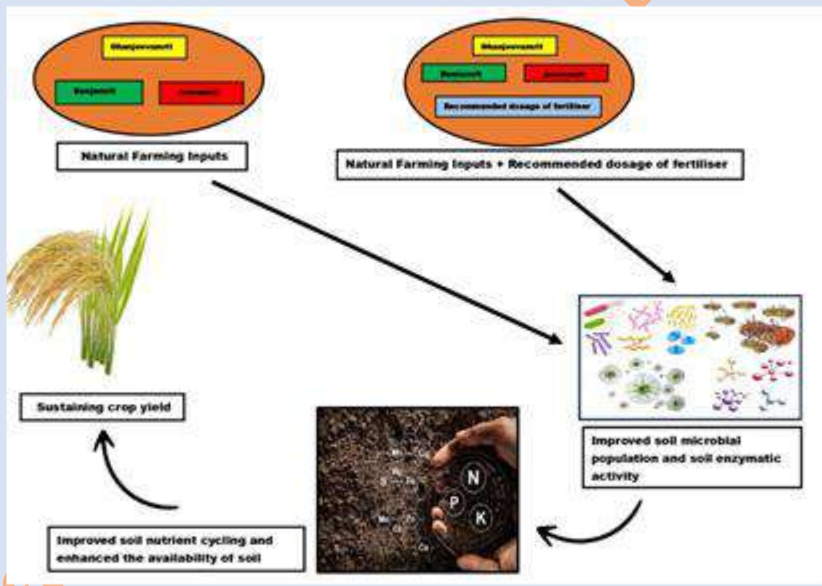


Fig 16: Pictorial representation of application of natural farming inputs (ghanjeevamrit, jeevamrit, beejamrit) and natural farming inputs integrated with recommended dosage of fertilizers showing significant improvement in soil biological quality, soil microbial community, soil nutrient availability and sustaining crop yield.

Assessing soil organic carbon variability across land use systems in northeast India

Soil organic carbon (SOC) is a vital constituent of terrestrial ecosystems, playing a key role in soil health, fertility, and carbon sequestration. The present study aims to assess and compare the effects of various land use systems, including bamboo, tea, mango, lemon, rice-rice, wheat-millet, okra-onion and uncultivated soils, on SOC dynamics in this region. Land use systems were selected as plantation crop (bamboo, tea), horticultural crops (mango, lemon) and agricultural crops (rice-rice, wheat-millet and okra-onion) and also selected the uncultivated field as a reference. All the land use systems are maintained by Horticulture Research Centre (HRC), Nagicherra, Agartala, Tripura. The carbon pools in selected LUS indicated the deviation depth and land use pattern Results showed that the pH of selected LUS has been found 4.66–5.60 under the strongly acidic range. (Fig 17)

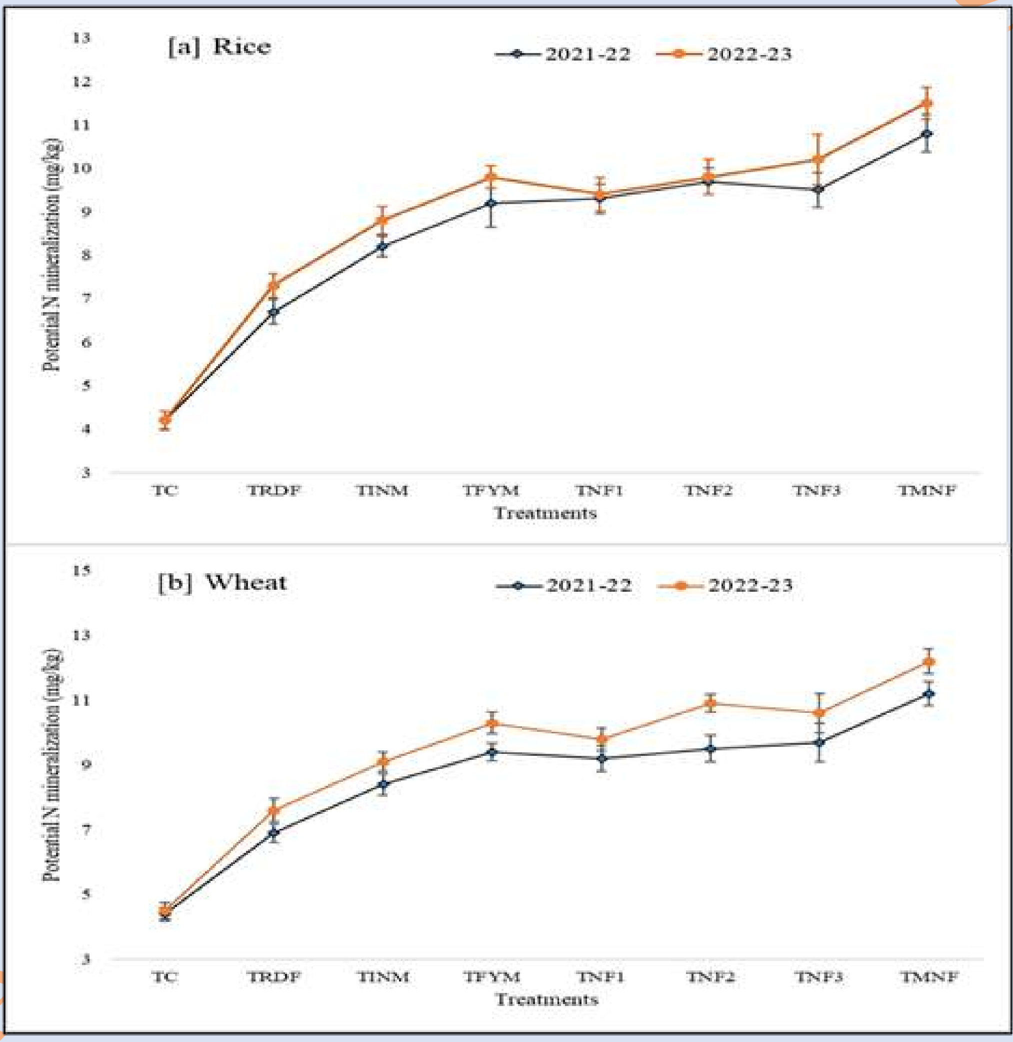
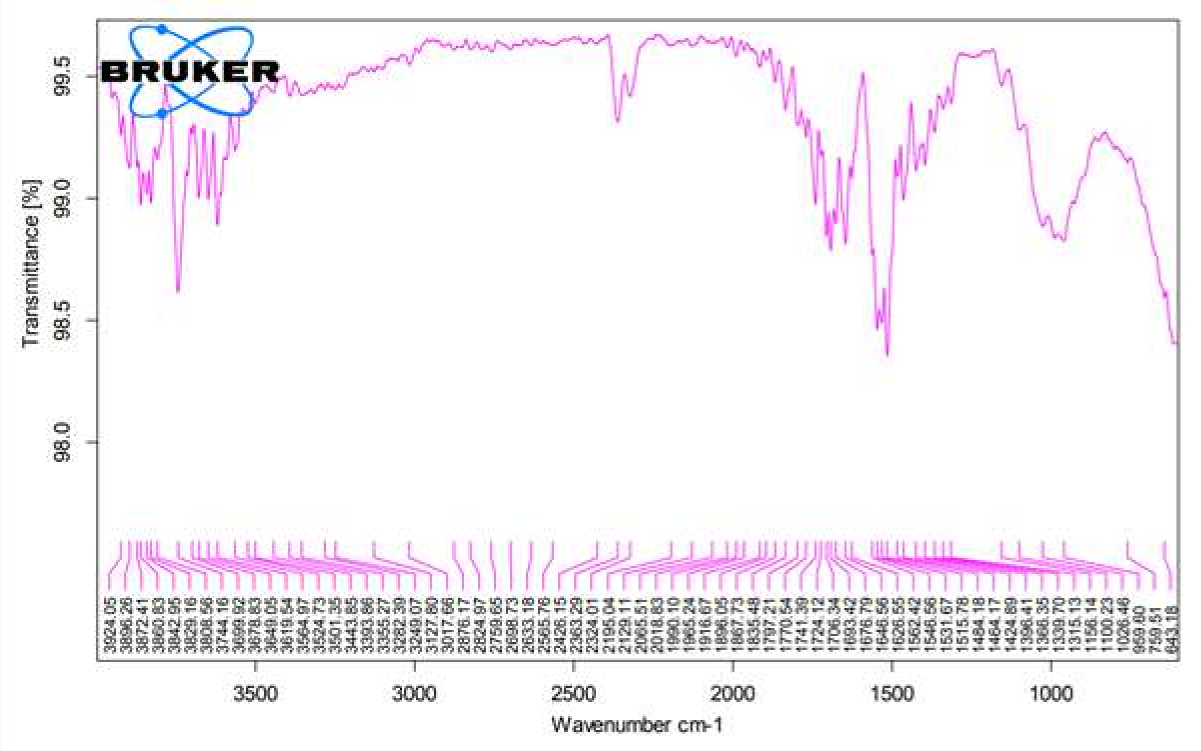


Fig 17: Effect of different nutrient management practices on potential nitrogen mineralization during rice and wheat cropping season 2021-22 and 2022-23. [TC: Control, TRDF: Recommended dosage of fertilizer, TINM: Integrated nutrient management, TFYM: Farm yard manure, TNF-1: Natural Farming-1, TNF-2: Natural Farming-2, TNF-3: Natural Farming-3, TMNF: Modified Natural Farming]

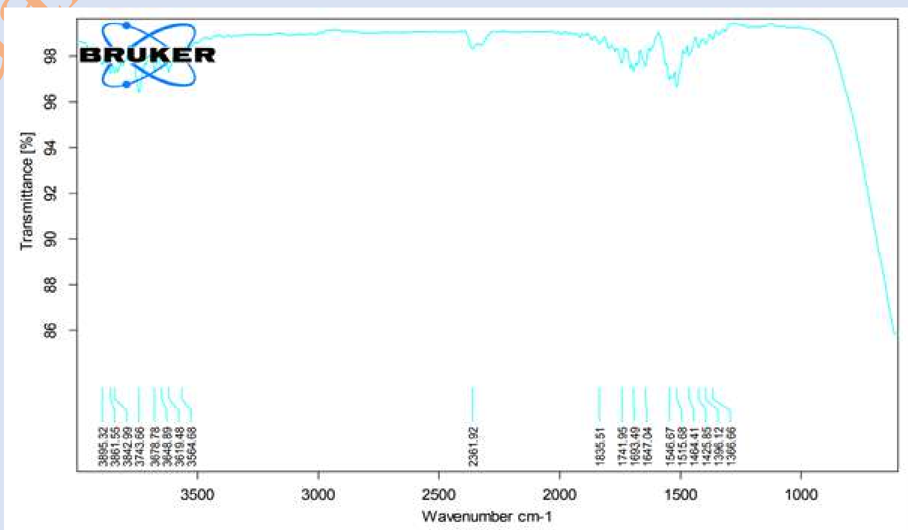
Bulk density varies from 1.21–1.38 g/cm, with significantly low BD in tea LUS compared to uncultivated system. Walkley and Black carbon (WBC) is significantly variable among the selected LUS, ranging from 7.14–12.5 g/kg, with the maximum values in tea LUS. Lability index (LI) varies from 1.50 to 1.63 and 1.40 to 1.74 in 0-30 cm and 30-60 cm depth, respectively. Carbon Pool Index (CPI) assessed highest in tea LUS, 1.78 and 2.1 from 0-30 and 30-60 cm, respectively. Carbon management index (CMI) was higher in selected LUS compared to uncultivated system. It was observed that tea system having highest active and passive carbon pools compared to other LUS. There was significant variation in active and passive pools within different depths among LUS. The results shown that the establishment period, tillage operations, intercultural activities, fertilization and other intervention have significant variations in active and passive carbon pools. The Carbon Management Index (CMI) is a valuable metric that stems from the overall SOC pool and LI. The positive impact of long-term or perennial land use systems, consistently enriching the soil with organic matter and contributing to carbon sequestration, thereby enhancing soil quality. Forests and perennial land use systems demonstrated higher soil carbon content and pools compared to seasonally cultivated land, thereby improving soil carbon fractions and overall soil quality in the NEH Region of India.

