2025 ANNUAL REPORT

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PREFACE

The ICAR-Indian Agricultural Research Institute (IARI) continues to stand as a globally recognized centre for agricultural innovation, research, and capacity building. The Annual Report 2025 reflects ICAR-IARI's commitment to advancing scientific knowledge, strengthening food and nutritional security, and promoting climate resilient and sustainable agriculture systems.

An evident impact of the institute was imposed on Indian agriculture, as Basmati rice varieties developed at ICAR-IARI account for 97% of India's exports, valued at INR 50,312 crores annually, while its wheat varieties contribute nearly 32 million tonnes of production worth INR 88,000 crores. It also plays an important role in seed systems, accounting for a substantial share of breeder seed indent, including 91% in basmati rice, 37.4% in wheat, 38% in Indian mustard, and 19.5% in lentil.

In 2025, twenty-nine field crop varieties and several vegetable hybrids, including tomato, cabbage, cucumber, cauliflower, broccoli, and carrot were released for diverse agroecological regions. The institute developed the world's first genome-edited rice variety, Pusa DST Rice 1, tolerant to salinity and alkalinity stress conditions, exemplifying the institute's leadership in genome editing for climate resilience. Other achievements include the identification of a low-sweetness mango genotype and advancements in protected cultivation through an IoT-enabled vertical hydroponic and plant factory system. Novel extraction technologies, such as flash vacuum-assisted extraction and ultrasound-assisted extraction, enhanced recovery of nutritionally important compounds from beetroot and mushrooms, respectively.

There has been significant development in precision agriculture and sustainable mechanization. Sensor-based irrigation, nano-fertilizers, and AI-driven decision support systems increased input efficiency while lowering environmental impact. Precision irrigation and fertigation enhanced water productivity by up to 50%, and sensor-based irrigation achieved water savings of 30%, without yield penalties. Innovations including robotic sprayers, nitrogen prescription devices, variable-rate fertilizer applicators, robotic harvesters, and energy-efficient processing systems have contributed to reducing labour dependency and production costs. Advances in remote sensing and data analytics enabled the development of hyperspectral signature-based machine learning models for soil fertility assessment, crop yield forecasting, residue burning monitoring, and precision farming applications. The Institute developed rapid, reliable diagnostic tools, including LAMP and RT-RPA assays and AI-based imaging systems, enabling early detection of major crop diseases.

The ICAR-IARI has also strengthened its outreach and innovation ecosystem through flagship events such as the Farmers' Conclave-2025 and Pusa *Krishi Vigyan Mela* 2025, which facilitated large-scale knowledge dissemination and stakeholder engagement. Through the Lab to Land initiative, 91 technologies were transferred to 133 industry partners, while strategic collaborations accelerated agri-startup development and entrepreneurship.

The institute's academic and research excellence is reflected in 119 peer-reviewed publications and expanding academic programmes across multiple regional hubs. International engagement has been further strengthened through collaborations with CGIAR centres and global institutions, including the successful organization of MAITRI 2.0, an India–Brazil agri-tech incubator programme fostering cross-border innovation.

During the 63rd Convocation, 415 students were awarded degrees, while the Pusa Launchpad facilitated placement opportunities for more than 200 post-graduates. The institute secured the top position in the NIRF ranking in Agriculture and Allied Sectors for the third consecutive year and achieved second place in the Sustainable Development Goals (SDGs) category. Further recognition came through the National Intellectual Property Award 2025 for excellence in incubation.

I thank Dr. M.L. Jat, Secretary, DARE, and Director General, ICAR, and Dr. D.K. Yadava, DDG (Crop Science), ICAR, for their constant guidance and support and for their valuable guidance in achieving the milestones during 2025. I am also grateful to acknowledge the international funding agencies, including DFID, JICA, ICARDA, BISA, IFDC, HHU, IRRI, UKRI, SPUN, CABI, and CIMMYT, and national agencies such as NASF (ICAR), ICAR (CFPs, ANIP, Genome Editing, AICRPs), DBT, DST, ISRO, IIT, NTPC, etc. for funding 241 projects in the financial year 2025-26.

The efforts of the annual report editorial team in ensuring the timely completion and publication of the report are appreciated. I wish many more successful years to come.

Date: June 11, 2026
Place: New Delhi

(Ch. Srinivasa Rao)
Director, ICAR-IARI

Contents

IARI: An Introduction

Originally established in 1905 at Pusa (Bihar) with the financial assistance of an American Philanthropist, Mr. Henry Phipps, the Indian Agricultural Research Institute (IARI) started functioning from New Delhi since 1936 when it was shifted to its present site after a major earthquake damaged the Institute's building at Pusa (Bihar). The Institute's popular name 'Pusa Institute' traces its origin to the establishment of the Institute at Pusa.

The Indian Agricultural Research Institute is the country's premier national Institute for agricultural research, education and extension. It has the status of a 'Deemed-to-be-University' under the UGC Act of 1956 and awards M.Sc./ M. Tech. and Ph.D. degrees in various agricultural disciplines.

The growth of India's agriculture during the past more than 120 years is closely linked with the research done and technologies generated by the Institute. The Green Revolution stemmed from the fields of IARI. Development of high-yielding varieties of all major crops that occupy vast areas throughout the country, generation and standardization of their production techniques, integrated pest management, and integrated soil-water-nutrient management have been the hallmarks of the Institute's research. The Institute has researched and developed a large number of agrochemicals that have been patented and licensed and are being widely used in the country. Over the years, IARI has excelled as a center of higher education and training in agricultural sciences at national and international levels.

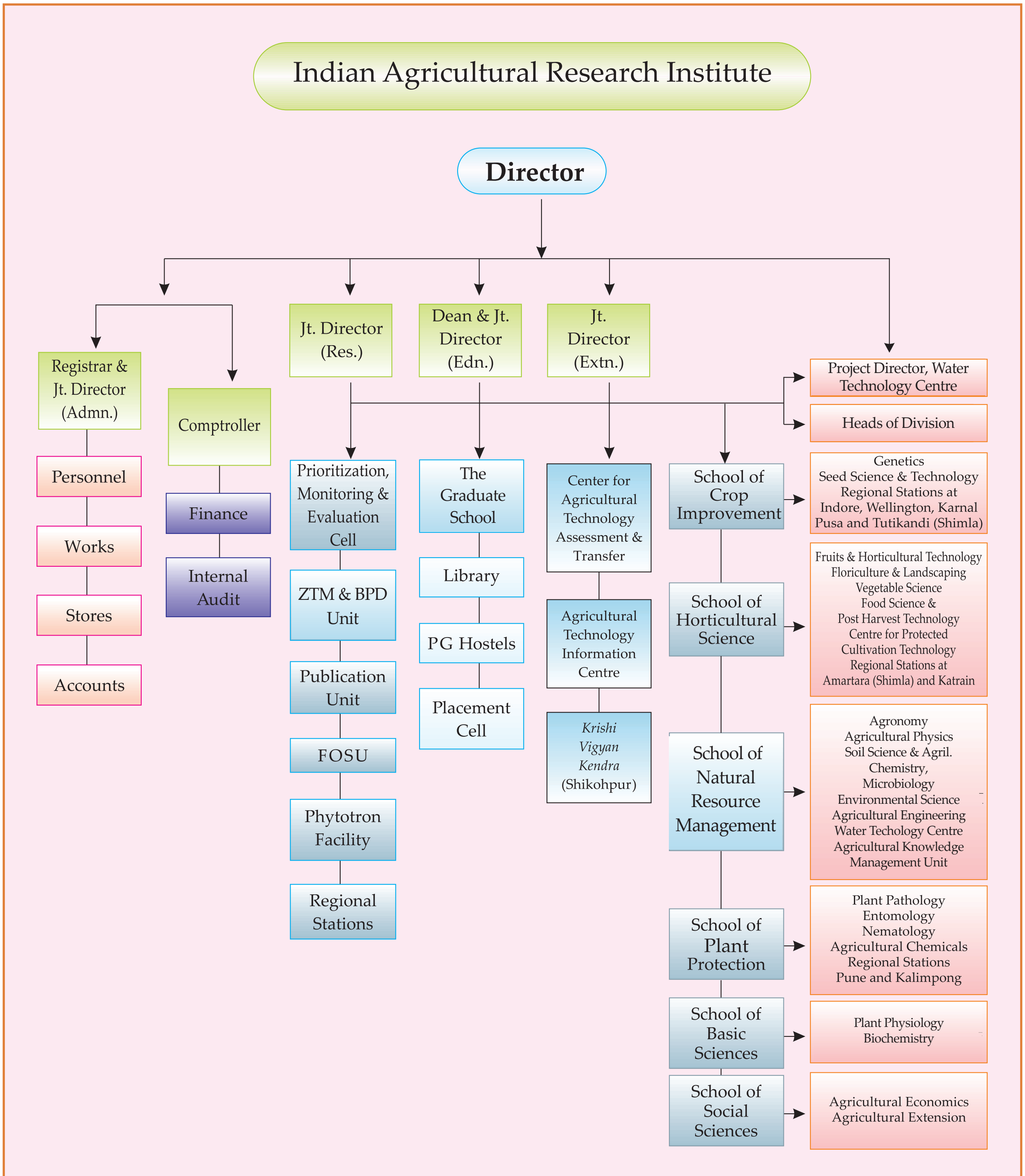
The mandates of the Institute are as follows:

- To conduct basic and strategic research with a view to understanding the processes, in all their complexity, and to undertake need-based research, that leads to crop improvement and sustained agricultural productivity in harmony with the environment
- To serve as a centre for academic excellence in the area of post-graduate and human resources development in agricultural sciences
- To provide national leadership in agricultural research, extension, and technology assessment and transfer by developing new concepts and approaches and serving as a national referral point for quality and standards
- To develop information systems, add value to information, share the information nationally and internationally, and serve as a national agricultural library and database

The present campus of the Institute is a self-contained sylvan complex spread over an area of about 500 hectares. It is located about 8 km west of New Delhi Railway Station, about 7 km west of Krishi Bhavan, which houses the Indian Council of Agricultural Research (ICAR), and about 16 km east of Indira Gandhi International Airport at Palam. The location stands at 28.38'23'' N and 77.09'27'' E with an altitude of 228.6 meters above mean sea level. The climate is sub-tropical and semi-arid, with warm and dry summers and cold winters. The long-term average (1984-2020) of maximum temperature in hot period ranged from 32.9 to 40.5 C and in winters ranged from 18.3 to 34.1° C. The minimum temperature ranged from 15.8 to 33.6° C in hot periods and 5.3 to 24.4° C in winter. The long-term average rainfall from June to September is 584.6 and 81.2 mm in winter.

The daily maximum temperature during the hot period (April 2025-September 2025) ranged from 28.6 to 44.1 °C and the daily minimum temperature ranged from 12.5 to 31.6 °C. During winter (January -March, 2025 and October-December, 2025), the daily maximum temperature ranged from 14.4 to 39.0 °C, and the minimum temperature ranged from 4.1 to 24.9 °C. June to September are rainy months during which 911.2 mm of rainfall is received, and during winter, 106.3 mm of rainfall was received in 2025.

The Institute has 20 divisions, one multi-disciplinary centre (WTC) situated in Delhi, 8 regional stations, 2 off-season nurseries, one Krishi Vigyan Kendra at Shikohpur, two all India coordinated research projects with headquarters at IARI, and 24 national centres functioning under the all India coordinated research projects. It has a sanctioned staff strength of 2276 comprising scientific, technical, administrative and MTS personnel. The revised budget estimates of the Institute constituted a total amount of ₹ 69690.70 lakh (Unified Budget) for the year 2025-26.



Organizational Structure

EXECUTIVE SUMMARY

ICAR-Indian Agricultural Research Institute (IARI), popularly known as the 'Pusa Institute', has been the seat of the '*Green Revolution*' in India. Through effective integration of modern scientific tools and techniques, the Institute has developed high-yielding, climate resilient varieties and hybrids of major field and horticultural crops which play vital roles in achieving food and nutritional security of the country, while further enhancing farmers' livelihood. The Institute has also developed integrated, farmer-friendly, resource-efficient, climate-resilient, and low-emission natural resource management technologies to enhance productivity, profitability, and agricultural sustainability. The significant achievements of ICAR-IARI in research, education, and extension during 2025 are summarized below:

The School of Crop Improvement released and notified 29 varieties/hybrids of field crops in 2025 for cultivation across various agro-ecologies of the country. The basmati varieties from ICAR–IARI account for 97% of total basmati rice exports, worth INR 50,312 crores annually. Among these, leading varieties such as 'Pusa Basmati 1121', 'Pusa Basmati 1509', 'Pusa Basmati 1692' and 'Pusa Basmati 1718' are cultivated in 96.7% (2.41 m ha) of the total 2.49 m ha area under basmati cultivation. Wheat varieties of ICAR-IARI contribute 32 million tonnes of grain, valued at INR 88,000 crores annually. Among these, prominent varieties such as 'HD 2967', 'HD 3086', 'HD 3226' and other ICAR-IARI-bred wheat varieties are cultivated in 8.5 million ha of area. Also, the breeder seeds of crop varieties developed at IARI accounted for a substantial share of the total breeder seed indent *i.e.* 91% in basmati rice, 37.4% in wheat, 38% in Indian mustard, and 19.5% in lentil. In cereals, three varieties of wheat (HD 3428, HI 1669 and HI 1674), one hybrid of rice (Pusa RH 60), eleven hybrids of maize, viz., Pusa HQPM4 Improved, Pusa Biofortified Maize Hybrid-6, Pusa Biofortified Maize Hybrid-7, Pusa Biofortified Maize Hybrid-8, Pusa HQPM1 Improved, Pusa HQPM5 Improved, Pusa Super Sweet Corn-3, Pusa Waxy Maize Hybrid-1, Pusa Male Sterile Baby Corn-3, Pusa Early Hybrid Maize-6, Pusa Jawahar Hybrid Maize-1 and one OPV of maize (Pusa Composite-5) were released. In pulses, two varieties of chickpea (Pusa Chickpea 4037 and BGD 133), three varieties of pigeonpea (Pusa Jawahar Arhar Dwarf 22-01, Pusa Jawahar Arhar 22-02 and Pusa Jawahar Arhar 21-29), and one variety of each of mungbean (PSM 12) and lentil (L 4717) were released. In oilseeds, four varieties of mustard (Pusa Mustard 37, Pusa Double Zero Mustard 33, Pusa Double Zero Mustard 35 and Pusa Double Zero Mustard 36) and two varieties of soybean (Pusa Soybean 6 and Pusa Soybean 21) were developed. In addition, 15 cultivars across wheat (7), barley (1), maize (3), pearl millet (1), chickpea (2) and mustard (1) have been identified for release across various agroecological zones.

During 2025, six genetic stocks across wheat (4), barley (1) and lentil (1) were registered for abiotic and biotic stress tolerance, at ICAR-NBPGR, New Delhi. In addition, unique germplasm from various crops was procured and developed for research purposes, serving as valuable donors of yield-enhancing traits, climate resilience, and nutritional qualities in the breeding programme.

In the School of Horticultural Sciences, The Division of Vegetable Science developed and released two vegetable varieties, viz., Pusa Red Cherry Tomato-3 and Pusa Red Cabbage-5, and one hybrid, viz., Pusa Gynoecious Cucumber Hybrid-1301, which were notified by CVRC. One variety, viz., KTCF-36, of snowball cauliflower and four hybrids, viz. KTCFH-534 (snowball cauliflower), KTHB-3411 (broccoli), KTCBH-225 (cabbage) and KTTCH-804 (temperate carrot) have been identified by AICRP-VC. In tomato, the genetic stock PTS-25 was registered at NBPGR (INGR25113) for high yield, moderate tolerance to ToLCV and low seed content. Grape hybrids Pusa Swarnika and Pusa Purple Seedless have been notified by CVRC. Sweet citrus scion hybrid SCSH 11-15, Hybrid Tea rose variety Pusa Glory, French marigold variety Pusa Prabha and African marigold varieties Pusa Shwetabh and Pusa Shobha were identified by IVIC for NCT of Delhi. Whereas, the ICAR-IARI Regional Station, Katrain, identified the capsicum genotypes KTGC-4 (Green), KTYC-3 (Yellow), KTGC-9 (Green), and KTOC-4 (Orange) with superior performance. Several promising F_1 hybrid combinations of snowball cauliflower, cabbage, broccoli, and ornamental kale were also identified. Mango genotype M-16-7 was identified as a potential selection characterized by low sweetness. In guava, the pink-pulp hybrids 8F, 7F and HSU x SH-16-8-2, and white-pulp hybrids GH-2016-7A, GH-2016-2A and HSU x SH-16-8-18 were promising. Chrysanthemum hybrids Pusa First Bloom for pot-mum production, garden beds, and landscape use, and Pusa Himank for both open-field and pot production, have been developed. In gladiolus, the *in vitro* regeneration protocol from female gametophytes has been optimized.

An IoT-based smart vertical hydroponic system for basil cultivation has been developed. Plant Factory Technology was designed and developed with artificial LED light and a multi-layer hydroponics system using Pak choi plants. A flash vacuum-assisted extraction system has been developed to enhance Betalain recovery from beetroot. Carboxy methyl cellulose (CMC) based active edible films activated with rose leaf (RL) extract were effective in maintaining the quality and maximizing the storage life of guava fruit. Processing treatments which positively alter the nutritional, structural and bioactive profile of the little millet and reduce the anti-nutritional factors have also been standardized.

The School of Natural Resource Management at the ICAR-IARI focuses on developing integrated, resource-efficient, climate-resilient, and low-emission agricultural technologies to enhance productivity, profitability, and sustainability. Conservation agriculture-based cropping systems, rainfed agronomy, precision nutrient, water management, and integrated farming system (IFS) models were developed that improved yields, soil health, and farmers' income. Long-term studies demonstrated the superiority of conservation agriculture and integrated crop management in improving system productivity (up to ~22%), carbon sequestration, and energy efficiency. Organic and integrated nutrient management practices significantly enhanced soil organic carbon, microbial activity, and sustainability indices. Crop diversification, legume integration, and residue management contributed to higher energy efficiency and reduced carbon footprints. Novel products like nano-clay fertilizers, multi-micronutrient fertilizers, enriched organic manures, silicon-rich agro-wastes, engineered biochar and biochar-based formulations were designed to enhance nutrient-use efficiency and mitigate greenhouse gas emissions.

Advanced tools such as sensor-based irrigation, nano-fertilizers, and artificial intelligence (AI) - driven decision support systems were developed to optimize input use and reduce environmental footprints. Precision irrigation and fertigation techniques improved water productivity by 40-50%, while sensor-based irrigation saved nearly 30% of water without yield loss. Whereas, AI and machine learning models were successfully applied for drought forecasting, rainfall analysis, and crop loss estimation. Precision mechanization technologies, viz., robotic sprayer, nitrogen prescription device, Variable Rate Technology (VRT) fertilizer robot, robotic harvester, and energy-efficient processing systems, enhanced productivity while reducing labour and input costs.

Climate projections (CMIP6) highlighted rising temperature extremes and rainfall variability, guiding adaptation strategies. High-efficiency fertilizers, drip fertigation, and coated urea technologies significantly lowered N_2O, CH_4, and NH_3 emissions and reduced GHG (Greenhouse Gas) intensity in rice-wheat and vegetable systems. Microbial consortia such as Pusa

BioGreen reduced methane emissions in rice by 20-31%, while improving nitrogen use efficiency and sustaining yields under reduced N inputs, and bioformulations strengthened drought resilience and soil health across major crops. Agroforestry, organo-mineral amendments, biomass valorization, and soil carbon stabilization studies further supported circular bioeconomy approaches. Collectively, these efforts strengthened sustainable productivity, environmental stewardship, and climate resilience in Indian agriculture.

The School of Plant Protection focused its research on diagnostics, the identification of resistant sources to biotic stresses, and the integrated management of important pests and pathogens of national importance.

The Indian Type Culture Collection (ITCC) and *Herbarium Cryptogamae Indiae Orientalis* (HCIO) maintained 4,220 fungal cultures, 170 bacterial cultures, and 50,765 fungal specimens. The causative organism of the blue mold disease in apple was identified as *Penicillium crustosum.* Modern diagnostic tools were developed for the early, rapid, reliable, and quick detection of diseases, such as the LAMP assay for *Rhizoctonia solani*, the reverse transcription recombinase polymerase amplification (RT-RPA) assay for detecting the *Onion yellow dwarf virus (OYDV),* and an IR image-based AI model for the *Chilli leaf curl* virus. Whole-genome sequencing of *Moesziomyces penicillariae* (TP-1), which causes smut disease in pearl millet, was performed. A chitosan-based formulation was effective in managing spot blotch disease of wheat. Soil and seed treatment of salicylic acid, Chlormequat chloride and Mepiquat chloride and *Trichoderma asperellum* were found effective against bakanae disease in wheat. *Beauveria bassiana* isolates, BbR2 and BbR3, had a higher antagonistic effect against chickpea seed mycoflora. Whole-genome transcriptome analysis revealed differential gene expression between hibernation and non-hibernation populations of *Chilo partellus.* The core gut symbionts such as *Lactobacillus*, *Fructobacillus*, *Gilliamella apicola*, *Bartonella apis*, and *Snodgrassella alvi* were characterized in honeybees *Apis mellifera* and *A. cerana.* Genome-wide analysis identified and characterized for the first time, 14 chemosensory proteins in of *Bemisia tabaci* Asia II-1.

Significant advances were achieved in pest biology, resistance mechanisms, and sustainable management strategies across multiple crops and insect systems. Nitrogen waste recycling microbes and metabolic pathway genes have been characterized in whitegrub, *Holotrichia longipennis*, which may serve as potential targets for developing sustainable pest control strategies. Two synergists (PBO, piperonyl butoxide and DEM, diethyl maleate) were observed to enhance the efficacy of insecticides for managing Fall Army Worm, *Spodoptera frugiperda*. Spinetoram was found to be the most effective in managing the storage pest Redflour beetle (*Tribolium castaneum*). UAV application of triflumezopyrim 0.5 C spray @94 ml per acre at a height of 2.5 m above canopy was most effective against rice brown planthoppers. *Geocoris ochropterus*, a predatory insect was also identified as an effective biological control agentin aphid-infested cotton. Wild crucifers *Lepidium sativum*, *Sisimbrium spp.*, *Eruca sativa*, and *Crambe abyssinica* exhibited the least preference and population build-up of aphids *Lipaphis erysimum.* A wild tomato cultivar of *Solanum habrochaites* tomato carrying Ty3 genes in a homozygous state was found to be resistant to whitefly. Tomato cv. Pusa Ruby was transformed with CRISPR-Casa plasmid pHSE401 targeting *SlSmD1* gene.

Insights into nematode management, host-pathogen interactions, and novel bioactive compounds have strengthened integrated approaches for crop protection. Transcriptome analysis of a susceptible rice line (Pusa Basmati 1121) and the resistant lines (Phule Radha and Suraksha) revealed that the three genotypes respond differently to nematode infection. Transcriptomic analysis unravelled the interaction between entomopathogenic nematode *Heterorhabditis indica* with its bioluminescent symbiont *Photorhabdus* sp. The incorporation of *Steinernema siamkayai* (*MZ318695*) infective juveniles or infected *Galleria* cadavers significantly suppressed *M. incognita* invasion and gall formation in tomato cv. Pusa Ruby. The tetrazole based diacyl hydrazines were effective antifungal agents against *R. solani.* Triazolopyimidines 5-(4-(pentyloxy)-

phenyl)-[1,2,4]-triazolo[4,3-a]-pyrimidine (5T) was most effective against *Macrophomina phaseolina*.

Hexane extracts *Cannabis sativa* showed *in vitro* nematicidal activity against *M. incognita.* A hexane-acetone mixed extract of *Ageratum conyzoides* was found to contain precocene-II, which exhibited antifeedant activity against *Spodoptera frugiperda*. The SPG-1118 was found to be better than Pusa Hydrogel in improving soil moisture availability. A robust LC-ESI-MS/MS method was developed for the identification and quantification of 100 pesticides in fresh red chilli. A rapid and sensitive GC-MS method was developed for the simultaneous determination of methyl eugenol and cypermethrin. β-Cyclodextrin-based smart Molecularly Imprinted Polymer (MIP) was found to be a reusable platform for the recognition and quantification of contaminants such as triclosan in environmental and food matrices.

In the biosystematics of insects, at present, 303 fungal isolates from 21 genera, comprising different species, and 64 bacterial isolates, including endophytic bacteria, are being conserved at Wellington. Four hundred twelve specimens belonging to different Orders of Coleoptera (110), Hymenoptera (115), and Lepidoptera (175) were identified for various stakeholders. A detailed revision of the genus *Eudemopsis,* discovery of three species *Lobesia lithogonia, Penthostola albomaculatis, Tetramoera flavescens* and two genera, *Eudemopsis*, and *Penthostola* were recorded from India. Additionally, four new species were described: *Eudemopsis hunliensis* sp. nov. *Eudemopsis gobuka* sp. nov. *Trophocosta apilobata* sp. nov. and *Eucosmogastra* sp. nov. Three new species of Gelechiinae *Gelechia adi* sp. nov., *G. bilobuncusa* sp. nov. and *Istrianis ladakhensis* sp. nov. were described from India. Three species of tortricid moths of the subfamily Olethreutinae, viz., *Acanthoclita acrocroca* Diakonoff, 1982, *Ageonychistica* Diakonoff, 1982 and *Bactra coronata* Diakonoff, 1950, were recorded for the first time from India. A field deployable colorimetric recombinase polymerase amplification (RPA) assay was developed for rapid detection of *Phthorimaea absoluta* infesting tomato. New records of three species, *Nipponoelater henscheli* (Schimmel 2007), *N. indosinensis* (Schimmel and Tarnawski 2010), and *N. sinensis* (Candèze 1882) were documented for the first time. A new genus of the leafhopper tribe Mukariini (Cicadellidae: Delcephalinae) *Shanaya* gen. n. and two new species of leafhopper have been described from India.

Diversity of *Hirschmanniella* spp. was studied in paddy rhizosphere across 17 rice-growing states in India, and a new species, named *H. paramucronata n. sp.*, was recorded. Plant-parasitic nematodes *Meloidogyne incognita*, *Helicotylenchus* sp., *Pratylenchus* sp., *Rotylenchulus reniformis*, and *Hoplolaimus indicus* were observed to be the dominant species across cucumber, tomato, brinjal, chilli, and capsicum grown under protected cultivation. *Meloidogyne enterolobii* infestation was observed in different guava growing districts of Rajasthan and this nematode was reported for the first time on alligator weed (*A. philoxeroides*).

The School of Basic Sciences reported that wheat genotypes with high epicuticular wax and high awn length, enhance yield under heat stress by maintaining cooler canopy temperatures and photosynthetic efficiency. Wheat recombinant inbred lines (RILs) exposed to elevated night temperatures (+3 °C and +6 °C over ambient) showed that early accumulation of total free amino acids during 3-7 days after anthesis is strongly associated with yield stability under stress. Nitrogen availability enhanced heat tolerance in wheat genotype HD 2967. Genome-wide association studies (GWAS) in cucumber identified 52 SNPs for drought tolerance. Under combined heat and drought stress, GWAS in 278 wheat lines identified 36 marker-trait associations linked to stay-green and stem reserve mobilization traits. Root trait-based screening of 150 mustard lines and phenotyping of ~200 wheat RILs enabled identification of drought-resilient genotypes. Hydroponic evaluation of 128 wheat genotypes uncovered extensive miRNA-mediated regulation under combined nitrogen and iron deficiency. The Pup1 QTL in rice was shown to regulate gene expression and alternative splicing under phosphorus deficiency. A rapid vacuum infiltration method significantly reduced leaf relative water content estimation time from approximately 4 hours while maintaining strong accuracy.

Genome editing approaches demonstrated significant potential for crop improvement, as the genome-edited rice variety Pusa DST Rice 1 produced higher yield (9.7, 14.7, and 30.4%) than MTU 1010, under different salt stress conditions. Targeted CRISPR-based modifications identified DEP1 mutant with enhanced grain number by ~15% and STOM mutants with reduced stomatal density. Functional validation studies showed that phytomelatonin receptor (*OsPMTR)* overexpression enhances biomass, stomatal density, tiller number, and grain yield, whereas genome edited mutants exhibit reduced growth under drought stress. In maize, CRISPR/Cas9-mediated transformation generated 12 PCR-verified transgenic plants, confirming efficient genome editing for haploid induction.

Genetic studies across crops revealed that in maize, the dominant A1 allele is strongly correlated with anthocyanin accumulation. In bitter gourd, elevated *McIDI* expression was associated with high charantin content. Studies in pearl millet, led to the identification of 66 marker-trait associations with rancidity traits. In pigeonpea, QTL mapping using 4,161 SNP markers explained up to 18.5% phenotypic variation for disease resistance, and in mungbean, 17 QTLs along with GWAS explained up to 29% variation for stress-related traits.

Biochemical and nutritional studies showed that pearl millet rancidity is associated with 1,350 lipase-like transcripts and 25 metabolites linked to lipid degradation, while barley processing increased beta-glucan content from 5.73 to 8.76%. Steam-infusion enhanced plant protein content (64.2 to 84.4%) and digestibility (80.2 to 98.9%), and ultrasound-assisted extraction in *Hericium erinaceus* improved bioactive recovery and neuronal responses.

Advances in sensing and management highlighted that hyperspectral analysis of 243 soil samples identified MIR spectroscopy as the most effective for soil fertility prediction, while satellite monitoring detected 33,028 rice and 60,915 wheat residue burning incidents. Environmental remediation achieved up to 99% removal efficiency for manganese. Machine learning approaches revealed 44-69% yield loss in chickpea under wilt stress and improved yield prediction using NDVI, while integrated modelling achieved soil organic carbon prediction accuracy of R^2 = 0.717.

The School of Social Sciences, plays a central role in advancing agricultural development by integrating research, policy analysis, and field-level interventions to enhance productivity, profitability, and sustainability. Its contributions in agricultural economics provide valuable insights into markets, technologies, and resource use.

The evaluation of the National Agriculture Market (e-NAM) reflects gradual improvements in market integration, though farmer participation remains relatively low. Policy initiatives such as neem-coated urea have significantly improved nitrogen use efficiency, reduced excessive fertilizer use, and increased crop productivity while supporting environmental sustainability. Studies in the Indo-Gangetic Plains emphasise the need to increase technological efficiency and optimise input use. Furthermore, the adoption of modern technologies, such as hybrid transformer-based models, has improved agricultural commodity price forecasting.

Agricultural Extension at the ICAR-IARI emphasizes agripreneurship, capacity building, and institutional convergence. Case studies of agri-entrepreneurs across different regions demonstrate the importance of innovation, enterprise diversification, and market linkages in improving rural livelihoods. Key drivers of agripreneurship include infrastructure development, awareness, and better market access. Capacity-building initiatives increasingly focus on experiential learning, practical training, and skill enhancement. Institutional mechanisms such as Farmer Producer Organizations, Self-Help Groups, and extension networks have promoted collective action and improved farmers' access to markets and services. The evaluation of major government programmes indicates positive impacts on farm income, sustainability, and mechanization, although challenges such as labour shortages and market volatility continue. Efforts in nutrition and health highlight the importance of integrating agriculture with behavioural and awareness-based approaches to address malnutrition and improve overall well-being.

Innovative extension approaches, such as the multimedia-based platform *Pusa Samachar*, have effectively disseminated timely scientific information to a wide audience. *Krishi Vigyan Kendras* have further strengthened these efforts through on-farm trials (OFTs) and capacity-building programmes for farmers and rural stakeholders. Large-scale outreach events, including the Pusa *Krishi Vigyan Mela* 2025 and the Innovative Farmers' Conclave 2025, have enhanced farmer engagement, knowledge exchange, and technology dissemination. During the year 2025, under Lab to Land Initiative, ninety-one innovative technologies of the ICAR-IARI were transferred to one hundred thirty-three industry partners. Pusa Krishi, ZTM & BPD Unit, that handles IP protection, licensing, and commercialization of technologies, varieties, and innovations entered into a strategic collaboration with HDFC Bank under its CSR flagship initiative "Startup Parivartan", to support high-potential agri-startups through structured acceleration and financial assistance. Overall, the School's multi-disciplinary approach successfully bridges research, policy, and practice, fostering resilient, inclusive, and sustainable agricultural systems.

The Graduate School of the ICAR-IARI continued to provide national and international leadership in human resource development. A total of 567 students were admitted to the 2025-26 academic session at IARI, New Delhi, and its hubs.

The 63rd Convocation of the Graduate School of the ICAR-IARI, held on March 22, 2025, was graced by Shri Shivraj Singh Chouhan, Hon'ble Union Minister of Agriculture & Farmers Welfare and Rural Development, Govt. of India, as the Chief Guest. During this Convocation, 415 students (M.Sc.: 226; M. Tech.: 10; & PhD: 179) from India and other countries received their Postgraduate and Doctoral degrees. Pusa Launchpad assisted more than 200 students to secure placements for various positions across India.

The scientists at the institute published 1119 research papers in peer-reviewed scientific journals with an international impact factor. In addition, several other publications, including symposia papers, books/book chapters, popular articles, technical bulletins, and regular and ad-hoc publications, both in English and Hindi, were brought out for the timely dissemination of technical know-how and other important information to the respective stakeholders. Fifty-seven national and international training courses and other capacity-building programs were conducted to benefit farmers, academicians, researchers, extension workers and other professionals. New linkages and collaborations with several CGIAR International Agricultural Research Centers and other national and international institutions/organizations were established. To strengthen international collaboration Pusa Krishi hosted MAITRI 2.0: India-Brazil Cross-Border Agri-Tech Incubators' Program.

In the NIRF ranking 2025, the ICAR- IARI topped in the 'Agriculture and Allied Sectors' category for the third consecutive year. It also gloriously debuted by securing second rank in the Sustainable Development Goals (SDGs) category. Pusa Krishi, developed by IARI won the National Intellectual Property Award-2025 under the category "Best Incubator for Nurturing IP". Besides, institutional recognition, many scientists, students and faculty of the institute received several prestigious awards and recognitions during this period. The ICAR-IARI is committed to *Viksit Bharat*, a long-term goal to turn India into a developed nation by 2047, the 100th anniversary of independence, using a holistic strategy that includes research, teaching, and extension operations.

1. CROP IMPROVEMENT

The Indian Agricultural Research Institute (IARI), the "Seat of Green Revolution" in India, is focused on enhancing the productivity and nutritional quality of various field crops. Since its inception, the School of Crop Improvement has made significant contributions to basic, strategic and applied research in genetics and plant breeding of various crops and serves as a cradle for farmers' seed security and the nation's food security.

1.1 CEREALS

1.1.1 Wheat

1.1.1.1 Varieties released and notified

HD 3428: It is a bread wheat variety released and notified for irrigated late sown conditions of North Western Plains Zone (NWPZ). It has an average yield of 51.2 q/ha. It has high resistance to leaf and stripe rusts. It is highly tolerant to both heat [Heat Susceptibility Index (HSI): 0.67] and drought [Drought Susceptibility Index (DSI): 0.79] stress. This variety has 12.2% protein, 41.1 ppm Fe, 38.5 ppm Zn, 8.1 Chapati score, 92 Glycemic Index (GI), and 10/10 Glu-1 score and is most suitable for making chapati.

Field view of HD 3428

HI 1669 (Pusa Gehun Kranti): It is a bread wheat variety released and notified for timely sown irrigated conditions of the Central Zone (CZ). It has an average yield of 59.2 q/ha. It has high levels of field resistance to stem rust [Average Coefficient of Infection (ACI)-5.1] and leaf rust (ACI-12.2). It is moderately tolerant to heat stress (HSI: 0.85) and drought stress (DSI: 0.99). HI 1669 has an excellent chapati quality (7.9), bread quality (6.8) and biscuit spread factor (7.0).

Field view of HI 1669

HI 1674 (Pusa Gehun Atulya): It is a bread wheat variety released and notified for late sown irrigated conditions of both CZ and Peninsular Zone (PZ). In CZ, it has an average yield of 50.3 q/ha, while in PZ, it is 46.0 q/ha. It has high levels of field resistance to stem rust and leaf rust. It is moderately tolerant to heat stress (HSI: 0.65) and drought stress (DSI: 1.0). HI 1674 has excellent chapati quality (7.3).

Field view of HI 1674

1.1.1.2 Varieties identified for release

HD 3463: It is a bread wheat variety identified for early sown, irrigated, high fertility conditions of CZ, with potential yield of 78.3 q/ha, and an average yield of 65.5 q/ha.

HD 3471: It is a bread wheat variety identified for timely sown irrigated conditions of NWPZ, with potential yield of 74.6 q/ha, and an average yield of 60.2 q/ha.

HI 1683: It is a bread wheat variety identified for timely sown irrigated conditions of CZ, with potential yield of 77.5 q/ha, and an average yield of 56.1 q/ha.

HI 1687: It is a bread wheat variety identified for late sown, irrigated conditions of the Peninsular Zone (PZ) with potential yield of 70.9 q/ha, and an average yield of 46.5 q/ha.

HI 8849: It is a durum wheat variety identified for timely sown, irrigated conditions of PZ. It has a potential yield of 71.8 q/ha, and an average yield of 51.9 q/ha.

HI 8850: It is a durum wheat variety identified for timely sown, irrigated conditions of CZ. It has a potential yield of 86.2 q/ha, and average yield of 56.5 q/ha.

HI 8851: It is a durum wheat variety identified for timely sown, restricted irrigated conditions of CZ. It has a potential yield of 61.8 q/ha.

1.1.1.3 Breeding for enhancement of yield

Whether genetic gain is sufficient to meet projected demand? India needs annual genetic gains of 38-80 kg/ha to meet wheat demand target of 2050. Long-term gains have average ~29 kg/ha/year, while recent gains (~111 kg/ha/year) exceed requirements, indicating current breeding progress is largely sufficient when scaled.

Verification of the yield stability of HD 3385: Across locations and conditions across India, HD 3385 demonstrated wide adaptability, performing consistently under early- to late-sowing conditions in Madhya Pradesh, Maharashtra, and Gujarat. It out-yielded check varieties by 2-4 q/acre, and in coordinated trials at New Delhi, it surpassed all checks and test entries by 2-17 q/ha.

Development of solid stem wheat lines: Solid stem wheat lines were developed by introgressing the *Solid stem1* (*Sst1*) gene/ QTL along with major rust resistance genes using CoW(W)1 and DBW 39. Overall, 125 lines successfully combined stem solidity and rust resistance with high yield potential. Field evaluation showed improved lodging tolerance, moderate stem rust resistance, and heat stress tolerance.

1.1.1.4 Breeding for abiotic stress tolerance

Breeding for climate resilience through conservation agriculture: Multi-year evaluation under conservation agriculture has enabled identification of high-yielding and lodging-tolerant genotypes. Early sowing by 10-12 days under conservation agriculture helped in identifying entries with yield potential exceeding 9 t/ha that may fail under conventional tillage.

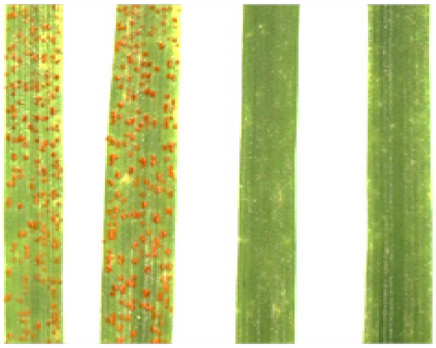
Evaluation and introgression of the Biological Nitrification Inhibition (BNI) trait: BNI donors, non-BNI lines, and elite lines were evaluated under varying nitrogen levels. MAS-derived BNI lines showed improved nitrogen use efficiency, and BC_2 lines were selected using molecular markers and GISH for field testing.

Introgressing herbicide-tolerance in elite wheat genotypes: The *ALS* gene from BCL0618 was introgressed into several elite wheat varieties through backcross breeding. Advanced lines showed stable tolerance to *ALS*-inhibiting herbicides (Imazethapyr) while maintaining strong agronomic performance and disease resistance. This led to the development of herbicide-tolerant and rust-resistant wheat genotypes for sustainable weed management.

1.1.1.5 Breeding for disease resistance

Marker-assisted transfer of genes for rust resistance: To restore resistance, *Lr52* (leaf rust) linked with *Yr47* (stripe rust) were introgressed into HD 3086 through marker-assisted backcrossing (MABB), leading to development of NIL (HD 3515) promoted to AVT-II.

Similarly, HD 3059 was improved using MABB by transferring *Lr52/Yr47*, *Yr10*, and *Yr15* in separate programs. The resulting NILs viz. HD 3495, HD 3541, and HD 3542 are under AVT-I or AVT-II evaluation for rust resistance.



Disease reaction of parents and backcross lines against leaf rust pathotype-77-5

Transfer of genes from wild and related species for rust and Karnal bunt resistance: Rust and Karnal bunt resistance genes from *Ae. markgrafii* and *T. militinae* were successfully introgressed into wheat varieties viz., HD 2967, HD 3059, HD 3086, and HD 2967 through backcrossing. Lines carrying *LrM*, *LrTm1*, *YrTm1*, and an unidentified Karnal bunt resistance gene are currently at BC_2-BC_3.

1.1.1.6 Acceleration of breeding cycle

Development of NILs through speed breeding: NILs carrying *Sr22* and *Sr50* were developed up to BC_4F_3 within two years using speed breeding, achieving ~96% recurrent parent genome (RPG) recovery. This method shortened the breeding cycle from 7 years (normal) to 2 years.

1.1.1.7 Pre-breeding for wheat improvement

Transfer of leaf rust resistance from rye into wheat using triticale as a bridge species: A triticale × wheat derivative, SW288 (T/W17-5), developed from TL2942/HS562, showed seedling resistance to 38 leaf rust pathotypes, including the highly virulent, 77-5 and 77-9 prevalent in Northern India.

Development of resistance to Fusarium Head Blight (FHB): FHB resistance QTL (*fhb1*, *fhb4 I* and *fhb5*) from Sumai-3 have been transferred into susceptible wheat varieties through backcrossing. Suppressor gene elimination enhanced resistance levels across generations.

1.1.2 Barley

1.1.2.1 Variety identified for release

BHS 497 (Pusa Shakuntala), a six-rowed hull-less barley genotype developed from HBL276/BHS352 has been identified for release in North Hill Zone (NHZ). This variety possesses an average grain yield of 21.9 q/ha under rainfed conditions with resistance to yellow rust and brown rust diseases. It has an amber grain colour, an oblong seed shape, and thousand-grain weight of 35.5 g. It contains 10.1% protein and 65.2% starch in grains.

1.1.3 Rice

1.1.3.1 Variety released and notified

Pusa RH 60: It is a high-yielding, short-duration, long slender grain aromatic rice hybrid with seed-to-seed maturity of 120 days, and an average yield of 59.2 q/ha in Bihar and Uttar Pradesh. It is a two-line hybrid based on thermosensitive genic male sterility (TGMS), which not only eliminates the cumbersome maintenance required for three-line hybrids based on WA-CMS but also diversifies the male sterility system for hybrid production in rice. It has been released and notified for cultivation in the states of Uttar Pradesh and Bihar.

Field view of Pusa RH 60

1.1.3.2 Breeding for disease resistance and micro-nutrients

Identification of a rice genotype (UPRH265) with broad spectrum resistance to *Magnaporthe oryzae*: The rice genotype, UPRH265 was identified as highly resistant, exhibiting a disease score of 1 against all tested *Magnaporthe oryzae* isolates, namely Mo-ni-0025, Gudalur isolate, and PB1637-NB isolates. Mo-ni-0025 displayed a compatible reaction with all 27 IRRI standard differential lines, indicating its broad virulence spectrum. Molecular characterization revealed absence of major blast resistance genes, including *Pi9*, *Pi2*, *Pita*, *Pi1*, *Pi54*, *Pib*, and *Pi5*, suggesting the presence of novel or uncharacterized resistance gene(s).

Identification of bakanae resistant rice genotype: The rice genotype, ARC 18325, was identified as resistant to bakanae disease when evaluated under artificial inoculation conditions using multiple virulent isolates of *Fusarium fujikuroi*, namely F250, F309, F501, F502, F503, and F504. It exhibited low seedling mortality ranging from 0-9.5% compared to the susceptible check, Pusa Basmati 1121 with 100% mortality.

Identification of superior high-zinc rice entries: A series of crosses were developed using the previously identified high zinc donor, Karuppunel. The derived progenies showed endosperm zinc content as: Pusa 3125-Zn-525 (40.58 ppm), Pusa 3125-Zn-5 (38.25 ppm), Pusa 3125-Zn-380 (37.01 ppm), Pusa 3125-205-1 (30.27 ppm), Pusa 3125-205-2 (30.04 ppm), Pusa 3125-202-1 (30.30 ppm), Pusa 3125-207-4 (30.13 ppm), Pusa 3125-238-3 (31.03 ppm) and Pusa 3125-240-5 (29.55 ppm).

1.1.4 Maize

1.1.4.1 Hybrids and varieties released and notified

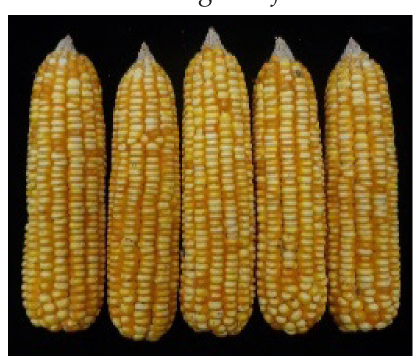
Pusa Biofortified Maize Hybrid-6 (PBMH-6): It possesses high α-tocopherol (21.38 ppm), provitamin-A (6.03 ppm), lysine (3.94%) and tryptophan (0.87%). It has an average yield of 64.8 q/ha with a potential yield of 111.0 q/ha. It is suitable for cultivation in NWPZ, North Eastern Plains Zone (NEPZ) and Central Western Zone (CWZ) during *kharif* season.

Grain characteristics of PBMH-6

Pusa Biofortified Maize Hybrid-7 (PBMH-7): It possesses low phytate (2.21 mg/g) and high lysine (3.72%) and tryptophan (0.91%). It has an average yield of 68.9 q/ha, with a potential of 98.1 q/ha. It is suitable for cultivation in NWPZ and CWZ during *kharif* season.

Ear and grain characteristics of PBMH-7

Pusa Biofortified Maize Hybrid-8 (PBMH-8): It possesses low phytate (2.17 mg/g) and high lysine (3.75%) and tryptophan (0.80%). It yields an average of 49.7 q/ha, with a potential of 77.2 q/ha. It is suitable for cultivation in NEPZ during *kharif* season.



Ear and grain characteristics of PBMH-8

Pusa HQPM-4 Improved (PHQPM-4I): It possesses high provitamin-A (6.04 ppm), lysine (3.99%) and tryptophan (0.90%). It has an average grain yield of 77.8 q/ha with a potential yield of 110.6 q/ha. It is suitable for cultivation in NWPZ and CWZ during *kharif* season.

Ear and grain characteristics of PHQPM-4I

Pusa HQPM-1 Improved (PHQPM-1I): It possesses high provitamin A (6.62 ppm), lysine (4.09%) and tryptophan (0.84%). It has an average grain yield of 79.3 q/ha with a potential yield of 130.7 q/ha. It is suitable cultivation in spring (NWPZ) and *rabi* (NEPZ, PZ and CWZ) seasons. Earlier, it was released across the country for *kharif* season.

Ear and grain characteristics of PHQPM-1I

Pusa HQPM-5 Improved (PHQPM-5I): It possesses high provitamin-A (7.18 ppm), lysine (3.98%) and tryptophan (0.90%). It has an average grain yield of 79.4 q/ha with a potential yield of 139.9 q/ha. It is suitable for cultivation in spring (NWPZ) and *rabi* (NEPZ, PZ and CWZ) seasons. Earlier, it was released across the country for *kharif* season.

Grain characteristics of PHQPM-5I

Pusa Super Sweet Corn-3 (PSSC-3): It possesses enhanced level of provitamin-A (6.89 ppm), lysine (2.56%) and tryptophan (0.63%). It contains high brix (16%). The average dehusked cob yield is 96.9 q/ha, with a potential of 147.2 q/ha. It is suitable for cultivation in NWPZ, NEPZ, PZ and CWZ during *kharif* season.

Ear and grain characteristics of PSSC-3

Pusa Waxy Maize Hybrid-1 (PWMH-1): It possesses high amylopectin (93.9% in starch). The average grain yield is 72.6 q/ha with a potential of 87.5 q/ha. It is suitable for cultivation in NWPZ during *kharif* season.

Ear and grain characteristics of PWMH-1

Pusa Male Sterile Baby Corn-3 (PMSBC-3): It is a male sterile-based baby corn hybrid developed through the transfer of CMS-T cytoplasm. It has an average dehusked cob yield of 14.1 q/ha with a potential yield of 20.5 q/ha. It is suitable for cultivation in CWZ zone during *kharif* season.

Ear characteristics of PMSBC-3

Pusa Early Hybrid Maize-6 (PEHM-6): It is an early maturing maize hybrid suitable for cultivation in CWZ during *kharif* season. It has an average yield of 81.8 q/ha with a potential yield of 110.0 q/ha. It is moderately resistant to Turcicum Leaf Blight (TLB), Maydis Leaf Blight (MLB), Curvularia leaf spot, charcoal rot, stem borer and fall army worm.

Grain characteristics of PEHM-6

Pusa Composite-5 (PC-5): It is an early maturing composite/ OPV suitable for cultivation in NHZ during *kharif* season. It has an average yield of 88.1 q/ha with a potential yield of 108.0 q/ha. It is resistant to *Fusarium* stalk rot and has moderate resistance to TLB and stem borers.

Grain characteristics of PC-5

Pusa Jawahar Hybrid Maize-1 (PJHM-1): It is a forage maize hybrid suitable for cultivation in CZ and Hill Zone (HZ) during *kharif* season. It has an average green fodder yield of 362.0 q/ha with a potential of 565.30 q/ha. Earlier, it was released for grain purpose in Madhya Pradesh for *kharif* season.

Fodder characteristics of PJHM-1

1.1.4.2 Hybrids identified for release

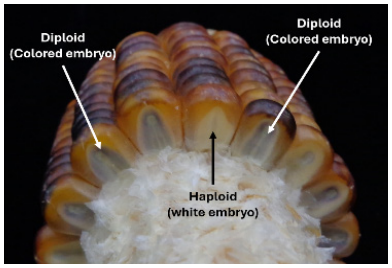
APTSKH-1: It is a sweet corn hybrid with enhanced level of provitamin-A (6.54 ppm) and α-tocopherol (21.7 ppm). APTSKH-1 contains high brix (15.3%). The average dehusked cob yield is 88.6 q/ha with a potential of 177.9 q/ha. It is suitable for cultivation in NWPZ, NEPZ, PZ and CWZ during *kharif* season.

AQWH-5: It possesses high amylopectin (93.5% in starch), lysine (4.06%) and tryptophan (0.89%). The average grain yield is 71.7 q/ha with a potential of 102.2 q/ha. It is suitable for cultivation in NWPZ, NEPZ, PZ and CWZ during *kharif* season.

APQWH-8: It possesses high amylopectin (95.2% in starch), provitamin-A (6.62 ppm), lysine (4.04%) and tryptophan (0.92%). The average grain yield is 83.9 q/ha with a potential of 118.4 q/ha. It is suitable for cultivation in PZ during *kharif* season.

1.1.4.3 Breeding for doubled haploids

Development of *indeterminate gametophyte 1 (ig1)* gene-based paternal haploid induction lines: The F_2 populations segregating for *ig1* were genotyped using gene-specific marker. Fertile plants with *ig1* homozygosity were selected. The selected paternal haploid inducer (HI) lines showed 0.5-2.5% haploid induction rate (HIR).

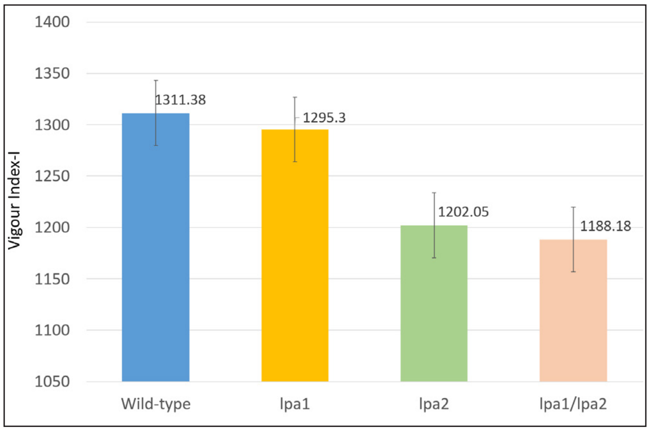


Haploid seeds (colourless embryo) generated using paternal HI lines

1.1.4.4 Breeding for nutritional quality traits

Development of hybrids with high methionine: Methionine levels among experimental hybrids varied from 0.058 to 0.306% with mean of 0.196%. Promising hybrids identified include MGU-MH-20 (methionine: 0.306%, grain yield: 8136 kg/ha), MGU-MH-17 (methionine: 0.269%, grain yield: 8178 kg/ha), MGU-MH-19 (methionine: 0.254%, grain yield: 8588 kg/ha), and MGU-MH-18 (methionine: 0.253%, grain yield: 9812 kg/ha).

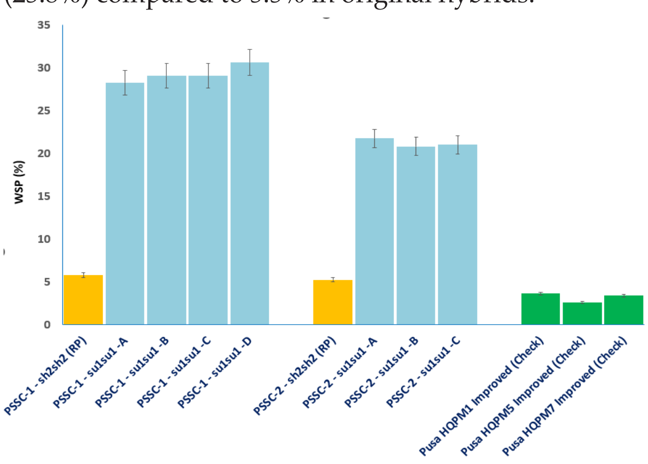
Evaluation of seed parameters in low phytic acid (*lpa*) inbreds: The novel double mutants (*lpa1/ lpa2*), respective single mutants (*lpa1* and *lpa2*) were evaluated along with the wild-type genotypes for seed germination and vigour. Germination of wild-type and *lpa1* was comparable, closely followed by *lpa2* and the double mutant (*lpa1* and *lpa2*). All types had similar trend in vigour index I and II.



Vigour index-I among wild-types and *lpa* mutants

1.1.4.5 Breeding for specialty maize

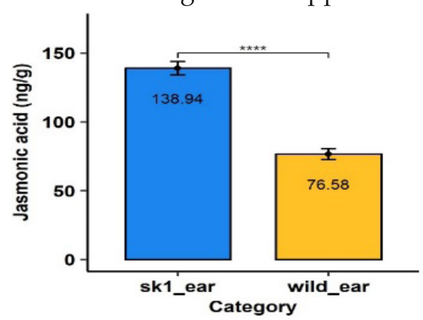
Development of maize hybrids with high phytoglycogen: Water soluble phytoglycogen (WSP) in maize kernel possesses industrial applications in cosmetic industry. Recessive *su1* gene was introgressed into four elite *sh2*-based parental lines (SWT-16, SWT-17, SWT-19 and SWT-20). Across environments, *su1*-based reconstituted hybrids possessed higher phytoglycogen (25.8%) compared to 5.5% in original hybrids.



WSP level in original-, improved- (*su1su1*) and check-hybrids

Biofortification of popcorn with essential amino acids: Biofortified popcorn versions of Pusa Pop Corn Hybrid-1 and Pusa Pop Corn Hybrid-2 with *o2* and *o16* were evaluated. Pusa Popcorn Hybrid-1-*o2o16* and Pusa Popcorn Hybrid-2-*o2o16* possessed 0.511 and 0.495% lysine compared to 0.174 and 0.206% in original hybrids, respectively. Pusa Pop Corn Hybrid-1-*o2o16* and Pusa Pop Corn Hybrid-2-*o2o16* recorded 0.128 and 0.135 tryptophan, respectively, over 0.040% and 0.034% in the original hybrids.

Characterization of sex determining genes: A total of 23 inbreds [*silkless1* (*sk1*)-, *tasselseed1(ts1)*, *tasselseed2 (ts2)* and *tasselssed4* (*ts4*) based and wild-type] were evaluated for nine agronomical traits, hormone profiles and molecular diversity. PMISL310 (*sk1*), PMISL326 (*ts2*), and PMISL330 (*ts4*) recorded higher yields (2713-2570 kg ha^{-1}). Hormonal profiling indicated elevated levels of jasmonic acid and reduced gibberellic acid in *sk1*-based mutant leading to silk suppression.



Concentration of Jasmonic acid in *sk1* based mutant and wild-type

1.1.4.6 Breeding for high grain yield

Identification of stable genetic resources for kernel-related traits: A total of 95 field corn genotypes were evaluated across two locations. Five genotypes *viz.*, C 70, DIM 310-R-1, PML 7, PML 73 and AI 578 were stable across the environments for kernel width and thickness. Considering both rASV and rYSI, AI 578 was the best-performing genotype that consistently showed superior kernel traits and stability across different environments.

1.1.4.7 Breeding for biotic stress resistance

Identification of hybrids with resistance to TLB: Among a set of 350 hybrids developed, H-2809, H-2837, H-2848, H-2850, H-2868, H-2873 and H-2893 were highly resistant to TLB with >10.0 t/ha of grain yield.

Identification of inbreds with resistance to diseases: PDI-44, PDI-117, PDI-639, PDI-638, PDI-647, PDI-1596, G-13, BGD-95, D-42, PDI-200, DIM-334, CDM-1345 and PDI-1506 were identified as stable sources of resistance to TLB. While, C-168, KRN-140, BGD-95, G-12, G-13, DIM-302, D-17, DIM-302, DIM-312 and PDI-639 were resistant to MLB and PDI-44, KRN-140, G-13, D-17, DMS-1 and PDI-639 were resistant to curvularia leaf spot.

Phenotypic contrast against infestation of MLB

1.2 MILLETS

1.2.1 Pearl Millet

1.2.1.1 Identification of hybrid for release

Pusa 2103: It is a dual-purpose, late-maturing biofortified pearl millet hybrid with high grain and dry fodder yield, well-suited for *kharif* cultivation. On an average, it yields 3420 kg/ha of grain and 108 q/ha of dry fodder yield. It possesses high degree of resistance to downy mildew, foliar blast, rust, smut and ergot. Pusa 2103 also recorded high grain iron (60 ppm) and zinc (37 ppm).

1.2.1.2 Identification of high protein and stable genotypes across environments

Evaluation of a diverse set of 250 pearl millet genotypes showed protein content in the range of 8.44 to 22.52%, with a grand mean of 14.65%. The AMMI analysis revealed significant genotypic variation and G×E interaction, with genotypes contributing the largest share of variance for protein content. G150, G211 and G143 consistently showed high protein content across the environments while G57, G209, G101 exhibited higher grain yield across all tested environments. Genotype selection index (GSI) aligned more closely with the GGE bi-plot analysis than with AMMI model in identifying superior genotypes. G218, G151, and G139 were consistently selected by four multi-trait models viz., MTSI, MGIDI, MTMPS, and FAI-BLUP and also showed good yields with early flowering.

1.3 GRAIN LEGUMES

1.3.1 Chickpea

1.3.1.1 Varieties released and notified

Pusa Chickpea 4037 (Pusa Chickpea Aswini): It is a superior chickpea cultivar amenable for mechanical harvesting. It has been released for NWPZ with potential yields up to 36 q/ha with wilt and AB resistance.

Grain characteristics of Pusa Chickpea 4037

BGD 133 (Pusa Sumangala): It is a short duration chickpea cultivar with average yield of 18 q/ha and potential yield of 27 q/ha. It has been released in Zone 3 & 8 of Karnataka state.

Grain characteristics of BGD 133

1.3.1.2 Varieties identified for release

Kota Desi Chana 4 (RKG 13-380): It is a superior desi chickpea variety identified for cultivation in Rajasthan with mean yield of 30 q/ha and resistance to wilt, early in maturity with 22.3% protein. It has been developed in collaboration with Agriculture University (AU), Kota and IARI, New Delhi.

Kota Desi Chana 5 (RKG 13-515-1): It is a superior desi chickpea variety identified for cultivation in Rajasthan with mean yield of 29 q/ha and resistance to wilt, dry root rot tolerance, with 19.3% protein. It has been developed in collaboration with AU, Kota and IARI, New Delhi.

1.3.1.3 Variety submitted for protection

Pusa Chickpea 4035 (BG 4035): It is an extra-large seeded kabuli variety suitable for cultivation in CZ. It flowers in 54 days and has a duration of 115 days. Due to its bold size and tolerance to wilt, it has a very high demand for export and domestic market, fetching farmers' premium price.

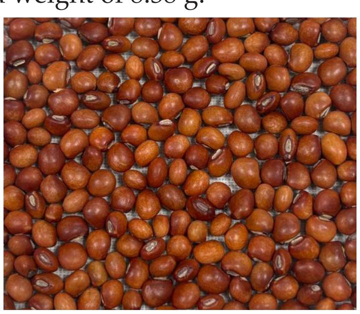
Grain characteristics of Pusa Chickpea 4035

Dry root rot (DRR) tolerant high yielding chickpea lines: Seven lines (SSD 718-46, SSD 11-72, SSD 12-81, SSD 11-43, SSD 718-41, SSD 718-40 and SSD 718-42) were promising for DRR, with disease incidence of less than 10% and grain yield of more than 18 q/ha.

1.3.2 Pigeonpea

1.3.2.1 Varieties released and notified

Pusa Jawahar Arhar Dwarf 22-01: It has dwarf plant type (84.40 cm) with early (132-138 days) and synchronous maturity suitable for mechanical harvesting. The dwarf stature facilitates spraying of insecticide. It is suitable for cultivation in Madhya Pradesh and gives an average yield is 17.9 kg/ha with a potential yield of 22.0 q/ha. It has 100 seed weight of 8.38 g.



Grain characteristics of Pusa Jawahar Arhar Dwarf 22-01

Pusa Jawahar Arhar 22-02: It is a semi-erect and semi-dwarf (92-95 cm) determinate variety with early (125-128 days) and synchronous maturity suitable for high density planting (45 × 20 cm) and mechanized cultivation. It is suitable for cultivation in Madhya Pradesh and has a mean yield of 18.6 q/ha with a potential yield of 18.8 q/ha. It has 100 seed weight of 7.42 g.

Grain characteristics of Pusa Jawahar Arhar 22-02

Pusa Jawahar Arhar 21-29: It has semi-erect medium tall plant type, early (138 to 142 days) and synchronous maturity with bold seeds (12.98 g/ 100 seed weight), and is suitable for mechanized cultivation. It is suitable for cultivation in Madhya Pradesh. It has mean yield of 19.2 q/ha with a potential of 19.5 q/ha.

Plant and pod characteristics of Pusa Jawahar Arhar 21-29

1.3.3 Mungbean

1.3.3.1 Varieties released and notified

PSM 12: It is a first mungbean variety recommended for sodic (usar) soil and has been released for cultivation in Uttar Pradesh. The average yield is 6.3 q/ha with maturity of 70 days. It is moderately tolerant to heat stress and resistant to MYMV.

Plant and pod characteristics of PSM 12

1.3.4 Lentil

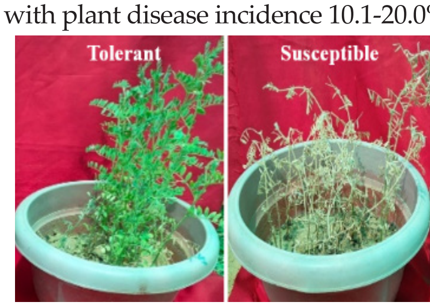
1.3.4.1 Varieties released and notified

L 4717: It is a short duration lentil variety notified and released for Bihar. It matures in 100 days and has medium size grain (2.5 gm/100 seed). The average yield is 16.0 q/ha and has a grain Fe concentration of 65 ppm. It is tolerant to wilt and rust. It was earlier released for CZ.

Grain characteristics of L 4717

1.3.3.3 Screening of lentil genotypes for resistance to dry root rot (DRR) disease

A set of 500 lentil germplasm lines were evaluated against the pathogen (*Fusarium sp.)* at seedling stage under controlled condition using sick pot method. Seven genotypes, IC201541, IC553082, IC 241429, IC 241152, IC 299645, IC 355616 and IC 283423 were found to be resistant with plant disease incidence <10%. Two genotypes, IC201534 and IC201542 were found to be moderately resistant with plant disease incidence 10.1-20.0%.



Phenotypic response of resistant and susceptible genotypes to DRR

1.3.4.3 Characterization of Indian mini core lentil collection for tannin concentration

A mini-core set of 150 lentil germplasms developed at ICAR-NBPGR, New Delhi showed tannin content in the range of 91.93-419.00 ± 50.0 mg/100g DW. Genotypes identified with high tannin (>300 mg/100g DW) include IC-267668 and IC-201548. However, IC-53237, IC-384473 and IC-39675 exhibited low tannin (<200 mg/100g DW).

1.4 OILSEEDS

1.4.1 Mustard

1.4.1.1 Variety released and notified

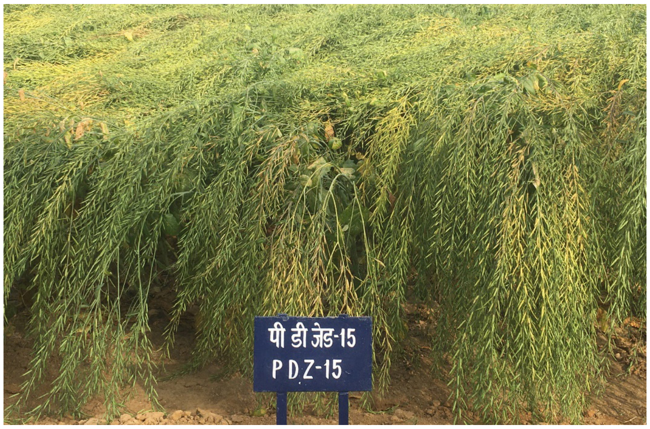
Pusa Mustard 37: It is a high-yielding variety of Indian mustard suitable for cultivation under timely sown irrigated conditions. Its average seed yield was 2641 kg/ha in Zone-II and 2683 kg/ha in Zone-III. It has extra bold seeds and wider adaptability, which takes about 145 days to mature in Zone-II and 134 days in Zone-III.

Grain characteristics of PM-37

Pusa Double Zero Mustard 33: It is double zero variety, possessing <2% erucic acid in the oil and <30 ppm total glucosinolates. It is now notified for cultivation in Kashmir, Himachal Pradesh and Western Uttar Pradesh. Average seed yield of this variety is 2644 kg/ha with 38% oil content in its seeds. It also possesses inbuilt resistance against white rust disease. It was earlier released for Rajasthan, Punjab, Haryana and Delhi.

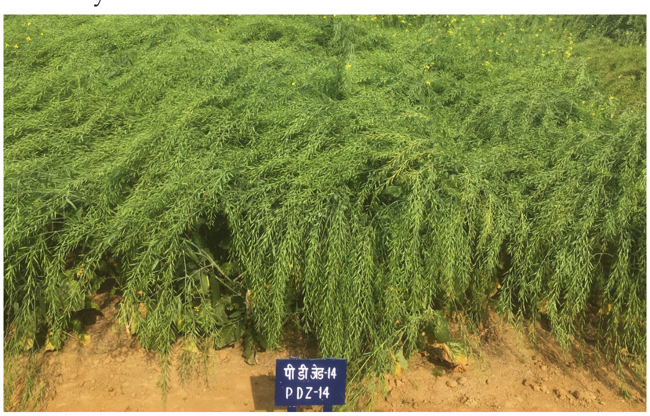
Pod View of Pusa Double Zero Mustard 33

Pusa Double Zero Mustard 35: It is a yellow seeded double zero Indian mustard variety, low in erucic acid (<2%) and glucosinolates (<30 ppm). It is now notified for cultivation in Delhi and Chhattisgarh. The average seed yield of this variety is 2148 kg/ha and it matures in ~132 days. It was earlier released for Zone-III.



Field view of Pusa Double Zero Mustard 35

Pusa Double Zero Mustard 36: It is a yellow seeded double zero Indian mustard variety, low in erucic acid (<2%) and glucosinolates (<30 ppm). It is now notified for cultivation in Delhi and Chhattisgarh. The average seed yield of this variety is 2148 kg/ha and it matures in ~132 days. It was earlier released for Zone-III.



Field view of Pusa Double Zero Mustard 36

1.4.1.2 Variety identified for release

Pusa Mustard-38: It is identified for timely sown irrigated conditions of Zone-II (Jammu, Punjab, Haryana, Delhi, Western Uttar Pradesh and Northern Rajasthan). It is a high yielding variety of mustard with an average yield of 2805 kg/ha. It has an average 1000-seed weight of 5.45g and takes about 145 days to mature.

Breeding for white rust and/or powdery mildew resistance: A diverse panel of 96 Indian mustard accessions was repeatedly screened for white rust resistance under natural epiphytotic conditions at Wellington over 15 consecutive seasons. Notably, seven accessions viz., WRW 28, WRW 34, WRW 38, WRW 41, WRW 71, WRW 142 and WRW 151 consistently expressed resistant reactions across all seasons. The newly identified white rust-resistant source, WRW 28 and the previously identified powdery mildew resistant donor, PMW 18 were utilized in the crossing programme. Consequently, 15 white rust-resistant and six white rust and/or powdery mildew-resistant advanced breeding lines (>F_8) have been developed and are currently under evaluation for agronomic traits.

1.4.2 Soybean

1.4.2.1 Varieties released and notified

Pusa Soybean 6: It has high oil content (20.08%), and matures in 120-125 days. It has resistance against yellow mosaic virus (YMV), *Rhizoctonia* aerial blight (RAB) and bacterial pustule (BP). It provides an average yield of 21.0 q/ha and has now been also released for Haryana and Punjab. It was earlier released for NCT of Delhi.

Grain characteristics of Pusa Soybean 6

Pusa Soybean 21: This is the first ever specialty soybean variety for North India and is free of Kunitz Trypsin Inhibitor (KTI). It has high protein (36.90%) and oil (23.69%) and shows resistance against major diseases such as YMV, Soybean Mosaic Virus (SMV) and Bud Blight (BB), and is moderately resistant to stem fly. It matures in 113 days. It was earlier released for NCT of Delhi.

Pod characteristics of Pusa Soybean 21

1.4.2.2 Seedling screening for rust resistance

A set of 30 exotic soybean lines along with JS335 (susceptible check) were screened at seedling stage against rust isolates collected from 10 different locations. Lesion types were recorded as RB (reddish-brown, resistant) and Tan (susceptible). PI 567104B showed RB reaction at 9 out of 10 locations, PI 594760B recorded RB at nine locations, PI 567046A exhibited RB at 8 locations, PI 567099A expressed RB at six locations and Rust-29 recorded RB at 6 locations.

1.4.2.3 Identification of genotypes with yield and yield related traits in interspecific RILs

A set of inter-specific RILs (*Glycine max* × *G. soja*) viz., RIL15-2-1, RIL15-2-3, RIL15-48-1, RIL8-21-5, RIL2-24-4, RIL8-26-3, RIL7-17-1, RIL25-4-1, RIL7-12-3, RIL8-27-1, RIL9-14-1, RIL13-2-2, RIL14-15-1, RIL 15-43-1, RIL24-29-3 and RIL7-33-11 were identified to be promising based on yield and yield related traits including resistance to YMV disease.

Lines with extra-high number of pods/plant: Two inter-specific RILs viz., IS-1 and IS-2 were selected for having more than 700-1000 pods/plant.

1.5 SEED SCIENCE AND TECHNOLOGY

1.5.1 Studies on Seed Quality Traits

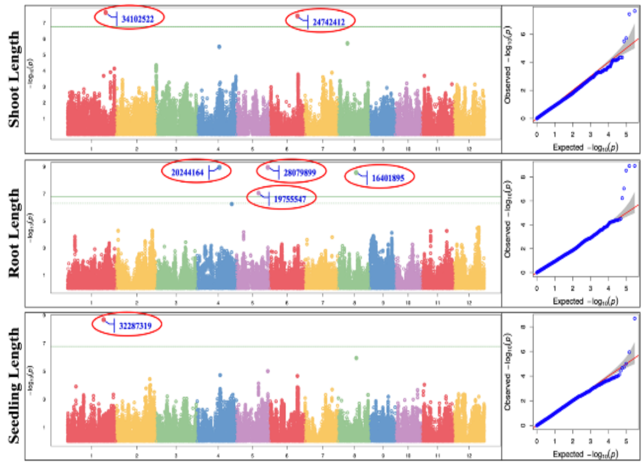
1.5.1.1 Seed viability

A ready-to-use, farmer-friendly kit, the *SpeedySeed™ Viability Kit*, with >90% accuracy, was designed for rapid viability assessment (4.5-12 h) in nine crops (maize, wheat, rice, soybean, lentil, green gram, pumpkin, cucumber, and broccoli). It is based on the principle of faster rate of respiration in viable seeds compared to non-viable seeds. The differential CO_2 release alters the colour of the indicator solution at varying rates, green or yellow for viable seeds, while it remains blue for non-viable seeds.

