वार्षिक प्रतिवेदन
Annual Report 2024

भा.कृ.अनु.प. – भारतीय कृषि अनुसंधान संस्थान - झारखण्ड

ग़ौरिया करमा (खेरौन), हजारीबाग– 825405, झारखण्ड , भारत

ICAR - Indian Agricultural Research Institute - Jharkhand

Gauria Karma (Kheron), Hazaribagh – 825405, Jharkhand , INDIA

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Editors:

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Dr. Monika M

Dr. Asha Kumari

Conceptualization

Prof. (Dr.) Vishal Nath
Officer on Special Duty
ICAR - Indian Agricultural Research Institute - Jharkhand,
Gauria Karma (Kheron), Hazaribagh – 825405, Jharkhand,
INDIA

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Dr. Ch. Srinivasa Rao
Director & Vice Chancellor
ICAR - Indian Agricultural Research Institute - Jharkhand,
Gauria Karma (Kheron), Hazaribagh – 825405, Jharkhand,
INDIA
E-mail: iarijharkhand@gmail.com
Web: http://www.iarij.res.in

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Foreword

Agriculture is the backbone of Indian economy with over 58 percent of the population deriving their livelihood and income from agriculture and allied activities. Indian agriculture experiences a vast range of climatic and socio-economic conditions throughout the country and requires agricultural planning and strategies as per the unique characteristics of different geographical areas. Despite these challenges, our country has witnessed unprecedented progress in agriculture and allied sectors, especially in last five decades. However, the eastern regions of India, known for its rich biodiversity, high rainfall, fertile Indo-Gangetic plains and Chota Nagpur plateau, could not attain it with same pace as achieved by the western and southern parts of the country. The ICAR-Indian Agricultural Research Institute (IARI) Jharkhand was conceived by the Hon'ble Union Government to harness this untapped potential in agriculture, animal husbandry, fisheries, horticulture, forestry etc. and drive inclusive agricultural growth in the eastern regions of India, comprising of Bihar, Chhattisgarh, Eastern UP, Jharkhand, Odisha and West Bengal.

IARI-Jharkhand is a premium institute under the aegis of Indian Council of Agricultural Research, New Delhi to execute agricultural research, and extension targeting the challenges and opportunities in eastern regions of the country. The research and outreach programs mainly focus on multidisciplinary approach, encompassing crop improvement, sustainable agricultural practices, natural resource management and technology dissemination in animal husbandries and fisheries. In recent years, it has emerged as one of the prime institutions in agricultural education as ICAR-IARI Mega University Jharkhand Hub, imparting Bachelor's and Master's degrees in agricultural sciences.

The institute has state-of-the-art infrastructure including administrative building, guest house, two hostels, smart classrooms and moderately equipped laboratories to support its academic mission. More infrastructures are coming up. A total of 15 M.Sc. students have completed their degree in various disciplines of agricultural sciences during the period. As per availability of expertise and with modest facilities at the institute, research is focused on creating genetic resources of various field and horticultural crops like, rice, wheat, maize, pigeon pea, lentil, mungbean, chickpea, papaya, mango, guava and vegetable crops, developing natural resource maps, identifying efficient cropping zones in Jharkhand, evaluating suitable feeding and management systems for milch bovine and goats, studies on soil microbes etc. Efforts are underway for improving aluminium toxicity tolerance and phosphorus use efficiency under acidic soils of Jharkhand. High-end laboratory work on various aspects of molecular and qualitative evaluations is being undertaken in cereals, pulses and vegetable crops in collaboration with ICAR-IARI, New Delhi and ICAR-IIAB, Ranchi to maintain quality research in different fields. IARI Jharkhand has also been actively working at the grassroots level through schedule caste sub plan (SCSP) and tribal sub plan (TSP) projects to uplift marginalized farming communities.

The ICAR-IARI, Jharkhand is getting 11 years old on June 28th, 2025. The 11th Foundation Day of IARI-Jharkhand is a milestone that highlights a decade of agricultural research, education, and innovation in the region and I am honoured to release the second annual report of the institute on this occasion. I would like to express my sincere thanks to all the scientific, administrative and financial staffs, students and contractual supporting staff of IARI-Jharkhand for their hard work and contributions in various institute activities. I would also like to acknowledge the staffs of ICAR-IARI, New Delhi for their guidance and support in creating various facilities at this remote location in Jharkhand.

I express my gratitude to Former Secretary, DARE and Director General, ICAR, Dr. Himanshu Pathak and Secretary, DARE and Director General, ICAR, Dr. Mangi Lal Jat for their inspiring guidance and continuous support to our Institute. I would also like to thank Dr. T.R. Sharma, Former DDG (Crop Science), ICAR and Dr. D.K. Yadava, DDG (Crop Science), ICAR for their continuous guidance and encouragements and acknowledge the cooperation from all collaborators and supporters.

Last, but not the least, I express my sincere appreciation to the annual report editorial team for their hard works in bringing out the annual report timely.

(**Ch. Srinivasa Rao**)
Director & Vice Chancellor
ICAR-IARI-Jharkhand

Preface

I am pleased to present the Second Annual Report of ICAR-IARI-Jharkhand, highlighting our progress and achievements during the year 2024-25. Our institute continues to fulfil its mandate of addressing agricultural challenges in Eastern India, a region blessed with natural resources but facing productivity constraints. This year has been particularly rewarding as we have made significant strides across research, education and extension activities.

On the academic front, we now have 36 postgraduate students across four key disciplines and 169 undergraduate students in our B.Sc. Agriculture program. It is encouraging to see 43 of our M.Sc. graduates receiving their degrees from IARI-New Delhi convocations, reflecting the quality of education we provide.

Our research efforts have yielded promising results. In crop improvement, we identified several high-performing maize hybrids and developed varieties suited to acidic soil conditions- a major constraint in our region. Notable progress was made in pulses research with promising lentil and mung bean lines showing good adaptation to local conditions. Our collaboration with ICAR-NBSS & LUP has resulted in district-wise crop recommendations in Jharkhand state, which will greatly benefit farmers in making informed choices.

We have also made headway in addressing soil health issues through innovative bacterial consortia and biological interventions. These solutions are particularly relevant for improving productivity in our acidic soils. In animal husbandry, our interventions in scientific livestock farming and dissemination of location-specific advisories are enhancing livelihood opportunities for farming communities. Furthermore, the identification of superior fodder crops suited best for the agroclimatic conditions of the region like hybrid napier and cowpea will bolster livestock productivity. The integrated farming approach we have adopted, combining crops with livestock and fisheries, is showing excellent potential for sustainable agriculture and improving livelihoods across the farming community.

Our extension programs, strengthened through collaborations with relevant state line departments such as the Department of Agriculture (for dissemination of improved crop varieties like rice, pulses, and maize, and soil health practices), the Department of Animal Husbandry and Dairying (for promoting scientific goat and pig farming, poultry farming and improved fodder utilization) and the Department of Fisheries, Jharkhand (for advancements in aquaculture), have successfully reached farming communities. The positive response from farmers and measurable improvements in soil health validate our research-to-field approach.

Looking ahead, we remain committed to developing climate-resilient solutions tailored to Jharkhand's unique conditions. The foundation we have built over these years, positions us well to contribute meaningfully to agricultural transformation in Eastern India.

I thank our dedicated team of scientists, staff and students whose hard works have made these achievements possible. My gratitude also goes to Dr. Ch. Srinivasa Rao, Director, ICAR-IARI-Jharkhand for his continued guidance and support.

The partnerships we have forged with various institutions and farming communities continue to strengthen our impact. As we move forward, I am confident that ICAR-IARI-Jharkhand will play an increasingly important role in the region's agricultural development.

(**Vishal Nath**)
OSD
ICAR-IARI-Jharkhand

Executive Summary

Academic

Postgraduate program: IARI Jharkhand has started M.Sc. (Agriculture) program from the year 2015. In 2024-25 academic session, 18 students took admission through ICAR-AIEEA (PG) entrance examination across four disciplines (Genetics & Plant Breeding, Fruit Science, Vegetable Science, and Soil Science & Agricultural Chemistry). Currently, 36 students are enrolled in PG program. Recently 28 and 15 numbers of M Sc (Ag) students have received their degrees from 62nd and 63rd convocations, respectively held in IARI-New Delhi.

Undergraduate program: IARI Jharkhand has started B.Sc. (Agriculture) program from the year 2022. In 2024-25 academic session, 58 students took admission out of total 66 seats available through ICAR-AIEEA (UG) entrance examination. Currently, a total of 169 students are pursuing their UG program.

Research

In the year 2024, ICAR-IARI, Jharkhand has made a notable progress in crop-livestock-fishery research to enhance agricultural sustainability in the eastern region, which is rich in natural resources in terms of fertile soil, water resources and solar radiation, but lacks in adequate land productivity due to one or the other reason.

In maize, extensive multi-location trials and stability analyses have identified high-yielding baby corn hybrids (CR105, CR174, CR99, CR104, CR168, CR70, and CR87) suited to diverse agro-climatic zones. Under acidic and neutral soil conditions, genotypes P53 and P66 showed promise for acid soil tolerance, while hydroponic screening of 250 lines under aluminium stress revealed IMR349, IMR543 and IMR534 as tolerant lines. Furthermore, 38 elite maize inbreds have been developed for Eastern India.

In pulses like mung bean and lentil, genetic diversity studies were conducted focusing on abiotic stress resilience. Two lentil lines, PDL-1 and PSL-9 are under multilocation evaluation and they have been found as promising. Screening of 228 mung bean accessions from acidic regions identified wide variability and high heritability for phosphorus-use efficiency (PUE) and yield traits. Multivariate analyses revealed distinct diversity under low and optimal phosphorus.

In pigeonpea, 50 germplasm lines and 77 MAGIC lines were maintained, and promising lines under rainfed conditions have been advanced. GMFS lines exhibiting monogenic male-female sterility were validated, and a tissue culture protocol for genetic transformation in pigeonpea has been standardized. ICAR-IARI Jharkhand advanced wheat phosphorus use efficiency, identifying 10 superior lines.

Elite fruit crops like mango, lemon, and custard apple have been collected for regional evaluation. Okra and brinjal breeding yielded promising hybrids and high-yielding lines with disease resistance, supporting sustainable crop improvement under Eastern Plateau conditions.

Under a collaborative methodological study with ICAR-NBSS & LUP, Nagpur, relative spread index (RSI) and relative yield index (RYI) were applied to identify efficient cropping zones in Jharkhand for maize (rabi), wheat, pigeon pea, lentil, potato and guava, using data from 2022-2024. This study revealed district-level recommendations, improving region-specific agricultural planning.

Soil and crop management efforts included evaluation of osmotolerant bacterial consortia under varied irrigation, significantly improving wheat yield in acidic soils. Native diazotrophs enhanced rice productivity and nitrogen-use efficiency, while 50 low-pH tolerant cyanobacterial strains were conserved and physiologically characterized. Natural farming practices and resource mapping revealed improvements in soil health and crop performance across undulating terrain. Enzymatic modification of jackfruit starch (MEF-assisted hydrolysis) was found to enhance its utility in food and pharmaceutical sectors.

In livestock, goat and pig production remains a key livelihood in tribal-dominated villages. ICAR-IARI, Jharkhand facilitated scientific interventions in pig farming and disseminated location-specific advisories. Evaluation of fodder crops revealed Kamdhenu hybrid napier as the best performer for forage yield, and Bundel Lobia emerged superior amongst the fodder cowpeas under acidic conditions.

In fisheries, a model aquaculture farm has been developed with optimized pond structures to address local soil limitations. Performance recording of five carp species- Catla, Rohu, Common carp, Grass carp and Black carp is in progress under controlled feeding conditions. These integrated crop-livestock-fishery initiatives aim to foster sustainable and climate-resilient agricultural systems tailored to the unique agro-ecological context of Jharkhand.

कार्यकारी सारांश

शैक्षणिक

स्नातकोत्तर कार्यक्रम: आईसीएआर-आईएआरआई, झारखंड ने वर्ष 2015 से स्नातकोत्तर (एम.एस.सी कृषि) कार्यक्रम शुरू किया है। 2024-25 शैक्षणिक सत्र में, 18 छात्रों ने चार विषयों (पादप आनुवंशिकी और पादप प्रजनन, फल विज्ञान, सब्जी विज्ञान, और मृदा विज्ञान और कृषि रसायन विज्ञान) में ICAR-AIEEA (PG) प्रवेश परीक्षा के माध्यम से प्रवेश लिया। वर्तमान में, 36 छात्र पीजी कार्यक्रम में नामांकित हैं। हाल ही में आई.ए.आर.आई-नई दिल्ली में आयोजित 62वें और 63वें दीक्षांत समारोह में क्रमशः 28 और 15 एम.एस.सी (कृषि) छात्रों ने अपनी डिग्री प्राप्त की है।

स्नातक कार्यक्रम: आई.ए.आर.आई झारखंड ने वर्ष 2022 से स्नातक कार्यक्रम (बी.एस.सी, कृषि) कार्यक्रम शुरू किया है। 2024-25 शैक्षणिक सत्र में, ICAR-AIEEA (UG) प्रवेश परीक्षा के माध्यम से उपलब्ध कुल 66 सीटों में से 58 छात्रों ने प्रवेश लिया। वर्तमान में, संस्थान में कुल 169 छात्र अपने स्नातक कार्यक्रम में अध्ययन कर रहे हैं।

अनुसंधान

वर्ष 2024 में, आईसीएआर-आईएआरआई, झारखंड ने पूर्वी भारत में कृषि को बढ़ावा देने के लिए फसल-पशुधन-मत्स्य अनुसंधान में उल्लेखनीय प्रगति की है, जो की उपजाऊ मिट्टी, जल संसाधनों और सौर विकिरण के मामले में प्राकृतिक संसाधनों से समृद्ध है।

मक्का में, बहु-स्थान परीक्षण और स्थिरता विश्लेषण द्वारा उच्च उपज देने वाले बेबी कॉर्न हाइब्रिड (CR105, CR174, CR99, CR104, CR168, CR70, CR87) की पहचान की गई, जो विविध कृषि-जलवायु क्षेत्रों के लिए उपयुक्त हैं। अम्लीय मिट्टी सहिष्णुता जीनोटाइप P53 और P66 में पुष्ट हुई, जबकि एल्युमीनियम तनाव के तहत हाइड्रोपोनिक स्क्रीनिंग में सहिष्णु लाइनों IMR349, IMR543, और IMR534 का पता चला। इस क्षेत्र के लिए 38 उत्कृष्ट मक्का इनब्रेड विकसित किए गए।

दलहन शोध में मूंग और मसूर में अजैविक तनाव सहिष्णुता पर ध्यान केंद्रित किया गया। दो मसूर लाइनें (PDL-1, PSL-9) बहु-स्थान मूल्यांकन के अधीन हैं। अम्लीय मिट्टी से 228 मूंग नमूने की जांच में फॉस्फोरस उपयोग दक्षता (PUE) और उपज गुणों में उच्च परिवर्तनशीलता और उच्च आनुवंशिकता दिखाई दी। बहु-चर विश्लेषण ने विभिन्न फॉस्फोरस स्तरों पर स्पष्ट विविधता प्रकट की।

अरहर की 50 जर्मप्लाज्म लाइनें और 77 MAGIC लाइनें संरक्षित हैं; वर्षा आधारित परिस्थितियों में उन्नत लाइनों को बढ़ावा दिया गया। मोनोजेनीक मेल-फीमेल नपुंसकता वाली GMFS लाइनें सत्यापित की गईं, और अरहर के लिए जेनेटिक ट्रांसफॉर्मेशन हेतु टिशू कल्चर प्रोटोकॉल स्थापित किया गया। गेहूं सुधार में फॉस्फोरस उपयोग दक्षता पर बल दिया गया, जिसमें 10 श्रेष्ठ लाइनें पहचानी गईं।

आम, नींबू, और सीताफल जैसे उत्कृष्ट फल पौधों को क्षेत्रीय अनुकूलता के लिए संग्रहित और मूल्यांकन किया गया। भिंडी और बैंगन के बीजोत्पादन कार्यक्रमों में उन्नत उपज और रोग प्रतिरोधक क्षमता वाली संकर और उच्च उपज देने वाली लाइनें विकसित हुईं, जो पूर्वी पठार की परिस्थितियों के अनुकूल हैं।

आईसीएआर-एनबीएसएस एवं एलयूपी, नागपुर के सहयोग से, रिलेटिव स्प्रेड इंडेक्स (RSI) और रिलेटिव यील्ड इंडेक्स (RYI) विश्लेषण द्वारा झारखंड में मक्का (रबी), गेहूं, अरहर, मसूर, आलू और अमरूद के लिए प्रभावी कटाई क्षेत्रों की पहचान की गई, जिससे क्षेत्र-विशिष्ट खेती रणनीतियों को दिशा मिली।

मृदा एवं फसल प्रबंधन अनुसंधान में ऑस्मोटोलरेंट बैक्टीरियल कंसोर्टिया ने अम्लीय मिट्टियों में गेहूं की उपज में सुधार किया। देशज डायजोट्रॉफ ने धान की उत्पादकता और नाइट्रोजन उपयोग दक्षता बढ़ाई। 50 कम-पीएच सहिष्णु साइनोबैक्टीरिया प्रजातियों का संरक्षण और भौतिक-रासायनिक विश्लेषण किया गया। प्राकृतिक खेती के तरीकों और संसाधन मानचित्रण ने मृदा स्वास्थ्य और फसल प्रदर्शन में सुधार किया। MEF-सहायता प्राप्त हाइड्रोलिसिस द्वारा कटहल स्टार्च का एंजाइमेटिक संशोधन खाद्य और औषधि क्षेत्रों में इसके उपयोग को बढ़ावा देता है।

पशुपालन में, सूअर पालन जनजातीय क्षेत्रों में आजीविका का प्रमुख स्रोत बना हुआ है; आईसीएआर-आईएआरआई ने वैज्ञानिक हस्तक्षेप और क्षेत्र-विशिष्ट सलाह प्रदान की। कामधेनु हाइब्रिड नेपियर सर्वोत्तम चारा उपज देने वाला पाया गया, और अम्लीय परिस्थितियों में बुन्देल लोबिया किस्म लोबिया चारा के बीच श्रेष्ठ रही।

मृदा सीमाओं को ध्यान में रखते हुए अनुकूलित तालाब संरचना के साथ एक मॉडल एक्वाकल्चर फार्म स्थापित किया गया। पांच कार्प प्रजातियों— कटला, रोहू, कॉमन कार्प, ग्रास कार्प, और ब्लैक कार्प—को नियंत्रित आहार में परखा गया। ये समेकित फसल-पशुपालन-मछली पालन प्रयास झारखंड की विशिष्ट कृषि-परिस्थिति के अनुरूप, टिकाऊ और जलवायु-सहज कृषि प्रणाली विकसित करने का लक्ष्य रखते हैं, जो ग्रामीण आजीविका और खाद्य सुरक्षा को सुदृढ़ बनाते हैं।

1

Introduction

The Eastern region of India covering states like Bihar, Jharkhand, Odisha, West Bengal, and parts of Chhattisgarh, faces significant challenges in agricultural production, though it boasts fertile land and water resources. Despite potential, this region has not fully benefited from the green revolution and still lags behind other regions in agricultural productivity. Constraints include dependence on monsoon rains, poor irrigation infrastructure, fragmented land holdings, and limited access to quality agricultural inputs and markets etc. According to the United Nations' world population prospects-2022, India's population by 2050 is expected to rise to around 167 crores. Thus the country needs a second green revolution to feed 167 crores population by 2050, which can be realized from these eastern states of our country through holistic and integrated management of land, water, crops, biomass, horticultural, livestock, fishery and human resources. In this context, a proposal was placed to establish a state of the art Indian Agricultural Research Institute with Deemed University status in Jharkhand to accommodate the needs and to harness the potential of agriculture, animal husbandry, fisheries, horticulture and forestry. Later Shri Narendra Modi Ji, Honourable Prime Minister of India laid the foundation stone of IARI, Jharkhand on June 28, 2015 at 1000 acres of land in Gauriakarma village under Hazaribagh district of Jharkhand.

ICAR-IARI-Jharkhand is mandated with conducting basic, strategic and anticipatory research in frontier areas of agriculture and allied sectors, and developing human resources for academic excellence. At present the institute is operative under three schools namely, school of crop sciences, school of natural resource management and school of animal and fishery sciences to accomplish its research and extension activities, and even conducting cutting edge research in frontier areas (Fig 1). The institute has 11 divisions and it has sanctioned staff strength of 74 comprising of scientific (41), technical (22) and administrative (11) personnel. The institute has good infrastructure facilities of smart and virtual classroom for attending online classes, library, study room, laboratories, hostels, dedicated FOSU unit, large agri-cum-horticulture research farm area, outdoor game facility and guest house etc.

The institute has already served 10 years for the country, and solving the agrarian challenges and complexities of eastern India with linkages to different stakeholders in the region. It has undertaken research, education, and extension programmes in its mission towards developing quality human resources and generation of farmer-friendly technologies to enhance productivity as well as farm income. The institute is running its academic programme as PG outreach institute under Post Graduate School, ICAR-IARI, New Delhi since 2015-16 in several disciplines and started its UG programme for BSc (Ag) from 2022-23 session. Currently, 36 students are enrolled in PG programme, while a total of 169 students are pursuing their UG programmme.

The institute is also notably active and vibrant in conducting, collating and coordinating systematic research of crops, natural resources, livestock and fishes, transfer of new technologies and also offers training to government and non-government organizations, trainers, farmers, forest officers and other stakeholders. Institute is endeavouring in basic and applied research in several aspects *viz.*, cereal and pulse crops improvement, management of horticultural crops, management of natural resources, crop production and management, livestock and fish production. Institute has undertaken several research projects at levels like institute, inter-institute, externally funded collaborative projects to address the problems of low productivity of crops, livestock and fishes in eastern region of India. Other important activities of the institute are outreach programmes, conducted under SCSP, TSP and NEH budget of the institute to demonstrate the improved agricultural technologies at the doorsteps of farmers and other stakeholders in addition to providing direct benefits. The revised budget estimates of the institute constituted a total amount of rupees 2591 lakh for the year 2024.