Extraction and development of cellulose-based bioplastics synthesized using nano-particles from corn cobs

Corn cobs were collected from the field, ground into fine particles, and sieved through 30 mesh sieves. The corn cobs were treated with 5% NaOH solution for 3 hours at 80 degrees C temperature and stirred continuously at a ratio of 1:10. Then, acquired cellulose was washed with distilled water so that the effluent became neutral. The obtained pre-husk was bleached with 5% NaClO2 solution for 3 hours at 80℃ temperature at an acidic pH. The residual lignin present in the effluent was washed away by repeated washing with distilled water. The effluent was filtered and washed with deionized water. The obtained cellulose was dried for 24 hours in an oven and stored in a dry place.



TiO_2 nanoparticles were produced through the sol-gel method. FTIR spectrum of TiO_2 NPs shows two prominent bands. The first band is the broadest, observed at 3700 cm^{-1}, corresponding to the stretching vibration of the hydroxyl group O-H of the TiO_2 NPs. The second band is around 1690 cm^{-1}, corresponding to the bending modes of water Ti-OH. The peaks 3743 and 3678 cm^{-1} are related to H-O-H vibrational bonding, and the peaks at 1693 and 1515 cm^{-1} are indexed to -OH vibrational bonds, indicating the presence of absorbed hydroxyl groups in the samples.



The bioplastic sheets were prepared using cellulose obtained from corn cob and TiO_2 through xanthation, followed by the addition of natural plasticizers. The morphology of bioplastic films was studied under a Scanning Electron Microscope to understand their mechanical and barrier properties. The rough surface is due to the presence of cellulose particles rather than the matrix. This work will be continued for further testing and confirmation. The oxygenic photosynthetic microalgae have been

Valorization of Phycoremediated Microalgal Biomass for Biofertilizers and Bioproducts

The oxygenic photosynthetic microalgae have been considered as an environment-friendly renewable source for wastewater remediation, which simultaneously attributes for nitrogen (N) and phosphorus (P) removal along with CO_2 mitigation by converting solar energy into valuable biomass. Wastewaters represent rich sources of nitrogen and phosphorus, with promise for use as low-cost media for microalgae. Microalgae have ability to flourish in diverse types of environments and assimilate such nutrients.

Impact of Integrated Application of Biogas Slurry and Organo-mineral Amendments on Soil Microbial Biomass

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Carbon and Enzymes Activity under Rice-Wheat Cropping System (RWCS)

The mono-cropping system, lacking a balanced nutrient supply and facing diminishing water resources, is contributing to the degradation of soil health. Consequently, agricultural production is becoming unsustainable and leading to environmental degradation. The experiment was executed at the farm of ICAR-IARI in New Delhi under irrigated conditions during 2022-2024 to study the impact of integrated application of biogas slurry and organo-mineral amendments on soil microbial biomass carbon (SMBC) and enzyme activity under rice-wheat cropping system.

In this experiment, the doses of urea and biogas slurry were applied for both rice and wheat crop experiment field with 6 different treatments and 4 replications viz., T0-Control (where no urea/biogas slurry applied, BGS), T1-100% N by recommended dose of fertilizer (Urea), T2 – 25% N by BGS + 75% N by recommended dose of fertilizer, T3-50% N by BGS + 50% N by recommended dose of fertilizer, T4-75% N by BGS + 25% N by recommended dose of fertilizer and T5-100% N by BGS. The SMBC has been increased in all the treatments from 2023 to 2024 from 0.98 to 9.0 percent. The SMBC of T5 treatment is significantly higher than other treatments viz., T0, T1, T2 and T3 but it is at par with T4 treatment in the both years, respectively. In all the treatments the dehydrogenase activity was increased from 2023 to 2024, such as it increased about 8.48 percent in T5 treatment followed by T2/ T3 (8%), T4 (7.27%), T1 (1.45%) and T0 (1.37%), respectively. The activity of the acid and alkaline phosphatase was observed significantly higher in T5 treatment at reproductive stage of wheat, while minimum activity was recorded in T0 treatment during both the years. The maximum α-Glucosidase activity 404.25 mg/mL (2023) and 415.49 mg/mL (2024) was noticed in T5 treatment with a 100% dose of biogas slurry application and it is significantly higher than T0, T1, T2, T3 and T4 treatment. The activity of β-Glucosidase was increased in all the treatments from 2023 to 2024 and the maximum activity was recorded in T5 treatment 226.0 µg pNP g^{-1} dry soil h^{-1} (2023) and 232.41 µg pNP g^{-1} dry soil h^{-1} (2024) during both years, while recorded minimum in T0 treatment 169.25 µg pNP g^{-1} dry soil h^{-1} (2023) and 172.39 µg pNP g^{-1} dry soil h^{-1} (2024) during both years, respectively. In case of N Acetyl

Glycosaminidase (NaG), the activity was recorded maximum in T4 (4.65%) and T3 (3.27%) treatments in comparison to T5 (3.25%) treatments and it is observed minimum in T0 (0.43%) and T1 (0.67%) treatment, respectively. Hence, this experiment demonstrated that the SMBC and most of the enzyme activities are maximum when higher doses of biogas slurry is applied. The study demonstrates that biogas slurry has a significant positive impact on soil enzymes, which are crucial for maintaining soil health and biological diversity. This research is particularly valuable for mitigating the adverse effects of the rice-wheat cropping system on soil health.

Sustainable Approach of Microalgae Mediated Wastewater Treatment Through One Pot Multiphasic Fed Batch Strategy and Biopolymer Production Towards Metal Corrosion Inhibition

Mixotrophic Cultivation of Microalgae Using Wastewater Resources

- Identified and procured established microalgae strains suitable for mixotrophic growth.
- Collected and characterized different wastewater sources for nutrient composition.
- Conducted preliminary screening of microalgae strains under various wastewater conditions.
- Optimized culture conditions (pH, temperature, light intensity, and CO_2 supplementation) for mixotrophic growth.
- Monitored biomass productivity, lipid accumulation, and nutrient removal efficiency. (Fig 18)
- Selected the most suitable microalga based on maximum biomass production and overall growth efficiency.

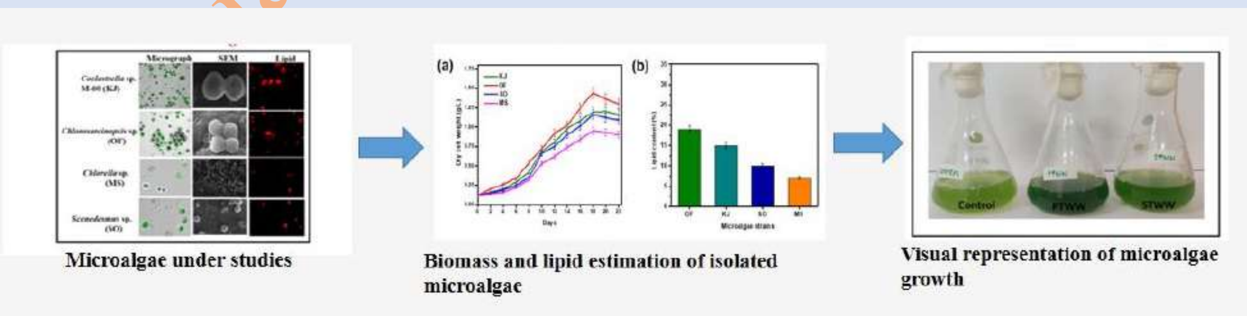


Fig 18: Biomass and lipid yield of isolated microalgae strains

2. Step-wise Extraction of Biopolymers Using One-Pot Multi-Phasic Fed-Batch Cultivation

- Designed a multi-phasic fed-batch cultivation strategy to optimize C/N/L ratio.

- Performed shake flask experiments to assess the effect of varying carbon, nitrogen, and lipid supplementation.
- Optimized culture conditions to enhance biopolymer production (e.g., polysaccharides, lipids, and proteins).
- Developed a step-wise extraction protocol for efficient recovery of biopolymers.
- Evaluated biopolymer yield and composition using biochemical and analytical techniques. (Fig 19)
- Assessed the feasibility and scalability of the process for industrial applications.

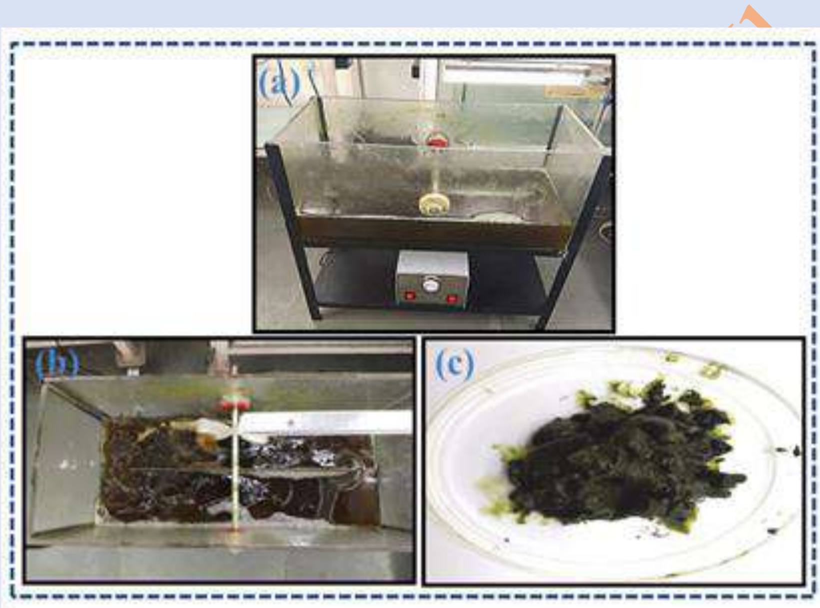
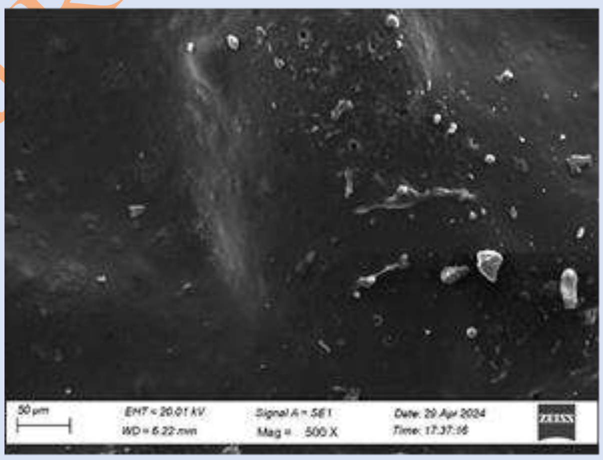


Fig 19: Biomass and lipid yield of isolated microalgae strains by using Raceway system