Colorimetric characterization of viable and non-viable seeds and SpeedySeed Vibaility Kit

1.5.1.2 Seedling vigour

A set of 271 rice accessions of 3KRGP was classified as short (ShL <12.4 cm, RL <17.4 cm, SdL <30.2 cm), intermediate (ShL 12.4-16.1 cm, RL 17.4-21.8 cm, SdL 30.2-37.5 cm), and tall (ShL >16.1 cm, RL >21.8 cm, SdL >37.5 cm), based on 14-day-old seedling shoot length (ShL), root length (RL), and seedling length (SdL). Of these, 69% were in the intermediate category, and 15% each were short and tall. Genome-wide association analysis revealed three potential candidate genes for shoot length (*OsPIN9*, *OsCycB1* and *OsTub16*), four for root length (*OsPK*, *OsNIN4*, *OsWOX9C* and *OsPPDKB*) and one for seedling length (*OsGH3.2*).



Manhattan plot of BLINK model of GWAS for seedling vigour traits in rice

1.5.1.3 Seed dormancy

Rice: The relationship between seed dormancy and vigour was examined among 295 rice genotypes, including 83 released varieties and 212 germplasm from the 3K rice panel. Dormancy traits, intensity (IOD) and depth (DOD) showed a highly significant ($p < 0.001$) but mild negative association with vigour traits (t50, MGT, TMGR, AUC and U9010) across all maturity groups. Medium (121-140 days) and late (141-160 days) maturity genotypes exhibited significant negative associations, whereas early (101-120 days) and very late (>180 days) groups showed non-significant associations. DOD displayed a stronger correlation with vigour in medium and late-maturity genotypes.

Cucumber: Seed dormancy in cucumber varied from 0-4 months across different sex expression phenotypes. Dormant genotypes (Pusa Barkha and Pusa Uday) had higher phenolic content, thicker seed coat, and reduced enzymatic and antioxidant activity compared to non-dormant genotypes (DC 307). In dormant genotypes, GA levels increased through upregulation of *CsGA3ox1* and *CsGA3ox2*, lowering the ABA/GA ratio after four months of after-ripening.

1.5.2 Seed Quality Enhancement

Maize inbreds: The optimum priming duration was determined using *Uniprime* technology for three maize inbreds with contrasting vigour and ageing. The low-vigour fresh lot (PML93) required 56 h, the high-vigour fresh lot (PML105) required 36 h, and the 18-month-aged genotype (IC253995) required 54 h to reach the second phase of imbibition suitable for priming. Seed priming with mimosine (100 μM), among various cell cycle inhibitors, effectively maintained higher germination (48%) after 10 days of controlled ageing at 35 °C and 75% RH, compared to the control (21%). The seed vigour index of mimosine-primed seeds (667) showed no significant decline after ageing relative to the initial vigour (782). The effect was more pronounced in the 18-month aged seed lot (IC253995) than in the fresh seed lots.

Specialty maize: Microbial seed coating with a cyanobacterial consortium (BF1-4) and *Anabaena* with *Providencia* sp., applied alone or in combination with chemical seed treatments (Gaucho @ 10 ml/kg seed and Thiram @ 3 g/kg seed), along with 75% of the recommended N and the full dose of P and K, enhanced performance of Pusa HQPM5 Improved. Improvements were observed in seed germination (6.5%), vigour (5.5%), seedling emergence (23%), plant stand establishment (19.5%), plant height (12%), and seed yield (3.25%). Microbial seed coating also improved soil fertility, organic carbon, and nutrient availability. Additionally, coated seeds exhibited better storability, with microbial viability retained for up to six months under ambient conditions.

Onion: The relative efficacy of seed priming treatments was evaluated in fresh and carryover seed lots of two onion genotypes, Pusa White Round and Pusa Red. Seed quality was first enhanced through specific gravity separation, with the heaviest fraction selected for priming. The seed lots were then subjected to osmo-priming at different water potentials (-0.2, -0.5, -1.0, and -1.5 MPa) and magneto-priming (100 mT for 30 minutes) using an electromagnetic field generator (Testron EM-60). Osmo-priming at -1.0 MPa and magneto-priming at 100 mT for 30 minutes proved most effective, promoting rapid and uniform germination and improving the planting value of onion seeds.

Green gram: Seed coating with microbial formulations (BF1-4 cyanobacterial consortium, *Anabaena laxa*, and An-Tr biofilm) was evaluated in green gram for seed yield and quality attributes, comparing 75% of the recommended nitrogen dose (RDN) with the control (recommended seed treatment without microbial formulation and 100% RDN). Microbial coatings showed a positive correlation with seed germination, field emergence, plant height, leaf chlorophyll content, bulk yield, yield-attributing traits, root parameters, and seed storability. However, microbial seed coating had no significant effect on the germination or quality parameters of the next-generation seeds. Coated seeds exhibited improved storability, maintaining germination and vigour for up to six months.

1.5.3 Seed Production Technology

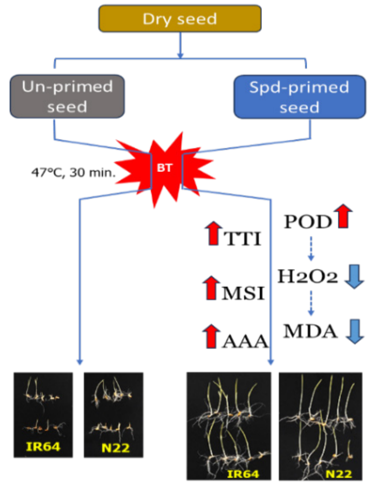
Cucumber: The seed production technology of Pusa Gynoecious Parthenocarpic Cucumber Hybrid-1 was standardized under protected cultivation. The spring-summer season was identified as the most suitable period for hybrid seed production. Planting the male parent 10 days before the female parent improved nicking. A row ratio of 3:1 (female: male) at 90 cm × 60 cm spacing was found optimal. Higher fruit and seed yields were achieved by pollinating the female line within 4 hours of anthesis. A fruit load of three fruits per vine was optimal for seed yield and quality. Using this technology, a hybrid seed yield of 1-1.2 kg can be obtained from a 100 m² net house, with a benefit-cost ratio of 1.2:1.

1.5.4 Abiotic Stresses and Their Mitigation

1.5.4.1 Heat stress

Rice: A total of 328 rice genotypes from the Rice Diversity Panel-1 (201), 3K panel (118), and released varieties (9) were screened for basal thermotolerance (BT) at the germination stage. Mean germination declined from 94.96% in the control to 21.08% under severe heat stress (HS). However, mild acclimation (thermopriming) enhanced mean germination to 84.3% even under HS. Using the multi-trait genotype-ideotype distance index (MGIDI), 49 heat-tolerant genotypes were identified based on 12 seed germination and vigour parameters under HS. All traits exhibited high heritability (>0.8 h²mg). Among them, BT G_{max} (positively desired), Acquired Thermotolerance Index (newly derived, negatively desired), and BT-Relative Mortality (negatively desired) exhibited very high selection differentials. These identified genotypes can be used in population development and breeding programs to improve heat-stress tolerance during germination.

Seed priming with 1 mM spermidine (Spd) using a 0.1 MPa PEG solution effectively mitigated the adverse effects of HS during rice seed germination. A study comparing a tolerant variety (N22) and a susceptible variety (IR64) under heat stress (47 °C for 30 min) revealed significant differences in normal seedling (NS) between N22 (57.5%) and IR64 (22.5%) before priming. However, these differences disappeared after Spd priming, with NS percentage increasing to 92.5% and 95%, respectively. Spd priming significantly reduced ROS (H_2O_2) production (1.5-fold) and malondialdehyde content (1.3-fold) by enhancing antioxidant enzyme activity, such as peroxidase (2-fold), compared to the control. Primed seeds also exhibited improved membrane stability (1.2-fold), thermotolerance index (1.6-fold), and α-amylase activity (1.3-fold), resulting in better seedling growth under heat stress.



1.5.4.2 Biochemical basis of thermotolerance induced by wheat seed priming with melatonin

Wheat: Germination tests identified 36 °C as the appropriate temperature for imposing heat stress. Melatonin (50 mg/L for 12 h) seed priming enhanced germination and increased activities of key enzymes (dehydrogenase, α-amylase, catalase, peroxidase, and superoxide dismutase), indicating improved metabolic activity under heat stress. It also reduced malondialdehyde and H_2O_2 levels, reflecting lower oxidative damage; genotype RAJ 3765 showed the highest response, while HD 2932 and HD 2967 were less responsive. Seed priming improved seedling emergence, stand uniformity, booting, and flowering under both timely and late-sown conditions. Foliar melatonin application was more effective than priming, enhancing chlorophyll content, water retention, membrane stability, yield traits, and overall productivity.

1.5.4.3 Cold stress

Maize: Low-temperature stress during germination hampers field establishment in maize during early spring and winter. Following initial screening for germination and vigour traits at 10 °C, 15 °C, and 20 °C, three tolerant (MGU-COLD3, MGU-COLD5 and MGU-COLD7) and three susceptible (MGU-COLD1, MGU-COLD6 and MGU-COLD10) lines were selected. At 10 °C, tolerant lines maintained significantly higher germination (60-75%) and vigour (VI-I: 1047, VI-II: 7010, MGR: 0.15, MGT: ~7 days) compared to susceptible lines (≤35% germination, VI-I: 117, VI-II: 824, MGR: <0.11, MGT: >9 days). They also exhibited superior root traits and higher enzymatic and antioxidant activities with lower H_2O_2 accumulation. The tolerant lines can be utilized in breeding programmes to develop low-temperature-tolerant hybrids for cultivation under sub-optimal conditions.

1.5.5 Seed Health

Lentil: Indigenous rhizospheric microbes act as broad-spectrum biocontrol agents for disease management. Of the 40 fungi and 30 bacteria isolated from lentil rhizosphere soil, three fungal isolates (*Trichoderma harzianum*, *Trichoderma asperellum* and *Talaromyces flavus*) and two bacterial isolates (*Pseudomonas fluorescens* and *Bacillus subtilis* consistently inhibited *Fusarium oxysporum* f. sp. *lentis*, *Rhizoctonia solani*, and *Botrytis cinerea*. These isolates also exhibited multiple biocontrol and plant growth-promoting traits, including hydrolytic enzyme activity, siderophore production, hydrogen cyanide (HCN), ammonia release, phosphate solubilization, and indole-3-acetic acid (IAA) synthesis, highlighting their potential as promising candidates for biocontrol formulation development.

Soybean: In field-infected soybean cultivars, *Carlavirus vignae* causing soybean vein necrosis and bud blight exhibited seed transmissibility for up to two generations. Moreover, mechanical sap inoculation was successfully achieved in cowpea cultivars, Arka Samrudhi and Arka Suman.

2. HORTICULTURAL SCIENCES

The horticulture sector in India is a major driver of agricultural growth, contributing approximately 33% to the agricultural gross value-added product. During 2024-25, the production has reached a record 367.72 million tonnes, surpassing food grain production. Horticultural crops ensure nutritional security, generate employment, aid in crop diversification and boosts farmers' income. The School of Horticultural Sciences focuses on development of trait-specific genetic resources, improved varieties and hybrids, cost effective production technologies, efficient input management, post-harvest management and value addition of horticultural crops. Several improved varieties, hybrids and genetic stocks in different horticultural crops have been developed, leading to increased productivity.

2.1 VEGETABLE CROPS

Notification and release of varieties/F_1 hybrids

Varieties/hybrids released by AICRP (Vegetable Crops) and notified by CVRC

Pusa Gynoecious Cucumber Hybrid-1301: It is an early-maturing hybrid notified by the Central Variety Release Committee (CVRC) for Zone I (H.P., J&K and Uttarakhand). Fruits become ready for first harvesting in 40-45 days after planting. It is suitable for open-field cultivation during the Spring–Summer and *Kharif* seasons. Fruits are light green with black spines, 15-17 cm long with average fruit weight of 213.5 g. Average yield is 46.49 t/ha.

Pusa Gynoecious Cucumber Hybrid-1301

Pusa Red Cherry Tomato-3: It is an indeterminate variety suitable for protected condition, notified for Zone I (H.P., J&K and Uttarakhand) and bears on average 18 fruits per cluster in two rows of fruits/ cluster. Fruits are 12 g in weight, acidic in taste with total soluble sugars (TSS) of 9 °Brix, lycopene 8 mg/ 100 g and ascorbic acid 35 mg/100g of fresh fruit. Average yield is 6.0 q/100m^2 area of polyhouse.

Pusa Red Cherry Tomato-3

Pusa Red Cabbage-5: This open-pollinated variety was notified by the CVRC for release for Zone-I (H.P., J&K and Uttarakhand). It has 10-12 non-wrapping, purplish and waxy leaves. Head is round in shape, very compact and covered with outer leaf and ready for harvest in 80-85 days after transplanting. It has 25-30 days field staying capacity. Average yield is 21 t/ha.

Pusa Red Cabbage-5

Varieties identified for release in the 43rd Annual Group Meeting of AICRP (VC)

KTCF-36: This open-pollinated variety of snowball cauliflower was identified for release in Zone-I (H.P., J&K and Uttarakhand).

KTCFH-534: At the National level, this is the first Cytoplasmic Male Sterile (CMS) based hybrid of snowball cauliflower, which was identified for release in Zone-I (H.P., J&K and Uttarakhand).

KTHB-3411: It is the first CMS based hybrid of broccoli from public sector in India and was identified for release in Zone-I (H.P., J&K and Uttarakhand), Zone-VI (Delhi, Haryana & Rajasthan) and Zone-VII (Madhya Pradesh & Maharashtra).

KTCBH-225: This CMS-based hybrid of cabbage has been identified for release in Zone-I (H.P., J&K and Uttarakhand).

KTTCH-804: This CMS-based hybrid of temperate carrot was identified for release for Zone-I (H.P., J&K and Uttarakhand).

2.1.1 Solanaceous Crops

2.1.1.1 Tomato

Promising hybrids and selections under polyhouse: DTPH-1 recorded a yield of 1.8 t/100 sq.m. area, followed by NS-4266 (1.75 t). Red Cherry Selection-1 recorded maximum TSS (11.0 ^{o}Brix), followed by Orange Cherry Selection 530 (9.0 ^{o}Brix).

Development of MABB-derived ToLCD-resistant varieties and hybrids: MABB lines were used in the development of Pusa Tomato Hybrid-6, Pusa Cherry Tomato Hybrid-1, Pusa Processing Tomato Hybrid-1, Pusa Tomato Hybrid-7 (Pusa TOLCV Hybrid-8) and Pusa Heat Tolerant Tomato-1 (Pusa Improved Sadabahar-1).

Popularisation of new varieties: The varieties Pusa Protected-1, Pusa Cocktail Tomato, Pusa Golden Cherry-2 and Pusa Cherry Tomato Hybrid-1 were popularised and seed chain was established. NSC has produced 50 kg of seeds of Pusa Prasanskrit.

Registration of tomato genetic stock: PTS-25 was registered by NBPGR (INGR25113) for high yield, low seed content and moderate tolerance to ToLCV.

PTS-25 in bearing stage and harvested fruits

2.1.1.2 Brinjal

Resistant genotypes to *Fusarium* wilt: Ninety accessions, including wild relatives, were screened for resistance to *Fusarium oxysporum* f. sp. *melongenae* under sick plot, pots and hydroponics, using multiple disease scoring methods. Genotypes G-204, Punjab Sadabahar and Guhela Local exhibited a highly susceptible reaction, while Swarna Mani, G-17, Sidhasar Local, Pink, H-183, CH-151, Special Muktokashi, DBR-160-2-3-13, EC-384970, *S. sisymbrifolium* (DWBsisy-1) and *S. torvum* (DWBtorv-1) consistently showed resistance across all environments.

H-183

Pink

Sidhasar Local

CH-151

Swarna Mani

Promising lines and hybrids: The line DBPML-101 was found most promising, yielding 35.7 t/ha during *kharif* season, which is 27.5% superior to check Pusa Purple Long (28 t/ha). The fruits are 12-15 cm long, shiny pink with non-spiny green calyx, weighing 70-80 g, and are ready for first harvest in 50-55 days after transplanting. In the round fruit segment, the hybrid DBHR-2519 was promising, yielding 59.5 t/ha, a 35.2% increase over the check Pusa Hybrid-6 (44 t/ha). The fruits are round, glossy, purple, with green calyx and weigh 150-180g. In the long fruit segment, the hybrid DBHL-2510, with a yield of 57.4 t/ha was found promising, having a 22.1% increase over the check Pusa Unnat (47 t/ha). Its fruits are long (18-20 cm), shiny, purple, weigh 105-110g, and have a non-spiny green calyx.

DBHL-2510 **DBHR-2519**

2.1.1.3 Chilli

Promising lines: DChBL-92 and DChBL-257 retained over 70% capsanthin, while DChBL-203 and DChBL-53-4 maintained over 90% of initial capsaicin, highlighting their potential as donors for pigment and pungency stability. Segregating generations (F_4–F_7) were advanced for heat tolerance and leaf curl disease tolerance.

Development of breeding material for drought/ moisture tolerance: PCS-BBL-1 was identified as a drought-tolerant genotype. This line consistently exhibited relatively higher total flavonoids (1300 mgQE/g DW), relative water content (40-50%), higher photosynthetic rates (10-15 μmolm^{-2}s^{-1}, higher chlorophyll levels (≈5-10 mg/g fresh leaf), high proline content (70-90 μmol/gDW), high total phenols (≈3mg GAE/gFW) and with optimum yield (17 t/ha) under drought conditions.

Screening of genotypes for yield and capsaicin content: Among the sixteen genotypes evaluated, capsaicin content was maximum in PCS-43 with 1014.04 μg/g DW, followed by EC787067 (944.27 μg/g DW) in comparison to check Pusa Jwala (315.45 μg/g DW) and Kashi Anmol (105.30 μg/g DW). Green chilli yield was found maximum in PCS-14-1 (20 t/ha) and PCS-BBL-1 (17 t/ha).

PCS-BBL-1 **PCS-43** **PCS-14-1**

Promising chilli genotypes

2.1.1.4 Capsicum

Evaluation of coloured capsicum germplasm under protected conditions: The genotypes KTGC-4 (Green) (46.81 t/ha), followed by KTYC-3 (Yellow) (40.04 t/ha), KTGC-9 (Green) (39.05 t/ha), and KTOC-4 (Orange) (38.79 t/ha) performed better over the check cultivars Pusa Capsicum-1 (Green) (36.21 t/ha) and California Wonder (Green) (33.77 t/ha).

KTGC-4 **KTYC-3** **KTGC-9** **KTOC-4**

Promising genotypes of coloured capsicum

Promising hybrids: The hybrids KTRC-6 × KTRC-11 (31.63 t/ha), KTOC-3 × KTGC-9 (29.74 t/ha) and KTOC-3 × KTRC-6 (28.54 t/ha) performed better over the check cultivar Asha (25.42 t/ha).

2.1.2 Cole Crops

2.1.2.1 Indian cauliflower

New promising hybrids: In early cauliflower, promising F_1 hybrids were DCEH-111, DCEH-192 and DCEH-411 for September (>15 t/ha); DCEH-155, DCEH-301, DCEH-126 and DCEH-209 for October (>20 t/ha) and DCEH-300, DCEH-303, DECH-118, DCEH-211 and DCEH-128 for November (>25 t/ha) maturity groups. Four F_1 hybrids, namely DCEH-9830, DCEH-990, DCMH-84161 and DCMLH-8411 were contributed to AICRP-VC.

Promising hybrids of orange cauliflower: DoCFH-15419, DoCFH-24 and DoCFH-529819 of mid-early group (>15 t/ha) and DoCFH-7619, DoCFH-1808 and DoCFH-8404 of mid-late group (>25 t/ha) were promising.

Promising hybrids of purple cauliflower: DpCMH-6783 and DpCMH-6736 were promising for November maturity (17.0 t/ha).

2.1.2.2 Snowball cauliflower

Promising CMS and inbred parental line-based hybrids: Twelve F_1 hybrids (12 nos.) performed better than the check cultivars *viz*., 'Pusa Snowball Hybrid-1 (PSBH-1)', 'Pusa Hybrid-301' and 'Geiwont' with a heterosis range of 12.98-35.08, 14.82-37.29 and 0.30-19.92%, respectively and were found suitable for harvesting during the 1st-4th week of March.

KTCF-46B × KTCF-80A

KTCF-82A × KTCF-40B

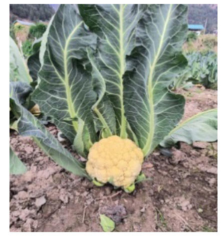
KTCF-80A × KTCF-33B

KTCF-82A × KTCF-26B

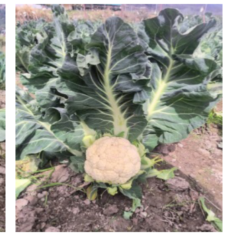
Promising CMS and inbred parental lines-based hybrids of snowball cauliflower

Promising CMS and DH parental line-based hybrids: Nine hybrids performed better than the check 'Pusa Snowball Hybrid-2 (PSBH-2)' with a heterosis range of 5.93-25.95% and were found suitable for harvesting during 2nd week of February to 3rd week of March.

KTCF-55A × KTCF-DH-11B

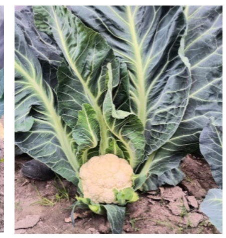


KTCF-75A × KTCF-DH-4B



KTCF-65A × KTCF-DH-4B

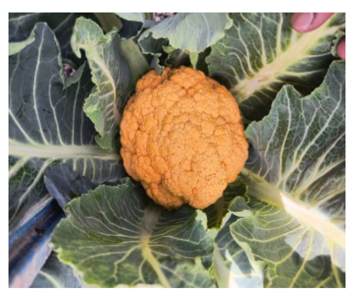
KTCF-59A × KTCF-DH-9B



PSBH-2 (Check)

Promising CMS and DH parental lines-based hybrids of snowball cauliflower

Introgression of β-carotene ('*Or*' gene) and anthocyanin ('*Pr*' gene) rich genes: BC_7 population of the introgressed β-carotene (*Or*) & anthocyanin (*Pr*) rich genes into different genotypes of snowball cauliflower (Pusa Snowball K-1 & Pusa Snowball K-25) was developed.



Orange cauliflower (BC_7)

Purple cauliflower (BC_7)

Evaluation of promising hybrids in multi-location yield trials: Nine promising F_1 hybrids were evaluated along with three check cultivars at three different locations viz., Katrain, New Delhi and Solan during winter 2024-25. The tested hybrids revealed a heterosis range of 13.17-34.02, 15.02-36.21 and 0.47-18.98% over the check cultivars, Pusa Snowball Hybrid-1 (PSBH-1), Pusa Hybrid-301 (PH-301) and Giewont, respectively. All the tested hybrids were found suitable for harvesting during 4th week of January to 4th week of March.



2024/KTCFH-5570 2022/KTCFH-6841 2024/KTCFH-7242


2023/KTCFH-774 2022/KTCFH-5137

Promising cauliflower hybrids in multi-location yield trials

2.1.2.3 Broccoli

Promising genotypes and hybrids of tropical broccoli: DC-Brocco-13 (15.8 t/ha), DC-Brocco-26 (14.9 t/ha) and DC-Brocco-25-5 (14.5 t/ha) were found promising for head yield. Three CMS-based hybrids DBrH-17 (19.7 t/ha), DBrH-17 (18.6 t/ha) and DBrH-9 (17.9 t/ha) were found promising for December maturity.

Evaluation of CMS-based F_1 hybrids: Broccoli hybrids (120 nos.) were evaluated for yield and horticultural traits, with Saki (F_1) and Lucky (F_1) as checks at IARI RS, Katrain. Hybrid 676710A × VCH (30.48 t/ha), followed by VCHA × BL-1, L-5 (30.03 t/ha), KTSA × BL-1, L-5 (28.67 t/ha), VCHA × SMD (28.28 t/ha) and VCHA × BL-2, L-217 (28.28 t/ha) gave significantly higher yield with 51.46, 49.51,42.72, 40.78, 40.78% increase, respectively, over the best check Lucky (20.09 t/ha).



676710A × VCH VCHA × BL-1, L-5 KTSA × BL-1, L-5


VCHA × SMD VCHA × BL-2, L-217

Promising CMS-based F_1 hybrids of broccoli

2.1.2.4 Cabbage

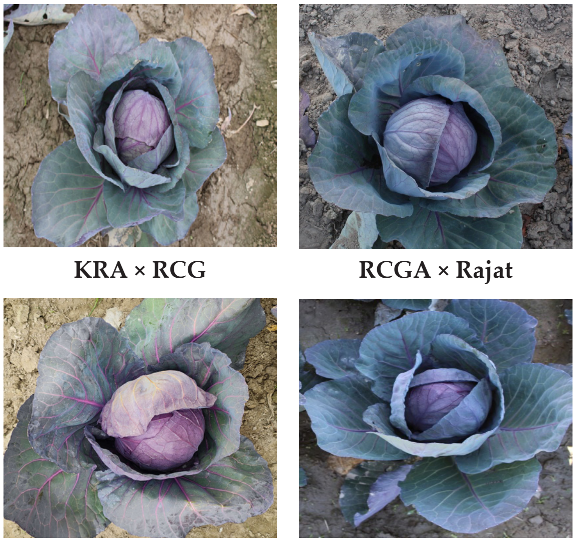
Evaluation of CMS-based F_1 hybrids: At ICAR-IARI Regional Station, Katrain, among 84 F_1 hybrids of white cabbage, the promising combinations for yield over the standard check Pusa Hybrid-82 (50.12 t/ha) were 5A × Chakki-2 (66.89 t/ha), 9A × Sel-5-KIRC-10 (64.55 t/ha), Sel-5-83-6A × EC-90 (62.99 t/ha), 6A × EC-48 (61.43 t/ha) and 9A × 51-17 (61.23 t/ha) showing a per cent increase of 33.46, 28.79, 25.68, 22.57 and 22.18, respectively.


5A × Chakki-2 9A × Sel-5-KIRC-10


Sel-5-83-6A × EC-90 6A × EC-48

Promising CMS-based F_1 hybrids of white cabbage

In red cabbage, the hybrids, KRA × RCG (48.70 t/ha), RCGA × Rajat (43.68 t/ha), RCGA × PoARC (39.00 t/ha), KRA × PoARC (35.10 t/ha) and RCGA × (RCG × RC-1) (31.20 t/ha) recorded significantly higher marketable yields over the check, Pusa Red Cabbage Hybrid-1 (27.61 t/ha) with 76.37, 58.19, 41.24, 27.12 and 12.99% increase, respectively.



KRA × RCG | RCGA × Rajat | RCGA × PoARC | KRA × PoARC

Promising CMS-based F_1 hybrids of red cabbage

2.1.3 Cucurbitaceous Crops

2.1.3.1 Cucumber

Genetics of Leaf Curl disease resistance: Genetic analysis revealed that resistance to *Tomato leaf curl New Delhi virus* (ToLCNDV) in genotypes DC-91 and DC-61 is governed by a single recessive gene.

Promising gynoecious and parthenocarpic hybrids: The gynoecious hybrids DGCH-143 and DGCH-148 yielded 27.8 t/ha and 28.8 t/ha, respectively, as compared to National check Pant Sankar Khira (18.6 t/ha) and are under AVT-II testing. The hybrids IMPUCH-143 and IMPUCH-148 are also under AVT-II stage of AICRP (VC).

2.1.3.2 Muskmelon

Promising monoecious lines and hybrids: Six monoecious lines with roundish fruit shape and excellent fruit quality were developed for hybrid development. New muskmelon hybrids DMH-27 (25.1 t/ha) and DMH-33 (24.8 t/ha) were selected for yield & quality.

2.1.3.3 Bitter gourd

Promising genotypes: DBGS-4-1, DBGS-2, NEH-4 and IC398610 were identified as promising. DBGS-4-1 was entered in IET varietal trials. Genotypes DBGS-100-0 (1.14 kg/plant) and DBG-100 (1.12 kg/plant) were superior in *muricata* group.

Promising hybrids: Two hybrids, DBGS-2 × G-66 and DBGS-2 × DBGS-100-0 were superior for yield per plant and entered in IET trials.

Promising genotypes and hybrids for protected cultivation: Genotypes, DBGS-21-06 (5.55), G-16-2 (4.95), DBGS-57 (4.63) and G-23 (4.53 q/100^2 area) were found promising.

Screening for virus resistance: Two genotypes, EC505638 and DBGS-2 were found resistant and DBGS-100-0, DBGS-100-1 and G-53 were moderately resistant to ToLCNDV.

2.1.3.4 Sponge gourd

Promising hybrids: Four hybrids, namely, DSGH-217 (25.5 t/ha), DSGH-215 (19.9 t/ha), DSGH-218 (19.7 t/ha), DSGH-219 (19.2 t/ha), were found promising during the spring-summer season and DSGH-220 (14.0 t/ha) during the *Kharif* season.

Screening for leaf mosaic disease resistance: Eleven genotypes namely, DSG-53, 54, 56, 57, 58, 59, 60, 63, 70, 78, 83 were found highly resistant to ToLCNDV in natural epiphytotic conditions during *Kharif* 2025.

Screening for downy mildew disease resistance: Eight genotypes namely, DSG-6, 47, 71, 507, VRSG-195, VRSL-1-1, 11, 16 showed highly resistant reaction to downy mildew disease in field conditions during *Kharif* 2025.

2.1.3.5 Ridge gourd

Screening for leaf mosaic disease resistance: The genotypes, VRRGL-1-13-3, VRRGL-3-5-3, VRRGL-3-7-2, VRRGL-3-7-3 were found resistant to ToLCNDV in natural epiphytotic conditions during *Kharif* 2025.

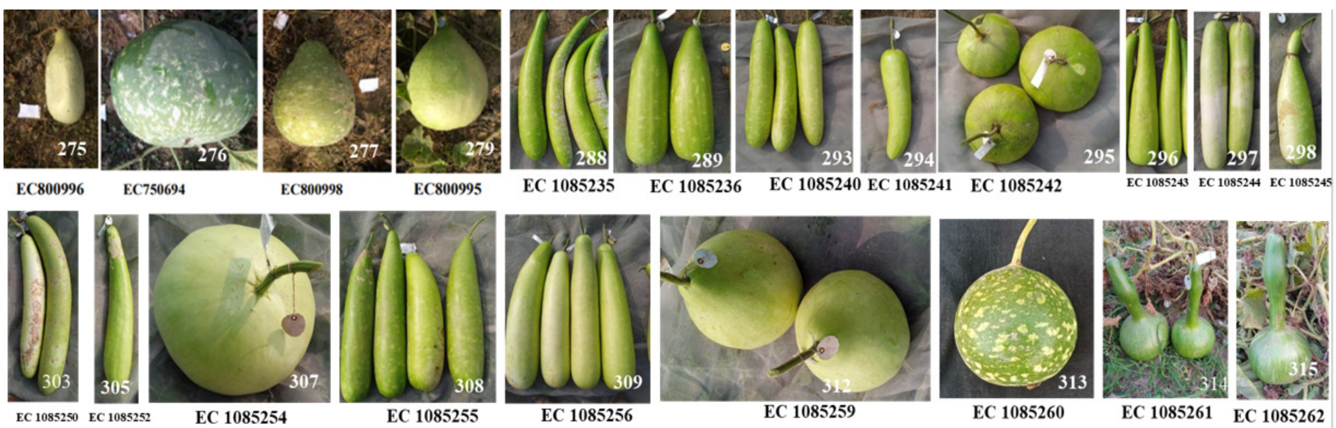
Screening for downy mildew disease resistance: DRG-110 showed resistant reaction to downy mildew disease in natural epiphytotic field conditions during *Kharif* 2025.

2.1.3.6 Bottle gourd

Characterization of genotypes: Days to first female flower anthesis ranged from 49 days in EC1085236 to 62 days in EC800998. Fruit length varied from 18.00 cm (EC1085260) to 61.00 cm (EC1085236), while fruit diameter ranged between 6.40 cm (EC800996) and 19.50 cm (EC1085254). Number of fruits per plant showed considerable variation, with a minimum of 2.33 fruits in EC1085261 and a maximum of 4.67 fruits in EC800998. Fruit weight ranged from 0.43 kg (EC1085261) to 1.68 kg (EC1085242), resulting in plant yield variation between 2.60 kg in EC1085256 and 6.43 kg in EC1085255. Total phenol content ranged from 28.03 mg/100 g (EC800998) to 105.08 mg/100 g (EC1085243), and total antioxidant activity from 93.22 mg/100 g (EC800998) to 190.22 mg/100 g (EC1085255).

Fruits of DPUH-45-36

DPU-43, DPU-133) than the susceptible genotype Pusa Vishwas at different time points post-inoculation by viruliferous whiteflies. Percent disease incidence (PDI) exhibited a highly significant negative correlation with total carotenoids (r = -0.66), DPPH (r = -0.72), and FRAP (r = -0.65).



2.1.3.7 Pumpkin

Promising hybrids for yield and quality: The best performing promising F_1 hybrids on the basis of fruit yield, shape and flesh colour were DPUH-45-36, DPUH-S4-7, DPUH-10-51, DPUH- 45-51 and DPUH-45-71 having average fruit weight 2.53, 6.15, 2.38, 2.27 and 2.13 kg and 3.10, 5.42, 3.00, 3.16 and 2.94 cm, respectively. The promising hybrids had orange flesh colour and 18.86 to 98.55% heterosis for yield over commercial check Pusa Hybrid-1.

Biochemical basis of resistance to *Begomovirus cucurbitachinaense* (squash leaf curl China virus; SLCCNV) in the resistant lines: An increasing trend in antioxidant (FRAP, DPPH) & phenol activity was observed in the SLCCNV resistant genotypes (DPU-41,

2.1.4 Malvaceae Crops

2.1.4.1 Okra

Promising hybrids: Among 61 hybrids, along with 21 private sector hybrids evaluated, earliest 50% flowering was recorded in DOH-7 (37 days) and fruiting at shorter internodes (3.6 cm) in DOH-9.

Screening of wild okra derivatives against enation leaf curl virus: Most of the wild types were resistant to okra enation leaf curl virus, except *A. ficulneus*.

Promising red-fruited genotypes: Pusa Lal Bhindi-1 exhibited superior phenolic content (23.37 mg/g) and antioxidant activity (356.99 μg/g GAE). Dietary fibre was highest in Pusa Lal Bhindi-1 (5.23%), while mucilage content varied widely (3.24–5.47%) across genotypes.

2.1.5 Root Crops

2.1.5.1 Carrot

Evaluation of hybrids for yield and quality: Thirty-six CMS-based F_1 hybrids of tropical carrot were assessed for yield, yield attributes and quality traits, of which the hybrids DCatH-86, DCatH-83, DCatH-869, DCatH-8H4, DCatH-800 and DCatH-817 were found promising.

Promising CMS-based F_1 hybrid DCatH-86

Promising genotypes of temperate carrot: KS-73 (24.83 t/ha), followed by KS-58 (22.95 t/ha) and KS-59 (22.36 t/ha) yielded better over the check cultivar Nantes (21.61 t/ha).

Evaluation of CMS-based F_1 hybrids of temperate carrot: At ICAR-IARI Regional Station, Katrain, out of 50 F_1 hybrids evaluated, KT-7 A × New Kuroda (29.27 t/ha), KT-95 A × KS-17-1 (28.53 t/ha), KT-80 A × KS-50 (27.57 t/ha), KT-28 A × KS-59 (21.88 t/ha) and KT-95A × KS-67 (21.55 t/ha) were found superior than the check cultivar Pusa Nayanjyoti (21.28 t/ha).

2.1.6 Bulb Crops

2.1.6.1 Onion

Promising genotypes for different seasons: In the *kharif* season, KP-62 (27.2 t/ha), KP-41 (26.8 t/ha) and Sel. 140 (25.5 t/ha) were found promising (seedling raised). The long-day onion genotypes Kt-On-3 (10.85 t/ha) and Kt-On-5 (9.40 t/ha) produced marketable bulbs under short- to intermediate-day conditions.

Promising selections for quality traits: High TSS bulbs (>15 °Brix) were selected from Pusa Shobha, while pungency was highest in KP-69 (6.66 μmol/ml) and KP-162 (6.64 μmol/ml). Sel. 417 (387.58 ppm), Sel. 140 (370.07 ppm) and Sel. 469 (369.77 ppm) had the highest sulphur content. High total phenol content was recorded in PKO-2123 (688.53 mgGAE/100g), followed by Nizampur Local (687.87 mgGAE/100g).

Screening genotypes against leaf blight complex: Genotypes KO-4 and Nizampur Local had minimal leaf yellowing under natural epiphytotic condition.

Development, maintenance and generation advancement of interspecific hybrid: More than 50% seed set was observed in cross Pusa Riddhi × Pusa Soumya and Pusa Shobha × Pusa Soumya. Chromosome doubling of the interspecific hybrids were achieved with colchicine 0.5% with 72 h treatment. In tissue culture, OISH-1 (Onion Interpecific Hybrid-1) and OISH-8 media resulted in seed set of Pusa Soumya × Pusa Riddhi hybrid.

Promising long-day red onion genotypes: KTON-69 (41.42 t/ha), KTON-64 (37.93 t/ha), KTON-55 (36.82 t/ha) and KTON-60 (34.99 t/ha) were found superior than the check cultivar Brown Spanish (33.07 t/ha).

Evaluation of short day × long day red onion hybrids: Hybrids, POS-17A × KTON-27 (38.82 t/ha), POS-6A × KTON-21 (37.08 t/ha) and POS-6A × KTON-8 (36.85 t/ha) performed better than the check cultivar Rani (32.94 t/ha).

POS-17A × KTON-27

POS-6A × KTON-21

POS-6A × KTON-8

Promising hybrids of short-day × long-day red onion

2.1.7 Leguminous Crops

2.1.7.1 Garden pea

Identification of new source of resistance to *Fusarium* wilt: Three germplasms, IC354946, IPF-440-9-2, and IC0424401, with high levels of resistance to *Fusarium* wilt were identified through field screening in sick plots and validated through artificial inoculation in pots and a newly developed hydroponic screening protocol. The CAPS marker (THO) associated with resistance to *Fusarium* wilt was validated.

2.2 FRUIT CROPS

2.2.1 Genetic Improvement of Fruit Crops for Desirable Horticultural Traits

2.2.1.1 Mango

Hybridization for trait-specific scion varieties: Among the different Amrapali cross combinations, Amrapali × Vanraj recorded the highest number of panicles (261), the maximum number of flowers (1025), and the highest fruit retention (41), indicating its superior reproductive efficiency and better compatibility with Amrapali. This was followed by Amrapali × Tommy Atkins. The lowest reproductive success was recorded in Amrapali × M. *zeylanica*, Amrapali × Janardan Pasand and Amrapali × *M. odorata*.

Development of mango rootstock(s) for dwarfness and abiotic stress tolerance: The cross, Kurukkan × 13-1 recorded the highest number of flowers (161) and maximum fruit retention (19 fruits), indicating superior cross compatibility and better fertilization efficiency and appears promising for developing rootstocks with improved vigour regulation and stress tolerance. The cross Olour × Bappakai showed relatively high fruit retention (17 fruits) despite a slightly lower number of flowers (136), suggesting efficient fruit set and reduced flower drop. In contrast, Olour × Kurukkan, though having the highest number of panicles (64), recorded lower fruit retention (9 fruits), indicating possible post-pollination fruit drop or incompatibility. The crosses Bappakai × Olour, Kurukkan × Vellaikolamban showed the low performance, indicating poor crossability. Overall, the cross combinations involving Kurukkan, particularly Kurukkan × 13-1, showed better reproductive performance and may be prioritized for further evaluation in rootstock development targeting dwarfness and abiotic stress tolerance.

Potential mango genotype: M-16-7 was identified as a potential selection characterized by low sweetness, fruit weight ranging from 210 to 245 g, fruit length of 90 to 115 cm, fruit width of 6.28 to 6.8 cm, TSS of 15 to 17 °Brix, semi-dwarf tree stature, and regular bearing.

Carbohydrate metabolism, C: N ratio, nutrient pathway and molecular studies in regular and irregular mango varieties: Deep RNA sequencing was used to assess gene expression dynamics between buds and flowers of Bombay Green and Totapuri varieties. Differential pathway analysis showed the greatest number of differentially expressed genes in metabolic processes (1377), followed by oxido-reductase (879), hormone (80), oxidative stress (77), starvation (39), alternate bearing (8), flowering (3), meristem (3), and cellular component (2) pathways. *In silico* analysis showed that among 15 genes, twelve were up-regulated in Totapuri and three in Bombay Green, confirmed by qRT-PCR. Additionally, 202 SNPs were identified in 32 alternate bearing-related genes. The study confirmed the reproductive bud's strong ability to import sugars, protein, and starch in the regular bearer variety, enhancing flowering and fruiting during off-years.

Estimation of mango (count) from the image based on convolutional neural networks (CNN) approach: Machine learning techniques were developed for estimation of mango(count) from the image using YOLO V8 and Faster RCNN, a computer vision algorithm which includes the detection of models & counting of fruit. The system provided output as total number of mangoes in images through Python in PyCharm platform.

2.2.1.2 Citrus

Development of trait specific acid scion varieties and rootstocks: Of the 29 acid citrus genotypes evaluated, the fruits of ACSH-7-13 showed the thinnest peel (1.33 mm) with higher juice (48.05%), TSS (7.52°B) and acid (5.77%) contents having resistance to citrus canker

ACSH-7-13

(9.77 PDI). The highest juice content was recorded in ACSH-11-13/18 (57.99%).

Development of trait specific sweet citrus scion hybrids: Seventy-nine sweet citrus hybrids were evaluated, which showed wide variability in respect of fruit weight (199.12-887.04 g), peel thickness (3.72-12.17 mm), juice content (30.48-60.85%), seeds per fruit (17-101), TSS (7.2-10.20°B) and acid content (0.41-1.37%). Two hybrids namely SCSH 6-17 and SCSH 13-12 have sweeter taste than others. Hybrid SCSH 11-15 (Pummelo × Mosambi) and SCSH 21-10 were promising for fruit yield (51.97 kg/tree), peel thickness (2.5mm), juice content (50.0%), TSS (7.97°B) and acidity (0.87%). No infestation of psylla (greening vector) was observed on the trees of SCSH 11-15.

SCSH 11-15 (Pummelo × Mosambi)

Exploitation of natural mutants of Redblush grapefruit: Three vegetatively propagated (VG1) mutants of Redblush (RB-1, RB-2 and RB-3) were found superior for total carotenoids (0.38-0.69 mg/100 g), lycopene (0.36-0.78 mg/100 g) and total flavonoids (230.5-270.0 mg QE/100 g) with low acid (0.89-1.02%) contents over standard Redblush cultivar.

Redblush RB-1 RB-2 RB- 3

Redblush grapefruit mutants

Evaluation of *in vitro* induced putative mutants: The morphologically and genetically distinguished one-year-old field planted *in vitro* induced putative M1 mutants exhibited 100% survival in gamma putative mutants and non-treated control, whereas it was observed to be 80% in EMS putative mutants. In the EMS mutants, a significant decrease of 78.63% and 2.47% in plant height was recorded in the mutants E3-11 and E8-43, respectively.

Validation and characterisation of *in vitro* EMS and gamma mutants in Kinnow mandarin: *In ovulo* nucellus obtained after excising embryos in the micropylar end from stage III fruits (21-25mm) of Kinnow mandarin showed Direct Somatic Embryogenesis (%) survival ranging from 4.76 to 100% after two successive subculturing within 2 months of first inoculation. In gamma-treated ovules (80 Gy), the somatic embryogenesis frequency ranged from 6.25 to 88.88%, whereas in EMS-treated ovules (0.1% EMS for 5 h), the frequency was from 0 to 100%. The response of gamma-treated ovules to embryo formation was faster (5-11 days) than that of EMS-treated ovules (7-14 days) in ICM media. A total of 100 EMS plants and 78 Gamma plants were obtained in liquid media. Overall, EMS generated point mutations with moderate phenotypic effects, whereas gamma rays exerted stronger disruptive impacts on regeneration and variability.

Physio-biochemical and metabolite alterations in sweet orange cv. Pusa Round on different citrus rootstocks under acid stress: Performance of Rangpur lime (RL), Troyer citrange (TC), Cleopatra mandarin (CM), X-639, and *Jatti khatti* (JK) was studied under four levels of soil pH (3.8, 4.6, 5.35, and 7.5). All the rootstocks exhibited their optimal growth under lower soil pH reiterating their acidophile nature. Rangpur lime (RL) exhibited better morphology, RSA, leaf pigments, total biomass, and absolute growth rate (AGR) at the lowest soil pH (3.8). Conversely, at higher soil pH (7.5), maximum assimilate partition to leaves was observed in JK. RL witnessed increasing values in terms of relative growth rate, net assimilation rate, and AGR with decreasing levels of soil pH. The stress susceptibility index (SSI) for biomass under soil pH 3.8 was significantly minimum in RL and maximum in JK. All the rootstocks studied can be established successfully at an optimum soil pH of 4.6. The rootstocks RL, X-639, and CM could withstand a pH level of 3.8, while TC and JK are recommended for areas having a pH range of 5.35–7.5.

2.2.1.3 Grapes

***In vitro* screening and identification of drought-tolerant grapes species:** The *Vitis vinifera* L. rootstock and scion genotypes namely, Pusa Navrang (PN), Pusa Swarnika (PS), Perlette (PER), Male Hybrid (MH), 110 Richter (110R) (*V. berlandieri* × *V. rupestris*), St. George (St.G) (*V. rupestris*), Dogridge (DogR) (*V. champinii*), and *Vitis parviflora* (VP) were evaluated for drought tolerance in an *in vitro* PEG screening medium. The rootstock 110R consistently showed better tolerance, maintaining higher water content, chlorophyll, and antioxidant activity, while exhibiting lower oxidative damage. The genotypes 110R, Dogridge, St. George, and Male Hybrid were identified as drought-tolerant rootstocks.

CVRC notification of grape hybrids

Pusa Swarnika: It is a hybrid between Hur x Cardinal, matures early with large berries that are round and golden-yellow in colour with firm pulp. It has loose bunches with bold, natural berries (15+ mm dia.) with high TSS (20+ °Brix). The average bunch size is 409 g, and the bunch length is 20 cm. The hybrid is tolerant to anthracnose and powdery mildew.

Pusa Purple Seedless: It is a cross between 'Pearl of Csaba' and 'Beauty Seedless', raised through embryo rescue. It is an extra-early berry ripening variety (75-80 days after full bloom) under sub-tropical region. Berries are seedless, purple-coloured, medium-sized, and have firm pulp. Berries have TSS 22% and good TSS: acid ratio in the 3rd week of May. It yields 8.60 kg (5-year-old vine) on the Kniffin system.

2.2.1.4 Guava

Evaluation of hybrids: Hybridity of the developed 96 F_1 progenies was confirmed using SSR markers. About 66% of the progenies were confirmed as true hybrids. Fruit weight showed a strong positive correlation with fruit width (r=0.80) and fruit length (r=0.70**), while the pulp-to-seed ratio was positively associated with fruit weight (r=0.73**). Several hybrids exhibited superior sweetness and nutritional quality compared to parents. TSS reached up to 12.5 °Brix, and total sugars up to 8.6% in promising hybrids. Antioxidant traits were significantly enhanced, with phenols exceeding 155 mg/100 g GAE, flavonoids up to 160 mg/100 g, antioxidant activity above 58%, and ascorbic acid reaching 168.9 mg/100 g in superior hybrids. Lycopene content, inherited from pink-fleshed parents, was successfully enhanced in some hybrids, reaching 9.48 mg/100 g, surpassing donor parents.

Genetic characterization: Seventy-eight guava genotypes including varieties, hybrids, cultivars, exotics (USDA collections), and wild species were characterized using 44 polymorphic genome-wide genomic microsatellite markers. A total of 187 alleles were detected (mean 4.25 per locus), with mean PIC 0.52, gene diversity 0.58, and heterozygosity 0.148, indicating moderate to high polymorphism. The neighbour-joining (NJ) tree grouped the genotypes into three major clusters with evident admixture (allelic divergence 0.0966). The analysis of molecular variance revealed 72% variation among individuals within populations, with 7% among populations and 21% within individuals ($P \leq 0.001$).

Development of genomic resources: High-quality genomic DNA was extracted from 101 diverse genotypes and subjected to Low-Pass whole-genome sequencing to establish the training population. The raw sequencing data from 84 samples were aligned and mapped to the guava reference genome assembly (GCA_016432845.1). Approximately 42 million SNPs were identified across all 84 samples. These raw variant calls were further filtered to ensure high-quality SNP selection, yielding a final set of 1,504,945 high-confidence SNPs.

Identification of promising guava hybrids

Guava hybrid 8F: This pink-pulp guava hybrid has a small seed core, average fruit weight 172.56 g, with 213 seeds/ fruit, total seed weight 2.1 g, seed hardness 11.92 kg/cm² and TSS 10.73 °Brix. The pulp has ascorbic acid 172.36 mg/100 g, phenolic compounds 130.28 mg/100 g GAE FW and flavonoid content 89.33 µM TE/g FW, along with antioxidant activity 7.0 mg/100 g FW. The average yield potential is 34–36 t/ha.

Guava hybrid 8F

Guava hybrid 7F: This pink-pulp guava hybrid has a small seed core with few seeds (about 26), average fruit weight 146.25 g, total seed weight 1.94 g and moderate TSS (10.94 °Brix). The pulp has ascorbic acid 171.38 mg/100 g, phenolic compounds 123.45 mg/100 g GAE FW, total flavonoids 81.24 µM TE/g FW and antioxidant activity 6.9 mg/100 g FW.

Guava hybrid 7F

GH-2016-7A: This large-fruited guava hybrid has average fruit weight 214.56 g, 197.66 seeds/ fruit, total seed weight 2.46 g and moderate sweetness with TSS 10.40 °Brix. The pulp has ascorbic acid 176.32 mg/100 g, phenolic compounds 128.28 mg/100 g GAE FW and total flavonoids 80.00 µM TE/g FW.

Guava hybrid 7A

GH-2016-2A: This white-pulp guava hybrid has large fruits with average weight of 245.38 g, 208.66 seeds/ fruit, total seed weight 2.74 g, seed hardness 10.00 kg/ cm² and moderate sweetness with TSS 10.68 °Brix. The pulp has ascorbic acid 181.31 mg/100 g, phenolic compounds 129.21 mg/100 g GAE FW, total flavonoids 87.04 µM TE/g FW and antioxidant activity 7.14 mg/100 g FW.

Guava hybrid 2A

HSUxSH-16-8-2: This pink pulped F_1 hybrid contains 5.806 mg/100g lycopene, 4.611 mg/100g total anthocyanin and 0.879 mg/100g total carotenoids. It has an average fruit weight 200.50 g, pulp thickness 14.06 mm, TSS 17.2°B and ascorbic acid content 192.33 mg/100g.

HSUxSH-16-8-18: This is a white pulped F_1 hybrid having an average fruit weight 148.06 g, pulp thickness 14.75 mm, TSS 16.4°B and ascorbic acid content 124.17 mg/100g.

2.2.1.5 Papaya

Mutation breeding: The seeds of the papaya P-7-2 were treated with gamma rays 0.1, 0.15, 0.2, 0.25 and 0.3 kGy. Two mutants viz. PM 04 and PM 28 were selected from two lower doses 0.10 kGy and 0.15 kGy which were outstanding in vigour having dwarf stature and bearing height. The maximum fruiting length (108.24 cm), number of fruits (40.22), fruit weight (0.920 kg), fruit length (21.56 cm) and fruit width (12.88 cm) was recorded in control (P 7-2) while minimum fruiting length (92.26 cm), number of fruits (34.24), fruit weight (0.720 kg), fruit length (16.24 cm) and fruit width (10.88 cm) was recorded in PM 04.

Performance of gynodioecious lines: PS-5-1 performed better for yield (19 kg/plant) with less disease severity (53.55%) in comparison to Red Lady (12 kg/plant; 87.78%).

2.2.1.6 Pomegranate

Development of genomic resource & characterization of germplasm: Chromosome specific genome wide SSRs and hypervariable SSRs have been designed and validated. DUS characterization of 192 genotypes was done based on leaf morphology. The characterization of 47 wild and cultivated genotypes collected from Uttarakhand, H.P. and Jammu revealed fruit size variation of 45.3 to 789.6 g and titratable acidity between 0.26 to 7.3%.

Screening of germplasm against blight, wilt, root knot nematode and salinity: Six *Xap* isolates collected from temperate and semi-arid tropics have been subjected to Koch's postulate, molecular confirmation with markers as well as 16s rRNA sequencing. The whole genome sequencing of *Xap* isolates and identification of structural variants across these isolates have been carried out. Challenge inoculation with virulent isolate revealed low incidence of blight (less than 10%) in wild pomegranate accession whereas in 'Bhagwa' it was 43%. In the initial screening of 30 pomegranate genotypes against root knot nematode, the number of galls/g of fresh roots varied from 0 to 38.7.

2.2.2 Production Technology

Effect of integrated nutrient management on newly developed mango hybrids: Maximum height (3.73 m) was recorded in treatment NPK 75% RDF + AMF (250g) + *Azotobacter* (250g). Among cultivars, maximum height (3.68 m) was found in Pusa Arunima and minimum (3.15 m) in Pusa Pratibha. Maximum number of fruit (45.15) was recorded in treatment NPK 75% + AMF (250 g) + *Azotobacter* (250 g), followed by 43.12 m in treatment NPK 75% + *Azotobacter* (250 g). Among varieties, the maximum number of fruit (48.58) was recorded in Pusa Arunima and the minimum (36.38) in Pusa Pratibha. Maximum weight of fruit (230.4 g) was observed in treatment NPK 75% + AMF (250 g) + *Azotobacter* (250 g). Among varieties, maximum fruit weight (240.4 g) was found in Pusa Arunima, followed by Pusa Lalima (225.5 g).

Growth and yield analysis of semi-vigorous mango varieties: The influence of rootstocks PAM-2, Kurukkan, Olour, K3, PAM-1 on scion cultivars Pusa Arunima, Pusa Surya and Amrapali was studied for growth parameters and yield attributes. Among the varieties, the minimum plant spread was measured in Amrapali (3.98 m), followed by Pusa Surya (4.05m), and the maximum for Pusa Arunima. Among the scion/rootstock combinations, Pusa Arunima showed the least plant spread with PAM-2, while Pusa Surya and Amrapali variety had the lowest plant height with PAM-1 rootstocks. The maximum yield (80.46 kg/tree), number of fruits (484.33) were found in the Amrapali/ Kurukkan combination.

Fruit yield and quality of sweet orange cultivars on different rootstocks: The varieties Pusa Sharad and Pusa Round were evaluated on 7 rootstocks (RLC-6, RLC-7, Jatti Khatti, C 35, X639, Yama Mikan and Soh Sarkar). Soh Sarkar, RLC-7 and Jatti Khatti were more productive for Pusa Sharad (68.32-74.65 Kg/tree) than others, while RLC-7 proved as most productive rootstock for Pusa Round (63.16 Kg/tree). The juice content in Pusa Sharad ranged from 51.16-53.91%, while it was 44.76-54.65% in Pusa Round on different rootstocks.

2.3 ORNAMENTAL CROPS

2.3.1 Marigold

Varieties identified by Institute Variety Identification Committee (IVIC)

Pusa Prabha: This French marigold variety flowers in 110-120 days during November-December and has

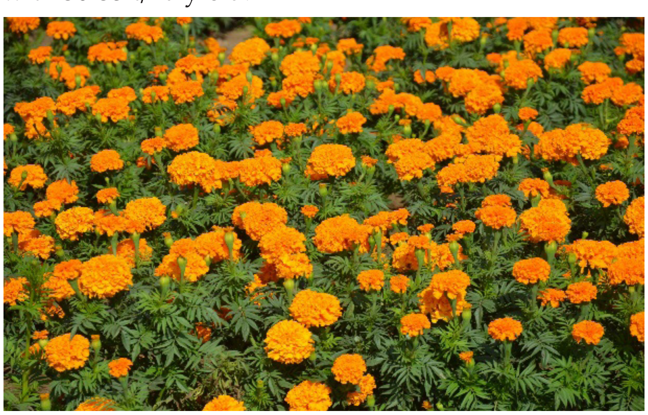
80-90 cm plant height. It produces 90-100 flowers per plant with yield of 18-20 t/ha.

Pusa Prabha

Pusa Shwetabh: This African marigold variety flowers in 100-110 days during October-November. Plants are medium tall (75-85 cm), produces 60-70 creamish white flowers/plant with yield of 20-25 t/ha.

Pusa Shwetabh

Pusa Shobha: This African marigold produces semi-dwarf plants of 40-50 cm height and flowers in 110-120 days during February-March. It produces 50-60 compact and large sized dark orange flowers per plant with 30-35 t/ha yield.



Pusa Shobha

Screening of marigold against *Alternaria* leaf spot resistance: Out of the 60 genotypes screened, most commercial varieties and male sterile lines (MS5, MS7, MS8) showed high susceptibility reaction against *Alternaria* isolate 'I-3'. Under *in vivo* conditions, Pusa Deep, Pusa Utsav, MGO-3, and DAMH-48 exhibited moderate resistance.

Standardization of production technology for imparting dwarfism in tall French marigold genotypes: Paclobutrazol (40 ppm) applied at 25 and 50 days after transplanting minimize plant growth, increasing the number of branches and flowers, and yield per plant.

Extraction and evaluation of functional stability of marigold carotenoids: Shade-dried petals of 'Pusa Narangi Gainda' extracted with 60% ethyl acetate under high-shear homogenisation had highest carotenoid yields (~1840 mg/100g DW) and strong antioxidant activities (FRAP ~363 μmol TE/g DW, CUPRAC ~284 μmol TE/g DW). Response Surface Methodology - Box-Behnken Design (RSM-BBD) validated shade drying with 60% ethyl acetate was optimised as the most efficient and sustainable strategy. The cabinet-dried extracts showed the lowest carotenoid degradation at 10°C. Degradation increased significantly with higher temperature, light exposure, and acidic pH. Carotenoid degradation followed first-order kinetics, with longer half-lives at low temperature, dark storage, and near-neutral pH.

2.3.2 Gladiolus

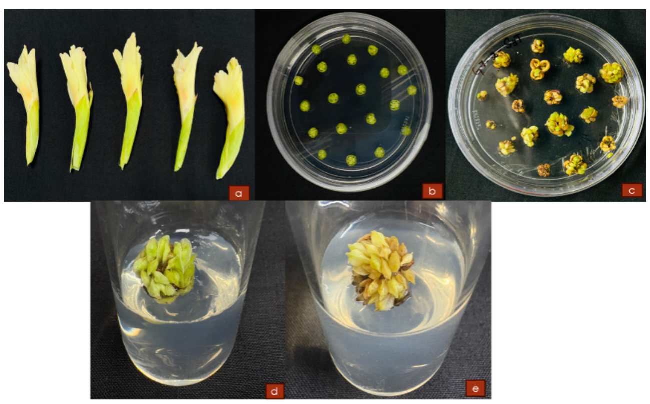
Evaluation of hybrids: Out of the 16 hybrids evaluated, (Urmil × Smoky Lady) × Salmon Queen recorded maximum plant height (141.53 cm), spike length (111.52 cm), and number of florets per spike (21.17); however, it exhibited a slow multiplication rate, producing only one corm per plant. Hybrids, Green Willow × Smoky Lady and Yellow Stone × Purple Flora exhibited superior plant height (121.57 and 138.83 cm), spike length (104.97 and 117.63 cm), number of florets per spike (21.17 and 16.67), and higher corm production (2.33 corms per plant each).

***In vitro* regeneration protocol from female gametophytes:** The effects of cold pretreatment durations (0, 1, 5, 7, 10 days), flower developmental stages (unopened, half-opened, fully opened flower

Smoky Lady x Heady wine | Canada x Green Finch | Ave x Green Willow | Swarnima x Viola | Green Pasteur x Regency

Promising hybrids of gladiolus

buds), and growth regulators like thidiazuron (0, 10, 20, and 30 µM), abscisic acid (0, 5.0, 10, and 15 µM), and putrescine (0, 0.5, 1.0, and 2.0 mM) were assessed for their influence on regeneration from the female gametophyte. Flower buds cultured at the half-opened stage exhibited significantly higher *in vitro* response compared to unopened & fully opened buds. Pusa Rajat & Pusa Red Valentine showed superior responses at lower concentrations of thidiazuron (10 & 20 µM) and putrescine (0.5 mM).



In vitro **regeneration from female gametophytes in gladiolus; a) gladiolus buds selected at half opened stage; b) Inoculation of unfertilised ovaries on suitable media; c) Increase in size of the ovaries, enlargement of ovules on TDZ-rich media; d & e): formation and maturation of Embryo-like structures (ELS)**

Effects of growth regulators on mass multiplication of wild species: The highest shoot proliferation and cormel induction were observed in wild species, GW-4, followed by GW-1. The maximum shoot proliferation was achieved on MS medium supplemented with $AgNO_3$ (10 mg L^{-1}) and putrescine (500 µM). Sucrose and indole-3-butyric acid (IBA) were effective for cormel induction. Optimal cormel induction was observed at higher sucrose concentrations (6–9%). At lower IBA concentrations (0.5–1.0 mg L^{-1}), early cormel initiation and enhanced rooting were recorded.

2.3.3 Chrysanthemum

2.3.3.1 Promising hybrids

Pusa First Bloom (CH-2020-4): It is an early-flowering hybrid (97.75 days to 50% bloom) developed by crossing Pusa Sona × Red Spoon. It has compact plant stature (32.25 cm height; 37.75 cm spread), 36.85 branches/plant and an average of 323 flowers/plant.

Pusa Himank (CH-2021-1): It has attractive flower, uniform growth and good keeping quality. It performs well under open-field as well as pot conditions.

2.3.4 Rose

Pusa Glory: It belongs to Hybrid Tea (HT) group, has dark pink colour, semi-double flowers and produces more rose hips (fruits).

Pusa Glory

Induction of genetic variability through *in vitro* mutagenesis: Axillary buds of rose cv. 'Rose Sherbet' were treated with different doses of gamma rays (20, 30, 40, 50, 60, 70, 80, 90 and 100 Gy) and inoculated on MS media under *in-vitro* conditions. An increased dose of gamma rays leads to a decrease in bud sprouting and survival percentage. Higher dose of gamma rays at 70 Gy exhibited 100% explant mortality. Gamma rays induced mutants, RSM-1 and RSM-2 were isolated from the *in-vitro* mutated population.

Extraction of natural dye from rose petals and its application on fabrics: Rose flower petals were used to extract natural dye via solvent extraction, optimized using RSM-BBD with better anthocyanin content (19.653 mg/g) and redness index achieved at 25°C, a 1:5 solid-to-solvent ratio, and 0.015% HCl. Anthocyanin degradation increased with temperature and time. The extracted dye was applied to cotton, silk, wool, and polyester fabrics using pre, meta, and postmordanting techniques with alum and potassium dichromate as mordants at varying concentrations. Silk exhibited the highest color strength (5.323) with 4.5% potassium dichromate postmordanting, followed by polyester (2.172) with 4.5% alum postmordanting. The cotton fabric had the best fastness using the postmordanting technique, wool fabric using the premordanting technique, and silk and polyester using the metamordanting technique.

2.3.5 Foliage and Potted Plants

Effect of wastewater irrigation on soil properties and heavy metal accumulation in indoor potted plants: The soil organic carbon content was enriched under kitchen wastewater irrigation, ranging from 0.56 to 0.60%. Nickel accumulation was highest in the roots (20.89 μg g^{-1}) and shoots (3.71 μg g^{-1}) of Chlorophytum and Philodendron plants irrigated with treated wastewater. The highest lead accumulation was observed in shoots of Jade plant (21.29 μg g^{-1}) and roots of Philodendron (28.65 μg g^{-1}). Syngonium exhibited the highest accumulation of micronutrients (Fe, Zn, Mn, and Cu) in both shoots and roots under kitchen wastewater irrigation.

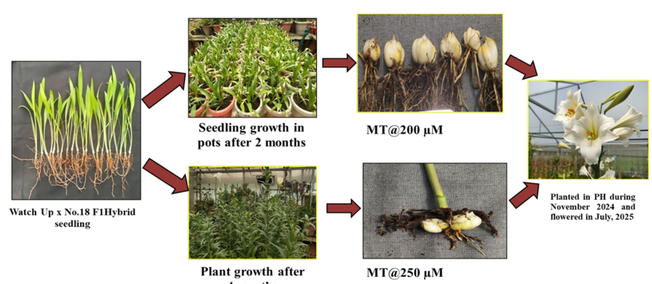
Screening of ornamental potted plants for air pollution mitigation using air pollution tolerance index (APTI): The APTI values ranged from 12.01 to 13.32 for tolerant species, 10.00 to 11.65 for moderately tolerant species, and 9.40 to 9.60 for susceptible species. Syngonium, Philodendron, Money plant, Coastal Lily, Chlorophytum, and Dracaena were identified as tolerant species. Coleus and Golden Money plant exhibited visible injury symptoms even at lower pollutant concentrations, categorized as sensitive species.

2.3.6 Lilium

Evaluation of interspecific cross combinations: The cross 'Rodengo × Treser' produced the highest number of viable seeds (110) but seed germination was successful in only six crosses with highest germination (15.4%) observed in 'Royal Sunset × Brunello'.

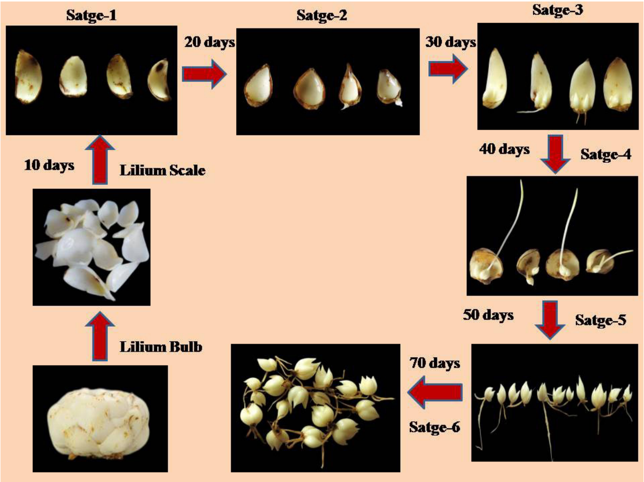
Polyploidization study: Seeds of *Lilium longiflorum* were treated with varying concentrations of colchicine and oryzalin. The highest survival rate (27.8%) was observed when seeds were immersed in oryzalin at 0.004% for 24 hours. Flow cytometry analysis confirmed that oryzalin at 0.004% induced a higher proportion of triploid plants (16.7%) compared to colchicine treatments across all exposure durations. Triploid plants exhibited an increased length of stomatal guard cells compared to diploid plants.

Propagation studies (effect of melatonin on bulb development): Foliar application of melatonin at 300 ppm at fortnightly intervals significantly enhanced bulb growth, yielding the maximum bulb size (27.17 mm) and bulb weight (11.8 g) in '*Watch Up × No. 18*' bulbils.



Effect of melatonin application on growth, bulb development and flowering in Lilium

Effect of growth regulators on propagation: Among the treatments *viz*. CPPU, GABA, and melatonin, melatonin @ 20 mg/l was found best for early induction (30 days), highest regeneration rate (96.44%), maximum number of bulblets per scale (3.88), maximum size (8 mm) and weight of bulblets (1.2 g) for bulblet induction in Lilium.



Propagation of Lilium through scale

2.3.7 Ornamental Kale

Evaluation of cut-stem-types: Among 20 inbred lines evaluated, Ktok-38-1 exhibited the smallest head size (13.32 cm), tallest plant height (39.70 cm), and longest head retention duration (114.67 days). The line Ktok-36-3 took only 55.33 days for head formation.

Evaluation of pot-types: Among 40 lines, Ktok-3 exhibited the smallest plant height (11.88 cm), longest head retention duration (117.67 days), and largest head size (23.90 cm). The inbred line Ktok-65 required the fewest days for head formation (53.33 days).

Evaluation of CMS based hybrids: Among 20 F_1 hybrids, five exhibited superior performance with a heterosis range of 11.8 to 31.0% for plant height and -3.2 to 28.8% for plant spread. The mean head size and the diameter of the central-colored portion varied from 21.73 to 24.93 cm and 9.97 to 16.67 cm, respectively, with heterosis ranges of -8.3 to -20.1% and -11.2 to 21.7%, where negative heterosis is preferable.

Characterization of CMS lines for seed setting and yield traits: Five Ogura CMS lines and three *Erucastrum canariense* lines were advanced to the BC_4 generation and characterised. The number of pods (73.0) and seed yield per plant were highest in CMS-17. Pod length (8.50 cm) was recorded maximum in CMS-7 followed by CMS-20 (8.40 cm).

2.3.8 Antirrhinum

Evaluation of inbred lines: The lines KTANT-63, KTANT-64, KTANT-65 were suitable for cut flower production and have plant height (134.64 to 142.44 cm). Maximum plant height was observed in KTANT-65 (142.44 cm), and minimum days to flowering in KTANT-64 (44.36 days). The maximum number of flowers per stem (44.20) was recorded in KTANT-65.

2.4 PROTECTED CULTIVATION TECHNOLOGY

2.4.1 Design, Development and Testing of an IoT-based Smart Vertical Hydroponic System

The developed vertical NFT hydroponic system accommodated 153 basil plants in 3.9 m², achieving 5.46× higher crop density than field cultivation. Automatic fertigation outperformed manual in growth and yield from 30 DAT onwards. IoT-based fertigation improved growth over manual by 12% plant height, 16% leaf area, 16% leaves, 19% fresh weight. Water Use Efficiency (WUE) was 49.22 kg/m³ in IoT-based system. IoT-based system gave highest Net Present Value (NPV), Benefit Cost Ratio (BCR), and gross revenue, proving it more profitable than manual/commercial systems.

Smart IoT Greenhouse Vertical Hydroponic Technology with Basil Crop

2.4.2 Effect of LED Spectra on Morphological and Physio-biochemical Performance of Pak Choi Grown under Controlled Environment Multi-Tier Hydroponic Production System

Plant factory technology was designed and developed with artificial LED light and multi-layer hydroponics system using Pak choi cv. Choko. Ratio of red and blue LEDs resulted in a potential boost in overall plant health and productivity. Red: Blue (R2B1;67: 33) induced maximum plant height, leaf number and biomass. R2B1 showed 50.91% higher yield in terms of leaf fresh wt. Pn was 1.91-fold (91.29%) higher compared to control (white light). Glucosinolate content increased in R2B1 (2.51 µmol g-1 aliphatic), including NAP and 4ME.

Plant Factory Technology with Pak Choi crop grown in LED

2.5 FOOD SCIENCE AND POST-HARVEST TECHNOLOGY

2.5.1 Flash Vacuum Assisted Extraction of Betalain for Enhanced Colourant Recovery from Beetroot

A 3-factor, 3-level Box-Behnken Design (BBD) was employed to evaluate the estimation of betalain content in beetroot. The optimized condition of extraction (time of superheated treatment: 3 min), vacuum pressure (250 mm of Hg) and vacuum time (3 minutes) led to an enhanced mass transfer rate and a significantly higher extraction yield—approximately 37% greater than that of the conventional method.

2.5.2 Identification of Bioactive Compounds in Ornamental Plant Extracts

A total of 126 compounds from rose and marigold were identified through UPLC-ESI-QToF-MS/MS and FTIR imparting antioxidant activity to the rose and marigold leaf and petal extracts. The primary polyphenol compounds in rose were quercetin, quercetin 3-O-rutinoside, and kaempferol acetyl disaccharide, while in marigold these were kaempferol, epicatechin gallate, and feruloyl-caffeoylquinic acid.

2.5.3 Testing the Efficacy of Functionalized Edible Coating on Maintaining the Quality of Guava Fruit

Carboxy methyl cellulose (CMC) and gum arabic (GA) based active edible films activated with rose leaf (RL) & marigold petal (MP) extracts were developed. When applied to guava fruits, the shelf life was extended up to 18 days for GA + RL, CMC + MP, and CMC + RL coatings. CMC + RL coated fruits retained higher weight retention percentage (91.03%) and showed lower ethylene production rates along with enhanced biochemical properties. Antioxidant (DPPH) activity was better preserved in coated fruits, with CMC + RL being the most effective. PME and APX enzyme activities were lower in active-coated fruits. CMC + RL coatings outperformed other coating formulations in maximizing storage life (18 days) and maintaining quality attributes with lowest ripening index (35.93) and total colour difference (82.80).

2.5.4 Utilization of Grape Pomace for Development of Extruded Snack

Optimal extrusion conditions were identified as 7.5% grape pomace inclusion, 11% feed moisture, a screw speed of 300 rpm, and a barrel temperature of

117-121°C. Under these conditions, the optimized product demonstrated desirable characteristics, including an expansion ratio of 1.92, porosity of 0.72, total phenolic content of 784.69 mg GAE/100 g, antioxidant activity (FRAP) of 182.47 µmol TE/g, and a sensory acceptability score of 6.54.

2.5.5 Nutritional Potential of Processed Little Millet (LM)

The effect of different processing treatments (roasting, pressure cooking, soaking, germination) was studied on nutritional, anti-nutritional, structural (XRD), thermal (TGA) and bioactive (NMR) profile of LM. *In vitro* digestion of LM showed significantly ($p<0.05$) higher DPPH radical scavenging activity and FRAP activity post digestion in pressure cooked LM, while CUPRAC activity, total phenolic content and total flavonoid content were significantly ($p<0.05$) higher in germinated LM. All the treatments significantly reduced the phytic acid content, and anti-nutritional component. Germination and roasting treatments significantly enhanced the α-amylase and α-glucosidase inhibition activity. XRD revealed enhanced crystallinity in soaked and germinated LM. The suitable processing treatments can positively alter the nutritional, structural and bioactive profile of the LM while reducing the anti-nutritional factors.