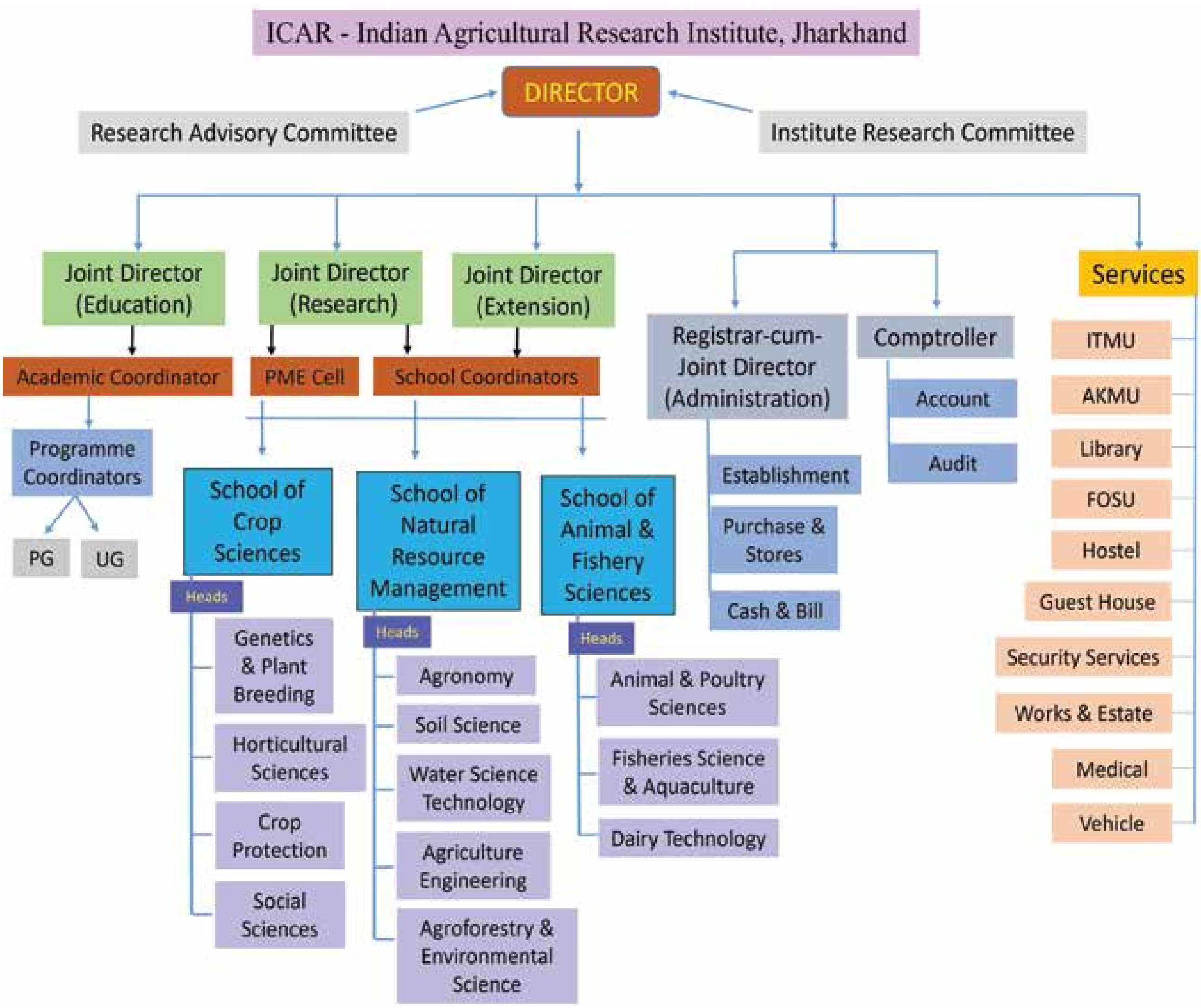


Fig 1.1 Organogram of the institute

2

Academic Achievements

Undergraduate program

IARI Jharkhand has started B.Sc. (Agriculture) program from the year 2022. In 2024-25 academic session (Oct 2024-Sept 2025), 58 students took admission out of total 66 seats available through ICAR-AIEEA (UG) entrance examination. As of now, a total of 169 students are pursuing their UG program (Table 2.1).

Table 2.1 Academic session-wise admission of UG students

Academic Session	2022-23	2023-24	2024-25
Students admitted	66	66	66
Current enrolment	55	56	58

Deeksharambh 2024, a recommendation of Sixth Dean Committee of ICAR

The Deeksharambh-2024 program, a Students' Induction-cum-Foundation Course, was organized from 15th to 28th October 2024. As part of the program, an exposure visit was conducted to various institutions in Hazaribagh, including the Central Rainfed Upland Rice Research Station (CRURRS) and Vinoba Bhave University (Table 2.2). In addition, a series of guest lectures and motivational sessions were conducted, featuring eminent speakers who contributed as resource persons. A variety of recreational activities aimed at team building and personality development were also organized. These included cultural events, sports activities, and yoga sessions to promote holistic development among the students. Exposure visits were also conducted for second and third year students (Table 2.2).

Table 2.2 Exposure visits and educational tours of B.Sc. (Agriculture) students held in 2024

Sl. No.	Place visited	Photographs
1	ICAR-Central Rainfed Upland Rice Research Station (CRURRS), a station of ICAR-CRRI, Cuttack	

Sl. No.	Place visited	Photographs
2	Vinoba Bhave University, Hazaribagh	
3	Food Corporation of India (FCI), Gaya	
4	BAU, Ranchi campus: Biofertilizer and seed processing unit	
5	Koderma Thermal Power Station	

Sl. No.	Place visited	Photographs
6	ICAR-RCER: Landscaping and hi-tech horticulture exposure	
7	Parasnath Wildlife Sanctuary for biodiversity exposure	 
8	BAU Farm, Hazaribagh	

Postgraduate program

Since 2015, IARI Jharkhand has started M.Sc. (Agriculture) program. In 2024-25 academic session (Oct 2024-Sept 2025), 18 students took admission through ICAR-AIEEA (PG) entrance examination across four disciplines (Genetics & Plant Breeding, Fruit Science, Vegetable Science, and Soil Science & Agricultural Chemistry). Currently, 36 students are enrolled in PG program. Recently 28 and 15 numbers of M Sc (Ag) students have received their degrees from 62^{nd} and 63^{rd} convocations held in IARI-New Delhi, respectively (Table 2.3-2.4). Mr. Satyam Rawat (Agronomy) got the IARI Merit Medal for outstanding academic performances in 62^{nd} Convocation held in 2024, while Mr. Arijit Chowdhuri (Soil Science) got the IARI Merit Medal for outstanding academic performances in the 63^{rd} Convocation held in 2025.

Table 2.3 M.Sc. (Ag) students who received degrees in 62nd convocation, 2024 (Batch: 2021-23)

Sl. No.	Name of student	Discipline	Thesis title	Name of the chairperson
1	Devireddy Meghana	Vegetable Science	Study on morphological, biochemical, and molecular diversity in vegetable soybean [*Glycine Max* (L.) Merrill]	Dr. Rabi Sankar Pan
2	B R Vasavi Devi	Vegetable Science	Genetic diversity and heterosis studies in okra for yield and quality attributes under Eastern Plateau Region of India	Dr. Krishna Prakash
3	Ankit Kumar Sinha	Vegetable Science	Genetic diversity studies in pointed gourd (*Trichosanthes Dioica* Roxb.) for yield & quality attributes	Dr. Arun Kumar Singh
4	Sarmistha Priyadarshini	Soil Science	Aggregation behavior of biochar and its impact on carbon and phosphorus fractions in an acidic Inceptisol under rice-wheat system	Dr. Manoj Chaudhary
5	Subhajeet Sarkar	Soil Science	Leaching loss of nutrients under different nutrient management options in maize and brinjal on an Alfisol	Dr. Sushanta Kumar Naik
6	Sayan Makur	Seed Science and Technology	Assessing the efficacy of seed coating with microbial formulations for quality enhancement in wheat (*Triticum Aestivum* L.)	Dr. Priya Ranjan Kumar
7	Mujtahida Khatun	Seed Science and Technology	Evaluation of seed coating with microbial formulations for enhancing seed yield and quality in chickpea (*Cicer Arietinum* L.)	Dr. Priya Ranjan Kumar
8	Lokesha G	Plant Pathology	Investigations on morpho-biological and biochemical alterations as influenced by groundnut bud necrosis Orthotospovirus (Gbnv) in tomato plants	Dr. Basavaraj
9	Cheruku Roshini	Plant Pathology	Biocontrol potential of *Beauveria Bassiana* (Bals) Vuill. against soil borne pathogens of chickpea	Dr. Tusar Kanti Bag
10	Ayesha Siddiqa	Plant Pathology	Characterization, diversity analysis of *Clavibacter Michiganensis* subsp. Michiganensis and evaluation of resistance source against bacterial canker of tomato	Dr. Dinesh Singh
11	Nallapareddy Bavana Reddy	Microbiology	Evaluating potential diazotrophic inoculants for boosting the productivity of DSR and transplanted rice under acidic soil conditions	Dr. (Ms.) Himani Priya
12	Raghavendra J S	Microbiology	Taxonomic and functional annotation of seed microbiome of parents-hybrid complex of *Zea mays*	Dr. (Ms.) Archna Suman
13	Bhargava Kotte	Genetics and Plant Breeding	Genetic analysis of kernel row number (Krn) gene(s) in the manifestation of heterosis in maize (*Zea mays* L.)	Dr. P Bhavana

Sl. No.	Name of student	Discipline	Thesis title	Name of the chairperson
14	Sayan Goswami	Genetics and Plant Breeding	Genetic diversity analysis for low phosphorus tolerance in mung bean germplasm	Dr. Anima Mahato
15	Firos Basha T M	Genetics and Plant Breeding	Genetic diversity and association mapping of early vigour in aus rice (*Oryza Sativa* L.)	Dr. Somnath Roy
16	Saikat Dey	Fruit Science	Morpho-biochemical and molecular characterization of segregating population of litchi (*Litchi chinensis* Sonn)	Dr. Mahesh Kumar Dhakar
17	Ms. Madhumathi	Fruit Science	Effect of Tephrosia biomass mulching on mango (*Mangifera indica* L.) under the rainfed upland condition	Dr. Bikash Das
18	Sai Kiran Burji	Environmental Sciences	Metal oxide nanoparticle production from agricultural byproducts and their application in removal of arsenic contaminated water	Dr. (Ms.) Anita Chaudhary
19	Mutra Balakrishna Reddy	Environmental Sciences	Effect of rice straw biochar application to rain-fed paddy soil on net ecosystem carbon balance and global warming potential	Dr. Dipak Kumar Gupta
20	Kirankumar H	Entomology	Allelochemical and antixenotic resistance traits of litchi fruits against *Conopomorpha Spp.* complex	Dr. Jaipal Singh Choudhary
21	Arbud Lala	Entomology	Population dynamics and bio-intensive management of insect pest complex in high-density mango orchards	Dr. Jaipal Singh Choudhary
22	Satyam Rawat	Agronomy	Effect of nano-urea on maize productivity and nitrogen use efficiency in acid soil of Jharkhand	Dr. Rajiv Kumar Singh
23	Indrani Saha	Agronomy	Effect of planting density and nitrogen management on hybrid maize (*Zea mays*) in Eastern India	Dr. Shankar Lal Jat
24	Inuganti Kavya	Agronomy	Effect of row arrangements in maize- based intercropping systems on productivity and profitability in Eastern India	Dr. Amal Ghosh
25	Tanmay Das	Agronomy	Effect of nano urea application for enhancing productivity of rainfed maize (*Zea mays* L.)	Dr. Teekam Singh
26	Nuthaki Venkata Leela Krishna Chaithanya	Agricultural Extension	Postural ergonomic assessment of paddy cultivation practices in coastal region of Andhra Pradesh	Dr. (Ms.) Sukanya Barua
27	Amit Sinha	Agricultural Extension	A study on effectiveness of public distribution system in Bihar	Dr. (Ms.) Sangeetha Vellaichamy
28	Rauminsh Kumar	Agricultural Engineering	Lysimeter based crop evapotranspiration and crop coefficients for furrow-irrigated maize and brinjal in the hot and sub-humid region	Dr. Santosh Sambhaji Mali

Table 2.4 M.Sc. (Ag) students who received degrees in 63rd Convocation, 2025 (Batch: 2022-24)

Sl. No.	Name of student	Discipline	Thesis title	Name of the chairperson
1	Theja M J	Vegetable Science	Genetic studies for yield and quality traits in advanced breeding lines of brinjal (*Solanum melongena* L.)	Dr. Krishna Prakash
2	Purbasa Kole	Soil Science	Soil carbon and nitrogen pools under different cropping systems of the Eastern Plateau and Hills Region	Dr. Sushanta Kumar Naik
3	Arijit Chowdhuri	Soil Science	Impact of natural farming on carbon fractions and properties in an alfisol under rice-rabi maize system	Dr. Manoj Chaudhary
4	Samrat Rej	Seed Science and Technology	Effect of seed coating with microbial formulations on seed yield and quality in green gram [*Vigna radiata* (L) R. Wilczek]	Dr. Priya Ranjan Kumar
5	Tanisha Metia	Plant Pathology	Deciphering bio-compatibility between *Trichoderma Spp* and *Pseudomonas Spp.* and its bioefficacy against *Sclerotinia sclerotiorum*	Dr. Lakshman Prasad
6	Jyoti Kumari Agarwal	Plant Pathology	Patho-genetical studies of Fusarium wilt resistance in tomato	Dr. Veerubommu Shanmugam
7	Bhaskar Chodasani	Genetics and Plant Breeding	Exploring the genetic and adaptive diversity of Oryza species naturalized in Jharkhand, India	Dr. P Bhavana
8	Jyotsna Maurya	Genetics and Plant Breeding	Genetic diversity analysis for low phosphorous tolerance in lentil germplasm	Dr. Anima Mahato
9	Aiswarya V S	Genetics and Plant Breeding	Exploring phosphorus starvation tolerance in Aus Rice (Oryza Sativa L.) and deciphering the genetic basis of tolerance through genome-wide association studies	Dr. Somnath Roy
10	Ayan Deb	Genetics and Plant Breeding	Genetic diversity and marker trait association analysis for morpho-biochemical traits in coloured rice (*Oryza sativa* L.) collected from Chhotanagpur Plateau	Dr. Shashi Bhushan Choudhary
11	Shivam Kumar Rajpoot	Fruit Science	In-situ characterization and diversity analysis of custard apple (*Annona squamosa* L.) germplasm of Chotanagpur Plateau Region	Dr. Mahesh Kumar Dhakar
12	Ramakrishna Panda	Environmental Sciences	Mapping of variation in soil organic carbon stock within IARI-Jharkhand farm	Dr. Dipak Kumar Gupta
13	Ashwini Yadav	Environmental Sciences	Isolation, characterization of biosurfactant and their effect on hydrocarbons' degradation in different soils	Dr. Ashish Khandelwal
14	Komal Priya Mitte	Entomology	Comparative symbiotic bacterial communities associated with litchi leaf roller, *Statherotis leucaspis* (Meyrick, 1902) (Lepidoptera: Tortricidae) reared on different litchi varieties	Dr. Jaipal Singh Choudhary
15	Pratyasha Mishra	Agricultural Engineering	Modelling water and nutrient dynamics of mustard crop under deficit irrigation	Dr. Santosh Sambhaji Mali

3

Research Achievements

1. Plant genetic resources and crop improvement

Genetic improvement of maize

Multilocation evaluation and stability analysis of baby corn hybrids

A multilocation trial was conducted to evaluate the performance of 60 baby corn hybrids (crosses developed at ICAR-IARI, Jharkhand) along with two standard checks across four diverse environments representing three agro-climatic zones: Hazaribagh, Jharkhand (NEPZ- North Eastern Plain Zone), Dholi, Bihar (NEPZ), Hyderabad, Telangana (PZ-Peninsular Zone), Barapani, Meghalaya (NHZ-North Hill Zone). The comprehensive analysis revealed significant genotype × environment (G×E) interactions for important traits including first picking date (PD), baby corn yield with husk (BCWH), baby corn yield without husk (BCWOH), and fodder weight (FW). This indicated that hybrid performance varied notably across locations, emphasizing the need for stability analysis. Based on the mean vs stability graphs for BCWOH and FW, hybrids CR 105, CR 174, CR 99 and CR 104, CR 165 demonstrated superior performance by combining high mean yield with good stability across environments, consistently outperforming the checks (Fig 3.1-3.2). The 'which-won-where' GGE biplot analysis further dissected location-specific adaptability. It identified CR 104 as the best performing hybrid at both Hazaribagh and Hyderabad locations, and CR 153 as the winning hybrid at Dholi and Barapani locations for baby corn yield without husk (BCWOH) (Fig 3.3-3.4). In the discriminativeness vs representativeness analysis, Hazaribagh environment emerged as both highly discriminative and highly representative, making it the ideal testing site for effective selection of superior genotypes with broad adaptability. Correlation analysis revealed a significant positive correlation between fodder weight (FW) and baby corn weight without husk (BCWOH) (r= 0.41**), and between baby corn weight with husk (BCWH) and baby corn weight without husk (BCWOH) (r= 0.62**). These correlations suggested that enhancing BCWH could simultaneously improve both BCWOH and FW, benefiting both marketable yield and fodder production. In conclusion, hybrids CR 105, CR 174, and CR 99 were identified as promising candidates exhibiting high yield potential, greater stability, and wider adaptability, making them highly suitable for further advancement in baby corn breeding programs targeted at diverse agro-climatic regions.

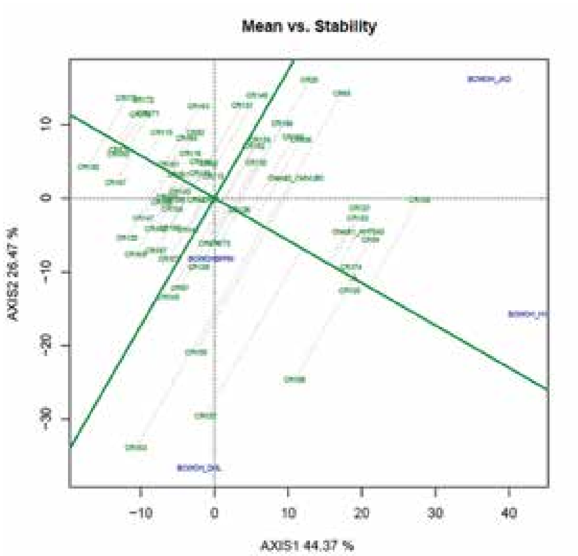


Fig 3.1 Mean vs stability for baby corn yield without husk

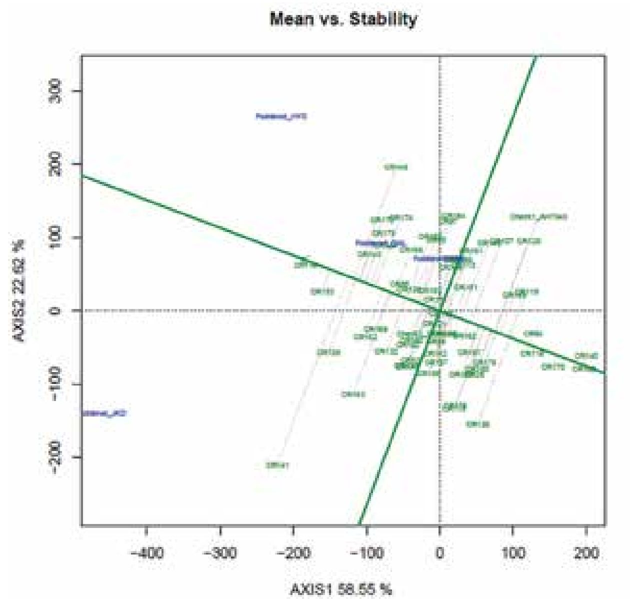


Fig 3.2 Mean vs stability for fodder weight

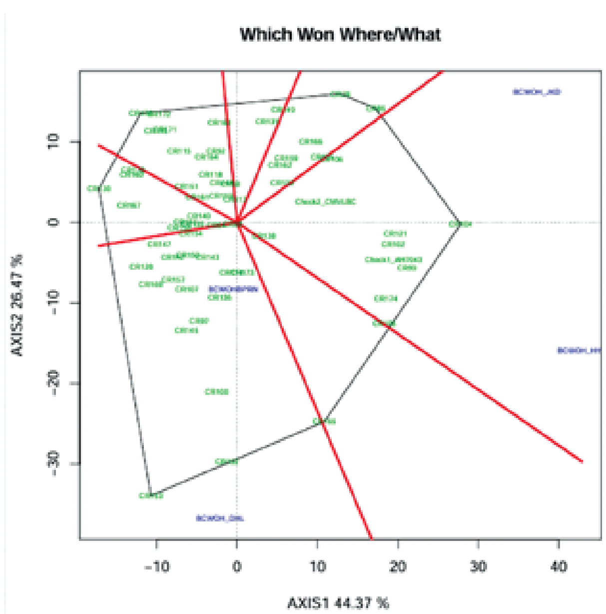


Fig 3.3 Which won where (baby corn yield without husk)

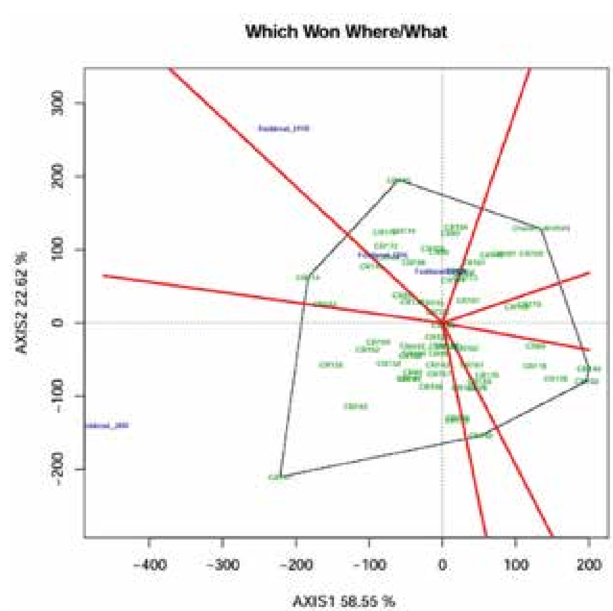


Fig 3.4 Which won where (fodder weight)

For AMMI stability value (ASV) and yield stability index (YSI), CR 104 followed by CR165, AH7043 (C), CR121, CR105, CR114, CR174, CR152 and CR 99 ranked below 10 with the lowest YSI value, indicating the best combination of high yield and stability (Table 3.1).