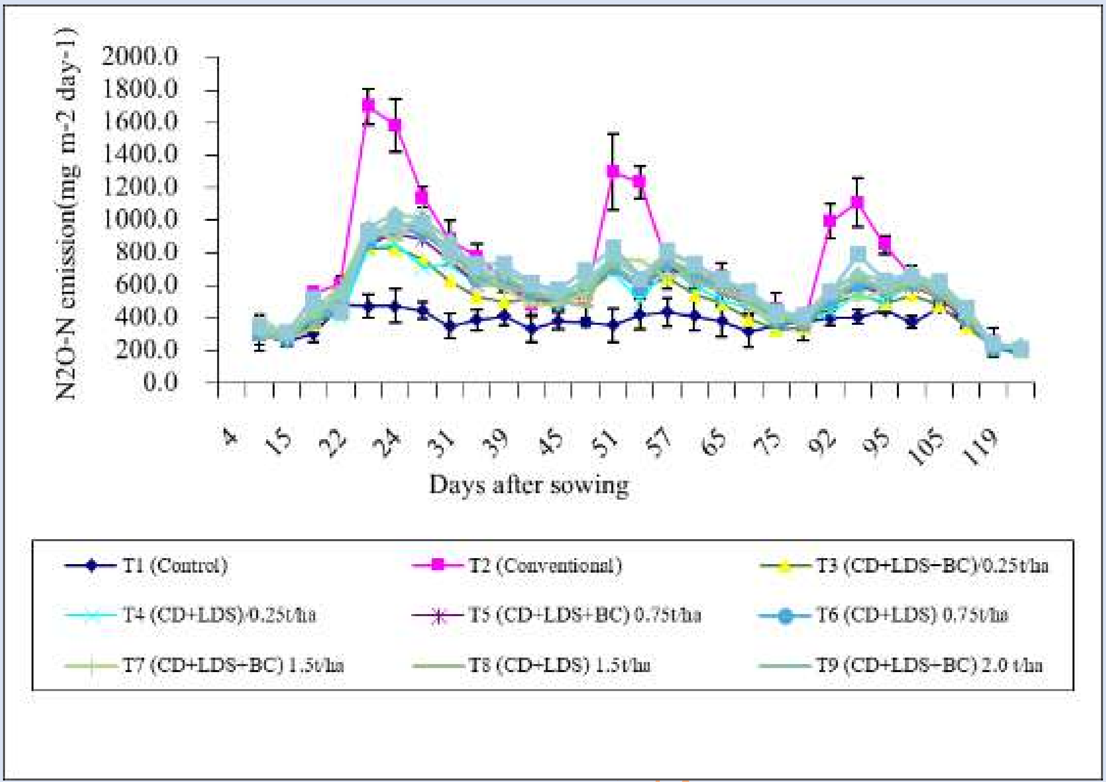


Lipopeptide based biosurfactant for removal of oil spill and degradation of Poly Aromatic Hydrocarbons' in soil

Surface-tension reducing compound (37.4 mN m^{-1}, yield 2.65 g L^{-1}) was isolated form *Lysinibacillus* sp. MW444883 and it's putative nature was identified as lipopeptide. 56.4-86.6% reduction in oil area (using ArCGIS software) showed the effectiveness of good dispersant. Fragmentation of oil into small droplets make biosurfactant as good option for providing oil as food substrate for microbes. Rheology showed decrease in viscosity with the addition of biosurfactant in oil-water emulsion, leads its role as lubricant. Foaming (40-70%) indicates its role as detergent. Biosurfactant was found to be stable at different temperature (25, 35 and 45 °C), salt concentration (0.5, 1, 3 and 5%) and pH (3, 5, 7, 9, 11). Degradation and half-life of PAHs in acidic and alkaline Inceptisol soils (collected from Delhi and Jharkhand agricultural field) under different environment (28 and 37 °C) varied for naphthalene (20.8-100%; 1.16-9.86 d), fluorene (5.8-93.8%; 5.6-14.4 d), phenanthrene (6.0-94.1%; 5.4-22.5 d) and pyrene (5.8-78.7%; 10.3-27.0 d), respectively.

Effect of LD slag on greenhouse gas (GHG) emissions in wheat

The experiment was conducted to analyze the effect of LD slag on greenhouse gas (GHG) emissions in wheat. The results illustrated that the average value of N_2O flux ranged from 307.0 to 721.3 mg/m^2/day. The highest N_2O emissions were observed in treatment T2 (conventional), followed by T11 (CD+BC), T10 (CD+LD slag), and T9 (CD+LD slag+BC). Moreover, the data indicated that N_2O emission in wheat was reduced by using a higher dose of bioaugmented LD slag. The study suggests that augmented LD slag is a viable option for reducing the global warming potential (GWP) in wheat crops. The utilization of bioaugmented LD slag with biochar and cow dung could be an effective strategy for managing N_2O emissions sustainably.


N2O-N emission(mg m-2 day-1)
2000.0
1800.0
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
4
15
22
24
31
39
45
51
57
65
75
92
95
105
119
Days after sowing
T1 (Control)
T2 (Conventional)
T3 (CD+LDS+BC)/0.25t/ha
T4 (CD+LDS)/0.25t/ha
T5 (CD+LDS+BC) 0.75t/ha
T6 (CD+LDS) 0.75t/ha
T7 (CD+LDS+BC) 1.5t/ha
T8 (CD+LDS) 1.5t/ha
T9 (CD+LDS+BC) 2.0 t/ha

2. Intellectual property:

Copyrights granted

- Copyright ID : SW-18287/2024 , Spinach Simulation Model v1
  Lead developer: Dr. S. Naresh Kumar
- Copyright ID : SW-18313/2024, VignaradSim v1
  Lead developer: Dr. S. Naresh Kumar

Patent Filed

- Namita Das Saha, Priyanka Kumari, Niveta Jain and Bhupinder Singh (2024) Device and method for separation and quantification of microplastics from soil, sludge and farm yard. Patent filed vide application no 202311059521
- Kalidindi Usha and Bhupinder Singh (2024) Laser-induced graphene from single-use plastic Patent filed vide application no 202311030667
- Biosurfactant formulation for degradation of hydrocarbons in soil and method of preparation thereof" by Ashish Khandelwal, Ashwini Yadav, Neera Singh (Patent Number: 202411054900 dated 18-07-2024 CBR Number: 47270)

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1.	पंजीकरण संख्या/Registration Number	SW-18313/2024
2.	आवेदक का नाम, पता तथा राष्ट्रीयता Name, address and nationality of the applicant	ICAR , KRISHI BHAWAN, DR RAJENDRA PRASAD ROAD, NEW DELHI-110001 INDIAN
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5.	कृति का शीर्षक Title of the work	VIGNARADSIM V1, GREEN GRAM SIMULATION MODEL
6.	कृति की भाषा Language of the work	FORTRAN, C#, .NET
7.	रचयिता का नाम, पता और राष्ट्रीयता तथा यदि रचयिता की मृत्यु हो गई है, तो मृत्यु की तिथि Name, address and nationality of the author and if the author is deceased, date of his decease	SOORA NARESH KUMAR , DIVISION ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSITUTUE, NEW DELHI-110012 INDIAN SHWETA AMRITA LAKHRA , PHD STUDENT DIVISION ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSITUTE, NEW DELHI-110012 INDIAN VIKAS KUMAR , YOUNG PROFESSIONAL II, DIVISON OF ENVIRONMENT SCIENCE INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI-110012 INDIAN RC HARIT , SR TO, DIVISION ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE-110012 INDIAN PK AGARWAL , NATIONAL PROFESSOR, DIVISION OF ENVIRONMENT SCIENCE, INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI-110012 INDIAN
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1.	पंजीकरण संख्या/Registration Number	**SW-18287/2024**
2.	आवेदक का नाम, पता तथा राष्ट्रीयता Name, address and nationality of the applicant	ICAR , KRISHI BHAWAN, DR. RAJENDRA PRASAD ROAD, NEW DELHI-110001 INDIAN
3.	कृति के प्रतिलिप्यधिकार में आवेदक के हित की प्रकृति Nature of the applicant's interest in the copyright of the work	OWNER
4.	कृति का वर्ग और वर्णन Class and description of the work	COMPUTER SOFTWARE WORK
5.	कृति का शीर्षक Title of the work	SPINACH SIMULATION MODEL V1
6.	कृति की भाषा Language of the work	FORTRAN, C#, .NET
7.	रचयिता का नाम, पता और राष्ट्रीयता तथा यदि रचयिता की मृत्यु हो गई है, तो मृत्यु की तिथि Name, address and nationality of the author and if the author is deceased, date of his decease	PROF. SOORA NARESH KUMAR , DIVISION OF ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI-110012 INDIAN VIKAS KUMAR , YOUNG PROFESSIONAL II DIVISION OF ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI-110012 INDIAN JAYANTH THOKDHAR , MSC STUDENT, DIVISION OF ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI-110012 INDIAN R.C. HARIT , TECHNICAL OFFICER, DIVISION OF ENVIRONMENT SCIENCE, ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI-110012 INDIAN
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9.	प्रथम प्रकाशन का वर्ष और देश तथा प्रकाशक का नाम, पता और राष्ट्रीयता Year and country of first publication and name, address and nationality of the publisher	N.A.
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14.	यदि कृति एक 'कलात्मक कृति' है जो किसी भी माल या सेवाओं के संबंध में उपयोग की जाती है या उपयोग किए जाने में सक्षम है, तो आवेदन में प्रतिलिप्यधिकार अधिनियम, 1957 की धारा 45 की उप-धारा (i) के प्रावधान के अनुसार व्यापार चिह्न रजिस्ट्रार से प्रमाणन शामिल होना चाहिए। If the work is an 'Artistic work' which is used or capable of being used in relation to any goods or services, the application should include a certification from the Registrar of Trade Marks in terms of the provision to Sub-Section (i) of Section 45 of the Copyright Act, 1957.	N.A.
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ICAR-NRM-IARI-Technology-2024-151

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Certified that

Arti Bhatia
(Lead Developer)

Associate Developers
Himanshu Pathak
Niveta Jain

of

ICAR-IARI, New Delhi

has developed the technology

Mitigating nitrous oxide (N_2O) emission with leaf colour chart based N application in rice-wheat system

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Concept-2024-147

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Niveta Jain

(Lead Developer)

Associate Developers

Rachana Dubey, H. Pathak

Arti Bhatia, M. Khanna

of

ICAR-IARI, New Delhi

has developed the technology

Emission and Scaling factor for greenhouse gases from continuous flooded rice and system of rice intensification (SRI)

16th July, 2024

New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

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ICAR

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Certified that

Niveta Jain

(Lead Developer)

Associate Developers

Arti Bhatia

H. Pathak

D. Chakraborty

of

ICAR-IARI, New Delhi

has developed the technology

Emission factor for N_2O from different crop types for GHG inventory of agricultural soils of India

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Concept-2024-145

भाकृअनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Ranjan Bhattacharya
(Lead Developer)

Associate Developers
T.K. Das, S. Das, Abir Dey, A.K. Patra
R. Agnihorti, A. Ghosh, A.R. Sharma

of

ICAR-IARI, New Delhi

has developed the technology

Conservation agriculture improves top soil aggregate-associated nitrogen but not the nitrogen use efficiency by wheat

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Product-2024-156

भाकृअनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Ashish Khandelwal

(Lead Developer)

Associate Developers

Neera Singh, Shashi Bala Singh
Lata Nain, Tirthankar Banerjee, Suman Gupta
Balasubramanian Ramakrishnan

of

ICAR-IARI, New Delhi

has developed the technology

PUSA BioPAH: Degradation of polyaromatic hydrocarbons (PAHs) in water and soil

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Technology-2024-136

भाकृअनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

T.K. Das

(Lead Developer)

Associate Developers

Jitesh Kumar Baghel, Sourav Ghosh
Rishi Raj, Ranjan Bhattacharya, Susama Sudhishri
Prabhu Govindasamy, Arti Bhatia, A.K. Biswas

of

ICAR-IARI, New Delhi

has developed the technology

CA-based direct-seeded rice-wheat-mungbean system for sustainable crop production, soil health, and environment

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Technology-2024-132

भाकृअनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

T.K. Das

(Lead Developer)