3. GENETIC RESOURCES AND BIOSYSTEMATICS

The infrastructure for basic and applied plant science research must include plant genetic resources. These are rich sources of genes hitherto unexploited and thus need to be conserved, evaluated and utilized. They play a major role in providing genetic resources to diseases and pests and quality for breeders. Genetic resources have a pivotal role in crop improvement programmes. The institute has a vibrant programme for the collection, maintenance, evaluation and utilization of germplasm, insects, pathogens, nematode and other genetic resources. A large number of genetic resources maintained as crop germplasm and at insect/microbe/nematode repositories are evaluated, characterized and utilized for crop improvement and crop protection.

3.1 CROP GENETIC RESOURCES

3.1.1 Wheat

3.1.1.1 Genetic stocks registered

BHS 491 (INGR24061): It possesses resistance to leaf and stripe rusts at seedling and adult plant stage.

BHS 488 (INGR24062): It carries seedling resistance to all the pathotypes of leaf rust except for *H1* race.

BHS 489 (INGR24063): It is a naked barley possessing seedling resistance to all the pathotypes of yellow rust with Average Coefficient of Infection (ACI) =1.3

UASD 22-5 (INGR 24060): It possesses drought tolerance.

3.1.2 Barley

3.1.2.1 Genetic stock registered

BHS 490 (INGR25007): BHS 490 has shown seedling resistance to all the pathotypes of leaf rust. It also possesses adult plant resistance to yellow rust with ACI 1.5 with the highest susceptibility score of 5S.

3.1.3 Rice

Evaluation of wild rice accessions: A set of 90 different accessions of wild rice collections of *O. rufipogon, O. nivara* and *O. longistaminata* were evaluated for different traits. Of these, nine accessions of *O. nivara* with resistance to bacterial blight have been used as donors in the breeding programme.

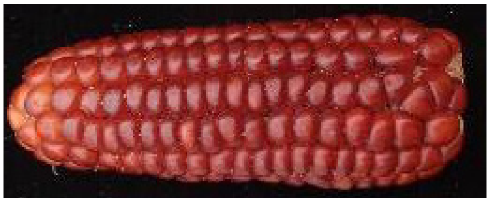
Evaluation of rice landraces for yield and other components: A total of 702 rice landraces collected from diverse agro-ecological regions of the country, along with 323 IRGC lines, were evaluated for yield and contributing traits. In addition, these genotypes were screened for phosphorus use efficiency (PUE), anaerobic germination, and reactions to rice root-knot nematode, sheath blight, bakanae and blast. Twelve landraces were found resistant to leaf blast, neck blast and bacterial blight.

Screening of rice landraces for resistance to root-knot nematode

3.1.4 Maize

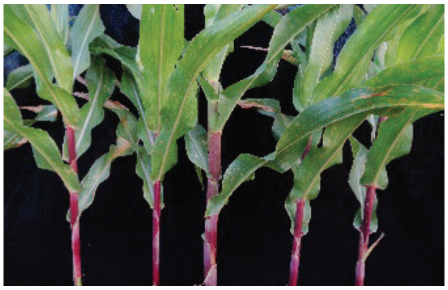
Development of genetic stock with red pericarp: *Pericarp1* (*P1*) gene produces phlobaphenes in the pericarp of maize. Phlobaphenes are water-insoluble reddish-brown polyphenolic compounds derived from flavonoid polymerization. They are used as natural plant-based pigment in food, cosmetics, and textiles. Phlobaphenes also act as antioxidants, antimicrobials, and anti-inflammatory agents in medicinal applications.

Accumulation of phlobaphenes is accompanied by thickening of pericarp thereby enhances resistance to various pathogens. MGU-P1-101 and MGU-P1-102 with red pericarp have been developed as genetic stocks.



Grain and cob characteristics of MGU-P1-101

Development of genetic stock with purple stem: Purple stem in maize is conditioned by dominant alleles, *Purple plant1* (*Pl1*) and *Booster1* (*B1*). Of these, *B1* is sun light dependent, while *Pl1* is independent of sunlight. Purple stem characteristics if present in haploid inducer lines serve as the phenotypic marker for removing diploid plants from selected haploid seedlings. MGU-PS-101 with purple stem has been developed as genetic stock.



Purple colored stem in MGU-PS-101

Identification of mutant with leaf angle: AI 544 was mutagenized with high-energy pulse electron beam. Among mutants, a line (AI 544-1089) showed <10^{o} leaf angle compared to 40-45^{o} leaf angle in the AI 544. It has medium cob placement, higher seed size (32 g/100 seed) and long pollen dispersal period (5 days).

Reduced leaf angle in AI544-1089

3.1.5 Chickpea

Development of wild species garden and hybridization block for pre-breeding: A total of 120 wild relatives involving *C. reticulatum, C. cuneatum, C. judaicum, C. bijugum, C. pinnatifidum, C. echinospermum* and *C. yamashitae* were maintained under wild species garden. GLW91, an advanced introgression line using *C. pinnatifidum* and *C. arietinum* has been developed having resistance to botrysis grey mould (BGM). Similarly, advanced pre-breeding population using ILWC118 - a drought tolerant donor of *C. reticulatum* has been used to develop large number of drought tolerant lines.

3.1.6 Lentil

3.1.6.1 Genetic stock registered

PHL-3 (INRGR24023): PHL-3 possessing heat stress tolerance was registered at NBPGR, New Delhi.

3.1.7 Soybean

Characterization of germplasm for soybean rust: A total of exotic 550 germplasm lines of soybean (*Glycine max* L.) were screened against soybean rust. A set of 10 promising lines were utilized in breeding programme.

3.1.8 Genetic Resources Developed in Vegetable and Flower Crops

Cauliflower: A total of 230 germplasm lines of white cauliflower (86 Cytoplasmic male sterile (CMS), 100 open pollinated (OP), 20 Exotic Collection (EC) lines, 14 Double haploid (DH) lines and 5 genotypes each of orange and purple coloured cauliflower) were purified and utilized in hybrid breeding programme. Further, two CMS lines of purple cauliflower (PC-6704-35 and PC-2304-36) and three in orange cauliflower (CMS-OrCF-8419, OrCF325 and OrCF4) were maintained and used in breeding programme.

Cabbage: Cabbage germplasm including 10 DH lines, 58 OP genotypes and 32 CMS lines were purified and utilized in hybrid breeding programme.

Broccoli: Three CMS lines *viz*., DC-Brocco-PS-64A (*Ogura*), DC-Brocco-15A (BC_7) (*Can*) and DC-Brocco-PPB-1 (*Ogura*) were advanced and used in breeding programme. In addition, 24 DH lines, 28 germplasm and 8 CMS lines were purified and utilized in hybrid breeding programme.

Carrot: Petaloid CMS lines have been established in three new genetic backgrounds. In addition, a set of 118 genotypes of temperate carrot including 98 OP lines and 20 CMS lines were purified and utilized in hybrid breeding programme.

Onion: Ten allied *Allium* species were characterized for 40 morphological and 10 biochemical traits. High total soluble sugars (TSS) were recorded in *A. cepa* var. *aggregatum* followed by F_1 of *Allium fistulosum* cv Pusa Soumya and *Allium cepa* cv. Pusa Riddhi and *Allium ascalonicum* (>15 ºB). Further, a set of 50 genotypes of long day onion (red, yellow and white) were purified.

Capsicum: A set of 95 open pollinated genotypes of capsicum [green (48), yellow (27), red (15) and orange (5)] were purified.

Summer squash: Twenty open pollinated genotypes of summer squash (green, orange, yellow, creamy white) were purified.

Marigold: Collection of five varieties of marigold *viz*., Super Hero Deep Orange, Super Hero Gold, Safari Yellow, Safari Orange and Safari Scarlet were made from secondary sources to enrich the marigold germplasm.

Gladiolus: Collection of 12 varieties of gladiolus *viz*. Advance, Blue Tropic, Chemistry, Fiorentina, For Evigt, Kenia, Performer, Sierra, Tavira, Amber Mystique, Purple Flora and Louise were made from secondary sources for germplasm enrichment.

Rose: Hybrid tea type rose varieties namely Blue Moon, Broadway, Blue Sky, Alec's Red, John F. Kennedy, Tata Pink, and Mount Cherry and Floribunda type rose varieties such as Cordula, Glowing Amber, and Nordia were collected from secondary sources to enrich the existing germplasm.

Bougainvillea: Collection of Poultoni special, Elizabeth, Blue Puff, Dream, Lateritia, Pallavi and Fantasy were made from secondary sources for germplasm enrichment.

3.2 BIOSYSTEMATICS AND IDENTIFICATION SERVICES

3.2.1 Biosystematics of Fungi

The rhizosphere and phyllosphere microbiota (fungi and bacteria) profiling in resistant and susceptible host plants of wheat for stem rust and mustard for white rust were carried out for two seasons. The different genera of fungi *viz*., *Beauveria* sp., *Myrothecium* sp., *Talaromyces* sp., *Alternaria brassicae*, *Purpureocillium* sp., *Fusarium oxysporum and Cladosporium* spp. from mustard and *Fusarium* spp., *Bipolaris* spp., *Cladosporium* spp., *Acremonium* spp., and *Epicoccum* spp., from wheat were identified and confirmed through molecular studies. At present 303 number of fungal isolates with 21 genera comprising of different species and 64 isolates of bacterial cultures including endophytic bacteria are conserved at Wellington.

3.2.2 Biosystematics of Insects

Identification service and National Pusa Collection (NPC) augmentation: Four hundred twelve specimens belonging to different orders of Coleoptera (110), Hymenoptera (115), and Lepidoptera (175) were identified for different stakeholders. Collections of these orders were made from different locations of Tamil Nadu, Meghalaya, Karnataka, West Bengal and New Delhi. Approximately 2,000 specimens of various orders and families were collected, processed, pinned, studied and stored in NPC.

Systematic studies on subfamily Olethreutinae (Lepidoptera: Tortricidae) from India: About 2000 specimens of moths belonging to the subfamily Olethreutinae were collected, pinned, and labelled. A detailed revision of the genus *Eudemopsis* was achieved, including identification keys and a checklist. Significant findings included the discovery of three species *Lobesia lithogonia, Penthostola albomaculatis, Tetramoera flavescens* and two genera, *Eudemopsis*, and *Penthostola* from India. Additionally, four new species were described: *Eudemopsis hunliensis* sp. nov. *Eudemopsis gobuka* sp. nov. *Trophocosta apilobata* sp. nov. and *Eucosmogastra* sp. nov.

Three new species of Gelechiinae (Lepidoptera: Gelechiidae) from India: This study described three new species, *Gelechia adi* sp. nov., *G. bilobuncusa* sp. nov. and *Istrianis ladakhensis* sp. nov. from India based on the characters of external morphology and the male and female genitalia.

Eudemopsis hunliensis **sp. nov.**

Eudemopsis gobuka **sp. nov**

Trophocosta apilobata **sp. nov.**

Taxonomic studies and DNA barcoding of sapota bud borer, *Eustalodes achrasella* (Bradley, 1981) (Lepidoptera: Gelechiidae) from India: This pest causes significant damage in the commercial sapota orchards leading to economic yield losses. Infestation and damage symptoms caused by *E. achrasella* was studied in Punjab. Illustrations of various life stages with detailed taxonomic redescription and molecular barcodes of this species were done.

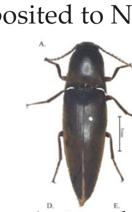
An Updated Global Inventory for Economically Important Insects on Cruciferous Crops (Brassicaceae): Functional diversity analysis highlights that foliage feeders dominate the pest category (52%), while nymphal-adult predators make up the majority of natural enemies (45%). Larval parasitoids and pupal parasitoids account for 27% and 10%, respectively. Hymenoptera (51%) leads among pollinators, followed by Lepidoptera (21%) and Diptera (17%). An inventory with comprehensive list of 286 agriculturally important insect species from cruciferous crops spanning 10 orders was prepared. This first-of-its-kind inventory would serve as a valuable resource for easy identification of these pests.

New combination and new records of Tortricid moths from India: Three species of tortricid moths of the subfamily Olethreutinae, viz., *Acanthoclita acrocroca* Diakonoff, 1982, *Ageonychistica* Diakonoff, 1982 and *Bactra coronata* Diakonoff, 1950, were recorded for the first time from India. The species, *Acroclita cheradota* Meyrick, 1912 is transferred from *Acroclita* Lederer, 1859 to *Ancylophyes* Diakonoff, 1988 as *Ancylophyes cheradota* (Meyrick, 1912) comb. nov.

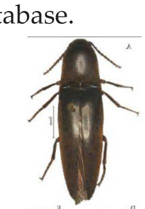
Development of field deployable colorimetric recombinase polymerase amplification (RPA) assay for rapid detection of *Phthorimaea absoluta* (Lepidoptera: Gelechiidae): The South American tomato pinworm is an economically important pest worldwide. An on-site and field deployable recombinase polymerase amplification (RPA) assay was developed for the detection of *P. absoluta*. RPA primers were designed to target the cytochrome c oxidase subunit 1 (COI) gene of *P. absoluta*. RPA assay was performed using a simple crude extract of this insect in 0.02 M Ethylene diamine tetra-acetic acid (EDTA), followed by incubation at 37^{o}C for 25 min. The assay was further simplified by adding colorimetric dye Hydroxynaphthol blue (HNB), which eliminates the gel-electrophoresis step. The presence of *P. absoluta* was detected by visual color change from dark blue to sky blue. The entire assay from crude extraction to calorimetric reading was rapid, user-friendly, and lasted 45 min. The assay was validated by setting a pheromone trap in the field, followed by crude extraction of the trapped moths in 0.02 M EDTA and their detection with RPA assay.

Taxonomic studies of Coleoptera: An extensive survey was conducted in the states of Himachal Pradesh, Uttarakhand, Kerala, Bihar, Kashmir and Delhi, Meghalaya and Arunachal Pradesh etc. and 770 specimens belonging to different coleopterans were collected. DNA barcodes of ten different species of Elateridae were deposited to NCBI database.

Pachyderes ferruginosus **new record**



Nipponoelater sinensis **new record**



Nipponoelater indosinensis **new record**

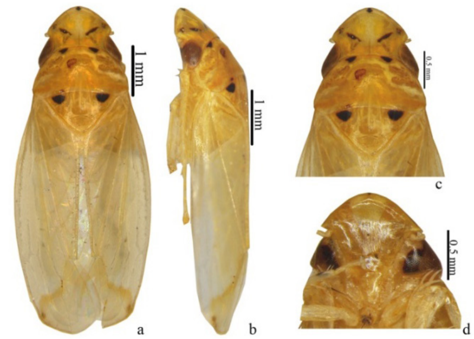
Catalogue on the subfamily Agrypninae (Elateridae): A catalogue on the subfamily Agrypninae in Indian context was prepared for the first time. Currently, 259 species of Agrypninae belonging to 26 genera classified into six tribes are reported from India. The tribe Agrypnini includes 154 species in eight genera and Platycrepidiini, represented by one species, in single genus. Twelve new combinations were also proposed.

Taxonomic review of genus *Pachyderes* Guérin-Méneville, 1829 (Coleoptera: Elateridae) from India with a new record: This study reviewed the genus *Pachyderes* Guérin-Méneville, 1829, from India, with a new country record, *Pachyderes ferruginosus* Platia and Sechi, 2023 from Nambol, Manipur.

New records of three species of the genus *Nipponoelater* Kishii (Elateridae:Elaterini) from India: *Nipponoelater henscheli* (Schimmel 2007), *N. indosinensis* (Schimmel and Tarnawski 2010), and *N. sinensis* (Candèze 1882) are documented for the first time from India. *N. sinensis* has been redescribed, while *N. henscheli* and *N. indosinensis* were supplemented with genitalia and diagnostic characteristics along with the illustrations. An updated diagnostic key of genus *Nipponoelater* from India was prepared.

Biosystematics studies on the family Cicadellidae (Order: Hemiptera): Leafhopper samples were collected (Andhra Pradesh and New Delhi), received from various locations across India through State Agricultural Universities (SAUs), extension functionaries, and students from ICAR–IARI and other institutions. A total of 56 leafhopper specimens were identified from the material received.

A new genus of the leafhopper tribe Mukariini (Cicadellidae: Delcephalinae) *Shanaya* gen. n. with two new species has recently been discovered from India. *Shanaya spatulata* sp. n. (Himachal Pradesh) and *Shanaya abeeri* sp. n. (Karnataka) are described and illustrated. A new bamboo- feeding leafhopper genus, *Bambusimukaria* Yang, Chen and Li, has been reported for the first time from Medziphema, Nagaland. Earlier *Bambusimukaria* had been described from China. The description is based on female genitalia of species *B. quinquepunctata*.



***Bambusimukaria quinquepunctata* Yang, Chen & Li, 2016 (Female): a. Habitus dorsal; b. Habitus lateral; c. Head; d. face**

3.2.3 Nematode Biosystematics & Identification Services

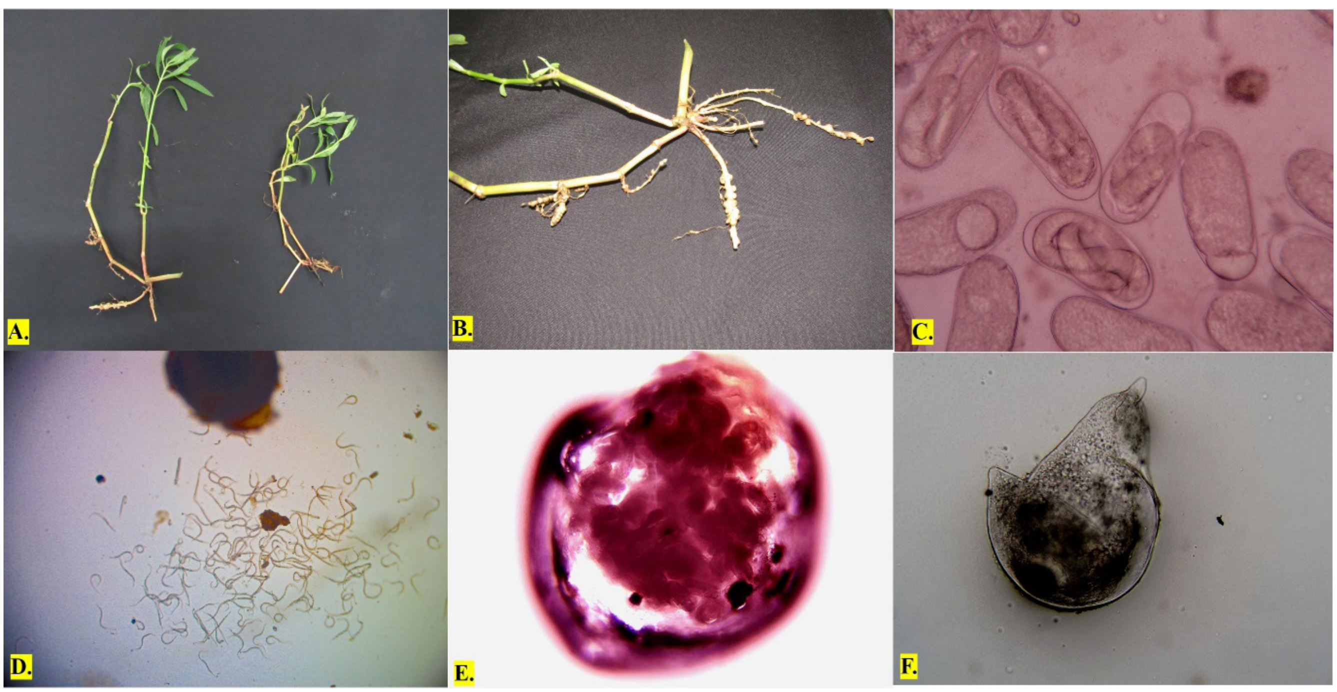
Diversity of *Hirschmanniella* spp was studied in paddy rhizosphere across 17 rice-growing states in India. Thirty-six populations of *Hirschmanniella* spp were identified. Morphological, morphometric, and molecular identification using species-specific markers confirmed that 29 of these populations are *H. oryzae*. Additionally, a new population from six localities, Jharkhand, Karnataka, Haryana, Uttar Pradesh, West Bengal, and Odisha, that is morphologically and morphometrically distinct from its closely related species, *H. mucronata*. was identified. This new species displays 6 to 7 head annules, a/ b ratio of 8.1 to 15.6, and a shorter stylet shaft length measuring 6.8 to 9.0 µm. Molecular characterization using the D2D3 region of 28S rDNA, Internal Transcribed Spacer (ITS) of rDNA, and 18S rDNA confirmed it as a distinct population. This new species has been named *H. paramucronata* n. sp. In this investigation, morphological and morphometric studies of the 6 populations, 21 populations of *Hirschmanniella oryzae* alone, seven populations of *H. paramucronata* n. sp. alone, and eight populations contained a mixture of both *H. oryzae* and *H. paramucronata* n. sp. In addition, microscopic images of *Meloidogyne* and *Hirschmanniella* were captured to prepare an image dataset for their future use in deep learning models for automated identification.

The diversity and community structure of plant and soil nematodes associated with crops grown under protected cultivation in Karnataka, Delhi

NCR, Haryana, and Uttar Pradesh were analysed. Plant-parasitic nematodes *Meloidogyne incognita*, *Helicotylenchus* sp., *Pratylenchus* sp., *Rotylenchulus reniformis* and *Hoplolaimus indicus* were the most frequent and dominant species across cucumber, tomato, brinjal, chilli, and capsicum. Predatory and microbivorous nematodes were recorded for the first time from these regions. Correlation analysis indicated species-specific preferences for soil conditions, while principal component analysis (PCA) highlighted the influence of soil parameters on nematode community structure. Soil pH showed a relatively isolated effect, whereas other nutrients were strongly associated with particular species. *Helicotylenchus* sp. and *H. indicus* were responsive to soil nutrient levels, while *M. incognita* and *Pratylenchus* sp. exhibited broader adaptability across varying soil conditions.

Different guava growing districts (Jaipur, Sawai Madhopur, Alwar & Sirohi) of Rajasthan were surveyed for identification of *Meloidogyne enterolobii* infestation in guava. A mix population of *M. enterolobii* and *M. incognita* from Sawai Madhopur while only *M. enterolobii* population were observed in Sirohi and Alwar districts and only *M. incognita* was found in Jaipur infecting guava roots.

In 2025, numerous galls were observed in Alligator weed (*Alternanthera philoxeroides*), collected from a Guava orchard (28°38′52.314″ N, 77°9′10.12″ E). Guava root-knot nematode, *Meloidogyne enterolobii* was found in all soil and root samples, with nematode population densities ranging from 23 to 60 J2s/cc of soil and 855 to 2,520 eggs and J2s/ g of fresh roots. Weed hosts are critical for *M. enterolobii* because they ensure off-season survival, facilitate field-to-field spread, and undermine control measures such as crop rotation and resistant varieties. Thus, weed management is an essential part of integrated nematode management (INM) to reduce *M. enterolobii* survival and spread.



A. Healthy and Infected Plant. B. Unhealthy Plant root. C. Eggs of *M. enterolobii*.
D. Hatching from eggmass. E. Eggmass F. Female

4. CROP AND NATURAL RESOURCE MANAGEMENT FOR SUSTAINABLE ENVIRONMENT

The School of Natural Resource Management adopts a holistic, system-based approach to managing crop, soil, water, and environmental resources, with the overarching goal of enhancing farm productivity, profitability, and long-term sustainability while conserving the natural resource base and minimizing environmental impacts. During 2025, focused efforts were directed towards strengthening climate-smart and resource-efficient production systems through improved nutrient and water use efficiency, restoration of soil health, and mitigation of greenhouse gas emissions. Notable advancements were achieved in conservation agriculture-based cropping systems, weather-informed crop management, precision input application, and integrated nutrient, water, and weed management strategies. Cutting-edge research integrating remote sensing, GIS, crop simulation modelling, digital agro-advisory platforms, biofertilizers, renewable bio-resources, agricultural waste valorization, emission analytics, watershed management, and appropriate farm mechanization has further strengthened evidence-based decision-making and enhanced field-level impact. Through innovation, capacity building, interdisciplinary collaboration, and farmer-centric technologies, the School continues to play a pivotal role in promoting sustainable intensification and resilient natural resource management for agricultural growth.

4.1 AGRONOMY

4.1.1 Evaluation of the Timing of Crown Root Initiation (CRI) in Wheat Grown under Zero-Tillage Condition

In wheat sown under zero-tillage conditions, CRI stage was observed at 17-18 days after sowing (DAS), whereas in conventional tillage it was seen at 23-25 DAS. Physiological parameters such as photosynthetic rate, stomatal conductance, intercellular CO_2 concentration and transpiration rate were improved in zero-tillage wheat (ZTW), especially when irrigated at 18 DAS, indicating reduced stress and enhanced crop vigor. This gave approximately 11% higher grain yield compared to irrigation at 25 DAS.

4.1.2 Integrated Crop Management (ICM) for Long-term Sustainability of Maize-wheat Rotation Focusing on Productivity, Energy and Carbon Footprints

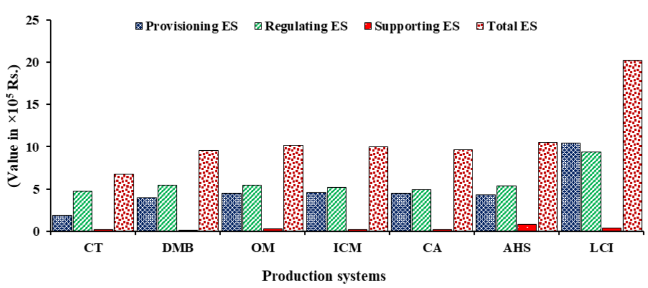
Eight ICMs were evaluated over nine years, including conventional flat-bed (ICM1–2) and raised-bed maize–wheat (ICM3–4), and conservation agriculture (CA)-based double (ICM5–6) and triple zero-till systems with residues and green manures (ICM7–8). CA-based ICMs increased system productivity by 16.5–22.9% over conventional ICMs and required higher energy input, 76–80% of which came from renewable crop residues. They also showed higher specific energy, human energy profitability, non-renewable energy use efficiency, nutrient energy use efficiency, and total output energy (12.5% higher). In contrast, conventional ICMs had greater energy productivity, net energy returns, and energy profitability. CA-based practices, however, achieved superior carbon output, sustainability, and efficiency, highlighting their long-term environmental benefits.

4.1.3 Impact Assessment of Two Decades of Organic Farming in Rice-wheat System on Environmental Footprints

The effect of 23-years of co-applying organic amendments in the rice-wheat system (RWS) with treatments combining *Sesbania* green manure (SGM), *Leucaena* green leaf manure (GLM), blue-green algae (BGA), farmyard manure (FYM), and *Azotobacter chroococcum* culture (seed treatment), were compared with the sole application of each amendment. The SBF-R (SGM + BGA + FYM to rice) followed by LAF-W (GLM + *Azotobacter* + FYM to wheat) treatment produced the highest rice-equivalent yield (REY) and net energy 80% and 77% over the control (no organic amendment nor chemical fertilizers), and 9-15% (REY) and 2-17% (net energy) over sole-organic treatments. Water footprints were 8-14% lower than sole-organic treatments under SBF-R followed by LAF-W. Nevertheless, SBF-R fb LAF-W achieved the highest C-sequestration (at 0-45 cm depth) and thereby improved carbon sustainability index (CSI) and carbon efficiency.

4.1.4 Quantifying Ecosystem Services under Diverse Agricultural Production Scenarios in the Indo-Gangetic Plains

Seven production systems were evaluated: Conventional System (CT), Diversified Maize-based System (DMB), Organic Management System (OM), Integrated Crop Management System (ICM), Conservation System (CA), Agri-horti System (AHS) and Livestock-Crop System (LCI). Economic values of provisioning services reported under various production systems followed the trend: LCI > ICM > CA; regulating services: LCI > DMB > AHS; supporting services: AHS > LCI > OM. Total ecosystem service values were recorded ~3 times higher in LCI than in CT, followed by AHS and OM production systems.



CT: Conventional System; DMB: Diversified Maize-based system; OM: Organic Management; ICM: Integrated Crop Management; CA: Conservation Agriculture; AHS: Agri-horti system; LCI: Livestock Crop Integration

4.1.5 Effect of Legume Integration and Nitrogen Management on Productivity-Energy-Economics-Carbon Footprints Trade-Off in Maize Cultivation

Four maize+legume integrations were assessed: sole maize, maize + cowpea, maize + black gram, and maize + *Sesbania* with three nitrogen (N) management practices, i.e., recommended dose of nitrogen (RDN;150 N kg ha^{-1}), 125% RDN, and 75% RDN. The maize + cowpea with RDN recorded 40.7% higher system productivity than sole maize with RDN. The maize+cowpea with an RDN had the highest net return (₹134,890 per hectare). The RDN recorded higher net energy (74.65 GJ ha^{-1}) over other N management options. The maize-cowpea with 75% RDN recorded ~16.7% higher energy use efficiency compared to the maize-cowpea with RDN. Cowpea+maize registered ~1.4 times higher carbon return than sole maize. Co-culturing of cowpea with maize recorded least carbon footprint on energy (20.67 kg CO_2-eq GJ^{-1}), productivity (0.304 kg CO_2-eq kg^{-1}), and economic (0.015 kg CO_2-eq ₹$^{-1}$) scales over the rest.

4.1.6 Soil Carbon Dynamics and Soil Biological Indicators under Intensified Maize-based Systems

Two land configurations; flat-bed (FB) and raised-bed and furrow (RBF) and four cereal-legume

Maize + Cowpea-wheat+lentil on raised bed and furrow

integrations; maize-wheat (M-W); maize + black gram + soybean-wheat + chickpea (M+B+Sy-W+Cp); maize + cowpea + soybean-wheat + lentil (M+C+Sy-W+Ln); and maize + cowpea + soybean-wheat + mustard (M+C+Sy-W+Ms) were evaluated. The carbon sequestration was ~8% higher in the RBF over FB, and cereal-legume integration enhanced soil organic carbon (SOC) by ~6.25% over the M-W. The cereal-legume integration increased the SOC sequestration by two times over M-W and the highest C-sequestration was recorded under maize + cowpea+ soybean–wheat + lentil.

4.1.7 Enhancing Wheat Productivity and Profitability through Efficient Weed Management using New Ready-mixed Herbicides

Application of bixlozone @750 g/ha+metribuzin @150 g/ha (PoE) (ready-mixed @1500 g/ha) and metribuzin @210 g/ha+clodinafop @60 g/ha (PoE) (tank- mixed) were most effective, registering high weed control index (WCI) (91.3 and 89.1%), very low weed index (WI) (1.2 and 2.2%), and higher wheat grain yield (6.46 and 6.40 t ha^{-1}), comparable to the weed-free control. Pendimethalin (PRE) followed by cono-weeding also resulted in effective weed control (WCI 88.1%) and higher yield (6.11 t ha^{-1}).

4.1.8 Sulphur and Micronutrient Nutrition for Maize Biofortification and Yield Enhancement

This study evaluated Zn-embedded sulphur (Zn-ES) and multi-micronutrient embedded sulphur (MM-ES) under varying recommended fertilizer-doses (RDF) on maize productivity, biofortification, and soil-health across diverse ecologies (Delhi, Karnal and Shimla). Co–application of S, Zn-ES and MM-ES produced highest yield in Karnal, surpassing Delhi (+2.9%) and Shimla (+14.2%). This study demonstrated that co-application of RDF with S, Zn-ES and MM-ES optimizes maize productivity and biofortification, while improving soil fertility, offering a sustainable strategy to address micronutrient malnutrition.

4.1.9 Optimizing Nitrogen Application with Sub-surface Drip-fertigated (SSDF) Maize-wheat System

Fertigation of 100% recommended dose of nitrogen (RDN) through SSDF in six splits (100% RDN-6S), 100% RDN in four splits (100% RDN-4S), 75% RDN in six splits (75% RDN-6S), and 75% RDN in four splits (75% RDN-4S) resulted in similar yield. All these treatments produced significantly higher grain yields compared to the conventional method of nitrogen application (100% RDN in three splits). Fertigating 75% RDN-6S and 100% RDN- 6S produced 21 and 24.5% higher maize grain yield, while 75% RDN- 4S, and 100% RDN- 4S could improve the yield by 17.3 and 18.6%, respectively, compared to conventional maize cultivation.

4.1.10 Integrated Farming System (IFS) Models for Irrigated and Rainfed Conditions

Integrated farming system (IFS) models combining crops with dairy, fishery, poultry, duckery, apiary, boundary plantation, biogas, and vermicompost achieved the highest system productivity and production efficiency, with the lowest water footprint, at a yield scale comparable to that of crop-only systems under irrigated conditions. Likewise, under limited irrigation, integration of horticulture, protected cultivation, field crops, agro-horti systems, mushroom production, backyard poultry and vermicomposting improved livelihood index and nutrient recycling over business-as-usual practices.

Different components of the IFS model under irrigated conditions

4.1.11 Performance of New Wheat Genotypes at Different Dates of Sowing under Irrigated Conditions

A total of thirteen wheat genotypes viz., MACS 6837, GW 554, HI 1683, MPO 1395, MP 3570, HI 8713, HI 8850, HI 8849, MACS 6768, GW 322, GW 555, GW 555 and MACS 4135 were evaluated under timely and late sown conditions. Data indicated that the difference between grain and biological yields under timely (5.06 and 11.73 t/ha) and late (4.94 and 12.05 t/ha) sowing conditions was not significant. While among genotypes, HI 8849 recorded maximum grain yield of 5.44 t/ha, which being at par with GW 555, MACS 4135, HI 8850 and MP 3570 was significantly higher over rest of the genotypes.

4.1.12 Performance of New Wheat Genotypes under Late Sowing Conditions

The field experiment was conducted, where seven wheat genotypes viz., CG 1029, MP 4010, GW 556, WSM 138, HI 1634, DBW 425 and HD 2932 were evaluated under late and very late sown conditions. Data revealed that delay in sowing from late to very late conditions significantly decreased the grain and biological yields of wheat to the tune of 13.0 and 12.1%, respectively.

4.1.13 Performance of New Wheat Genotypes under Restricted Irrigation Conditions

Among irrigation schedules, two irrigations applied at the CRI and boot leaf stages yielded the highest wheat grain (4.15 t/ha) and biological (10.05 t/ha) yields, compared with one irrigation and control. CG 1040 and HI 8823 recorded identical wheat grain yields of 3.56 t/ha but CG 1040 also recorded maximum biological yield of 8.75 t/ha. These yields were statistically at par with HI 8627, MACS 4131, DBW 432 and DBW 110 but significantly higher over rest of the genotypes.

4.2 SOIL MANAGEMENT

4.2.1 Novel Boron-Loaded Nano Clay Polymer Composite (B-NCPC) for Improving Use Efficiency

Conventional boron (B) fertilizers have low use efficiency (~2%) due to leaching losses. A boron-loaded nano clay polymer composite (B-NCPC) was developed and evaluated in tomato and wheat across different soils. Optimized synthesis achieved 10% B loading, with structural confirmation via XRD, SEM, and TEM. B-NCPC applied at half the recommended dose (0.446 mg kg^{-1}) produced yields comparable to the full dose of borax, demonstrating improved boron-use efficiency through controlled nutrient release.

4.2.2 Natural Soil Clay Fractions on Stabilization of Carbon in Major Soil Orders of India

The stabilization of external C input was obtained highest for Vertisol-SCF followed by Mollisol-SCF, whereas Alfisol and Inceptisol-SCFs showed similar stabilization capacity. Higher C saturation capacity was observed in Vertisol and Mollisol SCFs at 12g wheat residue kg^{-1} clay-sand mixture, whereas Alfisol and Inceptisol-SCF had lower C saturation capacity. Increasing clay content from 7.5 to 40%, has led to higher C stabilization and presence of sesquioxides provided large reactive surfaces to accumulate and stabilize labile carbon.

4.2.3 Assessment of Quality and Stability of Soil Organic Carbon (SOC) under Long-term Fertilizer Experiments

Quality and stability of SOC were assessed under 4 major soil orders, viz. Vertisol, Mollisol, Inceptisol and Alfisol using long-term experiments with sorghum-wheat, rice-wheat, rice-lentil and maize-wheat cropping systems, respectively. The treatment NPKZnF of Mollisol, NPKF+ of Vertisol, NPKGB of Inceptisol and PKFL of Alfisol performed best with respect to quality and stability of SOC.

4.2.4 Natural and Integrated Farming Approaches for Soil Health and Yield Optimization

The organic farming (OF) inputs significantly increased nutrient availability, with available N and K levels raised by 27.8 and 33.7%, respectively, compared to the control. Natural farming (NF) did not increase nutrient availability (N and P) except in control plots. Among all treatments, the highest soil microbial biomass carbon (SMBC) was recorded under NF plots, which significantly (p=0.05) increased by 7.42 and 14.4% in surface soil and by 29.1 and 60.3% in subsurface soil compared with organic farming and integrated crop management (ICM) plots, respectively. Similar to SMBC, the enzymatic activity of soil was higher under NF plots. Grain yield of rice was 16.8 and 11.8 % higher in ICM plots as compared to NF and OF plots, respectively.

4.2.5 Silicon-Rich Sugarcane Agro-wastes enhance Phosphorus Availability in Soils

A 75-day incubation study across four soils viz. acidic alluvial (Jorhat), acidic red (Hazaribagh), alkaline black (Nagpur) and alkaline alluvial (Central Delhi), showed higher soluble P release at 35 °C than 25 °C, with alkaline alluvial soil recording the highest values. Among sources, P release followed: sulphitation press mud (SPM) > sugarcane leaf (SL) > sugarcane bagasse ash (SBA) > fumed silica (FS) > control. Sugarcane by-products (SPM, SL, SBA) effectively enhanced P availability via ligand exchange and decomposition, with stronger effects in non-acidic soils.

4.2.6 STCR-based Novel Customized Compacted Fertilizer (CF) Products

Soil test crop response (STCR)-based novel customised compacted fertilizer (CF) products, with and without coatings of polyvinyl acetate +, triacetin (C), and pongamol (P), a nitrification inhibitor were studied for nutrient release and gaseous losses. Fertilizer coated with polyvinyl acetate and triacetin lead to slower and more synchronized nutrient release, thereby reducing losses through leaching, volatilization, and gaseous emissions.

4.2.7 Effectiveness of Nano Urea (NU) Fertilizer in Crop Production and Soil Health

The wheat and maize yield with recommended dose of fertilizer (RDF) and 75% conventional urea and one single spray of nano urea (NU) were statistically at par. Thus, replacing 25% of conventional urea with NU does not affect crop yield. N content, uptake by wheat grain, and straw were maximum under the recommended dose of fertilizer (RDF) and with 25% replacement of conventional urea with NU.

4.2.8 Dynamics of Metal in Sludge-Amended Soils under Cowpea-Lentil Cropping Sequence

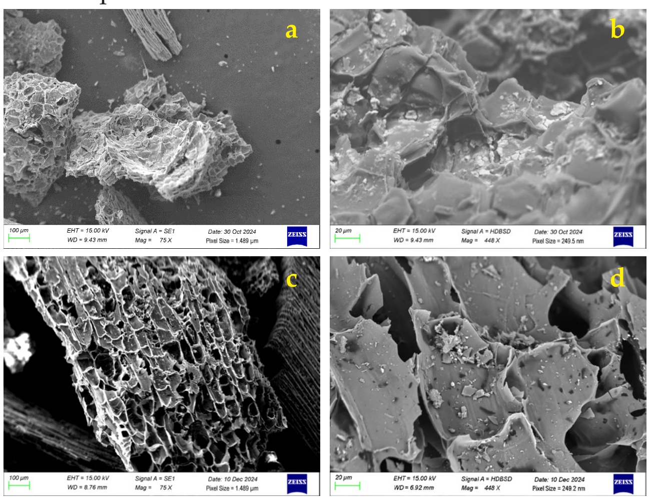
A 10-year study under a cowpea–lentil system showed highest cowpea yield with 100% RDF + 2.5 t sludge ha^{-1}, comparable to replacing 25% N with sludge (5 t ha^{-1} + NPK). Health risk assessment (hazard quotient for Ni, Pb, Cd) remained well below 1, indicating no consumer risk. Long-term sludge application did not pose human health hazards.

4.2.9 Effect of Treated Paper Mill Effluent on Metal Buildup and Yield of Crop

A field experiment was started in 2021-22 in Ahmednagar, Punjab, across rice–wheat, rice–maize, and vegetable systems. Metal contamination (Cr, Pb, Ni) increased with higher effluent irrigation with significantly less (20%) yield compared to groundwater irrigation.

4.2.10 Engineered Biochar for Reducing the Solubility of Anionic and Cationic Pollutants

Fe-doped engineered biochar was synthesized and characterized (SEM, XRD, FTIR) to reduce the solubility of anionic and cationic pollutants in broiler litter (BL)–amended soils, where iron impregnation enhanced biochar functionality and formed magnetite (Fe_3O_4) coatings. Amending BL-mixed soils with FeBC2 reduced solubility of total dissolved P (10.1-23.2%), dissolved reactive P (8.82-18.7%), NH_4^+-N (14.8-18.4%), NO_3^--N (3.14-12.2%), Cu (14.7-16.1%), and Zn (~20.9%) with respect to BL-mixed soils.



SEM images of engineered biochar (FeBC): (a-captured with secondary electron detector, b-captured with backscattered electron detector) and biochar (WBC):- (c-captured with secondary electron detector, d-captured with backscattered electron detector) samples showing coating of biochar surface with iron

5.2.11 Engineered Biochar for Immobilization of Arsenic from Contaminated Soil

Engineered biochar from rice straw, sugarcane bagasse, and jute stalk, modified with $FeCl_3$, goethite, and magnetite, was evaluated for arsenic immobilization in contaminated Inceptisols of Assam and West Bengal. $FeCl_3$-modified biochars showed the highest efficiency (up to 67.2% in Assam and 58.8% in West Bengal), with $FeCl_3$-treated sugarcane bagasse biochar exhibiting the greatest adsorption capacity (515 mg kg⁻¹).

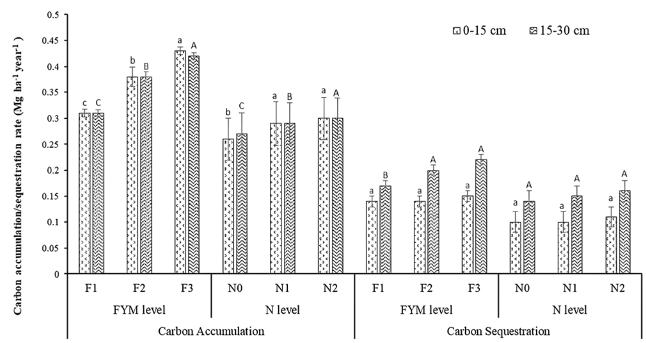
4.2.12 Assessing the Adsorption Behaviour of Molybdenum in Soils

Maximum adsorption of Mo was observed in the soils where pH ranges from 4-5, while in alkaline soils (pH >8) negative adsorption phenomena was found. Freundlich isotherm fitted better than Langmuir isotherm in a wide range of soil's pH. A highly significant negative correlation was observed between soil pH and adsorption parameters, while a significant positive correlation was found between SOC and adsorption parameters. It was observed that molybdenum sorption in soil is a spontaneous endothermic reaction.

4.2.13 Nutrient Management

4.2.13.1 Enhancing SOC through sustained use of farmyard manure and nitrogen

A 56-year study on a pearl millet–wheat system evaluated farmyard manure (0–30 Mg ha^{-1}) and N fertilizer (0–120 kg ha^{-1}) effects on SOC. The highest SOC increase (surface 143%, subsurface 183%) occurred with 30 Mg ha^{-1} FYM + 120 kg ha^{-1} N. FYM and N significantly enhanced active carbon pools, carbon sequestration, and the carbon management index. Results suggest that 20 Mg ha^{-1} FYM optimally improves both labile and stable SOC in sandy loam soils under semi-arid, subtropical conditions.



F0, without FYM; F1, FYM application @ 10 Mg ha^{-1}; F2, FYM application @ 20 Mg ha^{-1}; F3, FYM application @ 30 Mg ha^{-1}; N, nitrogen; N0, without nitrogen; N1, nitrogen application @ 60 kg ha^{-1}; N2, nitrogen application @ 120 kg ha^{-1}

4.2.13.2 Nutrient release and microbial community structure under Conservation Agriculture (CA)

Nutrient release pattern of CA-based practices viz. two tillage techniques, ZT+R (Zero tillage with residue retention) and CT+R (conventional tillage with residue incorporation) and four nitrogen management approaches (control, recommended dose of N (RDN), Urea+ Greenseeker (Urea+GS), and urea super granule+GS (USG+GS) were studied. CA practice significantly enhanced the mineral N, Olsen P, $CaCl_2$–S release and soil enzymes involved in mineralization of these nutrients as compared to CT+R plots. USG+GS treatment significantly outperformed the RDN in NO_3-N and $CaCl_2$–S release. In another, 12 years old rice-based cropping systems under CA the soil microbial community structure was assessed. It was found that Proteobacteria were the dominating phylum in rice-based cropping systems in coastal saline soils of Sundarban, followed by Actinobacteria, Chloroflexi, Firmicutes, Acidobacteria, *and Bacteroidota*. Rice-rice cropping system has higher alpha diversity index as compared to the rice-potato system.

4.2.13.3 Assessment of the suitable extractant along with the critical deficiency level of Fe in soils

A study across 20 Indo-Gangetic Plain soils evaluated seven Fe extractants under moist and air-dried conditions using lab and greenhouse tests. Diethylene Triamine Pentaacetic Acid (DTPA) performed best in moist soils, showing strongest correlation with plant Fe uptake. Critical deficiency thresholds were 4.4 mg kg^{-1} (moist) and 5.9 mg kg^{-1} (air-dried) for DTPA, and 1.8–2.0 mg kg^{-1} for the organic acid mixture; metabolically active Fe ranged 36.3–37 mg kg^{-1}. Air-drying altered Fe extractability, while the organic acid mixture emerged as a practical, moisture-insensitive Fe assessment tool.

4.2.13.4 Enriched organo-mineral fertilizer as an alternative source of P and K

A rock phosphate-enriched compost (PREC) was evaluated for supplementing chemical P fertilizer under maize-wheat and soybean-wheat cropping systems. The study revealed that PREC application reduced DAP application by 50% while maintaining crop productivity in both cropping systems. By replacing DAP, PREC was able to reduce P fertilizer cost by 11-17%. Application of PREC significantly improved residual soil P fertility and biological status in both cropping systems.

4.2.13.5 Preparation and evaluation of biochar-based novel fertilizer products

Chemical modification of maize stover biochar was done to enhance cation exchange capacity (CEC) and anion exchange capacity (AEC), and biochar-based novel fertilizer products were synthesized for enhancing nutrient use efficiency. Biochar treated with H_2SO_4-HNO_3-$FeCl_3$ significantly enhanced exchange capacities for N, P and K and emerged as a potential biochar fertilizer for slow and sustained release of nutrients.

4.2.13.6 Stability of composite beads for the removal of contaminants from aqueous solutions

Composite beads were developed by varying crop residue, sodium alginate, and $CaCl_2$, producing eight types (CACa1–CACa8). Stability was assessed via swelling index, size, and morphology, and their efficiency for dye and heavy metal removal was also tested. CACa7 (5 g crop residue, 1.5% alginate, 4% $CaCl_2$) showed the highest dye adsorption (158 mg g^{-1}) and removed up to 60% of Cr (VI).

4.3 WATER MANAGEMENT

4.3.1 Assessment of the Water Footprint of Rice in the North-Western Plain Zone

Green (WFg) and blue (WFb) water footprints of rice were assessed using CWR (crop water requirement) model based on 20 years (2000-2020) weather and yield data. WFg ranged 1,122.8–2,801.9 m^3 t^{-1}, lowest in southwestern districts (Gautam Buddha Nagar, Ghaziabad), moderate in Meerut, Jyotiba Phule Nagar, and Muzaffarnagar, and highest in northern/eastern districts (Saharanpur, Bijnor, Moradabad–Rampur, Bareilly), reflecting rainfall dependence. WFb varied 2,117.1–3,165.7 m^3 t^{-1}, with maximum irrigation use in Meerut, Ghaziabad, Baghpat, and Bulandshahr, and lower values in Bijnor and Bareilly. Overall, higher rainfall increased green water use, while intensive irrigation drove higher blue water footprints, showing spatial variability in rice water use.

4.3.2 Assessed the Efficacy of Machine Learning Models in Classifying Extreme Rainfall Events over New Delhi

Rainfall extremes (annual, monsoon, and monsoon wet-day) in Delhi from 1984–2024 were analyzed, revealing a significant upward trend (annual Sen's slope 0.55 events/year), concentrated in July–August. Among ML models, MLP performed best annually (AUC = 0.94, accuracy = 96%) and for monsoon wet-day extremes (AUC = 0.96, accuracy = 99%). For monsoon season extremes, MLP excelled in deficit events (AUC = 0.88), while RF and X GBoost were superior for heavy rainfall (AUC = 0.88). SVM and KNN showed lower predictive skill.

4.3.3 Optimization of Water-Footprints in Conservation Agriculture based Intensified Triple Zero-tilled Pearl Millet-based Cropping Systems

Three crop establishment systems viz., conventional-tillage (CT), zero-tillage (ZT), and zero-tillage with residue retention (ZTR) and three crop-sequence options viz., pearl millet-mustard (PM), pearl millet-mustard-mungbean (PMM), and pearl millet-mustard-clusterbean (PMC) were evaluated. The ZTRPMC system reduced total water footprints by 90% and increased economic profitability by about 40% compared to conventional practices. It also recorded the highest average yields: pearl millet 2.6 t ha^{-1}, mustard 2.51 t ha^{-1}, and clusterbean 4.02 t ha^{-1}. GGE-biplot analysis confirmed superior stability in system productivity and net returns for ZTRPMC and ZTRPMM over eight years. These systems offer a climate-resilient, water-efficient approach for resource-constrained environments.

4.3.4 Physiological Traits Governing Drought Tolerance in Mustard Varieties under Precision Irrigation

Three mustard varieties (Pusa Vijay, PM33, Rh30) were evaluated under no irrigation, 50%, and 100% irrigation at flowering and pod stages. PM33 performed best under 50% irrigation, with highest chlorophyll (a: 5.2 mg per g of fresh weight; b: 3.1 mg per g of fresh weight), carotenoids, oil content (42%), and micronutrients (Fe: 1.2 mg/100 g; Zn: 0.6 mg/100 g). It also achieved maximum grain and straw yields (2.5 t/ha and 4.2 t/ha) at 50% irrigation, showing that partial irrigation can save one irrigation without reducing growth or yield.

4.3.5 Deployment of DNN-Machine Learning Model for Drought Forecasting through Composite Drought Index

Drought forecasting was performed using a composite drought index (CDI) derived from principal component analysis of individual indicators at a 1-month scale. Five machine learning models, DNN, RF, SVM, ANN, and GB, were evaluated on an 80:20 train-test split. Performance metrics (R^2, RMSE, MAE, NSE) showed DNN captured the most variability with the lowest errors ($R^2 = 0.93$, RMSE = 0.213, MAE = 0.152, NSE = 0.932), outperforming SVM, ANN, RF, and GB. The study demonstrates that DNN-ML effectively improves drought forecasting, supporting advanced drought management planning.

4.3.6 Estimation of Water Productivity and Crop Coefficient of Broccoli through Sensor-based Drip Fertigation

Two broccoli varieties, Pusa Broccoli-13 (green) and Pusa Purple Broccoli-1 (purple), were evaluated under four irrigation regimes (15, 30, 45, 60% soil moisture depletion, SMD). Purple broccoli at 15% SMD received maximum irrigation (115 mm, 9 events) and produced the highest head weight (345 g) and yield (22.2 Mg ha^{-1}), while anthocyanin content peaked (55.3 mg/100 g) at 60% SMD. Maximum water productivity (19.4 kg m^{-3}) was observed at 30% SMD. Crop coefficients (Kc) computed via. CROPWAT from ET_0 closely matched FAO curves but were slightly higher, emphasizing the need for site-specific Kc values to optimize water use and productivity under water-scarce conditions.

4.3.7 Effect of Land Configuration, Irrigation Methods, and Mulching on Crop and Water Productivity in Direct Seeded Rice

A field experiment evaluated two irrigation methods (drip I1, surface I2), two sowing methods (raised bed S1, flat S2), and mulching (M1, M0). Yield and yield components were highest under I1S1M1, with grain yield 4.67 t ha^{-1}, straw 6.17 t ha^{-1}, and total biomass 10.84 t ha^{-1}. Drip irrigation improved irrigation water use efficiency (18.6 kg ha mm^{-1}), water use efficiency (14.65 kg ha mm^{-1}), irrigation water productivity (1.86 kg m^{-3}), and overall water productivity (1.46 kg m^{-3}). Mulching further enhanced these efficiencies. Nutrient uptake was also highest under I1S1M1, with N, P, and K accumulation of 127.2, 38.16, and 108.12 kg ha^{-1}, respectively.

4.3.8 Wireless Water Level Sensor-based Irrigation Scheduling in Transplanted Rice

Four irrigation treatments were tested using wireless water level sensors with LoRa and GSM communication, based on thresholds I1 (5 cm), I2 (3 cm), I3 (2 cm), and conventional I4. Irrigation was triggered when water level fell ≥50% below the threshold. Total irrigation applied was 23.21, 18.54, 12.25, and 29.75 cm for I1, I2, I3, and I4, respectively. Sensor-based irrigation saved nearly 30% water compared to conventional practice, with maximum water productivity of 0.75 kg m^{-3} achieved in I1.

4.3.9 Soil Moisture Sensor-based Irrigation Scheduling in Wheat

Resistance-based wireless soil moisture sensors were installed in the field at a depth of 30 cm. Irrigation was scheduled when soil moisture depletion exceeded 50%. The automatic check gate opens and closes as the soil moisture threshold is reached. A total of 290 mm and 201 mm of irrigation were applied under conventional and sensor-based irrigation, respectively. Nearly 30% water was saved in sensor-based irrigation with the highest yield recorded in this method.

4.3.10 Performance of Surface and Subsurface Drip Fertigated Summer Squash-Baby Corn-Broccoli under Different Irrigation Schedules and Nitrogen Doses

Summer squash-baby corn-broccoli was irrigated at 80 and 100% ETc using surface and subsurface drip, with nitrogen at 60, 80, and 100% of the recommended dose. Summer squash yield ranged 24.4–35.8 Mg ha^{-1} (avg. 30.0 Mg ha^{-1}), increasing 13–33% with higher N doses. Surface and subsurface drip produced similar yields, with 10% higher yield at 1.0 ETc vs 0.8 ETc. Subsurface drip at 0.8 ETc with 100% N achieved the highest squash yield (38.0 t ha^{-1}), comparable to surface drip with 100% NPK. Baby corn and broccoli yields also increased with higher N. Water savings at 0.8 ETc were 74% for squash, and 82% for baby corn and broccoli.

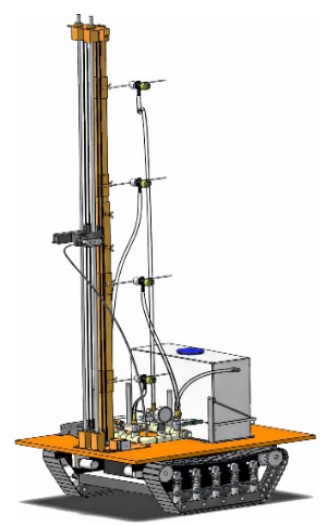
4.4 AGRICULTURAL ENGINEERING

4.4.1 Riding Type Prime Mover for Small Farms

A 10 hp (5.6 kW) diesel-engine riding-type prime mover was developed for small farms to operate multiple implements, including rotary tiller, weeder, cultivator, ridger, multi-crop seed-cum-fertilizer drill, sprayer, and reaper. The four-wheel design ensures stability, with rear-wheel drive, mechanical steering, PTO, and hydraulically actuated three-point hitch systems. Optimized chassis (track width 736.8 mm, wheelbase 1137.3 mm) includes front and rear three-point linkages. A versatile powertrain with selective gears enables tillage, sowing, intercultural operations, spraying, and harvesting using a single unit.

4.4.2 Real Time Machine Vision based Robotic Target Sprayer

A disease-detection-based, target-specific spraying robotic system was developed to detect diseased regions in real time and apply plant protection chemicals exclusively in disease affected areas. The system comprises a track-type robotic sprayer equipped with a linear camera–based scanning mechanism for continuous monitoring of crop rows. The robotic platform employs skid-type steering and integrates an embedded processing unit (Jetson Nano), vision sensors, Arduino-based controllers, solenoid valves, and selectively actuated spray nozzles to enable precise and localized chemical application. The system resulted in a pesticide saving of about 70% when compared with a conventional knapsack sprayer, demonstrating its potential for precision plant protection and environmentally responsible crop management.



Robotic target sprayer

4.4.3 Nitrogen Prescription Device for Cereal Crops

Nitrogen prescription device

A hand-held multi-vegetation index (NDVI, NDRE, and RVI) based device was developed for growth specific nitrogen assessment and prescription in direct seeded rice (DSR). The fertilizer application bin DSR based on device prescribed recommendation resulted in N fertilizer savings of 8.48 and 23.84% during first and second top dressings, respectively in comparison to conventional recommended dose of nitrogen (RDN) application. Also, the respective advantage in nitrogen use efficiency (NUE) and yield was 28.59 and 7.63%. In comparison to RDN, the device also achieved a cost saving of 8.07% through its precise growth specific fertilization recommendation. With its high precision, accuracy, and a total development cost of about $ 60, the device represents a promising, cost-effective option for improving nitrogen management in rice cultivation.

4.4.4 Pusa Robotic Seed Spices Harvester

A robotic harvester was developed for efficient harvesting of seed spice crops such as cumin, coriander, and fennel. Laboratory experiments were conducted to optimize key operational parameters for minimizing cutter bar, conveying, and shattering losses, followed by field evaluation under optimized conditions. Field performance indicated cutter bar losses of approximately 10%, conveying losses of 10–12%, and shattering losses below 9%, with an overall field efficiency of 71%. The developed harvester reduced harvesting time by 99, 72, and 61% compared to manual sickle harvesting, manually propelled harvesters, and battery-powered harvesters, respectively. The total cost of the system was approximately ₹1,20,000, with a net annual profit of ₹35,740, a break-even point of 34.38 ha/year, and a payback period of 3.36 years. The robotic harvester is well-suited for uneven terrain and lodged crop conditions, enhances operator safety through remote operation, and offers an efficient and sustainable solution for seed spice harvesting.

Robotic seed spice harvester

4.4.5 Pusa Robotic Root-Washed Type Paddy Transplanter

A telerobotic root-wash-type transplanter was developed in collaboration with an industry partner. The two-row paddy transplanter eliminates manual labour through smart automation and precise wireless control. Unlike conventional systems, it utilizes a root-washed seedling module that transplants nursery-raised seedlings with cleaned and properly aligned roots, ensuring uniform planting depth and spacing. The metering system comprises a double-stacked

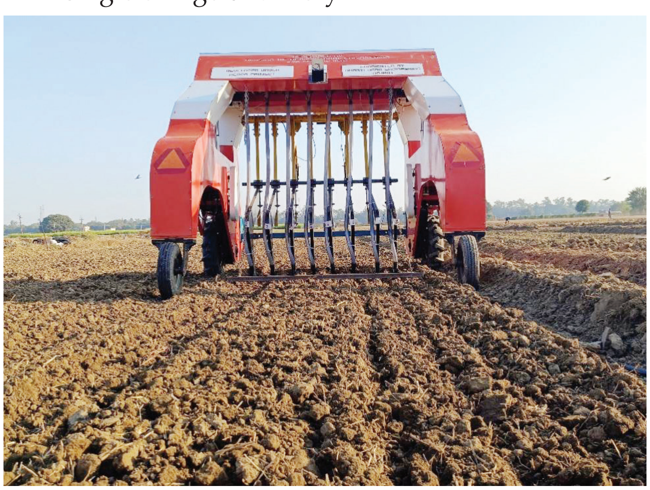
Robotic root washed type paddy transplanter

zigzag tray with reduced slope, a motor-driven belt conveyor, and Hall-effect sensor-based synchronized control for precise seedling delivery. Six finger geometries were evaluated using paddy varieties PB 1692 and PUSA 1612 at seedling ages of 20, 25, 30, and 35 days after sowing. The wider and shorter gap finger performed best, effectively handling seedlings with an average shoot diameter of 4 ± 0.2 mm. Laboratory optimization identified a disc speed of 90 rpm and a belt displacement of 15 mm per stroke as optimal.

Planting efficiencies of 99% for PB 1692 (30 DAS) and 98.5% for PUSA 1612 (25 DAS) were achieved, with seedling damage below 0.15%. Field trials on sandy clay loam soil indicated optimum performance at 48 hours of soil settlement and a forward speed of 1.0 km h^{-1}.

4.4.6 Pusa VRT Robot for Fertilizer Application

A Variable Rate Technology (VRT) based robot was designed to apply fertilizers at variable rates based on field variability maps, thereby optimizing nutrient use efficiency and minimizing input wastage. It is equipped with GPS-enabled system for fertilizer application, and a microcontroller-based control system and can be controlled using a remote. The system significantly reduces labour requirements by 50%, and the automated navigation and controlled dispensing ensure uniformity and repeatability, minimizing human error. The robot can for 4-5 hours with single charge of battery.



VRT Robot for fertilizer application

4.4.7 PUSA i-Therm Processor

The Pusa i-Therm Processor is an advanced, energy-efficient food drying and processing equipment designed to enhance preservation and product quality. This innovative compact system (76x170x215 cm) provides a continuous, multistage process ideal for sliced or chopped fruits, vegetables, herbs, spices, leaves, petals, flowers, and even granular materials (capacity ≈ 5 kg/h for leaves/petals). Key advantages include low initial investment, simple operation, minimal energy use, and superior retention of nutritional/sensory qualities over sun, solar, or hot air drying. Ideal for farmers and small processors.

4.4.8 Characterization of Arecanut Husk Fibers for Value-added Applications

Twelve commercial arecanut varieties were assessed for textile, composite, and industrial applications. VTLAH-2 exhibited the finest fibers (17.73 denier, 27.0 mm), suitable for fine textiles and cotton blending. Ratnagiri (24.41 denier, 34.8 mm) and Swarna Mangala (33.3 denier, 28.4 mm) were suitable for medium-grade textiles and biodegradable composites. Mangala and Madhura Mangala (~45 denier) fit coarse textiles like carpets and sacks, while Tirthahalli, Mohitnagar, and Sumangala (>60 denier) were ideal for nonwoven mats, ropes, packaging, and composites. Sirsi and S.K. Local showed balanced properties for geotextiles and mulch mats. Although coarser than cotton (1-3 denier, 25-40 mm), arecanut fibers possess adequate strength and length for sustainable coarse textiles, geotextiles, biodegradable packaging, and bio-composite applications.

4.5. MICROBIOLOGY

4.5.1 Microbial Strategies for Biotic-abiotic Stress and Nutrient Management

4.5.1.1 Pearl Millet seed bacterial microbiome for improving growth and nutrient use efficiency

Promising exopolysaccharide (EPS)-producing pearl millet seed endophytes *Atlantibacter hermannii* MPT27 and *Bacillus subtilis* subsp. *subtilis* PC7N47 and PC7T5 were identified, and their EPS showed favourable compositional, antioxidant, waterabsorbing properties, and biostimulant potential. Field trials in rainfed pearl millet using *Azospirillum formosense* alone or with a compatible *Bacillus* strain under 75 and 100% RDN demonstrated significant growth and yield enhancement, with stronger effects at 75% RDN. Co-inoculation was superior but statistically at par with *Azospirillum* alone across nitrogen levels.

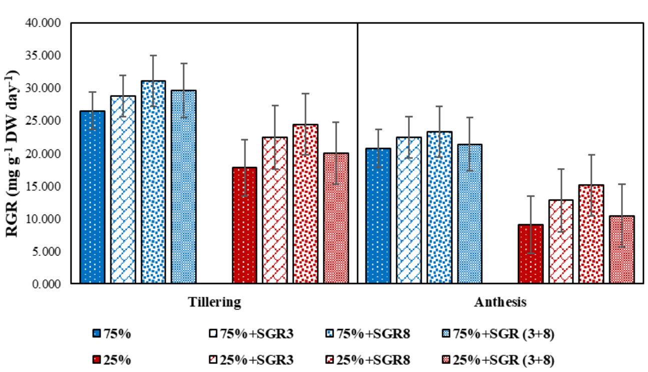
4.5.1.2 Pusa BioGreen: A synergistic microbial consortium for methane mitigation and yield enhancement in rice

A consortium of methane-oxidizing bacteria (*Methylobacterium oryzae* MNL-7 and *Pseudomonas* sp. MNR-81) and the oxygen-evolving cyanobacterium (*Anabaena doliolum* BF4) enhanced methane oxidation, while supporting nitrogen fixation and nutrient mobilization. Multi-location trials recorded 20-31% lower methane emissions, 0.77-9.8% yield gains across rice varieties, sustained performance with 25% reduced N inputs and improved Carbon Efficiency Ratio from 13.7-28.17%.

Pusa BioGreen

4.5.1.3 Evaluation of cyanobacterial strains for imparting desiccation tolerance in wheat

Cyanobacterial inoculation with *Nostoc* sp. (SGR3) and *Neowestiellopsis* sp. (SGR8) improved growth, physiology, antioxidant responses, and nutrient status in wheat cultivars HD2967 and C306 under drought (30-day irrigation withholding at tillering and anthesis).



Influence of Cyanobacterial inoculation on wheat growth (RGR, relative growth rate)

Inoculation significantly enhanced relative growth, water content, and membrane stability, especially in HD2967, and improved photosynthesis, root architecture, N and P uptake, while reducing oxidative damage through elevated antioxidant activity.

4.5.1.4 Rhizobacterial bioformulations enhance stress tolerance, yield and soil health in mustard

Field evaluation of rhizobacterial bioformulations for second year in mustard under different irrigation levels, at the Directorate of Rapeseed–Mustard Research, Bharatpur showed that all bioformulations significantly improved relative water content (RWC) and chlorophyll with reduced proline and SOD activity level compared to controls. Inoculation significantly increased dry matter, branching, siliquae per plant, 1000-seed weight, seed and stover yields with increment in microbial biomass carbon, and FDA, dehydrogenase, β-glucosidase, and alkaline phosphatase activities.

4.5.1.5 Characterization of nodule associated bacteria for enhancing BNF and drought resilience in lentil

A pot experiment was conducted to evaluate the effects of selected bacterial cultures (LE14, LE27) and their consortium on plant growth and drought resilience in lentil. Bacterial inoculation improved nodule number (46%), nodule weight (22%), shoot length (34%), root length (27%) and seedling dry biomass (17%), compared to uninoculated control under stress conditions (75% FC).

4.5.1.6 Exploring the diversity and function of non-rhizobial bacteria for improved plant growth, symbiosis and yield in chickpea

A set of 36 non-rhizobial bacterial isolates was evaluated under field conditions on chickpea (cv. BG 372) which revealed significant differences in terms of symbiotic traits, growth, and yield. At harvest, biomass increased by 1.3-59.1% over UI (Uninoculated), with NS133 and NS30 (≈59%) followed by NS8 (58%) showing the highest gains. Seed yield was also highest with NS133, NS30, NS8, and NS20 (≥56% over UI). BOX-PCR confirmed the genetic distinctness of the 12 best isolates. 16S rDNA analysis identified them as *Pseudomonas*, *Stenotrophomonas*, *Brucella*, *Pseudescherichia*, *Burkholderia*, *Klebsiella*, and *Silvania* species.

4.5.1.7 *In vitro* screening and identification of antagonistic activity in Actinobacterial isolates against pathogens causing major diseases of rice

A total of 45 previously PGP-characterized actinobacterial isolates (from rice-rhizosphere and endo rhizosphere) were screened for antagonistic activity against fungal and bacterial pathogens of rice diseases such as blast, sheath blight, bakanae and bacterial leaf blight. Out of these actinobacterial isolates, 28, 24, 28, and 27 showed effective antifungal activity (25-77% growth inhibition) against the fungal pathogens of rice-*M. oryzae, R. solani, Fusarium* sp., and *S. rolfsii*, respectively.

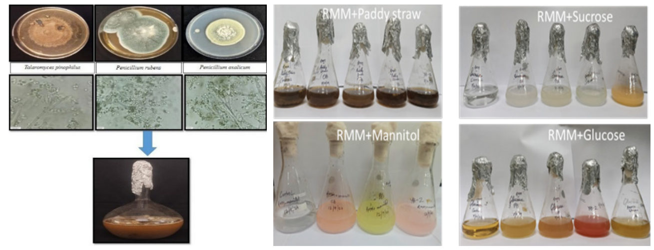
4.5.2 Agro-Biomass Valorization and Microbes in Value Addition

4.5.2.1 Upscaling gluconic acid production using small scale fermenter and its optimization

Talaromyces pinophilus, *Penicillium rubens*, and *Penicillium oxalicum* were evaluated for gluconic acid production using potato peel waste. Optimization showed that 30 g L^{-1} substrate at pH 6.0, 30°C, 4% inoculum, yielded 65.0 g L^{-1} gluconic acid after 11-day fermentation, demonstrating strong potential for industrial-scale production.

4.5.2.2 Growth media optimization for pigment production

Three pigment-producing bacteria identified through 16S rDNA namely *Micrococcus luteus*, *Microbacterium arborescens*, and *Exiguobacterium aurantiacum* were screened in various growth media including Reese's Minimal Medium (RMM) supplemented with agro-industrial residues such as paddy straw, wheat bran, as well as synthetic media like Nutrient Broth (NB) amended with different sugars. Sucrose supplementation to the nutrient broth was stimulatory; however, in Reese's minimal medium (RMM), *M. luteus* and *M. arborescens* did not produce any pigments. The highest pigments yield (expressed as β-carotene equivalents) was recorded in *M. luteus* (4.816 μg/mL) in sucrose-supplemented nutrient broth.



Growth media optimization for Gluconic acid and pigments

4.5.2.3 Study on the impact of Pusa Decomposer (WP) on soil nutrient and microbial dynamics

Winter field trials in Punjab (10.2 °C) with Pusa Decomposer wettable powder (WP) showed effective paddy straw degradation in PB1121+ urea + wettable powder and PR110 + urea + wettable powder, achieving 16.26-19.32% cellulose and 7.14-8.45% lignin reduction, and C:N ratio of 24.26, with enhanced soil microbial activity.

4.5.2.4 Salt stress and mixotropy enhance carotenoid production in cyanobacteria

Amid increasing consumer demand for natural carotenoids, the interactive effects of salinity levels (0-1.5%) under mixotrophy (1 g/L galactose) was evaluated in cyanobacterium *Nostoc* sp. Optimized conditions of 0.1% NaCl and 0.1% Galactose under 24:0 h illumination, led to 5 fold- enhancement in carotenoids, with increment in unsaturated fatty acids (palmitoleic acid, linolic acid and α-Linolenic acid). This highlighted that salt stress under mixotrophic condition can be a potential tool to improve production of carotenoids and other value-added compounds.

4.5.2.5 Role of sugars in stabilizing thermal degradation of phycobilins

Thermodynamic properties, degradation kinetics, color stability, and antioxidant potential of phycobiliproteins (PBPs) from *Oscillatoria* sp. BTA 170 were systematically evaluated under thermal treatment in the presence of different monosaccharides. Glucose proved to be the most effective stabilizing agent, significantly reducing the thermal degradation of

C-phycocyanin (C-PC), allophycocyanin (A-PC), and phycoerythrin (PE) at elevated temperatures.

4.5.2.6 Valorization of corn stover lignin using microbes

Corn stover is a viable biorefinery feedstock with~70% carbohydrates, 15-20% lignin. Sequential NaOH and dilute-acid pre-treatment enabled effective fractionation, yielding ~84 g lignin kg^{-1} biomass. *Rhodotorula glutinis* Y1 efficiently depolymerized lignin, achieving 37% degradation in minimal medium (0.5% lignin) and 50% with glucose co-metabolism (1%) with formation of value-added aromatics, including vanillin (11.40 ± 0.81 ppm) and ferulic acid (30.47 ± 1.27 ppm). Process optimization significantly enhanced yields, with soybean extract enabling maximal vanillin production (316.02 ppm), demonstrating the strain's potential for sustainable lignin valorization.