Table 3.1 AMMI stability value (ASV) and yield stability index (YSI) of baby corn hybrids

Genotype	ASV	YSI	rASV	rYSI	Means	Genotype	ASV	YSI	rASV	rYSI	Means
CR104	3.28	61	60	1	19.23	CR132	1.44	63	31	32	11.85
CR165	1.63	40	38	2	18.54	CR169	2.25	84	51	33	11.58
Check1 AH7043	1.71	43	40	3	18.19	CR107	1.45	66	32	34	11.57
CR121	2.33	56	52	4	17.17	CR98	0.44	44	9	35	11.47
CR105	2.17	55	50	5	17.12	CR158	1.31	64	28	36	11.40
CR114	2.65	61	55	6	17.10	CR162	1.61	74	37	37	11.33
CR174	2.16	56	49	7	16.80	CR151	1.18	64	26	38	11.10
CR152	3.11	67	59	8	16.72	CR144	0.31	40	1	39	11.00
CR99	2.75	65	56	9	16.69	CR150	1.02	64	24	40	10.96
CR102	2.58	63	53	10	16.20	CR164	0.85	62	21	41	10.91
CR97	2.85	68	57	11	16.13	CR143	0.92	65	23	42	10.89
CR155	1.83	55	43	12	14.99	CR141	0.84	61	18	43	10.85
CR106	2.01	60	47	13	14.40	CR118	0.41	51	7	44	10.80
CR153	4.45	76	62	14	14.01	CR140	0.41	51	6	45	10.64
CR28	2.87	73	58	15	13.87	CR135	0.61	58	12	46	10.60
CR88	0.84	36	20	16	13.57	CR154	0.70	62	15	47	10.40
CR149	2.04	65	48	17	13.53	CR147	1.43	78	30	48	10.16
Check2 CMVLBC	1.88	62	44	18	13.50	CR92	0.66	62	13	49	9.62
CR166	1.94	64	45	19	13.46	CR120	1.76	92	42	50	9.50
CR85	3.65	81	61	20	13.15	CR161	0.36	54	3	51	9.26
CR138	0.34	23	2	21	13.02	CR167	1.60	88	36	52	9.04
CR159	1.39	51	29	22	13.01	CR115	0.48	63	10	53	8.96
CR173	0.57	34	11	23	12.88	CR163	1.19	81	27	54	8.70
CR100	2.59	78	54	24	12.72	CR171	0.79	72	17	55	8.48
CR84	0.69	39	14	25	12.52	CR142	1.50	91	35	56	8.19
CR119	0.72	42	16	26	12.40	CR175	0.84	76	19	57	8.11
CR113	0.40	31	4	27	12.38	CR170	1.49	92	34	58	8.08
CR131	1.64	67	39	28	12.20	CR160	0.89	81	22	59	7.38
CR145	1.95	75	46	29	12.17	CR172	0.42	68	8	60	6.88
CR136	1.18	55	25	30	11.87	CR130	1.47	94	33	61	6.31
CR157	1.73	72	41	31	11.86	CR176	0.40	67	5	62	6.31

A separate set of 61 baby corn hybrids developed at ICAR-IARI, Jharkhand was evaluated for yield performance under multilocation trials along with two standard checks. The trials were conducted at four geographically and climatically diverse locations, namely: Hazaribagh (Jharkhand) (NEPZ), Ludhiana (Punjab) (NWPZ), Karimnagar (Telangana) (PZ) and, Srinagar (Jammu & Kashmir). These locations represent a broad range of agro-climatic conditions, providing a robust platform to assess hybrid stability and adaptability. Based on the GGE biplot analysis (mean vs. stability), hybrids CR168, CR70, CR82, and CR87 were identified as superior performers (Fig 3.5-3.6). These hybrids consistently demonstrated high mean baby corn yield without husk (BCWOH) along with greater stability across the test environments, outperforming the checks. For AMMI stability value (ASV) and yield stability index (YSI), CR168 ranked first with the lowest YSI value, indicating the best combination of high yield and stability. CR168 recorded a high mean BCWOH of 23.39 g, making it the most promising hybrid. It was followed by CR70 (YSI rank 2; 22.45 g) and CR87 (YSI rank 3; 20.98 g), both showing excellent yield performance along with stable expression across environments (Table 3.2). These findings highlight the potential of CR168, CR70, and CR87 as elite candidates for future baby corn improvement programs targeting wider adaptability and yield stability.

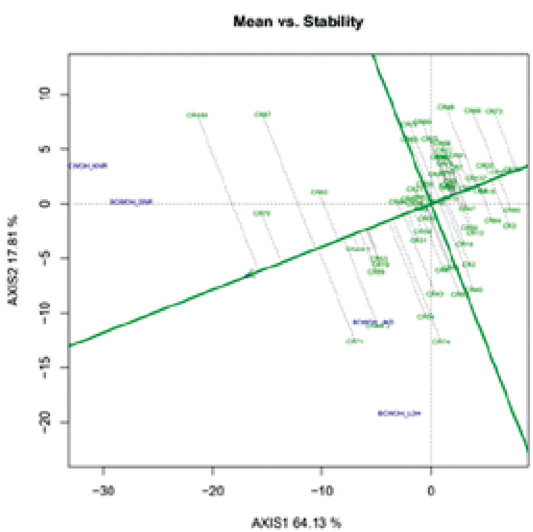


Fig 3.5 Mean vs Stability for Baby corn yield without husk

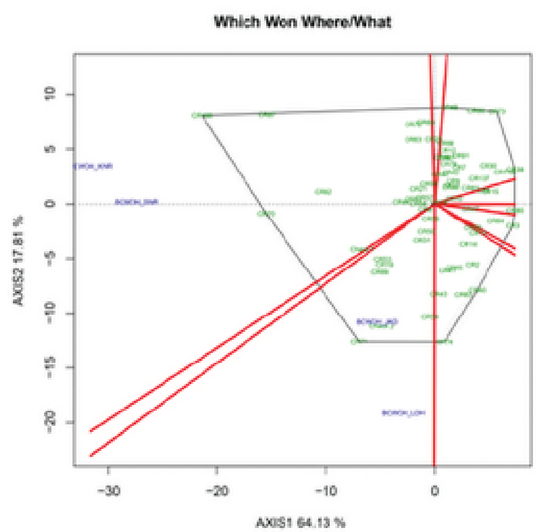


Fig 3.6 Which won where plot for baby corn yield without husk

Table 3.2 AMMI stability value (ASV) and yield stability index (YSI) of baby corn hybrids (Set II)

Genotype	ASV	YSI	rASV	rYSI	Means	Genotype	ASV	YSI	rASV	rYSI	Means
CR168	9.33	64	63	1	23.39	CR45	0.63	47	14	33	15.64
CR70	5.02	63	61	2	22.45	CR59	2.38	88	54	34	15.39
CR87	7.33	65	62	3	20.98	CR42	0.81	57	22	35	15.24
CR71	0.53	12	8	4	20.93	CR10	0.84	59	23	36	15.22
CR82	4.14	65	60	5	19.96	CR69	2.17	85	48	37	15.16
Check_2	0.58	17	11	6	19.89	CR46	0.54	47	9	38	15.15
Check_1	1.68	48	41	7	19.70	CR9	0.24	41	2	39	15.10
CR89	0.72	24	16	8	19.31	CR79	0.49	46	6	40	15.06
CR19	0.62	22	13	9	18.73	CR25	1.54	80	39	41	15.04
CR53	1.09	39	29	10	18.67	CR11	0.55	52	10	42	15.03
CR54	2.27	61	50	11	17.69	CR13	2.10	90	47	43	15.02
CR74	3.00	70	58	12	17.64	CR67	0.61	56	12	44	14.98
CR44	1.20	46	33	13	17.62	CR12	0.74	62	17	45	14.97
CR43	2.08	60	46	14	17.24	CR47	1.31	81	35	46	14.94
CR31	0.50	22	7	15	17.10	CR60	1.14	79	32	47	14.94
CR81	0.91	41	25	16	17.01	CR7	0.27	52	4	48	14.68

Genotype	ASV	YSI	rASV	rYSI	Means	Genotype	ASV	YSI	rASV	rYSI	Means
CR56	0.78	36	19	17	16.92	CR68	1.11	79	30	49	14.67
CR21	1.51	56	38	18	16.73	CR91	0.68	65	15	50	14.53
CR57	1.06	47	28	19	16.71	CR61	0.79	71	20	51	14.45
CR50	1.11	51	31	20	16.56	CR64	2.45	107	55	52	14.25
CR55	0.25	24	3	21	16.49	CR4	1.43	89	36	53	14.18
CR8	0.18	23	1	22	16.47	CR48	1.57	94	40	54	14.13
CR41	1.93	66	43	23	16.36	CR137	0.93	81	26	55	14.09
CR83	2.32	75	51	24	16.15	CR30	1.27	90	34	56	13.72
CR65	2.03	70	45	25	16.14	CR15	1.49	94	37	57	13.69
CR18	0.77	44	18	26	16.12	CR3	2.93	115	57	58	13.54
CR40	3.48	86	59	27	15.98	CR80	2.38	112	53	59	13.12
CR72	2.32	80	52	28	15.94	CR66	0.89	84	24	60	13.11
CR58	0.79	50	21	29	15.92	CR116	1.06	88	27	61	13.08
CR63	1.91	72	42	30	15.90	CR38	1.96	106	44	62	12.72
CR2	2.75	87	56	31	15.74	CR73	0.28	68	5	63	12.48
CR14	2.24	81	49	32	15.65						

Multivariate analysis for grain yield and agronomic traits in maize inbred lines

The study aimed to evaluate the multivariate analysis of grain yield and yield attributing traits in one hundred ten maize inbred lines grown in field under neutral soil (pH 6.7) and acidic soil conditions (pH 4.8) during the Rabi season of 2023-24. Analysis of variance revealed a significant difference among the selected lines for all characters except for anthesis silking interval. The yield per plant was negligible, but positively linked with days to 50% silk emergence, anthesis silking interval, days to 75% maturity, plant height, and ear height under neutral condition but under acidic soil, yield exhibited negligible positive association with all traits *viz.* days to 50% pollen shed, days to 50% silk emergence, anthesis silking interval, days to 75% maturity, plant height and ear height. The first three principal components explained a total variance of 81.6% (Table 3.3). Hierarchical clustering divided genotypes into four clusters under both acidic soil and neutral soils (Fig 3.7). The genotypes P53, P66, P37, P100, P60, P90, P59 and P36 performed relatively better under acid soil as compared to other genotypes, and these can be utilized as parents to develop maize hybrids with improved acidic soil adaptation.

Table 3.3 ANOVA of traits under acidic soil and neutral soil

Acidic soil							
Trait	DT	DS	ASI	DM	PH	EH	GY
Df	109	109	109	109	109	109	109
MSS	23.135	23.305	0.904	48.753	625.73	153.827	3.933
Pr (>F)	<2.2e-16 ***	< 2.2e-16 ***	0.8138	< 2.2e-16 ***	< 2.2e-16 ***	< 2.2e-16 ***	< 2.2e-16 ***
Neutral soil							
Trait	DT	DS	ASI	DM	PH	EH	GY
Df	109	109	109	109	109	109	109
MSS	22.357	22.375	0.250	46.913	625.66	165.400	4.064
Pr (>F)	< 2.2e-16 ***	< 2.2e-16 ***	0.454	< 2.2e-16 ***	< 2.2e-16 ***	< 2.2e-16 ***	< 2.2e-16 ***

Under low soil pH conditions, anthesis silking interval, ear height and grain yield recorded high PCV and GCV. A moderate PCV and GCV were observed for plant height. Days to 50% pollen shed, days to 50% silk emergence and days to 75% maturity, as in neutral conditions, exhibited low PCV and GCV (Table 3.4).

Table 3.4 Estimates of genetic variability parameters of various traits in maize inbred lines

	Mean	PCV (%)	GCV (%)	H^2	GAM (5%)
Neutral soil condition					
DT	53.1909	6.5110	6.0523	0.8641	11.5892
DS	47.0000	6.2409	5.7737	0.8559	11.0036
ASI	2.4455	19.92	4.7688	0.0573	2.3513
DM	84.9318	5.8380	5.5635	0.9082	10.9219
PH	111.3333	16.5090	15.2394	0.8521	28.9787
EH	30.8485	30.3374	28.7355	0.8972	56.0692
GY	9.2129	15.5456	15.3994	0.9813	31.4244
Acidic soil condition					
DT	55.2500	6.4278	5.8714	0.8344	11.0483
DS	59.7045	6.0851	5.3246	0.7657	9.5979
ASI	4.5409	20.3951	10.2538	0.2528	10.6190
DM	86.9364	5.8488	5.5044	0.8857	10.6714
PH	101.5164	18.1275	16.6903	0.8477	31.6564
EH	27.0207	33.5098	31.3684	0.8763	60.4896
GY	6.8270	20.9938	20.0775	0.9146	39.5547

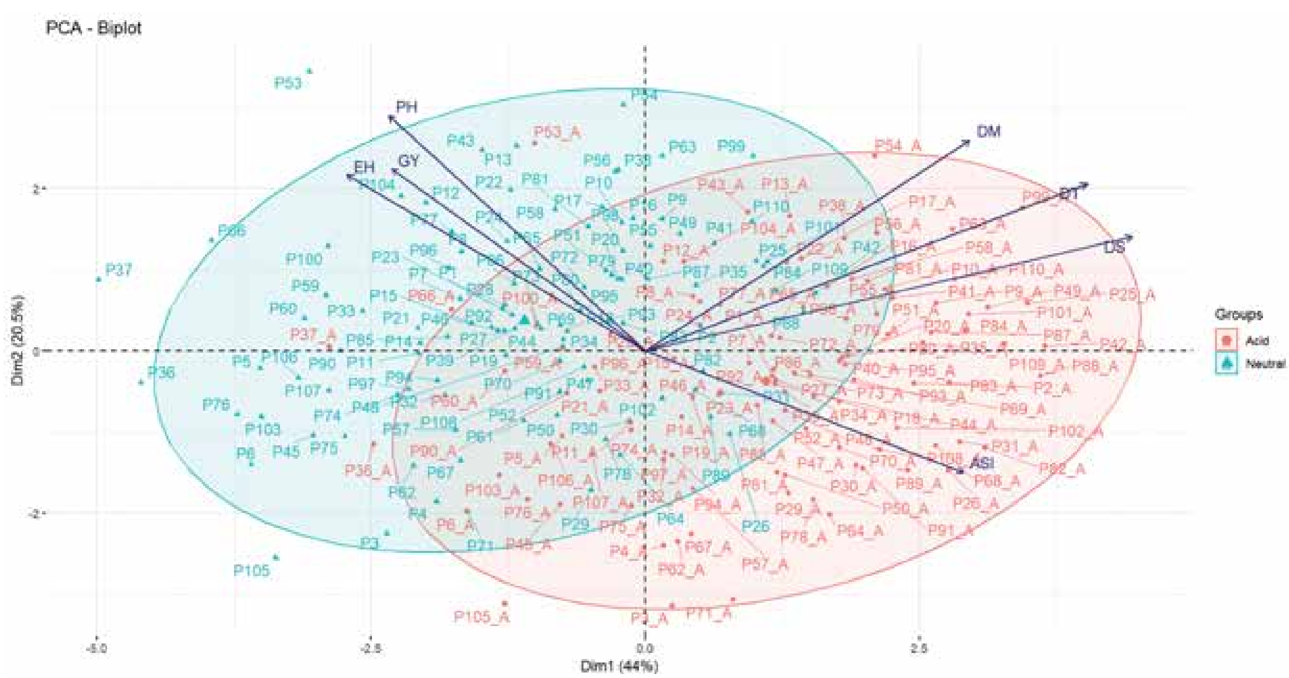


Fig 3.7 A principal component analysis biplot illustrating the variations between 110 maize inbred lines

Evaluation of maize inbred lines for aluminium toxicity tolerance

A hydroponics-based screening of 250 maize inbred lines from an association mapping panel was conducted to assess aluminium (Al) toxicity tolerance. Five root traits- total root length, root surface area, root volume, average root diameter, and number of root tips- were measured under control and Al-stressed conditions. Principal component analysis (PCA) revealed distinct clustering of genotypes by treatment, with PC1 and PC2 together explaining over 60% of the total variation (Fig 3.8). Root surface area and root volume were the most influential traits contributing to separation. While susceptible genotypes exhibited over 60% reduction in root growth parameters, tolerant lines such as IMR349, IMR 543, IMR 534 and IMR476 showed minimal changes under stress (Fig 3.9-3.11). The study highlighted significant genotypic variability in Al tolerance and identifies promising tolerant and susceptible inbred lines for its utilization in further breeding program for resilient maize suited to low soil pH.

Fig 3.8 Principal component analysis (pca) biplot of maize genotypes under acidic and neutral soil conditions

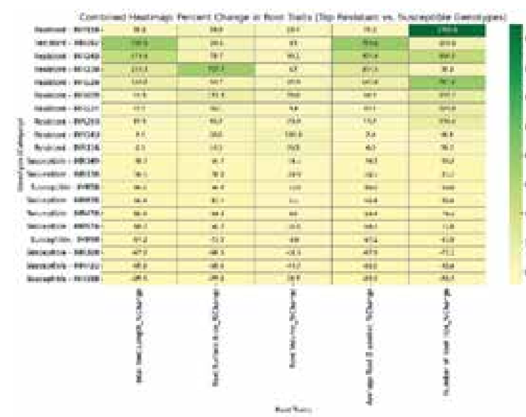


Fig 3.9 Heatmap depicting resistant and susceptible genotypes

Fig 3.10 Roots of resistant genotype under control and treated conditions

Fig 3.11 Roots of susceptible genotype under control and treated conditions

Development of elite maize inbred lines

At ICAR-IARI, Jharkhand, a total of 38 distinct inbred lines have been developed through systematic selfing and selection strategies. These lines were primarily derived from double crosses involving both local landraces and private-sector hybrids, ensuring a broad genetic base. Additionally, the program incorporated genetic materials sourced from CIMMYT, Hyderabad during the Field Day, 2022. Through rigorous cycles of self-pollination, phenotypic selection, and fixation of homozygosity, superior inbreds were isolated. These newly developed lines represent a valuable genetic resource for future hybrid breeding programs, particularly tailored to the agro-climatic conditions of eastern India. The genetic diversity captured in these lines offers promising potential for developing maize hybrids with improved yield, stress resilience, and adaptability.

Multilocation evaluation of high yielding maize hybrids under coordinated trials

Elite maize hybrids were tested in different zones of Jharkhand under state coordinated trials for yield and attributing traits along with the standard checks. The proposal of four hybrids (DMRH 1419, IMH-8-101, IQPMH-18-2, and DMRH 1417 (SMH-5)) which out yielded the check variety has to be submitted for state release. The data of these hybrids have been presented in table 5-8. The disease screening for these hybrids were also made at IARI Jharkhand (Table 3.9) and BAU, Ranchi (Table 3.10). Similarly, the screening against the major insect pests were also made at IARI-Jharkhand (Table 3.11) and BAU, Ranchi (Table 3.12). All these four hybrids were found to be moderately resistant to all the major diseases and insect pests. The trials were also conducted on the farmers' field in different districts as the mini kit trial (Table 3.13). The agronomic performance of these high yielding hybrids at different doses of fertilizers showed that these hybrids perform best economically at 100% RDF (Table 3.14). The DUS characterization of these four hybrids *viz.* DMRH 1419, IMH-8-101, IQPMH-18-2, and DMRH 1417 (SMH-5) were also made (Table 3.15-3.18).

Table 3.5 Performance of DMRH 1419 under multi-location coordinated trial in Jharkhand

Year	Grain yield (q/ha)								Per cent increase over check
	DMRH 1419				Check				
	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	
Kharif 2022	58.3	70.35	69.22	65.96	47.9 (HQPM-5)	52.40 (HQPM-5)	45.83 (HQPM-5)	48.71	24.84%
Kharif 2023	68.80	84.38	64.17	72.45	55.60 (DHM 117)	68.52 (BIO9544)	52.08 (HQPM-5)	58.73	
Kharif 2024	94.51	82.40	-	88.46	87.40 (Shaktiman5)	64.58 (BIO9544)		75.99	
Average	73.87	79.04	66.70	74.02	63.63	61.83	49.0	59.28	

Table 3.6 Performance of IMH-8-101 under multi-location coordinated trial in Jharkhand

Year	Grain yield (q/ha)								Per cent increase over check
	IMH-8-101				Check				
	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	
Kharif 2022	53.10	60.74	69.78	61.21	47.9 (HQPM-5)	52.40 (HQPM-5)	45.83 (HQPM-5)	48.71	18.25%
Kharif 2023	60.40	81.71	61.99	68.03	55.60 (DHM 117)	68.52 (BIO9544)	52.08 (HQPM-5)	58.73	
Kharif 2024	92.61	80.56		86.59	87.40 (Shaktiman5)	64.58 (BIO9544)		75.99	
Average	68.70	74.33	65.88	70.11	63.63	61.83	49.0	59.28	

Table 3.7 Performance of IQPMH-18-2 under multi-location coordinated trial in Jharkhand

Year	Grain yield (q/ha)								Per cent increase over check
	IQPMH-18-2				Check				
	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	
Kharif 2022	-	63.45	68.94	66.20	47.9 (HQPM-5)	52.40 (HQPM-5)	45.83 (HQPM-5)	48.71	25.42%
Kharif 2023	64.20	82.52	63.57	70.10	52.60 (Shaktiman5)	68.52 (BIO9544)	52.08 (HQPM-5)	57.73	
Kharif 2024	93.07	81.48		87.28	87.40 (Shaktiman5)	64.58 (BIO9544)		75.99	
Average	78.64	75.82	66.26	73.89	62.63	61.83	48.96	58.91	

Table 3.8 Average Performance of DMRH 1417 (SMH-5) (IMH 221) under multi-location coordinated trial in Jharkhand

Year	Grain yield (q/ha)								Per cent increase over check
	DMRH 1417 (SMH-5) IMH 221				Check				
	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	BAU, Ranchi	IARI, Jharkhand	ZRS, Chiyanki	Average	
Kharif 2022	64.50	73.72	70.69	69.64	47.9 (HQPM-5)	52.40 (HQPM-5)	45.83 (HQPM-5)	48.71	23.46%
Kharif 2023	59.70	82.29	61.25	67.75	55.60 (DHM 117)	68.52 (BIO9544)	52.08 (HQPM-5)	58.73	
Kharif 2024	94.27	79.16		86.72	87.40 (Shaktiman5)	64.58 (BIO9544)		75.99	

Table 3.9 Screening of high yielding maize hybrids against major diseases (Location: IARI-Jharkhand)

S. No.	Genotype	Turcicum leaf blight	Maydis leaf blight	Bacterial leaf and sheath blight
1	IMH8-101(M)	3.5	3.5	3.5
2	IMH10-23K1	4.0	3.5	5.0
3	IMH10-23K2	3.5	5.0	5.0
4	IMH10-23K3	4.5	3.5	4.0
5	IMH10-21K2	4.0	4.5	4.5
6	IMH-7248	4.5	5.0	3.5
7	IMH-7245	4.5	4.0	4.0
8	DMRH-1410(M)	3.5	3.5	3.5
9	DMRH-1417	3.5	3.5	3.5
10	DMRH-1419	3.5	3.5	3.5
11	SMC-8	5.5	6.0	5.0
12	IQH7-241	4.5	4.5	4.0
13	IQPMH-2001	4.5	4.5	3.5
14	IQPMH18-2	3.5	3.5	3.5
15	DHM 121	3.5	3.5	3.5
16	BIO 9544	3.5	3.5	3.5

Table 3.10 Screening of high yielding maize hybrids against major diseases (Location: BAU, Ranchi)