Associate Developers

Rishi Raj, Ranjan Bhattacharyya
Susama Sudhishri, K.K. Bandyopadhyay
A.K. Biswas

of

ICAR-IARI, New Delhi

has developed the technology

CA-based cotton-wheat system for sustainable crop production, profitability and soil health

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Protocol-2024-150

भाकृअनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

Shrila Das

(Lead Developer)

Associate Developers

Ranjan Bhattacharyya, T.K. Das
B.S. Dwivedi, M.C. Meena, Abir Dey
Sunanda Biswas, Kaustav Aditya

of

ICAR-IARI, New Delhi

has developed the technology

Identification of key soil quality indicators under conservation agriculture in North-Western Indo-Gangetic Plains

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

ICAR-NRM-IARI-Technology-2024-152

भाकृअनुप
ICAR

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Certified that

M.C. Meena
(Lead Developer)

Associate Developers
B.S. Dwivedi, Abir Dey
S.P. Datta, V.K. Singh, Renu Singh
Pravin K. Upadhyay, Kapila Shekhawat
Suresh Chand Sharma, Ashok Kumar

of

ICAR-IARI, New Delhi

has developed the technology

Nitrogen management protocols for conservation agriculture under maize-wheat-mungbean system

16th July, 2024
New Delhi

(Rajbir Singh)
Assistant Director General (AAF&CC)

(S.K. Chaudhari)
Deputy Director General (NRM)

3. Linkages and Collaboration

- Institutes/Industry/University, and details of collaboration (whether it is in project, if so, name of the project, PI etc).
- Agriculture Model Intercomparison and Improvement Project (AgMIP- Global Steering Council Member, led by Columbia University and NASA.
- DST Technology development Programme, Expert Member
- DST Device development Programme, Expert Member
- DST SHRI Programme, Expert Member
- DST INSPIRE Programme, Expert Member
- DAC committee on crop yield forecast (member)
- MoEF&Cc member on Persitant Organic Pollutants
- Bureau of Indian Standards, Expert member.
- MoEFCC Panel on Persitant Organic Pollutants, Expert member.
- MoA&FW committee for crop yield forecast, Expert member.
- Ministry of Steel and Steel Industry: Project (Code 24-774): Development of steel slag-based cost-effective eco-friendly fertilizers for sustainable agriculture and inclusive growth. Tata Steel Limited; JSW Steel Limited; SAIL
- Tata Steel Limited; JSW Steel Limited and SAIL, Ministry of Steel and AMNS Limited (TWO CRP's code 24-774 and 79-184)
- VNIT, Nagpur under the project Use of Biomass ashes to enhance the nutrient supply to the plant and effect on soil health
- IIT, Delhi
- G.B. Pant University of Agriculture & Technology, Pantnagar
- Bhabha Atomic Research Centre, Mumbai
- Collaboration with the NESA (National Environmental Science Academy) New Delhi and working as General Secretary of NESA for organizing environmental awareness and workshop and conferences
- AERB and BARC, Mumbai as Radiological safety Officer and In-charge Gamma Irradiation Facility

4. Education

a) Summary of UG, PG education

Details of courses offered in MSc and PhD during Semester I and Semester II

Course name	Course code		Credits
Semester I			
Introduction to Environmental Sciences	ES 501	MSc	2 + 1
Environmental Chemistry	ES 502	MSc	2 + 1
Climate Change and Climate Smart Agriculture	ES 503	MSc	2 + 1
Instrumental Methods for Environmental Monitoring	ES 504	MSc	2 + 1
Environmental Pollution	ES 506	MSc	2 + 1
Analysis of Agroecosystem	ES 601	PhD	2 + 1
Environmental Impact Assessment	ES 602	PhD	2 + 1
Waste Management	ES 603	PhD	2 + 1
Crop Geography and Ecology	ES 604	PhD	2 + 1
Agrostology and Agroforestry	ES510	MSc	2 + 1
Master's Seminar	ES 591	MSc	1 + 0
Doctoral Seminar I	ES 691	PhD	1 + 0
Doctoral Seminar II	ES692	PhD	1 + 0
Semester II			
Environmental Engineering	ES 505	MSc	2 + 1
Environmental Microbiology and Ecology	ES 507	MSc	2 + 1
Biofuels and Environmental Protection	ES 508	MSc	2 + 1
Environmental Toxicology	ES 509	MSc	2 + 1
Environmental Geosciences	ES 511	MSc	2 + 0
Biodiversity	ES 605	PhD	2 + 1
Plant Growth Modeling & Simulation of Ecological Processes	ES 606	PhD	2 + 1
Introduction to Environment Law and Policy	ES 607	PhD	2 + 1
Masters Seminar	ES 591	MSc	1 + 0
Doctoral Seminar I	ES 691	PhD	1 + 0
Doctoral Seminar II	ES 692	PhD	1 + 0

b) No. of students admitted: MSc- 9

PhD- 8

c) Fellowships secured by the students (other than IARI Fellowship)

S. No.	Name of the student	Name of the Fellowship	Awarding Agency
1.	Ms. Pooja LR	UGC, JRF	UGC
2.	Mr. Keerthikumar M	UGC, JRF	UGC
3.	Anusha B S	UGC-NET-NFSC	UGC
4.	Lokesh Kumar Meena	NFST Fellowship	Ministry of tribal affairs
5.	Rishabh Shrivastava	UGC NET JRF	UGC
6.	Lukeshwari Shyam	UGC NET JRF	UGC

d) Students awarded with degrees during 2024

S.No.	M.Sc./ Ph.D.	Name of the student	Name of the Chairman, Advisory Committee	Title of the Thesis
1.	M.Sc	Ms. Divya Sinha (Roll No. 21639)	Dr. S. Naresh Kumar	Response of different duration varieties of Indian mustard to climatic risks
2.	M.Sc	Mr. Keetrhikumar M (Roll No. 21640	Dr. Bidisha Chakrabarti	Assessing the Productivity and Plant Nutrients in Wheat at Elevated Ozone and Carbon Dioxide Interaction under Different Nitrogen Management
3.	M.Sc	Mr. Avinash C (Roll No. 21642)	Dr. Shiv Prasad	Effect of Organically Amended Linz-Donawitz Slag on Wheat (triticum aestivum l.) Crop Growth, Yield, and Grain Quality
4.	M.Sc	Mr. Lokesh Kumar Meena (Roll No. 21643)	Dr. Renu Singh	Production and evaluation of biofuel briquettes made from rice straw by using suitable binding material
5.	M.Sc	Ms. Suchitra Kunduru (Roll No. 21644)	Dr. Anita Chaudhary	Impact of Plant and Microbe Derived Biostimulants' Formulation on Chickpea (cicer arietinum) Under Water Stress

6.	M.Sc	Ms. Shevakula Manasa (Roll No. 21749)	Dr. S. Naresh Kuamar	Optimization of microclimatic conditions for capsicum (Capsicum annum L.) under protected cultivation through quantified response to temperature and water regimes
7.	M.Sc	Mr. Mutra Bala Krishna Reddy (Roll No. 60102)	Dr. Dipak Kumar Gupta	Effect of rice straw biochar application to rainfed paddy soil on Net Ecosystem Carbon Balance and Global Warming Potential
8.	M.Sc	Mr. Sai Kiran Burji (60103)	Dr. Anita Chaudhary	Metal Oxide nanoparticle production from agricultural byproducts and their application in removal of Arsenic contaminated water
9.	M.Sc	Mr. Ashok Kumar Subudhi (Roll No. 70011)	Dr. Dinesh Kumar Sharma	Combined effect of drought and heat stress on quinoa in marginal environments
10.	M.Sc	Ms. Nandimandalam Charishma (Roll No. 70012)	Dr. Ajay K Singh	Elevated carbon dioxide responsiveness of soybean genotypes differing in tolerance to soil moisture deficit conditions
11.	M.Sc	Ms. Prerna Kumari(70013)	Dr. Ajay K Singh	PB & CD Responsiveness Study of Soybean Genotypes Differing in Soil Moisture Deficit Stress Tolerance
12.	Ph.D.	Mr. Partha Pratim Maity (Roll No. 11246)	Dr. Bidisha Chakrabarti	Interactive effect of Elevated Carbon Dioxide and Temperature on Greenhouse Gas (GHG) Emission in Rice and its Simulation
13.	Ph.D.	Mr. Chandra Prakash (Roll No. 11249)	Dr. Shakeel A. Khan	Effect of Particulate Matter Associated Polycyclic-Aromatic Hydrocarbons and Heavy Metals on Growth and Nutraceutical Properties of Tomato (Solanum Lycopersicum)

14.	Ph.D.	Mr. Sethupathi N (Roll No. 11369)	Dr. Dinesh Kumar Sharma	Amelioration of ozone stress in chickpea through nutrient and microbial intervention
15.	Ph.D.	Ms. Divya Pooja B(Roll No. 11490)	Dr. Shiv Prasad	Effect of bioaugmented Linz-Donawitz slag on soil physicochemical properties, crop yield and grain quality in rice-wheat cropping system
16.	Ph.D.	Ms. Mamta Bisht (Roll No. 11492	Dr. Manoj Shrivastava	Pollutants source apportionment and suitability of groundwater for agricultural and domestic use in Southwest peri-urban area of Delhi
17.	Ph.D.	Ms. Gayathri J(Roll No. 11494)	Dr. Dinesh Kumar Sharma	Impact of elevated Ozone, Carbon dioxide and their interaction on pollination ecosystem services in Indian Mustard

e) Research Scholars registered in different universities for Ph.D.

S. No.	Name of the research scholar	Name of the Principal Investigator/ co-guide	Title of the thesis	University at which registered
1.	Bhawna Joshi (Technical Officer –T3)	Anita Chaudhary (Co-Guide)	Assessment of structural and functional divergence of soil microbial community under elevated CO_2 and O_3 in wheat crop	Amity University, Noida
2.	Ritu Nagdev (Scientist, NBSSLUP, RC Delhi)	Shakeel A. Khan (Co-Guide)	Biogas slurry valorization through organo-mineral amendments for sustainable crop production	Amity University, Noida
3.	Mrs Ankita Trivedi	Dr. Manoj Shrivastava (Co-	Recovery and recycling of	Sardar vallabhbhai patel

		Guide)	nutrients from contaminated water using bio-based sorbents	university of agriculture & technology meerut – 250 110 (U.P.)