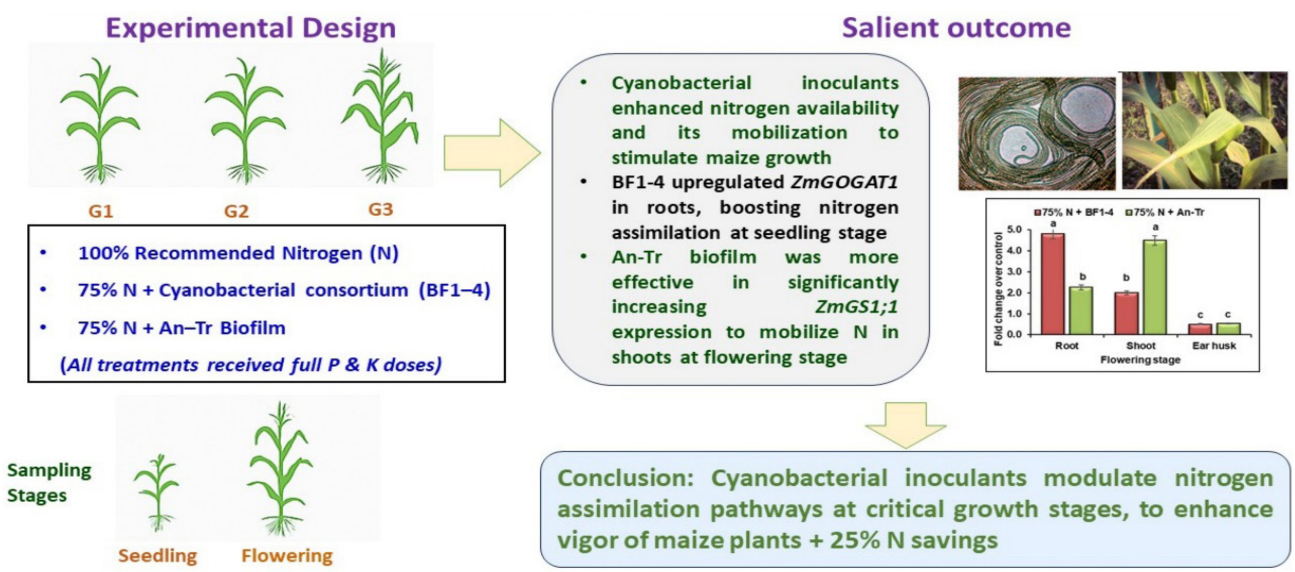
4.5.3 Omic Insights into their Interactions with Plants

4.5.3.1 Cyanobacteria-maize genotypes interactions

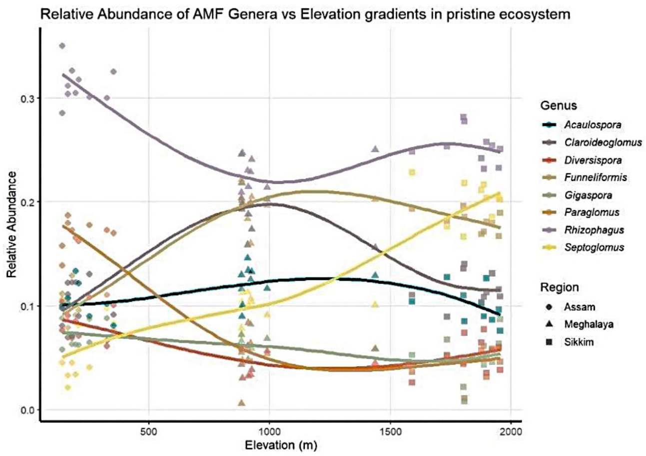
Inoculation of maize parents (G1: V345PV/PMI-PV4 (H), G2: V335PV/PMI-PV3 (L), respectively representing high and low yielding genotypes) and their hybrid (G3 : Pusa Vivek Hybrid-27 Improved) with BF1-4 (*Anabaena–Nostoc* consortium) and An-Tr biofilm (*Anabaena torulosa–Trichoderma viride*) at seedling and flowering stages significantly enhanced soil microbial biomass carbon (12.-41%), nutrient availability, and altered microbial community structure. Nitrogen assimilation genes were differentially regulated: An-Tr induced 2.6-4.5-fold upregulation of *ZmGOGAT1*, while BF1-4 upregulated 2.5-4.8-fold in roots and 0.3–2-fold in shoots. *ZmGS1;1* expression was strongly enhanced in shoots at flowering and ear husk tissues, particularly with An-Tr (4.8-fold). Overall, cyanobacterial inoculants optimized N assimilation, improved growth, and enabled ~25% nitrogen savings in elite maize genotypes.

4.5.3.2 Mapping arbuscular mycorrhizal fungal diversity across elevation gradients in Northeast India

Arbuscular mycorrhizal fungi (AMF) diversity and distribution across Sikkim, Meghalaya, and Assam was examined using high-throughput Illumina sequencing of soil samples (elevation gradients ranging from1411954 m above sea level). Soils of Sikkim possessed highest community richness, with Shannon values of 3.12 and ~ 38 ASVs per site. *Glomeraceae* dominated 75% of the sites, while unique lineages like *Paraglomus* and *Rhizophagus* were identified in Assam floodplains and Sikkim alpine soils respectively, with regional separation driven by soil pH and organic C.



Elicitation of plant N metabolism by cyanobacterial inoculation in maize genotypes



Relative abundance of AMF genera across elevation gradients in NE India.

4.5.3.3 Arbuscular mycorrhizal fungi (AMF) and associated bacteriome in maize

The impact of graded P and K fertilization on arbuscular mycorrhizal fungi (AMF) communities and associated bacteriome was evaluated in the maize rhizosphere. Metagenomi analyses highlighted that the fertilizer-dependent shifts in AMF diversity correlated with distinct AMF-specific bacterial assemblages, including *Funneliformis* with *Noviherbaspirillum* and *Rhizophagus* with *Sphingomonas*–*Acinetobacter*, while ~16% of bacterial genera remained unclassified.

4.6. ENVIRONMENTAL SCIENCE

4.6.1 CMIP 6 21 GCMs Bias-corrected Ensemble Scenarios for Agricultural Seasons in India

Kharif maximum and minimum temperatures are projected to rise by up to 3°C and 1.4°C by 2039, reaching 4.8-6.6°C and 2.8-4.4°C by end-century under SSP2-4.5, SSP3-7.0, and SSP5-8.5 scenarios. *Rabi* temperatures may increase by 1.6°C (max) and 1.9°C (min) by 2039, reaching 3.3-5.4°C and 4.4-7.1°C by end-century, with greater variability in minimum temperatures, especially in *Rabi*. Rainfall variability and extreme precipitation events are expected to intensify, particularly in *Rabi*. Heat waves may rise 5-17 times and above-normal temperature days ~6.5 times relative to 1985–2014. *Kharif* may see more warm spells, tropical nights, and extreme rainfall, while *Rabi* could experience up to 20-fold increases in warm spells, along with more cold waves and frost events. Regionally, warming is stronger in central and western India, with higher variability in the north. *Kharif* rainfall may increase in southern and central India but decline in the north, whereas *Rabi* rainfall may rise in northern and central regions and decrease slightly over the Western Ghats and northeast.

4.6.2 Effect of Different Agri-Management Practices on Soil Organic Carbon Stability and Quality of Soil Organic Matter under Present and Future Climatic Conditions

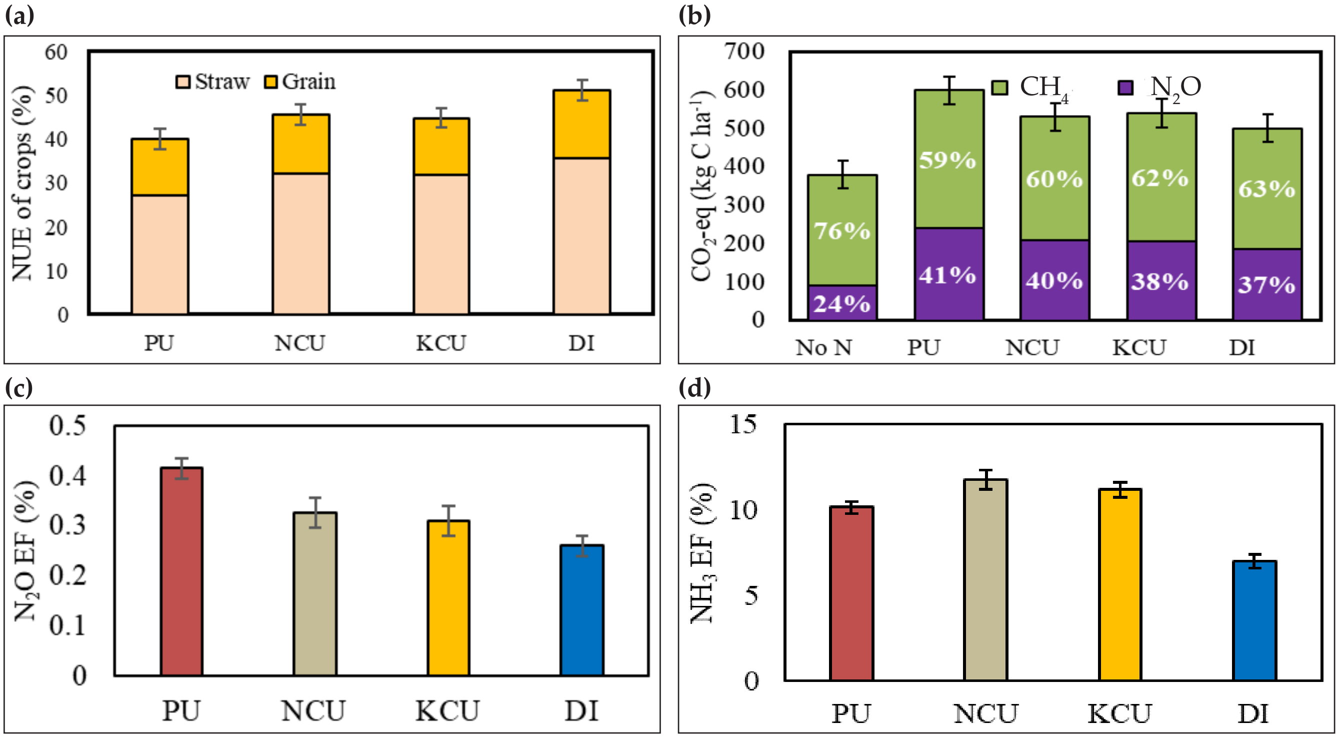
Soil organic matter quality was assessed *via* humic acid extraction and FTIR characterization. All humic acids showed typical bands of native humic substances, with similar spectral patterns across land uses. Prominent peaks appeared at 3400 cm^{-1} (O–H stretching) and 2933 cm^{-1} (aliphatic C–H stretching), while variations below 1800 cm^{-1} reflected differences in specific functional groups. Clear bands were observed in soils under bamboo, tea, mango, lemon, rice–rice, wheat–millets, okra–onion, and uncultivated systems, with strong peaks consistently detected at 3700–3400, 1650–1450, 1465–1340, 1200–1020, and 840–532 cm^{-1}, confirming key functional groups across land-use types.

4.6.3 Estimates of Methane and Nitrous Oxide Emissions from Agricultural Soils

An inventory of methane (CH_4) and nitrous oxide (N_2O) emissions from agricultural soils was prepared for 2022 using IPCC guidelines for India's biennial transparency report to the UNFCCC. Methane emissions from rice cultivation totaled 3.497 Gg across 47.4 M ha under multiple water regimes (MA, SA, CF, DW, RF-FP, RF-DP). Total direct N_2O emissions were 243.84 Gg (80.7% of total), while indirect N_2O emissions were 58.25 Gg (19.3%). Overall emissions were substantially higher than India's NDC base year (2005).

4.6.4 Dual Inhibitors for Reducing Ammonia Volatilization and Greenhouse Gas Emissions in Rice Cultivation

A two-season field study on Pusa 44 rice evaluated coated urea fertilizers-prilled urea (PU), neem oil-coated urea (NCU), karanj oil-coated urea, and dual inhibitor (DI: Limus + NCU)-for their impact on GHG and NH_3 emissions. Compared to PU, DI reduced N_2O by 23.7%, CH_4 by 11.9%, and NH_3 by 29.8%, while improving nitrogen use efficiency. N_2O emission factors ranged 0.28-0.41% and NH_3 6.5-11.8%, with DI reducing NH_3 36-39% versus other inhibitors. Overall, DI-coated urea lowered the global warming potential of rice cultivation in the trans-Indo-Gangetic Plains by 17.1%, highlighting its potential to mitigate India's agricultural GHG emissions.



(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

4.6.5 Emission Coefficient of Nitrous Oxide under Different Drip Irrigation Practice for Refinement of the GHG Emission Factor

In potato (Kufri Neelkanth), N_2O and CO_2 emissions were measured under surface drip and conventional furrow irrigation with three treatments. Drip fertigation significantly reduced N_2O emissions (EF lowered from 0.59 to 0.41% with NCU) while slightly increasing CO_2 emissions. Drip irrigation also increased yield and lowered the greenhouse gas intensity of potato cultivation.

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% N_2O	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

4.6.6 Reducing Greenhouse Gas Intensity of Rice-Wheat Cultivation with Different Agronomic N Management Practices in a Farmer's Field Experiment

A farmer-field study in Mumtazpur evaluated nitrogen management in rice-wheat (Pusa 1847 rice; HD 3226 wheat) using phosphogypsum-coated urea (PGCU), LCC-based neem-coated urea (NCU), NCU 75% + biofertilizer, NCU 75% + nano-urea spray, and 100% NCU (120 kg N/ha). PGCU (5% phosphogypsum) improved yields, reduced NH_3 volatilization, N leaching, and CH_4 emissions, lowering GHG intensity compared to NCU. N_2O emissions decreased significantly with PGCU in rice. Combining 75% N with biofertilizer or nano-urea also reduced GHG emissions, though yields were slightly lower.

4.6.7 Environmental Footprint of Tomato: Effect of Fertiliser & Water Management

Drip irrigation reduced the N_2O, NH_3 and leaching losses by ~29.6, 55.3 and 98% over bed and furrow irrigation, with 25% increase in fruit yield and reduced 70% N footprint and 43% water footprint. Recommended dose of fertiliser with micronutrients reduced the N_2O, NH_3 and leaching losses by ~13.6%, 37.3 & 18.9% over farmers' practice with similar fruit yield and reduction in N footprint by 30%. The scaling factors for N_2O and NH_3 under drip irrigation were 0.70 and 0.45, respectively.

Treatments	N_2O-N emission (kg/ha)	NH_3-N emission (kg/ha)	N Leaching (kg/ha)	Fruit Yield (t/ha)	N footprint (kg/ha)	Water footprint (m^3/t fruit)
Irrigation						
Bed and furrow irrigation	0.987	6.580	5.554	42.09	13.12	224.66
Drip Irrigation	0.691	2.939	0.135	52.81	3.87	127.11
Nitrogen						
No-N Control	0.346	0.204	0.376	19.59	0.93	394.41
Farmers practice	1.197	9.073	4.039	47.94	14.31	102.51
RDF with micronutrients	1.034	5.686	3.277	48.64	10.00	100.33

4.6.8 GHG Mitigation Potential of Biochar-coated Urea in Rice-wheat System

Biochar-coated urea (BCU) and Biochar + neem oil-coated urea (BNCU) were evaluated under field conditions growing rice (PB 1847) and wheat (HD 2967) and were compared with urea and neem-coated urea (NCU). The N was applied @ 150 kg N/ha in three equal splits. CH_4 emissions from the rice crop were reduced by 7.4% with BCU and 10.7% with BNCU. The emission of N_2O was reduced by ~7.5 & 8.6% in rice and wheat crops with BCU and 12.5-13.3% with BCU-NCU. The mitigation potential of BCU and BNCU was ~7.7 and 11.8% over NCU in the rice-wheat system. The grain yield with BCU (~3% increase) was at par with NCU and 5.8-6.3% higher with BNCU compared to NCU.

GHG mitigation potential of biochar-coated urea in rice wheat system

Treatments	Rice			Wheat		R-W system
	CH_4	N_2O	Yield	N_2O	Yield	GWP
	kg/ha	kg/ha	t/ha	kg/ha	t/ha	kg CO_2 eq/ha
Control	22.06	0.436	2.32	0.456	2.093	854
Urea	29.48	1.568	4.71	1.485	4.787	1634
NCU	26.02	1.356	5.01	1.296	4.979	1431
BCU	24.10	1.253	5.13	1.185	5.122	1321
BNCU	23.23	1.186	5.31	1.124	5.277	1263
LSD (±)(5%)	1.42	0.062	0.168	0.084	0.15	60

4.6.9 Development of Emission Factor for N_2O from Fertilizer Application to Cropped Soil

Field experiments were conducted over two consecutive years, growing cereal, vegetable, and oilseed crops under different N application rates to develop country-specific N_2O emission factors. The emission factor for N_2O-N ranged from 0.42-0.62% of applied N. The mean emission factor was estimated as 0.48±0.066% of applied N with an uncertainty of 12.4%.

Emission factor for N_2O from fertilizer application to cropped soil

Crop	Total N_2O emission (kg/ha)	Emission factor (%)
Onion (Bhima dark red)	1.425-1.762	0.491-0.502
Potato (Kufri Badshah)	1.966-2.383	0.539-0.611
Tomato (Pusa rohini)	1.625-1.881	0.480-0.554
Brinjal (Vaibhav)	1.708-0.537	0.498-0.426
Soybean (9712)	0.537-0.674	0.426-0.441
Maize	1.282-1.742	0.390-0.461
Wheat	1.287-1.521	0.399-0.419

4.6.10 Greenhouse Gases and Particulate Matter Emissions Due to Sugarcane Residue Burning using Measurements and Remote Sensing

In Shamli district, 200 sugarcane burning events were detected, and a burnt-area map using Sentinel-2A L2A images achieved 89% overall accuracy, showing 30.1% area burnt in 2023–24. Field monitoring of residue burning at five locations measured GHGs and particulate matter (PM) to develop emission factors. Average on-farm concentrations were 2.79 ± 0.13 ppm CH_4, 652.33 ± 39.52 ppm CO_2, and 394.98 ± 45.21 ppb N_2O. PM concentrations (μm) averaged 108.13 ± 62.11 (0.3), 456.58 ± 286.70 (0.5), 675.33 ± 507.00 (1), 512.00 ± 300.09 (2.5), 489.00 ± 297.55 (5), and 401.00 ± 241.75 (10).

4.6.11 Climate Resilience in Cowpea with Cyanobacteria under Elevated CO_2 and Temperature

A study on cowpea (cv. Pusa Sukomal) in a Temperature Gradient Tunnel evaluated the combined effects of elevated CO_2 (ambient vs. 550 ppm) and temperature (+0, +0.6 °C, +2.4 °C) with or without *Anabaena torulosa–Bradyrhizobium japonicum* cyanobacterial biofilm (An-Rh) inoculation. Temperature rise of +2.4 °C reduced nodule number, nodule weight, N_2 fixation, and yield by 10.9% compared to ambient. Cyanobacterial biofilm mitigated yield loss by 9.1% and, particularly under elevated CO_2, significantly enhanced seed yield, seed N concentration, and nitrogen fixation.

4.6.12 Root Exudation and Phytosiderophore Release by Graminaceous Crops

Root exudates from annual crops (wheat, rice, maize, oat) and perennial grasses (*Panicum maximum, Cenchrus ciliaris, Heteropogon)* were analyzed for phytosiderophore (PS) production and Fe mobilization, showing the efficiency order: perennials > maize > wheat > oat > rice. The impact of heavy metals on PS release and carbon partitioning in wheat genotypes revealed greater growth inhibition by Cd than Pb, but Fe/Zn-efficient varieties maintained better performance, reflected in higher grain yield and favorable physiological traits.

4.6.13 Development of Linz-Donawitz Slag-based Organo-Mineral Fertilizer Cum Soil Conditioners

The impact of Linz-Donawitz (LD) slag-based fertilizer products (ranging from 0.5-1.0 t ha^{-1} for different crops) with and without 80% recommended dose of NPK fertilizers (RDF) was assessed in multiple crops like cereals (wheat, rice, maize) vegetables (brinjal, tomato, amaranthus) and oil seed (mustard) crops, and on the soil physical and biological properties. These products possessed different mineral nutrients in the range of 0.23 - 0.85% N, 0.17 - 5.17 % P, 0.72 – 14.95% K, 0.004 – 0.733% S, 2.70 - 30.24% Ca, 0.35 – 7.15% Mg, 1.02 – 4.41 ppm Fe, 7.60 – 74.00 ppm Zn, 0.73 - 22.94 ppm Cu, 386.7 - 4556.0 ppm Mn,, 5.0 – 25.0 ppm Mo, 4.04 – 31.30% Si and 0.70 –7.75 ppm Co. Content of major heavy metals i.e., Pb, Ni and Cr ranged from 1.57 – 45.3, 1.10 – 20.0 and 50.5 -157.3 ppm respectively with no measurable cadmium content across the enriched slag products, which are well below the maximum safe limit of metals (Pb: 250 - 500 ppm; Cd: 3 - 6 ppm; Ni: 75 - 100 ppm and Cr: 150-210 ppm) allowed in a fertilizer/ soil conditioners as per national and international regulations. Thirteen SSBVAPs were given to Industry partners (TSL, JSW steel Ltd, SAIL) for independent testing.

4.6.14 Impacts of Agroforestry Practices on Soil Aggregation and Carbon Stabilization Within Aggregates in the Foot Hills of the Indian Himalayas

In surface soil (0–15 cm), the mulberry + cowpea-toria system (T7) significantly enhanced soil organic carbon (SOC), with total SOC 58, 26, and 30% higher than cultivated fallow (6.76 g kg^{-1}), sole mulberry (T5, 8.47 g kg^{-1}), and cowpea-toria (T4, 8.21 g kg^{-1}), respectively. Intra-aggregate particulate organic matter within microaggregates of macroaggregates (iPOM_mM) was highest under T7, ~104% higher than T5 and ~90% higher than T4. Stabilized C within iPOM_mM reached 5.63 g C per 1000 g bulk soil in T7, representing 152 and 164% increases over T4 (2.23 g C) and T5 (2.13 g C), respectively.

4.6.15 Impact of Integrated Application of Biogas Slurry and Organo-Mineral Amendments on Soil Microbial Biomass Carbon and Enzymes Activity under Rice-Wheat Cropping System

In a rice–wheat system, six treatments involving biogas slurry (BGS) and recommended fertilizer doses (RDF) were evaluated: T0 (control, no N), T1 (100% N by RDF), T2 (25% N BGS + 75% RDF), T3 (50% N BGS + 50% RDF), T4 (75% N BGS + 25% RDF), and T5 (100% N BGS). Soil microbial biomass carbon (SMBC) was highest in T5, and acid and alkaline phosphatase activities peaked in T5 at wheat reproductive stage, with lowest activity in T0. α-Glucosidase activity reached maxima in T5 (404.25 mg/mL in 2023; 415.49 mg/mL in 2024), while β-Glucosidase increased across years, peaking in T5 (226.0 µg pNP g^{-1} h^{-1} in 2023; 232.41 µg pNP g^{-1} h^{-1} in 2024) and lowest in T0. N-Acetyl Glycosaminidase (NaG) activity was highest in T4 (4.65%) and T3 (3.27%), slightly lower in T5 (3.25%), and minimal in T0 (0.43%) and T1 (0.67%), indicating that 100% BGS strongly enhanced microbial biomass and key enzyme activities, while NaG favored partial BGS–RDF combinations.

5. PLANT PROTECTION

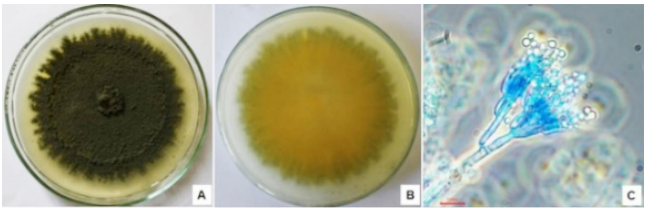
The School of Plant Protection is involved in the development of innovative technologies for the management of pests and diseases in crops. During the year under report, multitude of studies were taken up to record new pests/strains of pathogens, novel resistant sources and on molecular diagnostic kits for identification of pests/diseases. Genomics of insects/pathogens/nematodes unravelled the mining of genes for targeting pests/pathogens/nematodes. Development of novel formulations and bioactive agents and decontamination protocols complemented the crop protection strategies.

5.1 PLANT PATHOLOGY

5.1.1 Disease Diagnosis and Pathogen Characterization

5.1.1.1 Identification, maintenance and preservation of fungal and bacterial cultures /disease specimens

Indian Type Culture Collection (ITCC) and Herbarium Cryptogamae Indiae Orientalis (HCIO) maintained 4220 fungal, 170 bacterial cultures and 50,765 fungal specimens. A total of 389 fungal cultures were supplied to various scientific and industrial institutions. One hundred cultures were accessioned, and 124 were identified in 2025. The causative organism of the blue mold disease in apple was identified as *Penicillium crustosum* and *Pantoea agglomerans* was found to be associated with symptoms such as shot hole, canker, and gummosis in stone fruits.



Blue mold fungus showing bluish-green conidia (A) yellow to orange colour on the reverse side (B) and circular conidia (C)

Stone fruit plant showing symptoms

5.1.1.2 Development of diagnostic assays for rapid detection of rice fungal pathogens

A *Rhizoctonia solani* specific Loop-mediated Isothermal Amplification (LAMP) assay was developed and validated by targeting the Major Facilitator Superfamily (MFS) gene. The LAMP assay has a sensitivity of 1 ng DNA and no cross-reactivity with other rice pathogens. A species-specific genomic region (*Uv-05919*) unique to *U. virens* was utilized to develop molecular detection assays.

5.1.1.3 RT-RPA assays for rapid detection of viruses in onion and banana

A rapid cost-effective crude leaf extract-based reverse transcription recombinase polymerase amplification (RT-RPA) assay was developed for detection of Onion yellow dwarf virus (OYDV) infecting *Allium* crops. The optimized RT-RPA assay showed comparable sensitivity to RT-PCR, detecting OYDV up to 0.1 pg/µl, or 10^{-6}. A sensitive duplex RT-RPA/RPA assay was developed for simultaneous detection of banana streak and banana bunchy top virus.

5.1.1.4 Detection of pulse viruses in North-west and Central India

Major viruses in pulse crops in North-west and Central India were identified as Mungbean Yellow Mosaic India Virus (MYMIV), Mungbean Yellow Mosaic Virus (MYMV), Groundnut bud necrosis virus (GBNV), Cowpea mild mottle virus (CpMMV), Soybean yellow mottle mosaic virus (SYMMV), Tomato leaf curl New Delhi virus (ToLCNDV), Chili leaf curl India alpha-satellite and Papaya leaf curl beta-satellite, through high-throughput sequencing (HTS). An IR-images based AI model has been developed for early detection of leaf curl infection in chili (ChilCV). RNA sequencing revealed the presence of a grapevine leafroll-associated virus S(GLRaV-S) and based on established species demarcation criteria, this represents a new species in the family *Closteroviridae*.

5.1.1.5 Pathogenomics of fungal pathogens

Genome analysis of *Ralstonia solanacearum* provided insights into virulence mechanisms relevant to disease management. Comparative genomic studies of *Phytophthora capsici* and *P. tropicalis* elucidated pathogenicity determinants and effector diversity associated with black pepper foot rot. Characterization and pathogenicity of fungi associated with maize ear rot from Peninsular and the Northwestern Plain Zone of India was done. Molecular analysis of *Fusarium graminearum* cultures collected from the Wellington (Tamil Nadu) revealed that the Fhb1 locus was not present in Indian genotypes. Twenty-two isolates of *Tilletia indica* collected from Northwestern Plain Zone of India were analysed with 15 genome-based trinucleotide simple sequence repeat (SSR) markers. Pathogenicity tests revealed variation in virulence, with the coefficient of infection ranging from 3.7 to 46.9%. In *Fusarium fujikuroi* inoculated florets *versus* roots, a total of 2956 differentially expressed genes (DEGs) were observed. The genes associated with stress responses, immune system processes, and secondary metabolite biosynthesis were regulated in both roots and florets. Two uncharacterized genes (*ENH87556*, *ENH87679*) of *Colletotrichum orbiculare*, activated under host defense stress, were silenced *via* hpRNA constructs in *Nicotiana benthamiana*. Transgenic lines showed reduced disease severity and downregulated transcripts, confirming effective host-induced gene silencing (HIGS). Pathogenesis-related (PR) proteins, PR2 (β-1,3-glucanase) and PR3 (chitinase) which encode members of the glycosyl hydrolase (GH17 for PR2 and GH19 for PR3) superfamily, were identified within the wheat genome using *in-silico* techniques. Functional analysis through qRT-PCR showed temporal and phenotype specific expression of representative *TaPR2* and *TaPR3* genes in wheat in response to infection by *Puccinia striiformis* f. sp. *tritici*.

5.1.1.6 Functional confirmation of potential candidate virulence gene (s) of *Magnaporthe grisea*

A single guide RNA (sgRNA) designed to target the UTR of the promoter region of the Mg.00g031250 gene, encoding a peroxisomal targeting receptor sequence was cloned into the CRISPR interference (CRISPRi) vector containing transcriptional repression domains and catalytically inactive Cas9 (dCas9). Eleven putative transformants of *M. grisea* were identified for the presence of the hygromycin resistance gene and scaffold region of the sgRNA cassette.

5.1.1.7 5.1.1.7 Editing rice genes through CRISPR/Cas9 technology for blast resistance in rice

A set of rice blast susceptibility genes viz., *OsMAPK5, OsPi21, OsSEC3A, OsUGT, OsCAMTA3A,* and *OsCAMTAPL* were selected and CRISPR/Cas9 knockout constructs were developed for each gene. A multi-gateway cloning system was employed to simultaneously deliver two sgRNAs along with eSpCas9 for targeted mutagenesis of the selected loci.

5.1.1.8 Biochemical and gene expression analysis of resistant and susceptible *Brassica* genotypes

Two cultivars, Pusa Jaikisan (susceptible) and Pusa Jaikisan WRR (resistant) were analyzed for biochemical basis of resistance to diseases. Amongst the analysis of Salicylic acid SA-marker genes, (*PR1* and *PR2*) and JA/ET-marker genes (*PR3* and *PR12*), the *PR1* and *PR2* showed higher expressions at nearly all the time intervals in Pusa Jaikisan WRR, thus establishing their role in defense. The findings hint toward complementation of JA and SA pathways. Gene expression analysis showed upregulation of antioxidant enzymes Catalase, Peroxidase, Superoxide dismutase.

5.1.1.9 Expression analysis of wheat micro RNAs responsive to *Bipolaris sorokiniana*

Small RNA sequencing to profile miRNAs in a resistant (IC566637) and a susceptible (Agra Local) wheat genotype following *B. sorokiniana* infection identified 726 miRNAs, of which, 140 were differentially expressed (DEGs).

5.1.1.10 Genome sequence of *Moesziomyces penicillariae* causing smut of pearl millet

Whole genome sequencing of *Moesziomyces penicillariae* (TP-1) isolated from pearl millet smut disease samples revealed that the genome size was 18.31 Mb with GC content of 60.53 % using the Spades assembler.

5.1.1.11 Genome reconstruction of grapevine virus for sequence-specific gene silencing

Approximately 58 million high-quality RNA-seq reads were generated from nursery-grown grapevine rootstock. A 7,460-nt contig showed 89.23% sequence identity with grapevine virus M (GVM) and clustered closely with the only reported U.S. isolate (MK492703).

5.1.1.12 Virome analysis of bell pepper and peach

RNA sequencing of bell pepper (CH-497, IC112392) leaves showing severe virus-like symptoms identified a mixed infection of bell pepper endorna virus (BPEV), pepper leaf curl virus (PepLCV), and chili leaf curl virus (ChiLCV). Begomovirus infection was confirmed by rolling circle amplification (RCA). Peach virome analysis revealed the presence of eight known prune dwarf virus (PDV), prunus necrotic ringspot virus (PNRSV), nectarine stem pitting-associated virus (NSPaV), peach-associated luteovirus (PaLV), grapevine red globe virus (GRGV), grapevine asteroid mosaic-associated virus (GAMaV), peach virus D (PeVD), citrus sudden death-associated virus (CSDaV) and a novel peach associated marafivirus (PaMV).

5.1.1.13 Identification of citrus tristeza virus (CTV) mild strain for cross protection

Out of 17 putative CTV mild strains identified, three strains, BHKM-1 KKM-8 and DeKM-2 when challenged with severe CTV strain through grafting on different root stock showed no symptoms confirming that these three strains are mild CTV strain.

5.1.1.14 *Vasconcellea cauliflora* as a new host of Chilli leaf curl virus

Chilli leaf curl virus infecting *Vasconcellea cauliflora* plants at the experimental research field of the IARI Regional Station, Pune indicated it as an emerging concern for the global papaya industry, as this species is a resistant donor in papaya breeding programmes.

Infected *Vasconcellea cauliflora* plant showing crinkling, mottling and downward curling of leaves (left), healthy plant (right)

5.1.1.15 Tissue specific colonization and metabolome profiling of *Fusarium fujikuroi* in rice

Distinct differences in *F. fujikuroi* colonization were observed in susceptible and resistant rice genotypes. Tissue specific GC-MS based metabolome profiling revealed 15 compounds exclusive to roots and 22 exclusives to panicles. Compounds like 1-Monopalmitin, Pantolactone, Gluconolactone and Deoxyglucose could serve as biomarkers for resistance sources.

5.1.2 Host Plant Resistance

Rice: Out of 572 rice genotypes evaluated for blast resistance under artificial conditions, eight genotypes *viz., O.minuta*, Zenith, Tetep, Raminad str-3, Tadukan, RP-Patho 1, RP Patho-2, RP Patho-7 and RP Patho-8 showed resistance. Out of 700 rice genotypes, the entries IRBB58, IRBB59, IRBB60, IVT-BT-1806, IVT-BT-1807, IVT-BT-1802, IVT-BT-1821, IVT-BT-1920,

IVT-BT-1921, IVT-BT-1915, IVT-BT-1907, IVT-BT-1902 showed resistance against bacterial leaf blight disease. The accessions IC462881, IC449606X, IC516708, IC455687, IC555058, IC124860, IC99458, IC100051 were identified as resistant to bakanae disease. The accessions IC596807, IC298565, IC458658, IC115806, IC203140, IC133368, IC125869, IC388506, IC462975, IC514453, IC125779, IC516799, IC216830, IC515089, IC134470, IC133982, IC464526, IC463883 were identified as moderately resistant to sheath blight of rice.

Wheat: Race-specific studies of 146 entries against most predominant stripe rust pathotypes (46S119, 110S119, 238S119) and leaf rust (77-5) revealed that the genotypes, HD 3349, PBW 826, PBW 876, DBW 313, PBW 826, WH 1283, HD 3354, HI 1654, HD 3368, HD 3368, HD 3368, HD3360, HI 1653, HD 3360, HD 3368, HD 3368, PBW 848, HD 3369, K 1317, UP 3062, possess high degree of adult plant resistance resistance to both rust races. At Indore centre, 843 entries (~41% of the total) showed resistance to both stem and leaf rusts; The Indore entries viz., HI 1669, HI 1674, HI 1683, HI 1684, HI 1687, HI 8848, HI 8849, HI 8850, HI 8851, and HI 8852 possess high degree of resistance to both stem rust pathotypes. A set of 50 lines received as 27th FHBSN Int'l Nursery from CIMMYT and a population of durum comprising 130 lines received from Genetics division, IARI were also evaluated for head scab resistance by inoculating with *Fusarium graminearum*. 147 advance lines of wheat received from IIWBR, Karnal and 49 lines received from CIMMYT, Mexico under *Helminthosporium* Leaf Blight Nursery were evaluated against spot blotch of wheat.

Maize: Some promising MR genotypes identified for maydis leaf, banded leaf were BH418203, BMH 0085, AHD 2077, DH 380, BRM 21-4, CMH 18027 and against sheath blight disease, MLB AHD 2077, BMH 1114-36, BRM 21-3, IMH 2-24K-3, PM 24105, APH-9 were promising.

Chickpea: Out of 261 chickpea accessions evaluated against Fusarium wilt under natural condition in sick plot at MB4C, 39 entries were recorded resistant, 151 moderately resistant, 47 moderately susceptible, 18 susceptible and 6 highly susceptible.

Pearl millet: Out of 109 pearl millet genotypes, entries *viz.,* ICPMBL 16, ICPMBL 18, ICPMBL 21, ICPMBL 22, ICPMBL 25, ICPMBL 26, ICPMBL 30, ICPMBL 36, ICPMBL 37, ICPMBL 39, ICPMBL 50 and ICPMBL 55 showed resistance to blast.

Oilseed crops: Among the 60 *Brassica* genotypes evaluated against *Albugo candida,* nine genotypes- AJ-34, 252025, DRMR-2035, Heera, Donskaja-IV, Basanti, Pusa Jaikisan WRR, Pusa Bold WRR, DTM-34, GSL-1 were resistant.

5.1.3 Disease Management

5.1.3.1 Chitosan based ecofriendly management for spot blotch of wheat

The antifungal efficacy of chitosan tested against *Bipolaris sorokiniana* revealed significant reduction in mycelial growth of pathogen with maximum inhibition (78.53–86.14%) at 0.3% concentration. *In planta* evaluation showed that chitosan application effectively reduced spot blotch severity.

5.1.3.2 Management of bakanae disease using growth regulators and selected biocontrol agents

Different concentrations of salicylic acid (0.5 mM, 1mM, 1.5mM, 2.0mM, and 3mM) along with Chlormequat chloride and Mepiquat chloride were evaluated against bakanae disease as a spray treatment after 10 and 20 days of transplanting. Biocontrol agents like *Trichoderma asperellum* (DS1), *Chaetomium globosum* (Cg2), *Talaromyces flavus, Penicillum oxalicum* were evaluated against bakanae disease under field conditions. Soil and seed treatment of *Trichoderma asperellum* was most effective with less disease incidence (20%).

5.1.3.3 Management of chickpea wilt using biocontrol agents

Evaluation of *Beauveria bassiana* and *Trichoderma asperellum* isolates against chickpea seed mycoflora revealed that *B. bassiana* isolates, BbR2 and BbR3 showed significantly higher antagonistic effect against *A. niger* (52.33 and 50.76%) and *Curvularia lunata* (56.25 and 55.50%), respectively. *Trichoderma asperellum* (ITCC 8687) showed the best antagonistic effect against all the tested chickpea seed mycoflora.

5.1.3.4 Biocontrol Potential of *Trichoderma asperellum* strain A10 against pea wilt

Among 12 *Trichoderma* isolates screened, *T. asperellum* strain A10 exhibited superior inhibition of *F. oxysporum*. GC–MS analysis revealed a diverse volatile profile dominated by 2H-pyran-2-one, while LC-HRMS identified ten non-volatile bioactive compounds, including trichodermaerin and ergosta-7,22-dien-3-ol.

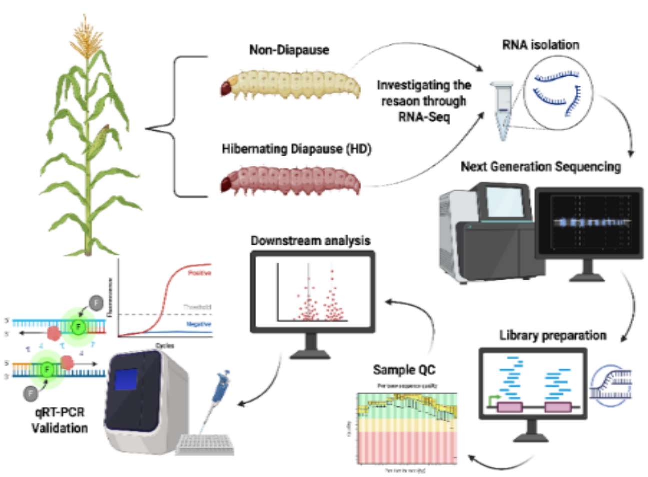
5.2 ENTOMOLOGY

5.2.1 Insect Physiology

5.2.1.1 Transcriptomics and protein analysis of hibernating vs non-diapausing *Chilo partellus*

Whole genome transcriptome analysis of hibernation and non-hibernation *C. partellus,* revealed that the genes such as *TRINITY_DN33201*; *TRINITY_DN31893*; *cpavelvLoc1692t9*; *cpavelvLoc2827t1*; and *cpavelvLoc6091t6* were upregulated and *TRINITY_DN26738*; *scaffold22091*; *cpavelvLoc60131t1* and *NODE_884324* were down regulated in the hibernation strain compared to nondiapause strain of *C. partellus*.

Total protein was significantly higher (P <0.001) in diapause stage of aestivation (11.96 µg/mg) followed by hibernation (10.51 µg/mg) and nondiapause larvae (9.61 µg/mg). The amino acid profiling revealed significant differences (P <0.001) among the diapause stage of hibernation and aestivation and larvae of nondiapause strains.



Transcriptomics of hibernating and non diapause populations of *Chilo partellus*

5.2.1.2 Constitutive and induced biochemical defense against mustard aphid, *L. erysimi*

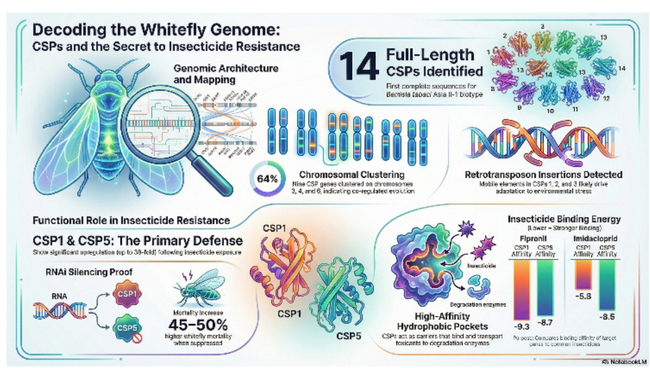
The wild species like like *Brassica fruticulosa, Diplotaxis spp., Eruca sativa, Crambe abyssinica,* and *Lepidium sativum* exhibited prolonged aphid developmental periods, lower survival, and fecundity compared to *B. juncea*, with species wild showing strong aphid-induced biochemical responses that hindered aphid development.

5.2.1.3 Gut microbiome analysis of honey bees

A comparative gut microbiome analysis identified the presence of core gut bacterial species, including Lactobacillus and Fructobacillus, Gilliamella apicola, Bartonella apis, and Snodgrassella alvi. Although *A. mellifera* and *A. cerana* share a similar ecological niche, *A. mellifera* harboured a significantly more diverse gut microbiota.

5.2.1.4 Functional insights into chemosensory proteins in whitefly *Bemisia tabaci*

Genome-wide analysis led to the identification for the first time, 14 chemosensory proteins in of *Bemisia tabaci* Asia II-1. Molecular docking analysis showed high-affinity binding of CSP 1 and 5 with two insecticides, imidacloprid and fipronil and functional validation through RNAi revealed that CSP1 and 5 might be associated with regulating insecticide resistance.



Genome-wide analysis of Whitefly

5.2.1.5 Gut bacteria mediate nitrogen (N) waste recycling pathways in white grubs

Gut bacteria mediate nitrogen waste recycling pathways in white grubs, *Holotrichia longipennis* as evidenced by enrichment of N metabolism genes in the hind gut of *H. longipennsi*. Further, isolation, characterization and deducing enzymatic activities of uricolytic and ammonia-tolerant bacteria (*Sporosarcina, Ureaplasma, Corynebacterium, Klebsiella*) confirm their active role in nitrogen metabolism. Targeting microbial nitrogen metabolism could serve as a novel as a novel microbial based strategy for management of white grubs.

5.2.1.6 Screening of native *Bacillus thuringiensis* strains against *Helicoverpa armigera* (Hub.)

Native *Bacillus thuringiensis* isolates were screened via diet incorporation against *Spodoptera litura*, *S. frugiperda*, *Earias vitella*, and *Helicoverpa armigera* larvae. Against *H. armigera*, the isolates VKK 14 and VKK 19 caused 100% mortality (single-dose); multidose LC_{50} values were 1.35×10^6 (VKK 14) and 1.44×10^6 (VKK 19) spores/g, with no significant difference. Late instars showed only 16.67% mortality but significant sublethal effects: reduced fecundity, stunted growth, prolonged development, pupation failure, adult non-emergence, and deformities.

5.2.2 Insect Toxicology

5.2.2.1 Synergistic study in fall armyworm, *Spodoptera frugiperda*

Two synergists [Piperonyl Butoxide (PBO) and Diethyl Maleate (DEM)] tested with three test-insecticides revealed that Synergistic Ratios (SR) were effectively more than unity, for all Insecticide: Synergist combinations (1: 1, 1: 2, 1: 5 & 1: 10) except for emamectin benzoate. For spinerotam the SRs are 2.91 and 3.27 for PBO and DEM, respectively.

5.2.2.2 Push pull strategy in termite management

A field trial was conducted to explore the utility of push-pull strategy for termite management. The left-over stubbles after harvesting served as sites for termite infestation and aggregation, without any damage to wheat crop. Stubbles were harboring the lady bird beetles as shelter site that promotes natural predation of aphids.

5.2.2.3 Alternate insecticides against Red flour beetle, *Tribolium castaneum*

The toxicities of newer insecticides in comparison to deltamethrin, were determined against a storage pest, Red flour beetle, *T. castaneum*. Spinetoram was found to be most effective with 1.68- 2.60-fold and chlorfenapyr 1.42-1.89-fold more toxicity than deltamethrin. Relative susceptibility of seven geographically different populations of *T. castaneum* revealed that the Delhi state population was most resistant to deltamethrin (resistance ratios [RR] = 2.23-2.27), followed by the Orissa population (RR= 2.14-2.17). The joint toxicities of deltamethrin and spinetoram at different proportions revealed that combinations 9:1 and 4:1 were synergistic and can be explored further for field application.

5.2.2.4 Insecticide application using unmanned aerial vehicles (UAVs) for managing major insect pests in rice

This study evaluated UAV-based insecticide application against conventional knapsack spraying for managing major rice pests. UAV spraying of isocycloseram and chlorantraniliprole at 2.0–2.5 m height significantly reduced yellow stem borer and rice leaf folder infestations compared to knapsack spraying, with minimal impact on natural enemies. For brown planthopper, UAV application of triflumezopyrim at 2.5 m was most effective. UAV-based treatments recorded higher profitability, with a maximum benefit-cost ratio of 1.67. Reduced doses (0.75×) of triflumezopyrim and pymetrozine applied through UAVs effectively managed BPH while conserving beneficial fauna, indicating UAV spraying as an efficient and sustainable alternative.

5.2.3 Biological Control

5.2.3.1 Studies on predation efficiency

This study assessed predation efficiency and olfactory responses of a predatory insect, *Geocoris ochropterus* (Blatchley). Nymphal (N1–N5) and preoviposition predation peaked on soft-bodied *A. gossypii* (cumulative >335 aphids in N5) and immobile *C. cephalonica* eggs (~274). Adults, especially females, showed highest lifetime consumption on *C. cephalonica* (~1800 eggs/female). Age-stage predation rates (cxj*cxj*) surged in late nymphs/adults on optimal prey, aligning with high survival (lx*lx*) and net predation (qx*qx*) during peak reproduction. GC-MS profiling revealed HIPV shifts with elevated levels of trans-β-caryophyllene and alkanes in aphid-infested cotton. The results demonstrate field-level effectiveness of *G. ochropterus* as a biological control agent.

5.2.4 Integrated Pest Management

5.2.4.1 Phenology and morphological traits of wild crucifers impacting host selection and population buildup of mustard aphid

The study found significant variation in phenology, morphological traits, and resistance to mustard aphid (*Lipaphis erysimi*) across wild crucifer genotypes, with traits such as siliqua number, seed count, plant height, and petal color influencing aphid preference and multiplication rate, while species like *Lepidium sativum*, *Sisimbrium spp.*, *Eruca sativa*, and *Crambe abyssinica* exhibited the least aphid preference and population build-up.

5.2.4.2 Behavioral and biological studies on *B. juncea* for resistance against painted bug, *Bagrada hilaris*

Field observations revealed significant variation in percent infestation and plant mortality, with highly susceptible responses in PDZM 33, PDZM 31, RLC 3 and RLC 2, moderate response in PM 30, PM 32 and Brijraj, and comparatively resistant reaction in RH 1706, RH 725, Pusa Bold and Kranti. Similar trends were recorded in no-choice and multi-choice tests for plant damage, mortality and insect preference. Incubation period, hatchability and sex ratio remained unaffected across cultivars. RH 1706, RH 725, Pusa Bold and Kranti exhibited resistance to painted bug infestation.

5.2.4.3 Assessment of avoidable yield losses by mustard aphid in rapeseed-mustard

The avoidable yield loss assessment studies on three mustard varieties *viz.*, BPM 11, RH 1975 and PM 37 (NPJ 253) revealed significant reduction in mustard aphid population after application of insecticide treatment, and could prevent the seed yield losses by 25.9, 11.9 and 20.0% in BPM 11, RH 1975 and PM 37 (NPJ 253), respectively. Seed yields were 2794.4, 2811.5 and 2712.3 kg/ha under protected, and 2219.7, 2512.1 and 2259.9 kg/ha in unprotected conditions in BPM 11, RH 1975 and PM 37 (NPJ 253), respectively.

5.2.4.4 Semiochemicals for leaf hopper *Amrasca biguttula biguttula*

The Y-tube olfactometer bioassay revealed that out of 19 host plant volatiles (VOCs), nine VOCs elicited attraction with Olfactrometric Preference Index (OPI) values of 1.41 to 1.69 and ten VOCs caused repellence with OPI values of 0.28 to 0.80. Further field evaluation of promising attractant compounds by using a yellow sticky trap in combination with compound lures identified the three most promising attractants with an increase in trap catches in the range of 168.63 to 386.27% compared to the conventional trap (only yellow sticky trap). These semiochemicals (repellents and attractants) can be further upscaled for development of a novel management strategy for the leafhopper, *A. biguttula.*

5.2.4.5 Monitoring of *Bemisia tabaci* and *Solanum* whitefly *Aleurothrixus trachoides*

Population abundance of these two major whitefly species of tomato was monitored over a period of two years. The population of *A. trachoides* reached >80% abundance during July-November while *B. tabaci* populations were recorded at >80% around March – April. Monthly time series indicated clear annual cycles wherein *B. tabaci* was dominant in dry months (Dec–Feb), while, *A. trachoides* peaked during the monsoon months (Jul–Sep), and then declined in dry seasons indicating of seasonal niche partitioning. The population abundance of *B. tabaci versus A. trachoides* showed highly significant negative correlation (r ≈ -0.98) with each other. Moderate negative correlation (r ≈ -0.48) was observed between rainfall vs *B. tabaci*. The association between rainfall and *A. trochoids* was moderately positive (r ≈ 0.47) indicating that *B. tabaci* is less abundant during the rainy season, while *A. trachoides* is more abundant in wetter months.

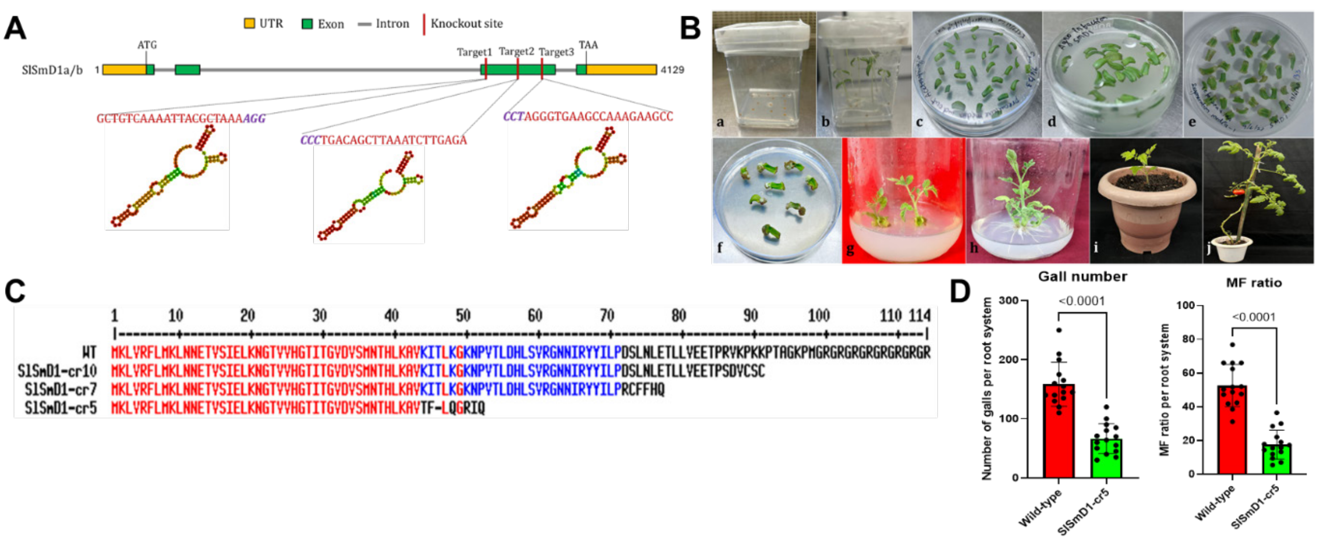
4.2.5 Vector & Virus-resistant Tomato Inter-species

Identification of whitefly-resistant *Solanum habrochaites* tomato carrying Ty3 genes in a homozygous state revealed that only 4.24% whiteflies preferred PTS-27 (*S. habrochaites)* host compared to 59.39% with preference to susceptible *S lycopersicum* tomato (Abhinav). Repellency level increased with the maturity of the plant. "Vector & Virus resistant" tomato Inter-species "F1" (*S habrochaites* X *S. lycopersicum*) were developed by crossing whitefly resistant "PTS-27" and virus-resistant line PTS-13 with fertile "F1" seeds. The F1 plants showed high tolerance to whiteflies.

5.3 NEMATOLOGY

5.3.1 Nematode Management Using Conventional and Molecular Methods

A spliceosomal factor *SlSmD1* was identified as a susceptibility factor that specifically expressed upon root-knot nematode *Meloidogyne incognita* infection in the symplasmically isolated tissues such as giant cells. Tomato cv. Pusa Ruby was transformed with Cas9 editor plasmid pHSE401 harbouring CRISPR guide RNAs targeting *SlSmD1* gene via leaf disc-*Agrobacterium* co-cultivation method. Homozygous mutant plants exhibiting nematode resistance were identified.

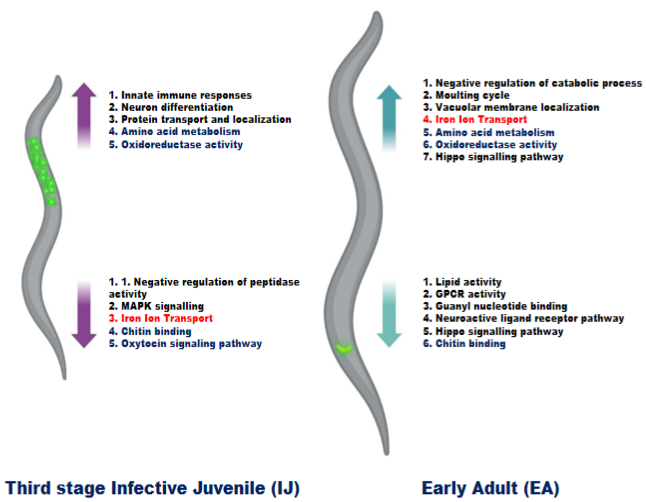


Generation of genome-edited tomato for improved nematode resistance. (A) Designing of 3 guide RNAs from the genomic location of susceptibility gene *SlSmD1*. (B) Pusa Ruby plants were transformed with editor plasmid *via* leaf disc-*Agrobacterium* co-culture method. (C) Mutant line SlSmD1-cr5 encoded a truncated peptide of 52 amino acids long. (D) Mutant line displayed reduced nematode susceptibility with 60% reduction in root gall counts

A field experiment was conducted to develop sustainable and integrated management strategies for rice root-knot nematode, *Meloidogyne graminicola* infecting the rice–wheat cropping system. The chemical check Velum Prime (flupyrum) effectively suppressed early penetration of *M. graminicola*, validating the experimental conditions in wheat variety HD 3385. Among non-chemical treatments, *Bacillus amyloliquefaciens* significantly reduced nematode penetration compared to untreated or botanical-only treatments. Botanical oils exhibited appreciable nematicidal activity, with citronella oil performing better than garlic oil. Integrated treatments involving the bioagent along with garlic and citronella oils showed superior performance asenhanced suppression of nematode penetration and reduced root galling, indicating synergistic effects. . The combined treatment of *B. amyloliquefaciens* (10 g plot^{-1}) + garlic oil (2000 ppm) + citronella oil (2000 ppm) emerged as the most effective, showing improved plant height, higher biomass, reduced gall formation, and the highest SPAD chlorophyll content in wheat.

5.3.2 Interaction of Entomopathogenic Nematodes and their Symbiont Bacteria

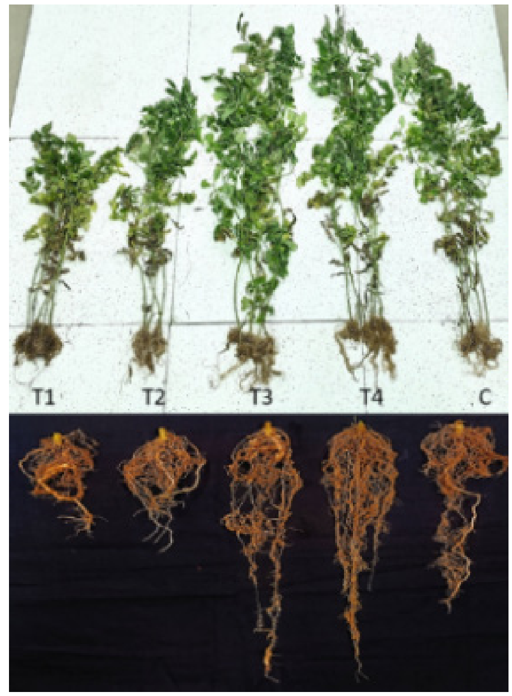
To understand the host genetic regulation of symbiotic interaction between entomopathogenic nematode *Heterorhabditis* with its bioluminescent symbiont *Photorhabdus*, single-worm and spatial transcriptomes of axenic and symbiotic *H. bacteriophora* at two developmental stages: infective juveniles (IJs) and early adults (EAs) were compared. Transcriptomic responses were strongly stage-specific and out of 769 DEGs, only 21 were common between the two stages. In IJs, enrichment of amino acid metabolism, neuronal differentiation, oxidoreductase activity, and innate immunity suggests controlled symbiont sensing, accompanied by immune restraint *via* downregulation of MAPK signalling and peptidase inhibitors. In contrast, EAs upregulated genes related to catabolism, moulting, ion transport, and Hippo signalling, consistent with tissue remodelling for bacterial colonization. Notably, the heme transporter HRG1 switched from downregulation in IJs, to upregulation in EA, implicating iron mobilization in symbiont maintenance in the EA stage.



A schematic model of metabolic and physiological processes active in *Heterorhabditis* IJs vs early adult stages

5.3.3 Role of *Steinernema siamkaiyai* in Rootknot Nematode Mangement

Based on the hypothesis of microbial niche exclusion, the incorporation of *Steinernema siamkayai* (MZ318695) IJs or infected *Galleria* cadavers significantly suppressed the invasion and gall formation by *M. incognita* in tomato cv. Pusa Ruby, and enhanced the overall plant biomass. Significantly higher emissions of CO_2 and NH_3 in the rhizosphere as respiratory and excretory byproducts of IJs and cadavers were directly correlated with suppression. Metabarcoding demonstrated a substantial shift in bacterial assemblies in *S. siamkayai* treated soil, which play key roles in plant growth promotion and suppressing plant antagonists by boosting plant's antioxidant defense system and enhance the synthesis of phytohormones and siderophores.



Reduction in *M. incognita* infection in tomato by treating *S. siamkayai* IJs and infected *Galleria* cadaver

5.3.4. Genomic Insights into the *H. indica* Himalayan Strain

Whole-genome sequencing of *Heterorhabditis indica* was done using the Illumina NovaSeq 6000 platform. The genome exhibited a moderate completeness with 46.9% complete BUSCOs. Gene Ontology and COG classifications indicated a broad functional spectrum, with dominance in catalytic activity, binding, transcription, and post-translational modifications. Comparative genomics with five other nematode species identified 2,700 gene clusters unique to *H. indica* and 2,790 proteins exclusive to the Himalayan strain, highlighting its unique adaptive genomic features. Phylogenomic analysis positioned the strain within the *H. indica* clade, closely clustering with reference *H. indica* and *H. bacteriophora*, confirming taxonomic identity and evolutionary proximity. The genomic data has been submitted at NCBI BioProject ID: PRJNA1248718.

5.4 AGRICULTURAL CHEMICALS

5.4.1 Synthetic Agrochemicals as Crop Protection Agents

The tetrazole based diacyl hydrazines were synthesized through multistep reactions and characterized using spectral and analytical techniques. The results of their *in vitro* evaluations against *Rhizoctonia solani* showed a range of antifungal activities against *R. solani*, with EC_{50} values varying between 34.3 µg/mL and 1.66 µg/mL. The results demonstrated the potential of these compounds as antifungal agents against *R. solani* and provided valuable insights into structure–activity relationships.

A series of twenty-five triazolopyimidines were synthesized by condensation of 2-hydroxyacetophenone derivatives with dimethylformamide dimethylacetal resulting in formation of enaminones. The treatment of enaminones with 3-amino-1,2,4-triazole gave triazolopyimidines which were screened for effectiveness against *Macrophomina phaseolina*. All triazolopyimidines showed good activity and compound 5-(4-(pentyloxy)-phenyl)-[1,2,4]-triazolo[4,3-a]-pyrimidine (5T) was most effective (ED_{50} 3.19 ppm) against *M. phaseolina*.

5.4.2 Bioactive Phyto-chemicals based Crop Protection Agents

Seven cannabinoids and four sesquiterpenoids were identified from hexane extract of leaves of *Cannabis sativa*. Six compounds, L-quebrachitol, sucrose, (2*S*, 3*S*, 4*R*, 16*E*) - 2 - [(2′*R*) - 2′ - hydroxy - nonadecanoylamino] - heneicosadec - 16 - ene - 1, 3, 4 - triol, *β*-sitosterol - 3 - *O* - *β* - D - glucoside, stigmasterol, and cannabispirone were identified and characterized by NMR and MS. Hexane and methanolic extracts showed dose-dependent *in vitro* nematicidal activity against *Meloidogyne incognita* (LC_{50}, 271.13 and 122.68 ppm) after 96 h. Pot experiment of the hexane and methanolic extracts showed lesser number of galls/plant (14.33±1.76 to 16.33± 0.88 galls/plant and 9.33±0.67 to 11.0±0.58 galls/plant) on tomato as compared to control (29.67±1.45 galls/plant) after 60 days.

Four compounds were isolated from hexane-acetone mixed extract of *Ageratum conyzoides* and were identified as precocene II, stigmasterol, coumarin, and caffeic acid using spectroscopic data. The methanolic extract of this plant exhibited aphidicidal activity against wheat aphids, *Rhopalosiphum maidis* (LC_{50} 0.987%) and *Sitobion avenae* (LC_{50} 0.953%). The various extracts/compounds of *A. conyzoides* were evaluated against *Spodoptera frugiperda* and *Bemisia tabaci.* The hexane extract displayed high antifeedant activity against *S. frugiperda* (LC_{50} 4.39% at 48 h) and contact toxicity against *B. tabaci* adults (LC_{50} 0.82% at 72 h). Precocene II showed exceptional antifeedant activity (LD_{50} 0.03% at 48 h), comparable to azadirachtin. Precocene II also induced 65.19±1.47% insect growth inhibitory activity with 20% mortality of the larva.

The EtOAc extract of *Gymnema sylvestre* leaves exhibited very good efficacy against P. expansum 2995 with EC_{50} 102.3 µg/mL. Ultrasonication assisted extraction showed higher extraction efficiency with 359.51 mg/2g sample extraction yield UPLC-QTOF-MS^E analysis gave identification of thirty-seven compounds dominating triterpenoidal saponins, flavonoid, lignan, steroids. Among these, gymnemic acid I, VII and gymnemagenin were isolated, purified and characterized using ^{1}H-NMR, ^{13}C-NMR and MS. *In silico* analysis against sterol 1,4-*α*-demethylase suggested higher binding efficacy of gymnemic acid I (-33.7 kJ/mol), gymnemagenin (-31.5kJ/mol) and gymnemanol (-29.0 kJ/mol). Ergosterol inhibition (87.50±4.96%) and membrane ionic concentration 3–34 µg/mL of *P. expansum* were recorded when treated with 1000 µg/mL concentration. Gymnemic acid I rich extract was encapsulated with chitosan to develop highly effective edible coatings for apples to provide protection.

The fresh leaves of *Ocimum tenuiflorum* (IC75730-Green Tulsi and IC381185-Black Tulsi) extracted using hexane, acetone and methanol. *In vitro* antifungal activity evaluation against *Fusarium oxysporum* (ITCC8113), *Sclerotium rolfsii* (ITCC 6866), *M. phaseolina* and *R. solani* revealed significant efficacy of acetone fraction against *Sclerotium rolfsii* (ED_{50} =227.04 ppm).

From most active acetone extract, ursolic acid was isolated by column chromatography and characterized by various spectroscopic techniques.

Fractionation of soil organic matter was modified using ultrasonic assisted extraction (UAE). In this method, time requirement for the extraction was reduced to half (2.5 h) from the method reported by International Humic Substance Society (IHSS). Also, higher yields of humin, humic acid and fulvic acid was obtained using the UAE method as compared to the IHSS method.

5.4.3 Moisture Retention Studies of Pusa Hydrogel and SPG-1118 in Soil

Hydrogel amendment significantly improved water retention in sandy loam soil across the matric suction range (0.3–15 bar), with moisture retention increasing with higher hydrogel doses (0.025–1%). SPG-1118 consistently outperformed Pusa Hydrogel, particularly at field capacity and across plant-available water ranges, indicating superior water-holding efficiency. Convergence at 15 bar suggested effective release of stored water before permanent wilting. Dissipation studies over 180 days showed that SPG-1118 degraded slowly (~40%), whereas Pusa Hydrogel degraded rapidly (>70%). Both followed first-order kinetics, with SPG-1118 exhibiting a much longer half-life (~253 days) than Pusa Hydrogel (~96 days). Overall, SPG-1118 demonstrated better persistence and suitability for long-term soil moisture management.

5.4.4 Development of Method and Decontamination of Contaminants in Food and Environment

5.4.4.1 Pesticide method & drying effects

A validated LC–ESI-MS/MS method quantified 100 pesticides with satisfactory recovery for 81, 76, and 49 pesticides at 0.1, 0.05, and 0.01 μg g^{-1}, respectively, and HorRat values of 0.3–1 in fresh red chilli. Mild matrix effects were observed for 86% of analytes, with uncertainty ranging from 4.44–30.43%. Drying of chilli led to concentration of residues in 96 pesticides after 7 days. Processing factors varied widely (1.00–17.58), indicating significant residue enrichment.

5.4.4.2 Tembotrione sorption and mobility in soils

Sorption and mobility assessment of tembotrione has been studied examining the adsorption–desorption and leaching behavior of the maize herbicide in soils of the upper (UGPZ), trans (TGPZ) and middle Gangetic plain zones of India. Tembotrione adsorption decreased with increasing pH and dissolved organic matter. Mobility was lowest in UGPZ soil and highest in TGPZ soil, with groundwater ubiquity scores of 4.27 and 4.81, respectively. Amendments reduced mobility in the order: unamended > wheat straw ash > wheat straw > FYM > compost. Compost was most effective in limiting leaching.

5.4.4.3 Determination of methyl eugenol and cypermethrin in pheromone trap for mutations

A rapid and sensitive GC–MS method was developed for the simultaneous determination of methyl eugenol and cypermethrin in pheromone trap formulations. It enables simultaneous detection of methyl eugenol and cypermethrin within 11 minutes and supports dissipation studies in lure-and-kill formulations under both field and laboratory conditions.

5.4.4.4 Biobed degradation of pesticides

Biobeds were used to degrade sequentially applied glyphosate and tricyclazole. Biobeds prepared using glyphosate pre-exposed soil, without (BM) and with wheat straw biochar [WBCBM (1%) and WBCBM (5%)] and inoculated with glyphosate degrading *Bacillus piscis*, were used in the study. Glyphosate residues declined from ~44–46 to 0.65–7.06 μg g^{-1} within 2 months, while tricyclazole decreased from ~31–33 to 1.13–7.79 μg g^{-1}. After 5 months, complete degradation of glyphosate occurred in BM and WBCBM (1%), with 7.37% remaining in WBCBM (5%). Tricyclazole degradation was complete in WBCBM (5%), with 14.71 and 2.10% remaining in BM and WBCBM (1%). Biochar dose significantly influenced degradation efficiency.

5.4.4.5 Molecularly imprinted polymer (MIP) and metal organic framework (MOF) sorbents for contaminant removal

β-Cyclodextrin based smart MIP for selective recognition of triclosan (an endocrine disruptor) in water was developed using a functionalized β-cyclodextrin (β-CD) as the recognition monomer, serving both as host molecule and binding enhancer, while incorporating a suitable support matrix and initiator. The β-cyclodextrin MIP showed high selectivity (imprinting factor 5.12) and adsorption capacity (28.9–75.4 mg g^{-1}). It retained >84.8% efficiency after five cycles, with detection limit 0.01 μg/mL and recovery up to 95.33%. Extraction recoveries ranged from 93.79–97.08%. MOF sorbents achieved 96–99% pesticide removal, with superior adsorption over biochar and good fit to Freundlich model.

5.4.4.6 Chloramphenicol dissipation in honey samples

The effect of different types of honey, spiking levels, storage temperatures, and effect of processing on the dissipation of chloramphenicol was carried out. Dissipation studies were conducted in honey samples of different botanical origins such as Acacia, Wild thyme, Honeydew, Multiflora, and Mustard honey. Half-life (DT50) varied by honey type, fastest in Multiflora and Honeydew (~7 days) and slowest in Mustard (~17 days), with DT90 ranging ~25–52 days. Half-life showed positive correlation with pH and negative correlation with moisture, EC, and HMF, with EC being the dominant factor. Dissipation increased with temperature and processing time.

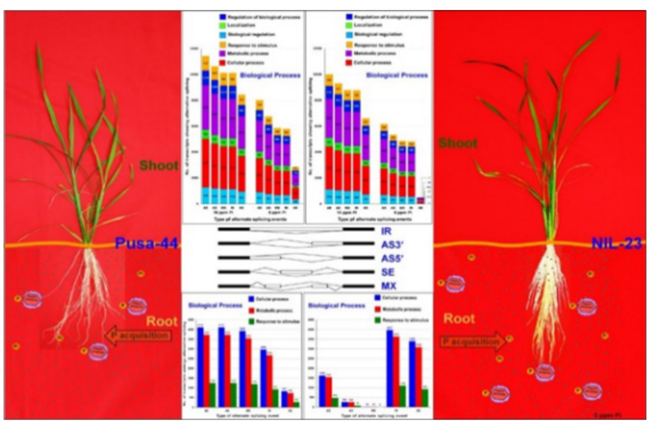
6. BASIC AND STRATEGIC RESEARCH

The School of Basic Sciences focuses on research on unlocking the genetic and molecular cues that underpin stress tolerance and crop yields. Basic research on identification of physiological processes, novel genes, QTLs, proteins, and metabolites to accelerate the crop improvement program are in progress. With cutting-edge technologies such as High-Throughput Plant Phenotyping (HTPP) and genome editing, climate-smart solutions for agriculturally important crops are being addressed. This section briefly presents the significant achievements under the above-mentioned areas.

6.1 BIOCHEMISTRY

6.1.1. *Pup1* QTL-Modulates Phosphorus Deficiency Tolerance in Rice

Rice varieties Pusa-44 and NIL-23 were studied under contrasting phosphorus (P) conditions (16 ppm *versus* 0 ppm). Pup1 QTL regulated stress-induced alternative splicing of ~20 differentially expressed genes. NIL-23 showed reduced splicing in roots, increased in shoots, affecting transcripts for bHLH transcription factors, P homeostasis, and serine hydroxy methyltransferase, highlighting the role of Pup1 role in nutrient-stress regulation.



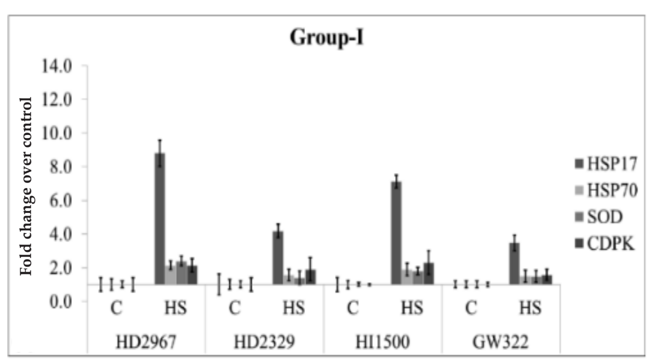
Differential expression of transcripts in root and shoot of rice under different phosphorus levels

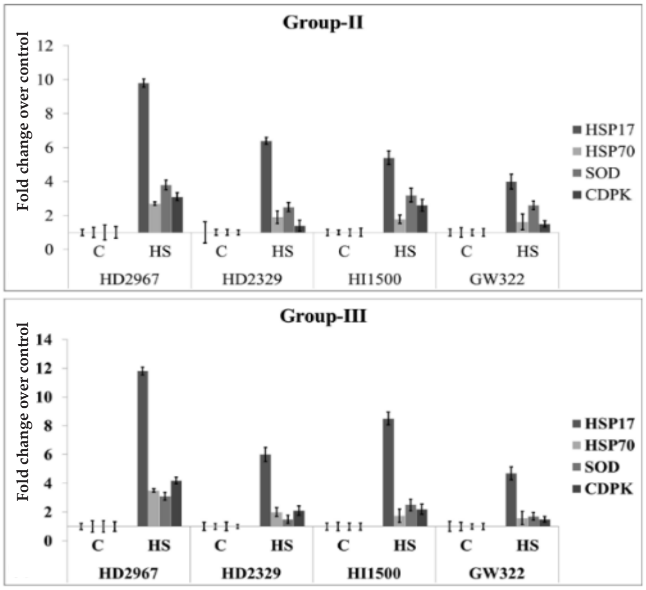
6.1.2 Phosphorus affects Seed Vigor and Grain Quality of Rice

Under varying phosphorus (4–64 ppm), NIL-23 exhibited superior root architecture, higher acid phosphatase activity, and enhanced P acquisition compared with Pusa-44. NIL-23 also showed improved tillering, grain yield, seed reserves, faster germination, and higher vigor, highlighting Pup1 QTL's role in P-deficiency tolerance.