S. No.	Genotype	Turcicum leaf blight	Maydis leaf blight	Bacterial leaf and sheath blight
1	IMH8-101(M)	3.5	4.0	3.5
2	IMH10-23K1	4.0	3.5	4.5
3	IMH10-23K2	3.5	4.5	5.0
4	IMH10-23K3	4.0	3.5	3.5
5	IMH10-21K2	3.5	3.5	4.0
6	IMH-7248	4.0	5.0	4.0
7	IMH-7245	3.5	4.0	3.5
8	DMRH-1410(M)	3.5	3.5	3.5
9	DMRH-1417	3.5	3.5	3.5
10	DMRH-1419	3.5	4.0	3.5
11	SMC-8	5.0	5.5	4.5
12	IQH7-241	4.0	4.5	4.5
13	IQPMH-2001	4.0	4.0	4.0
14	IQPMH18-2	3.5	3.5	3.5
15	Shaktiman-5(c)	3.5	4.0	3.5
16	DKC-8181 (c)	3.5	3.5	3.5
17	DKC9144(c)	3.5	4.0	4.0

Table 3.11 Screening of high yielding maize hybrids against major insect pests (Location: IARI-Jharkhand)

S. No.	Genotype	Leaf injury rating scale for spotted stem borer (*Chilo partellus*)	Leaf damage rating (LDR) scale to categorize maize germplasm for resistance to FAW	Ratings for ear and kernel damage caused by FAW (Davis and Williams, 1992)
1	IMH8-101(M)	1	1	1
2	IMH10-23K1	1	1	1
3	IMH10-23K2	1	2	1
4	IMH10-23K3	1	1	2
5	IMH10-21K2	1	2	1
6	IMH-7248	1	1	1
7	IMH-7245	1	1	1
8	DMRH-1410(M)	1	1	1
9	DMRH-1417	1	1	1
10	DMRH-1419	1	1	1
11	SMC-8	1	3	1
12	IQH7-241	1	1	1
13	IQPMH-2001	1	1	1
14	IQPMH18-2	1	1	1
15	DHM 121	1	1	1
16	BIO 9544	1	1	1

Table 3.12 Screening of high yielding maize hybrids against major insect pests (Location: BAU, Ranchi)

S. No.	Genotype	Leaf injury rating scale for spotted stem borer (*Chilo partellus*)	Leaf damage rating (LDR) scale to categorize maize germplasm for resistance to FAW	Ratings for ear and kernel damage caused by FAW (Davis and Williams, 1992)
1	IMH8-101(M)	1	1	1
2	IMH10-23K1	1	1	1
3	IMH10-23K2	1	1	1
4	IMH10-23K3	2	1	1
5	IMH10-21K2	1	2	1
6	IMH-7248	1	1	2
7	IMH-7245	1	1	1
8	DMRH-1410(M)	1	1	1
9	DMRH-1417	1	1	1
10	DMRH-1419	1	1	1
11	SMC-8	2	1	2
12	IQH7-241	1	1	1
13	IQPMH-2001	1	1	1
14	IQPMH18-2	1	1	1
15	Shaktiman-5(c)	1	1	1
16	DKC-8181 (c)	1	1	1
17	DKC9144(c)	1	1	1

Table 3.13 Performance of high yielding maize hybrids for grain yield (q/ha) under minikit trials over years (2023 & 2024)

2023								
Hybrid	Hazaribagh			Mean	Ramgarh			Mean
DMRH 1417	68.85	75.42	74.65	72.97333	79.5	76.25	67.85	74.53333
IQMH-18-2	79.68	83.57	74.35	79.2	77.65	72.64	79.9	76.73
DMRH 1419	75.62	80.95	83.49	80.02	71.5	82.49	79.26	77.75
IMH-8-101	86.6	83.5	79.5	83.2	82.9	78.5	85.6	82.33333
HQMP-5	54.65	62.5	67.4	61.51667	57.25	59.48	68.35	61.69333
DHM121	62.25	69.25	71.45	67.65	59.6	67.54	64.5	63.88
2024								
Hybrid	Hazaribagh			Mean	Ramgarh			Mean
DMRH 1417	65.96	77.68	66.81	70.15	78.4	70.24	74.5	74.38
IQMH-18-2	82.53	86.5	80.44	83.15667	70.2	81.83	73.56	75.19667
DMRH 1419	79.8	79.39	71.14	76.77667	82.7	76.21	83.9	80.93667
IMH-8-101	85.8	77.8	81.38	81.66	81.9	88.42	82.75	84.35667
HQMP-5	66.8	64.68	59.14	63.54	62.32	56.5	69.37	62.73
DHM121	68.3	70.9	58.11	65.77	67.47	64.8	71.59	67.95333

Table 3.14 Adaptability to agronomic variables in terms of yield performance of elite hybrids under varying nutrient management

Fertility levels	Genotypes	Grain yield (q/ha)			Mean	% increase over check
		R1	R2	R2		
100% RDF Normal spacing (60x20) Plant population: 83,300/ha	DMRH 1417	81.68	68.7	73.12	74.5	8.76
	DMRH 1419	83.09	75.76	80.57	79.8	16.50
	IMH-8-101	80.61	83.22	83.84	82.56	20.53
	IQPMH-18-2	85.5	68.02	79.09	77.54	22.13
	HQPM-5	73.14	65.26	52.11	63.49	
	DHM121	83.55	57.28	64.69	68.5	
125% RDF Normal spacing (60x20) Plant population: 83,300/ha	DMRH 1417	73.17	83.93	76.28	77.8	8.81
	DMRH 1419	82.7	69.04	99.19	83.64	16.98
	IMH-8-101	79.31	87.34	86.11	84.26	17.85
	IQPMH-18-2	91.98	87.34	68.17	82.5	24.06
	HQPM-5	73.5	62.86	63.16	66.5	
	DHM121	62.45	91.3	60.75	71.5	
150% RDF Normal spacing (60x20) Plant population: 83,300/ha	DMRH 1417	66.62	78.77	82.28	75.9	1.40
	DMRH 1419	83.4	75.33	83.22	80.65	7.75
	IMH-8-101	91.56	79.8	87.99	86.45	15.50
	IQPMH-18-2	84.71	81.56	69.45	78.58	15.39
	HQPM-5	70.16	73.91	55.37	66.49	
	DHM121	74.05	72	78.48	74.85	
	CV				11.91	
	CD				14.57	

Table 3.15 DUS characteristics of the hybrid (DMRH 1419) and their parents (Female: UMI 1210 and Male: IML 102)

S. No.	DUS characteristics	UMI 1210	IML 102	Candidate hybrid (DMRH 1419)
1	Leaf: Angle between blade and stem (on leaf just above upper ear)	Narrow (3)	Wide (7)	Wide (7)
2	Leaf: Attitude of blade (on leaf just above upper ear)	Straight (1)	Drooping (9)	Drooping (9)
3 (S)	Stem: Anthocyanin colouration of brace roots	Present (9)	Absent (1)	Present (9)
4 (*)	Tassel: Time of anthesis (on middle third of main axis, 50 % of plants)	Medium (5)	Medium (5)	Medium (5)
5 (+) (S)	Tassel: Anthocyanin colouration at base of glume (in middle third of main axis)	Absent (1)	Absent (1)	Absent (1)
6 (S)	Tassel: Anthocyanin colouration of glumes excluding base (in middle third of main axis)	Present (9)	Present (9)	Present (9)

S. No.	DUS characteristics	UMI 1210	IML 102	Candidate hybrid (DMRH 1419)
7 (S)	Tassel: Anthocyanin colouration of anthers (in middle third of main axis on fresh anthers)	Present (9)	Absent (1)	Absent (1)
8	Tassel: Density of spikelets (in middle third of main axis)	Sparse (3)	Sparse (3)	Sparse (3)
9 (*) (+)	Tassel: Angle between main axis and lateral branches	Wide (7)	Wide (7)	Wide (7)
10 (*) (+)	Tassel: Attitude of lateral branches (in lower third of tassel)	Curved (5)	Curved (5)	Curved (5)
11	Ear: Time of silk emergence (50% plants)	Medium (5)	Medium (5)	Medium (5)
12 (*)	Ear: Anthocyanin colouration of silks (on day of emergence)	Present (9)	Absent (1	Absent (1
13	Leaf: Anthocyanin colouration of sheath (below the ear)	Absent (1	Absent (1	Absent (1
14	Tassel: Length of main axis above lowest side branch	Short (3)	Large (7)	Large (7)
15.1 (*)	Inbred lines only: Plant: Length (up to flag leaf)	Medium (5)	Long (7)	
15.2 (*)	Hybrids and open pollinated varieties only: Plant: Length (up to flag leaf)		Medium (5)	Long (7)
16	Plant: Ear placement	Medium (5)	Medium (5)	Medium (5)
17	Leaf: Width of blade (leaf of upper ear)	Medium (5)	Medium (5)	Medium (5)
18 (*)	Ear: Length without husk	Medium (5)	Medium (5)	Medium (5)
19	Ear: Diameter without husk (in middle)	Medium (5)	Medium (5)	Medium (5)
20 (+)	Ear: Shape	Conical (1)	Conical (1)	Conical (1)
21	Ear: Number of rows of grains	Medium (5)	Medium (5)	Medium (5)
22 (*)	Ear: Type of grain (in middle third of ear)	Dent (2)	Flint (1)	Flint (1)
23 (*)	Ear: Colour of top of grain	Yellow (3)	Yellow (3)	Yellow (3)
24 (*)	Ear: Anthocyanin colouration of glumes of cob	White (1)	White (1)	White (1)
25 (+)	Kernel: Row arrangement (middle of ear)	Straight (1)	Straight (1)	Straight (1)
26	Kernel: Poppiness	Absent (1)	Absent (1)	Absent (1)
27	Kernel: Sweetness	Absent (1)	Absent (1)	Absent (1)
28	Kernel: Waxiness	Absent (1)	Absent (1)	Absent (1)
29	Kernel: Opaqueness	Absent (1)	Absent (1)	Absent (1)
30 (+)	Kernel: Shape	Toothed (4)	Indented (3)	Toothed (4)
31	Kernel: 1000 kernel weight)	Medium (5)	Medium (5)	Medium (5)

Table 3.16 DUS characteristics of the hybrid IMH 8-101 and their parents (Female: MIL 8-144 & Male: LM 14)

S. No.	DUS characteristics	MIL 8-144	LM 14	Candidate hybrid IMH 8-101
1	Leaf: Angle between blade and stem (on leaf just above upper ear)	Wide (7)	Wide (7)	Wide (7)
2	Leaf: Attitude of blade (on leaf just above upper ear)	Drooping (9)	Drooping (9)	Drooping (9)
3 (S)	Stem: Anthocyanin colouration of brace roots	Present (9)	Absent (1)	Present (9)
4 (*)	Tassel: Time of anthesis (on middle third of main axis, 50 % of plants)	Medium (5)	Medium (5)	Medium (5)
5 (+) (S)	Tassel: Anthocyanin colouration at base of glume (in middle third of main axis)	Absent (1)	Absent (1)	Absent (1)
6 (S)	Tassel: Anthocyanin colouration of glumes excluding base (in middle third of main axis)	Present (9)	Absent (1)	Absent (1)
7 (S)	Tassel: Anthocyanin colouration of anthers (in middle third of main axis on fresh anthers)	Present (9)	Present (9)	Present (9)
8	Tassel: Density of spikelets (in middle third of main axis)	Sparse (3)	Sparse (3)	Sparse (3)
9 (*) (+)	Tassel: Angle between main axis and lateral branches	Wide (7)	Wide (7)	Wide (7)
10 (*) (+)	Tassel: Attitude of lateral branches (in lower third of tassel)	Curved (5)	Curved (5)	Curved (5)
11	Ear: Time of silk emergence (50% plants)	Medium (5)	Medium (5)	Medium (5)
12 (*)	Ear: Anthocyanin colouration of silks (on day of emergence)	Present (9)	Absent (1	Absent (1
13	Leaf: Anthocyanin colouration of sheath (below the ear)	Absent (1	Absent (1	Absent (1
14	Tassel: Length of main axis above lowest side branch	Large (7)	Large (7)	Large (7)
15.1 (*)	Inbred lines only: Plant: Length (up to flag leaf)	Medium (5)	Medium (5)	
15.2 (*)	Hybrids and open pollinated varieties only: Plant: Length (up to flag leaf)	Medium (5)		Long (7)
16	Plant: Ear placement	Medium (5)	Medium (5)	Medium (5)
17	Leaf: Width of blade (leaf of upper ear)	Medium (5)	Medium (5)	Medium (5)
18 (*)	Ear: Length without husk	Long (7)	Medium (5)	Long (7)
19	Ear: Diameter without husk (in middle)	Medium (5)	Medium (5)	Large (7)
20 (+)	Ear: Shape	Conical (1)	Conical (1)	Conical (1)

S. No.	DUS characteristics	MIL 8-144	LM 14	Candidate hybrid IMH 8-101
21	Ear: Number of rows of grains	Medium (5)	Medium (5)	Medium (5)
22 (*)	Ear: Type of grain (in middle third of ear)	Flint (1)	Flint (1)	Flint (1)
23 (*)	Ear: Colour of top of grain	Yellow (3)	Yellow (3	Yellow (3)
24 (*)	Ear: Anthocyanin colouration of glumes of cob	Red (2)	White (1)	Red (2)
25 (+)	Kernel: Row arrangement (middle of ear)	Straight (1)	Straight (1)	Straight (1)
26	Kernel: Poppiness	Absent (1)	Absent (1)	Absent (1)
27	Kernel: Sweetness	Absent (1)	Absent (1)	Absent (1)
28	Kernel: Waxiness	Absent (1)	Absent (1)	Absent (1)
29	Kernel: Opaqueness	Absent (1)	Absent (1)	Absent (1)
30 (+)	Kernel: Shape	Toothed (4)	Toothed (4)	Toothed (4)
31	Kernel: 1000 kernel weight)	Medium (5)	Medium (5)	Large (7)

Table 3.17 DUS characteristics of hybrid IQPMH 18-2 and its parents (Female: DQL 2192 and Male: QIL 4-2047)

S. No.	Characteristics	Hybrid	Female	Male
		IQPMH 18-2	(DQL 2192)	(QIL 4-2047)
1	Leaf: Angle between blade and stem (on leaf just above upper ear	Small (3)	Wide (7)	Wide (7)
2	Leaf: Attitude of blade	Drooping (9)	Straight (1)	Drooping (9)
3	Stem: Anthocyanin coloration of brace root	Present (9)	Absent (1)	Absent (1)
4	Tassel: Time of anthesis	Late (7)	Late (7)	Late (7)
5	Tassel: Anthocyanin coloration at base of glumes	Absent (1)	Absent (1)	Present (9)
6	Tassel: Anthocyanin coloration of glumes	Present (9)	Absent (1)	Present (9)
7	Tassel: Anthocyanin coloration of anthers	Present (9)	Absent (1)	Present (9)
8	Tassel: Density of spikelets	Sparse (3)	Sparse (3)	Sparse (3)
9	Tassel: Angle between main axis and lateral branches	Wide (7)	Wide (7)	Wide (7)
10	Tassel: Attitude of lateral branches	Curved (5)	Straight (1)	Straight (1)
11	Ear: Time of silk emergence	Late (7)	Late (7)	Late (7)
12	Ear: Anthocyanin coloration of silk	Present (9)	Absent (1)	Present (9)
13	Leaf: Anthocyanin coloration of sheath	Absent (1)	Absent (1)	Absent (1)
14	Tassel: Length of main axis above lowest side branch	Long (7)	Medium (5)	Medium (5)
15	Plant: Length up to flag leaf	Very long (9)	Medium (5)	Short (3)
16	Plant: Ear placement	Medium (5)	Medium (5)	Medium (5)
17	Leaf: Width of blade	Medium (5)	Medium (5)	Medium (5)
18	Ear: Length without husk	Long (7)	Medium (5)	Medium (5)

S. No.	Characteristics	Hybrid	Female	Male
		IQPMH 18-2	(DQL 2192)	(QIL 4-2047)
19	Ear: Diameter	Medium (5)	Small (3)	Small (3)
20	Ear: Shape	Conical (1)	Conical (1)	Conico-cylindrical (2)
21	Ear: Number of rows of grains	Medium (5)	Medium (5)	Medium (5)
22	Ear: Type of grain	Flint (1)	Flint (1)	Flint (1)
23	Ear: Color of top of grain	Orange (5)	Orange (5)	Orange (5)
24	Ear: Coloration of glumes of cob	White (1)	White (1)	White (1)
25	Kernel: Row arrangement	Straight (1)	Straight (1)	Straight (1)
26	Kernel: Poppiness	Absent (1)	Absent (1)	Absent (1)
27	Kernel: Sweetness	Absent (1)	Absent (1)	Absent (1)
28	Kernel: Waxiness	Absent (1)	Absent (1)	Absent (1)
29	Kernel: Opaqueness	Present (9)	Present (9)	Present (9)
30	Kernel: Shape	Toothed (4)	Toothed (4)	Round (2)
31	Kernel: 1000 kernel weight	Medium (5)	Large (7)	Small (3)

Table 3.18 DUS characteristics of the hybrid DMRH 1417 and its parents (Female: IML 14 and Male: BML 6)

S. No.	DUS characteristics	IML 14	BML 6	Candidate Hybrid (DMRH 1417)
1.	Leaf: Angle between blade and stem (on leaf just above upper ear)	Narrow (3)	Wide (7)	Wide (7)
2	Leaf: Attitude of blade (on leaf just above upper ear)	Straight (1)	Drooping (9)	Drooping (9)
3 (S)	Stem: Anthocyanin coloration of brace roots	Present (9)	Absent (1)	Present (9)
4 (*)	Tassel: Time of anthesis (on middle third of main axis, 50 % of plants)	Early (3)	Medium (5)	Medium (5)
5 (+) (S)	Tassel: Anthocyanin coloration at base of glume (in middle third of main axis)	Present (9)	Absent (1)	Present (9)
6 (S)	Tassel: Anthocyanin coloration of glumes excluding base (in middle third of main axis)	Present (9)	Absent (1)	Present (9)
7 (S)	Tassel: Anthocyanin coloration of anthers (in middle third of main axis on fresh anthers)	Present (9)	Absent (1)	Present (9)
8	Tassel: Density of spikelets (in middle third of main axis)	Sparse (3)	Sparse (3)	Sparse (3)
9 (*) (+)	Tassel: Angle between main axis and lateral branches	Wide (7)	Wide (7)	Wide (7)
10 (*) (+)	Tassel: Attitude of lateral branches (in lower third of tassel)	Curved (5)	Curved (5)	Curved (5)

S. No.	DUS characteristics	IML 14	BML 6	Candidate Hybrid (DMRH 1417)
11	Ear: Time of silk emergence (50% plants)	Early (3)	Medium (5)	Early (3)
12 (*)	Ear: Anthocyanin coloration of silks (on day of emergence)	Present (9)	Absent (1)	Present (9)
13	Leaf: Anthocyanin coloration of sheath (below the ear)	Absent (1)	Absent (1)	Absent (1
14	Tassel: Length of main axis above lowest side branch	Medium (5)	Medium (5)	Large (7)
15.1 (*)	Inbred lines only: Plant: Length (up to flag leaf)	Medium (5)	Medium (5)	
15.2 (*)	Hybrids and open pollinated varieties only: Plant: Length (up to flag leaf)			Long (7)
16	Plant: Ear placement	Medium (5)	Medium (5)	Medium (5)
17	Leaf: Width of blade (leaf of upper ear)	Medium (5)	Medium (5)	Medium (5)
18 (*)	Ear: Length without husk	Medium (5)	Medium (5)	Medium (5)
19	Ear: Diameter without husk (in middle)	Medium (5)	Medium (5)	Medium (5)
20 (+)	Ear: Shape	Conical (1)	Conical (1)	Conico cylindrical (2)
21	Ear: Number of rows of grains	Medium (5)	Medium (5)	Medium (5)
22 (*)	Ear: Type of grain (in middle third of ear)	Flint (1)	Dent (3)	Semi Dent (1)
23 (*)	Ear: Color of top of grain	Yellow (3)	Yellow (3)	Yellow (3)
24 (*)	Ear: Anthocyanin coloration of glumes of cob	White (1)	White (1)	White (1)
25 (+)	Kernel: Row arrangement (middle of ear)	Straight (1)	Straight (1)	Straight (1)
26	Kernel: Poppiness	Absent (1)	Absent (1)	Absent (1)
27	Kernel: Sweetness	Absent (1)	Absent (1)	Absent (1)
28	Kernel: Waxiness	Absent (1)	Absent (1)	Absent (1)
29	Kernel: Opaqueness	Absent (1)	Absent (1)	Absent (1)
30 (+)	Kernel: Shape	Toothed (4)	Toothed (4)	Toothed (4)
31	Kernel: 1000 kernel weight)	Medium (5)	Medium (5)	Medium (5)

Genetic improvement of lentil

Screening of RIL for aluminium and phosphorus tolerances

A total of 150 F7 recombinant inbred lines derived from a cross between BM-4 x L-4602, were evaluated for yield and yield attributing traits in acidic soil condition with pH 4.85-5.52 (Table 3.19-3.20). Observations were recorded on days to flower, days to maturity, plant height, number of primary branches, pods/plant, seed yield/plant, 100 seed weight and phosphorus percent were measured for characterization of low P tolerances.

Table 3.19 Descriptive statistical analysis and analysis of variance (ANOVA) of F_7 recombinant inbred lines (RILs) for 8 traits under acidic field conditions

	RIL					Parents		
Trait	**Mean**	**Range**	**SD**	**CV**	**MSS(R)**	**BM-4**	**L-4602**	**MSS(P)**
Days to flower	67.0	51-78	5.6	2.8	8.80**	67.3	61.7	2.67
Days to maturity	127.0	120-136	3.5	0.8	34.17**	111.0	101.3	20.17
Plant height (cm)	22.9	12.60-32.50	5.3	5.6	80.93**	18.2	24.0	0.43
No. of primary branches	4.6	2.20-7.60	1.2	7.7	4.20**	3.0	5.5	1.04
Pods/plant	31.1	2.96-61.5	18.2	4.5	995.5**	11.5	46.4	11.20
Seed yield/plant	1.2	0.25-2.15	0.5	5.5	0.64**	0.8	1.5	0.003
100-seed weight	2.4	1.36-4.65	0.5	6.4	0.72**	2.5	3.3	0.61*
Phosphorus content	0.2	0.10-0.29	0.1	21.3	0.005**	0.1	0.2	0.002*

Evaluation of the RILs under hydroponic condition

The 150 RILs were also evaluated under hydroponic condition maintaining aluminium stress with 148 µM AlCl3.6H2O, pH 4.8 and Aluminium plus phosphorus combined stress with 148 µM Al + 0.01 mM P at ICAR-IARI, New Delhi. Multilocation evaluation of this RIL population was also carried out at acidic soils of College of Post Graduate Studies in Agricultural Sciences, Barapani (Meghalaya) and Lamsang, Imphal West, Manipur. SSR genotyping was also done for this RIL population at IARI, New Delhi. The SSR genotyping combined with the multilocation data were utilized for mapping of QTLs associated Al and P toxicity tolerance.