(f) Awards and recognitions received by the students

Name and roll no. of student	M.Sc./ M.Tech./ Ph.D.	Name of the award/Honour		Year for which given	Agency
Vinita Mulodia	PhD	Job with NABARD		2023-2024	NABARD
Naveen Kumar	PhD	Job with NTPC		2023-2024	NTPC
Mamta Bisht, 11492	Ph.D.	Best Oral Presentation in National Conference on Multifunctional Advanced Materials		2024	DRDO and Amity University
Pavan Kalyan	M.Sc.	Best Oral Presentation Award the National Seminar on "Alternative Fertilizers for Environmental Smart Agriculture" held on 26 September, 2024 at ICAR-IARI, New Delhi		2024	Indian Society of Soil Science
Shambhavi Singh	Ph.D	2nd Prize - Speech Competition		2024	ICAR-IARI, New Delhi
Shambhavi Singh	Ph.D	3rd Prize, Poster Presentation, 2024,		2024	Institute of Agricultural Sciences, Banaras Hindu University (BHU), Uttar Pradesh

Ms. Ashwini Yadav	M.Sc	Rs. 4 lakh grant from PUSA ARISE Start-up program		2024	Ministry of Agriculture and Farmers' Welfare and PUSA Krishi
Ms. Ashwini Yadav	M.Sc	1st rank in oral presentation on "Biosurfactant: An innovative solution for degradation of polyaromatic hydrocarbons in different soils" during 8th National Youth Convention "New Perspectives for sustainable agriculture livelihood security" jointly		2024	Institute of Agricultural Sciences, BHU and Indian Council of Agricultural Research
Ms. Ashwini Yadav, Roll No.	M.Sc	Best oral presentation award on "Biosurfactant triggered Degradation of Poly aromatic hydrocarbons in Agricultural Soil" during the 1st **Global** Petroleum and Chemical Industry Technical Conference,		2024	VDGOOD Professional Association, India

(g) Events organized by the Division:

New year 2024 celebration

World Environment Day 2024 celebration

World Environmental Day Quiz and painting Competition organized by Environmental Sciences division

Orientation Programme celebration

Freshers celebration for 2023-2024 batch

Farewell celebration for 2021-2023 batch

Hindi Diwas Celibration

Cultural and Sports Participation and Awards

5. Internship & mentorship by the scientist

Student internship

1. DST Post Doctorate Fellow (TARE)

- Dr. Anwesha Khanra **(DST No: TAR/2022/000232)** project entitled "A Sustainable Approach of Microalgae Mediated Wastewater Treatment Through One Pot Multiphasic Fed Batch Strategy and Biopolymer Production Towards Metal Corrosion Inhibition"
- Mr. Ravitija Machanuru has successfully completed 3-month Professional Attachment training under Dr. Manoj Shrivastava's guidance during 28.08.2023 to 29.11.2023.

6. Awards and recognitions received by the scientists

a) ICAR/National Awards

S. No.	Name of the Scientist	Name of the Award	Awarding agency	Nature of award (Medal/ Certificate / amount of Cash price)	Achievement for which the award was given (Life-time achievement/ any specific discover / technology etc for which the ward was given)
1.	Dr. S. Naresh Kumar	Appreciation Certificate from the World Meteorological Organization, Geneva • Steering Council (2018-2022; 2023-2025), Agricultural Model Intercomparison and Improvement Programme		Certificate Member	contribution as the Expert. (4th March, 2024)

		(AgMIP), NASA, GISS, Columbia University, USA • Member, Panel on Standards for Environmental Services, Bureau of Indian Standards, GoI (2020 onwards) • Inter-governmental Panel on Climate Change (IPCC) Expert Reviewer for • Govt. of India expert reviewer of IPCC AR 5 report (WGII) and SPM; • Lead author for IVA - Agriculture for India's Third National Communication to UNFCCC • Editor – in-Chief. Journal of Climate Change and Environmental Sustainability, New Delhi • Expert member, FASAL II programme of		Member Expert Reviewer Expert Reviewer Expert member	Special Reports, 2018 onwards

		MoA&FW and MNCFC • Expert member, DST Device Development Programme • Expert Member, DST SHRI programme • Expert Member, Scientific Committee, Indo-German Science and Technology Committee			
2.	Ranjan Bhattacharyya	Vice-Chair of the Working Group 1 of the The International Network on Soil Fertility and Fertilizers (**INSOILFER**)	FAO	Certificate	Excellent research on soil carbon sequestration and nutrient management
		Expert member of the Intergovernmental Technical Panel on Soils, FAO	FAO	Certificate	Excellent research on soil carbon sequestration and soil conservation
3.	Bhupinder Singh	Ministry of Steel, Govt of India	Member Core Group on Utilization of steel slag		
4.	Bhupinder Singh	Centre for Nanoscience and Nanotechnology, Aryabhatta	Member Academic Advisory Committee		

		Knowledge University, Patna (Memo no:008/AKU-NS&NT/108/2018-515 dated 8.2.24)			
5.	Dr. Arti Bhatia	Expert review of national inventory reports of agriculture sector for the enhanced transparency framework under the Paris Agreement.	United Nations Framework Convention on Climate Change (UNFCCC)	Certificate	
6.	Dr. Shakeel A. Khan	Fellow	NESA, New Delhi		
		Expert advisor and Adjunct Professor	Centre for Environment and Sustainable Development (CESD) Jamia Hamdard University, New Delhi-110062		
7.	Dr. Ashish Khandelwal	SPS India Best PhD. Thesis award 2022	Society of Pesticide Science India (announced on 21.03.2024)		
8.	Dr. Ashish Khandelwal	SSCE - Young Scientist	Society for Science of Climate Change and Sustainable Environment, New Delhi on 24th August 2024 at ICAR Central Agroforestry Research Institute, Jhansi		

		Research Excellence Award	VDGOOD Professional Association, India during 1st Global Petroleum and Chemical Industry Technical Conference on 5th October 2024		
9.	Dr. Sandeep Kumar	Outstanding Reviewer of the year 2024	appreciation certificate from the Journal of "Current World Environment".	certificate	

b) Fellowship of Professional societies of the relevant Discipline

S. No.	Name of the Scientist	Fellowship/ Associateship	Name of the Academy
1.	Ranjan Bhattacharyya	Fellowship	Royal Society of Biology, UK
2.	Dr. Shakeel A. Khan	External expert member of Board of Studies	AMU, Aligarh
3.	Dr. Shakeel A. Khan	General Secretary	NESA (National Environmental Science Academy) New Delhi

7. Budget Estimates

Head-wise budget received and expenditure under EFC 2023-24

Capital (Rs in Lakhs) : 9.5 (in lakhs)

Revenue (Rs in Lakhs): 52.5 (in lakhs)

Total expenditure

Capital (Rs in Lakhs) : 9.27 (in lakhs) (97.57%)

Revenue (Rs in Lakhs): 53.64 (in lakhs) (102.17%)

a) Budget received from external grant

S.No.	Name of the project	Name of the PI	Name of the Co-PIs	Duration (From--- to ----)	Sanctioned budget	Budget Received by the Division during the year 2024	Institutional charge for 2023-24
1.	"National innovation in climate Resilient Agriculture " (NICRA) (12-115)	Dr. S. Naresh Kumar		2021-2026	206 cr. per year	Rs. 2,72,325,000	**nil**
2.	"National Mission for sustainable Himalayan ecosystem" (NMSHE) (24-783)	Dr. S. Naresh Kumar		2021-2026	218	Rs. 27,07,934	**1,00,000**
3.	Assessments on climate change related agricultural losses, damage, impacts, vulnerability and adaptation for national communications (BTR and FNC) to UNFCCC	Dr. S. Naresh Kumar		2024-27	44.99	Rs. 13,50,000 (Fund received in March 2024)	
4.	"AICRP on	Dr Shiv		2021-24	-	Rs. 1,47,270	**nil**

	Renewable source of Energy" (12-103)	Prasad					
5.	Utilisation of Bioslurry (dry and liquid) in various cropping systems in identified regions in coordination with ICAR-KVK, State Agricultural Universities, MNRE and MoPNG installed biogas plants	Manoj Shrivastava	Dr. S.A. Khan	2022-24	63.5 Lakhs	2520000	7, 20, 000
6.	Effect of customized water soluble fertilisers (Mahadhan Solutek) on greenhouse gas emission from vegetable crops	Niveta Jain	A.Bhatia, V.Prajapati, M Khanna, H. Chaudhary	2023-2025	46.53 L	23.268	5.51 L +2.16L man day charges Total
7.	Development of steel slag based cost effective eco-friendly fertilizers for sustainable agriculture and inclusive growth	Bhupinder singh	Chandan K Gupta, Shiv Prasad, kalidindi Usha	2021-2024	866.4 Lakh	61 Lakh	10 lakh
8.	Assessment and Utilization of Yellow Gypsum in Agriculture	Bhupinder Singh	Manoj Shrivastava	1999-2024	247.4 Lakh	-	-

	Under Variable Environment						
9.	Characterization of iron ore tailings and assessing its suitability for agricultural application	Bhupinder singh	Chandan K Gupta and Shiv Prasad	2024-2025	26.4 Lakh	13.264 Lakh	2.02 lakh
10.	ACASA project, funded by BISA-CIMMYT	Arti Bhatia	Soora Naresh Kumar, Niveta Jain, Bidisha Chakrabarti, Vinay Sehgal, Pravin Upadhyay	November 2023 to March 2026	80.7	21.27	1.27
11.	GCRF SANH project, UKRI, UK	Arti Bhatia	Niveta Jain, Bidisha Chakrabarti, shiv Prasad, Sandeep Kumar, Renu Pandey, Dinesh Kumar, RN Padaria, Girish Kumar Jha	January 2020 to September 2024	470	52.50	2.57
12.	Quantification of greenhouse gas emission from Mulberry cultivation for inventory estimation, funded by central Silk	Arti Bhatia	Dinesh Sharma, Niveta Jain, Sandeep Kumar	Sept 2024 to March 2026	54.08	48.67	2.00

	Board, Ministry of textiles						
13.	Greenhouse gas emission inventory from Indian agricultural soils and rice cultivation for BTR 1, BUR4 preparation	Arti Bhatia	Niveta Jain, Bidisha Chakrabarti, Sandeep Kumar	April 2024 to June 2027	54.10	32.46	1.8
14.	Studies on greenhouse gas emission in rice-wheat and sugarcane wheat cropping system under different agri-management practices – (Contract research)	Arti Bhatia	Sandeep Kumar, Niveta Jain, Bidisha Chakrabarti,Pragati Pramanik	June 2024 to December 2026	70.94	24.83	3.0
15.	Quantifying Rice Greenhouse Gas Emissions (Queri): Impact of Water Management and Sowing Techniques in Telangana and Punjab, India-contract research	Arti Bhatia	Niveta Jain, Sandeep Kumar	October 2024 to March 2026	25.00	17.50	2.1
16.	Emission inventory of agriculture sector: crop residue burning,	Niveta Jain	A. Bhatia, V. Sehgal	March 2024-June 2027	38.10 L	16.0L	1L

	liming and urea application to soil						

b) **Revenue generated:**

S.No.	**Name of the Technology**	**Brief of commercialization**	**Revenue generated (Rs in Lakhs)**
1.	Gamma irradiation of tree species to improve the paper quality and in other crops	Crop and target based dose optimization and irradiation for Industry, researchers, students; A total of 327 including 84 paid samples of cereals, flowers, fruits, flowers, vegetables legumes, pollen etc were irradiated in 2023-24	0.76800
2.	PUSA Biosurfactant	Technology transfer to M/S S-Biologicals	0.59
3.	Sample Analysis Charge using HPLC	Lycopene estimation in tomato samples	1.88800

8. PUBLICATIONS

- During 2024, total number of publications:

a) Research and review Publications (in peer reviewed NAAS rated journals only)