6.1.3 Nitrate Flare in Root-Shielding the Stress effect in Wheat Under Heat

Wheat cultivars (HD 2967, HD 2329, HI 1500, GW 322) were grown hydroponically under N-deficient, N-normal, and N-sufficient conditions to study the role of nitrate in heat stress (HS) tolerance. Under N sufficient conditions, HD 2967 showed highest root nitrate and total antioxidant potential (TAP), while HI 1500 had maximum nitrite and root system architecture (RSA) proliferation. Nitrate reductase (NR) activity peaked in HI 1500 under normal N levels. Antioxidant enzymes and stress-associated genes (SAGs) expression increased under HS in N sufficient conditions, highlighting the role of nitrate in shaping RSA and supporting climate-resilient development of wheat genotypes.

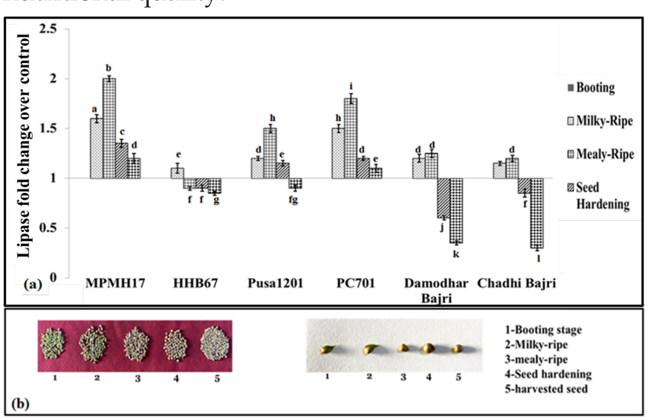




Expression analysis of stress-associated genes in wheat roots under varying nitrogen levels and heat stress

6.1.4 Unravelling the role of Pearl Millet *PgLPE-1* (Lipase/Esterase) in Rancidity

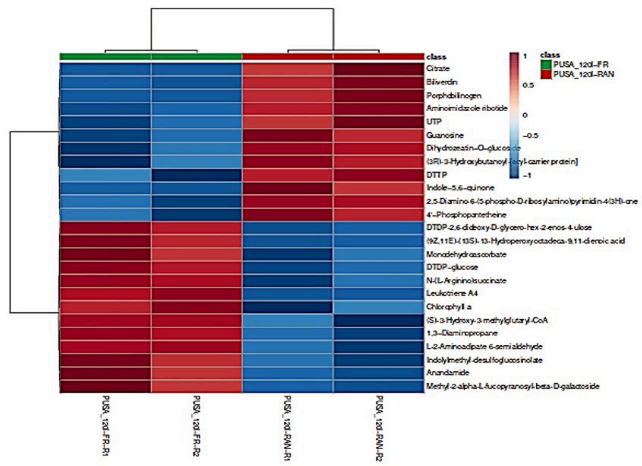
Rancidity in pearl millet flour limits its commercial use after a period of storage. Analysis of landraces, composites, and hybrids identified 1,350 lipase-like transcripts and *PgLPE-1,* an SGNH-type lipase, highly expressed in high-rancidity cultivar, MPMH17. Proteomics detected a triacylglycerol lipase active at pH 6.0 and 36 °C. Elevated lipase activity and free fatty acids in MPMH17 correlated with aldehydes and alcohols, providing molecular and metabolite markers for breeding pearl millet with improved shelf life and nutritional quality.



Expression analysis of putative PgLPE-1 gene in the developing endosperm of contrasting cultivars of pearl millet

6.1.5 Characterising the Enzyme-Driven Metabolic Shifts in Rancid Pearl Millet Flour

LC–MS metabolomics revealed Pusa-1201 accumulated lipid degradation products, pigments, and free fatty acids, while Chadhi Bajri retained antioxidants like quercetin 3-sulfate. Increased lipase, lipoxygenase, and peroxidase activities correlated with rancidity. Twenty-five metabolites, including phytol and chlorophyllide b, serve as biomarkers for metabolite-based rancidity sensors.



Heat-map of differentially expressed metabolites (DEMs) in fresh and rancid flour of Pusa-1201

6.1.6 Development of Beta-Glucan-Rich Barley Fraction

Barley is a valuable source of soluble dietary fibre beta-glucan linked to improved cholesterol, glycemic control, and gut health. In hulless variety Geetanjali, roller milling with 12–17% tempering produced flour and bran fractions. Fine bran from 17% tempering showed enriched beta-glucan, increasing from 5.73 to 8.76% after sieve fractionation.

6.1.7 Development of a High-Quality Steam-Infused Plant Protein Blend

A steam-infusion process improved protein quality of chickpea, rice, and peanut isolates, raising protein content from 64.2 to 84.4% and digestibility from 80.2 to 98.9%. A 3:3: 4 blend met FAO/WHO amino acid requirements with enhanced lysine and methionine. Structural analyses confirmed improved solubility, emulsifying, foaming, and rheological properties for next-generation protein-rich foods.

6.1.8 Nutribooster: Ultrasound-Assisted Sequential Extraction of a Bioactive Cocktail from *Hericium erinaceus* for Nootropic Effects

An optimized ultrasound-assisted sequential extraction from *Hericium erinaceus* recovered polyphenols, terpenoids, and β-glucans using aqueous ethanol and hot water. Response Surface Methodology maximized yield while reducing solvents and time. Extracts showed higher bioactive content than conventional methods and promoted SH-SY5Y cell proliferation, differentiation, and neurite outgrowth, especially from fruit bodies and control treatments.

6.2 PLANT PHYSIOLOGY

6.2.1 High Temperature Stress

6.2.1.1 Development of image-based phenotyping and modelling framework for Indian mustard

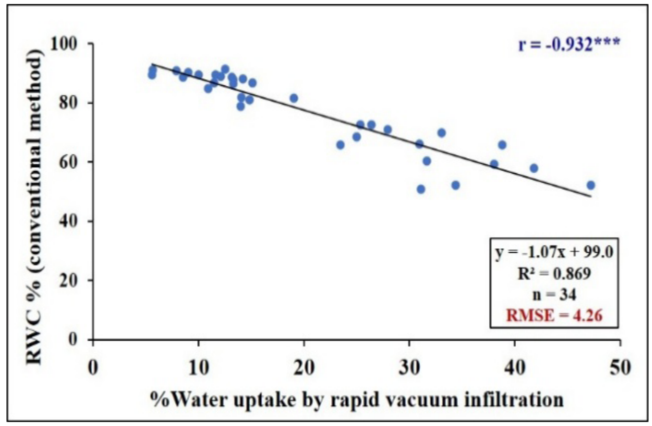
An image-based phenotyping framework for 120 Indian mustard genotypes used RGB, VIS, IR, NIR, and hyperspectral imaging. Machine and deep learning enabled biomass, leaf, and silique quantification, while smartphone imaging and WinRHIZO captured architectural and root traits, supporting early-vigour selection and heat-stress yield evaluation.

6.2.1.2 Ear-related physiological traits linked with terminal heat-stress tolerance in wheat

A study on 27 wheat genotypes under late-sown conditions revealed that higher epicuticular wax, ear glaucousness, and longer awns helped ears maintain lower temperatures, chlorophyll, and moisture. These traits enhanced photosynthetic contribution, grain number, weight, and harvest index, improving yield under terminal heat stress, highlighting ear-related traits as key targets for breeding thermo-tolerant wheat.

6.2.1.3 Development of a rapid method for phenotyping of leaf relative water content

Leaf relative water content (RWC) is a reliable index of plant water status but is time-consuming, requiring ~4 hours for turgid weight and drying. Rapid vacuum infiltration significantly accelerates water uptake, and a strong correlation was observed between conventional RWC and % water absorbed *via* vacuum infiltration in wheat leaves.



Relation between water uptake by vacuum-infiltrated leaf and RWC in wheat

6.2.1.4 Total free amino acid pool during early grain filling contributes to high night temperature tolerance in wheat

A two-year study evaluated 43 recombinant inbred lines (RILs) derived from the cross Raj 3765 × HD 2329 for total free amino acids (TFAA) at 3, 7, and 10 days after anthesis (DAA). The lines were grown under two high nighttime temperature (HNT) treatments: +3 °C (HNT1) and +6 °C (HNT2) above ambient, applied from heading to physiological maturity. Tolerant RILs showed earlier and greater accumulation of TFAA at 3 and/or 7 DAA. This increase was strongly positively associated with yield, indicating that TFAA could serve as a valuable physiological trait for breeding wheat cultivars resilient to rising night time temperatures.

6.2.2 Drought Stress

6.2.2.1 Root trait-based phenotyping for identificating of drought-tolerant Indian Mustard

A pot study with 150 Indian mustard lines under well-watered and drought conditions evaluated root traits using RhizoVision Explorer. Superior drought performance was correlated with root depth, angle, thickness, complexity, length, surface area, and tip density. Genotypes IM-17 and Varuna excelled, validating root traits as reliable selection criteria for breeding drought-resilient mustard.

Root trait groups, associated traits, and top-performing Indian mustard genotypes under drought stress

Trait Group	*Associated Root Traits*	*Top-Performing Genotypes under Drought*
Depth	Root system depth	IM-17, PR-2001-42, DJ-57
Angle	Root angle distribution (shallow, medium, steep angle frequency)	Varuna, LES-54, RLC-2, Pusa Jaikisan
Architecture	Root system complexity and spread (total root length, number of roots and root tips, network area, convex area, lower root area, surface area, volume)	NPJ-246, CN-101813, Varuna, NPJ 181, NPJ 245
Thickness	Root diameter traits (average, median, and maximum root diameter)	RE-8, DTM-4, IM-17
Orientation	Root growth orientation (average root orientation, width-to-depth ratio)	DJ-26, NPJ-246, DRMRIJ-31

6.2.2.2 Phenotyping of root traits in wheat RILs under moisture-deficit stress

A wheat RIL population (~200 lines) from HD 2967 × HI 1500 was phenotyped at Nanaji Deshmukh Plant Phenomics Centre for early vigour and root traits under drought. Multi-trait indices MGIDI (Multi-trait Genotype-Ideotype Distance Index), FAI-BLUP (Factor Analysis and Ideotype-Design), and SH (Smith-Hazel) identified superior seedlings and drought-responsive RILs. QTL mapping revealed loci for early vigour, root architecture, and drought-associated productivity traits, supporting selection of resilient lines.

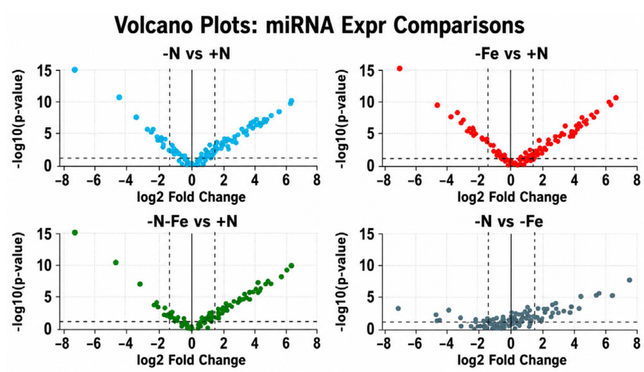
6.2.2.3 Deciphering the role of root physiological responses to terminal drought tolerance in lentil

Terminal drought-tolerant lentils (FLIP-96-51, IC560246) showed superior root architecture, enlarged metaxylem, stronger antioxidants, cooler canopies, higher biomass, and reduced yield loss. qRT-PCR revealed upregulated Indole-3-acetic acid-amido synthetase, linking root traits and stress resilience to drought adaptation.

6.2.3 Nutritional Deficiency Stress

6.2.3.1 Identification of miRNAs linked with iron and nitrogen deficiency tolerance in wheat

Global wheat productivity is limited by nitrogen (N) and iron (Fe) deficiencies. Hydroponic screening of 128 genotypes, including bread wheat and wild relatives, selected eight superior lines based on nutrient-use efficiency and stress tolerance. BT-Schomburgk (BTS) was used for miRNA sequencing, revealing 55,076, 64, 564, and 53,983 differentially expressed miRNAs under –N–Fe *vs* –Fe; –N–Fe *vs* –N; and –N vs –Fe, respectively, along with 108,649 unannotated reads. Analysis of the top 100 miRNAs showed unannotated miRNAs with stronger expression changes, highlighting complex regulatory networks under combined nutrient deficiency.



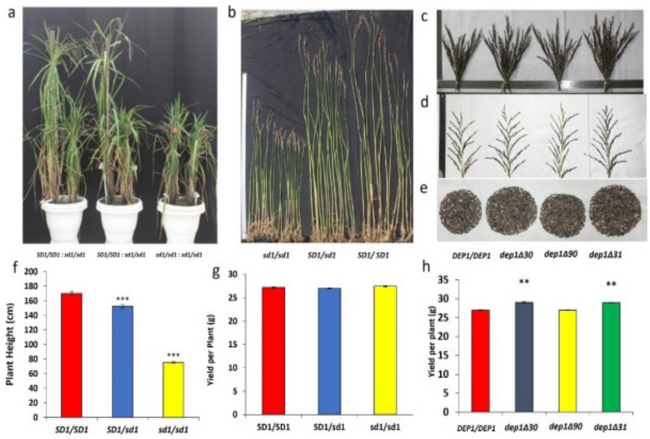
Volcano plot representing differentially expressed RNA sequencing data in BTS wheat genotype under different nutrient treatments (Control (+N), Nitrogen deficiency (-N), Fe Deficiency (-Fe) and combined N and Fe deficiency (-N-Fe)

6.2.4 Combined Stress

6.2.4.1 Physiological and genetic analysis of stem reserve mobilization and staygreen traits in wheat under combined heat and drought stresses

Stay-green (SG) and stem reserve mobilization (SRM) were evaluated in 278 wheat lines under heat–

drought stress. GWAS with 14,625 SNPs identified 36 MTAs across 16 chromosomes. Expression analysis showed Ser/Thr-protein kinase and wall-associated kinases enhance SRM, while *PP2C,* cytokinin dehydrogenase, and senescence genes regulate SG, aiding marker-assisted breeding.



Functional characterization of OsMMP1 mutants and overexpression lines under abiotic stresses in rice Kitaake

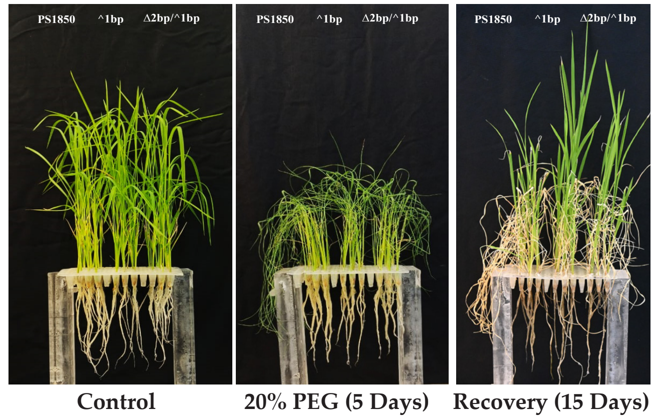
6.2.5 Genome Editing

6.2.5.1 Development of World's first genome edited rice variety Pusa DST Rice 1

The Institute has initiated genome editing of rice for enhancing yield and climate resilience in rice under ICAR-NASF project in 2018. Under this project, IARI has edited *DROUGHT AND SALT TOLERANCE* (*DST*) gene in rice *cv.* MTU1010, and obtained exemption from GMO Rules (Rules 1989) of India. This line was tested in national field trials in 2023 and 2024 under All India Coordinated Research Project on Rice (AICRPR). The DST edited line yielded 9.7, 14.7 and 30.4% higher grain yield than the parent variety under inland salinity stress, alkalinity stress and coastal salinity stress, respectively. This variety was identified in April, 2025 as Pusa DST Rice 1, the world's first genome edited rice variety developed and identified for release.

6.2.5.2 Genome editing for enhancing climate resilience of rice

For enhancing stress resilience and yield, *OsDST* gene was targeted for CRISPR-Cas9 mediated genome editing in Pusa Samba 1850, and Manipur Black rice Chakhao Amubi. DNA sequence analysis of transgenics (T0) led to the identification of 2 bp deletion mutant of *DST* (dst1_Δ2bp) gene in Chakhao Amubi. In Pusa Samba 1850 two genome edited mutants of *DST* (dst1_Δ2bp+^1bp and dst1_^1bp) were identified.



6.2.5.3 DST mutations confer osmotic stress tolerance to Manipur Black rice Chakhao Amubi PS 1850, WT; _^1bp, dst mutant with 1bp insertion; Δ2bp/^1bp dst mutant with 2bp deletion and 1bp insertion

Towards understading and improving root system, Robust Root System 1 (RRS1) gene was targeted for CRISPR-Cas9 SDN1 editing in rice *cv.* MTU1010. Putative transgenics obtained (T0) were sequenced, and heterozygous mutants *RRS1*_Δ716-1bp, *RRS1*_Δ716-2bp and *RRS1*_Δ715bp were identified.

To gain deeper insight into the role of photosynthesis pathway and Water Use Efficiency (WUE), EPIDERMAL PATTERNING FACTOR LIKE-9/ STOMAGEN gene was selected as targets for CRISPR/ Cas9-mediated gene editing in rice *cv.* MTU1010. Putative transgenic lines were confirmed by PCR using Cas9 specific primer. The *OsSTOM* PCR amplicons from T0 plants were sequenced by Sanger sequencing method and identified two homozygous mutants of *OsSTOM* (*stom*_Δ2bp and *stom*_Δ6bp) and two heterozygous mutants (*stom*_Δ3bp and *stom*_Δ11bp) were obtained in T1 generation. These mutants showed reduced stomatal density, and the stomatal density was lowest in *stom*_Δ2bp mutant followed by *stom*_Δ11bp mutant, as compared with wild type MTU1010.

Traditional black rice *cv.* Chakhao Amubi has high nutritional quality but suffers from tall stature, lodging, and low yield. Multiplex CRISPR/Cas9 editing of *SD1* (semi-dwarf 1) gene reduced plant height significantly and increased tillering. Editing of *DEP1* (*Dense and Erect Panicle 1*) enhanced panicle compactness and grain number by ~15%, improving lodging tolerance and overall yield in the edited lines.

6.2.5.4 Functional analysis of OsPMTR, putative rice melatonin receptor from rice

Melatonin receptor has been identified in Arabidopsis, maize, tobacco and cassava. However, no bona fide receptor has been identified in rice. For detail understanding of OsPMTR role in rice, we developed OsPMTR overexpression and CRISPR-Cas9 edited mutant plants. *OsPMTR* overexpression resulted in increased plant biomass, higher stomatal density, productive tiller number and grain yield. Conversely, genome edited *OsPMTR* mutants exhibited a substantial reduction in biomass, productive tiller and grain yield. Comparative analysis of *OsPMTR* overexpression lines and mutants subjected to drought stress demonstrated that *OsPMTR* is a positive modulator of drought tolerance, achieved through its role in maintaining transpiration-cooling, plant water balance, photosynthesis, and reducing reactive oxygen species levels. The growth impairments and drought susceptibility of *OsPMTR* mutants suggests that the cytoplasmic C-terminal region of OsPMTR is crucial for signaling pathways that regulate normal plant growth, development, and drought stress tolerance.

6.2.5.5 Functional characterization of *OsMMP1* gene in rice reveals potential negative role in multiple abiotic stress tolerance

The biological role of Matrix Metalloproteinase (OsMMP1) in rice was investigated using targeted genetic manipulation. Four homozygous knockout lines (M1–M4) and three single-copy overexpression lines (OX1–OX3) were generated in cultivar Kitaake. Under salinity (110 mM NaCl) and osmotic stress (20% PEG-6000), overexpression lines showed hypersusceptibility with reduced biomass, while knockout lines exhibited stress responses similar to wild-type plants, highlighting the role of OsMMP1 role in modulating abiotic stress tolerance.

6.2.5.6 gRNA design and construct development for the *ARE1* gene in pearl millet

sgRNAs targeting ARE1 in pearl millet were manually designed and assessed for efficiency and specificity. Selected gRNAs were cloned into pYLsgRNA vectors under the OsU3 promoter, multiplexed via Golden Gate ligation, and inserted into pYLCRISPR/Cas9Ubi-H. Constructs were validated through colony PCR, restriction digestion, and sequencing.

6.2.5.7 Genome-editing for haploid induction in maize

CRISPR/Cas9 constructs targeting DMP, MTL, and DMP+MTL were cloned into pBUE411 and introduced into *Agrobacterium tumefaciens* EHA105. Immature maize embryos (PMI-PV3) were infected, yielding 12 PCR-verified transgenic plants, demonstrating efficient single- and dual-gene CRISPR/Cas9 maize transformation.

Transgenic maize plants in rooting media

6.3 GENETICS

6.3.1 Wheat

Genetic diversity and population structure of Indian dwarf wheat (*T. sphaerococcum*): Population structure analysis revealed four distinct subpopulations with moderate gene flow (Nm = 1.286). Genome-wide haplotype analysis identified 260 haplotype blocks, reflecting substantial genetic diversity useful for breeding.

Genomic selection (GS) for grain yield and quality traits: GS was performed on 700 genotypes for yield, protein, and Fe content using multiple models. LASSO showed the highest prediction accuracy for yield (0.57), while GBLUP and Ridge Regression performed best for protein, leading to selection of five superior genotypes.

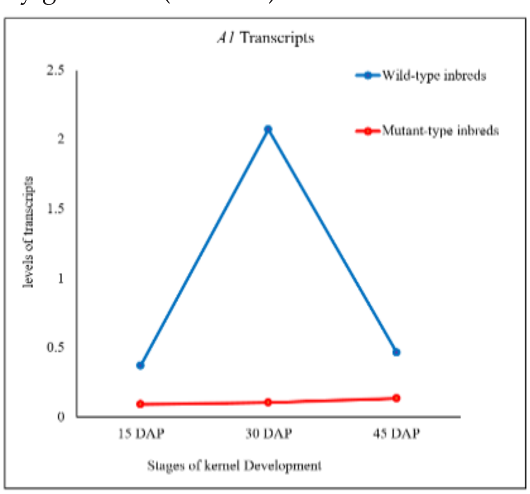
Association studies for silicon (Si) responsiveness in bread wheat: The genetic basis of silicon (Si) response in wheat for enhancing leaf rust resistance was investigated through GWAS to identify associated QTLs. SG86, SG73, SG92, SG110, and SG71 showed the most favourable average Si response, making them the best genetic stocks for breeding Si-responsive wheat varieties.

Molecular mapping of stripe rust resistance gene: The stripe rust resistance gene, *YrTm1* from *T. militinae* derivative TMD13-4-1 was mapped using BSA and a 34K SNP chip. SNP clusters associated with resistance were identified on chromosome 4D and validated by genotyping an F_4 population.

Mapping and utilization of yellow rust resistance in *T. spelta* accessions PI348764 and IARI276: Yellow rust resistance from *T. spelta* accession IARI276 was characterized using multi-location adult plant and seedling screening, BSA, and 35K SNP genotyping. The novel resistance gene, *YrIARI276* was mapped to putative regions on chr 1BL, 1DL, 5AL, or 7BL.

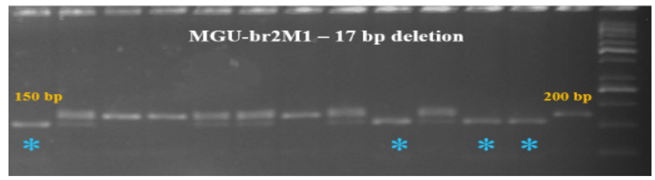
6.3.2 Maize

Expression analysis of *Anthocyanin1* gene governing anthocyanin accumulation in maize kernel: The dominant A1 allele showed 2.99-fold higher transcript levels than the recessive a1 across kernel development (15, 30, 45 DAP), peaking at 30 DAP. In contrast, a1 peaked at 45 DAP. The expression of A1 correlated positively with total anthocyanin (r = 0.502), cyanidin-3-glucoside (r = 0.445), and cyanidin-3,6-malonylglucoside (r = 0.816).



Expression profiling of *A1* gene at various DAPs

Development of breeder-friendly marker for *br2* gene governing shorter plant height: The 7,745 bp Br2 gene was sequenced in eight wild-type and two mutant maize inbreds. A 17 bp deletion in exon 3 (br2-mutant1) and a 4,763 bp Ty1-copia insertion in exon 5 (br2-mutant2) were identified, leading to development of PCR-based markers MGU-br2M1 and MGU-br2M2.

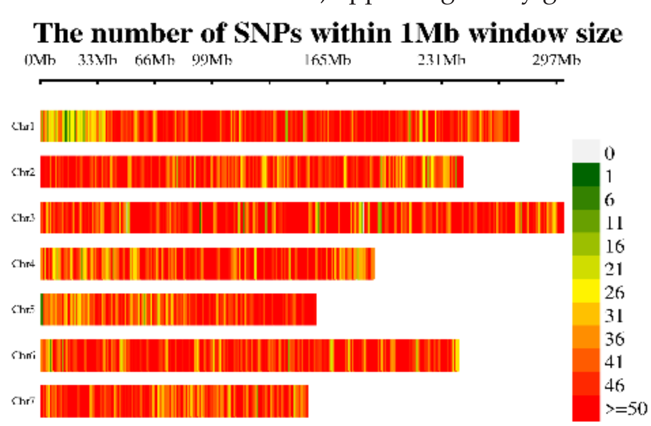


Validation of MGU-br2M1 in F_2 populations

Expression of *CTM* and GTP cyclohydrolase 1 (*GTPCH*) gene governing folate accumulation: Significant effects of genotype, days after pollination (DAP) and genotype × DAP interactions were observed for total folate content. Expression patterns of *CTM* and *GTPCH* genes in contrasting inbreds at 12 DAP and 24 DAP stages showed higher expression and lower accumulation at 24-DAP, while *GTPCH* showed the reverse trend.

6.3.3 Pearl millet

Association mapping for flour rancidity: Genome-wide SNP analysis identified seven sub-populations and 0.56 Kb LD decay. Sixty-six MTAs, including nine pleiotropic markers were mapped mainly to chromosomes 1, 3, 7 with S1_227804929 (lipid phosphatase), S5_148357217 (lipoxygenase, off-flavour), S3_29714103 (aldehyde dehydrogenase, reduces undesirable odors) appearing as key genes.



Distribution of SNPs across chromosomes

6.3.4 Chickpea

Expression analysis of *Ca-High Affinity Potassium Transporter (Ca-HKT)* gene: The *CaHKT1.1* gene was identified *via* TBLASTN and domain analysis using Arabidopsis *HKT* as reference. A 970 bp partial mRNA was cloned into TA13, verified, and introduced into *Agrobacterium*, generating transgenic *A. thaliana*. Superior lines (BG 4063–4069, BG 4072–4073, BGM 10224) are under evaluation for saline tolerance in Uttar Pradesh.

Identification of *NHX2* as key gene for salt tolerance: Ten candidate genes were analyzed for expression under 150 mM NaCl in roots and shoots. Sodium/hydrogen antiporter (*NHX2)*, in qSTI-7 (SNP Ca7:5500318), is a key salt-tolerance gene increasing early under stress peaking at 3–6 h and remaining high at 24 h.

6.3.5 Pigeonpea

Identification of QTLs for resistance to Fusarium wilt: The F1, F2, F2:3, and BC1F1 populations from ICP 8863 × ICP 2376 were evaluated for Fusarium wilt resistance, confirming single-gene dominant inheritance. SNP genotyping using a 62K chip generated a high-density linkage map with 4,161 markers. QTL mapping identified four resistance-associated QTLs: major qFWS8.1/qFWP8.1 on linkage group 8 (18.5% PVE) and three minor QTLs on groups 3 and 7 (8.2–9.2% PVE).

6.3.6 Lentil & Mungbean

Mapping of loci governing seed coat colour in mungbean: A RIL population ($F_{4:5}$) in mungbean [MH318 (Green seed coat & MYMIV susceptible) × KM18-83 yellow seed coat & MYMIV resistant)] was used for mapping of seed coat colour. The genetics of seed coat colour exhibited inhibitory gene action (13:3; Green:Yellow), while yellow seed coat colour was found recessive over green.

High density linkage mapping and QTL analysis of drought tolerance-related traits in mungbean: A total of 17 QTLs were detected for drought tolerance related traits using a cross between IPM02-3 (drought-sensitive) and PMD-2 (drought-tolerant) to construct high-density genetic map using SNP-derived from the GBS approach and map QTLs. These QTLs explained 1.62–6.97 % of the phenotypic variation. This is the first report of high-density linkage map for drought stress tolerance in mungbean.

Identification of aluminium responsive QTLs at the seedling stages in mungbean: Genotyping-by-sequencing (GBS) was used to map QTLs for morpho-physiological traits such as shoot length, root dry weight, root re-growth, callose content and aluminium content in RILs under aluminium stress condition. A total of 5 QTLs were detected for 8 traits on 3 linkage groups (LG-1, LG-5 and LG-8) using Ici Mapping. These QTLs explained 6.39-9.04% of the phenotypic variation.

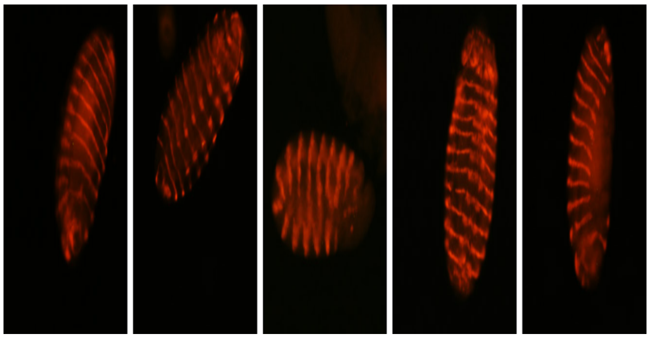
Genome wide association study (GWAS) for tolerance to pre-harvest sprouting in mungbean: A set of 118 mungbean genotypes was evaluated for pre-harvest sprouting (PHS), germinated pod (GP), and pod length (PL). GWAS identified 19, 9, and 15 significant SNPs for PHS, GP, and PL, respectively. Candidate genes include *VRADI05G19410 (PHS)* and *VRADI05G08380 (GP)*, explaining 4–29% phenotypic variability.

6.3.7 Mustard

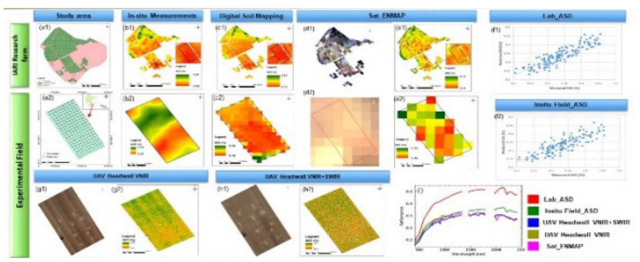
Marker development for genes governing 1000-seed weight (TSW) and their expression analysis: An F2 population from DRMRIJ-31 (bold) × RLC-3 (small) was used to develop markers for SAMBA (SNP Bj-B3-p17726495) and NAC-TF-25 (SNP Bj-B4-p10707039) using Varuna sequences. Genes were cloned in contrasting parents and sequencing of ARF-18 revealed 3 insertions and 22 SNPs. Expression analysis showed higher NAC-TF-25 and ARF-18 in bold seeds, enhancing TSW, while SAMBA was upregulated in small seeds, suggesting a negative effect on TSW.

6.3.8 Drosophila

Studying expression pattern of different segment polarity genes: To study the genetic interactions among the segment polarity genes in light of absence of *DWnt4* functions, we characterize the expression of *DWnt4* in the null alleles of these genes. Most of the segment polarity genes like *engrailed*, *Hedgehog* and *wingless* have *LacZ* genes cloned downstream of their expression cassette. Using balancers like *Fushi tarazu-lacZ* (*ftz-lacZ*) and *Hunchback LacZ* (*hb-lacZ*), we distinguished the null alleles of gene under study and check the expression of *DWnt4* in these homozygous null embryos. We first validated the *LacZ* lines of these genes using immunostaining assay.



LacZ expression of Engrailed in Drosophila embryos



6.4 AGRICULTURAL PHYSICS, REMOTE SENSING AND GIS, AND AGRICULTURAL METEOROLOGY

6.4.1 Comparative Evaluation of Different Hyperspectral Sensors for Soil Fertility Estimation

Hyperspectral non-imaging sensors (VIS-NIR-MIR) and AVIRIS-NG imaging were evaluated for soil fertility assessment using 243 samples from Banganpalli (AP) and Raichur (Karnataka). Machine learning models were compared using R^2 values for each soil property, revealing that MIR spectroscopy outperformed all other sensor-based techniques in predicting soil fertility parameters.

6.4.2 Scaling-up Sensor-based Soil Fertility Estimation from Laboratory to Field Scale

Hyperspectral imagery from ENMAP (30 m) and UAV sensors (2.3 cm) was collected over ICAR–IARI research farms during April–May, 2024. Soil samples (200 per site) were measured for spectral reflectance (350–2500 nm) under field and lab conditions, followed by chemical analysis. LAB_ASD, Field_ASD, UAV, and ENMAP data were evaluated using SVM regression to estimate soil organic carbon and generate spatial maps. SOC prediction accuracy was highest for LAB_ASD, followed by Field_ASD, UAV VNIR+SWIR, ENMAP, and UAV VNIR, highlighting hyperspectral sensing as a rapid soil fertility assessment tool.

6.4.3 Modelling Sun Induced Fluorescence (SIF) for Remote Sensing of Abiotic Stresses

Sun-Induced Fluorescence (SIF), linked to Photosystem-II, was analyzed in wheat using the SCOPE model, calibrated with field Fv/Fm measurements under varying water and nitrogen. Far-red SIF (740 nm) outperformed red SIF, correlating with LAI, chlorophyll, nitrogen, and PAR, highlighting its potential for satellite-based crop stress monitoring.

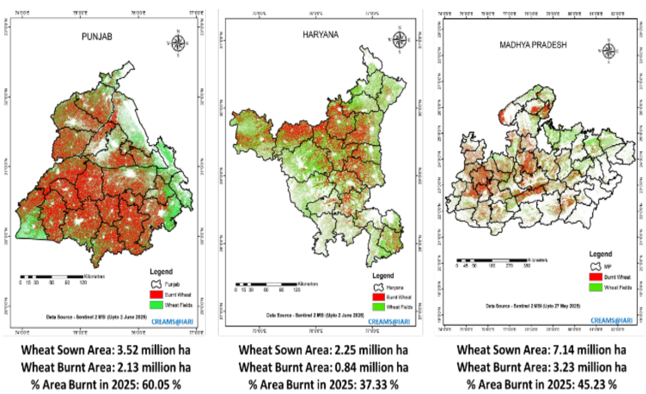
6.4.4 Forecasting Rice, Mustard and Wheat Yield by Assimilating Remote Sensing into Simulation Model

Under the FASAL 2.0 scheme of MoA&FW, district-level yield estimates of paddy, mustard, and wheat were generated by assimilating remote-sensing-derived crop parameters into a crop simulation model. Sentinel-1 and Sentinel-2 (10 m)–derived LAI at 5–12 day intervals, along with gridded weather data, were used to run the model at 10 m resolution to estimate yield and above-ground biomass, which were aggregated to district scale for 304 paddy, 87 mustard, and 242 wheat districts in India during the 2024–25 season.

Results of rice, mustard and wheat yield estimates for different districts spread across states of India during 2024-25

6.4.5 Monitoring Crop Residue Burning using Satellite Remote Sensing during 2025

In 2025, daily monitoring of rice and wheat residue burning in North-West India and across India was conducted using thermal satellite remote sensing. Bulletins were disseminated to government stakeholders. Between 15 September–30 November, 33,028 rice-burning events were detected across six states, and 60,915 wheat-burning events between 1 April–30 May. Multidate Sentinel-2 MSI (20 m) imagery and machine learning were used to map sown and burnt areas, enabling precise quantification of crop residue burning for management and mitigation.



Maps of wheat area burnt in the year 2025 in the three states

6.4.6 Optimizing Drone Spraying Parameters for Enhanced Uniformity and Efficiency

This study optimized drone spraying in precision agriculture, examining nozzle configuration and operational parameters. Configuration B produced the lowest variability in droplet coverage and RSF, especially at higher heights. Optimal conditions were 80°–110°–110°–80° nozzles, 3 bar pressure, 2 m/s flight speed, and 3 m spraying height, maximizing uniformity and application efficiency.

6.4.7 Effect of Zinc Oxide (ZnO) and Ferric Oxide (Fe_2O_3-NPs) Nanoparticles on Wheat

Two wheat cultivars (HD 3226, HD 3298) received seven foliar treatments, including ZnO and Fe_2O_3 nanoparticles (0.2% and 0.138% w/v) and equivalent sulfates at jointing and grain-filling stages. ZnO-NP and Fe_2O_3-NP significantly improved growth (SPAD +14.6%), spike length (+11.6%), grains per spike (+14.8%), biomass (+16.1%), and grain yield (+13.9%) *versus* sulfates and control. Similar experiment was carried out on wheat under temperature gradient tunnels (TGT). Nanoparticle treatments significantly increased relative water content (19–58%), spike length (+15.5%), spikelets per spike (+21.9%), grains per spike (+20.2%), and grain yield (+13.8%) compared with TGT control.

6.4.8 Methodology for Optimization of Scan Rate Response of Fabricated 2-D Carbon Allotrope Based Nanosensor using Cyclic Voltammetry

Graphene oxide was used as a nanosensor substrate to develop a systematic methodology for optimizing scan rate. Using a 50 mM phosphate buffer with 5 mM $[Fe(CN)_6]^{3-/4-}$, cyclic voltammetry was conducted at 10–100 mV/s. Peak currents and voltages were plotted versus the square root of scan rate to optimize sensor characterization. The developed methodology for studying the relationship between scan rate and the peak oxidation and reduction responses is useful for the characterization and optimisation of a nanosensor.

6.4.9 Evaluation of an Electric Field-based System for the Remediation of Heavy Metal-polluted Irrigation Water

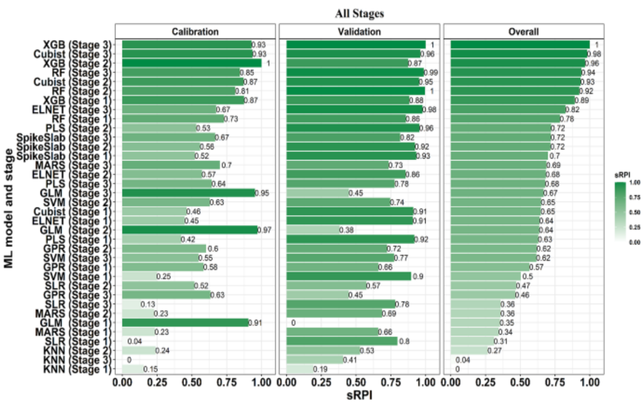
The electrochemical process using graphite electrodes is effective in removing heavy metals from both synthesised and natural irrigation water. Heavy metal removal efficiency was found to depend on applied voltage, operating time, and initial concentration. Energy consumption increases with both operating time and voltage. The highest removal efficiency for cadmium, zinc, cobalt, and manganese was 93.55, 85.55, 91.11, 99%, respectively.

6.4.10 Weather-based Agromet Advisory Bulletin for NCR Region

In 2025, 104 bilingual agromet advisory bulletins (Hindi and English) were disseminated to NCR farmers via multiple platforms. Feedback showed advisories reduced cultivation costs and increased profits. For example, based on 14 January rainfall forecasts, farmers avoided irrigation and sprays in vegetables and crops, saving one irrigation, several sprays, and approximately ₹ 3,500 per acre per crop.

6.4.11 Optimizing Chickpea Yield Prediction under Wilt Disease through Integrated Machine Learning Models

A three-year ICAR–IARI study on 85 chickpea genotypes assessed wilt severity impacts on biophysical traits. Increased wilt reduced LAI, photosynthesis, stomatal conductance, transpiration, RWC, MSI, and NDVI, causing 44–69% yield loss in susceptible genotypes. XGBoost models, with NDVI as key predictor, accurately predicted yield, improving near harvest.



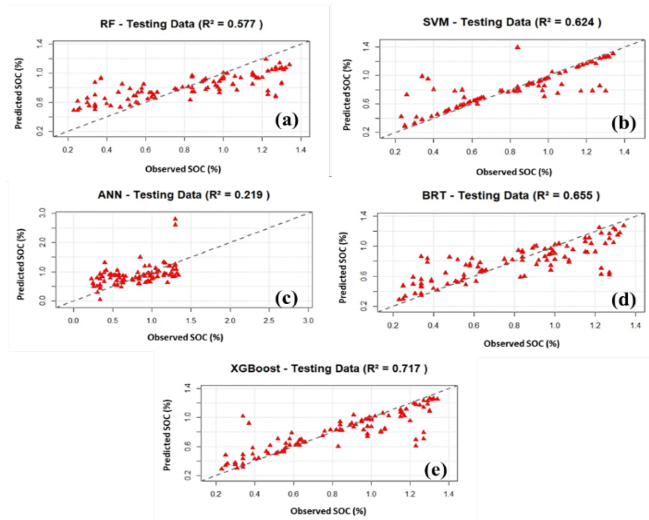
Ranking of ML models for all stages in predicting chick pea yield using sRPI

6.4.12 Screening of Wheat Genotypes under Salinity Stress using Thermography and Multivariate Techniques

Twenty-five wheat genotypes were evaluated under saline irrigation (EC 4 dS m^{-1}) using thermography and biophysical traits. A new Normalized Salinity Stress Tolerance Index (NSSTI) classified genotypes as tolerant, moderate, or sensitive, strongly correlating with yield (0.76–0.84) and biomass (0.73–0.82).

6.4.13 Integration of Smartphone Imagery and Topographic Predicts Soil Organic Carbon

Five machine learning models (RF, ANN, SVM, BRT, XGBoost) were evaluated to predict soil organic carbon (SOC) across the Indo-Gangetic Plains using 200 soil samples from Haryana, Delhi, UP, and West Bengal. While models using smartphone imagery or topography alone performed poorly, the integrated approach excelled, with XGBoost achieving $R^2 = 0.717$ and nRMSE = 0.16. Variable importance highlighted aspect and spectral features, demonstrating a rapid, low-cost SOC assessment framework without laboratory dependence.



Correlation graphs in Observed vs Predicted SOC (%) testing dataset using model-3

6.4.14 Ecosystem Service Calculator (ESS CAL) for Wheat Crop

A web-based Ecosystem Services Calculator (ESSCAL) was developed using HTML, CSS, and JavaScript to quantify provisioning, regulating, supporting, and cultural services, plus dis-services, monetizing crop yields, soil health, water retention, and biological control, providing integrated economic valuation for arable farming systems.

6.4.15 Development of an Automated Climate-Driven Decision Support and Advisory System for Pest and Disease Forecasting in Crops

An automated application package (APK) was developed to extract daily weather data from 360 IMD stations (temperature, humidity, rainfall, wind, and cloud cover) into the IARI internet system, creating a database of over 774,838 records since 2022. These data were used to develop thumb rule–based and regression-based pest and disease prediction models for major crops.

6.4.16 Artificial Intelligence based Hybrid Model or Meteorological Drought Modelling and Forecasting

A Genetic Algorithm (GA)-based hybrid model has been developed to enhance drought forecasting accuracy by optimally combining multiple predictive models. Monthly precipitation data from 1975 to 2022 were used to compute the Standardized Precipitation Index (SPI). Forecasting models including ARIMA, SVM, ANN, and LSTM were trained and integrated using GA-based optimization. Model performance was evaluated using RMSE, MAE, and MAPE, and results indicated that the GA-based hybrid model outperformed the individual models in forecasting accuracy.

6.4.17 Two-stage Triangular Fuzzy STARMA–TDNN Hybrid Model for Drought Forecasting

A two-stage triangular fuzzy STARMA–TDNN hybrid model was developed for improved drought forecasting by capturing linear and nonlinear spatiotemporal dynamics. Using 44 years of Standardized Precipitation Evapotranspiration Index (SPEI) data from 12 districts of Southern Telangana, the model combines STARMA for linear dependencies and TDNN for nonlinear patterns, integrated via. fuzzy logic. Performance evaluation using MSE and the Diebold–Mariano test showed significant improvement over ARIMA and STARMA models.

6.5 VEGETABLE SCIENCE

6.5.1 Cauliflower

Breeding for Alternaria leaf spot resistance (ALS): Backcross of (Cauliflower-DC 351 ×*Diplotaxis gomez-campoi* -WS-14)] ×Cauliflower DC-351] was advanced to BC4F1. It was also crossed with cabbage and broccoli. *Diplotaxis erucoides* × Cauliflower (PM) were screened against ALS and with cauliflower specific CDAG1 marker. The ALS resistant + *CDAG1* positive plants were selfed to BC_1F_2.

Glucosinolates-diamondback moth (DBM) interaction: Ninety-six cauliflower genotypes were screened for DBM resistance under *in vitro* and *in planta* conditions. DBM damage ranged 0–75%, with HPLC analysis showing sinigrin accumulation to be positively correlated and 3MSOP (3-(methylsulphinyl) propyl) and Indol-3-ylmethylglucosinolate (I3M) glucosinolates to be negatively correlated, indicating their potential deterrent effects.

6.5.2 Cucumber

Physio-biochemical and molecular insights for drought tolerance: Drought tolerance in 109 cucumber genotypes was evaluated via root traits. Tolerant lines DGC-21 and WBC-23-2 maintained root growth, photosynthesis, membrane stability, and antioxidants, with upregulated stress-related genes and transcription factors.

Genome-wide association mapping for water stress traits: A GWAS study using 86 diverse cucumber lines identified 52 stable SNPs associated with shoot and root traits under water-deficit and PEG-induced stress. Several SNPs were located near candidate genes involved in auxin signaling, transcriptional regulation, and root development, providing useful genomic resources for marker-assisted breeding of drought-resilient cultivars.

Marker-assisted breeding for key traits: Marker-assisted backcross breeding was successfully employed to introgress gynoecious, parthenocarpic, and downy mildew resistance traits into elite cucumber backgrounds using robust foreground and background selection. Stable gynoecious lines were developed and deployed in hybrid breeding programs.

6.5.3 Muskmelon

Candidate gene(s) conferring resistance against ToLCNDV: Six candidate genes were analyzed in eight melon genotypes after ToLCNDV inoculation. Eukaryotic Translation Initiation Factor 4 Gamma 1 (EIF4G) gene was overexpressed in susceptible genotypes (7–14 dpi), while Serine/threonine kinase and Glutathione-S-transferase genes were overexpressed in resistant genotypes (21–28 dpi), indicating roles in susceptibility and resistance.

6.5.4 Bitter gourd

Gene expression for charantin and β-carotene biosynthesis: Gynoecious line PVGy-201 exhibited the strongest gene expression profile with the highest transcript levels for five key genes, including *McIDI* (~16,493-fold), *McPMK* (~694-fold), and *McSE* (~466-fold), which corresponded with the maximum charantin content (38.53 µg/g FW). DBGS-2 showed elevated expression of *McHMGR1* (~271-fold) and *McMK* (~13-fold), supporting its high charantin accumulation (35.27 µg/g FW).

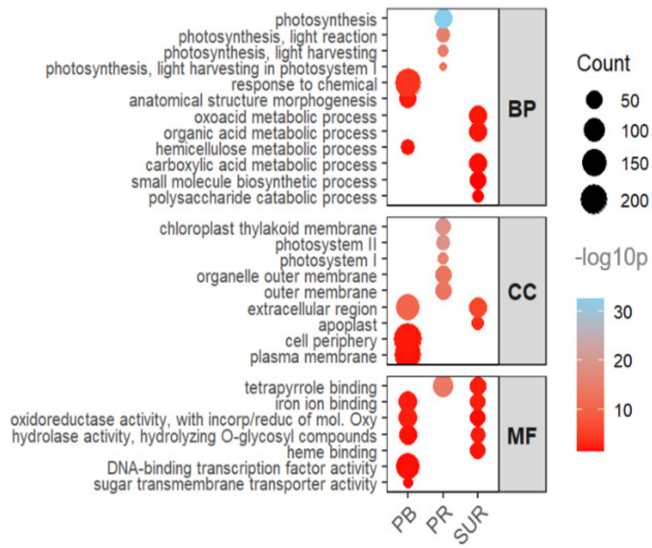
6.5.5 Okra

Novel alpha-satellite associated with monopartite okra enation leaf curl virus (OELCuV): The identified alphasatellite has 88.98-99.02% nucleotide sequence identity (nt) with other OELCuV isolates.

6.6 NEMATOLOGY

6.6.1 Basic and Fundamental Research in Plant Nematology

Previously, the rice germplasm Phule Radha and Suraksha were identified as resistant to *Meloidogyne graminicola* through extensive screening. To elucidate the genes underlying compatible and non-compatible plant–nematode interactions, we performed RNA sequencing on a susceptible (Pusa Basmati 1121) and the resistant (Phule Radha and Suraksha) varieties of rice. Transcriptomes of healthy and nematode-infected plants at 2, 4, and 10 days after inoculation (DAI) were sequenced in triplicate, generating an average of 30 million reads per sample. In Pusa Basmati 1121, a total of 5,703 transcripts were differentially expressed across the three time points, with 3,188 upregulated and 3,211 downregulated; among these, 3,404 transcripts were successfully annotated to Gene Ontology (GO) terms and KEGG pathways. In Phule Radha, 7,436 transcripts were differentially expressed, of which 4,748 were upregulated and 5,564 downregulated, and 5,551 were annotated to GO and KEGG categories. In Suraksha, 3,336 transcripts showed differential expression over the same period, including 2,692 upregulated and 1,046 downregulated transcripts, with 2,215 receiving GO and KEGG annotations. Our analysis reveals that the three rice genotypes respond to nematode infections differently.



Gene Ontology (GO) enrichment analysis of differentially expressed genes (DEGs) in three varieties after 10 days of infection PB : Pusa Basmati 1121; PR: Phule Radha; SR: Suraksha

7. SOCIAL SCIENCES AND TRANSFER OF TECHNOLOGY

The School of Social Sciences plays a vital role in evaluating and promoting agricultural technologies to improve productivity and profitability. Studies under Social Science, highlight benefits of improved crop varieties and policy reforms in fertilizers and markets. Institutional initiatives like Farmer Producer Organizations (FPOs), Kisan Credit Card (KCC) and Mahatma Gandhi National Rural Employment Guarantee Act enhance incomes and food security. Outreach programmes and platforms such as *Pusa Krishi Vigyan Mela, Pusa Samachar* and KVK trainings strengthen adoption, entrepreneurship, and sustainable agricultural development.

7.1. AGRICULTURAL ECONOMICS

7.1.1 Markets, Trade and Value Chain

The Division's assessment of the National Agriculture Market (e-NAM) for 2024 highlights progress alongside persistent challenges in agricultural marketing. Cultivator participation remains limited at 14%, with 55% of major markets integrated and trade contributing about 2% to agricultural Gross Value Added (GVA). Price realization has improved significantly, with higher-price transactions rising from 23% (2019–2021) to 52% (2019–2022). However, awareness is low, with only 23% of farmers in Haryana and Rajasthan familiar with e-NAM. Operational constraints such as trader cartelization, delayed payments, and manual quality assessment continue to hinder efficiency, indicating the need for better assaying infrastructure. Evidence shows that institutional linkages enhance farmer incomes; among 6,535 maize growers, participation in modern markets increased prices by ₹4,627 per tons over informal channels. Farmer Producer Organizations further strengthen value chains by reducing input costs and improving productivity. However, challenges remain in processing, including declining capital productivity and high material costs. Additionally, pesticide compliance issues persist, with significant export rejections due to residue violations, underscoring the need for better traceability and Good Agricultural Practices.

7.1.2 Technologies and Policies

The research synthesizes multiple studies on agricultural innovations and their impacts in India, highlighting both technological and policy-driven advancements. The neem-coated urea policy has improved nitrogen use efficiency, enhanced crop yields, and moderated urea consumption, delivering environmental benefits. Direct Seeded Rice (DSR) has shown significant potential in the Indo-Gangetic Plains, saving 15–20% irrigation water, reducing labour costs, and lowering emissions, though adoption challenges remain due to limited awareness and weed management issues. Yield gap analysis indicates substantial scope for improving productivity in pulses and oilseeds through better management and improved varieties. Digital innovations, such as SaaS-based e-market platforms, have increased farmers' income, with potato growers in Haryana receiving higher prices compared to traditional markets. Similarly, Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) has positively influenced rural wages, particularly for women, reducing gender disparities. Varietal innovations from ICAR-Indian Agricultural Research Institute have generated substantial economic benefits. Basmati variety PB 1509 and wheat HD 3086 have contributed significantly to consumer and producer surplus. Seed production models show that IARI-SPU ensures higher technical and marketing efficiency, though challenges such as payment delays and compliance issues persist across stakeholders. Overall, access to quality seeds, institutional linkages, and effective information dissemination systems remains crucial for enhancing agricultural productivity and farmers' income.

7.1.3 Ecosystem and Sustainability

Research across the Indo-Gangetic Plains highlights key challenges and opportunities in sustainable agriculture. Among 906 rice farmers, 37% overuse urea, while average technical efficiency remains 65%, indicating scope for improvement. Training, soil testing, and insurance help reduce nitrogen misuse, whereas poor nutrient balance and irrigation practices lower productivity. Information flows are dominated by traders and family networks, with limited institutional outreach, emphasizing the need for stronger extension systems and digital inclusion. Policy analysis using Computable General Equilibrium (CGE) models show fertilizer subsidy cuts reduce fiscal burden but may lower sectoral output, while direct transfers protect farm incomes. Environmental assessments confirm benefits of DSR in reducing emissions. Studies also reveal significant crop losses from human–wildlife conflict and highlight the economic value of pollinators. It is thus evident that crop diversification improves income and sustainability, requiring better credit access and market linkages.

7.1.4 Meta-transformer for Agricultural Commodity Price Forecasting

A hybrid forecasting framework combining Transformer models with Particle Swarm Optimization (PSO), Grey Wolf Optimizer (GWO), and Whale Optimization Algorithm (WOA) optimizes hyperparameters to enhance accuracy. Applied to weekly potato price data from Northern India, results using RMSE (Root Mean Squared Error) and MAE (Mean Absolute Error) show that Transformer-GWO and Transformer-WOA outperform conventional forecasting methods significantly.

7.2 AGRICULTURAL EXTENSION

7.2.1 Converging Agripreneurship, Farmers' Innovations and Modern Technologies

7.2.1.1 Analysis of business models of agricultural entrepreneurship

The study presents a comprehensive synthesis of agri-preneurship by integrating farmers' innovations with modern technologies and enterprise models across diverse regions of India. A detailed case-based analysis of twelve agri-entrepreneurs from states such as Uttar Pradesh, Hyderabad, Kerala, Maharashtra, Karnataka, Haryana, West Bengal, and Madhya Pradesh highlighted varied enterprises, including millet-based products, organic processing, drone services, nurseries and sustainable farming initiatives. Using the Business Model Canvas (BMC) framework, the study examined key components as value propositions, resources, partnerships, and revenue streams.

7.2.1.2 Growth drivers of agripreneurship development

The analysis of growth drivers revealed that infrastructure development, awareness of entrepreneurial opportunities and access to markets were perceived as major factors influencing agripreneurship development.

7.2.1.3 Capacity development needs and competencies for value chain development

Capacity-building needs were identified in technical skills, business education, and soft skills, with a strong emphasis on experiential and practice-oriented training methods. While lectures remained widely used, institutions increasingly adopted demonstrations, simulations, and interactions with successful entrepreneurs to enhance learning outcomes.

7.2.1.4 Extension strategies for stakeholder convergence through networks and institutional linkages

The study highlighted the importance of stakeholder convergence through effective institutional linkages among farmers, traders, processors, and extension agencies. Extension interventions implemented in

Faridabad and Delhi included entrepreneurial training, formation of Farmer Producer Companies (FPCs) and Self-Help Groups (SHGs), and facilitation of market access through platforms like *Pusa Krishi Haat*. Strong mutual trust, member involvement, satisfaction, sense of attachment, conviction, and ownership emerged as key drivers of collectivization, leading to the successful formation of the FPC *'Dauji Phool Utpadak Sangh'* in village Fatehpur Biloch.

7.2.1.5 Measuring entrepreneurial readiness and the agripreneurial ecosystem

Modern Entrepreneurship Education System (MEES)-based evaluation showed moderate institutional support, highlighting gaps in technical, financial, legal, and marketing systems, and the need to strengthen frameworks for improving entrepreneurial readiness and farm income.

7.2.2 Evaluation of Farmer-centric Government Schemes and Programmes for Agricultural Extension Policy Advocacy

7.2.2.1 National Horticulture Mission

A multi-state study evaluated the National Horticulture Mission (NHM) across Tamil Nadu, Odisha, Gujarat, Madhya Pradesh, Haryana, and West Bengal using surveys and case studies. In Tamil Nadu, farmers reported high satisfaction with subsidies for protected cultivation, though labour shortages and price fluctuations persisted. Haryana showed strong economic viability of capsicum cultivation under polyhouses. West Bengal recorded increased adoption of high-value crops and income gains. Gujarat and Madhya Pradesh demonstrated profitable protected cultivation, while Odisha saw growth in nurseries despite high costs. Overall, NHM enhanced diversification, income, and technology adoption, but challenges like labour constraints, weak market linkages, and delays in subsidy delivery need attention.

7.2.2.2 Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM)

A study in Haryana and Maharashtra found solar photovoltaics in agriculture to be technically efficient and socially beneficial, enhancing energy access, environmental sustainability, and climate resilience. Around 38–43% farmers showed favourable perceptions. Recommendations included streamlined Direct Benefit Transfe (DBT) subsidies, localized support, and training rural youth as solar pump technicians under Skill India.

7.2.2.3 Sub-Mission on Agricultural Mechanization (SMAM)

In aspirational districts of West Bengal, 160 beneficiaries (Nadia, Birbhum) and 160 non-beneficiaries (South 24 Parganas) were studied. Beneficiaries perceived increases in annual income, cropping intensity, yield, and farm power use, with reduced cultivation costs. Major constraints were fragmented landholdings and machinery maintenance, while officials reported irregular fund flow and staff shortages.

7.2.2.4 Kisan Call Centre (KCC)

In Haryana, analysis of 26.8 lakh calls (Jan 2009–May 2024) revealed spatial, temporal, crop-wise, and seasonal patterns of farmer information needs, enabling district-specific interventions. Farmers preferred wheat varieties with early maturity, high grain and straw yield, large grain size, higher market price, low irrigation need, and pest resistance.

7.2.2.5 Deendayal Antyodaya Yojana: National Rural Livelihood Mission (DDY-NRLM)

A study in Andhra Pradesh (n=150) across four districts showed that SHG members had significantly higher financial inclusion (0.742 vs 0.375) and livelihood security (0.811 vs 0.446) than non-members, with strong statistical significance. Most SHG members reported moderate to high outcomes. Key drivers included income, social participation, and expenditure.

7.2.3 Agricultural Extension for Nutrition and Health (AE4NH) Strategies and Model

7.2.3.1 Nutrition and Health Security Assessment in Rural Communities

Despite rising agricultural productivity, undernutrition persists in developing countries, highlighting the need to assess nutrition and health security holistically. This study integrated agricultural, socio-economic, behavioural, and health factors, using Q-sort to identify 21 key indicators. A composite index was developed for assessment.

7.2.3.2 Safe Pesticide Use Behaviour among Farmers (Plains Region)

A study in Bulandshahr (Uttar Pradesh) covering 50 farmers found heavy reliance on private agents for pesticide information, with only 32% accessing institutional sources and 18% using digital media. It was found that unsafe practices were common, including improper storage (64%) and ignoring labels (36%). The study highlights the need for training and promotion of safer and sustainable farming practices.

7.2.3.3 Knowledge and Perception of Health and Hygiene among Rural Labourers (South India)

A survey of 320 rural labourers in Andhra Pradesh and Telangana assessed six health dimensions. Most respondents had medium knowledge, with better understanding of physical health but gaps in mental, social, and hygiene aspects. Education showed a strong positive influence, while family size and gender were negatively associated with health awareness and perception levels.

7.2.3.4 Dietary Diversity and Malnutrition in Hill Agriculture Systems (Uttarakhand)

A Kumaon study of 400 adults was taken and it was found that 21% men and 37% women are underweight. Women accessed information via anganwadi workers and SHGs, while men relied on media. Most of the respondents were willing to use video-based modules developed by the ICAR institutes.

7.2.3.5 Eating Behaviour and Psychological Factors among Agricultural Students

A national study of 3,150 agricultural students was also taken up which showed suboptimal diets, BMI imbalance, and significant psychological and social influences on eating behaviour.

7.2.3.6 Nutrition Literacy and Healthy Eating Behaviour among Undergraduate Students

A survey of 914 agriculture students found moderate nutrition literacy and healthy eating behaviour. Key determinants included literacy, residence, and information exposure; hostel students performed worse, while most showed normal BMI and high information needs.

7.2.3.7 Food Safety and Pesticide Behaviour in Hilly Regions

A study of 250 respondents showed poor pesticide awareness, no residue testing, mixed hygiene practices, and high fast-food consumption among children, indicating significant health and food safety concerns.

7.2.3.8 Consumer Acceptance and Willingness to Pay for Nutri-rich Foods

It was found that consumers pay 15–25% premium for fortified and millet products; awareness, income, and education drive acceptance, requiring better labelling and marketing.

7.3. TECHNOLOGY ASSESSMENT AND TRANSFER

7.3.1 Assessment and Outscaling of IARI Technologies for Enhancing Farm Income

During *rabi* 2024–25, the project was implemented in Nidana (Rohtak, Haryana), Maholi (Palwal, Haryana), and Kanvi (Hapur, Uttar Pradesh), covering 60.91 ha with 3,733.8 kg seeds. Improved varieties of wheat, mustard, carrot, onion, and spinach outperformed local checks in yield, profitability, and adaptability. Wheat varieties like HD 3369, HD 3406, and HI 1653 recorded up to 23.8% higher yields, with strong returns (B:C up to 3.17). Mustard and vegetables demonstrated higher productivity and market acceptance. Integrated Nutrient Management with Leaf Color Chart (LCC) enhanced yields significantly. During *Kharif* 2024, improved paddy varieties such as Pusa Basmati 1692 and 1509 achieved 8–31% higher yields, while vegetables like okra and cowpea improved income. Overall, technology adoption, diversification, and farmer-led dissemination strengthened productivity, profitability, and nutritional security.

7.3.2 Agro-Advisories to Farmers

Agricultural advisories for rabi crop sowing, intercultural operation, pest and disease management, harvesting & threshing, sowing of *rabi* and *kharif* vegetables; *Kharif* crops package and practices and other allied activities were disseminated through AIR, DD, Newspapers and mobile phone in adopted villages namely Nidana (Rohtak, Haryana), Maholi (Palwal, Haryana) and Kanvi (Hapur, U.P).

Field Days at Adopted Villages

Sl. No.	Programme	Location	Date	No. of Beneficiaries
1	Field Day on improved varieties of Wheat and Mustard	Maholi, Palwal, Haryana	11.03.2025	100
2	Field Day on improved varieties of Wheat and Mustard	Nidhana, Rohtak, Haryana	20.03.2025	100
3	Field Day on improved varieties of Wheat and Mustard	Kanvi, Hapur, UP	20.03.2025	80
4	Field Day on improved varieties of Paddy	Nidana, Rohtak, Haryana	19.09.2025	50
5	Field Day on improved varieties of Paddy	Maholi, Palwal, Haryana	24.09.2025	80
6	Field Day on improved varieties of Paddy	Kanvi, Hapur, UP	08.10.2025	50

7.3.3 Technology Integration and Transfer to Strengthen the Farming System in Partnership Mode

7.3.3.1 Technology integration and transfer to strengthen the farming system in partnership mode

The partnership project with ICAR institutes, SAUs, AUs, and NGOs promoted IARI technologies through demonstrations and training. *Rabi* 2024–25 results showed 13–46% yield gains in wheat and mustard across regions, with strong profitability and adaptability in diverse agro-climatic conditions.

Agro-Climatic Zone	Location / State	Crops and Varieties	Yield Increase	B: C Ratio	Farmer Feedback
Western Himalayan Region (Zones I & II)	KVK Kathua, J&K	Wheat: HD 3369; HD 3406; HD 3226; HI 1653; Mustard: PM 33	Wheat: 13–39% Mustard: 46%	1.17–2.42	High adoption; suitable for rice-wheat system
	CSKHPKV Palampur, HP	Wheat: HS 562; Spinach: Pusa Bharati; All Green	Wheat: 24.07% Palak: 21.53–30.76%	2.94–3.92	High profitability; strong yield advantage
	Career Point University, HP	Wheat: HS 562; Mustard: PM 32; Spinach: P. Bharti; Carrot: Pusa Rudhira; Garden Pea: Pusa Pragati	Wheat: 24.19% Mustard: 48.93 % Spinach: 25.07% Carrot: 27.58% Pea: 21.44%	2.80–4.06	Strong farmer acceptance; high net returns
	MVS Bilaspur, HP	Wheat: HS 562; Mustard: PM 33; Spinach : Pusa Bharati and All green ; Garden Pea: Pusa Pragati Onion: Pusa Riddhi	Wheat: 15.77% Mustard: 13.39 Palak (P. Bharti): 9.27% Palak (All Green): 4.04% Onion: 6.94% Pea: 13.00%	2.36–3.32	Good profitability; positive feedback

Agro-Climatic Zone	Location / State	Crops and Varieties	Yield Increase	B: C Ratio	Farmer Feedback
	HESCO Dehradun, Uttarakhand	Wheat: HD 3406; HD 3369; HI 1653; HD 3271; HD 3298	5.73–18.06%	2.51–2.94	Performs well with limited irrigation
Lower Gangetic Plains (Zone IV)	Shamayita Math, WB	Wheat: HD 3406; HD 3271	Wheat HD 3271: 11.03% HD 3406: 45.96%	2.31–4.06	High profitability; excellent crop quality
	Vivekananda Institute of Bio-technology. Nimpith, WB	Spinach: All Green; Pusa Bharati Carrot: Pusa Rudhira	Spinach: All green 4.19% P. Bharati 2.50% Carrot: 8.00%	1.67–4.22	Carrot highly profitable; strong women participation
Middle Gangetic Plains (Zone V)	KVK Deoria, UP	Wheat: HD 3406; HD 3271	11.26–19.78%	Up to 2.42	HD-3271 suitable for late sowing
	MGKVK Gorakhpur, UP	Wheat HD 3406, HD 3271 Mustard var. PM 32 Spinach var. P. Bharati Carrot var. P. Rudhira Garden Pea var. P. Pragati	Wheat: ~ 3-4.58% Mustard: 3.99% Spinach: 23.15% Carrot: 15.81% Pea: 13.65%	2.90–5.84	Pea & Palak highly profitable
Upper Gangetic Plains (Zone VI)	FARMER, Ghaziabad UP	Wheat: HD 3226; HD 3406; HD 3369; HI 1653	8.33–21.87%	2.98–3.35	HD-3226 highest profitability
	DRI Chitrakoot, UP	Wheat: HD 3407; HI 1634 Mustard: PM 32 Onion: Pusa Riddhi	Wheat: HD 3407: 11.92% HI 1634: 19.70% Mustard: 30.33% Onion: 21.09%	2.68–3.14	Onion yield increase 21.09%
Central Plateau & Hills (Zone IX)	MPUAT Udaipur, Rajasthan	Wheat: HI 1634; HD 3407 Onion: Pusa Red Carrot: Pusa Rudhira Spinach P. Bharati Vegetable Kit	Wheat: 13.12–17.50% Onion: 14.90% Carrot:19.56% Spinach: 15.55%	1.44–3.30	Biofortified wheat preferred; strong vegetable performance, Vegetable kit is liked by farmers in Kitchen gardening for enhancing nutritional security.
	Pragati Trust KVK, Rajasthan	Wheat: HD 3226; HI 1653; HD 3369; HD 3298; HD 3406 Mustard: PM 33 Onion: Pusa Ridhi Carrot: Pusa Rudhira Marigold (P. Narangi, Pusa Bahar)	Wheat: 2–19.18% Onion: 11.76% Carrot: 16.89% Marigold: ~18.00-20.54%	2.98–5.58	HD-3226 highest net return
	DRMR Bharatpur, Rajasthan	Wheat: HD 3406; HD 3369	14.58–14.63%	1.82–1.85	Moderate profitability

Agro-Climatic Zone	Location / State	Crops and Varieties	Yield Increase	B: C Ratio	Farmer Feedback
Gujarat Plains & Hills (Zone XI)	Navsari Agricultural University, Gujarat	Wheat: HI 1634	6.15%	1.99	Stable and reliable performance
Western Plateau & Hills (Zone XII)	MPKV Rahuri, Maharashtra	Wheat: HI 1633	17.41%	2.63	Preferred for short duration & low irrigation requirement

Kharif 2024 demonstrations across ICAR agro-climatic zones showed strong crop performance and profitability. Basmati paddy varieties recorded 29–50% yield gains with high acceptance. Vegetables like okra, spinach, and cowpea showed 10–31% increase in Himalayan regions. West Bengal and Odisha reported significant gains and high B:C ratios, indicating profitability.

Agro-Climatic Zone	Location / State	Crops and Varieties	Yield Increase	B: C Ratio	Farmer Feedback
Western Himalayan Region (Zones I & II)	SKUAST KVK, Kathua, J&K	Rice: PB 1692, PB 1847, PB 1885, PB 1509	29.68–49.59%	4.15–4.78	High aroma, early maturity, lodging resistance
	CSKHPKV KVK, Palampur, HP	Spinach: Pusa Bharati; Okra: Pusa 5; Brinjal: Pusa Krishna; Cowpea: Pusa Dharni; Bottle gourd: Pusa Naveen	10.39–30.77%	1.33–5.66	All varieties economically beneficial
	Manav Vikas Sansthan, HP	Spinach: P. Bharati; Okra: Pusa 5; Brinjal: P. Krishna; Bottle gourd: P. Naveen; Cowpea: P. Dharni	2.6–10.74%	2.04–4.68	Good adaptation
	HESCO Dehradun, Uttarakhand	Rice: PB 1692; PB 1509; PB 1847; PB 1885	12.78–18.33%	2.51–2.69	PB-1692 early maturity; PB-1847 disease resistant
Lower Gangetic Plains (Zone IV)	Shamayita Math, WB	Spinach: P. Bharati Okra: Pusa 5; Brinjal: P. Krishna; Bottle gourd: P. Naveen; Cowpea: Pusa Dharni	14.04–25.66%	1.33–13.24	High yield and economic returns
	Vivekananda Institute of Bio-technology, Nimpith, WB	Okra: Pusa 5; Cowpea: Pusa Dharni; Spinach: Pusa Bharati: Brinjal: P. Krishna	3.84–14.52%	2.41–6.00	Dharni seed in high demand
Middle Gangetic Plains (Zone V)	IIVR KVK, Deoria, UP	Rice: Pusa Sambha 1853; Pusa Sugandha 2	14.54–17.21%	2.78–3.09	High yield and grain quality
	MGKVK Gorakhpur, UP	Rice: Pusa Sambha 1853	8.13%	–	Stable returns
	ISHARA, Deoria	Rice: Pusa Sambha 1853	16.08%	–	Good profitability

Agro-Climatic Zone	Location / State	Crops and Varieties	Yield Increase	B: C Ratio	Farmer Feedback
Upper Gangetic Plains (Zone VI)	Ghaziabad Farmer, UP	Rice: PB 1692; PB 1509; PB 1847; PB 1885	11.81–21.18%	2.19–2.60	PB-1692 highest demand
	DRI Chitrakoot, UP	Rice: Pusa Sugandha 2 Bottle gourd; Pusa Naveen Cowpea: Pusa Dharni	3.08–28.23%	2.71–3.24	Positive returns for all crops
	RKPG College, Shamli	Rice: PB 1509; PB 1692; PB 1847	13.79–19.72%	–	Farmers satisfied
Eastern Plateau & Hills (Zone VIII)	NRRI KVK, Cuttack, Odisha	Okra: Pusa 5 Bottle gourd: Pusa Naveen Spinach: Pusa Bharati Cowpea: Pusa Dharni	14.58–32.60%	2.26–3.71	Excellent performance; Dharni seed shortage
Central Plateau & Hills (Zone IX)	MPUAT Udaipur, Rajasthan	Okra: Pusa Bhindi 5 Cowpea: P. Dharni Brinjal: P. Krishna Bottle gourd: P. Naveen Marigold: P. Narangi, P. Bahar and P. Parv	Cowpea: 28.24%; Brinjal: 19%	–	Marigold widely accepted
	Pragati Trust KVK, Rajasthan	Okra: Pusa Bhindi 5 Cowpea: Pusa Dharni Bottle gourd: P. Naveen Brinjal: P. Krishna	16.66–24.44%	3.00–4.89	High economic returns
Gujarat Plains & Hills (Zone XI)	Navsari Agric. Univ, Gujarat	Okra: Pusa Bhindi 5 Bottle gourd: Pusa Naveen	6.08–8.44%	5.74–5.89	Very high profitability
West Coast Plains & Ghats (Zone XV)	KAU Thrissur, Kerala	Okra: Pusa Bhindi 5 Cowpea: Pusa Dharni Bottle gourd: P. Naveen Brinjal: P. Krishna	15-25%	–	Market preference

7.3.4 Off-campus Exhibitions

Sl. No.	Exhibition / Event	Location	Date
1	Foundation Day Program of ICAR-IARI	NRIIPM, Maidan Garhi, New Delhi	12.02.2025
2	International Conference on Vision 2047: Prosperous & Great Bharat	NASC Complex, New Delhi	24.04.2025–26.04.2025
3	Exhibition on Empower Women, Empower India – Viksit Bharat with Nari Shakti	Ambedkar International Centre, New Delhi	31.07.2025
4	Exhibition in the International Conference on Ever-green Revolution: The Pathway to Bio-happiness	NASC, New Delhi	07.08.2025–09.08.2025
5	Exhibition at World Food India 2025	Bharat Mandapam, New Delhi	25.09.2025–28.09.2025
6	All India Farmers Fair & Agro-Industrial Exhibition (*Kisan Mela*)	SVBPUA&T University Campus, Meerut	14.10.2025–16.10.2025

7	21st Foundation Day of PPV&FRA	NASC, New Delhi	12.11.2025
8	6th International Agronomy Congress	NPL Auditorium	24.11.2025–26.11.2025
9	9th Edition of EIMA Agrimach India 2025	IARI Mela Ground, Pusa	27.11.2025–29.11.2025
10	Innovative Farmers Conclave	Ag. Engineering, ICAR-IARI	23.12.2025-24.12.2025

7.3.5 Farmers'/Stakeholders' Outreach/ Mobilization: 07

1. On January 27, 2025, 1,000 farmers visited ICAR–Indian Agricultural Research Institute, exploring 18 thematic clusters on advanced farming technologies and entrepreneurship.
2. On March 08, 2025, IARI organized a women-focused training-cum-field visit, engaging 75 participants from Uttar Pradesh and Uttarakhand.
3. On May 06, 2025, Agriculture Officers from (Bihar Institute of Public Administration and Rural Development (BIPARD) visited IARI for lectures and field exposure on modern agricultural technologies.
4. On November 18, 2025, SC farmers (250 nos.) in Deoria received training and quality seeds on improved Rabi crop production.
5. On November 04, 2025, tribal farmers (500 nos.) in Jhabua were trained and provided inputs under the TSP initiative.
6. On November 19, 2025, a Kisan Gosthi at IARI engaged 264 farmers during the 21st PM-KISAN installment event.
7. On December 23–24, 2025, farmers (250 nos.) attended the Innovative Farmers Conclave at IARI, focusing on innovations and entrepreneurship.