Mapping of QTLs for aluminium and/ or P tolerances

The 10 SSRs previously mapped on linkage group 1 harbouring Al resistance QTL were used to map the QTLs for aluminium and/or phosphorus tolerance in hydroponics and acidic field conditions. Among these, seven SSRs were again found to be linked, covering a total map distance of 287.3 cM in the 146 RILs. Out of the seven QTLs, three QTLs, designated as qAlt1.1, qAlt2.1and qAltP1, were detected on linkage group 1 for Al and P tolerance, respectively under hydroponic condition (E-2). Two QTLs *viz., qAltdf1.1* and *qAltdm1.1* were also detected on linkage group 1 for days to flower and days to maturity, respectively in acidic field conditions (Fig 3.12).

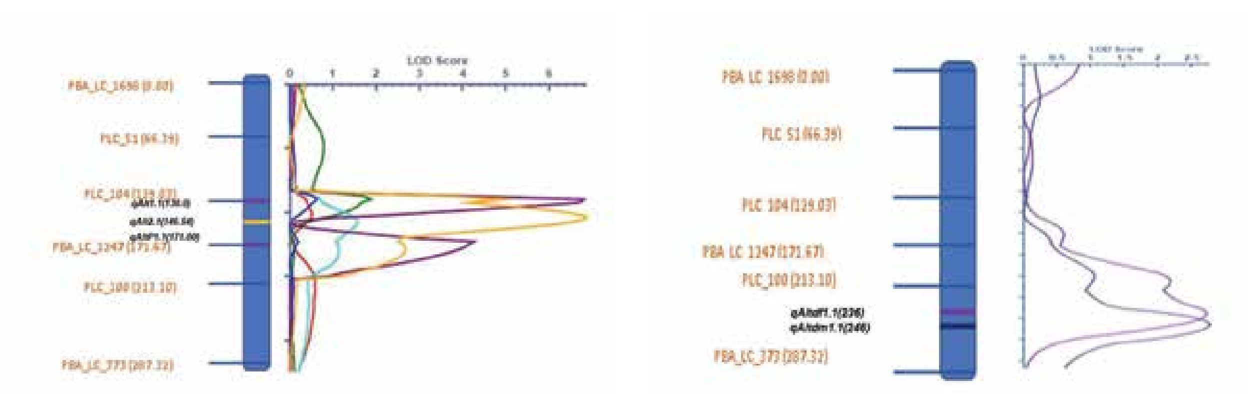


Fig 3.12. Genetic linkage map of RILs [a-hydroponic] and [b-acidic field (pooled)] using SSR markers screened for Al/P resistance

Table 3.20 Promising RILs identified under acidic field (pooled) conditions based on seed yield and 100 seed weight

RIL no.	DF	DM	PH	PB	PP	SY	SW
37	70.0	123.0	32.6	6.05	77.81	4.67	3.37
22	74.0	129.0	32.9	5.71	92.38	4.07	2.33
63	67.0	124.0	29.0	8.12	77.42	4.13	3.01
135	64.0	121.0	31.2	5.84	74.41	4.00	3.04
144	77.0	129.0	32.2	6.43	95.18	4.28	3.64
106	69.0	121.0	32.2	6.17	67.90	4.02	3.22
96	68.0	121.0	32.3	6.40	70.35	4.06	4.29
97	72.0	131.0	34.9	5.90	98.08	4.05	2.57
9	65.0	125.0	28.7	5.80	75.21	3.82	2.92
34	67.0	124.0	34.2	5.92	69.76	3.75	2.96
1	73.0	128.0	33.2	6.39	69.84	3.64	3.50
116	62.0	121.0	31.6	5.68	73.70	3.70	2.80
27	72.0	128.0	34.6	6.42	91.01	3.72	2.55
112	70.0	123.0	34.4	6.50	82.60	4.18	2.91
15	68.0	129.0	30.8	5.30	74.28	3.79	2.68
127	66.0	126.0	30.3	6.21	85.21	3.73	2.19
113	64.0	123.0	33.0	5.42	81.98	3.75	2.76
2	72.0	127.0	32.4	5.63	69.34	3.50	3.09
133	67.0	127.0	31.0	5.72	73.96	3.69	3.55
118	65.0	124.0	31.1	5.88	75.86	3.66	2.68
140	64.0	119.0	32.0	6.99	77.05	3.98	4.42
L-4602 (P1)	62.0	115.0	32.5	6.11	83.80	3.70	3.53
BM-4 (P2)	66.0	115.0	25.6	4.81	51.65	1.57	3.05

DF: Days to flower; DM: Days to maturity, Plant height (cm), PB: Primary branches, PP: Pods/plant, SY: Seed yield/plant (g), SW: 100-seed weight (g)

Genetic diversity analysis for low phosphorus tolerance in lentil germplasm

A diverse set of 150 lentil accessions, collected from the acidic zones of Jharkhand, Odisha, Andhra Pradesh, Uttar Pradesh, Himachal Pradesh, Punjab, Uttarakhand, Madhya Pradesh and other parts of India, was evaluated in the acidic field conditions of IARI-Jharkhand (Fig 3.13).

Fig 3.13 Lentil accessions collected from different parts of the country

The experimental design was meticulously structured to evaluate the performance of these genotypes under two distinct soil phosphorus environments: low phosphorus (11.2 kg/ha) and optimum phosphorus (66.3 kg/ha). Thirteen (13) traits related to phosphorous use efficiency (PUE) as well as yield were evaluated, showed noteworthy variations for all traits and the average PUE in optimum P condition was recorded to be 0.52 which reduced by 46.87% under P stress with an average value of 0.35 in low P condition (Table 3.21).

Table 3.21. Descriptive statistics of the measured traits in lentil genotypes under optimum and low phosphorous conditions

Traits	Optimum phosphorus					Low phosphorus					% Reduction of mean
	Max.	Min.	Mean	CV%	SE	Max.	Min.	Mean	CV(%)	SE	
SL	29.59	9.50	21.10	10.63	0.09	24.00	9.00	16.03	13.30	0.09	-31.61
RL	19.00	5.25	12.93	14.04	0.07	19.50	7.50	13.26	14.42	0.08	2.50
FW	12.84	0.74	3.97	23.78	0.04	2.82	0.26	1.09	12.48	0.01	-265.34
RSR	2.01	0.20	0.64	21.84	0.06	1.52	0.44	0.86	20.83	0.01	24.91
RV	0.90	0.10	0.32	24.00	0.01	0.25	0.10	0.12	30.62	0.002	-156.03
SFW	11.10	0.67	3.41	23.26	0.03	2.37	0.18	0.89	21.91	0.01	-283.08
RFW	2.15	0.11	0.56	27.07	0.01	1.13	0.01	0.19	38.85	0.003	-185.01
SDW	2.14	0.12	0.72	23.71	0.01	0.49	0.03	0.18	30.99	0.002	-291.78
RDW	0.15	0.01	0.04	17.74	0.001	0.08	0.001	0.01	40.79	0.001	-157.53
TDW	2.47	0.13	0.75	22.41	0.007	0.51	0.04	0.19	29.19	0.002	-281.53
PC	3.27	0.26	1.68	3.43	0.002	2.18	0.04	0.70	2.19	0.001	-138.98
TPU	3.28	0.17	1.65	3.38	0.002	2.18	0.02	0.68	2.09	0.001	-143.03
PUE	3.43	0.10	0.52	19.97	0.004.	6.59	0.03	0.35	53.32	0.008	-46.87

Analysis of variance (ANOVA) for 13 traits associated with low phosphorus tolerance was carried out separately for optimum and low P conditions as well as across the locations to find the interaction of genotypes with P levels. In combined analysis, the variance due to interaction between genotype and P level or environment was also recorded to be highly significant for all 13 traits. Principal component analysis (PCA) and cluster analysis illustrated high genetic diversity among the 150 lentil genotypes (Table 3.22-3.23).

Table 3.22. Estimates of variance components and broad-sense heritability (H) for phosphorus use efficiency related traits under optimum and low phosphorous conditions

Traits	Optimum phosphorus		Low phosphorus		Combined analysis		$H_{(com)}$
	Genotypes	H	Genotypes	H	Genotypes	Genotypes x P levels	
SL	38.43**	0.77	14.31**	0.52	30.62**	22.12**	0.63
RL	15.09**	0.64	13.51**	0.57	15.18**	13.41**	0.59
FW	11.28**	0.85	0.57**	0.94	6.40**	5.45**	0.60
RSR	0.09**	0.64	0.10**	0.51	0.09**	0.10**	0.55
RV	0.04**	0.77	0.002**	0.26	0.02**	0.02**	0.59
SFW	10.26**	0.89	0.37**	0.81	5.73**	4.89**	0.60
RFW	0.27**	0.84	0.15**	0.92	0.21**	0.20**	0.58
SDW	0.45**	0.88	0.02**	0.67	0.25**	0.21**	0.60
RDW	0.001**	0.93	0.001**	0.92	0.001**	0.001**	0.58
TDW	0.46**	0.88	0.02**	0.69	0.26**	0.22**	0.60
PC	0.79**	0.99	0.11**	0.99	0.45**	0.45**	0.57
TPU	0.86**	0.99	0.11**	0.99	0.49**	0.48**	0.57
PUE	0.31**	0.93	0.58**	0.88	0.43**	0.46**	0.56

** ($P < 0.01$); SL: Shoot length, RL: Root length, FW: Fresh weight, RSR: Root to shoot ratio, RV: Root volume, SFW: Shoot fresh weight, RFW: Root Fresh Weight, SDW: Shoot dry weight, RDW: Root dry weight, PC: Phosphorus content, TPU: Total phosphorus uptake, PUE: Phosphorus utilization efficiency

Table 3.23 Top 15 efficient genotypes identified based on population mean and standard deviation under low-phosphorus and optimum-phosphorus conditions

S. No.	Genotype	SDW	RDW	TDW	TPU	PUE	Total score out of 15	SDW	RDW	TDW	TPU	PUE	Total score out of 15	Total score out of 30
		Low P						Optimum P						
1	IC0623666	E	E	E	E	M	14	E	E	E	E	E	15	29
2	IC78460	E	I	E	E	M	12	E	E	E	E	E	15	27
3	IC260897	E	M	E	E	M	13	E	E	E	I	E	13	26
4	IC78449	I	E	M	E	M	11	E	E	E	E	E	15	26
5	IC78455	E	I	E	I	E	11	E	E	E	E	E	15	26
6	IC0623667	E	E	E	I	E	13	E	E	E	I	E	13	26
7	IC201569	E	I	E	E	M	12	E	I	E	E	E	13	25
8	IC78376	M	E	M	E	M	12	E	I	E	E	E	13	25
9	NMK11/17	E	E	E	I	E	13	E	M	E	M	M	12	25

S. No.	Genotype	SDW	RDW	TDW	TPU	PUE	Total score out of 15	SDW	RDW	TDW	TPU	PUE	Total score out of 15	Total score out of 30
		Low P						Optimum P						
10	IC201741	M	I	M	E	M	10	E	E	E	E	M	14	24
11	IC201533	M	I	M	E	M	10	E	M	E	E	E	14	24
12	IC201566	E	M	E	E	M	13	E	I	E	I	E	11	24
13	IC78463	M	E	M	E	M	12	M	E	M	E	M	12	24
14	IC78474	E	I	E	I	E	11	E	E	E	I	E	13	24
15	EC795496	E	E	E	I	E	13	M	M	M	E	M	11	24

Evaluation of advance breeding lines for rice fallow ecosystem

Eleven advance breeding lines of lentil, as received from Division of Genetics, IARI-New Delhi, were evaluated under late sown condition, targeting the rice fallow ecosystem of Jharkhand during *Rabi* 2022-23 and 2023-24 (Table 3.24).

Table 3.24 List of crosses and checks

S. N.	Name of crosses
1A	PDL 1 X L 4618
1B	PDL 1 X L 4618
2A	IPL 316 X PDL 2
2B	IPL 316 X PDL 2
3A	L 4590 x PAL 6
3B	L 4590 x PAL 6
4A	VL 507 x L 4602
4B	VL 507 x L 4602
5A	VL 507 x PSL 9
S.N.	Name of crosses
5B	VL 507 x PSL 9
6A	BM 4 x PAL 6
6B	BM 4 x PAL 6
7A	L 4590 x L 4078
7B	L 4590 x L 4078
8A	L 4076 x 330/12
8B	L 4147 x L 4078
9A	JL 3 x PAL 6
9B	JL 3 x PAL 6
S.N.	Name of crosses
10A	PL 5 x L 4602
10B	PL 5 x L 4602
11A	PL 5 x L 4602
11B	PL 5 x L 4602
12	PDL 1 ((Check 1)
13	PSL 9 (Check 2)
14	L 4147 (Check 3)
15	HUL 57 (Check 4)

Station trials in collaboration with IARI-New Delhi

The station trial comprised of eight entries was carried out in collaboration with IARI, New Delhi in order to identify potential entries for rice fallow ecosystem. Two potential entries *viz.*, **PAL 14** and **PAL 15** has been identified and will be subjected to further evaluation under All India Coordinated trials on *Rabi* pulses (Table 3.25; Fig 3.14).

Table3.25 List of entries and checks

S. N.	Name of crosses	S. N.	Checks
1.	PAL-9	9.	PDL-1
2.	PAL-10	10.	PL-4
3.	PAL-11	11.	HUL-57
4.	PAL-12A	12.	L-4602
5.	PAL-12B	13.	KLS-218
6.	PAL-13	14.	PSL-9
7.	PAL-14	15.	L-4717
8.	PAL-15	16.	L-4727

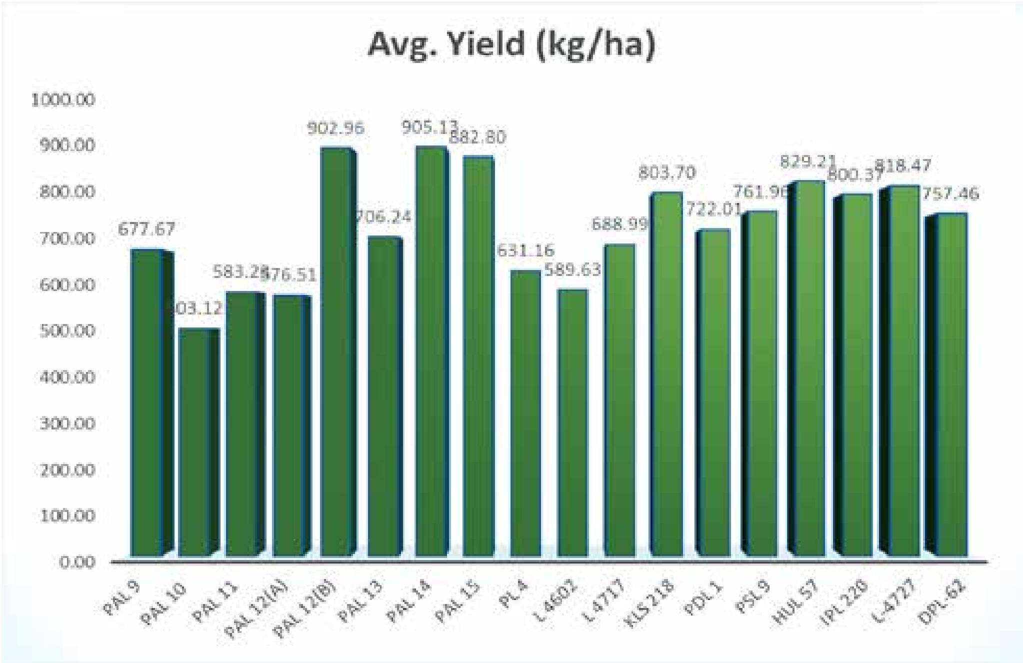


Fig 3.14. Average yield (kg/ha) of different lentil entries

Multilocation testing of lentil in collaboration with BAU, Ranchi

Two varieties of lentil, PDL-1 and PSL-9, developed by IARI-New Delhi, have been released and notified for cultivation in Haryana and Uttar Pradesh in 2020. These two varieties are performing great and have good potential under the agroclimatic conditions of Jharkhand. So multilocation trials for these two entries has been started in collaboration with BAU, Ranchi since *Rabi* 2022-23 for the promotion of these potential varieties for state release and area expansion under state varietal release committee (Table 3.26).

Table 3.26 Yield data (kg/ha) of multilocation trials in lentil

***Rabi* 2022-23**				***Rabi* 2023-24**				
Entries	**BAU Ranchi (DOS 22.12.2022)**	**IARI-Jharkhand (DOS 25.11.2022)**	**Mean**	**Entries**	**BAU Ranchi (DOS 15.12.2023)**	**IARI-Jharkhand (DOS 15.11.2023)**	**ZRS (BAU), Darisai (DOS 09.11.2023)**	**Mean**
Test entries				**Test entries**				
PDL - 1	1072*(1)	1052* (1)	1062 [1]	PDL - 1	1150* (1)	1048 (1)	957 (1)	1052 [1]
PSL - 9	990 (3)	980 (2)	985 [2]	PSL - 9	1082 (2)	936	830	949 [3]
RNCL 15-02	925	966	946	RNCL 14-06	949	903	787	880
RNCL 14-06	957	926	941	RNCL 15-02	1072 (3)	1038 (2)	817	976 [2]
Checks				RNCL 15-05	862	1004 (3)	763	876
IPL - 406 (C)	904	862	883	RNCL 16-02	963	992	800	918
WBL 77 (C)	875	737	806	**Checks**				
HUL - 57 (C)	990 (3)	975 (3)	982 [3]	IPL - 406 (C)	941	782	833	852
DPL - 62 (C)	1004 (2)	918	961	WBL 77 (C)	1057	861	823	914

Rabi 2022-23				*Rabi* 2023-24				
Entries	BAU Ranchi (DOS 22.12.2022)	IARI-Jharkhand (DOS 25.11.2022)	Mean	Entries	BAU Ranchi (DOS 15.12.2023)	IARI-Jharkhand (DOS 15.11.2023)	ZRS (BAU), Darisai (DOS 09.11.2023)	Mean
CV%	6.33	8.47		HUL - 57 (C)	889	968	847 (3)	901
CD (P<0.05)	49.70	63.85		DPL - 62 (C)	951	794	900 (2)	882
SEM	16.23	20.85		IPL -220 (C)	938	887	837	887
				CV%	9.45	6.38	6.09	
				CD (P<0.05)	159.89	102.41	87.30	
				SEM	53.81	34.47	29.39	

Genetic improvement of mung bean

Genetic diversity analysis for low phosphorus tolerance

This study was conducted with evaluation of 228 mung bean accessions collected from acidic zones of Jharkhand, Bihar, Odisha, West Bengal, Andhra Pradesh and north-Eastern states for low phosphorus tolerance in the acidic soil condition of Jharkhand (Fig 3.15). The mung bean crop is highly vulnerable to low phosphorus conditions, particularly during reproductive stage, leading to substantial yield losses. To address this, a comprehensive study was conducted on 228 genotypes to explore genetic parameters of traits influencing low phosphorus tolerance and yield in mung beans. Eleven traits related to phosphorus use efficiency (PUE) as well as yield were evaluated, revealing noteworthy variations for all traits, except root-to-shoot ratio (RSR) (Table 3.27). The phenotypic and genotypic coefficient of variation was also reported to be high indicating substantial genetic influence with minimal environmental impact on these traits. Heritability assessments for various traits, including shoot fresh weight (SFW), root fresh weight (RFW), shoot dry weight (SDW), root dry weight (RDW), phosphorus content (PC), total phosphorus uptake (TPU), phosphorus utilization efficiency (PUE) and yield-associated attributes *i.e.*, days for bud initiation (DBI), days for 50% flowering (DF), days for pod initiation (DPI), days for 50% podding (DFP), cluster/plant (CPP), total no of pods (TP), total pod weight (TPW), yield (Y) and yield/ plant (YPP) unveiled high heritability, denoting the potential for selective breeding to enhance these traits.

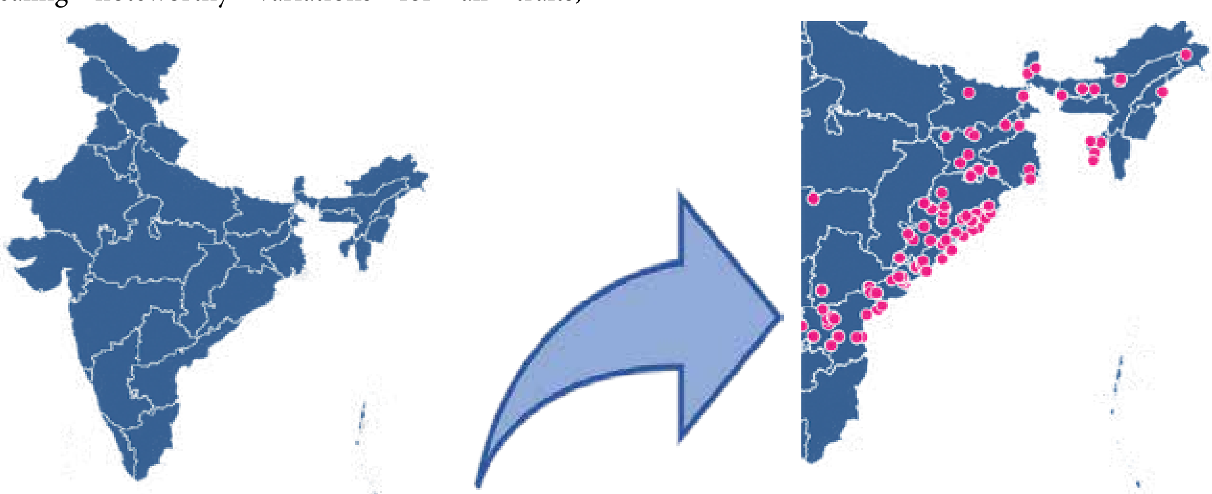


Fig 3.15 Map of India representing the GPS locations of sample collection site

Table 3.27 Analysis of variance for PUE and other related traits in low (LP) and optimum phosphorus (OP) condition

Variables	Mean square								CV	
	Genotype		Replication		Block		Error			
Df	227		1		22		205			
Env	LP	OP	LP	OP	LP	OP	LP	OP	LP	OP
SL	25.30**	87.40**	10.00	144.00	10.30	40.70	9.77	30.40	20.90	20.20
RL	15.80**	14.70**	25.40	0.83	5.14	6.13	6.41	6.22	20.80	16.90
RSR	0.09	0.05	0.22	0.13	0.07	0.030	0.08	0.03	33.60	31.70
RV	0.04**	0.63**	0.001	0.001	0.005	0.06	0.009	0.05	45.40	25.30
SFW	11.00**	518.00**	2.49	10.70	0.79	38.60	0.71	31.60	19.10	25.70
RFW	0.07**	0.83**	0.001	0.002	0.002	0.03	0.001	0.02	10.60	15.70
SDW	0.54**	8.82**	0.001	0.073	0.004	0.220	0.005	0.161	11.10	11.50
RDW	0.01**	0.06**	0.001	0.001	0.001	0.005	0.001	0.004	25.00	21.80
PC	0.51**	0.41**	0.001	0.001	0.006	0.005	0.005	0.007	3.50	3.10
TPU	4.00**	241.00**	0.01	0.91	0.04	1.45	0.043	1.28	12.40	11.50
PUE	0.03**	0.01**	0.001	0.001	0.001	0.001	0.001	0.001	4.10	3.30

Principal component analysis (PCA) and cluster analysis illustrated the genetic diversity of 120 mung bean genotypes based on 21 traits, *i.e.*, including all PUE related and yield attributing traits (Fig 3.16). Interestingly, correlations and PCA patterns for phenological and yield attributes were comparable under both low phosphorus (E1) and optimal phosphorus conditions (E2). However, the relationship between phosphorus use efficiency (PUE) and its associated traits exhibited contrasting trends in E1 and E2 conditions. Negative associations were apparent under E1, while positive associations were evident under E2 condition.