S. No.	Bibliography of Publication (in IJAS format)	NAAS Rating (2024)	Impact Factor (Thomson Reuters)
1	S. Kunduru, **A. Chaudhary**, A. Kamra, R.S. Bana,S.N. Kumar and V.R. Yalamalle (2024). Seed priming with Aloe vera and Trichoderma asperellum improves germination in chickpea under osmotic and temperature stress. Seed Science and Technology, 52, 3, 265-281.https://doi.org/10.15258/sst.2024.52.3.04	7.7	1.7
2	Namita Das Saha, Priyanka Kumari, Bappa Das, R.N. Sahoo, Rajesh Kumar, Debasis Golui, Bhupinder Singh, Niveta Jain, Arti Bhatia, **Anita Chaudhary**, Bidisha Chakrabarti, Arpan Bhowmik, Partha Saha, Sadikul Islamm (2024). Vis-NIR spectroscopy based rapid and non-destructive method to quantitate microplastics: An emerging contaminant in farm soil, Science of The Total Environment,Volume 927,2024,172088, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2024.172088.	9.8	8.2
3	**Chakrabarti B**, Bhatia A, Sharma S, Tomer R, Sharma A, Paul A, Kumar V and Sutton MA (2024) Nitrification and urease inhibitors reduce gaseous N losses and improve nitrogen use efficiency in wheat exposed to elevated CO_2 and temperature. Front. Sustain. Food Syst. 8:1460994. doi: 10.3389/fsufs.2024.1460994	10.7	4.7
4	**Chakrabarti Bidisha**, Sharma Sheetal, Mishra Ajay Kumar, Kannojiya Sudha, Kumar V., Bandyopadhyay S. K., Bhatia Arti (2024) Application of additional dose of N could sustain rice yield and maintain plant nitrogen under elevated ozone (O_3) and carbon dioxide (CO_2) condition. Frontiers in Sustainable Food Systems. 8, DOI=10.3389/fsufs.2024.1477210	10.7	4.7
5	Darjee Sibananda, **Singh Renu**, Dhar Shiva, Pandey Renu, Dwivedi Neeta, Sahu Pramod Kumar, Rai Mayank Kumar, Alekhya Gunturi, Padhan Smruti Ranjan, Ramalingappa Pooja Laksmidevarhalli, Shrivastava Manoj. (2024) Empirical observation of natural farming inputs on nitrogen uptake, soil health, and crop yield of rice-wheat cropping system in the organically managed Inceptisol of Trans Gangetic plain. Frontiers in Sustainable Food Systems.8. https://www.frontiersin.org/articles/10.3389/fsufs.2024.1324798 DOI=10.3389/fsufs.2024.1324798, ISSN=2571-581X.	10.7	4.7
6	Sahu, P. K., **Singh, Renu***, Shrivastava, M., Darjee, S., Mageshwaran, V., Phurailtpam, L., & Rohtagi, B. (2024).	10.3	4.3

	Microbial production of α-amylase from agro-waste: An approach towards biorefinery and bio-economy. Energy Nexus,14: 100293. https://doi.org/10.1016/j.nexus.2024.100293		
7	Ajay Mathumkunnath Velayudhan, Bhupinder Singh, Manoj Shrivastava, Ashish Khandelwal, Poonam Yadav, Bharti Rohatgi, Sibananda Darjee, Pooja Laksmidevarhalli Ramalingappa, **Renu Singh***. Development of Low heavy metal - Linz-Donawitz slag for safe spinach cultivation, Sustainable Chemistry for the Environment, Vol 1, 2023, 100003, ISSN 2949-8392, https://doi.org/10.1016/j.scenv.2023.100003	-	-
8	**Renu Singh*,** Sibananda Darjee, Manoj Shrivastava, Shiva Dhar Mishra, Neeta Dwivedi and Pooja LR. 2024. Effect of Microbial consortium (Azotobacter and Mycorhiza) on Nitrogen losses and yield in Wheat (*Triticum Aestivum* L.). International Journal of Tropical Agriculture, 41(1-2), 1-6.	9.49	3.49
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b) List of Research Papers Published in Conference, Symposia and Other Papers.

- Technical Bulletin on Volarization of waste for environmental sustainability. Editors A. Khandelwal, A Sharma, B Singh, M Shrivastava and R Singh.
- Renu Singh Sibananda Darjee. (2023) Entrepreneurship opportunities in waste management for environmental sustainability. Volarization of waste for environmental sustainability. Editors A. Khandelwal, A Sharma, B Singh, M Shrivastava and R Singh. 175-182. 978-81-19006-35-9
- Singh, Renu, Sibananda Darjee, Bharti Rohtagi, Ashish Khandelwal, Sapna Langyan, Amit Kumar Singh, Manoj Shrivastava, Anu Bharti, Har Mohan Singh, and Sujata

Kundan. "Biobutanol Production Using Nanotechnology: A Way Forward." In Sustainable Butanol Biofuels, pp. 241-257. CRC Press, 2023. 9781003165408

- Ashwini Yadav, Ashish Khandelwal, Neera Singh, Arti Bhatia, Rajeev Ranjan, Kaushik Banerjee, Shalini Gaur Rudra, EldhoVerghese (2024) Biosurfactant: An innovative solution for degradation of polyaromatic hydrocarbons in different soils, 8th National Youth Convention on New Perspectives for Sustainable Agriculture and Livelihood Security, Souvenir & Abstract, page 248, pp. 1-333. (ISBN: 978-81-973588-4-5)
- Bhupinder Singh, Chandan Kumar Gupta, Shiv Prasad, Sneha Kumari and Kalidindi Usha (2024) Opening up new vistas for eco-friendly and sustainable utilization of Linz-Donawitz (LD) slag in agriculture as nutrient-enriched and soil conditioning supplement. In proceedings of International Conference on Process and Product Innovation in Metals Production organized by The Indian Institute of Metals held at IICC, New Delhi during 27-29 Sep, 2024. Pp. 11-18

Oral Presentations in International Conferences:

- Invited lecture "Advanced techniques for in-situ ammonia measurements for nitrogen management in agriculture" 15th International Conference ICAHPS on 24-25 June 2023 in Delhi.
- Oral presentation "Scheduling and rate of nitrogen fertilization impacted ammonia volatisation losses and yield in maize-wheat field" 9th INI conference Guru Gobind Singh Indraprastha University in New Delhi, India, from February 5-8 2024
- H. M. Rose, N. Jain*, S. D. Misra, O. Kumar, A.Bhatia, 2024, Emission of Nr species from open windrow composting of crop residues and the suitability of neem litter compost as a compost additive , Oral presentation at International N Conference, INI 24, Delhi
- N. Jain, A. Bhatia, A. Shukla, S. Tomlinson, Ed. Carnell, C. Pearson, U. Dragosits, M.Sutton, Emission of reactive nitrogen from crop and livestock production in India and their mitigation strategies, International N Conference, INI 24, Delhi
- Ashwini Yadav (2024) Biosurfactant triggered degradation of polyaromatic hydrocarbons in agricultural soil, 1st Global Petroleum and Chemical Industry Technical Conference 2024 organized by VD Good Professional society

- Ashish Khandelwal (2024) Degradation of crude oil and polyaromatic hydrocarbons using microbial/derived formulations, 1st Global Petroleum and Chemical Industry Technical Conference 2024 organized by VD Good Professional society
- Skiba, Ute*, Bhatia, A., Jain, N., Chakrabarti, B., Sharma, S., Pearson, C., Sana Ullah, M., Shahid, R., Zirkullah, S., Raj, K., Ghimire, P., Suraj Chhetri, Arathne, M., Nissanka, S.; Sutton, M.S., 2024, Nitrous oxide IPCC Tier 1 emission factor calculations based on refined agronomic management practices for 7 Southern Asian main crops, International N Conference, INI 24, Delhi
- Arti Bhatia, Invited Oral Presentation on Mitigating Methane Emissions from Irrigated Rice Cultivation Using Modified Urea Fertilizer at Asia Oceania geosciences society meeting, AOGS2024, held at Pyeongchang-gun, Gangwon-do, South Korea, 23rd to 28th June 2024.
- Arti Bhatia, Presentation at project completion workshop of GCRF-South Asian Nitrogen Hub project funded by UKRI, UK at UK Centre for Ecology & Hydrology, Penicuik, Scotland, UK from 9th to 13th September 2024.

c) List of Books / Chapter in Books

Book

- Prasad, S., Dinesh, G. K., Sinduja, M., Sathya, V., Poornima, R., & Karthika, S. (Eds.). (2024). The Role of Microbes and Microbiomes in Ecosystem Restoration. Bentham Science Publishers. Volume 1. DOI:10.2174/97898152565981240101. ISBN: 978-981-5256-60-4 (Print). ISBN: 978-981-5256-59-8 (Online).
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- Prasad, S., & Chandel, A. K. (2024). Precision Biomass Collection, Storage, and Transportation of Feedstock at the Biorefinery Gate. In Biorefinery and Industry 4.0: Empowering Sustainability (pp. 29-46). Cham: Springer Nature Switzerland.

- Divya Pooja, Shiv Prasad, Govindaraj Kamalam Dinesh and C. Avinash. (2024). Role of Environmental Factors Influencing Microbes and Microbiomes for Ecosystem Restoration. Pp: 44-69 (26). Bentham Science Publishers.
- Attri SD and S. Naresh Kumar 2024. IMPLICATIONS OF CLIMATE CHANGE ON AGRICULTURE AND ADAPTATION. In Climate Change in India: Impacts and Assessments ed. Neloy Khare. CRC press. Pg 266. https://doi.org/10.1201/9781003485995
- Training E-manual: Ashish Khandelwal, Akriti Sharma, Bhupinder singh and Manoj Shrivastava (2024) Agripreneurship Development Program on Entrepreneurship opportunities for management of food loss and waste in agricultural and industrial sectors for environmental sustainability" Editors, Ashish Khandelwal, Akriti Sharma, Bhupinder singh and Manoj Shrivastava, organised from 22nd to 31st January, 2024 organized by Pusa Krishi ZTM & BPD Unit and Division of Environment Science, ICAR-IARI, Pusa, New Delhi
- Book Chapter: Bhupinder Singh, Shrenivas Ashrit, Manoj Shrivastava, Kalidindi Usha, Pratik Swarup Dash, Prem Ganesh and Subrat Kumar Baral (2024) Development of a Novel Steel Slag-Based Sulfur-Enriched Multi-Nutrient Fertilizer and Its Performance in Agriculture In : Advances and Challenges in Hazardous Waste Management Editors Hosam M. Saleh, Amal I. Hassan and Refaat F. Aglan, IntechOpen., pp 1-22, doi: 10.5772/intechopen.1003929
- Book Chapter: Usha Kalidindi and Bhupinder Singh (2024) Reifying "Yamuna": Unpacking Pluriversal Possibilities for Rejuvenation of the River at Poiya-Ghat, Swarg-Dhaam, Agra, Paritantra, Journal of Systems Science and Engineering, Special issue 28 (1): 40-46, ISSN 0972-5032(P)
- N. Jain*, Helen Mary Rose, Anusha Kumar, Mathiyarasi K, Arti Bhatia, Bidisha Chakrabarti, Sandeep Kumar, Organic Farming and greenhouse gas emission, 2024, in Agricultural Greenhouse Gas Emissions: Problems and Solutions,eds Nirmali Bordoloi, Kuldeep Bauddh, K. K. Baruah , pp33-48
- Kumar S, Chakrabarti B, Jain N, Kanojia S, Sandilaya D, Sharma A & Bhatia A * (2024). Advanced Facilities for Climate Change Research and Greenhouse Gas Mitigation. In: Pathak, H., Chatterjee, D., Saha, S., Das, B. (eds) Climate Change Impacts on Soil-Plant-

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- Divya Pooja, Shiv Prasad, Govindaraj Kamalam Dinesh and C. Avinash. (2024). Role of Environmental Factors Influencing Microbes and Microbiomes for Ecosystem Restoration. Pp: 44-69 (26). Bentham Science Publishers
- Khandelwal A., Joshi R., Karthikeyan G., ….. Balu, D. (2024) "Souvenir & Abstract Book: New Perspectives for Sustainable Agriculture and Livelihood Security, Published by All India Agricultural Students Association, pp. 352, (ISBN: 978-81-973588-4-5)
- Saurabh V., Paul T., Singh S., Yadav B., Khandelwal A. ……. Balu D. (2024) AIASA Cabinet 2024, Published by All India Agricultural Students Association, pp. 92, (ISBN: 978-81-973588-0-7)
- Saurabh V., Paul T., Singh S., Yadav B., Khandelwal A. ……. Balu D. (2024) AIASA Cabinet 2023, Published by All India Agricultural Students Association, pp. 94, (ISBN: 978-81-973588-8-3)

d) List of Popular article(s)