7.3.6 Training Programmes Organized

7.3.6.1 On-campus Training

Ten HRD training programmes in 2025 trained 233 farmers and extension personnel on advanced, climate-resilient agriculture, supported by ATMA and government agencies.

7.4 AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

The Agricultural Technology Information Centre (ATIC) ensures direct dissemination of technologies and information, minimizing distortion, while offering advisory services, helpline support, exposure visits, and sale of seeds, biofertilizers, and farm literature.

7.4.1 Pusa Helpline

ATIC is effectively providing products, technologies and information services to the different stakeholders through a 'Single Window Delivery System'. Besides farm advisory services, farmers are given farm advice through Pusa Helpline (011-25841670, 25846233, 25841039 and 25803600-PRI line), Pusa *Agricom* 1800-11- 8989, exhibitions, farm literatures and letters. A IInd level of *Kisan Call Centre* (1800-180-1551) has also been established at ATIC to solve the problems/queries of farmers of Delhi and Rajasthan. A total number of 5,750 farmers calls from 12 states were received and queries answered through Pusa *Agricom* (A toll free Helpline Number-1800-11-8989) Pusa Help-line (011-25841670, 25841039, 25846233, 25803600) and *Kisan Call Centre* 1800-180-1551 (IInd level) on various aspects of agriculture.

7.4.2 Advisory Services

Farm advisory services to 14,940 farmers and other stakeholders were provided at ATIC during the year. Visitors (farmers/ farm women/ entrepreneurs/ officials/ students) visited ATIC for an exposure visit to seek advisory services, purchase Pusa seeds, access farm publications, and enquire about the training programme. Information & advisory needs of the visitors are also being catered through LED display boards, farm literature, information museum, plant clinic, farm library and exhibits

7.4.3 Pusa Seed and Publication sale

Pusa seeds of worth ₹ 92,290/- and farm publication of ₹ 16,440/- have been sold to the farmers during the year.

7.4.4 Crop *Cafeteria*

Live demonstrations were organized at the ATIC crop cafeteria of Indian Agricultural Research Institute, showcasing improved crop varieties. Wheat (HD 3086, HD 3406), paddy (PB 1885, PB 1509), mustard (Pusa Mustard 30), chickpea (Pusa 3022), and lentil (PSL 17) were displayed. Summer vegetables like brinjal (Pusa Uttam), okra (Pusa A-5), and chilli (Pusa Sadabahar), along with winter crops such as cauliflower (Pusa Snowball-1), cabbage, tomato (Pusa Rakshit), and carrot (Pusa Rudhira), were demonstrated. Marigold varieties Pusa Basanti and Pusa Narangi were also included. A nutri-garden featuring diverse vegetables and fruits like guava, mango, ber, and kinnow highlighted nutritional security and crop diversification for visiting farmers.

Herbal garden: For awareness of farmers and visitors, herbal block has been developed in crop *cafeteria* which includes medicinal plants of Aloevera, *Ashwagandha, Satavar*, Coleus, *Giloe, Mushkdana, Sadabahar, Mint, Tulsi* (Basil), Lemon grass, Java Citronella and Turmeric etc.

Publication of *Prasar Doot*: Four issues of Hindi farm magazine *Prasar Doot* have been published by the Centre during the reporting period.

Feedback and linkages: ATIC collects farmer feedback to develop need-based technologies and has built strong linkages with KVKs, SAUs, ICAR institutes, line departments, and FPOs through farmer and student exposure visits.

Pusa Agri *Krishi Haat*: ICAR-Indian Agricultural Research Institute established Pusa Agri *Krishi Haat*, a 60-shop direct marketing platform enabling farmers, FPOs, and agripreneurs to sell fresh and value-added produce directly to urban consumers. Operational since April 2023, it benefits both farmers and buyers, supported by promotional events like exhibitions and fairs.

7.4.5 Pusa *Beej* Sale Portal

The Pusa *Beej* Sale Portal, developed by ICAR-IARI, is a user-friendly online platform for farmers and gardening enthusiasts to purchase diverse seeds. Built on Core PHP (Hypertext Preprocessor) and MySQL (My Structured Query Language) it offers secure transactions, easy navigation, real-time stock updates, and integrated databases for seed availability, pricing, sales, and package of practices.

7.5 *KRISHI VIGYAN KENDRA* (KVK)

7.5.1 On Farm Trials

7.5.1.1 Assessment of late sown varieties of mustard

In Sohna block of Gurugram, waterlogging restricts mustard cultivation after rice harvest. KVK Gurugram introduced BPM-11 in Sarmathla village, yielding 21.65 q/ha, a 6.65% increase over the farmers' variety Radhika (20.30 q/ha).

7.5.1.2 Assessment of yield & economics of different wheat varieties for saline affected areas of district Gurugram

In Farrukhnagar block of Gurugram, saline water limits wheat productivity. Krishi Vigyan Kendra Gurugram introduced salt-tolerant wheat KRL 210 in Birhera, yielding 42.50 q/ha; an 8.23% increase over DBW 222 (39.25 q/ha).

7.5.1.3 Management of *Spodoptera frugiperda* & *Helicoverpa armigera* in pearl millet

Infestation of *Spodoptera frugiperda* and *Helicoverpa armigera* in pearl millet emerged as a serious issue. *KVK* Gurugram conducted on-farm trials in Safedanagar, introducing pheromone traps, *Azadirachtin* spray, and Thiamethoxam + Lambda Cyhalothrin application. These integrated pest management practices effectively controlled infestations, resulting in a 13.35% yield increase over farmers' practices and generating a net profit of Rs. 42,984 per hectare for farmers.

7.5.2 Training Programmes for Farmer/Rural Youth/ Women/ Extension Functionaries

7.5.2.1 Farmers trainings

KVK Shikohpur organized multiple trainings during 2025 on fermented organic manure, IPM in various crops, sustainable dairy farming, beekeeping, ICT tools, mushroom production, millet value addition, and women empowerment across villages and the KVK campus. These programmes covered diverse agricultural and livelihood themes, strengthening farmers' skills and knowledge. A total of 434 participants, including farmers, women, and rural youth, actively took part in these capacity-building initiatives, enhancing their technical competencies and income opportunities.

7.5.2.2 In-service training for extension functionaries

KVK Gurugram conducted in-service trainings on IPM in mustard and pearl millet for Department of Agriculture officials at Gurugram and Pataudi, benefiting 54 field functionaries.

Glimpses of front-line demonstration on mung crop organized by KVK Shikohpur

7.5.2.3 Cluster front line demonstrations (CFLD) / front line demonstrations

Crop	Variety	Area (ha.)	Demonstrations/ No. of farmers
***Rabi* 2024-25**			
Mustard	DRMR 215-17 (Radhika)	100.0	157
Vegetables	Palak	2.0	8
	Methi	2.0	8
	Dhaniya	2.0	10
Wheat	HD 2969	4.0	10
	HD 3296	6.0	15
	HD 3086	4.8	12
	HD 3406	5.20	13
***Kharif* 2025**			
Summer Moong	MH 1142	10.0	25
Pearl Millet	HHB 299	13.60	30
***Rabi* 2025-26**			
CFLD on Mustard	DRMR 215-17 (Radhika)	50.0	89
CFLD on Wheat (Bio-fortified)	HD 3298	46.0	112
Animal Husbandry	Poly herbal mixture in cattle	-	10
	Total	**245.6**	**489**

7.5.3 Agricultural Extension Activities

7.5.3.1 Kisan Gosthi cum awareness programmes

KVK Gurugram organized multiple *Kisan Gosthi* and awareness programmes in 2025 on PM-*Kisan Samman Nidhi*, national events, cleanliness, and government schemes at *KVK* Shikohpur and villages. These included live telecasts, *Kisan Chaupal* discussions, and special campaigns throughout the year. A total of 1,182 participants, including farmers, farm women actively took part in these outreach activities.

7.5.3.2 Awareness programme on natural farming

KVK Shikohpur organized a natural farming awareness programme on March 24, 2025, covering *Jeevamrut*, *Beejamrut*, and *Panchgavya*; 45 farmers, women, and students participated.

7.5.3.3 Method demonstration through agricultural drone spray

KVK Gurugram demonstrated agricultural drone spraying in Tirpari, Basunda, and Khandewala (Feb 5–7, 2025), covering 135 acres of wheat with nano urea and *sagarika*.

7.5.3.4 Field Day on mustard

During the reported period, four field days on mustard were organized on March 12, 2025 at village Raiseena; March 19, 2025 at village Tirpari; March 20, 2025 at village Tajnagar and Maujabad of Gurugram district. A total of 185 farmers participated in the programme.

7.5.3.5 *Poshan Pakhwada*

KVK Shikohpur observed *Poshan Pakhwada* (April 8–22, 2025), organizing kitchen garden awareness programmes at Shikohpur and Naharwadi Anganwadi centres. Vegetable seed kits were distributed, benefiting 117 participants, including Anganwadi workers and students.

7.5.3.6 *Viksit Krishi Sankalp Abhiyan* (*VKSA*)

VKSA was conducted with line departments and ICAR-Indian Agricultural Research Institute (May 29–June 12, 2025), covering 137 villages. Farmers received guidance on *Kharif* practices, soil testing, drone technology, natural farming, and schemes, reaching 22,739 beneficiaries.

7.5.3.7 Scientific Advisory Committee Meeting

The 39th SAC meeting reviewed the progress during 2024–25 and planned the activities for 2025–26 under the chairmanship of Dr. Ch. Srinivasa Rao, Director ICAR-IARI.

7.5.3.8 Participation in *Sewa Pakhwada*

KVK Gurugram participated in the event conducted on Sept 17–Oct 2, 2025 by delivering lectures on agriculture and animal husbandry, covering over 500 farmers.

7.5.3.9 *Swatcch Bharat Abhiyan*

KVK Gurugram organized *Swachhata Pakhwada* during Sept 15–Oct 2 and Dec 16–31, 2025, promoting cleanliness, hygiene, and waste recycling. Activities included campus cleaning, and awareness on composting and vermicomposting. Farmers were encouraged to avoid residue burning and adopt sustainable practices. Over 500 participants were sensitized.

7.5.3.10 Exhibition

KVK Shikohpur showcased technologies at the International Agronomy Congress 2025 and Tribal Expo in New Delhi, attracting over 1,000 visitors.

7.5.3.11 Exposure visits

KVK Gurugram organized several exposure visits of farmers and students for enhancing practical agricultural learning.

7.5.3.12 Cucumber Field Day

ZTM & BPD in collaboration with the Division of Vegetable Science, successfully organized Cucumber Field Day on April 21, 2025 in IARI, New Delhi campus. The event drew broad participation from researchers, entrepreneurs, progressive farmers, and private-sector stakeholders. Attendees witnessed live demonstrations of IARI-developed elite cucumber lines and hybrids, showcasing their superior performance in both open-field and protected-culture systems.

Cucumber Field Day in ICAR-IARI

7.5.4 Celebration of Important Days

7.5.4.1 Celebration of ICAR Foundation Day and Technology Day

KVK Gurugram organized an exposure visit of 50 farmers to National Agricultural Science Centre on July 16, 2025. The group, including 36 farmers and 14 farm women, observed advanced agricultural technologies displayed during the programme.

7.5.4.2 World Food Day 2025

KVK Gurugram organized a Kisan Gosthi on October 16, 2025, emphasizing soil health, food quality, and reducing food wastage. Farmers were informed about government schemes, capacity building, and entrepreneurship opportunities. A total of 82 farmers participated.

7.5.4.3 *Krishi Shiksha Diwas*

It was observed on December 3, 2025, at a government school in Shikohpur, the programme where modern agricultural technologies were highlighted and students were encouraged to pursue agriculture as a career. Around 150 students and teachers participated in the program.

An awareness programme for School children on occasion of Agricultural Education Day

7.5.4.4 World Soil Day

An awareness programme on December 5, 2025, focused on soil testing, balanced fertilization, and organic practices. Farmers were educated on soil sampling and sustainable nutrient management. Soil Health Cards were distributed to 46 participants.

7.5.4.5 *Kisan Diwas*

It was celebrated on December 23, 2025, at Hasanpur. The event included a *Kisan Goshthi* on soil and water management, cost reduction, waste recycling, and natural farming. A total of 88 farmers and farm women participated.

7.6 TRANSFER OF TECHNOLOGY THROUGH OUTREACH PROGRAMMES

7.6.1 Interventions under Scheduled Caste Sub-Plan

Four training sessions for farmers were held across different locations in Himachal Pradesh. Shared technical know-how on cereals and horticultural crops among the farmers/fruit growers. Planting materials for fruit crops, wheat seed (variety HS562), and farm inputs (spade, sickle, crate, steel buckets, tirpal, cap, bag) were also distributed to farmers during the training.

KVK, Bara, Hamirpur

KVK, Sunder Nagar, Mandi

(Chailchowk, Mandi)

7.6.1.1 Training under SCSP By Division of FS & PHT

Sl. No.	Name of the training programme	Date	Number of trainee (s) participated
1.	Two days training programme-cum-seed and inputs distribution programme in Processing Techniques for Horticultural and Arable Produce (Off campus-Uttarakhand)	13.10.2025 to 14.10.2025	100

7.6.1.2 IARI Regional Station, Kalimpong technologies adopted under SCSP

S. No.	Name of the technology	Location (Dist.)	No. of farmers
1	Rice variety Pusa samba 1850	Darjeeling, Kalimpong and Jalpaiguri	50
2	Mustard, PM-26, PM-30, Pusa Vijoy (1.5 q)	Jalpaiguri and Coochbehar	225
3	Grafted Darjeeling mandarin (2000 nos.)	Kalimpong, Darjeeling and Jalpaiguri	200
4	Lemon (Gandharaj, Assam Lemon and Kagji), (1000 nos).	Kalimpong, Jalpaiguri and Coochbehar	100
5	Sweet lemon (500)	Kalimpong and Coochbehar	50
6	Strawberry (Winter Don, 100 nos.)	Kalimpong and Coochbehar	50

7.6.1.3 Training at IARI Regional Station, Katrain

IARI Regional Station Katrain organized one day training programme for 50 farmers under SCSP on March 20, 2025 and distributed farm implements & vegetable seed kits amounting to ₹ 2.0 lakhs

'One Day Training Program' for the Farmers under 'SCSP Scheme'

7.6.1.4 Training under SCSP By IARI Regional Station, Karnal

S. No.	Name of Training Programme	Date	No. of Trainees
1.	Training-cum-Seed Distribution Programme	April 08, 2025	1000
2.	Training-cum-Seed Distribution Programme	October 16, 2025	500

7.6.1.5 Training under SC-SP By Division of Seed Science and Technology

S. No.	Name of training program	Date	No. of trainees
1	"Protected cultivation of vegetable crops" at CPCT, ICAR-IARI, New Delhi	Jan 07-09, 2025	25
2	"Production of quality planting material for Horticultural Crops under Protected Cultivation" at CPCT, ICAR-IARI, New Delhi	Feb 17-19, 2025	25

S. No.	Name of training program	Date	No. of trainees
3	"On-farm identification and management of parasitic nematodes" at Division of Nematology, New Delhi	March 17-19, 2025	25
4	Exposure visit, Pusa Krishi Vigyan Mela 2025 at IARI, New Delhi	Feb 22-24, 2025	1681
5	"Improved package of practices for higher productivity of field crops" at ICAR-IARI Regional Station, Karnal	March 08, 2025	500
6	"*Vikshit Krishi Sankalp Abhiyaan*" at Jewar, Gautam Budh Nagar	June 12, 2025	300
7	Training-cum-planting material distribution on Fruit crops at Panchayat (Dakri) (H.P.) & ICAR-IARI Regional Station, Shimla	June 30, 2025	50
8	"Improved Rabi Crop Production' & Input Distribution" at Village Pragpura, Alwar, Rajasthan	August 05, 2025	300
9	Farmers training programme-cum-exposure visit, M.S. Swaminathan Centenary International Conference, NASC Complex, N. Delhi.	August 7-9, 2025	150
10	"Improved Crop Management in Paddy & Input Distribution" at Village Hardeki, Saharanpur, Uttar Pradesh	September 03, 2025	150
11	"Quality seed production techniques of basmati rice" at ICAR-Indian Agricultural Research Institute, Regional Station, Karnal	September 24-26, 2025	20
13	"Improved Production Technologies in *rabi* crops (Wheat, mustard and vegetable kits)" at Village Nagliya Vijna Dist. Aligarh (UP)	October 11, 2025	350
14	"Processing Techniques for Horticultures and Arable Produce" at Sitarganj (UK)	October 13-14, 2025	100
15	Seed day and seed and input distribution programme at IARI RS, Karnal	October 16, 2025	500
16	Farmers training-cum-input distribution programme at IARI RS, Pusa Bihar	October 6-10, 2025	35
17	Farmers training and seedling/ seed distribution programme by IARI RS, Katrain at Chailchowk, Himachal Pradesh	November 05, 2025	100
18	"Agricultural residue management for income generation & input distribution programme" at Tana Shamli (UP)	November 08, 2025	200
19	"Improved *rabi* crop production & input distribution programme" on KVK, Deoria (UP)	November 18, 2025	250
20	Field Day-cum-training programme on "सब्जी एवं फलदार फसलों की उन्नत किस्मों व कीट प्रबंधन प्रथाओं का प्रदर्शन" at ICAR -IARI RS Pusa Bihar, Samastipur	November 05, 2025	250

7.6.2 Tribal Sub Plan (TSP)

7.6.2.1 IARI Regional Station, Kalimpong's Technologies, adopted under TSP

S. No.	Name of the Technology	Location (Distt.)	No. of farmers adopted
1	Grafted Darjeeling mandarin (2000 nos.)	Kalimpong, Darjeeling and Alipurduar	200
2	Large cardamom	Kalimpong and Darjeeling	150
3	Lemon (Gandharaj, Assam Lemon and Kagji, 1000 nos.)	Kalimpong, Alipurduar and Darjeeling	100
4	Sweet lemon (500 nos.)	Kalimpong, Alipurduar and Darjeeling	50
5	Strawberry (Winter Don), (500 nos.)	Kalimpong, Alipurduar and Darjeeling	50

6	Azalea (500 nos.)	Kalimpong, Alipurduar and Darjeeling	50
7	Camellia	Kalimpong, Alipurduar and Darjeeling	100

7.6.2.2 Training under TSP By IARI Regional Station, Kalimpong

S. No.	Name of training programme	Date	No. of trainees
1.	Entrepreneurship Development in Horticultural Crops" at Kagey, Darjeeling	February 22-24, 2025	56
2.	Livelihood diversification for sustainable development in changing climatic condition" at Darjeeling	March 04-06, 2025	53
3.	Revival and Sustainable Cultivation of Darjeeling at Icchey Gaon, Kalimpong	March 03-05, 2025	50

One day training program' for the Tribal Farmers under 'TSP Scheme'

7.6.3 *Mera Gaon Mera Gaurav* (MGMG) Programme

7.6.3.1 IARI Regional Station, Kalimpong's Technologies, adopted under MGMG

S. No.	Name of the Technology	Location (Distt.)	No. of Farmers
1	Rice variety Pusa samba	Darjeeling, Kalimpong and Jalpaiguri	50
2	Mustard, PM-30, 0.5 q	Jalpaiguri	75
3	Grafted Darjeeling mandarin (500 nos.)	Kalimpong, Darjeeling and Jalpaiguri	80
4	Dargon (Siam red, 500 nos.)	Jalpaiguri and Coochbehar	50
5	Lemon (Gandharaj, Assam Lemon and Kagji, 500 nos.)	Kalimpong, Jalpaiguri and Coochbehar	50
6	Ladies finger (Jhatpat-F 1 hybrid)	Kalimpong and Jalpaiguri	30
7	Radish (Milky)	Kalimpong and Jalpaiguri	50
8	Brinjal (Farm Sona)	Kalimpong and Jalpaiguri	50
9	Tomato (F1 hybrid 2160)	Kalimpong and Jalpaiguri	50
10	Coriander (Ruby)	Kalimpong and Jalpaiguri	50

7.6.4 *Pusa Samachar*

7.6.4.1 Multimedia-based farmer-centric agricultural extension model: '*Pusa* Samachar'

Developed by ICAR-IARI, Pusa Samachar is a weekly video-based extension bulletin. A total of 281 Hindi episodes were produced, including 53 in 2025, with subscribers reaching about 61,400. The platform delivered over 18,000 WhatsApp advisories and achieved 2.7 million views with 1.7 lakh watch hours. Episodes include crop management practices, farmer success stories, weather updates, and expert advisories. Content analysis of *Pusa Samachar* (Hindi) revealed 521 topics across 17 disciplines, with major focus on vegetable science, agronomy, and allied fields. The programme recorded 2.7 million views, with 23% high, 60% medium, and 17% low viewership. Audience demographics showed 80.23% male and 19.77% female viewers, mainly aged 35–44 years (49%), followed by 45–54 years (22%). Total watch time reached 1,70,000 hours, indicating strong engagement. Content sharing was highest through WhatsApp, followed by Facebook, while traffic primarily originated from browse features, external sources, and suggested videos, reflecting wide digital outreach and growing popularity.

7.6.4.2 Analysis of multimedia-based extension model: Pusa Samachar based on primary data from stakeholders

Multimedia-based needs assessment: A comprehensive need assessment was conducted across the Indo-Gangetic Plains using primary data of 1200 farmers, collected through KVKs. Regions included Haryana and Punjab (Trans-Gangetic), Eastern Uttar Pradesh (Middle), and Western Uttar Pradesh (Upper). The collected data provided a strong empirical base for analysing farmers' information needs and multimedia usage behaviour.

Information need and Information seeking Behavior of Farmers in Multimedia Based Extension: Farmers' information needs were assessed across 13 parameters using a five-point Likert scale. Seed availability ranked highest, followed by weed management and insect pest management. Information-seeking behaviour was analysed using Channel Characteristic Score (CCS), revealing that farmers preferred YouTube as the primary source, followed by web portals and mobile applications.

Perception of Farmers towards Multimedia-based Extension: Farmers evaluated multimedia content based on design, clarity, and relevance. About 84% reported that content was timely, systematic, and easy to understand. However, 51% suggested improvements in audio-visual quality. While 75% found segment duration appropriate, many recommended reducing overall episode length. Additionally, 72% emphasized the need for more attractive thumbnails to enhance engagement. In addition to these, a knowledge test revealed that 51% of farmers achieved high knowledge gain after exposure to multimedia content such as *Pusa Samachar*, followed by 28% in the medium and 21% in the low category, indicating strong effectiveness of the approach.

7.6.5 Pusa *Krishi Vigyan Mela* 2025

Pusa *Krishi Vigyan Mela* 2025, themed "*Unnat Krishi: Viksit Bharat*", was organized at the IARI Mela Ground from 22–24 February 2025. The event was inaugurated by Shri Shivraj Singh Chauhan, Hon'ble Union Minister of Agriculture and Farmers Welfare, Government of India. The event was attended by Shri Ramnath Thakur, Minister of State for Agriculture and Farmers' Welfare; Dr. Himanshu Pathak, Secretary DARE & DG ICAR; Dr. Ch. Srinivas Rao, Director ICAR-IARI; senior ICAR officials, agricultural scientists and progressive farmers.

Mela **Publication being released by chief guest and ICAR officials during PKVM, 2026**

Chief Guest of the PKVM, 2026

The IARI Fellow Awards were conferred to six farmers and seven useful publications were released. Over 30,000 visitors attended 250 stalls, generating ₹1.82 crore seed sales and honoring 35 innovative farmers.

Fellow and Innovative farmers receiving awards during PKVM 2026

7.6.6 Innovative Farmers' Conclave 2025

The Innovative Farmers' Conclave 2025 was inaugurated on December 23, 2025 to commemorate the birth anniversary of Shri Chaudhary Charan Singh. Hon'ble Union Minister for Agriculture & Farmers Welfare, Shri Shivraj Singh Chouhan described the role of farmers as the foundation of nation-building.

Shri Bhagirath Choudhary, Hon'ble Minister of State for Agriculture & Farmers Welfare, paid rich tributes to Shri Chaudhary Charan Singh, describing him as a leader who dedicated his life to farmers' welfare. Dr. M.L. Jat, Secretary, DARE & Director General, ICAR, addressed farmers as the "real jewels of the nation". Dr. D.K. Yadava, Deputy Director General (Crop Science), ICAR, congratulated ICAR-IARI for organizing this innovative initiative. Dr. Ch. Srinivasa Rao, Director ICAR-IARI, recalled the visionary leadership of Shri Chaudhary Charan Singh, whose farmer-centric policies motivated generations of farmers to work towards self-reliance and sustainability. On this occasion, two books documenting farmer innovations were also released.


Dignitaries and participants in Innovative Farmers' Conclave 2025

7.6.7 Training programs organized by Divisions and Regional Stations

S. No.	Name of Training Programme	Date	No. of trainees
Seed Science and Technology			
1.	Seed quality testing by conventional and advanced technologies for the Kala Namak growers of Uttar Pradesh	07-09 Jan., 2025	10
2.	From seed to storage: Ensuring quality in field and vegetable crops	22 to 27 Sept, 2025	40
Vegetable Science			
3.	Fostering entrepreneurship for varietal and hybrid vegetable seed production	January 27 to February 01, 2025	17
Food Science and Post Harvest Technology			
4.	ICAR sponsored winter school on Recent Advances in Food Processing Technologies for Agri-Horti Produce	January 15- February 04, 2025	19
5.	ADP on Recent avenues in Food Processing Technology for Agritech Startups	September 8-13, 2025	33
Agricultural Engineering			
6.	Modern Tools and Technologies for Improving Livelihood of NEH Farmers'	August 27-September 03, 2025	20
7.	Innovations in Post-Harvest Machinery: Design, Development, and Digital Advancements	September 8–14, 2025	71
8.	Modern Tools and Technologies for Improving Livelihood of NEH Farmers'	December 1-10, 2025	20
Microbiology			
9.	Cultivation and processing of Spirulina biomass towards developing value added product.	January 28-31, 2025	33

10.	Cultivation and processing of Spirulina biomass towards developing value added product	November 03-06, 2025	33
11.	Training on nursery raising of rootstock and propagation methods	August 05-08, 2025	20
12.	Training on multiplication of plants through standardized method of propagation	August 05-08, 2025	15
13.	Training on multitier fruit-based cropping system for increased income from small land area	August 05-08, 2025	15
14.	Awareness creation about possibilities of developing entrepreneurship through mycorrhiza production, Azolla cultivation, nursery organization, and weed management tool manufacturing using cheap local resources (Conducted thrice)	January 09, 2025 March 01, 2025 July 16, 2025	35
15.	Awareness training about the usage of biofertilizers in agriculture for integrated nutrient management in crops with low input cost, nutritional security through biofortification.	June 19-21, 2025	45
16.	Mycorrhiza and compost production for starting a small-scale enterprise to improve regular income and livelihood status	January 07-11, 2025	30
17.	On farm water conservation technologies, irrigation hardware usage, crop diversification for cultivating need-based high-value crops, and high-density plantation	February 27-March 04, 2025	31
18.	Processing and value addition of soyabean and horticultural crops for improved livelihood and nutritional security.	March 04-05, 2025	6
19.	Simple and cost-effective multiplication techniques for Azolla production and maintenance for producing protein-rich animal feed for self-use and sale	March 26-27, 2025	41
20.	Training on Kitchen gardening and distribution of hybrid seeds	July 17, 2025	49
21.	Biofertilizer use in *Rabi* crops	November 18-19, 2025	56
Plant Pathology			
22.	ICAR Sponsored CAFT Training on Advances in Detection and Management of Emerging Plant Diseases of National Importance	Feb 28-March 20, 2025	16
23.	Pedagogy Training sponsored by NAAS, New Delhi	January 31, 2025	05
Agricultural Physics			
24.	Training-cum-workshop on Drone and Sensor Technology in Fisheries Co-organized with ICAR-CIFE, Mumbai at Mumbai, funded by ICAR—CIFE and ICAR-NePPA	March 24, 2025	60
25.	Geodata Processing using Python and Machine Learning	February 17-28, 2025	5
Biochemistry			
26.	Five days ADP training program on “Microgreens Growing Practices: A Hands-on Approach for better health and business opportunities)	November 17-21, 2025	25
27.	One-Day workshop-cum-hands on training on “Isolation and characterization of edible oils and importance of blending”	December 18, 2025	24
28.	Role of Artificial Intelligence in Advancing Food Science and Nutritional Biochemistry	November 28, 2025	25

Agricultural Extension			
29.	CAFT training on 'Extension Approaches and Initiatives for Enhancing Farmers' Income through Nutripreneurship"	January 3-23, 2025	19
30.	Winter School Training on 'Augmenting Communication & Managerial Competencies of Extension Professionals'	January 21 - February 10, 2025	22
31.	Training for Technical staff (T1) on Enhancing Personal Effectiveness of Technical Staff	December 1-5, 2025	64
32.	Workshop on Food systems Sustainability in India; under the Project Bright spots in collaboration with Institute of Social Sciences in Agriculture, University Hohenheim, Germany	October 01, 2025	50
33.	Workshop on Farmers' Voices: Moving towards Biohappiness under the International Conference on "Evergreen revolution-the pathway to bio-happiness, organized by MSSRF in partnership with ICAR	August 7-9, 2025	45
34.	*Kisan Goshthi* cum Farmers' Field Day program on Farmer Participatory seed production and Climate Smart Agriculture	January 9, 2025	50
35.	Training program on climate resilient agricultural practices in the Rajpur village of Aligarh district of Uttar Pradesh with collaboration of NICRA and Division of Agril Extension	January 31, 2025	50
36.	International Women's Day and exposure visit	March 08, 2025	75
37.	Training of farmers on climate smart technology under NICRA in Rajpur village of Aligarh district	April 24, 2025	55
38.	Training on Wheat variety HD 3406 at Jahari village, Sonipat, Haryana under the in-house project "Agricultural Extension for Nutrition and Health (AE4NH)- Strategies and Models"	April 28, 2025	50
39.	Training on paddy varieties and biofertilizers under MGMG project in the villages of Jahari, Sandel Kila, Sandel Khurd, Shejadpur, and Tharu in Sonipat district, Haryana	May 26, 2025	20
40.	Training on improved agricultural practices of IARI for crop production under farmers' FIRST project	September 24, 2025	50
41.	*Kisan Goshthi*- cum- demonstration for farmers on improved varieties of IARI for rabi season at Lahchoda village Baghpat district under MGMG programme	October 14, 2025	51
42.	*Kisan Goshthi* cum Demonstration for farmers on improved varieties of IARI at Bulandshar, U.P under MGMG	October 24, 2025	60
43.	Training of farmers on improved variety of IARI at Lahchauda and Fakharpur, Baghpat district Western Uttar Pradesh	November 03, 2025	22
ZTM and BPD Unit organized Agripreneurship Development Program (ADP) in collaboration with			
44.	Division of Plant Pathology, program on "Skill Development in Mushroom Cultivation Technology."	20-24 January 2025	30
45.	Division of Vegetable Science, conducted a training program on "Entrepreneurship in Vegetable Seed Production."	27-31 January 2025	17
46.	CCUBGA, organized a program on "Cultivation & Processing of Spirulina Biomass."	28-31 January 2025	34
47.	Division of Soil Science and Agricultural Chemistry, conducted a program on "Soil Testing and Water Quality Assessment."	02-09 July 2025	24

48.	Division of Plant Pathology, organized a training program titled "Mushroom Cultivation for Sustainable Agribusiness."	25-29 August 2025	33
49.	Division of FS & PHT, conducted an Agripreneurship Development Program (ADP) titled "Recent Avenues in Food Processing for Agritech Startups."	08-13 September 2025	32
50.	Division of Seed Science and Technology, organized a training program titled "From Seed to Storage: Ensuring Quality in Field and Vegetable Crops."	22–27 September 2025	40
51.	Division of Vegetable Science, conducted a training program titled "Entrepreneurship Development through Hybrid Seed Production of Vegetable Crops."	06-11 October 2025	22
52.	CCUBGA and the Division of Microbiology, organized a program on "Cultivation and Downstream Processing of Spirulina Biomass Towards Developing Value-Added Products & Exposure to Commercial Ventures."	03-06 November 2025	35
53.	Division of Biochemistry, conducted a training program titled "Microgreens Growing Practices: A Hands-on Approach for Better Health and Business Opportunities."	17-21 November 2025.	28
54.	IP&TM Unit, ICAR organized a five-day Intellectual Property Awareness Programme with the objective to enhance awareness and understanding of Intellectual Property Rights (IPR) among students, researchers and scientists.	16-23 January 2025	120
55.	In observance of World Intellectual Property (IP) Day on 26 April 2025, Pusa Krishi organized a special session titled "Innovative Concepts: Transforming Ideas into Intellectual Property."	02 May 2025	50
56.	Pusa Krishi hosted a five-day Faculty Development Program (FDP) on Innovation & Entrepreneurship, supported by AICTE and the Ministry of Education's Innovation Cell.	17-21 March 2025	50
57.	Geodata Processing using Python and Machine Learning	February 17-28, 2025	5

8. EMPOWERMENT OF WOMEN IN AGRICULTURE AND MAINSTREAMING OF GENDER ISSUES

While women play a crucial role in advancing agricultural development and securing household livelihood and nutritional security, they remain a vulnerable demographic within the social system, primarily stemming from limited access to resources and opportunities for skill development. Recognizing the imperative of empowering women to foster inclusive development, various efforts have been undertaken to enhance their capabilities in value addition, nutritional security and group-oriented action.

8.1 ENHANCING NUTRITIONAL SECURITY AND GENDER EMPOWERMENT

To achieve the objective, *Krishi Vigyan Kendra* (KVK)), Gurugram organized following activities in the year 2025, which benefitted 130 village women.

Name of activity	Location	Date	No. of farm women
Training on Integrated Dairy Management for enhanced productivity	KVK Campus	September 8-12, 2025	26
Training on Value addition in millets	Hasanpur	November 27-28, 2025	19
Training on Income Generation activities for empowerment of women	Garhi Harsaru	December 11-12, 2025	19
Training on Establishment of Nutri-garden to achieve nutritional security	Shikohpur	December 17-18, 2025	16
Training Benefits of value addition in Millets	Chandu	December 29-30, 2025	21
Training on Dairy Management for quality production	Hasanpur	December 02-08, 2025	29

During the trainings, the rural women were made aware about eradication of anemia in adolescent girls, and the correct dietary practices to reduce the cases of anemia. Hands-on training to prepare millet products (*jowar, bajra, ragi* and *sanwa*) to incorporate millets in their routine diet to achieve micronutrient security at household level were organised. Women were given knowledge about nutrients, their food sources, requirement and role in our body and were motivated to make nutri-cereals like jowar, bajra, ragi etc. a part of their daily diet. They were motivated to adopt healthy dietary practices and to establish a nutri-garden in their backyard to include more fruits and vegetables in their family's diet. They were given appropriate knowledge and the skill on dairy farming wherein participants were made aware about different aspects of dairy farming like breed of cattle, housing, care & management practices, health management, production and post production practices (marketing and value addition), etc.

8.2 EFFECTIVENESS OF SHGs FOR GENDER EMPOWERMENT

A total of eight women SHGs trained under Attracting and Retaining Youth in Agriculture (ARYA) project are running their value addition enterprise in a sustainable manner and creating their own identity and securing recognition in the society.

The annual turnover for eight SHGs the year 2025 is given below:

Sl. No.	Name of SHG	No. of women	Village	Main products	Annual turnover (2025, in lakhs)
1.	Kshitij SHG	10	Chandu	Bakery products of millets,	42.00
2.	Arzoo SHG	10	Sakatpur	Spices	43.00
3.	Naya Din SHG	10	Harinagar	Ladoos & savoury items	2.85
4.	Nari Shakti SHG	12	Khwaspur	Pickles & ladoos	4.65
5.	Muqabala SHG	09	Garhi Harsaru	Aonla products	4.90
6.	Prajapat SHG	10	Tajnagar	Aonla products	3.25
7.	Pragati SHG	10	Kherki Majra	Pickles & ladoos	1.25
8.	Dev SHG	10	Dhani Chitrasen	Spices	3.80

8.3 CAPACITY BUILDING AMONG FARM WOMEN

Kitchen gardening was promoted among the rural women in the project "Assessment and Outscaling of IARI Technologies for Enhancing Farm Income" for promoting nutritional security, intervention in the Model village: Nidana, District Rohtak, Haryana. Pusa Vegetable Seed kits were distributed among 20 women farmers during *Kharif* 2024 and Rabi 2024-25 to provide to each family with the access to fresh, nutritious vegetables, thereby decreasing dependency on market purchase and improving household diet.

Pusa Vegetable Seed Kit Distribution in village Nidana, Rohtak (Haryana)

9. THE POST GRADUATE SCHOOL EDUCATION AND INFORMATION MANAGEMENT

The Indian Agricultural Research Institute (IARI) has a rich legacy of excellence of more than 119 years in research, teaching and extension. The Graduate School of IARI continues to provide national and international leadership in Human Resource Development by awarding degrees in 26 disciplines. So far, the Graduate School has awarded degrees to 12146 students comprising 903 IARI Associateships, 5273 M.Sc., 125 M. Tech. and 5845 Ph.D., including 520 international students from various countries. The Institute has received accreditation from the National Assessment and Accreditation Council (NAAC) of UGC valid for a period of five years (2023-2028) with 'A' Grade; as well as National Agricultural Education Accreditation Board (NAEAB) of ICAR for a period of five years i.e. 2025-2030 with a score of 3.64/4.00 equivalent to Grade A+.

9.1 THE GRADUATE EDUCATION

The Graduate School continues to attract students seeking admission to 26 disciplines in all five streams of admission, namely, Open competition, Faculty upgradation, ICAR in-service nominees, Departmental candidates and Foreign students. The admissions to the B.Sc./B. Tech./M.Sc./M. Tech./Ph.D. degree programmes are based on an 'All-India Entrance Test' conducted by the NTA/ICAR. The foreign students are admitted through DARE and are exempted from the written test. During the academic year 2025-26, admissions under the open scheme are given below:

9.1.1. Admission during the Academic Session 2025-26

SI. No.	Name of hub	UG		PG		Ph.D.	
		Total no. of seats	Admitted	Total no. of seats	Admitted	Total no. of seats	Admitted
1.	IARI, New Delhi	0	0	172	172	233	224
2.	Bengaluru hub	0	0	14	14	9	9
3.	Baramati hub	0	0	3	2	0	0
4.	Bhopal hub	0	0	9	9	6	6
5.	Ranchi hub	0	0	9	9	6	6
6.	Raipur hub	0	0	3	2	0	0
7.	Assam hub	60	55	0	0	0	0
8.	Jharkhand hub	60	59	0	0	0	0
	Total	**120**	**114**	**210**	**208**	**254**	**245**

9.1.2. Convocation

IARI organized its 63rd Convocation in the Bharat Ratna Shri C. Subramanium Auditorium of NASC, New Delhi on March 22, 2025. Shri Shivraj Singh Chouhan, Hon'ble Union Minster of Agriculture & Farmers Welfare and Rural Development, Govt. of India, graced the occasion as the Chief Guest and delivered the Convocation Address. Shri Bhagirath Choudhary and Shri Ram Nath Thakur, Hon'ble Union Ministers of State for Agriculture and Farmers Welfare, Govt. of India, were the Guests of Honour during the function.

The Convocation was declared open by Dr. Ch. Srinivasa Rao, Director, ICAR-IARI, followed by the presentation of Welcome Address and Director's Report on the significant research achievements of the Institute during 2024. He highlighted that IARI wheat varieties are cultivated across nearly 15 million hectares, contributing approximately 60 million tons to the nation's granary. Also, currently, the Pusa Basmati rice varieties account for 90% of the total foreign exchange.

During the Convocation, Union Ministers of State for Agriculture and Farmers Welfare, Govt. of India, Shri Bhagirath Choudhary and Shri Ram Nath Thakur awarded IARI Merit Medals to five M.Sc. students and five students receiving their doctoral degrees. The Guests of Honour also awarded the IARI Best Student of the Year Award-2024 and the NABARD-Professor V.L. Chopra Gold Medal-2024 to Mr. Rudra Gouda, doctoral student of the Division of Entomology and the Best M.Sc. student award to Ms Sneha Bharadwaj, Division of Agronomy. They also presented the VIth Dr. H.K. Jain Memorial Young Scientist Award to Dr. Vignesh Muthusamy, Senior Scientist, Division of Genetics, for the year 2024; XXVIII Hooker Award for the biennium 2022-23 to Dr. Gyan Prakash Mishra,

Award of IARI Merit Medal by the dignitaries

Principal Scientist & Head, Division of Seed Science & Technology, and IV NABARD Researcher of the year 2024 to Dr. Girijesh Singh Mahra, Scientist (SS), Division of Agricultural Extension. In this Convocation, a total of 415 students (M.Sc.: 226; M. Tech.:10; & PhD: 179), including two international students, studying at IARI under international programmes, have received their Post Graduate and Doctoral degrees.

On this occasion, Hon'ble Union Minister released different varieties of field and horticultural crops including wheat, maize, chickpea, mungbean, mango etc. He also released three publications including the Annual Report (2023-2024) of The Graduate School, IARI; Pusa Krishiksha Magazine; a book on "Advances in Agricultural Engineering Vol-I" (as per 6th Dean Committee) and the "Rapid Seed Viability Testing Kit".

Address by Hon'ble Union Minister of Agriculture and Farmers Welfare and Rural Development

9.1.3 Special Lectures

Lal Bahadur Shastri Memorial Lecture: As a part of the Convocation Week, 55th Lal Bahadur Shastri Memorial Lecture was delivered by Dr. Rajesh S. Gokhale, Secretary, Department of Biotechnology, Govt. of India, New Delhi on March 21, 2025 on the topic "The BioE3 Policy: Biotechnology for Economy, Environment and Employment - Driving Bio-Innovation in Bharat" in A.P. Shinde Symposium Hall, NASC, New Delhi. The session was chaired by Dr. Himanshu Pathak, Secretary, DARE & DG, ICAR, New Delhi.

Dr. Rajesh S. Gokhale, Secretary, DBT, delivering Sh. Lal Bahadur Shastri Memorial lecture

School children on National Science Day

Celebration of National Science Day: In a tribute to Sir C.V. Raman, Nobel Laureate, ICAR- IARI celebrated National Science Day with involvement of rural school children on February 28, 2025 at NRL Auditorium, ICAR-IARI. In his inaugural address, Dr. Ch. Srinivasa Rao, Director, ICAR-IARI highlighted the significance of scientific aspirations and the transformative journey of India from a nation struggling with food security to becoming self-sufficient and an exporter of agricultural produce.

During the event, Dr. Anupama Singh, Joint Director (Education) & Dean, highlighted the contribution of IARI to the Green Revolution and emphasized the role of science in everyday life, particularly in agriculture.

32^{nd} Dr. B.P. Pal Memorial Lecture: The 32^{nd} Dr. B.P. Pal Memorial Lecture was organized on May 28, 2025 by The Graduate School, ICAR-IARI, New Delhi and Genetics Club of IARI. On this occasion, Dr. M.L. Jat, Secretary, DARE & Director General, ICAR, presented a thoughtful and enlightening lecture on "Transitioning from Commodity-centric Agriculture to Agri-Food System is a Must for *Viksit Bharat*@2027". The session was presided over by Padma Bhushan Dr. R.S. Paroda, Chairman, TAAS, President of the IARI Alumni Association & Former Secretary, DARE & DG, ICAR, New Delhi.

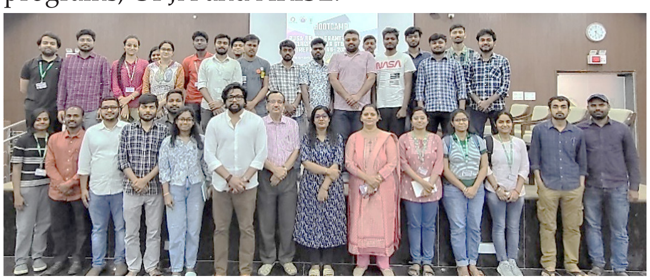
Dr. M.L. Jat delivering the lecture

'SpectraNova' 25: A 'Celebration of Culture and Creativity' festival of IARI was organized by the Post Graduate Students' Union (PGSSU), ICAR-IARI at Bharat Ratna C. Subramaniam Hall, NASC,

Inauguration of SpectraNova' 25

during May 16-17, 2025. The inauguration ceremony was presided over by Dr. R.S. Paroda, Chairman, TAAS, President of the IARI Alumni Association and Former Secretary, DARE & DG, ICAR alongwith Dr. Ch. Srinivasa Rao, Director, ICAR-IARI, Dr. Anupama Singh, Joint Director (Education) & Dean, ICAR-IARI, Shri Sudhir Bhinchar, President, PGSSU, ICAR-IARI and Shri Kirubhakaran S., Social & Cultural Secretary, PGSSU, ICAR-IARI. This event provided an open platform for students to exhibit their talent through a range of performances and competitions, reflecting the vibrant diversity that thrives within the campus. Students engaged with great enthusiasm, making the most of every moment.

Pusa Krishi Bootcamp 2025: Pusa Krishi and The Graduate School, ICAR-IARI, jointly organized an engaging bootcamp for IARI students on May 2, 2025, in the Agricultural Engineering Auditorium, ICAR-IARI, to introduce them to its flagship incubation programs, UPJA and ARISE.



Pusa Krishi Bootcamp 2025

Plastic Clean Up Drive: A Cleanliness Drive Campaign was successfully organized around Arjun Path at ICAR-IARI, New Delhi, by the Nature Club of The Graduate School on June 5, 2025. The event aimed to promote cleanliness, environmental awareness, and active student participation in maintaining the campus's ecological health.

Cleanliness Drive Campaign

Teachers' Day Lecture: The ICAR-IARI and the Genetics Club organized the Teachers' Day celebration on September 4, 2025 on the eve of Teachers' Day. Dr. Sanjay Kumar, Chairman, ASRB, New Delhi delivered the lecture on "Live Where the Sparks Fly". The programme was presided over by Dr. Ramesh Chand, Member, NITI Aayog, New Delhi.

Dr. Sanjay Kumar, Chairman, ASRB, delivering the lecture

Agricultural Education Day Lecture: The ICAR-IARI celebrated Agricultural Education Day on December 3, 2025. Shri Hemendra Mathur, Chairman, FICCI Taskforce on Agri Start-ups and Co-founder, *ThinkAg*, delivered the Agricultural Education Day Lecture on the theme "Agritech as the Core Pillar of Agricultural Transformation" through online mode. In order to encourage students to pursue agriculture and related sciences as a career or to become agri entrepreneurs, a painting competition for the school students (class 6-8 and class 9-12) of the NCR region was also organized on December 2, 2025 in NRL auditorium of ICAR-IARI.

Agricultural Education Day activities

INSA-IARI National Seminar: The Indian National Science Academy (INSA), in collaboration with the ICAR-IARI, organized the INSA-IARI National Seminar "From STEM to STEAM" at ICAR-IARI, New Delhi, on December 04, 2025, as part of the celebration of science week at Delhi, with a focus on Agricultural Sciences. The seminar highlighted the urgent need to transition from traditional STEM approach to a broader STEAM framework by integrating creativity, societal context, and innovation to tackle issues related to agriculture, food security, and sustainable development.

In her welcome address, Dr. Anupama Singh, Joint Director (Education) & Dean, ICAR-IARI, emphasized the significance of a natural evolution from STEM to STEAM. Dr. Brajesh Pandey, Executive Director, INSA and Co-Chair, discussed the origin of INSA's initiative to decentralize its Annual General Meeting, thereby enhancing scientific engagement across various institutions. Chairing the session, Dr. Ch. Srinivasa Rao, Director, ICAR-IARI, hailed INSA's pivotal role in advancing science in India and remarked that the transition from STEM to STEAM is both timely and essential.

IARI *Deeksharambh*-2025 (Students Induction-cum-Foundation Program): In compliance to 6th Dean's Committee recommendations and UGC requirements, IARI *Deeksharambh*-2025 (Students Induction-cum-Foundation Program) for the newly admitted PG & Ph.D. students of IARI and its off-campuses (Academic session 2025-26) was organized during November 28 to December 4, 2025. In this context, addresses of the Hon'ble Director, ICAR-IARI, Joint Director (Education) & Dean, ICAR-IARI and other functionaries of The Graduate School were held on December 3, 2025 in the auditorium of Division of Agricultural Engineering.

IARI Deeksharambh-2025

The Deeksharambh-2025 for the newly admitted students of IARI-Assam and Jharkhand (Academic session 2025-26) was also organized during November 28 to December 11, 2025.

Participants at INSA-IARI National Seminar

SPARDHA 2025: The PGSSU organized the SPARDHA 2025 - Annual Sports Meet during December 19-22, 2025 at the Vasant Hostel Ground, IARI, New Delhi. Almost 450+ students participated in the event. The event was inaugurated by Dr. Ch. Srinivasa Rao, Director, ICAR-IARI, New Delhi.

SPARDHA 2025- Annual Sports Meet

9.1.4. Introduction of Skill Enhancement Courses

IARI has introduced four new skill enhancement courses: Diploma in Freshwater Aquaculture and Fisheries Management (IARI Assam), Diploma in Soil Testing and Nutrient Management (Division of Soil Science and Agricultural Chemistry), Certificate in Rapid Composting and Quality Assessment (Division of Microbiology) and Certificate in Greenhouse Hydroponics and Aeroponics Farming (CPCT) to enhance skills, employability and entrepreneurship possibilities for the participants. The inauguration of the skill development course on Greenhouse Hydroponics and Aeroponic Farming for the duration of three months was held on December 15, 2025 at the Centre for Protected Cultivation Technology (CPCT), ICAR-IARI, New Delhi.

Inauguration of the skill development course

9.1.5. Visit of the Peer Review Team (PRT) for Accreditation of ICAR-IARI

The NAEAB, ICAR Peer Review Team (PRT) visited ICAR-IARI, New Delhi during August 25-27, 2025 for its accreditation (4th cycle) and approved accreditation for a period of five years w.e.f. 16-03-2025 to 15-03-2030 with a score of 3.64/4.00 equivalent to Grade A+.

Visit of the Peer Review Team

9.1.6. NIRF Ranking-2025

In the NIRF Ranking-2025, released on September 4, 2025, IARI topped in the ‘Agriculture and Allied Sectors’ category for the third consecutive year.

Award ceremony of NIRF Ranking-2025

In addition, IARI made an impressive debut in the newly introduced Sustainable Development Goals (SDGs) category by achieving 2nd rank, next to IIT Madras. In the Overall category, IARI was ranked 24th, while in the Research Institutions category it stood at 29th position, marking a remarkable improvement by eight positions compared to last year.

9.1.7. Pusa Launchpad - Students Placements

Two hundred and ten students secured placements for various positions across India. Among them, 33 students were selected as scientists in the Agricultural Research Service (ARS) Examination, while 46 in other Services (ISRO, DRDO, ICFRE, Central Silk Board, Spices Board, and Rubber Board). Additionally, 74 students were appointed as Officers in Agriculture and Horticulture, and 29 as Assistant Professors in State Agricultural Universities (SAUs) and Central Agricultural Universities (CAUs). Few students were also selected for Civil Services, NABARD, Nationalized Banks, as well as Marketing Officers, Patent Officers, Teaching Associates, KVKs, and various positions in the private sector.

9.1.8. Programs Organized by the IARI Alumni Association (IAA)

The IARI Alumni Association hosted the following guest lectures by eminent international scientists and academicians to foster professional development among faculty and students.

- "Large Language Models (LLMs) and the Future of Education and Extension" by Prof. Dharmendra Saraswat, Professor, Department of Agricultural and Biological Engineering, Purdue University, USA on the topic on January 21, 2025 in hybrid mode.

Lecture by Prof. Dharmendra Saraswat

- "Managing India's Food Systems Transformation Top Policy Priorities" by Prof. Prabhu Pingali, Director, Tata-Cornell Institute, Cornell University, Ithaca, USA on the topic on March 12, 2025 in hybrid mode.

Lecture by Prof. Prabhu Pingali

- "Science and Innovation for Food Security and Peace" by Dr. Bram Govaerts, Director General, CIMMYT on the topic on June 24, 2025 in the auditorium of Division of Agricultural Engineering, ICAR-IARI, New Delhi.
- "Options for Entrepreneurship for Agricultural Graduates" by Dr. G.R. Chintala, Former Chairman, NABARD, on on October 31, 2025.

Lecture by Dr. G.R. Chintala

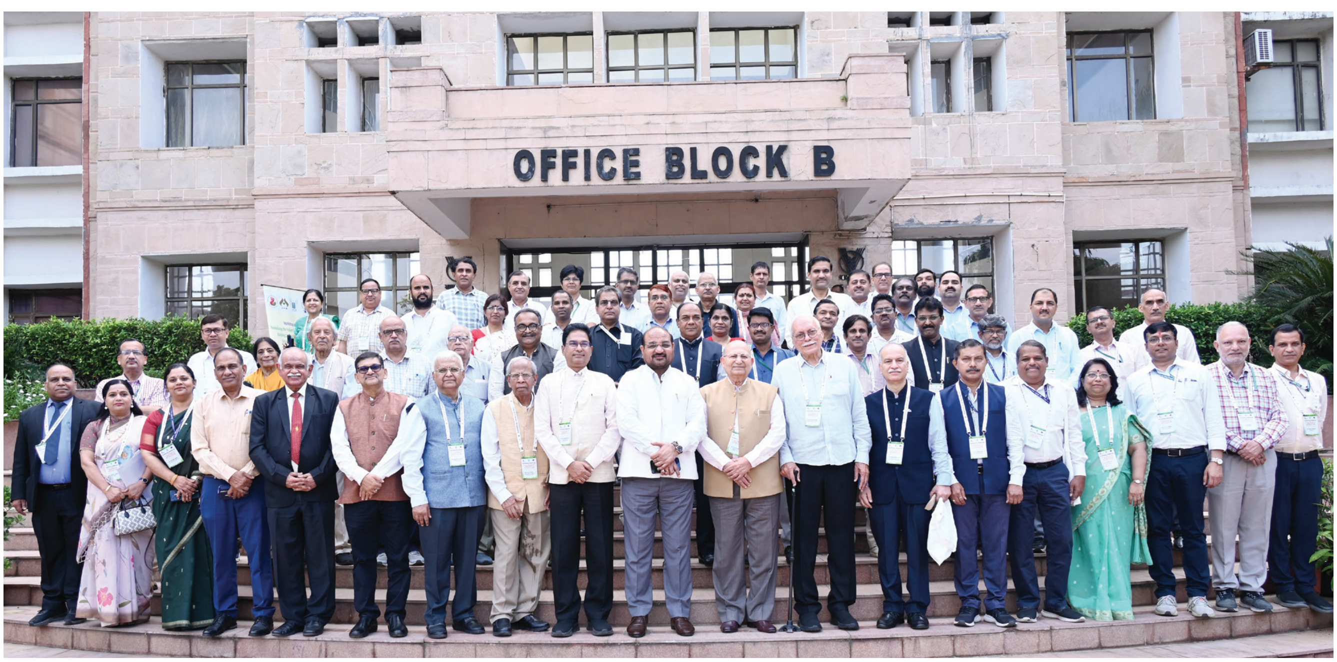
- IAA also organized a roundtable consultation on "Industry-Academic Partnership in making ICAR-IARI a Global Hub" with the leaders of agro-industries and entrepreneurs, besides academicians on March 22, 2025 to coincide with the 63rd Convocation of The Graduate School, ICAR-IARI, New Delhi.
- The IAA and ICAR-IARI, New Delhi, jointly organized a two-day National Seminar on "IARI Towards a World-class Higher Education

Institution" on September 29-30, 2025, at the NASC, New Delhi. The seminar brought together around 100 distinguished scientists, policy makers, academicians, industry leaders, and young researchers to deliberate on strategies for transforming IARI into a globally recognized hub of higher education, research, and innovation and evolving into a Multidisciplinary Education and Research University (MERU).

Eminent speakers, including Dr. M.L. Jat (Secretary, DARE & DG, ICAR), Dr. R.S. Paroda (President, IAA & Chairman, TAAS), Dr. Ch. Srinivasa Rao (Chief Patron, IAA and Director, IARI), Dr. Anupama Singh (Patron, IAA and Joint Director (Edn.) & Dean, IARI), Prof. Kadambot Siddique (Director, Institute of Agriculture, University of Western Australia), Dr. R.S. Kanwar (Former VC, LPU, Phagwara) and Dr. K. Maredia (Director, College of Agriculture and Natural Resources International Programs, Michigan State University) emphasized that innovation, entrepreneurship, and international collaboration will be key drivers of IARI's global positioning.

- The IARI Alumni Association (IAA) organised its 2nd Foundation Day lecture on December 02, 2025 in the auditorium of Agricultural Engineering, ICAR-IARI, New Delhi, focusing on the pivotal role of innovation in building a resilient, inclusive, and future-ready agricultural sector. The lecture was delivered by Dr. R.A. Mashelkar, Former Director General, Council of Scientific and Industrial Research (CSIR), on the theme "Innovation's Holy Grail: More from Less for More" on 02-12-2025 followed by the Alumni Meet.

Foundation Day lecture and Alumni Meet of IAA



National Seminar on "IARI Towards a World-class Higher Education Institution"

9.1.9. International Exposure

Afghanistan National Agricultural Sciences and Technology University (ANASTU) at Kandahar, Afghanistan, is being developed in collaboration with ICAR-IARI and ICAR-IVRI, under the bilateral cooperation between India and Afghanistan, and support of the Ministry of External Affairs, Government of India.

Under this program, so far, four batches of M.Sc. Agronomy and one batch each of M.Sc. Horticulture, M.Sc. Plant Protection and M.Sc. Animal Husbandry have graduated from IARI. In 2024, the Ministry of External Affairs (MEA) approved the continuation of online teaching of fresh batches of the ongoing M.Sc. courses in four disciplines: Agronomy, Horticulture, Plant Protection, and Animal Science (name changed to Livestock Production Management), and the initiation of new M.Sc. courses in four disciplines i.e., Soil Science & Water Management, Agriculture Economics, Agricultural Extension, and Plant Breeding. A total of 41 students enrolled in the program with 11 students in Agronomy, 7 each in Horticulture and Plant Protection, 6 in Agriculture Economics, and 10 in Livestock Production Management.

The online teaching of the fresh batches of M.Sc. in disciplines Agronomy (5th batch), Horticulture (2nd batch), Plant Protection (2nd batch), Livestock Production Management (2nd batch), and Agriculture Economics (1st batch) started on April 30, 2025, after a brief online orientation programme.

Orientation programme of the online teaching of the new batches of M.Sc. students of Agronomy (5th batch), Horticulture (2nd batch), Plant Protection (2nd batch), Agricultural Economics (1st batch), and Livestock Production & Management (2nd batch) was held on April 30, 2025.

As on December 31, 2025, teaching of 32 courses – including five courses each of Agronomy and Livestock Production Management, and seven courses each of Horticulture, Plant Protection and Agricultural Economics, and one common course of statistics for students of all the disciplines has been completed.

9.2 LIBRARY AND LEARNING RESOURCES

IARI library was established in the year 1905 in Pusa Bihar. and has been catering to the literature requirement of scientific community for more than 120 years. In its early collection, there were only 5000

Library related meetings

publications which were donated by the Secretary, Department of Agriculture, Govt of India. Due to devastative earthquake on 15th January 1934, the library along with the institute was shifted to the present campus in Delhi on July 29, 1936. As a tribute to Prof. M. S. Swaminathan, the library was renamed as "Prof M S Swaminathan Library" on April 29, 2016. In pursuance of Library Advisory Committee (LAC) 2019 meeting recommendation, the status of Prof. M. S. Swaminathan Library was upgraded and is now designated as "Prof. M. S. Swaminathan National Agricultural Science Library" w.e.f. January 17, 2020.

It is playing a role of National Repository for agriculture related literature in India. The library is one of the largest and finest agro-biological libraries in South-east Asia housing over four lakh research publications including books, monographs, reference materials, journals, annual reviews, abstracting and indexing journals, translated periodicals, statistical data publications, bulletins, reports, post-graduate theses of IARI, and ICAR research fellowship theses.

The library provides services as lead centre to all ICAR sister institutes/SAUs and International institutes. The library has 1610 active registered members *viz*., scientists, students, and technical/administrative staff in its role. The library provides reference services, bibliographical services, documentation services, online international abstracting database searches services etc.

9.2.1 Books/Serials

During the period, the library procured 411 e-books and also acquired 175 books on *gratis*/gift *gratis*. It received 436 CDs of IARI Ph.D/M.Sc thesis and uploaded 436 thesis on Krishikosh database. During the period, the library procured 68 Indian journals, 26 foreign journals, 315 *gratis* journals, 19 annual reports, 8 bulletins, 30 newsletters/magazines and 51 advances/annual reviews. IARI library is one of the members under One Nation One Subscription (ONOS) and has access of all the major journals (foreign and Indian) launched by INFLIBNET. (https://www.onos.gov.in/journalSearch)

9.2.2 Library e- Resources Available on IARI Website

1. CABI Digital Library
2. Books Catalogue
3. E-resources from CeRA
4. Krishikosh@IARI
5. National Digital Library of India
6. 179 e-books of ASAP
7. 196 e-books by CUP
8. 228 e-books by Wiley
9. 183 Taylor & Francis e-books
10. CABI e-books
11. 145 ASAP global e-books
12. 63 Scientific Publisher (India) e-book
13. 197 NIPA Genx Publisher e-book
14. CABI e-books (2000-2020)
15. RemotLog (Off-Campus Library e-Resources)
16. CeRA Journals
17. DOAJ (e-Resources)
18. e-Resources
19. CSIRO Journals
20. Online Journal 2024

9.2.3 Online Courses

The Institute also offers three online courses

1. Online Effective Public Speaking, Presentation and Interpersonal Skills Programme
2. Online English Language Development and Improvement Resource
3. Online Personality Development and Human Values Programme

9.2.4 Resource Management

Apart from 2078 active registered members, the library serves 150 to 200 users per day who consult approximately 50 to 100 library publications/articles through online/offline mode. Apart from registered members, the library serves approximately 150 to 200 users per day from different agricultural universities/

ICAR institutes/SAUs. About 375 new users registered in the current year. During the period under report, 1448 publications were issued and 1318 were returned. Under the Inter Library Loan System, 10 publications were issued to various institutions. Additionally, 399 No Dues Certificate were issued.

9.2.5 e-Granth

It provides ready software platform to implement all aspects of the open access policy, similar to 'Cloud Service' for individual institution's self-managed repository with central integration. The two products of e-Granth (i) Krishikosh and (ii) IDEAL are being used by all SAUs/DUs/CUs & ICAR Institutes. Up to December, 2025, total IARI publications on Krishikosh were 13288, while the total theses were 7110.

9.2.6 e-Language Lab

With the help of library strengthening program, the Language Lab was established with seating capacity of about 50 participants to facilitate english language classes for IARI foreign/ Indian students with modern facilities like 30 computers with internet facility, interactive board, visualizers, interactive panel, headphones etc. The language lab is also used for conducting workshops, trainings, LIS course, summer/ winter school courses, hindi language training of personal from different Divisions and Directorate for the benefit of Scientists/Technical staff. Total number of participants for these trainings were 120.

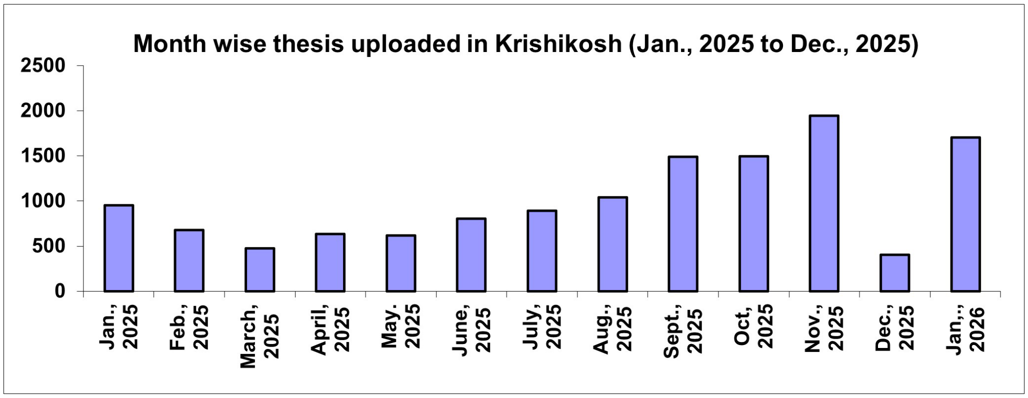
9.2.7 Library Information System (LIS) Course

The library is actively involved in the Post Graduate teaching programme with one credit course (LIS) for M.Sc. & Ph.D. students of all disciplines. The objective of this course is to train the students to search for the literature of their interest and the available literature search tools.