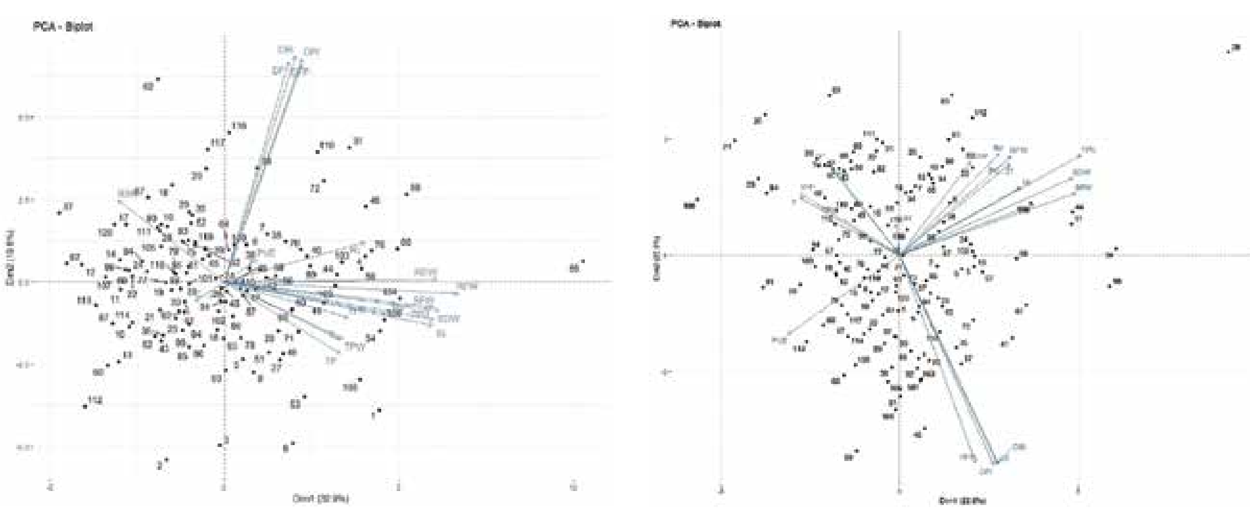


Fig 3.16 PCA biplot depicting genetic diversity of mung bean genotypes based on morphological, yield attributing, PUE and other related traits

Seven tolerant and five susceptible checks were used for comparison (Table 28). Under low P condition, nine accessions *viz.,* IC0105576, IC0392343, IC0398988, IC0400063, IC0400174, IC0565278, IC0623693, IC0639817 and IC0610380 were reported to be superior in terms of PUE over all the checks. Likewise, 12 accessions *viz.,* IC0000022, IC0019402, IC0024787, IC0343864, IC0343889, IC0343946, IC0347913, IC0400062, IC0400160, IC0565252, IC0565293, IC0623693, were identified with higher PUE than the checks under optimum P condition. The genotype, IC 0623693 had higher PUE under both the environments and could be a used as a potential source against low P tolerance in mung bean.

Table 3.28 Comparison of genotypes with checks in terms of PUE under LP and OP conditions

LP					OP				
Checks	**Type**	**PUE**	**Acc.**	**PUE**	**Checks**	**Type**	**PUE**	**Acc.**	**PUE**
MH-805	Tolerant	0.39	IC0105576	0.53	MH-805	Tolerant	0.52	IC0000022	0.75
Pusa 9531	Tolerant	0.52	IC0392343	0.52	Pusa 9531	Tolerant	0.44	IC0019402	0.76
EC398885	Tolerant	0.36	IC0398988	0.55	EC398885	Tolerant	0.60	IC0024787	0.91
M 209	Tolerant	0.31	IC0400063	0.72	M 209	Tolerant	0.34	IC0343864	0.77
PDM-139	Tolerant	0.35	IC0400174	0.54	PDM-139	Tolerant	0.65	IC0343889	0.70
IC0280489	Tolerant	0.45	IC0565278	0.53	IC0280489	Tolerant	0.60	IC0343946	0.80
IC0121316	Tolerant	0.37	IC0623693	0.58	IC0121316	Tolerant	0.60	IC0347913	0.79
IPM02-3	Sensitive	0.36	IC0639817	0.67	IPM02-3	Sensitive	0.43	IC0400062	0.73
IC0119005	Sensitive	0.32	IC0610380	0.53	IC0119005	Sensitive	0.33	IC0400160	0.72
IC0073401	Sensitive	0.35			IC0073401	Sensitive	0.59	IC0565252	0.82
IC0488526	Sensitive	0.50			IC0488526	Sensitive	0.54	IC0565293	0.76
IC0325853	Sensitive	0.39			IC0325853	Sensitive	0.59	IC0623693	0.74

Genetic improvement of pigeonpea

Pigeonpea germplasm collection and maintenance

Total 50 Nos. of germplasm were maintained and evaluated for various agro-morphological traits (Table 3.29). The data are presented graphically in the following figures. Continuous efforts are being made to further enrich germplasm base at IARI Jharkhand for its systematic utilization in Pigeon pea improvement program. The details of germplasm being maintained are listed in the following table.

Table 3.29 Germplasm maintained during 2023-24 cropping season

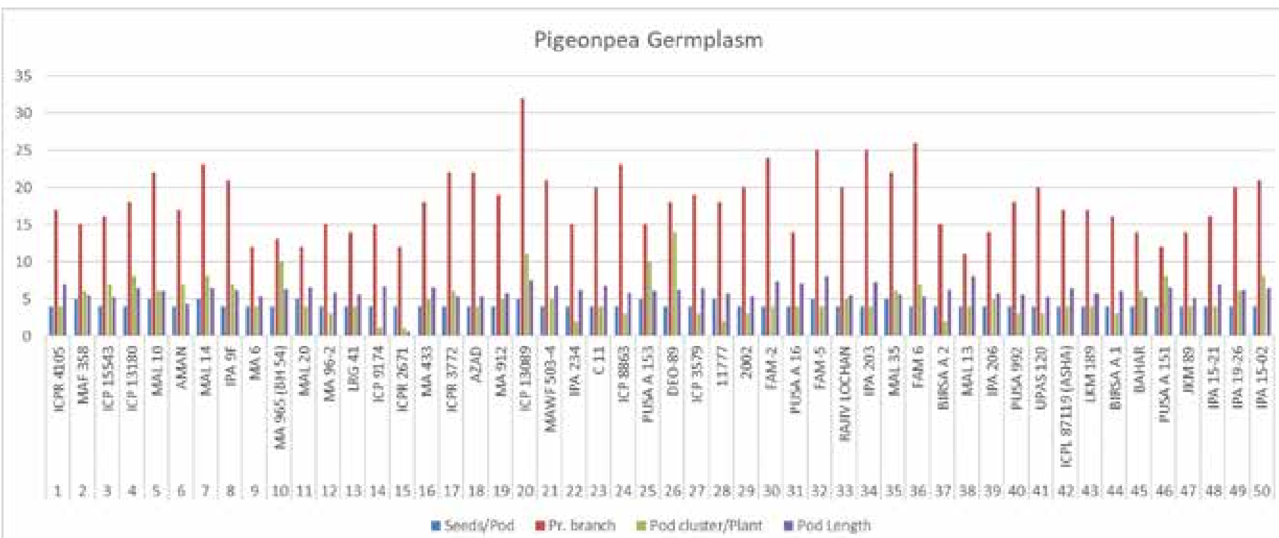
S. N.	Germplasm	S. N.	Germplasm	S. N.	Germplasm
1	ICPR 4105	18	AZAD	35	MAL 35
2	MAF 358B	19	MA 91-2	36	Farmer Variety – 6
3	ICP 15543	20	ICP 13089	37	BAU PP-9-22 (Birsa Arhar 2)
4	ICP 13180	21	MAWF 503-4	38	MAL 13
5	MAL 10	22	IPA 234	39	IPA 206
6	AMAN	23	C 11	40	PUSA 992
7	MAL 14	24	ICP 8863	41	UPAS 120
8	IPA 9F	25	Pusa Arhar 153	42	ICPL 87119 (ASHA)
9	MA 6	26	Deo 89	43	LKM 189
10	MA 965 (BH 54)	27	ICP 3579	44	Birsa Arhar 1
11	MAL 20	28	11777	45	BAHAR
12	MA 96-2	29	2002	46	Pusa Arhar 151
13	LRG 41	30	Farmer Variety – 2	47	JKM 89
14	ICP 9174	31	Pusa Arhar 16	48	IPA 15-02
15	ICPR 2671	32	Farmer Variety – 5	49	IPA 15-21
16	MA 433	33	Rajiv Lochan	50	IPA 19-26
17	ICPR 3772	34	IPA 203		

Screening of pigeonpea advance breeding lines in rainfed conditions

The early segregating generation MAGIC populations derived from eight founder parents were received from IARI, New Delhi. The MAGIC populations consisted of two sets: the first set named Varietal Magic-1 (VM1) consisting of 42 lines and the second set named Varietal Magic-2 (VM2) consisting of 35 lines, and therefore a total of 77 MAGIC lines were initially characterized, screened and advanced under rainfed conditions during 2021-22 and 2022-23 cropping seasons. Both advance MAGIC lines were evaluated for yield and yield associated traits and based on its performance, 20 and 19 lines in VM-1 and VM-2 respectively were screened and sown in 2023-24 cropping season. The advanced selected lines from both MAGIC populations (VM1 and VM2) were further screened based on yield and other yields determining traits (Fig 3.17-3.18).

Validation of GMFS line identified by IARI New Delhi

Unique segregant were observed at IARI, New Delhi in F2, following monogenic inheritance (in large enough population ~ 325) for male and female sterility in the same plants and maintained in heterozygous condition generation after generation. IN RILs derived NILs they exactly follow 3:1 ratio (F: S) in NILs also.



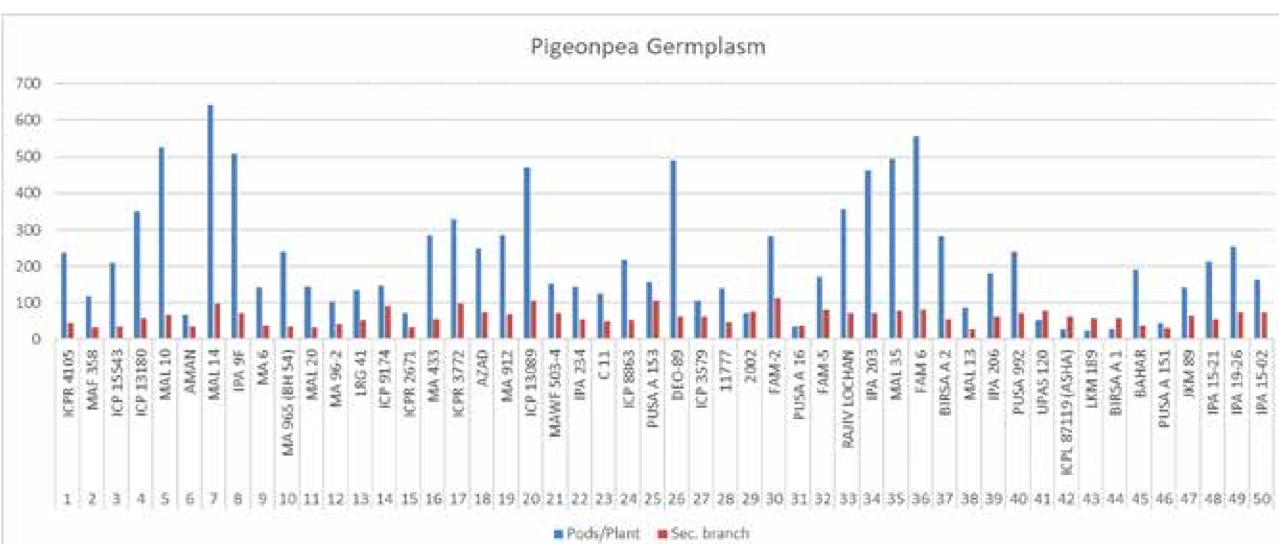


Fig 3.17 Yield traits recorded on germplasm evaluation during 2023-24 cropping season

Fig 3.18 Pigeonpea trials during 2023-24 cropping season

Genetic improvement of wheat

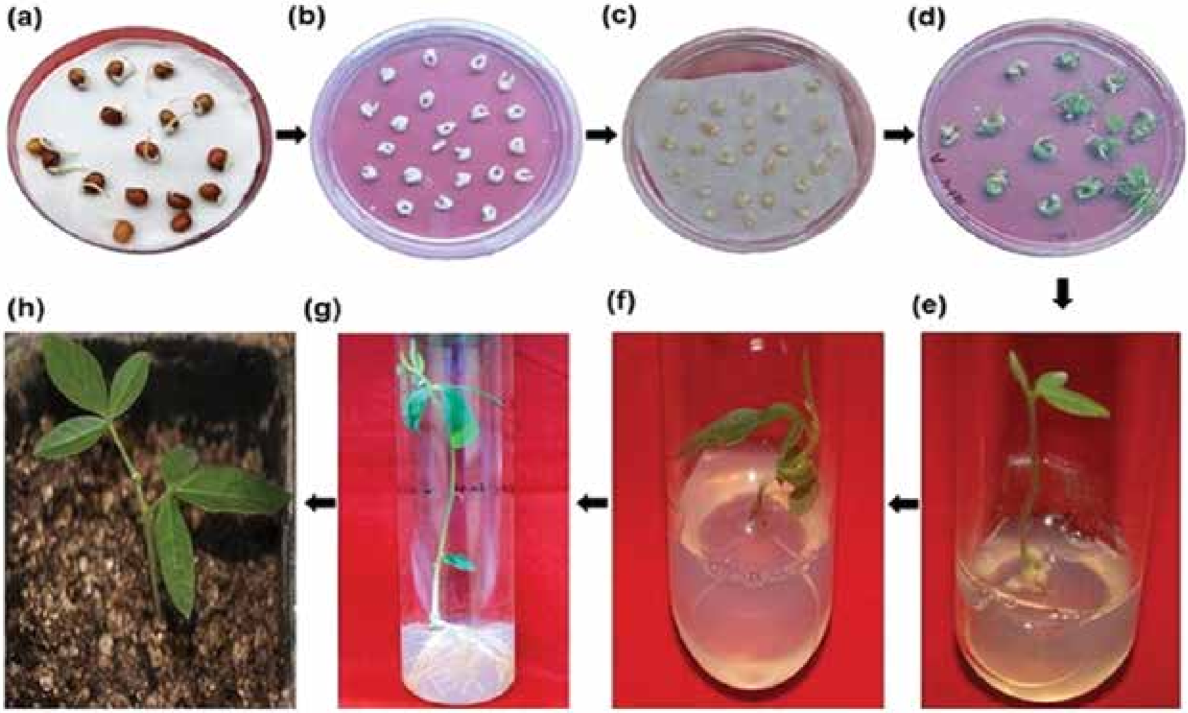
An experiment was conducted on 'phosphorus use efficiency' in wheat (*Rabi*-2023) at ICAR-IARI, Jharkhand experimental field. The soil samples were first collected, and available phosphorus levels were analysed. Based on the soil parameters obtained, 315 association panels were screened for high phosphorus content under field conditions. Yield-related parameters such as plant height, grains/spike, seed weight, number of tillers etc., were recorded. Among those 10 promising lines were selected based on yield attributes. Amongst the 10 top-performing lines, biological yield was recorded as highest in DBW 335 (780 g) and HD 3360 (595 g) under treatment +P and -P, respectively. Spike length was also highest in DBW 39 (12.5 cm) and DBW 314 (12 cm) under treatment +P and -P, respectively., while the corresponding lines for seed weight per 10 spike were UAS 472 (49 g) and MACS 6755 (31 g), respectively (Table 3.30).

Table 3.30 Effect of P on biological yield, spike length, and seed weight/10 spike of wheat lines

Biological Yield(g)				Spike length(cm)				Seed Weight /10 spike(g)			
wheat lines	+P	wheat lines	-P	wheat lines	+P	wheat lines	-P	wheat lines	+P	wheat lines	-P
DBW335	780	HD3360	595	DBW 39	12.5	DBW 314	12	UAS 472	49	MACS 6755	31
HS681	695	DBW 187	575	HS675	12	PBW830	11.5	HS680	47	MP3529	29
VL3022	645	HD3361	560	HPW472	12	JKW275	11.5	AAI-W29	47	HPW470	29
PBW832	615	NW7092	555	HD3352	12	NW8000	11.5	UAS3008	43	HS680	28
UAS3008	600	WH1273	525	UP3033	12	MP1367	11	WH1283	42	WH1252	28
VL2042	575	HD3352	510	HI1544	11.5	PBW644	11	HD3249	42	DBW328	27
UAS472	575	HI1646	410	UAS428	11.5	PBW840	10.5	DDW47	41	DBW39	24
DBW 187	570	DBW 110	385	UAS466	11.5	GW322	10.5	PBW840	40	HD3043	21
HD 3249	560	UAS3008	375	PBW812	11	DBW 187	10	PBW813	40	HD3090	20
DBW319	550	CG1029	365	HI1651	11	HI1636	10	HI 1628	39	WH1105	18

Tissue culture based propagations

A robust tissue culture-based regeneration and transformation protocol has been established using the embryo axis of pigeon pea (*Cajanus cajan*). The shooting efficiency was 82% and 77% for cultivars Pusa 992 and Asha, respectively. Rooting efficiency was nearly 100% for both when cultured on half-strength MS containing 15 g/l sucrose and 0.5 mg/l IAA. Regenerated plants exhibited a high level of survival of 90% upon transplantation into pots (Fig 3.19).



(a) Germination, (b) pre-culturing, (c) co-cultivation, (d) multiple shoot induction, (e) plantlet elongation, (f) root induction (g) rooted plantlets (h) hardening.

Fig 3.19 Summary of plant transformation and regeneration in pigeon pea

For soybean (*Glycine max*), it was observed transcription-factor-derived functional SSR markers using in silico analysis following validation. The coding sequences of *Glycine max* were downloaded from PlantTFDB and used for the identification, followed by the localization of SSRs by using a Perl 5 script (MISA, MIcroSatellite identification tool). The flanking primers to SSRs were designed, and chromosomal distribution and gene ontology searches were performed using BLAST2GO. Twenty random SSR markers were validated to check cross-species transferability, and a genetic diversity study was performed. A set of 1138 simple sequence repeat markers from transcription factor coding genes were designed and designated as TF-derived SSR markers. They were anchored on 20 *G. max* chromosomes, and the SSR motif frequency was one per 4.64 kb. Trinucleotide repeats were found to be abundant, and tetra- as well as pentanucleotide frequency was least in soybean. Gene Ontology search revealed the diverse role of SSR-containing TFs in soybean (Table 3.31).

Table 3.31 Summary of TF-derived SSR searches in soybean

Search Items	Numbers
Total number of TFs examined	6150
Total number of identified SSRs	1550
Number of SSR containing TFs	1138
Number of TFs containing more than 1 SSR	282
Number of SSRs present in compound formation	160
Repeat type	
Mononucleotide	26
Dinucleotide	49
Trinucleotide	1455
Tetranucleotide	1
Pentanucleotide	1
Hexanucleotide	18
The total length of sequences searched (kb)	7200
Frequency of SSRs	One per 4.64 kb

Evaluation of fruit crop genotypes and varieties

The elite planting material of different varieties of potential fruit crops were collected from different places of the country and established in the research farm of ICAR-IARI, Jharkhand area (Table 3.32). The evaluation of these collected genotypes is under progress for their suitability in the region based on growth, fruit quality and yield attributes. Further the local germplasm of mango (seedlings), lemon and custard apple have been collected to assess the diversity of perennial fruit crops in the region.

Table 3.32. Details of fruit crops and their varieties/ genotypes collected

Fruit crop	Varieties/ genotypes
Mango (38 genotypes)	**Variety** (1) Totapuri, (2) Swarnarekha, (3) Banganapalle, (4) Neelam, (5) Chausa, (6) Dashehari, (7) Langra, (8) Malda, (9) Kesar, (10) Arka Neelachal Kesari, (11) Zardalu, (12) Bombay Green, (13) Himsagar, (14) Kisan Bhog, (15) Sukul, (16) Imam Pasand, (17) Raspuri, (18) Alphonso, (19) Paharpur Sindhuria **Hybrids** (1) Manjeera, (2) Neeleshan, (3) Neeleswari, (4) Neelgoa, (5) Mahmood Bahar, (6) Arunika, (7) Ambika, (8) Amrapalli, (9) Mallika, (10) Pusa Arunima, (11) Pusa Sreshtha, (12) Arka Puneet, (13) Pusa Peetamber, (14) Pusa Lalima, (15) Pusa Pratibha, (16) Arka Uday, (17) Akra Suprabhat, (18) Pusa Manohari, (19) Pusa Deepsikha
Guava (12 genotypes)	(1) Lucknow 49, (2) Allahbad Safeda, (3) Arka Kiran, (4) Arka Mridula, (5) Pusa Prateeksha, (6) Pusa Arushi, (7) CISH Lalit, (8) CISH Sweta, (9) CISH Dhawal, (10) CISH Lalima, (11) Arka Poorna, (12) Arka Rashmi
Jamun (3 genotypes)	(1) CISH-J-37 Jamvant, (2) CISH J-42, (3) Dhupdal
Litchi (7 genotypes)	(1) Shahi, (2) Rose Scented, (3) China, (4) Gandaki Yogita, (5) Gandaki Sampada, (6) Gandaki Lalima, (7) Late Bedana
Ber (3 genotypes)	(1) Apple Ber, (2) Gola, (3) Umran
Sapota (5 genotypes)	(1) Cricket Ball, (2) Kalipatti, (3) Murabba, (4) DSH-1, (5) DSH-2
Custard apple (3 genotypes)	(1) Akra Neelachal Vikram, (2) Arka Sahan, (3) Balanagar
Jackfruit (2 genotypes)	(1) Siddhu, (2) Shankara
Citrus (13 genotypes)	Lemon: Kagzi Kalan Sweet orange: Mosambi, Pusa Round and Pusa Sharad Lime: Seedless, Kagzi lime, Pusa Abhinav, Pusa Udit Mandarins: Kinnow, Coorg Mandarin Pummelo: Arka Ananatha, Arka Chandra, Pusa Arun, Devanhalli
Grapes (4 genotypes)	Pusa Aditi, Pusa Trishar, Pusa Navrang, Pusa Urvashi
Bael (5 genotypes)	(1) CISH B1, (2) CISH B2, (3) NB 5, (4) NB9, (5) Swarna Vasudha
Aonla (6 genotypes)	(1) Chakaiya, (2) Kanchan, (3) Krishna, (4) NA-6, (5) NA-7, (6) NA 10

Heterosis studies and evaluation of new okra hybrids

Total 36 okra new hybrid combinations, those were generated last year after crossing 15 diverse parents in Line x Tester mating designs (12 lines and 3 testers), were evaluated in ICAR-IARI Jharkhand field condition for their per se performance and incidence of viral disease resistance during both summer and kharif season of the current year. Analysis of variance for 10 quantitative measurements of field data of the parents and crosses were highly significant for most of the traits (Table 3.33). On the basis of GCA effect and per se performance, Kashi Kranti and DOV-7 was considered as a best parent for yield per plant, while cross combination KRK/GKLF-20 × Pusa Sawani considered as a best hybrid on the basis of both SCA effect and per se performance for number of branches and yield per plant. Hybrid KRK/GKLF-20 × Pusa Sawani exhibited maximum positive and significant heterosis over mid parent (32.84%), better parent (31.37%) and commercial check (31.37%). Data on agronomic performance and biochemical evaluation of advance generation lines raised through selfing of the new hybrid combinations were generated for overall selection of better okra lines. The result revealed that there exists tremendous scope for commercial exploitation of heterosis in okra through selection of better parents with high combining ability and utilization of their new hybrid combinations with desirable traits based on their *per se* performance under the Eastern Plateau Region of India.