- Bhupinder Singh (2024) Climate smart carbon and nutrient use to address the malnutrition challenge, In proceedings of the Centre of Advanced Faculty Training Agri-derived Nutrients and Nutraceuticals for Innovative Health Foods: Tools and Strategies, from December 15, 2023 - January 4, 2024 at the Division of Biochemistry, ICAR-IARI, New Delhi – 110012, pp 1-9
- Bhupinder Singh and Kalidindi Usha (2023) Determination of plant mineral nutrients and heavy metals by Atomic Absorption Spectrophotometer (AAS) Using Atomic Absorption Spectroscopy, in proceedings of the IDP-NAHEP sponsored 10 days Training: "High Throughput Analytical Techniques for Phytonutrient Profiling" w.e.f. 22nd November to 1 st December, 2023 at School of Biotechnology, Sher-e Kashmir University of Agricultural Science and Technology of Jammu, Jammu pp 1-13
- Bhupinder Singh, Jyoti Sharma and Kalidindi Usha (2024) The 3 R's of Effective waste management in: Agripreneurship Development Program proceedings "Entrepreneurship opportunities for management of food loss and waste in agricultural and industrial sectors for environmental sustainability" from 22nd to 31st January, 2024 organized by Pusa Krishi ZTM & BPD Unit and Division of Environment Science, ICAR-IARI, Pusa, New Delhi, pp 1-6
- Expert Penalist on DD Kisan Vichar Vimarsh program on "जलवायु में बदलाव, खेती पर प्रभाव" date of telecast 13.1.24.
- Ritu Nagdev, Shakeel Ahmad Khan and Renu Dhupper (2024). Soil enzymes and their significance. Agriculture & Food e-Newletter 6(4), Pp 106-108, Article ID 48632.
- Ashwini Yadav, Ashish Khandelwal, Aakash Kumar Saini (2024), Biosurfactants: Properties and potential applications in environmental and industrial sectors (Article ID: 60444), Agriculture & Food : E-Newsletter (E-ISSN: 2581-8317)
- Ashwini Yadav, Ashish Khandelwal, Anju Choudhary (2024), Advances in biosurfactant production and environmental factors which affect the biosurfactant production (Article ID: 60493), Agriculture & Food : E-Newsletter (E-ISSN: 2581-8317)
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- Shah P, Shemeem., Kumar, Sandeep., Shrivastava, Manoj., and Yadav, Sunita. (2024) Role of Artificial Intelligence (AI) in Phytoremediation of Heavy Metals. Food and Scientific Reports, 5(1): 63-68. March 2024.
- Yadav, S. Kumar, S. and Roy, P. (2024). Carbon Farming: A Way to Sustainable Agriculture. Agri-India TODAY 4(10): 30-34. (October 2024)
- Roy, P., Ash, M. and Yadav, S.(2024). Plastic Purge: Transforming Urban Landscapes for Sustainable Futures. Food and Scientific Reports, 5(7):36-44.

1. Trainings/workshop/seminar organized

Sl. No.	Name of programme	Training/ workshop/ seminar	Duration (from--- to----)	Nature of trainees (Students, Scientists, teachers, farmers, etc. Please specify)	Number of trainee (s)		
					Male	Female	Total
1.	ICAR-HRM training programme 'Advances in Simulation Modelling and Climate Change Research Towards Knowledge Based Agriculture' for the Scientific Staff (2024-25)	Training	21 days (19th Nov- 9th Dec, 2024)	Scientists	17	9	26
2.	Capacity Building on Simulation Modelling and Climate Change Research Towards Knowledge Based Agriculture' for the students under NMSHE-TF-Agriculture project	Training	21 days (19th Nov- 9th Dec, 2024)	Students	21	23	44
3.	Workshop on Adaptation options for managing climatic risks in major crops in India	workshop	28-29 August, 2024		33	12	45

4.	Entrepreneurship opportunities for management of food loss and waste in agricultural and industrial sectors for environmental sustainability	Training	10 days; 22-31 January 2024		9	1	10

Division of Environmental Sciences
ICAR-Indian Agricultural Research Institute, New Delhi-110012
Training programme on 'Capacity Building on Simulation Modelling and Climate Change Research Towards Knowledge Based Agriculture' for the students and project staff under NMSHE-TF-Agriculture project (2024-25)
During 19th Nov. to 9th Dec., 2024

1st Row (L to R): Shaziya Farhat, Anju Choudhary, Pavithra Pidikiti, Arti Bhatia, Bidisha Chakrabarti, Soora Naresh Kumar, Sushila Negi, C. Viswanathan, Bupinder Singh, Rupam Bharti, Ananya Gairola, Diksha Sharma, Kakul Smiti, Sandeep Kumar, Ramesh Chand Harit
2nd Row (L to R): Manisha, Ashwini Yadav, Pooja L R, Shiwani Meena, Shambhavi Singh, N Charishma, Akash Saini, Manisha Budgujjar, Nisha Khatri, Anik Chandel, Kanchan Kundlas, Madhur D G, Priya Rai, Suman, Krishna K M, Manjar Alam, Harshit Bhasin, Akash Singh
3rd Row (L to R): Vinod Kumar, Rushali K, Devika A R, Jagadam Sai Rupali, Eere Vidya Madhuri, Karan Kumar, Sandip Kumar, Vikas, Vipin Kumar, Shemeem S P, Keerthikumar M, Alok Sinha
4th Row (L to R): Abhinav, Jatinderpal Singh, Prajwal, Azhar Mehmood

Division of Environmental Sciences
ICAR-Indian Agricultural Research Institute, New Delhi-110012
ICAR-HRM training programme 'Advances in Simulation Modelling and Climate Change Research Towards Knowledge Based Agriculture' for the Scientific Staff (2024-25)
During 19th Nov. to 9th Dec., 2024

1st Row (L to R): Shubham Bhatnagar, Manoj Kumar Dwivedi, V. Sujatha, Sangeeta Ahuja, Arti Bhatia, Bidisha Chakrabarti, Soora Naresh Kumar, Sushila Negi, C. Viswanathan, Bupinder Singh, S B Patil, Ashish Khandelwal, Chandan Gupta, Shilpi Verma
2nd Row (L to R): Jhonson Raju Sankati, Munmun Rai, Sonalika, Mona Nagargade, Ravi Kumar, Shiv Prasad, G S Yadahalli, Anand Kumar, Truptimayee Suna, Sevak Das, Sandeep Kumar, Ramesh Chand Harit
3rd Row (L to R): Ved Prakash, Chandran K P, Raghubar Sahu, Manoj Kumar, Vishal Tyagi, Arjun Singh, Pathan A. Latif, Sanket J More, Kuldeep Medhi

2. Participation by scientists in scientific meetings, etc.

S.No.	Detail	Number only	Detail/description of each item
(i)	**In India**		
	Seminars		• Review of project proposals of BRICS on Climate change Adaptation and Mitigation • Moderation Board meeting for BSCBCH programme of IGNOU • Course Finalization for different Semesters; Allocation of the students of M.Sc and Ph D • Preparation of Joint project proposal with IPTG Paderborn – IIT Group for IRTG • National Conference on Steel in Infrastructure organized by Metalogic and Ministry of steel on 16.3.24 (DOL: 16.3.24) • FICCI sponsored conference "Indian Mining Industry: the Amrit Kaal Journey at FICCI Federation House New Delhi, 22nd March 2024. • UNFCCC virtual, UNEP virtual, INI, virtual
	Scientific meetings		• Brainstroming session on "Emerging trends in nanobiotechnology" at Uttar Pradesh Pandit Deen Dayal Upadhaya Pashu Chiktsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura on 15.12.23 (DOL: 15.12.23) • Core committee meeting on formulation of 10 years comprehensive plan for R and D in the iron and steel sector at Steel Room, Ministry of Steel, Udyog bhavan under the Chairmanship of the Secretary, Steel on 11.5.23 and 17.1.24. • MoEFCC, Niti Aayog

	Workshops		• Validation of adaptation options for climatic risk reduction in major crops, ICAR-IARI, New Delhi (28-29 Aug, 2024) • National workshop cum training programe on "Accelerating sustainable development through invasive water management strategies" from 21-22 March 2024, organized by Amity Institute of Environmental Sciences (AIES), Amity University, Noida • Innovative technologies for wastewater treatment, reuse and resource recovery • AICRP on Energy (online)
	Symposia		• BBACI 2023 - International Conference on Biochemical and Biotechnological Approaches for Crop Improvement, 30th October to 01st November 2023, NASC, New Delhi Biochemistry • Impact Assessment of Elevated Carbon Dioxide and Elevated Ozone on the Soil Microbial Communities Structure and Functional Diversity in Wheat Agroecosystem" ISC2024 International Conference on Climate-Proofing Cereal Agriculture: Strategies for Resilience and Sustainability ICAR-IIWBR, Karnal • Assocham National Conference "Curbing Post Harvest Losses to Enable Resilient Food Systems" February 09, 2024; Hotel Le-Meridien, New Delhi • Wastewater Treatment and Reuse: Challenges and Solutions in India"
	Any other		• Agripreneurship Development Program "Entrepreneurship opportunities for management

			of food loss and waste in agricultural and industrial sectors for environmental sustainability" from 22nd to 31st January, 2024
(ii)	**Abroad**		
	Seminars		• Online interactive webinar on Uncertainty Analysis in National Greenhouse Gas Inventories from developing countries organized by UNFCCC, Bonn from 19 to 23 February 2024
	Scientific meetings		• IPCC lead authors meeting • Asia Oceania geosciences society meeting, Invited Oral Presentation at AOGS 2024, held at Pyeongchang-gun, Gangwon-do, South Korea, 23rd to 28th June 2024.
	Workshops		• To attend the 20th Workshop of the ITPS, FAO, Rome, Italy • Spatial Crop Modelling Workshop" at Colombo, Sri Lanka (16-18 January 2024). • APO, Tsukuba, Japan; APO Thailand • Presentation at project completion workshop of GCRF-South Asian Nitrogen Hub project funded by UKRI, UK at UK Centre for Ecology & Hydrology, Penicuik, Scotland, UK from 9th to 13th September 2024.
	Symposia		• AOGS, South Korea
	Any other		• Online Training Course on "Inter Personal Effectiveness (IPE-07)" 26th to 27th February, 2024 • Online training on "Intellectual Property Rights" November 20-22nd 2023

Foreign Deputation by Scientists:

1. Dr. Ranjan Bhattacharyya, pr. scientist, ICAR-Indian Agricultural Research Institute, New Delhi to attend the 4th International Soil Modelling co1191ium (ISMC) conference at Tianjin University, Tianjin CHINA from 07/05/2024 to 11/05/2024 (excluding journey time)

2. Dr. Ranjan Bhattacharya, Pr. Scientist, Div. of Environment Science, IARI in the afternoon of 06-05-2024 to visit China to attend the 4th International Soil Modelling Consortium (ISMC) at Tianjin University, China form 07th - 11th. May, 2024

3. Dr Ashish Khandelwal, attended two days workshop on Future Food I-lab: Cultivating Innovation for Agri-food system transformations; at FAO, Rome, Italy from 17-18th June

4. Dr. Arti Bhatia, Pr. Scientist, Div. of Environment Science to attend the AoGs international conference at AoGs, PyeongChang, Gangwon-Do, south Korea under GcRF-sANH Project during, 23 June - 28th June 2024

5. Dr. Niveta Jain, Pr. Scientist, Div. of Environment Science to attend the AoGs international conference at AoGs, PyeongChang, Gangwon-Do, south Korea under GcRF-sANH Project during, 23 June - 28th June 2024

6. Dr. S. Naresh Kumar, Head, Div. of Environment Science in the afternoon of 10-09-2024 for attending ACASA climatic risks and adaptation options write-shop at Kathmandu, Nepal from 11-12 September 2024 (excluding journey time)

7. Dr. Niveta Jain, P.S., Division of Environment Science, ICAR-|AR| in the afternoon of 27-9-2024 for Personal foreign visit for paper presentation in Capacity Development Workshop on Soil Carbon Visualization under the Center of Excellence on Climate Smart Agriculture (CSA) at Asia Productivity Organization, Tsukuba, Japan during 01/10/2024 to O4/10/2O24

8. Dr. Ashish Khandelwal, Scientist, Div. of Environment Science, IARI in the afternoon of 15-10-2023 to visit Rome Italy to attend World Food Forum flagship event under the theme of Good food for all, for today and tomorrow; organized by Food and Agriculture Organization of United Nation, Rome, Italy at Italy during 16th - 18th October, 2024

9. Dr. Soora Naresh Kumar, Head of Division, ICAR-Indian Agricultural Research Institute, New Delhi to attend 13th Korean Green Innovation Days (KGID, Jeju 2024) Workshop at Jeju, South Korea during 04/11/2024 to 09/11/2024

10. Dr. S. Naresh Kumar Head of Division, ICAR-Indian Agricultural Research Institute, New Delhi to attend the Spatial Crop Modelling Workshop under ACASA project at SRI LANKA, COLOMBO during 14/01/2024 to 19/01/2024.