9.3 AGRICULTURAL KNOWLEDGE MANAGEMENT UNIT (AKMU)

9.3.1 Krishikosh a Digital Repository

Krishikosh (https://krishikosh.egranth.ac.in/) is a unique repository of knowledge in agriculture and allied sciences, having a collection of theses, old and valuable books, institutional publications, technical bulletins, project reports, lectures, preprints, reprints, records and various documents spread all over the country in different libraries of Research Institutions and State Agricultural Universities (SAUs). It is a customized digital repository platform for users of NARES Institutions, where they can upload and manage their own contents for compliance to open access policy of ICAR. It's a central, open-access agricultural information platform that benefits students, researchers, policymakers, and farmers, with 55 million pages of content (theses, research papers, datasets, articles, etc.). There are 107 contributor institutions with an average of 20,000 daily views. Currently, this digital repository has 3,53,000 items (221,000 theses across all NARES Institutions) for research, farming, and educational purposes on the open-access portal. Google Analytics for Krishikosh during October 2018 to December 2025 indicates more than 40 million hits for the repository. The month-wise thesis submitted in Krishikosh repository are given below:



10. PUBLICATIONS

An important mandate of the Institute is to develop an information system, add value to the information and share the information nationally and internationally. Publications are an integral component of the information system. During the reported period, the Institute scientists brought out quality publications in the form of research papers in peer-reviewed journals, books/ book chapters, popular articles, etc., both in English and Hindi. Apart from these publications, the Institute brought out several regular and *adhoc* technical publications in English and Hindi. The details of these publications are given below:

10.1 In-House Publications

10.1.1 Regular Publications (English)

- IARI Annual Report 2024 (ISSN: 0972-6136)
- IARI NEWS, October-December 2024, January-March 2025, April-June 2025 and July-September 2025
- IARI Current Events (Monthly) - 12 issues (Available only on IARI website)

10.1.2 Niyamit Prakashan (Hindi)

- पूसा सुरभि (अर्ध वार्षिक) (ISSN : 2348-2656)
- वार्षिक रिपोर्ट 2024 (ISSN : 0972-7299)
- पूसा समाचार, अक्टूबर- दिसम्बर, 2024, जनवरी-मार्च 2025 एवं अप्रेल – जून, 2025
- प्रसार दूत (त्रैमासिक)
- भा.कृ.अ.स. सामयिकी (मासिक) (केवल संस्थान की वैबसाइट पर उपलब्ध)

10.1.3 Technical Publications

S. No.	Title of the Book	Name of Division/Unit	Date of issue	ISBN No.
1.	Assessment and Transfer of IARI Technologies through Collaborative Approach	CATAT	February 06, 2025	ISBN 978-93-83168-91-0
2.	कृषि उद्यम एवं व्यवसाय प्रबंधन	प्रकाशन इकाई	February 11, 2025	ISBN 978-93-83168-92-7
3.	स्वरोज़गार के लिए फूलों की व्यावसायिक खेती	प्रकाशन इकाई	February 11, 2025	ISBN 978-93-83168-93-4
4.	आधुनिक कृषि मशीनों द्वारा टिकाऊ खेती	कृषि अभियांत्रिकी	February 14, 2025	ISBN 978-93-83168-94-1
5.	अध्येता एवं नवोन्मेषी किसान	एक परिचय	CATAT	February 18, 2025	ISBN 978-93-83168-95-8
6.	औद्यानिक एवं अनाजीय उत्पादों का मूल संवर्धन: सिद्धांत एवं उपयोग	FS&PHT	March 13, 2025	ISBN 978-93-83168-96-5
7.	मक्का, बेबिकॉर्न, स्वीटकॉर्न की वैज्ञानिक खेती एवं प्रसंस्करण	CATAT	March 18, 2025	ISBN 978-93-83168-97-2
8.	Conservation Agriculture for Efficient Resource Use and CR	Agronomy	June 13, 2025	ISBN 978-93-83168-98-9
9.	जलवायु सहनशील तकनीकें	प्रकाशन इकाई	September 11, 2025	ISBN 978-93-83168-99-6
10.	Communication Skills: Tactics to Practice	Agricultural Extension	October 16, 2025	ISBN 978-81-986753-4-7
11.	Participatory Rural Appraisal: A Practical Guide by IARI for Field Facilitators and Trainers	CATAT	October 21, 2025	ISBN 978-81-986753-9-2
12.	मध्य भारत की जनजातियों के सशक्तिकरण हेतु उन्नत कृषि प्रौद्योगिकियाँ	CATAT	October 30, 2025	ISBN 978-81-986753-3-0
13.	Inspiring Farmers of India: Innovations for Transformation	CATAT	December 23, 2025	ISBN 978-81-986753-7-8
14.	बीज उत्पादन तकनीकी	SST	December 27, 2025	ISBN 978-81-986753-5-4

S. No.	ICN Book Title	Division/ Regional Station/PD	Date	ICN Number
1.	Recent Advances in Food Processing Technologies for Agri-horti Produce	Food Science & Post Harvest Technology	January 10, 2025	TB-ICN: 352/2025
2.	Extension Approaches and Initiatives for Enhancing Farmers' Income through Nutripreneurship	Agricultural Extension	January 14, 2025	TB-ICN: 353/2025
3.	Mushroom Cultivation and Production Technology	Plant Pathology	January 17, 2025	TB-ICN: 354/2025
4.	Seed Quality Testing by Conventional and Advanced Technologies	Seed Science & Technology	January 21, 2025	TB-ICN: 355/2025
5.	Division of Seed Science and Technology: An Introduction and Achievements	Seed Science & Technology	January 24, 2025	TB-ICN: 356/2025
6.	Fostering Entrepreneurship for Varietal and Hybrid Vegetable Seed Production	Vegetable Science	January 28, 2025	TB-ICN: 357/2025
7.	Augmenting Communication & Managerial Competencies of Extension Professionals	Agricultural Extension	January 30, 2025	TB-ICN: 358/2025
8.	Divine Dough	Biochemistry	February 18, 2025	TB-ICN: 359/2025
9.	IARI- bred Crop Cultivars for Improving Productivity and Farmers' Prosperity	Genetics	February 19, 2025	TB-ICN: 360/2025
10.	The Rise of AgriBots-Automation & All in Farming	ZTM & BPD Unit	February 19, 2025	TB-ICN: 361/2025
11.	Advances in the Detection and Management of Emerging Plant Diseases of National Importance	Plant Pathology	February 24, 2025	TB-ICN: 362/2025
12.	Emerging Innovation in Biochemistry and Biotechnology for Holistic Development of Agriculture	Biochemistry	March 10, 2025	TB-ICN: 363/2025
13.	Technical Education and Practical Training through Skill Development in Horticulture (Fruit Science)	Fruit & Horticulture Technology	March 12, 2025	TB-ICN: 364/2025
14.	Soil Health-Measure, Monitor and Manage for Ensuring Food Security and Climate Change Mitigation	Soil Science & Agricultural Chemistry	March 12, 2025	TB-ICN: 365/2025
15.	63rd Convocation - Significant Research Achievements of Post Graduate Students 2024	The Graduate School	March 12, 2025	TB-ICN: 366/2025
16.	Genetic and Genomic Approaches for Improvement of Stress Resilience and Nutritional Quality in Crops	Genetics	March 18, 2025	TB-ICN: 367/2025
17.	Wellness Choice-Pearl Millet Flour Mix (Gluten Free) for Soft and Fluffy Dough	Biochemistry	March 20, 2025	TB-ICN: 368/2025
18.	Fast Feast Instant Pearl Millet Dalia	Biochemistry	March 20, 2025	TB-ICN: 369/2025

S. No.	ICN Book Title	Division/ Regional Station/PD	Date	ICN Number
19.	Cultivars Released from ICAR-IARI, New Delhi 2024-25	Genetics	March 21, 2025	TB-ICN: 370/2025
20.	Ameliorating Quality and Productivity of Oilseeds and Pulses through Classical, Modern and Disruptive Technologies	Genetics	March 21, 2025	TB-ICN: 371/2025
21.	The BioAgri Revolution-Growth of Bioinputs in Indian Farming	ZTM & BPD Unit	March 27, 2025	TB-ICN: 372/2025
22.	Innovative Agricultural Engineering Research (2023-24)	Agricultural Engineering	March 27, 2025	TB-ICN: 373/2025
23.	Annual Report 2024	SST	April 11, 2025	TB-ICN: 374/2025
24.	Taxonomy of Agriculturally Important Insects	Entomology	April 17, 2025	TB-ICN: 375/2025
25.	Protected Cultivation of Vegetable Crop (Tomato, Capsicum, Cucumber)	CPCT	April 25, 2025	TB-ICN: 376/2025
26.	Annual Report 2024	Environmental Science	May 06, 2025	TB-ICN: 377/2025
27.	Greenhouse Cultivation Practices for Sweet Pepper	CPCT	June 02, 2025	TB-ICN: 378/2025
28.	Off-Season Cultivation of Cucurbits through Low Tunnel Technology	CPCT	June 02, 2025	TB-ICN: 379/2025
29.	Greenhouse Cultivation Practices for Tomato	CPCT	June 02, 2025	TB-ICN: 380/2025
30.	Greenhouse Cultivation Practices for Cucumber	CPCT	June 02, 2025	TB-ICN: 381/2025
31.	Plant Protection Practices for Greenhouse Cucumber	CPCT	June 02, 2025	TB-ICN: 382/2025
32.	Protected Structures for Horticultural Crops	CPCT	June 02, 2025	TB-ICN: 383/2025
33.	Plant Protection Practices under Greenhouse Cultivation of Sweet Pepper	CPCT	June 02, 2025	TB-ICN: 384/2025
34.	UEXT 101 Rural Sociology and Educational Psychology	Agricultural Extension	June 04, 2025	TB-ICN: 385/2025
35.	EDBM 201 Entrepreneurship Development and Business Management	Agricultural Extension	June 04, 2025	TB-ICN: 386/2025
36.	Harvesting Innovation-The Success Story of NASF Project	Biochemistry	June 26, 2025	TB-ICN: 387/2025
37.	General Guidelines for Laboratory Waste Management	Environmental Science	August 05, 2025	TB-ICN: 388/2025
38.	Millet Magic: Timeless Millet recipes from Indian Heritage	Biochemistry	August 19, 2025	TB-ICN: 389/2025
39.	CSBC-302 Economics and Marketing	Agricultural Extension	August 22, 2025	TB-ICN: 390/2025
40.	Recent Avenues in Food Processing for Agritech Startups	Food Science & Postharvest Technology	September 02, 2025	TB-ICN: 391/2025

S. No.	ICN Book Title	Division/ Regional Station/PD	Date	ICN Number
41.	Rural Agricultural Work Experience (RAWE) (Student Ready Programme)	ATIC	September 19, 2025	TB-ICN: 392/2025
42.	From Seed to Storage: Ensuring Quality in Field and Vegetable Crops	Seed Science and Technology	September 25, 2025	TB-ICN: 393/2025
43.	Entrepreneurship Development through Hybrid Seed Production of Vegetable Crops	Division of Vegetable Science	October 15, 2025	TB-ICN: 394/2025
44.	Innovations in Post-Harvest Machinery: Design, Development, and Digital Advancement	Agricultural Engineering	October 09, 2025	TB-ICN: 395/2025
45.	Plant Component Functionalization for Novel Food Applications	Food Science & Post Harvest Technology	October 14, 2025	TB-ICN: 396/2025
46.	New Generation Plant Based Foods	Food Science & Post Harvest Technology	October 14, 2025	TB-ICN: 397/2025
47.	Optimized Standard Protocols for Electrocatalytic Remediation of Heavy Metals from Irrigation Water	Agricultural Physics	October 14, 2025	TB-ICN: 398/2025
48.	Nutri-Blend: A Rational Blend for Function Nutrition	Biochemistry	November 11, 2025	TB-ICN: 399/2025
49.	MicroMagic Tea: Enriched with Vitamins, Minerals, and Powerful Antioxidants	Biochemistry	November 14, 2025	TB-ICN: 400/2025
50.	Deep Learning Approaches for Image-Based Insect Pest Classification, Image Recognition and Smart Pest Control	Regional Station, Pusa, Samastipur	November 14, 2025	TB-ICN: 401/2025
51.	Turkey Tail Mushrooms: Colorful Stripes, Powerful Benefits	Biochemistry	November 26, 2025	TB-ICN: 402/2025
52.	Enhancing Personal Effectiveness of Technical Staff (T-1)	Agricultural Extension	November 26, 2025	TB-ICN: 403/2025
53.	Transforming Northeast India's Agriculture Through Engineering Innovations	Agricultural Engineering	November 28, 2025	TB-ICN: 404/2025
54.	Golden Roots: Exploring Carotenoids and Business Opportunities in Carrots	Biochemistry	December 17, 2025	TB-ICN: 405/2025
55.	Beta Carotene: A Nutritional Life-Booster Element	Biochemistry	December 17, 2025	TB-ICN: 406/2025
56.	Enhancing Managerial and Communication Competencies of Extension Professional for Achieving Professional Excellence	Agricultural Extension	December 31, 2025	TB-ICN: 407/2025

वर्ष 2025 में तकनीकी हिंदी बुलेटिन हेतु आबंटित आईसीएन

क्र. सं.	बुलेटिन का शीर्षक	संभाग/इकाई	आईसीएन जारी करने की तिथि	आईसीएन सं.
1.	पॉलीहाउस के लिए सब्जी की खेती	सी.पी.सी.टी.	28.01.2025	ICN: H-228/2025
2.	बीज विज्ञान एवं प्रौद्योगिकी संभाग – परिचय एवं उपलब्धियां	बीज विज्ञान एवं प्रौद्योगिकी	28.01.2025	ICN: H-229/2025
3.	चिकनी तोरई में संकर बीज उत्पादन	बीज विज्ञान एवं प्रौद्योगिकी	28.01.2025	ICN: H-230/2025
4.	खीरा में संकर बीज उत्पादन	बीज विज्ञान एवं प्रौद्योगिकी	28.01.2025	ICN: H-231/2025
5.	संरक्षित परिस्थितियों में बागवानी फसलों के लिए गुणवत्तापूर्ण पौध सामग्री का उत्पादन	सीपीसीटी	04.02.2025	ICN: H-232/2025
6.	अधिक उत्पादन एवं व्यावसायीकरण के लिए उन्नत अनुमोदित किस्में	सब्जी विज्ञान	17.02.2025	ICN: H-233/2025
7.	उत्पादकता और किसानों की समृद्धि में सुधार के लिए आई.ए.आर.आई.-प्रजनित फसल की किस्में	आनुवंशिकी	19.02.2025	ICN: H-234/2025
8.	सब्जियों एवं फलों की उच्च उत्पादन तकनीकी	एटिक	12.03.2025	ICN: H-235/2025
9.	सब्जियों एवं फसलों की जैविक खेती	एटिक	12.03.2025	ICN: H-236/2025
10.	कृषि बागवानी फसल उत्पादन में आधुनिक दृष्टिकोण और हालिया विकास	भा.कृ.अ.सं. क्षेत्रीय केन्द्र, पूसा	07.10.2025	ICN: H-237/2025
11.	आधुनिक कृषि एवं बागवानी पद्धतियां और बेहतर बाजारों के लिए मूल्य संवर्धन	भा.कृ.अ.सं. क्षेत्रीय केंद्र, पूसा	10.10.2025	ICN: H-238/2025
12.	पर्यावरण हितैषी हरित नैनो प्रौद्योगिकी	प्रकाशन यूनिट	08.11.2025	ICN: H-239/2025
13	जैव उर्वरक का जैविक एवं समन्वित खेती में उपयोग	प्रकाशन यूनिट	08.11.2025	ICN: H-240/2025
14.	मशरूम की उन्नत उत्पादन तकनीकी	प्रकाशन यूनिट	12.11.2025	ICN: H-241/2025
15.	माइक्रोग्रींस सूक्ष्म दूनिया का जादू	जैव रसायन विज्ञान	12.11.2025	ICN: H-242/2025
16.	माइक्रोग्रींस सूक्ष्म पत्तियां विशाल विज्ञान	जैव रसायन विज्ञान	12.11.2025	ICN: H-243/2025
17.	न्यूट्री बलेंड कार्यात्मक पोषण के लिए एक तर्कसंगत मिश्रण	जैव रसायन विज्ञान	12.11.2025	ICN: H-244/2025
18.	मिलेट का जादू: भारतीय विरासत की कालातीत मिलेट नुस्खे	जैव रसायन विज्ञान	12.11.2025	ICN: H-245/2025

10.2 PUBLICATIONS AT A GLANCE

1. Research/Symposia Papers		
a.	Research papers (with international impact factor or NAAS rating 6 and above) published in journals	**1119**
b.	Symposia/conference papers	**235**
2. Books/Book Chapters		
a.	Books	**50**
b.	Chapters in books	**251**
3. Popular Articles		**258**
4. Training Manuals		**10**

10.3 RESEARCH PUBLICATIONS (NAAS rating >10)

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bioactive compounds, enhances antioxidant activity, reduces softening and prolongs shelf life of cherry tomato (*Solanum lycopersicon* var. Cerasiformaeae) during cold storage. *Journal of Future Foods* doi.org/10.1016/j.jfutfo.2025.03.008

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11. TECHNOLOGY COMMERCIALIZATION, IP MANAGEMENT, PATENTS, AND AGRIBUSINESS INCUBATION ACTIVITIES

11.1 Technology Commercialization

11.1.1 Commercialization of Technology/Products

During the year 2025, under Lab to Land Initiative, 91 innovative technologies of ICAR-IARI were transferred to 133 industry partners resulting in revenue generation of ₹ 3.62 crore.

The following technologies were commercialized as per the table given below:

S. No.	Name of Technology	Name of Industry	Commercialization Date
1	Bitter gourd c.v. Pusa Vishesh	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
2	Bottle gourd c.v. Pusa Naveen	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
3	Brinjal c.v. Pusa Uttam	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
4	Brinjal c.v. Pusa Ankur	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
5	Tomato c.v. Pusa Ruby	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
6	Methi c.v. Pusa Kasuri	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
7	Palak c.v. All Green	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
8	Sponge gourd c.v. Pusa Supriya	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
9	Pumpkin c.v. Pusa Vishwas	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
10	Cow pea c.v. Pusa Komal	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
11	Onion c.v. Pusa Red	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
12	Radish c.v. Pusa Chetki	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
13	Redish c.v. japanese White	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
14	Cauliflower c.v. Pusa Deepali	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
15	Amaranthus c.v. Pusa Kiran	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
16	Capsicum c.v. Califfornia	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
17	Carrot c.v Nantese	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
18	French bean c.v. contender	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
19	Lettuce c.v. Great Lakes	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
20	Beetroot c.v. Crimson Globe	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
21	Broccoli c.v. Pusa Brpccoli KTS-1	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
22	Cabbage c.v. Golden Acre	Namdeo Umaji Agritech (India) Pvt Ltd.	08.01.2025
23	Onion c.v. Pusa Red	Premium Onion Growers Farmer's Producer Company Ltd.	09.01.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
24	Onion c.v. Pusa Red	Devdhenu Seeds	09.01.2025
25	Onion c.v. Pusa Madhvi	Devdhenu Seeds	09.01.2025
26	Easy PCR kit for Mungbean yellow mosaic India Virus (MYMIV)	Zenomix BioaLab Private Limited	17.01.2025
27	Easy PCR kit for Bhendi yellow vein mosaic Virus (BYVMV)	Zenomix BioaLab Private Limited	17.01.2025
28	Pusa Biofortified Maize Hybrid 3	Image Crop Sciences Private Limited	28.01.2025
29	HQPM 5 Improved	Image Crop Sciences Private Limited	28.01.2025
30	HQPM 1 Improved	Sri Rama Agri Genetics (India) Pvt Ltd	28.01.2025
31	HQPM 5 Improved	Sri Rama Agri Genetics (India) Pvt Ltd	28.01.2025
32	Garlic Extract as Bionematicide	IPL Biologicals Limited	30.1.2025
33	HD 3410	Hari Ram Seeds	31.01.2025
34	Pusa Arhar 2018-4	Sworn Agritech Private Limited	14.02.2025
35	Pusa Arhar 2017-1	Sworn Agritech Private Limited	14.02.2025
36	PJHM 1	Sworn Agritech Private Limited	14.02.2025
37	Pusa Jawahar Hybrid Maize 2	Sworn Agritech Private Limited	14.02.2025
38	Divine dough	Melwach LLP	14.02.2025
39	Fast Feast: Instant Pearl millet Dalia	Melwach LLP	14.02.2025
40	Speedyseed Viability kit	Vfarmz Supplychain Pvt Ltd	14.02.2025
41	HQPM 5 Improved	Ananya seeds Pvt Ltd	27.02.2025
42	Pusa 1431	Jetaa Seeds Pvt. Ltd.	28.02.2025
43	Pusa Black Garlic	Tholua Pratisthan Pvt Ltd	04.03.2025
44	Palak c.v. All Green	Bapna Seeds Private Limited	05.03.2025
45	Tomato c.v. Pusa Ruby	Bapna Seeds Private Limited	05.03.2025
46	Pumpkin c.v. Pusa Vikas	Bapna Seeds Private Limited	05.03.2025
47	Pusa Bio-surfactant	S Biologicals	13.03.2025
48	Sponge gourd c.v. Pusa Sneha	Utpann Seeds	18.03.2025
49	Pumpkin c.v. Pusa Vishwas	Utpann Seeds	18.03.2025
50	Tomato c.v. Pusa Ruby	Utpann Seeds	18.03.2025
51	Bottle gourd c.v. Pusa Santushti	Utpann Seeds	18.03.2025
52	PUSA- Nitrogen Prescription Device	W S Telematics Private Limited	24.03.2025
53	Process for Purification of Raw Propolis	Indo World Trading Corporation	27.03.2025
54	Onion c.v. Pusa Red	Yash Seeds	27.03.2025
55	Onion c.v. Pusa Madhvi	Yash Seeds	27.03.2025
56	Pusa 1431	Sun Shine Agro Tech	01.04.2025
57	PB 1718	Alliance Agri Tech	11.04.2025
58	PB 1692	Alliance Agri Tech	11.04.2025
59	PB 1847	Alliance Agri Tech	11.04.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
60	PB 1718	Vardhnam Agro Solutions Pvt. Ltd	23.04.2025
61	PB 1692	Supple Tek Rice Pvt. Ltd	23.04.2025
62	Pusa Jawahar Hybrid Maize 2	Wasli Adarsh Kisan Producer Company	01.05.2025
63	Pusa TOLCV tomato Hybrid	SOMANI KANAK SEEDZ PVT LTD	02.05.2025
64	Pusa Arhar 16	Krushisharang Agriclinic Private Limited	06.05.2025
65	PB 1885	Sood seeds Co. Pvt. Ltd	07.05.2025
66	Pusa Biofortified Maize Hybrid 3	Gold Vasundhara Seeds	09.05.2025
67	Pusa Arhar 16	Gold Vasundhara Seeds	09.05.2025
68	PB 1692	Fine Seeds	15.05.2025
69	PB 1718	Punjab Seed Company (Hr)	11.06.2025
70	Pusa Arhar 16	GPS Hybrid Seeds Pvt Ltd	28.05.2025
71	Methi c.v. PEB	GPS Hybrid Seeds Pvt Ltd	28.05.2025
72	Onion c.v. Pusa Red	GPS Hybrid Seeds Pvt Ltd	28.05.2025
73	Palak c.v. All Green	GPS Hybrid Seeds Pvt Ltd	28.05.2025
74	Amaranthus c.v. Pusa Kiran	GPS Hybrid Seeds Pvt Ltd	28.05.2025
75	PB 1882	Abhimanyu Seeds Pvt ltd	20.05.2025
76	PB 1718	Dayal Seeds (P) Limited	20.05.2025
77	PB 1882	Shakti Vardhak Hybrid Seeds Pvt. Ltd	21.05.2025
78	PB 1885	Alfa Hybrid Seeds Co.	21.05.2025
79	PB 1509	Alfa Hybrid Seeds Co.	21.05.2025
80	PB 1885	Sahib Seeds Limited	28.05.2025
81	PB 1509	Sahib Seeds Limited	28.05.2025
82	PB 1718	Sahib Seeds Limited	28.05.2025
83	PB 1692	Sahib Seeds Limited	28.05.2025
84	PB 1509	Rallis India Limited	28.05.2025
85	PB 1718	Rallis India Limited	28.05.2025
86	PB 1692	Rallis India Limited	28.05.2025
87	Pusa Narendra KN1	Rallis India Limited	03.06.2025
88	PB 1979	Shakti Vardhak Hybrid Seeds Pvt. Ltd	03.06.2025
89	PB 1985	Shakti Vardhak Hybrid Seeds Pvt. Ltd	03.06.2025
90	PB 1509	Onkar Seeds	05.06.2025
91	PB 1718	Maa Narmada Seeds	05.06.2025
92	Pusa Biofortified Maize Hybrid 3	Sharayu Seeds Pvt. Ltd	03.06.2025
93	PB 1979	Yashoda Hybrid Seeds Pvt. Ltd.	09.06.2025
94	PB 1985	Yashoda Hybrid Seeds Pvt. Ltd.	09.06.2025
95	Pusa Deepshikha	Bugyal	05.06.2025
96	Pusa Arhar 16	Yashoda Hybrid Seeds Pvt. Ltd.	16.06.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
97	Pusa Arhar 2017-1	Yashoda Hybrid Seeds Pvt. Ltd.	16.06.2025
98	Pusa Biofortified Maize Hybrid 2	Yashoda Hybrid Seeds Pvt. Ltd.	16.06.2025
99	HQPM 5 Improved	Yashoda Hybrid Seeds Pvt. Ltd.	16.06.2025
100	PM 37	Yashoda Hybrid Seeds Pvt. Ltd.	17.06.2025
101	Pusa Manav	Yashoda Hybrid Seeds Pvt. Ltd.	17.06.2025
102	Pusa Arhar 16	Bharatiya Beej Sahakari Samiti Ltd	17.06.2025
103	Pusa Biofortified Maize Hybrid 3	Geeta Seeds Pvt. Ltd	16.07.2025
104	PB 1985	DCM Shiriram Limited	08.07.2025
105	PB 1979	DCM Shiriram Limited	08.07.2025
106	Onion c.v. Pusa Madhvi	GPS Hybrid Seeds Pvt Ltd	24.06.2025
107	Pusa Jawahar Hybrid Maize 2	MP State Cooperative Seed Producer and Marketing Federation	04.07.2025
108	PJHM 1	MP State Cooperative Seed Producer and Marketing Federation	04.07.2025
109	PB 1718	Punjab Seed Company	15.05.2025
110	Cucumber line DC-48 (Gynoecious nature with extended shelf life)	Indo American hybrid Seeds (India) Pvt. Ltd	04.07.2025
111	Cucumber line DC-61 (Resistant to ToLCNDV)	Indo American hybrid Seeds (India) Pvt. Ltd	04.07.2025
112	Cucumber line DC-44	Indo American hybrid Seeds (India) Pvt. Ltd	04.07.2025
113	Brinjal c.v. Pusa Uttam	Mahanandi Agro Genetics	04.07.2025
114	Sponge gourd c.v. Pusa Sneha	Mahanandi Agro Genetics	04.07.2025
115	Tomato c.v. Pusa Ruby	Mahanandi Agro Genetics	04.07.2025
116	Methi c.v. PEB	Mahanandi Agro Genetics	04.07.2025
117	Palak c.v. All Green	Mahanandi Agro Genetics	04.07.2025
118	Carrot c.v. Pusa Kesar	Mahanandi Agro Genetics	04.07.2025
119	Dolichus bean c.v. Pusa Garima	Mahanandi Agro Genetics	04.07.2025
120	Chilli c.v. Pusa Jwala	Mahanandi Agro Genetics	04.07.2025
121	Cow pea c.v. Pusa Komal	Mahanandi Agro Genetics	04.07.2025
122	Chilli c.v. Pusa Jwala	Plants valley Nursery	04.07.2025
123	HQPM 5 Improved	Indo Us Bio-Tech Limited	04.07.2025
124	Pusa Biofortified Maize Hybrid 3	Krishi Vikas Sahakari samiti Limited	08.07.2025
125	Pusa Deepshikha	Shelter Agri-Horti Farms Pvt. Ltd.	10.07.2025
126	Pusa Manohari	Shelter Agri-Horti Farms Pvt. Ltd.	10.07.2025
127	Pusa Arhar 16	Star Agriseeds Private Limited	14.07.2025
128	Pusa 1641	Star Agriseeds Private Limited	14.07.2025
129	Pusa Biofortified Maize Hybrid 3	Safex Seed India LLP	16.07.2025
130	Methi c.v. PEB	Safex Seed India LLP	16.07.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
131	Palak c.v. All Green	Safex Seed India LLP	16.07.2025
132	HD 3385	Safex Seed India LLP	16.07.2025
133	Pusa Biofortified Maize Hybrid 2	Enseme Crop Science INC	29.07.2025
134	Pusa Decomposer Wettable Powder	M D Bio Coals Private Limited	04.08.2025
135	Pusa Decomposer Wettable Powder	Microplex (India)	04.08.2025
136	Pusa Decomposer Wettable Powder	Parashar Agrotech Bio Pvt Ltd	04.08.2025
137	Pusa Decomposer Wettable Powder	Ankur Organics Biofertilizers	04.08.2025
138	Pusa Decomposer Wettable Powder	Agrella Crop Sciences Pvt Ltd.	04.08.2025
139	Pusa Decomposer Wettable Powder	Om Agro Organics	04.08.2025
140	Pusa Decomposer Wettable Powder	Vijay Sales Corporation	04.08.2025
141	Pusa Super Sweet Corn 1	Sagar Bio Tech Private Limited	12.08.2025
142	Pusa Krishna (DBR 03)	Sagar Bio Tech Private Limited	12.08.2025
143	Lentil variety L-4717	Star Agriseeds Private Limited	14.08.2025
144	Pusa Manav	Jetaa Seeds Pvt. Ltd.	19.08.2025
145	PM 32	Kosco Hybrid and Research Pvt Ltd	02.09.2025
146	Pusa Manav	Dattapurna FPO	02.09.2025
147	HD 3406	Sai Agro Seed	03.09.2025
148	HD 3386	Sai Agro Seed	03.09.2025
149	Lentil crackers	Proteogenixx Lifescience Pvt. Ltd	12.09.2025
150	Minor millets pasta	Proteogenixx Lifescience Pvt. Ltd	12.09.2025
151	HI 1650	Sunita Krishi Seeds	12.08.2025
152	Pusa Chickpea 4035 (BG 4035)	Star Agriseeds Private Limited	23.09.2025
153	Pusa Biofortified Maize Hybrid 3	Sanscar Multi State Cooperative Society Ltd	23.09.2025
154	Pusa Biofortified Maize Hybrid 2	Sanscar Multi State Cooperative Society Ltd	23.09.2025
155	HQPM 5 Improved	Sanscar Multi State Cooperative Society Ltd	23.09.2025
156	HQPM 1 Improved	Sanscar Multi State Cooperative Society Ltd	23.09.2025
157	Pusa Manav	Antra Corporation	25.09.2025
158	HD 3385	Antra Corporation	25.09.2025
159	Pusa Manav	Krishak Mitra Beej Utpadak Shakari Samiti Maryadit SomgaonKala	25.09.2025
160	Pusa chickpea 4035 (BG 4035)	Vasundhara Seeds	25.09.2025
161	Pusa Manav	Vasundhara Seeds	25.09.2025
162	HD 3386	Sai Seeds	01.10.2025
163	HD 3386	C. L. Agro Seeds	03.10.2025
164	HD 3386	Shiv Ganga Hybrid Seeds Private Limited	13.10.2025
165	HD 3386	Mudit Seeds	03.10.2025
166	Pusa chickpea 4035 (BG 4035)	Namami Seeds	09.10.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
167	HD 3386	Chamunda Agro Pvt. Ltd.	03.10.2025
168	HI 1650	Chamunda Agro Pvt. Ltd.	03.10.2025
169	Pusa chickpea 4035 (BG 4035)	Jaiv Vasundhara Farmers Production Ltd	03.10.2025
170	Pusa Manav	Jaiv Vasundhara Farmers Production Ltd	03.10.2025
171	HD 3086	Shiv Ganga Hybrid Seeds Private Limited	06.10.2025
172	Pusa Manav	Namami Seeds	09.10.2025
173	PM 27	Bhoomi Seeds	13.10.2025
174	HD 3386	Gayatri Seeds	13.10.2025
175	Palak c.v. All Green	R P Sharma Beej Bhandar	13.10.2025
176	HD 3086	Mudit Seeds	05.10.2025
177	HD 3086	Ganga Kaveri Seeds Pvt Ltd	17.10.2025
178	HD 3386	Punjab Seed Co.	23.10.2025
179	Cucumber line DC-48 (Gynoecious nature with extended shelf life)	Chamunda Agro Pvt. Ltd.	13.10.2025
180	HD 3086	Bandhan Seeds	17.10.2025
181	Pusa Manav	Shakti seeds	17.10.2025
182	HD 3406	Sood Hybrid Seeds	25.09.2025
183	HD 3086	Sharda Enterprises	31.08.2025
184	HD 3386	Haryana Beej Company	14.10.2025
185	HD 3086	Shri Ram Traders	30.10.2025
186	HD 3406	Abhimanyu seeds Pvt. Ltd	17.10.2025
187	HD 3086	Punjab Agri Seed Farm	18.10.2024
188	HD 3386	Sirsa Beej Co.	17.10.2025
189	HD 3086	Quality Hybrid Seeds Co.	10.10.2025
190	HD 3386	Sobhari Seeds & Farms	23.10.2025
191	Pusa Manav	Harnavada Beej Utpadak anv Krishi Vikash Sahakari Sanstha Maryadit	23.10.2025
192	HD 3086	Gee Seeds Company	10.10.2024
193	HD 3086	Punjab Seed Company	1.10.2025
194	HD 3385	Jaria Seed Farm	24.10.2025
195	HD 3086	Agri Superior seeds	25.09.2025
196	HD 3386	Shipra seeds	27.10.2025
197	HD 3086	Ganpati Agro Tech	27.10.2025
198	HD 3086	Mico Seed Farm	14.10.2025
199	HD 3086	Kissan Seed Corporation	29.09.2025
200	Pusa Manav	Kashtkar Seeds	31.10.2025
201	Pusa Manav	Sowverest Agritech Solution	31.10.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
202	HD 3386	Samag Seeds Pvt. Ltd	28.10.2025
203	Vegetable Seedline Cucumber line, DPaC-48	Nuziveedu Seeds Limited	31.10.2025
204	Vegetable Seedline Pusa Parthenocarpic, Cucumber-6	Nuziveedu Seeds Limited	31.10.2025
205	Cucumber line DPaC-41)	Nuziveedu Seeds Limited	31.10.2025
206	Cucumber Cucumber line DG 303 (Gynoecious)	Nuziveedu Seeds Limited	31.10.2025
207	Cucumber line DPaC-43	Nuziveedu Seeds Limited	31.10.2025
208	Pusa chickpea 4035 (BG 4035)	Gold Vasundhara Seeds	03.11.2025
209	PM 37	Gold Vasundhara Seeds	03.11.2025
210	Pusa Manav	Gold Vasundhara Seeds	03.11.2025
211	HD 3386	Ashoka Hybrid Seeds	03.11.2025
212	HD 3386	Prakash Hybrid Seed Co.	03.11.2025
213	HD 3386	Shri Ram Agritech India	03.11.2025
214	Pusa Manav	Trimurti Krishi Abhikaran	03.11.2025
215	HD 3086	Tej Genetics Seeds	03.11.2025
216	HD 3386	Tej Genetics Seeds	03.11.2025
217	HD 3386	Surya Seeds and Chemicals	03.11.2025
218	HD 3086	Surya Seeds and Chemicals	21.10.2025
219	Pusa chickpea 4035 (BG 4035)	K.D. Beej Utpadak Sahkari Santha Maryadit	06.11.2025
220	Pusa Manav	K.D. Beej Utpadak Sahkari Santha Maryadit	06.11.2025
221	HD 3386	Indian Farm Forestry Development Co-op Ltd.	06.11.2025
222	Pusa Biofortified Maize Hybrid 3	Ecozea India Pvt Ltd	10.11.2025
223	Pusa chickpea 4035 (BG 4035)	Sunita Krishi Seeds	09.11.205
224	Pusa Manav	Sunita Krishi Seeds	09.11.2025
225	HD 3386	Deep Seeds	12.11.2025
226	Onion c.v. Pusa Red	Premium Onion Growers Farmer's Producer Company Ltd	19.11.2025
227	Sprayable biopolymeric nano-conjugated double- stranded RNA formulation for in-planta systemic protection against thrips	ATGC Biotech Private Limited	18.11.2025
228	Pusa Manav	Bapna Sahab Beej Utpadak Co-operative Limited	27.11.2025
229	HD 3388	Basudha Seeds	27.11.2025
230	HI 1650	Radhey Seeds	03.12.2025

S. No.	Name of Technology	Name of Industry	Commercialization Date
231	Onion c.v. Pusa Red	Godapravara Farmer Producer Company Limited	08.12.2025
232	Radish c.v. Pusa Chetki	GPS Hybrid Seeds Pvt	08.12.2025
233	Pusa Manav	Shreebalram Agro Farmers Producer Company Limited	09.12.2025
234	Pusa Manav	Siddhi Laxmi Agrotech	09.12.2025
235	Pusa Biofortified Maize Hybrid 2	Hemtrix Agritech Private Limited	31.12.2025
236	HD 3386	Trimurti Plant Science Private Limited	23.12.2025
237	Pusa Parthenocarpic Cucumber Hybrid 2	Devkishanji Vaktaji And Sons	23.12.2025
238	Palak c.v. All Green	Gauri Shankar Natural Seeds	30.12.2025
239	Methi c.v. PEB	Gauri Shankar Natural Seeds	30.12.2025
240	HQPM 5 Improved	Hemtrix Agritech Pvt. Ltd.	31.12.2025

11.1.2 Commercialization of Technology/Products Division of Seed Science and Technology

- The *Grain*^{Ex} technology was commercialized in e-NAM, Merta, Rajasthan.
- The *Grain*^{Ex} technology was licensed to AgNext Company.

11.2 CORPORATE MEMBERSHIP

To foster strong, meaningful partnerships with industry and commercial enterprises for effective dissemination of IARI varieties and technologies towards benefitting farmers and society, the ZTM & BPD Unit offers Corporate Membership as a collaboration model. In 2025, the Unit enrolled 41 new industry partners and renewed memberships of 118 existing partners, generating total revenue of ₹7,85,500.

11.3 INTELLECTUAL PROPERTY RIGHTS

11.3.1 Intellectual Property Rights from ZTM & BPD Unit

IPRs	Application No.	Name of Innovation	Date of Filing
Patents Filed	202511000644	Multimodal Drone-Assisted Spray Formulation	03.01.2025
	202511002330	System and Method for Testing Seed Viability & Vigour	10.01.2025
	202511029072	Solar Powered Variable Swath Herbicide Applicator Robot for Agricultural Application	27.03.2025
	202511034700	Agathis flavone-enriched Antiviral Formulation for Begomovirus Disease Management & Method of Application Thereof	09.04.2025
	202511068688	Method for the Conversion of Starch to Resistant Starch	18.07.2025
	202511073344	Sprayable Biopolymeric Nano-Conjugated Double-Stranded RNA Formulation for In-Planta Systemic Protection Against Thrips	01.08.2025
	202511074737	A Telerobotic Seed Spices Crop Harvester	06.08.2025
	202511074738	Robotic Paddy Transplanter for Root Washed Seedlings	06.08.2025
	202511092493	Smart Phyto Farm System for High Density Crop Cultivation in Controlled Environments	26.09.2025

	202511100171	Method for Preparing Soil Conditioner Compositions Through Microbial & Mineral Valorization	16.10.2025
	202511100172	Silica Enriched Agri-Residue & Steel Slag Based Soil Conditioners & Method of Preparation	16.10.2025
	202511100173	Steel Slag-Based Soil Conditioner Compositions for Acidic Soil Reclamation & Heavy-Metal	16.10.2025
	202511102517	Low Calories Ultrasonicated Aonla Candy & Method of Preparation Thereof	24.10.2025
	202511111417	Quick Reagent Strip Method: A novel and rapid method for detection and quantification of pullulanase activity"	14.11.2025

IPRs	Application No.	Name of Innovation	Date of Filing	Date of Grant
Patents Granted	201711009555	A Semi-Synthetic Diet for Mass Rearing Five Species of Genus Bactrocera (Insecta: Diptera: Tephritidae) of Agricultural and Quarantine Significance	March 2017	24.04.2025
	202011024290	A Microcontroller Based Real Time Data Acquisition System Integrated Solar Dryer	June 2020	01.05.2025

IPRs	Diary No.	Name of Work	Kind of work	Date of Filing
Copyrights Filed	5439/2025-CO/SW	Indian Plusiinae: A Taxonomic Database for Looper Moths	Computer software	17.02.2025
	6820/2025-CO/SW	Indian Tortricidae: An Online Taxonomic Database	Computer software	17.02.2025
	SW-16718/2025-CO	Decision Support System on Soil Organic Carbon-based Soil Quality Assessment	Computer software	25.04.2025
	SW-16717/2025-CO	Decision Support System for Online Assessment of Soil Health	Computer software	25.04.2025
	SW-32355/2025-CO	Digital Surveillance System (App) for Monitoring Leaf Curl Disease in Chilli	Computer software	12.08.2025
	SW-30720/2025-CO	Weed Indices- an R Package to Calculate 11 Different Weed Indices	Computer software	01.08.2025
	SW-35078/2025-CO	Nema Omics	Computer software	01.09.2025
	LD-37199/2025-CO	कृषि पोषक	Literary Work	15.09.2025
	LD-37209/2025-CO	Policy Brief: Accelerating Information Dissemination Through social media Led Multimedia Based Extension	Literary Work	15.09.2025
	LD-37220/2025-CO	Technical Writing & Communication Skills	Literary Work	15.09.2025
	LD-36122/2025-CO	Agri-Nutri Information: A Ready Reference	Literary Work	08.09.2025
	SW-43955/2025-CO	Code for the AI-based Brinjal Detection System	Computer software	30.09.2025
	LD-46206/2025-CO	Agri - Nutri Meter	Literary Work	10.11.2025
	LD-46706/2025-CO	Agri Nutri Pocket Diary	Literary Work	12.11.2025
	SW-50316/2025-CO	SeedliMorphX: Image Based Seedling Morphometric Analysis Tool (v1.0.0)	Computer Software	03.12.2025
	SW-50323/2025-CO	lPantESdb: Plant Environment Stress-Responsive Gene Database	Computer Software	03.12.2025

IPRs	Diary No.	Name of Work	Kind of Work	Date of Filing and Registration
Copyrights Registered	20789/2024-C0/L	Wings of Agri Innovate Book	Literary	Filed on June, 2024 Registered on 04.02.2025
	20809/2024-CO/L	Startup Book	Literary	Filed on 28.06.2024 Registered in February, 2025
	33743/2024-CO/SW	Algorithm on Maturity Detection of Tomatoes	Computer Software	Filed on 25.10.2024 Registered in January, 2025
	SW-16718/2025-CO	Decision Support System on Soil Organic Carbon-based Soil Quality Assessment	Computer software	Filed on 25.04.2025 Registered on 08.08. 2025

IPRs	Application No.	Name/ Mark/ Class	Date of Filing	Date of Registration
Trademarks Filed	7048404	Divine Silk; Wordmark; Class 30	06.06.2025	-
	12490992	Divine Dough	06.06.2025	-

IPRs	Application No.	Name/ Mark/ Class	Date of Filing	Date of Registration
Trademarks Granted	5481691	BEEJ; Wordmark; Class 42	09.06.2022	31.05.2025
	5481692	PUSA KRISHI; Wordmark; Class 35	09.06.2022	24.09.2025
	5481694	PUSA KRISHI; Wordmark; Class 42	09.06.2022	14.06.2025
	5481696	ARISE; Devicemark; Class 42	09.06.2022	23.01.2025
	5481698	ARISE; Devicemark; Class 35	09.06.2022	31.03.2025
	5481704	UPJA; Devicemark; Class 35	09.06.2022	26.09.2025
	5481705	UPJA; Devicemark; Class 42	09.06.2022	26.07.2025
	5481706	AGRIINDIA HACKTHON; Devicemark; Class 42	09.06.2022	16.07.2025
	5481711	SHITIJ; Devicemark; Class 35	09.06.2022	13.01.2025
	5481712	BEEJ; Devicemark; Class 41	09.06.2022	20.06.2025
	5481714	BEEJ; Devicemark; Class 42	09.06.2022	21.08.2025
	6354487	PUSABEEJ; Devicemark; Class31, 35 and 42	19.03.2024	15.01.2025

11.3.2 Intellectual Property Rights from Divisions

11.3.2.1 Division of Genetics

IPR	PPVFRA Variety	Details	Date of registration
1.	Pusa HM4 Male Sterile Baby Corn-2 (ABSH4-2)	REG/2025/0534	04.12.2025
2.	Pusa Popcorn Hybrid-1 (APCH-2)	REG/2025/0535	04.12.2025
3.	Pusa Popcorn Hybrid-2 (APCH-3)	REG/2025/0536	04.12.2025
4.	Pusa Biofortified Maize Hybrid-5 (APTQH-5)	REG/2025/0537	04.12.2025
5.	Pusa Arhar 16	REG/2025/0084	06.05.2025
6.	Pusa Arhar 2017-1	REG/2025/0082	06.05.2025
7.	Pusa Arhar 2018-4	REG/2025/0081	06.05.2025
8.	Pusa Arhar Hybrid 5	REG/2025/0083	06.05.2025

11.4 INCUBATION ACTIVITIES

11.4.1 UPJA & ARISE 2025

UPJA 2025 (Seed Stage) and ARISE 2025 (Pre-Seed Stage) incubation programs were launched on April 1, 2025, to support innovation and entrepreneurship in India's agri-startup ecosystem.

This year, over 1600 applications were received under both the programs. From June 16 to July 15, 2025, 114 selected startups underwent a one-month training and mentoring phase. During this period, they received comprehensive support, including technical mentoring and validation, financial management, IP management, industry connections, business mentoring, pilot opportunities, investment facilitation and guidance for building a sustainable business. Following this training, the RAFTAAR Incubation Committee (RIC) meeting was held from July 24 to August 1, 2025, to select pre seed stage and seed stage startups for further rounds. Soon after that the Selection & Investment Committee (SIC) was conducted from August 11-14, 2025, to make final recommendations for funding these startups. This year, a total of 44 startups have been selected for the grant under UPJA, ARISE and Student category. A MoU was signed with these startups on November 6, 2025 at Pusa Krishi, ZTM & BPD office.

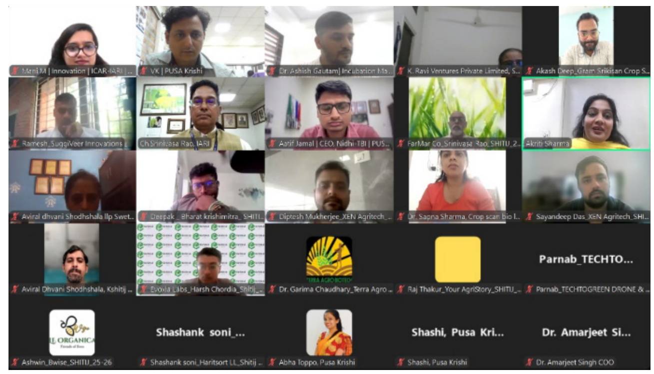
UPJA & ARISE 2025 MoU signing ceremony

11.4.2 SHITIJ 2025

SHITIJ 2025, an innovative year-long incubation program, was launched on August 29, 2025 with the aim of transforming Indian agriculture and fostering startup engagement in the sector. The program is basically divided into two phases:

- Phase 1: Technical + Business Mentorship (15-Day Extensive Training & Mentoring Program)
- Phase 2: 4 months primer (Learning + Technical Sessions) (1-Year Incubation Program)

This year, 47 startups were selected for Phase I training that covered key topics like pitching, funding, branding, startup compliance, IPR and business strategy etc. Subsequently, 12 startups progressed to Phase II, which included focused one-on-one mentoring sessions with finance and marketing experts to improve their investment and market readiness.



SHITIJ 2025, an innovative incubation program

11.4.3 HDFC Startup Parivartan Initiative

Pusa Krishi, ICAR–IARI, entered into a strategic collaboration with HDFC Bank under its CSR flagship initiative, Startup Parivartan, to support high-potential agri-startups through structured acceleration and financial assistance. The MoU was signed on February 24, 2025 during the Pusa *Krishi Vigyan Mela* 2025 by Dr. Ch. Srinivasa Rao, Director, ICAR-IARI and Mr. Harmanpreet Singh Khanna, Head – Strategic Affairs & Government, HDFC Bank. Under this initiative, ₹1.49 crore was allocated to Pusa Krishi, out of which ₹1.267 crore was disbursed as grant-in-aid to five selected agri-startups, while the remaining funds supported outreach, evaluation and capacity-building activities. To ensure wide participation, Pusa Krishi implemented a comprehensive ATL and BTL outreach campaign, including live bootcamps at Udhmodya Foundation (Delhi University Incubator), ANDC Instart Startup Incubator, and Aspirelabs Accelerator, along with print advertisements in Hindustan Times, Dainik Jagran and The Times of India, supported by targeted digital campaigns. These efforts resulted in 656 applications received from across India. It was followed by a rigorous three-stage evaluation process jointly conducted by Pusa Krishi, HDFC Bank and domain experts, leading to the selection of five innovative startups based on technology novelty, business viability, scalability and farmer-level impact. The initiative featured a three-day Startup Capacity Building Program (March 17–19, 2025), including the UK–India Agri-Tech Event in collaboration with the British High Commission, expert session with Mr. Ashish Bhargava, Ex-Partner, True North Co. on investment, fund raising and scalability at ICAR-IARI and a Startup–Farmers Meet for direct farmer engagement and on-ground validation. Additionally, startups were supported to showcase their innovations at Startup Mahakumbh 2025 (April 3–5, 2025), enhancing market visibility, product demonstrations and marketing activities.

ICAR–IARI collaboration with HDFC Bank under CSR flagship initiative

11.4.4 MAITRI 2.0: India-Brazil Cross-border Agri-Tech Incubators' Program

In a strategic effort to strengthen international collaboration in agri-tech innovation, Pusa Krishi, IARI, along with IP&TM, ICAR, hosted MAITRI 2.0: India–Brazil Cross-Border Agri-Tech Incubators' Program from 22–26 September 2025. Building on MAITRI 1.0 (2019-2020), the week-long engagement brought together incubator leaders, startups, ecosystem stakeholders and policymakers from both countries to move beyond relationship-building toward institutional action, co-learning and co-development. With a focused emphasis on agri-incubators as key drivers of innovation, the program enabled knowledge exchange, sharing of best practices and deeper bilateral cooperation between Indian and Brazilian incubation ecosystems.

MAITRI 2.0: India-Brazil Incubators' Program

11.4.5 PUSA Krishi Masterclass Series for RABI Startups

The PUSA Krishi Masterclass Series for RABI Startups, organized under the RKVY-RAFTAAR scheme of the Ministry of Agriculture & Farmers' Welfare, was conducted online from April 3-16, 2025. This ten-day intensive virtual workshop was specially curated for SIC-recommended startups (pre-seed and seed stage) incubated under nine RAFTAAR Agri Business Incubators (RABIs) of North zone. The initiative marked a key milestone in fostering innovation, business preparedness and entrepreneurial growth within the agri-startup ecosystem. Designed as a focused three-week program, the Masterclass series aimed to empower early-stage startups with strategic knowledge, actionable insights and expert mentorship essential for scaling sustainable agri-businesses.

PUSA Krishi Masterclass Series

11.5 MoUs/AGREEMENTS SIGNED

11.5.1 MoU with ACCESS Development Services

In a significant step towards fostering innovation and entrepreneurship in Indian agriculture, Pusa Krishi signed an MoU with ACCESS Development Services on June 16, 2025. This collaboration aims to support startups working across agroecological value chains under the Green and Resilient Agri-Enterprises Platform (GAP) Fund, an initiative supported by the International Fund for Agricultural Development (IFAD).

MoU with ACCESS Development Services

11.5.2 MoU with CSIR–CSIO, Chandigarh

Indian Council of Agricultural Research has signed a Memorandum of Understanding with CSIR–Central Scientific Instruments Organisation (CSIO), Chandigarh, on June 27, 2025, to foster collaborative research in cutting-edge agri-tech innovations.

11.5.3 MOU's with the Industry

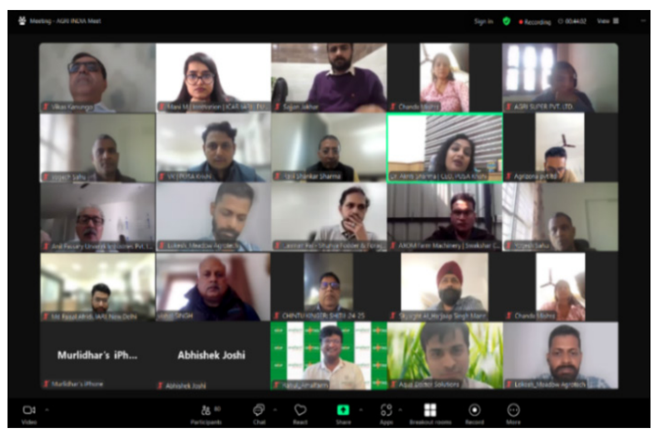
(1) Memorandum of understanding between ICAR-IARI and Coromandel International Limited was signed on 24 March, 2025 to undertake a CRP during 2025-2026 to assess the effectiveness of foliar applied nano-urea and nano-DAP. (PI: Dr Manoj Shrivastava; Associates: Dr's Bhupinder Singh and Renu Singh).

(2) Memorandum of understanding between ICAR-IARI and Arcelor Mittal Nippon Steel India Limited, Hyderabad was signed on 2.9.24 to undertake CRP during 2024-2025 on 'Characterization of iron ore tailings and assessing its suitability for agricultural application'. (PI: Dr Bhupinder Singh; Associates: Dr's Chandan Kumar Gupta and Shiv Prasad).

11.6 OTHER ACTIVITIES

11.6.1 Agri India Meet 2025

The fifth edition of the Agri India Meet (AIM 5.0), themed "Revolutionizing Agri-Commerce: Leveraging Digital Platforms for Inclusive Growth," was hosted by Pusa Krishi on February 13, 2025. The event aimed to foster insightful discussions on pressing agricultural issues, provide actionable insights and create collaborative opportunities to drive sectoral progress. With over 100 participants, the virtual format ensured broad accessibility, transcending geographical boundaries and maximizing participation. As the agricultural landscape continues to evolve, AIM 5.0 proved to be a vital platform for stakeholders across the agri and allied sectors to come together, share ideas and strategize sustainable growth, enhancing resilience within the startup ecosystem.



Agri India Meet (AIM 5.0)

12. LINKAGES AND COLLABORATION

The Indian Agricultural Research Institute has linkages with various National and International Institutes/Organizations. At the national level, the Institute has close linkages with almost all Agricultural Sciences Research Institutes, Centers, Project Directorates, and Coordinated Projects, as well as a few other selected Institutes of the ICAR. Similar linkages exist for Natural Resource and Socio-economic Research Institutes. Collaboration exists with almost all State Agricultural Universities (SAUs), selected conventional universities, several of the institutes of the CSIR and departments of the Ministry of Science and Technology such as the Department of Biotechnology, Space Research, Meteorology, and several other ministries/departments/organizations/banks of the Government of India, besides some private organizations/banks.

IARI is the lead center to coordinate the accelerated crop improvement program for breeding rust-resistant wheat varieties involving 10 centers, improving maize quality, and enabling several SAUs and ICAR institutes to upgrade and update themselves with new tools and techniques. Under the NAIP and NASF, IARI is the lead center to develop state-of-the-art facilities and infrastructure for food science and phenomics-led sciences.

In lieu with the consortia mode of the project of ICAR, the Institute has been encouraging linkages and professional collaborations among national institutes to work on major research focus on 'Molecular breeding' for improvement of tolerance to biotic and abiotic stress, yield and quality traits in crops, and 'Hybrid technology' for higher productivity in selected field and horticultural crops. The Institute is leading ICAR-Genome editing program with 23 ICAR institutes as partners. The Institute also identified some of the priority research areas through other ICAR Consortium Research Platforms as Mega Seed platform, Genomics platform, Diagnostic and Vaccines, Energy platform, Water platform, Conservation Agriculture platform, Farm mechanization and Precision farming, etc.

In the public-private partnership mode, the role and participation of the private sector in agricultural services are increasing in different forms and capacities. This underlines the need to ensure effective public-private partnerships and linkages besides improving the institutions' structural and operational efficiency and governance to make them farmer-friendly. Keeping this in mind, the Institute has planned to forge collaboration with some of the private seed sector, which has a strong R&D base and expertise in seed quality enhancement, as well as with advanced research centers in other countries.

The Institute has extended liaison with private companies for commercialization of its technologies. Many IARI technologies with private and public enterprises have been commercialized.

The linkage system is being studied for strengthening extension under IARI-NGO Partnership programme as well. Linkage with post offices as a new extension model was developed by IARI. The IARI has initiated an innovative extension program for technology dissemination in partnership with selected NGOs for feasibility trials and promotion of agricultural technologies in their operational areas.

The Institute is playing a very important role in institution building in Afghan National University of Agricultural Sciences and Technology, Afghanistan. Further linkages extend towards establishment of IARI off-campus in selected ICAR Institutes. The classic examples are PhD programmes in IIHR, Bangalore and CIAE, Bhopal. The Institute is helping establish two IARI-like Institutions of excellence in Jharkhand and Assam. Students are being admitted to these institutions, namely, M.Sc. at IARI-Assam and IARI–Jharkhand in five disciplines *viz*., Agronomy, Genetics, Soil Science & Agricultural Chemistry, Vegetable Science, and Water Science & Technology from the academic year 2015-16.

In the arena of training, the centers of excellence at IARI have established linkages with different national institutions through their regular training programs and also through other programs offered through the Centre of Advanced Faculty Training.

At the international level, the Institute has close linkages with some of the CGIAR's International Agricultural Research Centers (IARCs), *viz*., ICRISAT, CIMMYT, IRRI and ICARDA. It also has linkages with other international organizations, *viz*., FAO, IAEA, USAID, UNDP, WMO, UNIDO and UNEP. Several bilateral research linkages involving developed and developing countries also exist. These include linkages with USDA, selected universities in USA, Canada, Australia, World Bank, Rockefeller Foundation, Bill & Melinda Gates Foundation, European Commission, JAICA, JIRC, JSPS, ACIAR, AVRDC (Taiwan), etc.

The number of externally funded projects in operation during the period from January 01- December 31, 2025 is given below:

Name of Funding Agency	Number of Projects
Within India	
1. Department of Biotechnology (DBT)	
2. Department of Science & Technology (DST)	
3. National Committee Plasticulture Application in Horticulture (NCPAH)	
4. Council of Scientific and Industrial Research (CSIR)	
5. Department of Agriculture and Cooperation (DAC)	
6. Indian Meteorological Department (IMD)	
7. Board of Research in Nuclear Sciences (BRNS)	
8. Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA)	
9. Ministry of Human Resource and Development (MHRD)	
10. UP Council of Agricultural Research (UPCAR)	
11. Rashtriya Krishi Vikas Yojna (RKVY)	
12. Defense Research & Development Organization (DRDO)	226
13. Department of Scientific and Industrial Research (DSIR)	
14. Central Pulp and Paper Research Institute (CPPRI)	
15. Central Council for Research in Ayurvedic Sciences (CCRAS)	
16. Ministry of Agriculture & Farmers Welfare (MoAFW)	
17. National Horticulture Board (NHB)	
18. Rashtriya Uchattar Shiksha Abhiyan (RUSA)	
19. Ministry of Environmental Forest & Climate Change (MoEFCC)	
20. Department of Environment Science & Technology (DEST)	
21. Central Sericulture Research Board (CSRB)	
22. Central Council for Research in Homeopathy (CCRH)	
23. Indian Institute of Technology, Kharagpur (IIT)	

Name of Funding Agency	Number of Projects
24. Indian Council of Agricultural Research (ICAR) 25. Indian Council of Medical Research (ICMR) 26. Ministry of Jal Shakti 27. Indian Space Research Organization (ISRO) 28. S & M Sehgal Foundation 29. Indian Institute of Technology (IIT), Kharagpur 30. National Bee Board (NBB) 31. Birla Institute of Technology & Science (BITS), Pilani 32. National Thermal Power Corporation (NTPC)	
Outside India 1. Gates Foundation USA 2. UK Department of International Development (DFID) 3. Borlaug Institute of South Asia (BISA)-Japan International Cooperation Agency (JICA) 4. Borlaug Institute of South Asia (BISA) 5. ICAR-International Rice Research Institute (IRRI) 6. United Kingdom Research & Innovation (UKRI) 7. International Center for Agricultural Research in the Dry Areas (ICARDA) 8. SPUN, USA 9. Centre for Agriculture and Bioscience International (CABI), United Kingdom 10. Heinrich Heine University (HHU), Germany 11. CIMMYT, Mexico 12. International Fertilizer Development Centre (IFDC), USA	15
Total	**241**

13. AWARDS AND RECOGNITIONS

Name of Stablishment	Award / Recognition
ICAR-IARI	• उत्कृष्ट राजभाषा कार्यान्वयन पुरस्कार
Pusa Taksay - Pusa Krishi, ICAR-IARI	• Bharat Incubator Award 2025 • National Intellectual Property Award 2025 under the category *"Best Incubator for Nurturing IP"*
Dr. Ch. Srinivasa Rao Director, ICAR-IARI	• *Vividhlaxi Audyogik Samshodhan Vikas Kendra* (VASVIK) Award 2025
Dr. Viswanathan C. Joint Director (Research)	• Fellowship of NASI • NAAS Recognition Award, 2025
Dr. Anupama Singh, Joint Director (Education) & Dean	• INSA Women Associateship Pioneer Batch 2025
Name of Scientist	**Award / Recognition**
Division of Genetics	
Dr. D. Singh, PS	• NAAS Fellow
Dr. Niharika Mallick, SS	• NAAS Associate
Dr. Vignesh Muthusamy, SS	• NAAS Fellowship • Dr HK Jain Memorial Young Scientist Award 2025 • Japan International Award for Young Agricultural Researchers (Japan Award)-2025 • ISGPB- Joginder Singh Memorial Award 2025
Dr. H.K. Dikshit, PS Dr. D. Singh, PS Dr. G.P. Mishra, PS Dr. M. Aski, SS Dr. Soma Gupta, S	• Best Centre award 2024 by IIPR and AICRP MULLARP
Dr. Prashanth Babu H., SS	• ISGPB Fellow
Dr. Mallikarjun M., SS	• ISGPB Fellow
Dr. Ranjith Kumar Ellur, SS	• ISGPB Fellow
Dr. Haritha Bollinedi, S, Genetics	• Dr. M. S. Swaminathan Women Scientist Award by ISGPB
Division of Seed Science and Technology	
Dr. Gyan Prakash Mishra, PS & Head	• 28th Hooker Award, 2025 • NAAS Recognition Award by NAAS, New Delhi • 5th Dr. PN Bahl Award
Division of Vegetable Science	
Dr. Arpita Srivastava, SS	• Fellow of Society for Plant Research
Division of Fruits & Horticultural Technology	
Dr. O.P. Awasthi, PS & Head	• Girdhari Lal Chadha Award in Fruit Science • Fellow of Confederation of Horticultural Association of India, New Delhi
Dr. Kanhaiya Singh, PS	• Best Research Paper Award, Indian Academy of Horticultural Sciences
Dr. R. M. Sharma, PS	• Fellow of the Indian Society of Citriculture • Member, GIR - GI Application Summary Report Consultative Group, GoI

Name of Scientist	Award / Recognition
Dr. N. V. Singh, PS	• HP Singh Young Scientist Award of Excellence-2025
Dr. A.K. Goswami, SS	• D.P Ghosh Young Scientist Award -2025 by IAHS, New Delhi
Division of Floriculture & Landscaping	
Dr. Markandey Singh, PS & Head	• LOTUS Award of Indian Society of Ornamental Horticulture
Dr. Reeta Bhatia Dey, PS	• Fellow, Indian Academy of Horticultural Sciences
Dr. Namita, PS	• Fellow, Indian Academy of Horticultural Sciences
Division of Food Science and Postharvest Technology	
Dr. Alka Joshi, SS	• *Pusa Vishisht Pravakta* Award • Technology on 'Antioxidant Rich Papaya Candy' selected by Agrinnovate India and Kerala Startup Mission under the Branding Challenge 2.0 among the top two entries having commercial potential
Division of Agronomy	
Dr. Subhash Babu, SS	• Fellow, NAAS • Member NASI
Dr. Rajiv Kumar Singh, PS	• ISA-Gold Medal
Dr. Mona Nagargade, S	• ISA-P.S. Deshmukh Young Agronomist Award
Dr. S.L. Meena, PS	• ISA-Fellow
Division of Soil Science and Agricultural Chemistry	
Dr. Debashis Mandal, PS & Head	• NAAS Fellow
Dr. M.C. Meena, PS	• Fellow, National Academy of Biological Sciences (NABS), Chennai
Division of Microbiology	
Dr. Pranita Jaiswal, PS	• FSSAI Scientific Panel Member
Division of Agricultural Engineering	
Dr. R. Pandiselvam, Senior Scientist	• *Rashtriya Krishi Vigyan Puraskar* (Outstanding Young Scientist), Indian Council of Agricultural Research (ICAR) • Shri Nilesh Patel (N.K. Proteins) Innovation Award by The Solvent Extractors' Association of India (SEA) • Commendation Medal for Professional Achievements (2025), Indian Society of Agricultural Engineers (ISAE)
Dr. Roaf Ahmad Parray, S	• Outstanding Young Researcher Award (2025) from Asian Association for Agricultural Engineering
Division of Environmental Sciences	
Dr. Arti Bhatia, PS	• Certificate of recognition from United Nations Framework Convention on Climate Change for completing training programme for technical expert review of national inventory reports of LULUCF sector and country adaptation reports for the enhanced transparency framework under the Paris Agreement
Dr. Manoj Shrivastava, PS	• Dr. J.S.P. Yadav Memorial Award for Excellence in Soil Science by Indian Society of Soil Science
Dr. Niveta Jain, PS	• IPCC Lead Author • UNFCC certifid reviewer for GHG inventories • Member of Technical Committee for Net Zero Emission of India, MoEFCC, GoI • Member of Net Zero Emission of Agriculture Sector, Niti Aayog, GoI

Name of Scientist	Award / Recognition
Dr. Ranjan Bhattacharyya, PS	• Expert Member of ITPS, FAO • Fellow, Indian Society of Soil Science
Division of Plant Pathology	
Dr. V. Shanmugam, PS	• Fellow of Indian Society of Plant Pathologists (FINSOPP)-2025
Dr. Malkhan Singh Gurjar, SS	• Fellow of Indian Mycological Society, FIMS
Dr. Amalendu Ghosh, SS	• Fellow, NAAS, New Delhi
Dr. Bishnu Maya Bashyal, SS	• S. Sinha Memorial Award, 2024 by Indian Phytopathological Society
Division of Entomology	
Dr. Subramanian S., PS	• Elected Member of the National Academy of Sciences, India (NASI) • Best Teacher Award conferred by Entomological Society of India
Dr. P.R. Shashank, SS	• NAAS Associate • Member NASI • SBA–Dr. H. Nagaraja Memorial Award from the Society for Biocontrol Advancement
Dr. Suresh Nebapure, SS	• Kannan Nagarajan Award for Young Scientist 2024-25 by Prof TNA Foundation, Chennai.
Dr. Ramaiah Mogili, Scientist	• ESI-Best Ph.D. Thesis Award
Division of Nematology	
Dr. Vishal Singh Somvanshi, PS	• Fellow, Nematological Society of India
Division of Agricultural Chemicals	
Dr. Supradip Saha, PS	• NAAS Recognition Award
Division of Biochemistry	
Dr. Veda Krishnan, SS	• INSA-Woman Associate • IARI-Best Young Scientist Award (Female) • GYA Executive Member
Dr. Ranjeet R Kumar, PS	• Fellow Bihar Agricultural Science Academy (BASA)
Division of Plant Physiology	
Dr. Renu Pandey & Dr. Ruchi Bansal	• Shri Ram Puruskar for best Hindi Article by Fertiliser Association of India
Dr Anjali Anand	• IARI-Best Scientist for Institutional Services
Dr. Ruchi Bansal	• J. C. Bose Gold Medal Award by ISPP, New Delhi
Division of Agricultural Physics	
Dr. Rabi N Sahoo, PS	• Member, VAIBHAV Steering Committee for Vaibhav Research Fellow Program of DST • Area Review Panel (Agriculture, Veterinary Sciences and Aquaculture), BIRAC, DBT, Govt of India • BIRAC, DBT, Govt of India • Formulating SoPs for Application of Drone Technology in Fisheries and Aquaculture, NFDB, Dept of Fisheries, Ministry of Fisheries
Dr. Pragati Pramanik Maity, PS	• Visiting Faculty by Anusandhan National Research Foundation (ANRF) and Purdue University, West Lafayette, USA

Name of Scientist	Award / Recognition
Division of Agricultural Economics	
Dr. Praveen KV, SS	• IARI Young Social Scientist Award • Young Agricultural Economist Award of Agricultural Economics Research Association
Renjini V.R., Scientist	• N A Mujumdar prize for the best paper by Indian Society of Agricultural Economics, Mumbai
Asha Devi S.S., Scientist	• Best Research Article in Indian Journal of Dairy Science
Division of Agricultural Extension	
Dr. Satyapriya, PS & Head	• Fellow, Bihar Agricultural Science Academy
Dr. Girijesh Mahra, SS	• NABARD Researcher of the Year (2025) Award
Dr. Sujit Sarkar, SS	• NAAS Associate
Regional Station, Dharwad	
Dr. B. P. Mallikarjuna, S	• Young Scientist Award in the International Conference on Sustainable Innovations in Agriculture, Veterinary and Allied Sciences,organised by University of Agricultural Sciences, Raichur and National Agriculture Development Cooperative Ltd (NADCL)
Regional Station, Karnal	
Dr. Sandeep, S	• Best Young Scientist Award (Regional Station) for the year 2024-25 from IARI.
Regional Station, Karnal	
Dr. M.R. Dhiman, PS	• Best Floriculturist Award by the National Gladiolus Trust
Regional Station, Pune	
Dr. Savarni Tripathi, PS	• Member of the Accreditation Panel under NCS-TCP by the Department of Biotechnology, Govt. of India
Seed Processing Unit	
Dr. Gyanendra Singh, PS	• IARI-Best Scientist Award for Institutional Services
ZTM & BPD Unit	
Dr. Akriti Sharma, Scientist	• IARI-Best Scientist Award for Institutional Services

14. BUDGET ESTIMATES & UTILIZATION

(₹ In Lakhs)

S. No.	Head	B.E. 2025-26					R.E. 2025-26				
		Other than NEH & TSP	NEH	TSP	SCSP	Grand Total	Other than NEH & TSP	NEH	TSP	SCSP	Grand Total
1	2	3	4	5	6	7	8	9	10	11	12
Grants for creation of Capital Assets (CAPITAL)											
1	Works										
	A. Land										
	B. Building										
	i. Office Building	1621.80				**1621.80**	2006.80				**2006.80**
	ii. Residential Building	385.00				**385.00**	0.00				**0.00**
	iii. Minor Works	796.00				**796.00**	796.00				**796.00**
2	Equipments	600.80				**600.00**	600.00				**600**
3	Information Technology	158.00				**158.00**	158.00				**158.00**
4	Library Books and Journals	74.00				**74.00**	74.00				**74.00**
5	Vehicles & Vessels	0.00				**0.00**	0.00				**0.00**
6	Livestock	3.00				**3.00**	3.00				**3.00**
7	Furniture & fixtures	0.00				**0.00**	0.00				**0.00**
A	**Total – CAPITAL (Grants for creation of Capital Assets)**	**3637.80**	**12.00**	**44.40**	**354.71**	**4048.91**	**3637.80**	**12.00**	**44.40**	**354.71**	**4048.91**
	Grants in Aid - Salaries (REVENUE)										
1	Establishment Expenses										
	Salaries										
	i. Establishment Charges	26100.00				26100.00	26100.00				26100.00
	ii. Wages	0.00									

	iii. Overtime Allowance	0.00									
	Total – Establishment Expenses (Grant in Aid - Salaries)	**26100.00**				**26100.00**	**26100.00**				**26100.00**
Grants in Aid - General (REVENUE)											
1	**Pension & Other Retirement Benefits**	27000.00				**27000.00**	27000.00				**27000.00**
2	**Traveling Allowance**										
	A. Domestic TA/ Transfer TA	154.00				**154.00**	154.00				**154.00**
	B. Foreign TA	0.00				**0.00**	0.00				**0.00**
	Total-Traveling Allowance	**154.00**				**154.00**	**154.00**				**154.00**
3	**Research & Operational Expenses**										
	A. Research Expenses	1014.00				**1014.00**	1014.00				**1014.00**
	B. Operational Expenses	1284.00				**1284.00**	1284.00				**1284.00**
	Total - Research & Operational Expenses	**2298.00**				**2298.00**	**2298.00**				**2298.00**
4	**Administrative Expenses**										
	A. Infrastructure	3546.67				3546.67	3046.67				3046.67
	B. Communication	41.00				41.00	21.00				21.00
	C. Repairs & Maintenance	0.00				0.00	0.00				0.00
	i. Equipments, Vehicles & Others	331.00				331.00	331.00				331.00
	ii. Office building	773.00				773.00	773.00				773.00
	iii. Residential building	408.00				408.00	408.00				408.00
	iv. Minor Works	207.00				207.00	207.00				207.00
	D. Others (excluding TA)	715.00				715.00	935.00				935.00
	Total - Administrative Expenses	**6021.67**				**6021.67**	**5721.67**				**5721.67**

5	**Miscellaneous Expenses**										
	A. HRD	122.00				122.00	22.00				22.00
	B. Other Items (Fellowships, Scholarships etc.)	1355.00				1355.00	1755.00				1755.00
	C. Publicity & Exhibitions	239.00				239.00	139.00				139.00
	D. Guest House – Maintenance	0.00				0.00	137.02				137.02
	E. Other Miscellaneous	224.00				224.00	224.00				224.00
	Total - Miscellaneous Expenses	**1940.00**				**1940.00**	**2277.02**				**2277.02**
	Total Grant in Aid-General	**10413.67**	**603.03**	**250.00**	**1050.00**	**12316.70**	**10450.69**	**647.63**	**325.00**	**1119.16**	**12541.79**
	Total (Pension + General)	**37413.67**				**39316.70**	**37450.69**				**39541.79**
B	**Total Revenue (Grants in Aid - Salaries +Pension+ General)**	**63513.67**				**65416.70**	**63550.69**				**65641.79**
	Grand Total (Capital + Revenue)	**67151.47**				**69465.61**	**67188.49**				**69690.70**

	Grand Total (Capital +General)	**14051.47**	**615.03**	**294.40**	**1404.71**	**16365.61**	**14088.49**	**659.63**	**369.40**	**1473.87**	**16591.39**

Note: Sub Head wise allocation under Revised Estimate 2025-26 is tentative and is subject to change based on final expenditure figures.