Table 3.33. ANOVA for parents and hybrids for yield and yield attributing traits in okra

Source of variation	df	DFF	D 50%F	INL (cm)	TNFP	FL (cm)	FD (cm)	FW (cm)	NBP	PH (cm)	YPP (g)
Replication	2	0.03	6.15	0.05	1.19	0.43	0.00	0.05	0.13	17.07	95.20
Treatment	50	39.19**	27.79**	0.33**	17.59**	3.66**	0.14**	5.10**	0.69**	204.33**	2328.78**
Parents	14	38.91**	13.82**	0.13**	7.06**	2.92*	0.04**	1.37**	0.72**	183.83**	1516.89**
Crosses	35	13.31**	25.04**	0.38**	13.33**	3.97**	0.15**	4.74**	0.69**	75.27**	2591.92**
Parents vs crosses	1	949.05**	319.56**	1.18**	314.2**	2.90**	1.14**	70.04**	0.03**	5008.52**	4485.13**
Lines	11	17.11**	33.45**	0.53**	32.19**	2.99**	0.29**	11.20**	0.98**	206.62**	5285.66**
Testers	2	7.95**	57.02**	0.21**	5.58**	13.09**	0.13**	8.40**	0.00	39.80**	4609.86**
Lines × testers	22	11.89**	17.93**	0.32**	4.60*	3.64**	0.08**	1.18**	0.61**	183.84	1061.60**
Error	100	3.92	4.85	0.06	0.73	0.60	0.01	0.41	0.04	21.49	160.93

*(P<0.05); **(P<0.01); DFF: Days to first flowering, DF1: Days to 50% flowering, INL: Internodal length (cm), TNFP: Total number of fruits/plant, FL: Fruit length, FD: Fruit diameter, FW: Fruit weight, PH: Plant height, NBP: No. of branches per plant, YPP: Yield per plant

Evaluation of advance breeding lines of brinjal

In continuation with the previous year work to identify suitable genotypes and hybrid crosses for their improved yield potential and wilt resistance in the Eastern Plateau Region of India, a set of 45 advance breeding lines (genotypes) of brinjal in both round and long-type segment including both open pollinated as well as hybrid crosses (Developed by ICAR- IIVR, Varanasi) were evaluated in natural field condition of ICAR-IARI, Jharkhand. Based on morphological and biochemical studies, the analysis of variance revealed significant differences among the genotypes for the studied traits, indicating substantial genetic variability. High estimates of GCV and PCV were observed for traits such as fruit length, fruit diameter, fruit length-to-diameter ratio and quality traits like ascorbic acid, total phenol and total antioxidant capacity. High heritability coupled with genetic advance was observed for plant height, number of branches, fruit yield and ascorbic acid, while low variability was found for days to 50% flowering and average fruit weight. Qualitative trait characterization revealed diverse plant growth habits (erect, semi-spreading and spreading), fruit shapes (round and long) and colours (light green, purple and white), contributing valuable information for the development of new brinjal varieties. The genotypes BWT-44 (28.43 t/ha), BWT-16 (28.01 t/ha) and BWT-3 (26.85 t/ha) were identified as high-yielding and were recommended as elite lines for further varietal testing and advancement. Traits such as the number of fruits per plant, fruit weight and fruit diameter showed positive associations with fruit yield. Path analysis indicated that the number of fruits per plant, fruit weight and fruit diameter had the most significant positive direct effects on fruit yield. The findings from this study highlight the broad genetic diversity within the advanced brinjal breeding lines, the significance of specific traits for yield improvement and the potential for selection to enhance both yield and quality in brinjal cultivars (Table 3.34-3.35; Fig 3.20-3.21).

Table 3.34 Trait-wise best performing genotypes of brinjal

Traits	Best performing lines
Plant height (cm)	BWT-41 (98.76 cm), BWT-16 (93.33 cm) and BWT-44 (90.57 cm).
Number of branches per plant	BWT-16 (16.20), BWT-41 (15.00) and BWT-24 (14.37)
Number of flowers per cluster	BWT-22 (5.00), BWT-25 (4.67) and BWT-28 (4.53)
Fruit length (cm)	BWT-48 (14.74 cm), BWT-16 (13.74 cm) and BWT-24 (13.65 cm)
Fruit diameter (cm)	BWT-3 (5.83 cm), BWT-19 (5.60 cm) and BWT-7 (5.59 cm)
Fruit weight (cm)	BWT-33 (60.55 g), BWT-44 (57.65 cm) and BWT-3 (57.30 g)
Number of fruits per plant	BWT-16 (16.00), BWT-41 (15.33), BWT-24 (14.67)
Total fruit yield (t/ha)	BWT-44 (28.43 t/ha), BWT-16 (28.01 t/ha), BWT-3 (26.85 t/ha)

Table 3.35 Range and mean values of traits studied for brinjal genotypes

Sl. No.	Traits description	Mean	Range	
			Max	Min
01	Plant height (cm)	70.60	98.76	45.52
02	Number of branches per plant	11.60	16.20	9.57
03	Leaf blade length (cm)	11.87	15.43	9.31
04	Leaf blade width (cm)	7.18	10.23	4.99
05	Days from transplanting to first flowering	52.44	69.00	41.00
06	Days from transplanting to 50% flowering	78.95	90.33	71.33
07	Number of flowers per cluster	3.64	5.00	1.60
08	Fruit length (cm)	9.03	14.74	5.24
09	Fruit diameter (cm)	4.30	5.83	2.63
10	Fruit length: diameter ratio	2.45	5.19	1.00
11	Fruit peduncle length (cm)	4.66	6.63	2.93
12	Fruit weight (g)	49.16	60.55	41.37
13	Number of fruits per plant	11.19	16.00	8.00
14	Fruit yield (t/ha)	20.38	28.43	13.84
15	Percent incidence of fusarium wilt (%)	21.70	36.67	10.00
16	TSS (°Brix)	4.65	6.10	4.00
17	Ascorbic acid (mg/100 g)	8.21	14.73	3.67
18	Dry matter (%)	6.41	9.00	4.36
19	Total phenol (mg GAE/100 g)	28.35	85.79	6.18
20	Total antioxidant capacity (mg AEAC/100 g)	254.48	487.72	165.19

Fig 3.20 Field view of the brinjal crop

Fig 3.21 Representative photographs showing Brinjal fruit diversity in the advance breeding lines of brinjal

2. Natural resources management and crop production

Identification of efficient cropping zone in Jharkhand

A methodological study was made at ICAR-IARI, Jharkhand and ICAR-NBSSLUP, Nagpur during 2024-25 to identify the potential districts for cultivation of maize (rabi), wheat, pigeonpea, lentil, potato and guava in Jharkhand. The data on area, production and productivity of study crops for 2022-2023 to 2023-24 were collected and indices such as relative spread index (RSI) and relative yield index (RYI) were computed and the potential cropping districts for the study crops were identified. In Jharkhand, five districts were found to be most efficient regions for maize (rabi), nine districts for wheat, six districts for pigeonpea, three districts for lentil, six districts for potato and five districts for guava as in these areas both the RYI and the RSI were high. In some of the districts, RSI was more for a particular crop, while the RYI was low indicating non-suitability of that crop. However, due to other factors such as market demand and value of the produce, farmers cultivate the crops that are not suitable for their location which relates in high RSI with low RYI (Fig 3.22).

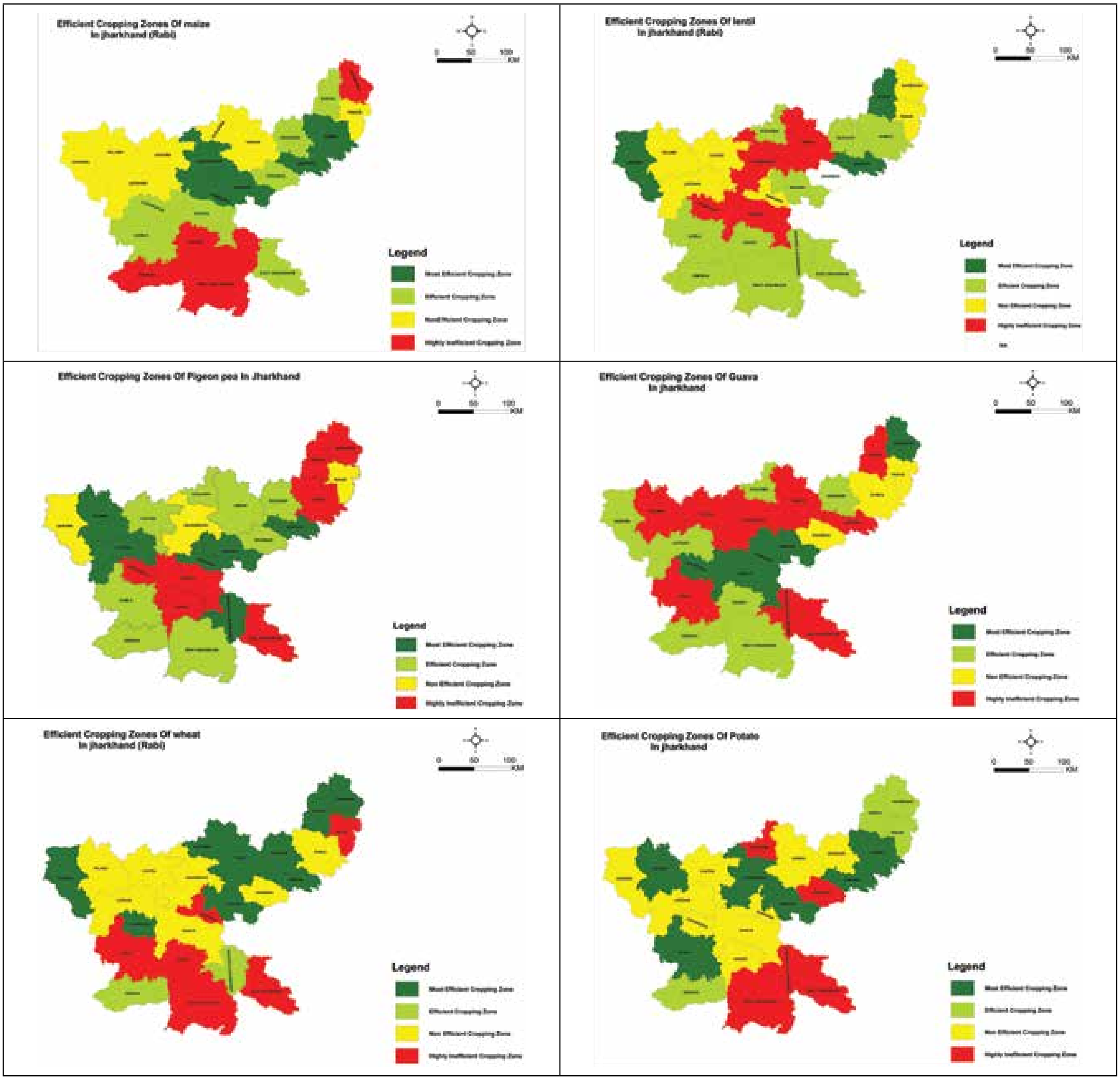


Fig 3.22 Efficient cropping zones for different crops in different districts of Jharkhand

Preparation of GIS based soil physico-chemical and biological map

A detailed soil analysis conducted at ICAR-IARI Jharkhand Research Farm revealed considerable variability in soil fertility parameters, reflecting the heterogeneity of the farm's soil resources. The bulk density ranged from 1.48 to 1.74 g/cm^3, indicating moderate compaction across different locations. Soil pH varied widely between 4.52 and 7.43, showing the presence of highly acidic to near-neutral soils, which can significantly influence nutrient availability. Electrical conductivity (EC) values were low (0.11-0.54 dS/m), suggesting non-saline conditions across the farm. The soils exhibited low organic carbon (OC) content (0.22-0.62%), correlating with generally low available nitrogen (N) levels ranging from 84 to 398 kg/ha, indicative of poor organic matter and fertility status. Available phosphorus (P; 2.81-23.81 kg/ha) and potassium (K; 52-243 kg/ha) also showed wide ranges, pointing to varying nutrient sufficiency across the farm. Total carbon and total nitrogen content ranged between 0.18-1.22% and 0.047-0.13%, respectively, further reinforcing the variability in organic nutrient reserves. Texturally, the soils varied from sandy loam to silty loam and clay loam, with sand content from 18.8-60.2%, silt from 37-56%, and clay from 1.6-21.6%, influencing water retention and nutrient holding capacity. Water holding capacity (WHC) ranged from 30-43%, and cation exchange capacity (CEC) varied significantly (8.3-57 meq/100g), indicating that some soils have better nutrient retention abilities than others. In terms of micronutrients, available zinc (0.18-0.88 ppm), copper (0.12-3.36 ppm), iron (2.48-56.60 ppm), manganese (0.80-139 ppm), and boron (84-398 ppm) demonstrated significant variation, suggesting that site-specific micronutrient management would be beneficial. In conclusion, the ICAR-IARI Jharkhand farm exhibited high variability in soil fertility attributes, necessitating site-specific nutrient and soil management strategies to optimize crop productivity and ensure sustainable soil health management (Fig 3.23).

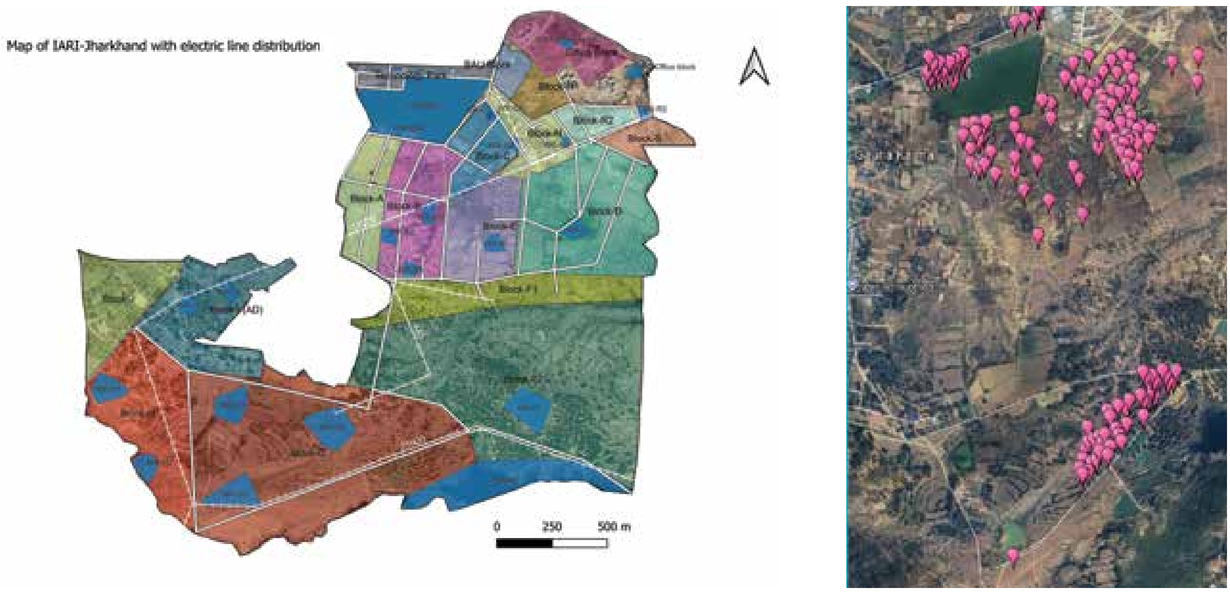


Fig 3.23 Schematic representation of the study area

Evaluation of osmo-tolerant bacterial consortia in wheat

Field experiments were conducted at ICAR-IARI, Jharkhand, during the 2023-24 Rabi season to evaluate the effects of three osmotolerant bacterial consortia bioformulations [(Consortium 1= MKS-6 + *Azotobacter* W7), (Consortium 2= MRD-17 + *Azotobacter* W7), (Consortium 3= MKS-6 + MRD-17 + *Azotobacter* W7)] and three irrigation levels (3, 4, and 5 irrigations) on the physiological parameters, growth, grain yield and other yield attributing parameters of two wheat varieties HD 2967 (drought susceptible) and HD 3171 (drought tolerant) grown in acidic soil (pH 5.7; Fig 3.24). The experiment, laid out in a randomized block design with 24 treatments and three replications, assessed physiological traits, growth, and yield parameters. Treatment T12 [five irrigations + consortium 3] recorded the highest values for shoot length (91.56 and 99.00 cm), shoot fresh weight (57.45 and 59.57 g), shoot dry weight (24.98 and 25.90 g), root length (21.22 and 18.56 cm), root volume (5.11 and 5.22 cm^3), and flag leaf area (43.27 and 46.63 cm^2) in HD 2967 and HD 3171, respectively. Chlorophyll a, b, total chlorophyll, and carotenoids were also significantly enhanced by consortium 3 inoculation. At maturity, T12 produced the highest plant height (90.60 and 94.47 cm), productive tillers (385.33 and 370.67 m^{-2}), spike length (9.47 and 10.47 cm), grains per spike (73.23 and 82.30), 1000-grain weight (41.37 and 44.97 g), grain yield (4.40 and 4.81 t ha^{-1}), biological yield (10.10 and 10.87 t ha^{-1}), and harvest index (48.78 and 52.32%) in HD 2967 and HD 3171, respectively. Overall, rhizobacterial bioformulations, especially MKS-6 + MRD-17 + *Azotobacter* W5 under five irrigations, significantly improved leaf pigments, growth and productivity of wheat compared to uninoculated controls. The study aimed to assess the impact of irrigation regimes and rhizobacterial inoculation on the growth and productivity of wheat varieties HD 2967 and HD 3171 under recommended agronomic practices (Table 3.36-3.37).

Fig 3.24 Field view and wheat crop growth stages in the experimental plot

Table 3.36 Growth and yield attributes of wheat variety HD 2967

Treatments	Plant height (cm)	No. of productive tillers m^{-2}	Spike length (cm)	No. of grains spike^{-1}	1000 grain wt. (g)	Harvest index (%)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})
3 Irrigations + Un-inoculated	82.73^{i}	277.67^{h}	7.13^{f}	52.73^{h}	30.50^{g}	40.01^{e}	281.20^{f}	703.33^{h}
3 Irrigations + MKS-6 + *Azotobacter* (W5)	87.60^{efg}	316.67^{cd}	8.47^{cd}	60.00^{ef}	35.70^{de}	43.80^{bcd}	392.90^{c}	835.00e^{f}
3 Irrigations + MRD-17+ *Azotobacter* (W5)	86.80^{fg}	303.00^{g}	8.33^{cd}	57.93^{f}	35.13^{e}	43.15^{bcde}	373.03^{d}	806.67f^{g}
3 Irrigations + (MKS-6 + MRD-17 + *Azotobacter* (W5)	88.00^{def}	328.33^{cd}	8.47^{cd}	62.23^{de}	36.57^{d}	43.88^{bcd}	396.43^{c}	873.33d^{e}
4 Irrigations + Un-inoculated	84.27^{h}	290.67^{gh}	7.80^{e}	54.60^{gh}	33.37^{f}	40.86^{de}	340.60^{e}	766.67^{gh}
4 Irrigations + MKS-6 + *Azotobacter* (W5)	88.87^{cde}	348.33^{cd}	8.60^{c}	65.20^{c}	38.37^{c}	45.80^{abc}	427.43^{ab}	933.33^{bcd}
4 Irrigations + MRD-17+ *Azotobacter* (W5)	88.80^{cde}	337.00^{de}	8.40^{cd}	63.07^{cd}	36.80^{d}	45.44^{abc}	416.77^{b}	913.33^{cd}
4 Irrigations + (MKS-6 + MRD-17 + *Azotobacter* (W5)	89.13^{bcd}	351.00^{c}	9.07^{b}	65.27^{c}	38.90^{bc}	46.42^{ab}	428.03^{ab}	946.67^{abc}

Treatments	Plant height (cm)	No. of productive tillers m-2	Spike length (cm)	No. of grains spike-1	1000 grain wt. (g)	Harvest index (%)	Grain yield (t ha-1)	Biological yield (t ha-1)
5 Irrigations + Un-inoculated	86.40[g]	290.00[gh]	8.13[de]	57.37[fg]	34.43[ef]	42.39[cde]	341.57[e]	780.00[fg]
5 Irrigations + MKS-6 + *Azotobacter* (W5)	90.40[ab]	371.00[b]	9.27[ab]	70.40[b]	41.37[a]	48.72[a]	439.37[a]	1000.00[a]
5 Irrigations + MRD-17+ *Azotobacter* (W5)	89.53[abc]	353.00[c]	9.20[ab]	65.67[c]	39.90[b]	46.87[ab]	431.40[ab]	983.33[ab]
5 Irrigations + (MKS-6 + MRD-17 + *Azotobacter* (W5)	90.60[a]	385.33[a]	9.47[a]	73.23[a]	40.17[ab]	48.78[a]	440.03[a]	1010.00[a]
CD (P<0.05)	1.310	13.097	0.351	2.784	1.336	3.767	17.288	63.420