11. Dr. Ranjan Bhattacharya, pr. scientist, ICAR-Indian Agricultural Research Institute, New Delhi to attend the 20th Workshop of ITPS, FAO, Rome, Italy at Italy during 19/03/2024 to 21/03/2024.

9. Extension activities

- Created awareness about the carbon trading, biofertilizer to farmers in cluster 86 under MGMG programme
- Distributed seeds of Wheat variety HD3226, Pusa Mustard 33 and vegetable seeds kit for kitchen garden in Cluster Number 86, Gannaur Block, Sonipat, Haryana
- Creating awareness about the greener technologies and biofertilizers usage for adaptation and mitigation in climate change scenarios in cluster 86 under MGMG programme
- Participated in Krishi Mela. Conducted field visits for students and farmers in Climate Change Research Facility of the institute
- Resource person and invited lecture on "The 3 R's of Effective waste management" In: Agripreneurship Development Program "Entrepreneurship opportunities for management of food loss and waste in agricultural and industrial sectors for environmental sustainability" from 22nd to 31st January, 2024 organized by Pusa Krishi ZTM & BPD Unit and Division of Environment Science, ICAR-IARI, Pusa, New Delhi (DOl: 22.1.24)
- Resource person and invited lecture on "Climate smart carbon and nutrient use to address the malnutrition challenge" under the Centre of Advanced Faculty Training Agri-derived Nutrients and Nutraceuticals for Innovative Health Foods: Tools and Strategies, from December 15, 2023 - January 4, 2024 at the Division of Biochemistry, ICAR-IARI, New Delhi (DOL: 3.1.24)
- Expert Penalist on DD Kisan Vichar Vimarsh program on "जलवायु में बदलाव, खेती पर प्रभाव" date of telecast 13.1.24.
- Two farmers field visits under the MGMG and participation in the Krishi Vigyan Mela 2024

TV talk at Doordarshan

PUSA Samachar

10. List of staff member

Scientific Staff	Technical Staff
Dr. S Naresh Kumar, Head	Dr. Parveen Sachdeva, T 9
Dr. K. Usha, PS	Dr. N.K. Singh, T-7/8
Dr. Bhupinder Singh, PS	Sh. R.C. Harit, T-7/8
Dr. Anita Chaudhary, PS	Sh. Munish Bhatt, T-5
Dr. Shiv Prasad, PS	Dr. Vinod Kumar, T-4
Dr. Dinesh kumar Sharma, Professor	Mrs. Neeraj Panwar, T-3
Dr. Arti Bhatia, PS	Mrs. Bhawana Joshi, T-4
Dr. Niveta Jain, PS	Sh. Ankit Kumar, T-1
Dr. Ranjan Bhattacharya, PS	
Dr. Manoj Shrivastava, PS	
Dr. S.A. Khan, PS	
Dr. Bidisha Chakrabarti, PS	
Dr. Renu Singh, PS	
Dr. Chandan Kumar Gupta, Sr. Scientist	
Dr. Ashish Khandelwal, Scientist	
Dr. Sandeep Kumar, Scientist	
Dr. Sunita Yadav, Scientist	
Administrative staff	**Supporting Staff**
Mr. Munesh Chand Meena, AAO	Sh. Mahesh K, Rai, SSS
Mrs. Vandana Rawat, Assistant	Smt Kaliya Devi, SSS
Mrs. Durgesh Sharma, Assistant	Mr. Sunil Kumar,SSS
Mrs. Ankita Kumari, PA	Mr. Sonu Kumar,SSS
Mr. Dinesh Kumar, LDC	

11. Divisional Committees

1. **Divisional Budget and Research committee**

1. Dr. S. Naresh Kumar Head & Pr. Scientist	-Chairman.
2. Dr. D. K. Sharma, Pr Scientist	-Member
3. Dr. (Mrs.). Niveta Jain, Pr. Scientist	-Member
4. Dr. Chandan Kumar Gupta, Scientist	-Member
5. Dr. Sandeep Kumar, Scientist	- Member Secretary

2. BOS committee

1. Dr. D. K. Sharma, Pr Scientist	-Chairman.
2. Dr. S. Naresh Kumar Head & Pr. Scientist	-Member
3. Dr. Manoj Shrivastava, Pr Scientist	-Member
4. Dr. Anita Chaudhary, Pr Scientist	-Member
4. Ms. Mathiyarsi K, Student	-Member
5. Dr Ashish Khandelwal, Scientist	- Member Secretary

3. **Divisional/ Local purchase committee**

1. Dr. (Mrs) Arti Bhatia, Pr. Scientist	-Chairman.
2. Dr. Shiv Prasad, Pr Scientist	-Member
3. Dr. (Mrs.). Niveta Jain, Pr. Scientist	-Member
4. Dr Ashish Khandelwal, Scientist	-Member
5. Sh Munesh Chand Meena, AAO	- Member Secretary

4. **Divisional Database Committee:**

1. Dr. (Mrs) Arti Bhatia,Pr. Scientist	-Chairman.
2. Dr Ashish Khandelwal, Scientist (SS)	-Member
3. Dr Sandeep Kumar. Scientist (SS)	-Member

4. Mrs Bhawana Joshi, Tech Asst -Member

5. Mrs. Neeraj Panwar, Tech Asst - Member Secretary

5. Technology Information, Assessment & Forcasting Committee:

1. Dr. S. Naresh Kumar Head & Pr. Scientist -Chairman.
2. Dr. Anita Chaudhary, Pr Scientist -Member
3. Dr. (Mrs.). Arti Bhatia, Pr. Scientist -Member
4. Dr. Shiv Prasad, Pr. Scientist -Member
5. Dr. Manoj Shrivastava, Pr. Scientist -Member
6. Dr. Ranjan Bhattacharya, Pr. Scientist -Member
7. Dr. Sandeep Kumar, Scientist - Member Secretary

6. Labour & Farm In-charge

1. Sh Ramesh Harit, ACTO
2. Dr Vinod Kumar, STA

7. Price Fixation Committee

1. Dr. Bhupinder Singh - Chairperson
2. Dr. Arti Bhatia - Member
3. Dr. Shiv Prasad - Member
4. Dr. Manoj Shrivastava - Member
5. Sh Muneesh Chand Meena - Member
6. Dr. Ashish Khandelwal - Member Secretary

8. Facilities Committee

1. Dr. Shiv Prasad, Pr. Scientist -Chairman.
2. Dr Renu Singh, Pr. Scientist -Member
3. Dr Ashish Khandelwal, Scientist (SS) -Member

4. Sh Muneesh Chand Meena -Member

5. Dr. Praveen Sachdeva - Member Secretary

9. <u>Foreign Deputation Proposal committee</u>

1. Dr. Manoj Shrivastava, Pr Scientist -Chairman.
2. Dr. Shakeel A. Khan, Pr. Scientist -Member
3. Dr. Ashish Khandelwal, Scientist (SS) -Member
4. Sh Muneesh Chand Meena -Member

12. Miscellaneous

Divisional field facilities:

Divisional Lab facilities:

Environmental Modeling Lab

ICP-AES, Gas Chromatography, HPLC and Spectrophotometer

Microbiology Lab


Air Pollution Measurement instruments
Respirable Dust Sampler (RDS) & PM2.5 sampler
NTPC - FARIDABAD
RESPIRABLE DUST SAMPLER
Envirotech APM 460BL
FINE PARTICULATE
SAMPLER
Envirotech APM 550

Divisional facilities visit by delegates

Professor Rattan Lal, visited the climate change research facilities at the Division of Environmental Sciences, IARI, New Delhi

UKRI project field visit

Divisional facilities visit by Students and Trainees

Visit by SRI University Students

Visit by CAU, Pashighat forestry and agriculture students





Educational tour and training by students

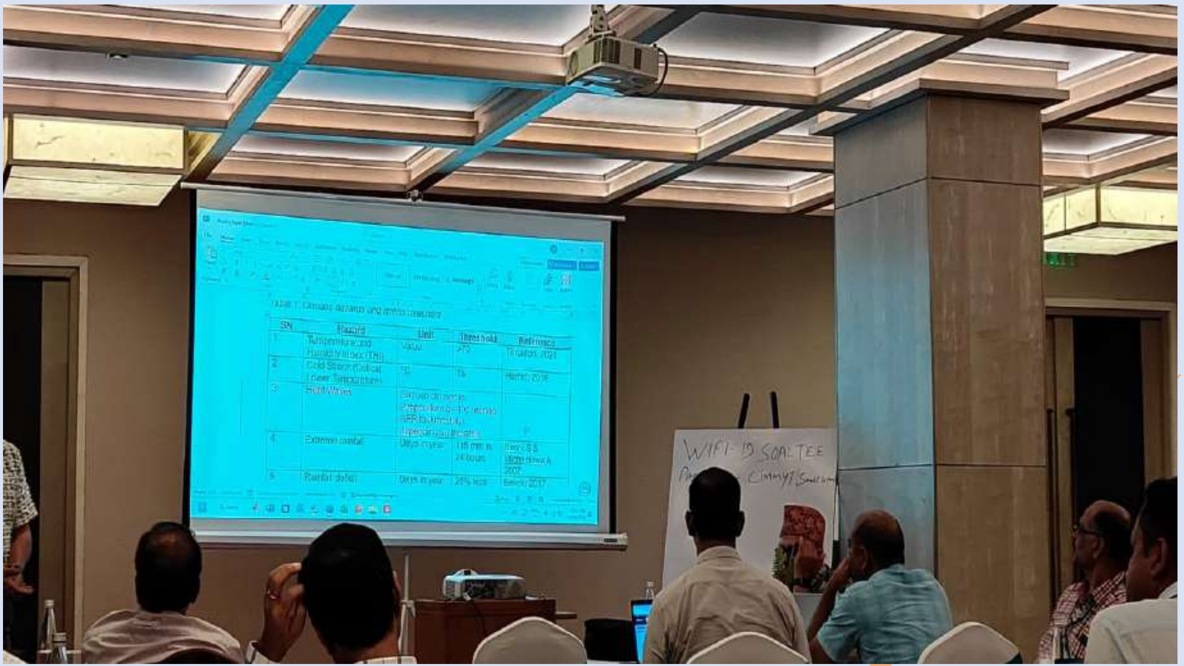
Foreign deputation by scientist

Visit to South Korea

Visit to Japan

Visit to Thailand

Visit to Sri Lanka



Advancing Agriculture
Co-Hosted by World Bank KGGTF
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ENVIRONMENTAL
STUDIES DIVISION