15. STAFF POSITION, APPOINTMENTS, PROMOTIONS AND TRANSFERS

(As on 31.12.2025)

Sl. No.	Category	No. of posts	
		Sanctioned	Filled
A.	**SCIENTIFIC STAFF**		
1)	Research Management Personnel	05	05
2)	Principal Scientist	61	43
3)	Senior Scientist	128	83
4)	Scientist	373	288
	Total	**567**	**419**
B.	**TECHNICAL STAFF**		
1)	Category III	17	14
2)	Category II	268	122
3)	Category I	277	242
	Total	**562**	**378**
C.	**ADMINISTRATIVE STAFF**		
1)	Group A	30	24
2)	Group B	277	189
3)	Group C	110	59
	Total	**417**	**272**
D.	**SKILLED SUPPORT STAFF**	**730**	**282**
	Total	**2276**	**1351**

15.1 SCIENTIFIC STAFF

15.1.1 Appointment

Name of the Employee	Name of the Post	Place of Posting
Dr. Zakaullah Khan	Principal Scientist	IARI, New Delhi
Dr. Priya Ranjan Kumar	Principal Scientist	RS Pusa, Bihar
Dr. Aradhika Gupta	Senior Scientist	RS Katrain
Dr. Tamoghna Saha	Senior Scientist	RS Pusa, Bihar
Dr. Gurumurthy S.	Senior Scientist	RS Indore
Dr. Mrinmoy Ray	Senior Scientist	IARI, New Delhi
Dr. R. Pendiselvam	Senior Scientist	IARI, New Delhi
Dr. Prashant Vikram	Senior Scientist	IARI, New Delhi
Dr. Satheesh Naik SJ	Senior Scientist	RS, Pusa Bihar
Dr. Kingsly I.T.	Senior Scientist	IARI, New Delhi

Name of the Employee	Name of the Post	Place of Posting
Dr. Jairam Chaudhary	Scientist	IARI, New Delhi
Dr. Ashish Kumar Singh	Scientist	IARI, New Delhi
Dr. Ekta Narwal	Scientist	IARI, New Delhi
Dr. Gopal Krishnan R	Scientist	IARI, New Delhi
Dr. Prashant Vashisth	Scientist	IARI, New Delhi
Dr. Satyabrata Pradhan	Scientist	IARI, New Delhi
Dr. Ashok K.	Scientist	IARI, New Delhi
Dr. Ashwin Kumar Katral	Scientist	IARI, New Delhi
Dr. Pooja Devi	Scientist	RS Shimla
Dr. Pothiraj G	Scientist	RS Pune
Dr. Sunil Jadhav	Scientist	RS Indore
Dr. Priyanka Rahul Kodag	Scientist	IARI, New Delhi
Dr. Rakesh Kumar	Scientist	IARI, New Delhi
Dr. Harish Kumar H.R.	Scientist	IARI, New Delhi
Dr. Hem Lata	Scientist	RS Katrain
Dr. Jagadhesan	Scientist	IARI, New Delhi
Dr. Jagjeet Singh	Scientist	IARI, New Delhi
Dr. Priyanka M	Scientist	IARI, New Delhi
Dr. Smruti Ranjan Pradhan	Scientist	IARI, New Delhi
Dr. Sushmita Saini	Scientist	IARI, New Delhi
Dr. Vaisali C	Scientist	IARI, New Delhi
Dr. Warwate Sunil Inderjeet	Scientist	IARI, New Delhi

15.1.2 Promotions

Name of the Employee	Name of the Post	Post after Promotion
Dr. Nripendra Vikram Singh	Senior Scientist	Principal Scientist
Dr. Pragati Pramanik Maity	Senior Scientist	Principal Scientist
Dr. Namita	Senior Scientist	Principal Scientist
Dr. Dhara Singh Gurjar	Senior Scientist	Principal Scientist
Dr. Ranjeet Kumar Ranjan	Senior Scientist	Principal Scientist
Dr. Dibakar Mahanta	Senior Scientist	Principal Scientist
Dr. Ganpati Mukri	Scientist	Senior Scientist
Dr. Dr. Kiran B. Gaikwad	Scientist	Senior Scientist
Dr. M. Vignesh	Scientist	Senior Scientist
Dr. Dr. Rama Prashat G.	Scientist	Senior Scientist
Dr. Vishwanath Rohidas Yalamalle	Scientist	Senior Scientist
Dr. Sarvendra Kumar	Scientist	Senior Scientist
Dr. Amrita Das	Scientist	Senior Scientist
Dr. Raj Kumar Dhakar	Scientist	Senior Scientist
Dr. Pranjal Yadava	Scientist	Senior Scientist
Dr. Vikas Bamel	Scientist	Senior Scientist
Dr. Vinutha T.	Scientist	Senior Scientist
Dr. Shaloo	Scientist	Senior Scientist

15.2 TECHNICAL STAFF

15.2.1 Appointment

Name of the Employee	Name of the Post	Place of Posting	Date of Appointment
Sh. Sankalp Pandey	Technician (T-1)	RS Pune	12.02.2025
Sh. Vivek Kumar	Technician (T-1)	RS Wellington	13.02.2025
Sh. Kunal Tripathi	Technician (T-1)	RS Dharwad	19.03.2025
Sh. Dhiraj	Technician (T-1)	PME Cell	03.06.2025
Sh. Kush Kumar Meena	Technician (T-1)	Agricultural Economics	05.08.2025

15.2.2 Promotions

Name of the Employee	Name of the Post	Post after Promotion
Sh. Ram Narayan	MTS	Technician (T-1)
Sh. Bindeshwar Sahni	MTS	Technician (T-1)
Sh. Sukh Ram	MTS	Technician (T-1)
Sh. Ram Udgar Mahto	MTS	Technician (T-1)
Smt. Phool Kumari	MTS	Technician (T-1)
Sh. Ramesh Kumar	MTS	Technician (T-1)
Sh. Arun Kumar Rai	MTS	Technician (T-1)
Sh. Jay Kumar	MTS	Technician (T-1)
Sh. Sohan Lal	MTS	Technician (T-1)
Sh. Surender Rai	MTS	Technician (T-1)
Sh. Sanjay Kumar Mishra	MTS	Technician (T-1)
Sh. Anil Kumar Poddar	MTS	Technician (T-1)
Sh. Ram Singh	MTS	Technician (T-1)
Sh. Kapildeo Roy	MTS	Technician (T-1)
Sh. Bindeshwar Manjhi	MTS	Technician (T-1)
Sh. Saheb Ray	MTS	Technician (T-1)
Sh. Ramesh Rai	MTS	Technician (T-1)
Sh. Luder Chand	MTS	Technician (T-1)
Sh. Dhaneshwar Dass	MTS	Technician (T-1)
Sh. Sudesh Kumar	MTS	Technician (T-1)
Sh. Jamuna Prasad	MTS	Technician (T-1)
Sh. Mahender Shah	MTS	Technician (T-1)
Sh. Praveen Kumar	MTS	Technician (T-1)
Sh. Shiv Chander Prasad	MTS	Technician (T-1)
Sh. Puran Singh	MTS	Technician (T-1)
Sh. Ram Kumar	MTS	Technician (T-1)
Sh. Raghunath Maurya	MTS	Technician (T-1)
Sh. Mohamad Mumtaj	MTS	Technician (T-1)
Sh. Raj Krishna	MTS	Technician (T-1)
Sh. Chandramani	MTS	Technician (T-1)
Sh. Mohan Lal	MTS	Technician (T-1)

15.3 ADMINISTRATIVE STAFF

15.3.1 Appointments

Name of Employee	Post	Place of Posting
Sh. Amit	Assistant	P-II
Ms. Nisha	Assistant	Library
Ms. Jyoti	Assistant	PCA Section
Sh. Praveen Singh	Assistant	P-V Section
Ms. Vijaylaxmi Sharma	Assistant	Audit Wing
Sh. Abhishek Maurya	Assistant	Audit Wing
Sh. Neha Meena	Assistant	WTC
Sh. Narendra Kumar Meena	Assistant	P-I Section
Sh. Gaurav Chaudhary	Assistant	Environmental Science
Sh. Akshay Gandhi	Assistant	P-V Section
Sh. Ravi Prakash Tripathi	Assistant	PG School
Sh. Jagmeet Nagar	Assistant	Recruitment Cell
Sh. Priyanshu Pankaj	Assistant	E&P section

15.3.2 Promotions

Name of the Employee	Name of the post	Post after Promotion
Sh. Satya Prakash	AAO	AO
Sh. Kumud Kaushal	AAO	AO
Sh. Arun Kumar Tripathi	AAO	AO
Sh. Manish Kumar Bharti	Assistant	AAO
Smt. Shashikant Sinha	Assistant	AAO
Sh. Ratan Sen	Assistant	AAO
Sh. Raju	Assistant	AAO
Sh. Ashok Kumar	UDC	Assistant
Sh. Sita Ram Roy	UDC	Assistant
Sh. Rohit	LDC	UDC
Sh. Roshan Paswan	LDC	UDC
Sh. Dilip	LDC	UDC
Sh. Ram Bua Singh	LDC	UDC

16. POLICY DECISIONS AND ACTIVITIES UNDERTAKEN FOR THE BENEFIT OF DIFFERENTLY-ABLED PERSONS

16.1 POLICY DECISIONS FOR DIFFERENTLY-ABLED PERSONS

The decisions and activities undertaken for the benefit of the differently-abled persons are as follows:

- The benefits to the differently abled candidates in service matter as per the instructions of ICAR/DOPT. Govt. of India, as the case may be, is followed. Five per cent of the total number of seats in each scheme of admission open to Indian nationals are reserved for differently-abled candidates, subject to their being otherwise suitable as per the norms of ICAR/ Govt. of India.
- During 2025-26, 23 physically challenged students (4 UG, 7 M.Sc./M.Tech. and 12 Ph.D.) were admitted against the seats reserved for differently able candidates. However, in the event of there being no eligible, suitable differently-abled candidates in the earmarked discipline, such unfilled seats shall be transferred to other disciplines, where eligible differently-abled candidates are available to fill these seats.

16.2 NUMBER OF BENEFICIARIES AND THEIR PERCENTAGE IN RELATION TO THE TOTAL NUMBER OF BENEFICIARIES

The number of beneficiaries with disabilities and their percentage in relation to the total number of beneficiaries as on December 31, 2025, are as follows:

Category	Total number of beneficiaries	Number of beneficiaries with disability	Percentage (%)
Technical	378	07	1.85
Administrative	417	11	2.63
Skilled Support Staff	282	05	1.77

17. OFFICIAL LANGUAGE (RAJBHASHA) IMPLEMENTATION

Under Article 343 of the Constitution of India, Hindi has been accorded the status of the Official Language of the Union. In accordance with this constitutional provision, ICAR–Indian Agricultural Research Institute (ICAR-IARI) is continuously working towards increasing the use of Hindi in research, academic, extension, and administrative activities. The Institute remains committed to promoting Rajbhasha in both policy and practice.

17.1 ORGANIZATIONAL ARRANGEMENTS FOR PROMOTION OF RAJBHASHA

To ensure structured and effective implementation of the Official Language policy, ICAR–Indian Agricultural Research Institute has put in place a dedicated organizational framework through the constitution of an Official Language Implementation Committee. The Committee functions under the leadership of the Director and is responsible for ensuring compliance with the provisions of the Official Languages Act, 1963 and the Official Languages Rules, 1976.

The Committee was reconstituted with effect from December 13, 2024. Its membership comprises Joint Directors, PD (WTC), Heads of the Divisions of Seed Science and Technology, Agronomy, Floriculture and Landscaping, Fruit and Horticultural Technology, the Senior Comptroller, and the Hindi Translator as ex-officio members. The Deputy Director (Official Language) serves as the Member Secretary of the Committee.

During the period under report, the Committee met on a quarterly basis to review the status of Rajbhasha implementation and to issue necessary directions for increasing the use of Hindi in official correspondence, records, and institutional procedures. To facilitate effective follow-up and execution of the decisions taken, sub-groups were constituted in various Divisions, Regional Stations, and the Directorate.

In addition, under the leadership of the Director and the Joint Director (Education), an Official Language Lab is being developed at the Institute with the objective of imparting Hindi language training to students from non-Hindi backgrounds as well as to foreign students of IARI. This initiative aims to enhance linguistic inclusion and promote wider acceptance and practical use of Hindi within the academic community.

17.2 MONITORING AND EVALUATION OF HINDI USAGE

In line with the recommendations of the Committee and the objectives outlined in the Annual Programme of the Department of Official Language, Ministry of Home Affairs, Government of India, a monitoring mechanism was established through the constitution of an Official Language Inspection Committee. This Committee functioned under the chairmanship of Dr. Viswanathan Chinnusamy, Joint Director (Research) and Deputy Director (Official Language) as member secretary.

The Committee conducted inspections in regional stations, IARI Assam, IARI Jharkhand Divisions, Units, and in all Sections of the Directorate to assess the extent and quality of Hindi usage in official work. Based on these inspections, practical and constructive suggestions were provided to the concerned offices to strengthen compliance with Rajbhasha norms. Detailed inspection reports were submitted accordingly. During the period under review, 26 inspections were successfully conducted.

17.3 FOSTERING A CULTURE OF HINDI THROUGH AWARDS AND INCENTIVES

With a view to strengthening the use of Hindi as the Official Language, ICAR–Indian Agricultural Research

Institute implemented a range of award schemes and competitive initiatives during 2025. These initiatives were designed to motivate officers and staff to actively adopt Hindi in their day-to-day official work. The programmes received an encouraging response, with enthusiastic participation from employees across various categories, reflecting a growing institutional commitment towards Rajbhasha.

17.3.1 Recognition for Outstanding Official Work in Hindi

In line with the directives of the Department of Official Language, Ministry of Home Affairs, Government of India, an award scheme was implemented to recognize employees who demonstrated exemplary use of Hindi in official work throughout the year (2024–25). Under this scheme, cash awards were conferred to acknowledge consistent efforts and dedication.

1. **First Prize (₹5,000/- each)** was awarded to Mr. B.S. Rawat, PS, Publication unit and Mr. Sukhdev Singh, LDC, Division of Agriculture Engineering, for their exceptional contribution.
2. The **Second Prize (₹3,000/- each)** was awarded to Mrs. Madhu Bala, Assistant, Pay bill section; Mrs. Jannat, Assistant, Division of Biochemistry; and Mr. Sanjay Singh, UDC, The Graduate School.
3. The **Third Prize (₹2,000/-)** was awarded to Mrs. Inderjeet Kaur Sachdeva, PS, Economics Division

17.3.2 Encouraging Collective Excellence: Hindi Usage Competition

To promote teamwork and collective responsibility in the use of Hindi, the *Hindi Vyavahar Pratiyogita* was organized among Divisions, Sections, and Regional Stations of the Institute. Shields were awarded to units demonstrating outstanding performance in maximizing the use of Hindi during the year.

Based on the assessment carried out by an Evaluation Committee chaired by the Joint Director (Administration) and the Senior Registrar, WTC and the Division of Biochemistry were recognized as first and second, respectively, among the Divisions. The Pay Bill Section and the Estate & Protocol Section were awarded first and second, respectively, among the Units/Sections, while the Regional Station, Katrain and the Regional Station, Bihar, received accolades as first and second, respectively, among the Regional Stations.

17.3.3 Strengthening Grassroots Implementation: Best Rajbhasha Nodal Officer Award

To ensure effective implementation of *Rajbhasha* at the operational level, *Rajbhasha* Nodal Officers have been designated in all Divisions and Regional Stations. Recognizing their pivotal role, the *Best Rajbhasha Nodal Officer Award* was conferred on Dr. Swati Saha, Senior Scientist, Regional station, Pune and Dr. Madhu Patial, Senior Scientist, Regional station, Shimla for their commendable efforts in promoting and monitoring the use of Hindi. They were awarded a cash prize of ₹5,000/- jointly.

17.3.4 Promoting Hindi Dictation in Official Work

To further encourage the use of Hindi in official correspondence, the Institute implemented the incentive scheme of the Department of Official Language, Ministry of Home Affairs, Government of India, to promote Hindi dictation by officers. During the reporting period, Dr. Debashish Mandal, Head, Division of Soil Science and Agriculture Chemistry, and Dr. Aruna Tyagi, Head, Division of Biochemistry, were each awarded a cash prize of ₹2,500/- for their consistent efforts in encouraging Hindi dictation in official matters.

17.3.5 Awards for Popular Science Writing in Scientific Journals

To promote scientific communication and encourage researchers to disseminate scientific knowledge in an accessible manner, ICAR–IARI organized a 'Popular Science Writing Competition' for Scientists and Technical Officers of the Institute. The competition aimed to recognize high-quality popular science articles published in reputed journals. Under this initiative, First, Second, and Third Prizes of ₹7,000/-, ₹5,000/-, and ₹3,000/- respectively, along with three Incentive Awards of ₹2,000/- each, were awarded for outstanding contributions for the year 2024-25.

The First Prize was jointly awarded to Dr. Anchal Das, Principal Scientist, Dr. Shivadhar Mishra, Principal Scientist, and Dr. Ranbir Singh, ACTO, Division of Agronomy, for their article titled *"Floating Agriculture: A Climate-Smart Agricultural Technique."* The Second Prize was awarded to Dr. Ranbir Singh, ACTO, Division of Agronomy, for the article *"Smart Water Management,"* while Dr. Shivadhar Mishra, Dr. Ranbir Singh, and Dr. Gyan Prakash Mishra, Head, Division of Seed Science and Technology, were also recognized for their article *"Crop Biofortification through Agronomic Techniques."* The Third Prize was awarded to Dr. Chandu Singh, Seed Production Unit, and Dr. Ranbir Singh, ACTO, Division of Agronomy, for their article *"Artificial Seed Production Technology."* The First Incentive Award was conferred on Dr. Sanjay Singh Rathore, Head, Dr. Kapila Shekhawat, Principal Scientist, and Dr. Ranbir Singh for their article *"Smart Farming: A New Dimension of Modern Agriculture."* The Second Incentive Award was awarded to Dr. U.K. Behera, Retired Principal Scientist, Division of Environmental Sciences, Dr. Kapila Shekhawat, and Dr. Ranbir Singh for the article *"Self-Reliant India through Integrated Farming Systems."* The Third Incentive Award was conferred on Dr. Swati Saha, Senior Scientist, and Dr. K. Chandrashekhar, ICAR–IARI Regional Station, Pune, for their article *"Integrated Pest Management in Chilli Peppers."*

17.3.6 Dr. Ram Nath Singh Award for Original Book Writing - Biennial (2023-2025)

The Dr. Ramnath Singh *Puraskar* for Hindi Book Writing (biennial) was conferred to recognize outstanding contributions to scientific literature in Hindi. Carrying a cash prize of ₹10,000/-, the award for the reporting period was presented to Dr. Dilip Kumar Kushwaha, Scientist, and Dr. Pramod Sahoo, Head, Division of Agricultural Engineering, for their book entitled *"Agricultural Drone Technology: Principles and Applications"*.

17.3.7 *Pusa Vishisht Hindi Pravakta Puraskar* for Best Lecture

To recognize excellence in the use of Hindi during academic and training activities, the *Pusa Vishisht Hindi Pravakta Puraskar* was instituted for scientists delivering outstanding lectures in various training programmes. The award carries a cash prize of ₹10,000/-. During the reporting period 2024–25, this prestigious award was conferred upon Dr. Alka Joshi, Principal Scientist, Division of Fruit Science and Post-Harvest Technology, in recognition of her exemplary lectures delivered in Hindi during training programmes.

17.4 HINDI *CHETNA MAAS*

Hindi *Chetna Maas* was organized at ICAR–IARI to commemorate the declaration of Hindi as the Official Language of the Union of India on September 14,1949 and to promote awareness and usage of Hindi in official work. To motivate employees to adopt Rajbhasha, Hindi *Chetna Maas* was held from September 14 to October 13, 2025. The programme was inaugurated on September 14, 2025 with an Official Language Conference organized by the Official Language Section. During the observance period, a series of competitions were conducted, including a Hindi Language Knowledge Quiz for RA/SRF/JRF/YP/Project Assistant/Contractual Office Assistant/Contractual Stenographer, *Prashn-Manch*, extempore speech, picture-based story or poetry writing, dictation, noting and drafting, descriptive general knowledge competition for MTS staff, poetry recitation, Dictation, translation and Hindi typing. All competitions were successfully organized on scheduled dates and witnessed enthusiastic participation from the staff of the Institute Headquarters. In addition, several Divisions and Regional Centres of the Institute independently organized Hindi Day celebrations, competitions, and Hindi Fortnight programmes, further reinforcing the spirit and objectives of Hindi *Chetna Maas*. The month-long programme concluded on October 13, 2025 with a Hindi workshop.

Participants at the dictation competition

17.4.1 Hindi Competitions Organized by Divisions of the Institute

17.4.1.1 Division of Seed Science and Technology

To promote Rajbhasha Hindi and encourage its increased use in official work, the Division of Seed Science and Technology organised various activities on Hindi Day. On this, a Hindi Quiz Competition, a Hindi Dictation Competition, and a Prize Distribution Ceremony were successfully conducted. Dr. Vishwa Bandhu Patel, Assistant Director General (Fruits and Plantation Crops), graced the occasion as the Chief Guest. A total of 11 participants, including students, officers, staff, and contract personnel, took part in the competitions. The winners were selected after a fair and impartial evaluation by the judging committee.

Prize distribution in Hindi competition

17.4.1.2 Division of Microbiology

During the Hindi *Chetna Maas*, various competitions were organized on September 29, 2025 in to promote the use and propagation of Rajbhasha Hindi. The activities included a general knowledge–based quiz competition (*Boojho To Jaane*), extempore speech competitions on contemporary topics, and a word-based Antakshari. Scientists, technical and administrative staff, research scholars, and daily wage workers participated enthusiastically in the programme. The event was organized by Dr. Brijesh Kumar Mishra, Principal Scientist and Rajbhasha Nodal Officer, and Certificates were awarded to all winners by Dr. Radha Prasanna, Head of the Division.

Program organized by Division of Microbiology

17.4.1.3 Division of Agricultural Extension

Various Hindi-related competitions were organised at the divisional level on September 18, 2025. All officers, staff members, students, and researchers of the Division actively participated in the competitions. The programme was presided over by Dr. Satyapriya, Head of the Division. In the valedictory session, Dr. Rabindra Nath Padaria, Joint Director (Extension), graced the occasion as the Chief Guest.

Prize distribution in the competition

17.4.1.4 CATAT

To enhance awareness and encourage the use of Hindi among staff, a one-day Hindi Day programme was held on September 23, 2025, at the Seminar Hall, CATAT, featuring five competitions. All staff members from CATAT, ATIC, and the Pusa Agricultural Produce Sales Centre participated.

Staff members at one-day Hindi program

18. DIRECT DELIVERY OF IARI SEEDS, OTHER INPUTS AND SERVICES TO THE FARMERS AND OTHER STAKEHOLDERS

18.1 SEED PRODUCTION OF FIELD CROPS (JANUARY 01 TO DECEMBER 31, 2025)

18.1.1 Seed Production Unit, ICAR-IARI, New Delhi

The production of quality seeds of 87 varieties of cereals, pulses and oilseeds was 1217.25 tons, which comprises of nucleus seeds (13.31 tons), breeder seeds (164.522 tons) and TFL/IARI seeds 1039.4175 tons (32.0245 tons & 1007.393 tons at the Institute farm and under Farmer's participatory seed production program, respectively) at the Seed Production Unit, ICAR-IARI, New Delhi.

Seed production of agricultural crops at Seed Production Unit & Farmer's field

Crop	Total Number of varieties	Classes of seeds (in tons)				Total Production (tons)
		NS (tons)	BS (tons)	IARI Seeds /(TFL) (tons)		
				At Institute	Under FPSP	
Wheat	21	8.190	150.215	7.7000	507.236	673.3410
Paddy	18	0.050	3.643	8.5250	434.318	446.5360
Chickpea	13	4.740	6.339	-	28.351	39.4300
Pigeon pea	04	0.050	0.468	-	0.858	1.3760
Lentil	03	0.050	1.045	8.9320	2.419	12.4460
Moong	04	0.180	1.069	-	8.718	9.9670
Mustard	08	0.050	1.225	6.0000	23.897	31.1720
Maize	12	-	0.238	0.2675	-	0.5055
Bajra	01	-	0.080	-	1.596	1.6760
Soybean	03	-	0.200	0.6000	-	0.8000
Total	**87**	**13.310**	**164.522**	**32.0245**	**1007.393**	**1217.2500**

NS-Nucleus seed, BS-Breeder Seed, TFL- Truthful Label Seed (IARI Seed), FPSP- Farmers Participatory Seed Production

***Funds generated: ₹ 13.56 crore**

(*fund generated includes the seed production from Field and Horticultural crops)

18.1.2 ICAR-IARI Regional Station, Karnal

At the IARI Regional Station, Karnal, 6643.03 q of quality seed of different crop varieties of cereals, pulses, oilseeds, and forage crops was produced during *rabi* 2024-25 and summer/*kharif 2025*. A total of 28.81 q nucleus, 1811.18 q breeder and 4803.03 q of IARI seed was produced.

Seed production of field and vegetable crops during (*Rabi* 2024-25) and *Summer/Kharif* 2025

Type	No. of Crops	No. of Varieties	Seed Production (q)				
			Nucleus	Breeder	FPSP (TL)	IARI (TL)	Total
Cereals	4	36	27.09	1752.93	4344.62	400.28	6524.92
Pulses	4	11	1.59	26.41	--	16.93	44.93
Oil seeds	1	4	--	14.49	--	14.68	29.17
Vegetables	15	25	0.13	14.15	0	2.47	16.76
Others (Dhaincha/ Bajra/ Sorghum)	3	4	0	3.2	0	24.05	27.25
Total	**27**	**80**	**28.81**	**1811.18**	**4344.62**	**458.41**	**6643.03**

****Funds generated: ₹ 4.5 crore**

(**fund generated included the seed production from Field and Horticultural crops)

18.1.3 ICAR-IARI, Regional Station, Indore

Crop	Name of Variety	Classes of Seeds (in tons)				Total Seed (tons)	Fund Generated (₹)
		NS	BS	IARI Seeds (TFL)			
				At Institute	Under FPSP		
Wheat	HI 1544, HI 1605, HI 1633, HI 1634, HI 1636, HI 1650, HI 1655, HI 1665, HI 8759, HI 8777, HI 8823, HI 8826, HI 8830, HI 8840	11.05	314.6		72.8	398.45	**3,01,22,100**

18.1.4 ICAR-IARI, Regional Station, Wellington

Name of Service	Name of Variety	Classes of seeds (in tons)				Total (tons)	Fund generated (₹)
		NS	BS	IARI Seeds /(TFL)			
				At Institute	Under FPSP		
Breeder/TFL seed of wheat variety	HW 1098	1.5	2.5	1.5	1.5	6.5	**1,50,000**

Total funds generated = ₹ 1.50 lakhs

18.2 SEED PRODUCTION OF HORTICULTURAL CROPS (JANUARY 1 TO DECEMBER 31, 2025)

The production of high-quality seeds of horticultural crops (vegetables, fruits & flowers) at the Institute farm, Regional Stations, and under the Farmers Participatory Seed Production program was carried out. The crop-wise details of the production of various classes of seeds of horticultural crops are given below:

18.2.1 Vegetable Crops

18.2.1.1 Seed Production Unit, ICAR-IARI, New Delhi

The production of quality seed of 39 varieties of 24 horticultural crops (vegetables and flowers) was 52322.0 kg, which comprises of nucleus seeds (179.0 kg), breeder seeds (908.50 kg) and IARI seeds/TFL seeds (51234.50 kg)

(3303.50 kg & 47931.00 kg at Institute farm and under farmer participatory seed production programs, respectively) by Seed Production Unit, ICAR-IARI, New Delhi.

Seed production of flower & vegetable crops at Seed Production Unit & Farmer's field

Crop	Total Number of varieties	Classes of seeds (in kg)				Total Production (kg)
		NS (kg)	BS (kg)	IARI Seeds /(TFS) (kg)		
				At Institute	Under FPSP	
Palak	02	4.0	24.0	92.0	4810.0	4930.0
Amaranth	02	2.0	10.0	256.0	389.0	657.0
Methi	02	5.0	20.0	329.0	6475.0	6829.0
Bottle gourd	02	1.5	25.0	23.0	3040.0	3089.5
Sponge gourd	01	1.0	5.0	2.50	2525.0	2533.5
Cowpea	01	-	-	-	1565.0	1565.0
Turnip	01	1.0	0.50	41.0	1367.0	1409.5
Radish	01	5.0	25.0	236.0	4832.0	5098.0
Carrot	02	1.0	10.0	186.0	2376.0	2573.0
Bathua	01	0.5	-	1.5	-	2.0
Veg. Mustard	01	2.0	-	268.0	1785.0	2055.0
Onion	03	1.0	4.00	94.0	672.0	771.0
Onion (Bulb)	02	-	750.0	750.0	-	750.0
Brinjal	02	0.5	0.5	15.0	879.0	895.0
Cherry Tomato	01	-	-	3.50	-	3.50
Tomato	01	-	0.50	14.0	-	14.50
Cucumber	01	-	-	-	1078.0	1078.0
Garden pea	01	150.0	-	820.0	4284.0	5254.0
Okra	01	1.0	15.0	-	8800.0	8816.0
Marigold	05	0.5	4.0	27.0	566.0	597.5
Sem	01	3.0	-	75.0	-	78.0
Fababean	01	-	-	-	647.0	647.0
Coriander	01	-	15.0	70.0	976.0	1061.0
Muskmelon	01	-	-		48.0	48.0
Bitter gourd	02	-	-	-	817.0	817.0
Total	**39**	**179.0**	**908.5**	**3303.5**	**47931.0**	**52322.0**

NS-Nucleus seed BS-Breeder Seed, TL- Truthful Label Seed (IARI Seed) & FPSP- Farmers Participatory Seed Production

18.2.1.2 ICAR-IARI, Regional Station, Karnal

At IARI-Regional Station, Karnal, 1676.02 kg seed of 25 varieties of 15 vegetable crops was produced during *rabi* 2024-25, summer/ *kharif* 2025. A total of 13.55 kg nucleus, 1415.35 kg breeder and 247.12 kg of IARI seed was produced.

Seed production of vegetable crops

Crop	Variety	NS (kg)	BR (kg)	TL (kg)	Total (kg)
Flower					
Marigold	Pusa Bahar	--	--	7.3	7.3
	Pusa Basanti	--	--	2.9	2.9
Vegetable					
Pea	Pusa Pragati	--	0	10	10
	Pusa Arkel	--	1020.0	--	1020
	Pusa Shree	--	0	123	123
Bhindi	Pusa Bhindi-5	--	105.5	39	144.5
Cowpea	Pusa Dharni	2.20	58.0	--	60.2
Cucumber	Pusa Barkha	0.09	1.40	--	1.49
Onion	Pusa Red	3.2	--	25	28.2
	Pusa Ridhi	2.8	--	23.5	26.3
	Pusa Madhavi	0.4	--	2.4	2.8
	Pusa Shobha	0.4	--	8	8.4
	Pusa Sona	0.4	--	5.1	5.5
Methi	Pusa Kasuri	--	143	--	143
Palak	Pusa Vilayati	3	65	--	68
Bathua	Pusa Green	0.9	8.2	--	9.1
Brinjal	Pusa Uttam	--	--	0.3	0.3
Tomato	Pusa Golden Cherry 1	--	--	0.09	0.09
Tomato	Pusa Golden Cherry 2	--	--	0.5	0.5
Tomato	Pusa Cocktail Tomato	--	--	0.03	0.03
Pumpkin	Pusa Vishwas	--	12.5	--	12.5
Bitter Gourd	Pusa Aushdhi	0.1	--	--	0.1
Fruit					
Water Melon	Sugar Baby	--	0.9	--	0.9
Muskmelon	Pusa Madhurima	0.06	--	--	0.06
	Pusa Kazri	--	0.85	--	0.85
	Total	**13.55**	**1415.35**	**247.12**	**1676.02**

NS-Nucleus seed BS-Breeder Seed, TL- Truthful Label Seed (IARI Seed)

18.2.1.3 ICAR-IARI, Regional Station, Katrain, Himachal Pradesh

Seed production (kg)				Revenue Generated from seed sale (₹ Lakh)	Revenue from others (₹ Lakh)	Total Revenue Generated (₹ Lakh)
Nucleus	Breeder	IARI-TFL	Total			
125.00	58.82	2079.00	2262.82	37.16	3.10	**40.26**

18.2.1.4 ICAR-IARI, Regional Station, Wellington

Name of Service (Crop, Culture, Identification service etc.)	Name of Variety	Classes of seeds (in tons)				Total (tons)	Fund generated (₹)
		NS	BS	IARI Seeds /(TFL)			
				At Institute	Under FPSP		
Potato seeds	Himalini				30.0 (including seeds kept for station sowings)	30	**10,50,000**

18.2.2 Fruit Crops

18.2.2.1 Division of Fruit and Horticultural Technology, ICAR-IARI, New Delhi

Fruit crop & variety	Type of planting material	Jan, 2025-Dec, 2025
Mango		
Amrapali	Grafted Plants & scion	1905
Mallika	Grafted Plants & scion	1736
Pusa Arunima	Grafted Plants & scion	1673
Pusa Surya	Grafted Plants & scion	1054
Pusa Lalima	Grafted Plants & scion	1660
Pusa Pratibha	Grafted Plants & scion	430
Pusa Shrestha	Grafted Plants & scion	493
Pusa Peetamber	Grafted Plants & scion	674
Pusa Manohari	Grafted Plants & scion	2292
Pusa Deepshikha	Grafted Plants & scion	3
PAM-1*	Seedling	0
PAM-2*	Seedling	0
Citrus		
Kagzi Kalan	Sapling (Air layered)	596
Pusa Round	Grafted Plants	224
Pusa Sharad	Grafted Plants	426
Pusa Udit	Sapling & Seedling	34
Pusa Abhinav	Grafted Plants	698
Pusa Arun	Sapling & Seedling	20
Pusa Lemon-1	Sapling (Air layered)	40
Grapes		
Pusa Navrang	Saplings/rooted cuttings and cuttings	1826
Pusa Urvashi	Saplings/rooted cuttings and cuttings	13

Pusa Trishar	Saplings/rooted cuttings and cuttings	75
Pusa Aditi	Saplings/rooted cuttings and cuttings	316
Pusa Swarnika	Saplings/rooted cuttings and cuttings	14
Pusa Purple Seedless	Saplings/rooted cuttings and cuttings	13
Guava		
Pusa Aarushi	Saplings (Grafted Plants)	869
Pusa Pratiksha	Saplings (Grafted Plants)	786
Papaya		
Pusa Nanha	Seedling	137
Pusa Peet	Seedling	131

Funds generated = ₹ 21.62 lakhs

18.2.2.2 ICAR-IARI Regional Station, Karnal

Propagation of horticultural crops during 2025

Plants of mango (Amrapalli, Mallika, Dasheri, Arunima & other varieties), guava (Allahabad Safeda), lemon (Kagzi Kalan) and papaya (Pusa Nanha) 1089 nos. were produced and distributed to various stakeholders at the Regional Station, Karnal.

Propagation of horticultural crops during 2025

Sl. No.	Crop	Mango Varieties	2025
1	Mango	Amrapali	61
2	Mango	Mallika	33
3	Mango	Dasheri	23
4	Mango	Pusa Arunima	51
5	Mango	Pusa Surya	12
6	Mango	Langra	23
7	Mango	Ramkela	19
8	Mango	Chausa	19
9	Mango	Pusa Shreshta	40
10	Mango	Pusa Lalima	45
11	Mango	Pusa Pitamber	23
12	Mango	Pusa Pratibha	9
13	Mango	Pusa Manohari	11
14	Mango	Pusa Deepshikha	2
15	Mango scion	Arunima	10
16	Lemon	Kagzi Kalan	308
17	Guava	Allahabad Safeda	75
18	Papaya	Pusa Nanha	325
		Total	**1089**

18.2.2.3 ICAR-IARI Regional Station, Karnal

Production of planting materials in Horticultural crops

Crop	Type of planting materials	Quantity	Amount
Kiwi	Hard wood cutting raised plants	1384	221440
Anar	Hard wood cutting raised plants	11	1375
Apricot	Grafted	12	2040
Persimmon	Grafted	120	38420
Walnut	Grafted	235	51450
Plum	Grafted	408	69360
Peach	Grafted	101	17170
Almond	Grafted	136	23120
Pear	Grafted	20	3000
Fig	Grafted	4	680
Strawberry	Runners	120	1800
Pear and apricot	Bud-wood	258	5160
Total		**2809**	**435015**

18.2.3 Ornamental Crops

18.2.3.1 Seed Production Unit, ICAR-IARI, New Delhi

Seed production of flower crops at Seed Production Unit & Farmer's field

Crop	Total Number of varieties	Classes of seeds (in kg)				Total Production (kg)
		NS (kg)	BS (kg)	IARI Seeds /(TFS) (kg)		
				At Institute	Under FPSP	
Marigold	05	0.5	4.0	27.0	566.0	597.5

18.2.3.2 ICAR-IARI, Regional Station, Karnal

Crop	Variety	NS (kg)	BR (kg)	TL (kg)	Total (kg)
Flower					
Marigold	Pusa Bahar	--	--	7.3	7.3
	Pusa Basanti	--	--	2.9	2.9

18.3 DIVISION OF MICROBIOLOGY

Name of service	Name of item	Total (kg/L)	Fund generated (₹)
Biofertilizers	PUSA Decomposer	17600 packets of Wettable Powder + 450 L of Liquid Pusa Decomposer + 750 kits of capsule Pusa Decomposer	23,31,250
	PUSA Mycorrhiza	3682 kg	2,76,150
	BioPhos (solid and liquid)	48.40 kg + 277 .85 L	4,28,875
	BioPotash (solid and liquid)	16.200 kg + 276.45 L	4,18,725
	BioZinc (solid and liquid)	8 kg + 296.50 L	4,46,750
	Rhizobium	46 kg	11,500
	PUSA Sampoorna	94.70 L	1,42,050
		Total	**40,55,000**

19. MISCELLANY

I. Scientific Meetings Organized	
Workshops	45
Seminars	8
Summer/Winter School	4
Farmers' day (s)	40
Others	23
Total	**120**
II. Participation of Personnel in Scientific Meetings	
India	
Seminars	126
Scientific meetings	247
Workshops	152
Symposia	106
Others	52
Total	**683**
Abroad	
Seminars	1
Scientific meetings	5
Workshops	11
Symposia	5
Others	1
Total	**23**

III. Ongoing Projects at IARI as on 31.12.2025

(A) Research Projects: 241

School of Crop Improvement	76
School of Plant Protection	38
School of Basic Science	26
School of Natural Resource Management	52
School of Social Science	16
School of Horticultural Science	33

(B) Number of on-going contract research/ consultancy/contract service projects: 24

School of Crop Improvement	01
School of Plant Protection	05
School of Basic Sciences	-
School of Natural Resource Management	11
School of Social Sciences	2
School of Horticultural Sciences	05

List of sanctioned Contract Research Projects in 2025

S. No.	Name of PI	Title of Project	Name of funding agency	Date of Start	Date of End	Sanctioned amount in lakhs
1.	Dr. Arun Kumar T.V., Senior Scientist, Division of Agricultural Engineering	Development of process machines for effective drying and utilization of mango kernel	Kinjal Food Products	06.01.2025	05.01.2026	10.07
2.	Dr. Sanjay Singh Rathore, Head, Division of Agronomy	Evaluating the impact of bioStimuli on yield improvement and carbon footprints in wheat and canola mustard crops	String Bio Private Limited	09.01.2025	08.01.2026	34.18
3.	Dr. K. K. Gangopadhyay, Principal Scientist, Division of Vegetable Science	Evaluation of biostimulants on growth and yield of tomato, okra, sponge gourd and cowpea	Agro Inputs Manufacturers Association of India (AIM)	14.02.2025	13.08.2025	9.98

S. No.	Name of PI	Title of Project	Name of funding agency	Date of Start	Date of End	Sanctioned amount in lakhs
4.	Dr. K. K. Gangopadhyay, Principal Scientist, Division of Vegetable Science	Evaluation of biostimulants G-5 Foliar, Chargex, and Swa Urja on growth and yield of tomato, okra, and cowpea	Swaroop Agrochemical Industries	28.02.2025	27.08.2025	9.99
5.	Dr. T.K. Das, Professor & Principal Scientist, Division of Agronomy	Bio-efficacy, crop phytotoxicity, persistence and residue of imazethapyr (10% SL) in herbicide tolerant wheat variety and its effect on succeeding crop	Mahyco Private Limited	10.03.2025	09.03.2026	28.29
6.	Dr. Y. S. Shivay, Principal Scientist, Division of Agronomy	Dose calibration of the Gromer Nano DAP (2:5:0) in wheat crop	Coromandel International Limited	21.03.2025	20.03.2027	14.11
7.	Dr. Manoj Shrivastava, Principal Scientist, Division of Environment Science	Evaluation of the effectiveness of foliar applied nano urea and nano DAP using dual labeling ^{32}P and ^{15}N isotopic technique in maize	Coromandel International Limited	23.04.2025	22.04.2026	32.89
8.	Dr. Suresh M. Nebapure, Senior Scientist, Division of Entomology	Baseline susceptibility of key Lepidopteran pests against newer insecticide under controlled conditions	PI Industry Limited	24.04.2025	23.10.2026	27.82
9.	Dr. M. R. Khan, Principal Scientist, Division of Nematology	Evaluation of Vetonema against root knot nematode (*Meloidogyne incognita*) in okra	M/S Swaroop Agrochemical Industries	29.05.2025	28.11.2025	7.30
10	Dr. Khajanchilal, Principal Scientist, WTC	Evaluation of water filtration system with biodegradable bead-based treatment for pollutant degradation	M/s Biomimicry Technologies Pvt. Ltd.	11.06.2025	10.08.2025	1.74
11.	Dr. Jogendra Singh, Scientist, Division of Vegetable Science,	Assessment of the impact of Nano zinc (1%), and Nano boron (0.1%) on growth, yield, and quality of brinjal and bottle gourd	Combe Project Private Limited	4.08.2025	3. 08. 2026	15.42

S. No.	Name of PI	Title of Project	Name of funding agency	Date of Start	Date of End	Sanctioned amount in lakhs
12.	Dr. Jai Prakash, Principal Scientist, Division of Fruits and Horticultural Technology	Evaluating IFFCO Nano fertilizer for enhanced mango fruit quality and productivity	Indian Farmers Fertilizer Cooperative Limited	13.10.2025	12.10.2026	8.83
13.	Dr. Rajiv Kumar Singh, Principal Scientist, Division of Agronomy	Evaluation of Nano MoP and NPK liquid fertilizer on growth, productivity and profitability of maize-wheat and pearl millet-mustard system	Combe Project Private Limited	09.10.2025	08.10.2026	16.16
14.	Dr. Livleen Shukla, Principal Scientist, Division of Microbiology	Conversion of waste from biomass pellet plants and Compressed Biogas (CBG) digestate into value-added product as Phosphate Rich Organic Manure (PROM) and Fermented Organic Manure (FOM) as per Fertilizer Control Order (FCO)	Manikaran Power Limited	10.11.2025	09.11.2026	11.87
15.	Dr. Pankaj, Head, Division of Nematology	Evaluation of vegetable varieties/ lines for resistance against root-knot nematodes	Ellora Natural Seeds Pvt. Ltd.	17.11.2025	16.11.2026	7.41
16.	Dr. Dinesh Kumar, Head, Division of FS&PHT	Optimization of process parameters for novel green superfoods and their characterization	M/s GOOD &HAPPY Botanies Pvt. Ltd.	02.12.2025	01.12.2026	10.64
17.	Dr. Arti Bhatia, Principal Scientist, Division of Environmental Science	Co-Benefits of biochar and enhanced rock weathering application to cropped soils	CRIA-Carbon Removal India Alliance	02.12.2025	01.12.2027	62.77

List of Sanctioned Consultancy Projects in 2025

S. No.	Name of PI	Title of Project	Name of funding agency	Date of Start	Date of End	Sanctioned Amount
1.	Dr. Ravinder Kaur, Principal Scientist, WTC	Designing an IARI technology (JalopcharTM) based domestic Wastewater Treatment Facility for rejuvenation of a pond at Adhyana Village in Tehsil Nakud, Saharanpur, UP	Power Grid Corporation of India Limited	17.06.2025	25-man days	6.11 lakh

List of sanctioned Contract Service Projects in 2025

S. No.	Name of PI	Title of Project	Name of funding agency	Date of Start	Date of End	Sanctioned Amount
1.	Dr. K.K. Pramanick, Principal Scientist, Regional Station, Shimla	Assessment of the bio efficacy of Etoxazole 10% SC (New Source) against European red mite (*Panonychus ulmi*) & two-spotted spider mite (*Tetranychus urticae* Koch) in apple	Sumitomo Chemicals India Ltd	11.09.2025	10.09.2027	3.51 lakh
2.	Dr. Santosh Watpade, Senior Scientist, Regional Station, Shimla	Evaluation of PIF320 for post-harvest disease management in apple during ambient temperature and refrigerated condition	PI Industries Limited	19.11.2025	18.11.2027	4.73 lakh

List of sanctioned Collaborative Projects under CSR fund in 2025

S. No.	Name of PI	Title of Project	Name of funding agency	Date of Start	Date of End	Sanctioned Amount
1.	Dr. Gopala Krishnan S., Head, Division of Genetics	Development of facilities at ICAR-IARI for improvement of field and oilseed crops	Corteva Agrisciences Seeds Private Limited	27.01.2025	26.06.2025	50.00 lakh

IV. All India Coordinated Research Projects in Operation during the year January 1 - December 31, 2025

Sl. No.	Name of the project	Division
Project Head Quarters		
1.	All India Coordinated Project on Plant Parasitic Nematodes with integrated Approach for their control.	Division of Nematology
2.	All India Network Project on Pesticide Residues	Division of Agricultural Chemicals
3.	All India Coordinated Research Project on Honey Bees and Pollinators	Division of Entomology
Centers functioning at IARI under AICRP		
1.	All India Network project on Soil Biodiversity - Biofertilizers (erstwhile All India Coordinated Research Project on Biological Nitrogen Fixation)	Division of Microbiology
2.	All India Coordinated Project on Long Term Fertilizer Experiments	Division of Soil Science &Agricultural Chemistry
3.	All India Coordinated Research Project on Soil Test Crop Response Correlations	Division of Soil Science & Agricultural Chemistry
4.	All India Coordinated Research Project on Floriculture	Division of Floriculture & Landscaping & RS Katrain
5.	All India Coordinated Research Project on Renewable Energy Sources for Agriculture and Agro-based Industries	Division of Environmental Sciences
6.	All India Coordinated Research Project on Soybean	Division of Microbiology
7.	All India Coordinated Research Project on Fruits	IARI RS, Pune
8.	All India Coordinated Research Project on N.S.P.(Crops)	Division of Seed Science & Technology and IARI RS Pune
9.	All India Coordinated Research Project on Mustard	Division of Genetics
10.	All India Coordinated Research Project on Wheat	Division of Genetics.
11.	All India Coordinated Research Project on Rice	Division of Genetics
12.	All India Coordinated Research Project on Pulses	Division of Genetics
13.	All India Coordinated Research Project on Vegetables	Division of Vegetable Science.
14.	AINP on Whitegrubs and other Soil Arthropods (AINPWOSA)	Division of Entomology
15.	Front Line Demonstration on Pearl Millet – AICRP Pearl Millet under National Food Security Mission (NFSM)	KVK Shikohpur
16.	All India Coordinated Research Project on Vegetable Crops	Division of Vegetable Science
17.	Adhoc Cooperating Center of AICRP on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants, Indian Institute of Soil Science, Bhopal	Division of Soil Science & Agricultural Chemistry
18.	All India Coordinated Research Project on Ergonomics & Safety in Agriculture (ESA)	Division of Agril. Engineering
19.	All India Coordinated Research Project on Pearl Millet	Division of Agronomy
20.	All India Coordinated Research Project on Rapeseed-Mustard	Division of Agronomy
21.	All India Network Research Program on Onion & Garlic (AINRPOG)	Division of Vegetable Science
22.	Engineering Interventions for Enhanced Nutritional Security of Pearl Millet During Milling and Storage Under AICRP On Pearl Millet	Division of Agril. Engineering
23.	All India Coordinated Research Project on Fruits-PAPAYA	IARI RS, Pune
24.	AICRP on Rapeseed Mustard Research (Testing Component)	Division of Genetics
24.	AICRP on Rabi Pulses	Division of Microbiology

V. Resource Generation

1) Revolving fund
Sale Proceeds Revenue Generated

(a) Seed: ₹

(b) Commercialization: ₹ 36200000 crore

(c) Prototype manufacturing:

Total: ₹ 3.62 crore

2) Post Graduate School receipt
Training Programme

(a) Foreigners & Indians: Nil

M.Sc./Ph.D. Program

(b) Institutional economic fee from foreign scholars under Work Plan: **902,280/-**

(c) Receipt from Registrar (A) Account No. 5432 (9029.201.4314) all fees except institutional economic fee: ₹ **40,157,355/-** (April 01-November 25, 2025)

(d) Receipt deposited in Director's Account No. 305/17 for Theses Evaluation, PDC & Misc. (does not include refund of IARI scholarship by students): ₹ **33,912,868/-** (November 26, 2025 to March 31, 2026)

Total: ₹ 74,972,503/-

Grand Total (1+2): ₹ 36200000 + ₹ 74,972,503 = ₹ 111,172,503/-

VI. Significant suggestion(s) given/decision(s) taken at Senior Management Personnel (SMP) meetings during the period January 1 to December 31, 2025

The important policy decisions taken by the Academic Council in the period under report for further improving the standards of teaching at IARI included:

- Allowed continued allocation of students to Chairperson placed in different Government Organizations/NARES (National Agricultural Research & Education System) on the following terms:

  (i) No fresh allotment of students shall be done.

  (ii) In case of superannuation/moving out in different Government Organizations/ NARES: The extension shall be given for 6 months only as Chairperson.

- Introduction of one year Skill Enhancement Diploma Course on " Freshwater Aquaculture and Fisheries Management "at IARI Assam.
- Introduction of a Skill Development Course on "Rapid Composting and its quality assessment".
- Divisional level award in the name of Dr. P.K. Aggarwal, former Head of Division of Seed Science and Technology to confer upon the best M.Sc. and Ph.D. students of discipline of Seed Science and Technology.
- Divisional level award in the name of Dr. Linga's Foundation Ph.D Merit Medal Award and Dr. Linga's Foundation M.Sc. Merit Medal Award in the discipline of of Plant Physiology, ICAR-IARI, New Delhi.
- Implementation of the Council decisions communicated to IARI regarding discontinuation of UG programs and phasing out of IARI-Hubs and their replacement with Students Research Partners (SRPs) from the AY 2025-26.
- Scholarship/Fellowship support to students selected under twinning/ joint/ dual degree programmes under international c**ollaborat**ions.

IARI Internship Training Programme

The Internship Training Programme, lasting one to six months, has been offered at ICAR-IARI since 2019 for students pursuing B.Sc./M.Sc./M. Tech in Agricultural or Life Sciences and B.Tech (Biotechnology/Bioinformatics) on a payment basis. The programme provides hands-on research exposure in various aspects of agricultural sciences, broadens students' academic horizons, and motivates them to pursue careers in agricultural research.

Year	No. of persons joined/ completed an internship at IARI	Total Income Generated (₹ in Lakh)
2025	86	17.48

- CAG Exit Meeting of Subject Specific Compliance Audit-Management of Research & Development Activities in IARI was held on October 17, 2025
- EFC and review of Hon'ble Agricultural Minister (HAM) meeting were held on 5-6 and 9-11, and December 26, 2025.
- Five-year Review Meeting with DG- ICAR was held on December 30, 2025.
- ISO Auditor conducted a surveillance visit at IARI on March 7, 2025 to assess continued compliance with the established ISO standards. The visit focused on reviewing institutional systems, processes, and documentation to ensure ongoing effectiveness and conformity.

National and International visitors to ICAR-IARI, New Delhi, from January 01 to December 31, 2025

In 2025, ICAR-IARI hosted 21 International and 2 National delegations, strengthening global collaboration, knowledge exchange, and exposure to agricultural research and innovation.

S. No.	Details of Visit	Date of Visit
1.	A delegation from the Netherlands, including Ms. Bernice Bockting (Export Partner), Mr. Robertus Cornelis Johannes (CEO, Horti XS), and Mr. Jorik Bremer (Director Sales, Hudson River Biotechnology)	January 07, 2025
2.	A BASF foreign delegation led by Mr. Livio Tedeschi, President, BASF SE, Germany	February 06, 2025
3.	An Argentinian delegation led by HE Mr. Raul Jalil, Governor of Catamarca	February 25, 2025
4.	Visit of a delegation from Madagascar	March 13, 2025
5.	Mr. Bill Gates, Chairman, Bill & Melinda Gates Foundation, visited IARI to watch a live demonstration of Drone Technology by NAMO Drone Didis from Bihar at IARI Research Farm	March 17, 2025
6.	South Asia Delegates for Regional cooperation & knowledge exchange	March 17, 2025
7.	A delegation from the Federal Ministry of Food and Agriculture (BMEL), Germany, led by Ms. Silvia Bender, State Secretary	March 18, 2025
8.	Visit of a delegation from 10 African countries, under a National Institute of Labour Economics Research and Development (NITI Aayog) training program	April 04, 2025
9.	Visit of a delegation from Michigan University	April 14, 2025
10.	Visit of the Bhutanese delegation led by Dasho Thimley Namgyel, Secretary, Ministry of Agriculture & Forests	April 21, 2025
11.	Visit of Mr. Kamal Bahadur Shah, Chief Minister of Sudurpashchim Province, Nepal	May 01, 2025
12.	Visit of Newly Recruited Agriculture Officers from Bihar Institute of Public Administration and Development (BIPARD)	May 06, 2025
13.	Visit of members of the Malaysian Agricultural Research and Development Institute, Malaysia, facilitated by Dr. Khushnood Ali of African-Asian Rural Development Organization	June 24, 2025

S. No.	Details of Visit	Date of Visit
14.	Visit of Dr Indra Mani, Vice Chancellor, VNMKV Parbhani, along with high-level officials of the University	July 22, 2025
15.	Visit of 37 Participants of the 82nd edition of the Know India Programme of the Ministry of External Affairs, representing 12 countries	August 01, 2025
16.	A visit of Ethiopian delegation led by Mr. Solomon Euyda Alemn, DG, Legal Affairs	August 22, 2025
17.	Visit of a Sikkim delegation of farmers, represented by 15 FPOS led by Shri Tshering Tendup Bhutia, Principal Director, Agriculture Department, Govt. of Sikkim and Mrs Raihan Gurung, Additional Director, Agriculture Department	September 01, 2025
18.	Visit of a delegation from Indonesia for Institutional/research collaboration	October 03, 2025
19.	Visit of Nigerian delegation	October 07, 2025
20.	Visit of a delegation from Bill & Melinda Gates Foundation (BMGF)	October 17, 2025
21.	A delegation from Sri Lanka for Bilateral cooperation & knowledge exchange	October 30, 2025
22.	A delegation from Sri Lanka for Follow-up interaction and collaborative discussion	November 03, 2025
23.	A 39-member delegation of young people of Indian origin (PIOs) from 17 countries under the 80^{th} Know India Programme (KIP)	December 18, 2025

A delegation from the Netherlands, including Ms. Bernice Bockting (Export Partner), Mr. Robertus Cornelis Johannes (CEO, Horti XS), and Mr. Jorik Bremer (Director Sales, Hudson River Biotechnology) visited on January 07, 2025

A BASF foreign delegation visited ICAR-IARI, New Delhi, led by Mr. Livio Tedeschi, President, BASF SE, Germany on February 06, 2025

An Argentinian delegation led by HE Mr. Raul Jalil, Governor of Catamarca, visited on February 25, 2025

A Madagascar Delegation visited ICAR-IARI on March 13, 2025

South Asia Delegates for Regional Cooperation & Knowledge Exchange visited on March 17, 2025

A delegation from the Federal Ministry of Food and Agriculture (BMEL), Germany, led by Ms. Silvia Bender, State Secretary, visited ICAR-IARI on March 18, 2025

A delegation from 10 African countries, under a National Institute of Labour Economics Research and Development (NITI Aayog) training program visited ICAR-IARI on April 04, 2025

Visit of a delegation from Michigan University on April 14, 2025

Visit of the Bhutanese delegation led by Dasho Thimley Namgyel, Secretary, Ministry of Agriculture & Forests, on April 21, 2025

Visit of Mr. Kamal Bahadur Shah, Chief Minister of Sudurpashchim Province, Nepal on May 01, 2025

Visit of newly recruited Agriculture Officers from Bihar Institute of Public Administration and Development (BIPARD) on May 06, 2025

Visit of members of the Malaysian Agricultural Research and Development Institute, Malaysia, facilitated by Dr. Khushnood Ali of African-Asian Rural Development Organization on June 24, 2025

Visit of 37 Participants of the 82nd edition of the Know India Programme of the Ministry of External Affairs, representing 12 countries, on August 01, 2025

A visit of Ethiopian delegation led by Mr. Solomon Euyda Alemn, DG, Legal Affairs on August 22, 2025

Visit of a Sikkim delegation of farmers, represented by 15 FPOS led by Shri Tshering Tendup Bhutia, Principal Director, Agriculture Department, Govt. of Sikkim and Mrs Raihan Gurung, Additional Director, Agriculture Department, on September 01, 2025

A Delegation from Indonesia for Institutional/Research Collaboration visited on October 03, 2025

A Nigerian delegation visited on October 07, 2025

Bill & Melinda Gates Foundation (BMGF) Delegation visited on October 17, 2025

Delegation from Sri Lanka for bilateral cooperation & knowledge exchange visited on October 30, 2025 and November 03, 2025

A 39-member delegation of young People of Indian origin (PIOs) from 17 countries visited on December 18, 2025, under the 80th Know India Programme (KIP)

Appendix 1
Members of Board of Management of IARI
(As on 31.12.2025)

Chairman

Dr. Ch. Srinivasa Rao
Director, ICAR- IARI, New Delhi

Members

Dr. Viswanathan C.
Joint Director (Research), ICAR-IARI

Dr. Anupama Singh
Dean & Joint Director (Education), ICAR-IARI

Dr. R.N. Padaria
Joint Director (Extension), ICAR-IARI

Dr. Triveni Dutt
Director, IVRI, Izzatnagar, Bareilly (U.P.)

Dr. Abhilaksh Likhi,
Member of Governing Body, ICAR

Ms. Sushma Singh
Member of Governing Body, ICAR

Dr. P. S. Brahmanand
Project Director, WTC

Dr. Alka Singh
Head, Division of Agricultural Economics

Dr. Sanat Kumar Mahanta
Campus In-charge, IARI, Hazaribagh, Jharkhand

Dr. Amjad K. Balange
Campus In-Charge, IARI, Assam

Dr. Shiv Kumar Yadav
Head, IARI-RS, Karnal

Dr. Jang Bahadur Singh
Head, IARI-RS, Indore

Dr. Bidyut Chandan Deka
Vice Chancellor, Assam Agricultural University, Jorhat, Assam

Dr. D.K. Yadava
Deputy Director General (Crop Science), ICAR

Dr. W.G. Prasanna Kumar
Former Chairman, Mahatma Gandhi National Council of Rural Education

Dr. P.K. Singh
Agriculture Commissioner
Deptt. of Agril. and Cooperation
Ministry of Agriculture, Krishi Bhawan, New Delhi

Dr. Narendra Singh Rathore
Former DDG (Ag. Edu.) ICAR

Sh. Dharamender Singh Lakra
Non-Official Member nominated by President, ICAR

Sh. Sandeep Sarkar
Additional Secretary & Financial Advisor, (DARE/ICAR)

Sh. Shurbir Singh, IAS
Commissioner & Secretary (Development), Development Department,
Govt. of NCT of Delhi, 5/9, Hill Road, Delhi-110054

Dr. Payal Mago
Principal,
Shaheed Rajguru College of Applied Science for Women
University of Delhi – 110 096

Member - Secretary

Sh. Suresh Kumar
Joint Director (Admn.), ICAR-IARI

Appendix 2
Members of Research Advisory Committee of IARI
(As on 31.12.2025)

Chairman
Prof. (Dr.) Sudhir Kumar Sopory
Emeritus Senior Scientist
International Centre for Genetic Engineering and Biotechnology,
New Delhi

Members
Dr. Surinder Singh Banga
DAE Raja Ramanna Fellow and Professor (Honorary Adjunct),
Department of Plant Breeding and Genetics
PAU, Ludhiana, Punjab

Dr. Kailash Chander Bansal
Former Director
NBPGR, New Delhi

Dr. P.S. Naik
Former Director, ICAR-IIVR,
Varanasi

Dr. M.R. Dinesh
Former Director, ICAR-IIHR,
Bengaluru

Dr. Biswapati Mandal
Former Pro-Vice Chancellor,
BCKV, West Bengal

Dr. Vijay Paul Sharma
Chairman, Commission for Agricultural Costs and Prices (CACP)
MoA & FW, GoI, New Delhi

Dr. Surinder Tikoo
Co-founder and Director Research, Breeding and Development,
Hyderabad

Prof. Appa Rao Podile,
Former Vice Chancellor,
University of Hyderabad
Senior Professor, Department of Plant Sciences
School of Life Sciences, University of Hyderabad, Telangana

Dr. Ch. Srinivasa Rao
Director,
ICAR-IARI, New Delhi

Dr. D.K. Yadava
DDG (CS), ICAR Krishi Bhawan
As per the nomination on the Management Committee under Rule 66(a) (5)

Member – Secretary
Dr. C. Viswanathan
Joint Director (Research)
ICAR-IARI, New Delhi

Appendix 3

Members of Academic Council of IARI

(As on 31.12.2025)

i)	Dr. Ch. Srinivasa Rao Director		Chairman
ii)	Dr. Anupama Singh Jt. Director (Edn.) & Dean		Vice-Chairperson
iii)	Deputy Director General (Agril. Edn.), ICAR (Acting)	Member	Dr. J.K. Jena
iv)	Directors of Sister Institutes in IARI Campus and nodal coordinator Directors, ICAR-IARI hubs	Members	Dr. Kairam Narsaiah Director, ICAR-IASRI, New Delhi Dr. Gyanendra Pratap Singh Director, ICAR-NBPGR Dr. R.C. Bhattacharya Director, ICAR-NIPB, New Delhi Dr. C.R. Mehta Director, ICAR-CIAE, Bhopal and Nodal Coordinator, ICAR-IARI, Bhopal hub Dr. T.K. Behera Director, ICAR-IIHR and Nodal Coordinator, ICAR-IARI, Bengaluru hub Dr. P.K. Rai Director, ICAR-NIBSM, Raipur and Nodal Coordinator, ICAR-IARI, Raipur hub Dr. Sujay Rakshit Director, ICAR-IIAB, Ranchi and Nodal Coordinator, ICAR-IARI, Ranchi hub Dr. K. Sammi Reddy Director, ICAR-NIASM, Baramati and Nodal Coordinator, ICAR-IARI, Baramati hub
v)	Joint Director (Research)	Member	Dr. C. Viswanathan
vi)	Joint Director (Extension)	Member	Dr. R.N. Padaria
vii)	Project Director Water Technology Centre	Member	Dr. P.S. Brahmanand

viii)	Four Eminent Scientists/ (Outside Members)	Members	Dr. H.C. Sharma Former VC, YSPUHF, Nauni, Solan Dr. N.S. Rathore Former VC, MPUAT, Udaipur and Former DDG (Edn.), ICAR, New Delhi Dr. A.K. Singh Former Vice Chancellor RVSKVV, Gwalior Dr. A.K. Singh Vice Chancellor, RLBCAU, Jhansi, U.P.
ix)	Associate Dean (PG Affairs)	Member	Dr. Atul Kumar
x)	Associate Dean (UG Affairs)	Member	Dr. Harshawardhan Choudhary
xi)	Associate Dean (International Affairs)	Member	Dr. K.K. Vinod
xii)	Associate Dean (Hubs/Off Campuses and Sister Institutes/ constituent colleges) and Professor, SST	Member	Dr. (Ms.) Monika A. Joshi
xiii)	Associate Dean (Student Opportunities, Outreach and New Initiatives)	Member	Dr. M.R. Khan
xiv)	Controller of Examinations	Member	Dr. Akshay Talukdar
xv)	Professors of Teaching Disciplines at IARI	Members	Dr. (Ms.) Suman Gupta Professor, Agricultural Chemicals Dr. Pramod Kumar Professor, Agricultural Economics Dr. Murtaza Hassan Professor, Agricultural Engineering Dr. M.S. Nain Professor, Agricultural Extension Dr. (Ms.) P. Krishnan Professor, Agricultural Physics Dr. (Ms.) Cini Varghese Professor, Agricultural Statistics Dr. Y.S. Shivay Professor, Agronomy Dr. Ranjit Ranjan Kumar Professor, Biochemistry Dr. (Ms.) Sarika Professor, Bioinformatics Dr. Alka Arora Professor, Computer Application Dr. Subramaniam S. Professor, Entomology Dr. D.K. Sharma Professor, Environmental Science

			Dr. K.P. Singh Professor, Floriculture and Landscaping Dr. Radha Mohan Sharma Professor, Fruit Science Dr. C. Bharadwaj Professor, Genetics and Plant Breeding Dr. Rajeev Kaushik Professor, Microbiology Dr. (Ms.) Jasdeep Chatrath Padaria Professor, Molecular Biology and Biotechnology Dr. Anil Sirohi Professor, Nematology Dr. Sunil Archak Professor, Plant Genetic Resources Dr. Aundy Kumar Professor, Plant Pathology Dr. (Ms.) Anjali Anand Professor, Plant Physiology Dr. Ram Asrey Professor, Post-harvest Management Dr. T.J. Purakayastha Professor, Soil Science Dr. R.K. Yadav Professor, Vegetable Science Dr. Khajanchi Lal Professor, Water Science & Technology
xvi)	Professors (UG)	Special Invitees	Dr. T.K. Das Professor, B.Sc. (Agriculture) Dr. (Ms.) Rashmi Singh Professor, B.Sc. (Community Science) Dr. (Ms.) Sangeeta Chopra Professor, B.Tech. (Agril. Engineering) Dr. Jasdeep Chatrath Padaria Professor, B.Tech. (Biotechnology)
xvii)	Master of Halls of Residences (MOHR)	Member	Dr. C. Bharadwaj
xviii)	Sr. Comptroller	Member	Shri. Avesh Yadav
xix)	Elected Faculty Representatives	Members	Dr. Renu Singh Pr. Scientist, Environmental Science Dr. Roaf Ahmad Parray Scientist, Agril. Engineering
xx)	Incharge, Prof. M.S. Swaminathan Library	Member	Shri. Deep Chand
xxi)	Elected Students of PGSSU (2)	Members	Mr. Sudhir Bhinchar President PGSSU Mr. B. Sharatchandra Students' Representative to the Academic Council
xxii)	Senior Registrar & Joint Director (Admn.)	Member-Secretary	Shri P.K. Jain

Appendix 4

Members of Extension Council of IARI

(As on 31.12.2025)

Chairman
Dr. Ch. Srinivasa Rao, Director, IARI, New Delhi

Five Managerial Scientists representing six schools
Dr. B.S. Tomar, Head, Vegetables Sciences, School Coordinator, Horticultural Sciences

Dr. Pankaj, Head, Nematology and School Coordinator, Plant Protection

Dr. Gopala Krishanan S, Head, Genetics and School Coordinator, Crop Improvement

Dr. Renu Pandey, Head, Plant Physiology & School Coordinator, Basic Sciences

Dr. S.S. Rathore, Head, Agronomy, ICAR-IARI, New Delhi

Five Scientists representative of IARI
Dr. O.P. Awasthi, Head, Fruits and Horticultural Technology, IARI

Dr. Radha Prasanna, Head, Microbiology, IARI

Dr. A. K. Singh, I/C CATAT

Dr. G.P. Mishra, Head, SST, IARI, New Delhi

Dr. Gyanendra Singh, I/C, Seed Production, Unit, IARI

One Project Coordinator/ Project Director
Dr. P.S. Brahmanand, Project Director, WTC, IARI
One Scientist, from IARI Regional Research Station

Dr. Shiv K. Yadav, Head, IARI Regional Station, Karnal

One Representative of Deptt. of Agriculture, MoA
Dr. P.K. Singh, Agril. Commissioner, MoA & FW

Two Representatives of Delhi Administration
Sh. Chandra Pal Singh, Extension Officer, Agril. Deptt., Delhi Govt.

One Extension Scientist representative of Livestock Development and Animal Health Cover
Dr. Hans Ram Meena, Head (Extension Education), ICAR-IVRI, Izzatnagar, Bareilly

Director (Farm Information), Directorate of Extension, MoA
Dr. Shailesh Kumar Mishra, Director (Farm Information Unit) Directorate of Extension, Krishi Vistar Sadan, IARI Campus New Delhi

Dy. Director General (AE), ICAR

Dr. R.N. Padaria, Jt. Director (Extension), IARI, New Delhi

Dr. Viswanathan C., Joint Director (Research), IARI, New Delhi

Sh. P.K. Jain, Joint Director (Admn.), IARI, New Delhi

Sh. Avesh Yadav, Sr. Comptroller, IARI, New Delhi

Head, Agricultural Extension, IARI, New Delhi
Dr. Satyapriya, Head, Ag. Extension, IARI, New Delhi (Member-Secretary)

Mr. Rajesh Aggarwal, Managing Director, (Agro-Industry Representative) Insecticide India Limited, 401-402, Lusa Tower, Azadpur Commercial Complex Delhi-33)

Sh. B.K. Santosh (DD Representative)

Sr. Production Executive, DD Kisan

Sh. Shiv Nandan Lal (The Additional Director General Representative)
All India Radio, Akashwani Bhawan

Farmers
Shri Pritam Singh, Panipat, Progressive Farmer, Haryana

Shri Sukhjeet Singh, Progressive Farmer Sangrur, Punjab

Appendix 5

Members of Institute Research Council (IRC)

(As on 31.12.2025)

Chairperson
Director, ICAR-IARI, New Delhi

Co-chairperson
Joint Director (Research), IARI

Members
Deputy Director General (Crop Sciences), ICAR

Project Directors/Project Coordinators of IARI

Heads of Divisions / Regional Stations of IARI

Principal Investigators of IARI

Member Secretary
In-charge, PME Cell, IARI

Appendix 6

Members of Institute Joint Staff Council (IJSC)

(As on 31.12.2025)

Chairman
Dr. Ch. Srinivasa Rao
Director, ICAR-IARI, New Delhi

Members (Official Side)
Joint Director (Extension), ICAR-IARI, New Delhi

Joint Director (Research), ICAR-IARI, New Delhi

Head, IARI-RS, Wellington, ICAR-IARI, New Delhi

Head, IARI-RS, Indore, ICAR-IARI, New Delhi

Sr. Comptroller, ICAR-IARI, New Delhi

Secretary (Official Side)
Joint Director (Admn.), ICAR-IARI, New Delhi

Members of the Staff Side (Elected)

Sh. Yogesh Kumar
AAO, Agril. Extension, Secretary (Staff side), ICAR-IARI, New Delhi

Sh. Pankaj Kumar
Assistant, Directorate

Sh. Jag Mohan Tiwari
Assistant, Directorate

Sh. Raj Kumar
Assistant, Directorate

Sh. Sunil Kumar
Technical Assistant, Agril. Engineering

Sh. Koshal Kishor Sameriya
Technical Officer, Division of Plant Pathology

Sh. Rakesh Kumar
Technical Assistant, Agril. Engineering

Sh. Praveen
Technician, Division of Agril. Extension

Sh. Raj Pal
MTS, Directorate

Sh. Dharmendra Kumar
MTS, CATAT

Sh. Umesh Thakur
MTS, Directorate

Sh. Sunil
MTS, Division of Seed Science and Technology

Appendix 7

Members of Grievance Committee of IARI

(As on 31.12.2025)

Chairman
Dr. P.S. Brahmanand
PD, WTC

Members (OffiMembers
Dr. Sanjay Singh Rathore
Head, Division of Agronomy

Sh. A.K. Soni
Chief Admin Officer, Directorate

Members of the Staff Side (Elected)
Dr. Indu Chopra,
Scientist, Division of SS&AC

Ms. Kanya
Technical Assistant, Division of Plant Physiology

Sh. B. S. Rawat
Private Secretary, Publication Unit

Member-Secretary
Smt. Vinita
AAO, IMC

Appendix 8
Personnel
(As on 31.12.2025)

Director
Dr. Ch. Srinivasa Rao Cherukumalli

Joint Director (Research)
Dr. Viswanathan Chinnusamy

Dean & Joint Director (Education)
Dr. Anupama Singh

Joint Director (Extension)
Dr. R.N. Padaria

Joint Director (Adm.) & Registrar
Mr. P.K. Jain

Principal Scientist (PME)
Dr. Pramod Kumar

Incharge, Publication Unit
Dr. Anjali Anand

Senior Comptroller
Sh. Avesh Yadav

Chief Administrative Officer
Sh. Ravi Chauhan

Agricultural Chemicals
Head
Dr. N.A. Shakil
Professor
Dr. Suman Gupta

Network Coordinator (Pesticide Residue)
Dr. Vandana Tripathi

Agricultural Economics
Head
Dr. Alka Singh
Professor
Dr. Pramod Kumar

Agricultural Engineering
Head
Dr. P.K. Sahoo
Professor
Dr. Murtaza Hassan

Agricultural Extension
Head
Dr. Satyapriya
Professor
Dr. Manjeet Singh Nain

Agricultural Physics
Head
Dr. Subhash Nataraja Pillai
Professor
Dr. P. Krishnan

Agronomy
Head
Dr. Sanjay Singh Rathore
Professor
Dr. Y.S. Shivay

Biochemistry
Head
Dr. Suresh Kumar (Acting)
Professor
Dr. Ranjit Ranjan Kumar

Entomology
Head
Dr. Mukesh Kumar Dhillon
Professor
Dr. Subramanian S

Floriculture and Landscaping
Head
Dr. Markandey Singh
Professor
Dr. K.P. Singh

Fruits and Horticultural Technology
Head
Dr. O.P. Awasthi
Professor
Dr. R.M. Sharma

Genetics
Head
Dr. Gopala Krishnan S.
Professor
Dr. C. Bhardwaj

Microbiology & CCUBGA
Head
Dr. Radha Prasanna
Professor
Dr. Rajiv Kaushik

Nematology
Head
Dr. Pankaj
Professor
Dr. Anil Sirohi

Plant Pathology
Head
Dr. M.S. Saharan
Professor
Dr. Aundy Kumar

Plant Physiology
Head
Dr. Renu Pandey
Professor
Dr. Anjali Anand

Food Science & Post Harvest Technology
Head
Dr. Dinesh Kumar
Professor
Dr. Ram Asrey

Seed Science and Technology
Head
Dr. Gyan Prakash Mishra
Professor
Dr. Monika Atul Joshi

Soil Science and Agricultural Chemistry
Head
Dr. Debasish Mandal
Professor
Dr. T.J. Purakayastha

Vegetable Science
Head
Dr. B.S. Tomar
Professor
Dr. Ramesh Kumar Yadav

Environment Science
Head
Dr. S. Naresh Kumar
Professor
Dr. D.K. Sharma

Water Technology Centre
Project Director
Dr. P.S. Brahmanand
Professor
Dr. Khajanchi Lal

Centre for Agricultural Technology Assessment and Transfer
Incharge
Dr. A.K.Singh

Centre for Protected Cultivation Technology
Incharge
Dr. P.S. Brahmanand

Agricultural Knowledge Management Unit (AKMU)
Incharge
Dr. Amrender Kumar

Agricultural Technology Information Centre (ATIC)
Incharge
Dr. N.V. Kumbhare

Farm Operation Service Unit
Incharge
Dr. J.P. Sinha

National Phytotron Facility
Incharge
Dr. Akshay Talukdar

Seed Production Unit
Incharge
Dr. Gyanendra Singh

Zonal Technology Management & Business Planning and Development (ZTM & BPD) Unit
Incharge
Dr. Akirti Sharma

IARI Library
Coordinator (Library Services)
Dr. Dinesh Kumar Sharma

IARI Regional Station, Amartara Cottage, Shimla
Head
Dr. Dharam Pal

IARI Regional Station, Indore
Head
Dr. Jang Bahadur Singh

IARI Regional Station, Kalimpong
Incharge
Dr. Sujit Sarkar

IARI Regional Station, Karnal
Head
Dr. Shiv Kumar Yadav

IARI Regional Station, Katrain
Head
Dr. Chandar Prakash

IARI Regional Station, Pune
Head
Dr. Anil Khar

IARI Regional Station, Pusa
Incharge (Acting)
Dr. Priya Ranjan Kumar

IARI Regional Station, Wellington (The Nilgiris)
Head
Dr. M. Sivaswamy

IARI Rice Breeding & Genetics Research Centre, Aduthurai
Incharge
Dr. M. Nagarajan

IARI Centre for Improvement of Pulses in South, Dharwad
Incharge
Dr. B.S. Patil

IARI Krishi Vigyan Kendra, Shikohpur, Gurgaon
Incharge (Acting)
Dr. Rajiv Kumar Singh

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