Table 3.37. Growth and yield attributes of wheat variety *HD 3171*

Treatments	Plant height (cm)	No. of productive tillers m-2	Spike length (cm)	No. of grains spike-1	1000 grain wt. (g)	Harvest index (%)	Grain yield (t ha-1)	Biological yield (t ha-1)
3 Irrigations + Un-inoculated	89.33[d]	281.33[f]	6.47[f]	58.90[g]	35.27[g]	46.09[ef]	369.23[g]	800.00[d]
3 Irrigations + MKS-6 + *Azotobacter* (W5)	90.07[d]	302.67[cde]	7.53[de]	65.87[ef]	38.87[ef]	47.49[d]	412.63[e]	843.33[d]
3 Irrigations + MRD-17+ *Azotobacter* (W5)	89.93[d]	302.00[cde]	7.53[de]	65.13[ef]	38.00[f]	46.50[e]	392.10[f]	836.67[d]
3 Irrigations + (MKS-6 + MRD-17 + *Azotobacter* (W5)	90.47[d]	310.33[bcd]	7.60[de]	66.73[e]	39.77[de]	47.44[d]	415.33[e]	916.67[c]
4 Irrigations + Un-inoculated	89.73[d]	288.67[ef]	7.27[e]	63.90[f]	36.23[g]	45.64[f]	371.43[g]	816.67[d]
4 Irrigations + MKS-6 + *Azotobacter* (W5)	92.00b[c]	315.67[bc]	7.93[d]	70.90[cd]	42.07[bc]	49.23[b]	459.47[c]	950.00[bc]
4 Irrigations + MRD-17+ *Azotobacter* (W5)	90.53[cd]	314.33[bc]	7.93[d]	69.43[d]	40.57[cd]	47.53[d]	435.63[d]	916.67[c]
4 Irrigations + (MKS-6 + MRD-17 + *Azotobacter* (W5)	92.20[b]	316.00[bc]	8.80[c]	71.43[cd]	42.37[b]	48.59[c]	466.87[bc]	960.00[bc]
5 Irrigations + Un-inoculated	89.93[d]	292.33[def]	7.47[de]	64.10[f]	37.97[f]	46.67[e]	388.53[f]	836.67[d]
5 Irrigations + MKS-6 + *Azotobacter* (W5)	93.20[ab]	323.67[b]	9.60[b]	79.57[b]	43.17[b]	49.67[b]	479.90[ab]	1060.00[a]
5 Irrigations + MRD-17+ *Azotobacter* (W5)	92.27[b]	319.33[bc]	9.20b[c]	73.37[c]	42.63[b]	51.77[a]	469.73[abc]	973.33[b]
5 Irrigations + (MKS-6 + MRD-17 + *Azotobacter* (W5)	94.47[a]	370.67[a]	10.47[a]	82.30[a]	44.97[a]	52.32[a]	481.27[a]	1086.67[a]
CD (P<0.05)	1.484	18.333	0.520	2.628	1.539	0.591	14.283	50.279

Native diazotrophic bioinoculants for rice growth and soil nutrients

A study conducted at ICAR-IARI, Jharkhand, to develop and evaluate a native diazotrophic bacterial consortium for improving rice productivity and soil health under acidic soil conditions using direct seeded rice (DSR) and transplanted rice (TPR) methods (Fig 3.25). A bacterial consortium (F1) comprising *Brucella oryzae*, *Brucella ciceri* and *Pseudomonas nitroreducens* was prepared using two carriers- vermiculite + paddy straw compost (C1) and charcoal (C2). Two popular rice varieties: Abhishek & IR 64 Drt1 were used for the study. Pot trials identified vermiculite + paddy straw compost (C1)- based inoculum as superior in enhancing plant growth, enzyme activity and nutrient availability in both the varieties. In the field trial, vermiculite + paddy straw compost (C1)- based bacterial consortium, comprising B1 *Brucella oryzae*, B2 *Brucella ciceri* and B3 *Pseudomonas nitroreducens* (C1F1) was used under two planting methods *viz*., direct seeded rice (DSR) and transplanted rice (TPR), with 4 treatments under acidic soil conditions to evaluate the influence of diazotrophs in rice growth. Soil and plant samples were collected at tillering, panicle initiation, maturity and harvesting stages in both the varieties. A similar trend in terms of performance of bacterial diazotrophic consortia inoculant T3 (75% N + 100% PK + C1F1) was found better performing at all stages for almost all the plant and soil parameters in both modes of cultivation and in both varieties. Field trials with C1- based bioformulations showed that treatment (75% N + 100% PK + C1F1) consistently outperformed others across growth stages and planting methods, especially in variety IR64 Drt1 under DSR. Treatment (75% N + 100% PK + C1F1) also allowed 25% nitrogen saving, while improving soil enzymatic activities and plant physiological traits. The study underscores the potential of native microbial consortia in sustainable rice production under resource-constrained and acidic soil environments.

Fig 3.25 Field view and crop growth at different stages under transplanting and DSR methods

Conservation of cyanobacterial germplasms and their characterization

Total 50 strains (approx.) of cyanobacteria (especially rice isolates and low pH tolerant) were conserved and maintained in culture room facility at Microbiology Section of NRM, IARI Jharkhand. The aim of the present study was to formulate rice-specific cyanobacterial strains for sustainable rice production under eastern Indian conditions. (Table 3.38; Fig 3.26).

Table 3.38 Details of cyanobacterial germplasm maintained in culture room facility

S. No.	Name	Rice variety/location	Heterocystous/ Non-Heterocystous
1.	*Anabaena* sp.	Pusa 1612/Leaf	Heterocystous
2	*Nostoc* sp.	Pusa 1612/Root	Heterocystous
3	*Phormidium* sp.	Pusa1612/ Root	Non-Heterocystous
4	*Anabaenopsis* sp.	PS-5/Leaf	Heterocystous
5	*Anabaenopsis* sp.	PS-5/Leaf	Heterocystous
6	Anabaena oryzae	PS-5/Leaf	Heterocystous
7	*Anabaena* sp.	PS-5/Stem	Heterocystous
8	*Nostoc* sp.	PS-5/Root	Heterocystous
9	*Anabaena* sp.	PS-5/Root	Heterocystous
10	*Nostoc* sp.	PS-5/Rhizospheric soil	Heterocystous
11	*Anabaenopsis* sp.	PB1401/Leaf	Heterocystous
12	*Nostoc* sp.	PB1401/Leaf	Heterocystous
13	*Anabaena* sp.	PB1401/Stem	Heterocystous
14	*Anabaena* sp.	Pusa 1401/Rhizospheric soil	Heterocystous
15	*Anabaena* sp.	PB1401/Stem	Heterocystous
16	*Anabaena* sp.	PB1401/Rhizospheric soil	Heterocystous
17	*Anabaenopsis* sp.	PB1509/Stem	Heterocystous
18	Aulosira fertilissima	PB1/Leaf	Heterocystous
19	*Anabaena* sp.	PB1/Leaf	Heterocystous
20	*Anabaena* sp.	PB1/Stem	Heterocystous
21	*Plectonema* sp.	PB1/Stem	Non-Heterocystous
22	Anabaena doliolum	PB1/Root	Heterocystous
23	Phormidium fovelarum	PB1/Soil	Non-Heterocystous
24	*Oscillatoria* sp.	IR64/Stem	Non-Heterocystous
25	*Microcheate* sp.	IR64/Stem	Heterocystous
26	*Anabaena* sp.	IR64/ Soil	Heterocystous
27	*Westiellopsis* sp.	PB-1401/Leaf	Heterocystous
28	*Oscillatoria limosa*	PB-1401/ Stem	Non-Heterocystous
29	*Microcheate* sp.	PB-1401/ Stem	Heterocystous
30	*Stygonema* sp.	PB1509/Leaf	Heterocystous
31	*Nostoc* sp.	PB1509/ Stem	Heterocystous
32	*Anabaena* sp.	PS-5/Stem	Heterocystous
33	Nostocopsis lobatus	PS-5/ Soil	Heterocystous
34	*Westiellopsis* sp.	IR64/Leaf	Heterocystous
35	*Nostoc* sp.	IR64/Leaf	Heterocystous
36	*Anabaena* sp.	IR64/Root	Heterocystous
37	*Oscillatoria* sp.	PB1/Stem	Heterocystous
38	*Nostoc punctiformae*	PB1/Stem	Heterocystous

S. No.	Name	Rice variety/location	Heterocystous/ Non-Heterocystous
39	Tolypothrix tenuis	BGA biofertilizer culture	Heterocystous
40	Nostoc muscorum	BGA biofertilizer culture	Heterocystous
41	Anabaena variabilis	BGA biofertilizer culture	Heterocystous
42	Aulosira fertilissima	BGA biofertilizer culture	Heterocystous
43	*Nostoc* sp. Ns1	Alipurduar (West Bengal)	Heterocystous
44	*Nostoc* sp. Ns2	Alipurduar (West Bengal)	Heterocystous
45	*Nostoc* sp. Ns3	Ernakulum (Kerala)	Heterocystous
46	*Nostoc* sp. Ns4	Mokokchung (Nagaland)	Heterocystous

Fig 3.26 Cyanobacterial germplasm maintained in culture room facility

Evaluation of selected rice cyanobacterial strains

In order to study the growth and physiological parameters of cyanobacterial strains, cell dry weight (CWD), total soluble proteins, chlorophyll and carotenoids contents were estimated at exponential phase (15th day) of growth. Total soluble protein values ranged from 2.09 to 88.83 µg mg^{-1} CDW and cell dry weight values ranged from 0.68 to

3.00 mgml-1. Amongst them *Nostoc muscorum* (Bioinoculant in commercial BGA biofertilizer) and *Anabaenopsis* sp. (PB1401/Leaf) showed highest total soluble protein (88.83µgmg-1CDW) and cell dry weight (3.00 mgml-1), respectively (Fig 3.27). Chlorophyll content varied from lowest of 3.43 to highest 25.05 µg ml-1. On the other hand, carotenoid contents varied between 0.25 to 14.24 µg ml-1. Amongst them, *Anabaena sp.* (IR64/ Soil) and *Anabaena sp.* (PS-5/ Root) showed highest chlorophyll (25.05 µg ml-1) and carotenoids (14.24 µg ml-1) contents, respectively (Fig 3.28).

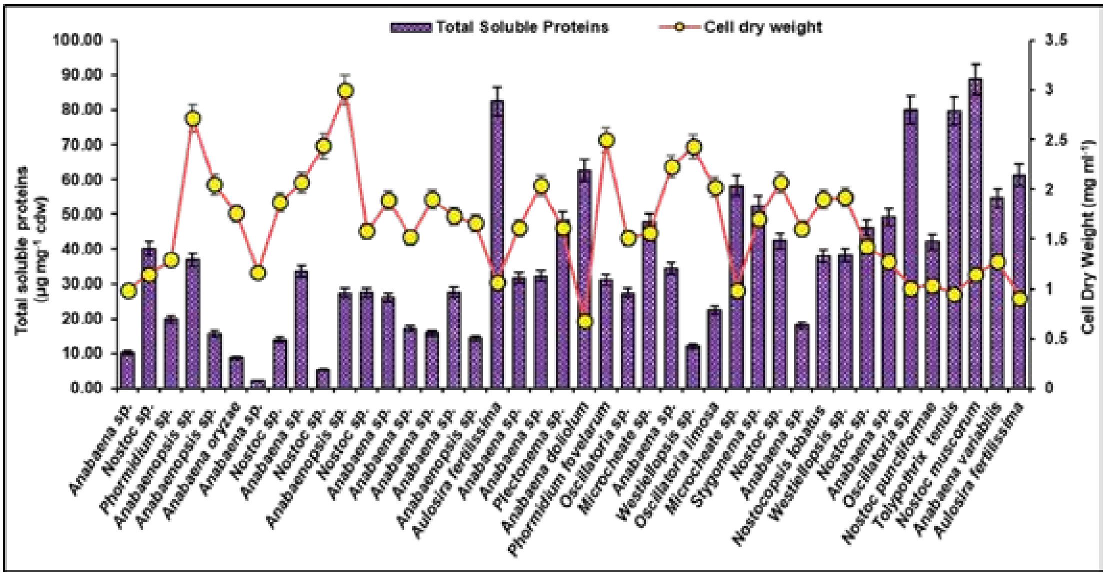


Fig 3.27 Comparative and cell dry weight amongst selected cyanobacterial strains

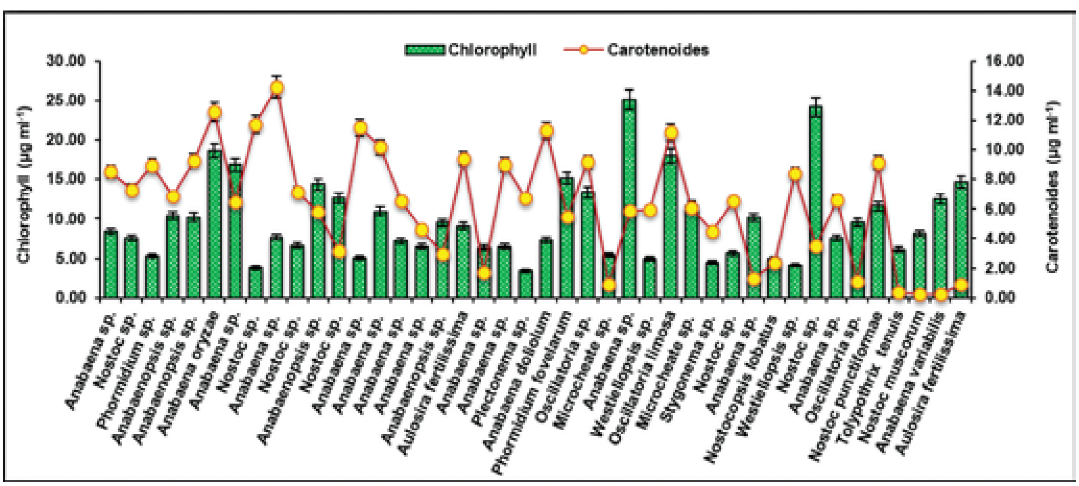


Fig 3.28 Comparative chlorophyll and carotenoids contents amongst selected cyanobacterial strains

Mapping of natural resources of IARI-Jharkhand

Land resources: Elevation and contour map of IARI-Jharkhand (IARIJ) was developed using CartoSAT Degital Elevation Model (DEM) with spetial resolution 30 m downloaded from Bhuvan Portal of ISRO. The elevation of IARIJ land surface ranged from 320-361 m above mean see level. The DEM map superimposed on hill shed clearly showed that topography of IARIJ land surface is undulating having two micro watershed with runoff accumulation zones in west part of IARIJ geographical extent. Aspect map and contour map was developed from DEM which also showed undulating topograpy of IARI-Jharkhand land as evident from presence of slops in all the four direction and presence of higly curved countour lines (Fig 3.29). The grid sampling was done for the asessment of soil depth. According to depth, the soil of IARIJ varied from shallow to moderatly deep soil.

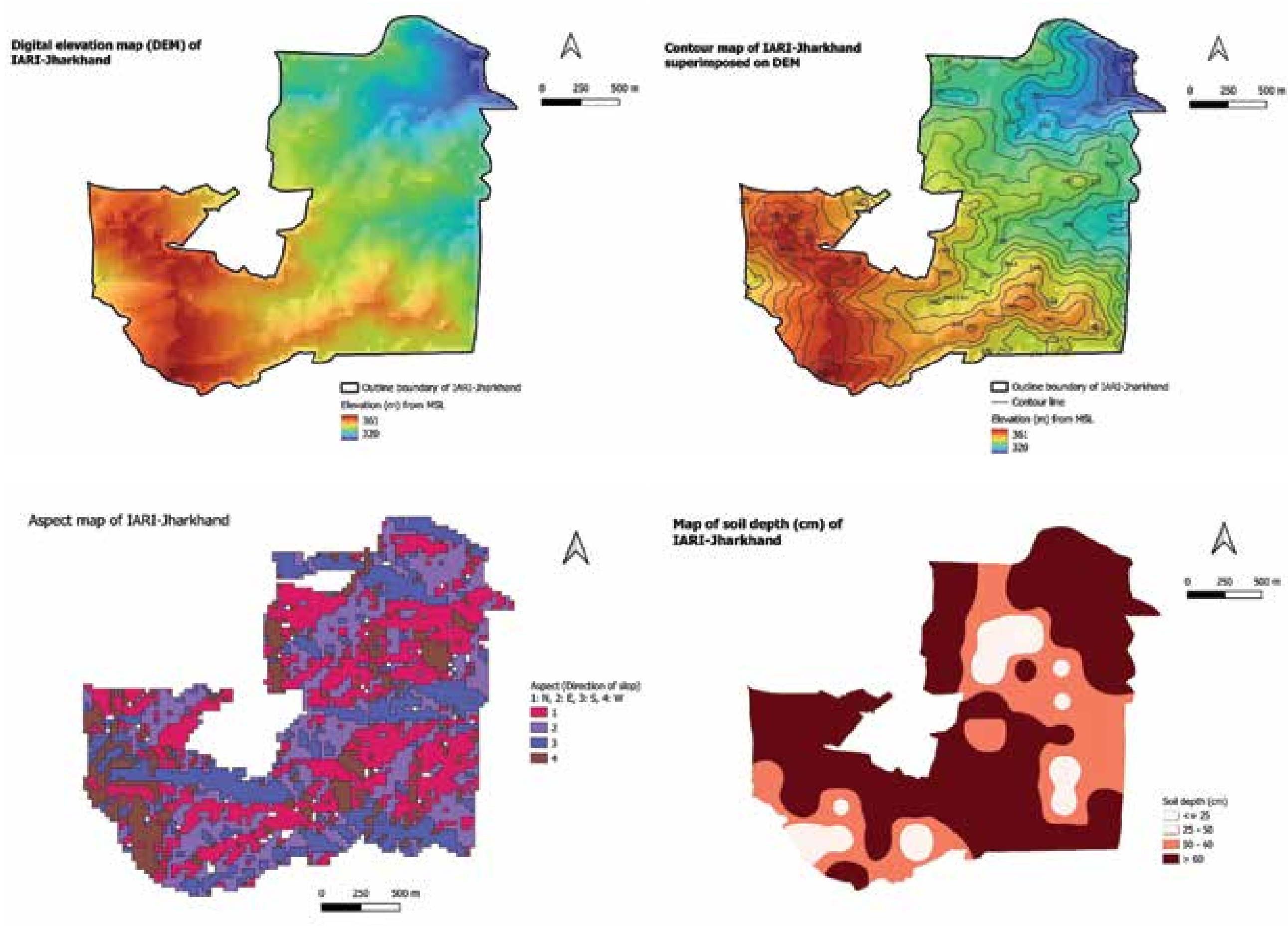


Fig 3.29 Digital elevation, contour, aspect and soil depth (cm) maps of IARI-Jharkhand

***Tree diversity*:** The area under tree cover (F1 block) of IARIJ was surved for identification of tree species and their counting follwed by geotagging of the tree. About 16 tree species were identified and geotagged in F1-Block of IARIJ and these included *Shorea robusta (Sal)*, *Madhuca longifolia (Mahuwa), Terminalia elliptica (Aasan), Terminalia chebula (Harre), Terminalia bellirica (Baheda), Acacia catechu (Khair), Terminelia arjuna (Arjun), Lagerstroemia parviflora (Sida), Buchanania cochinchinensis (Chironji/ Piyar), Butea monosperma (Palas), Anogeissus pendula (Kendu), Syzygium cumini (Jamun), Ficus benghalensis, Tamarindus indica, Bombax ceiba,* and *Ceiba Pentandra* (Fig 3.30).

Fig 3.30 Few identified and geotagged tree specieses of IARI-Jharkhand

Improving soil health for enhancing input use efficiency and productivity

Natural farming practices with organic nutrient management: Application of 75% nutrients through chemical fertilizers and 25% through FYM in pearl millet-chickpea system resulted significantly higher plant height (cm), length of ear head (cm), head girth (cm), number of seeds/head, weight of seed/head (g), test weight (g) and grain yield (kg/ha) in pearl millet, but in chickpea the test weight (g) and grain yield (kg/ha) were found maximum with application of ghanjeevamrit (5q/ha) with two spray of jeevamrit over control. Soils of experimental plots of ICAR-IARI-Jharkhand are acidic in nature, low in organic carbon, nitrogen and phosphorus, low to medium in potassium, and sandy loam in texture (Fig 3.31).

Fig 3.31 Growth pattern of pearl millet and chickpea crops

Moderate electric field assisted enzymatic hydrolysis of starch from jackfruit (*Artocarpus heterophyllus* L.): kinetic analysis and modelling using machine learning

Starch extracted from Malay variety of jackfruit seeds was treated with thermostable alpha enzyme and moderate electric field (MEF) under the specified conditions of field strength: (5, 15 & 25) V/cm (50 Hz); treatment time: (20, 40, 60 & 80) min and reaction temperature: (50, 60 & 70°C). The moderate electric field (MEF) assisted alpha enzyme-treated samples were analysed to obtain FTIR and XRD data for analysing the chemical composition, molecular structure, and crystallinity of jackfruit seed starch. Results indicated that MEF assistance altered the relative crystallinity of hydrolyzed jackfruit seed starch, reducing it from 58% to 38% as the applied electric field increased from 0 V/cm to 15 V/cm. This consequently modified the starch granule structure for food and pharmaceutical uses (Fig 3.32-3.34).

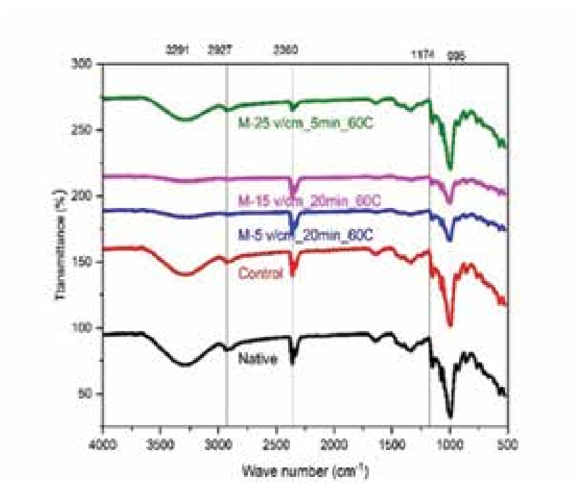


Fig 3.32 FTIR curves of MEF, enzyme treated starch

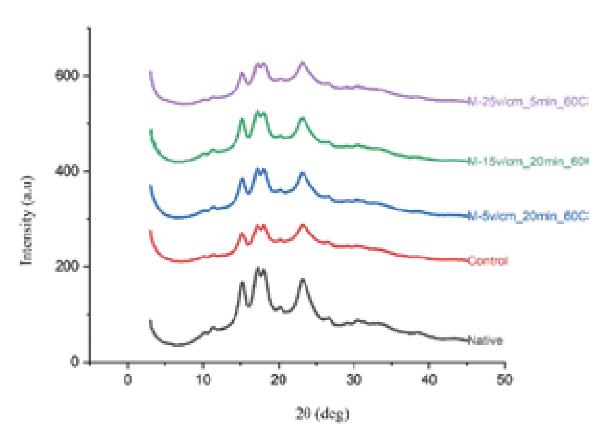


Fig 3.33 X-ray diffraction curves of MEF, enzyme treated starch

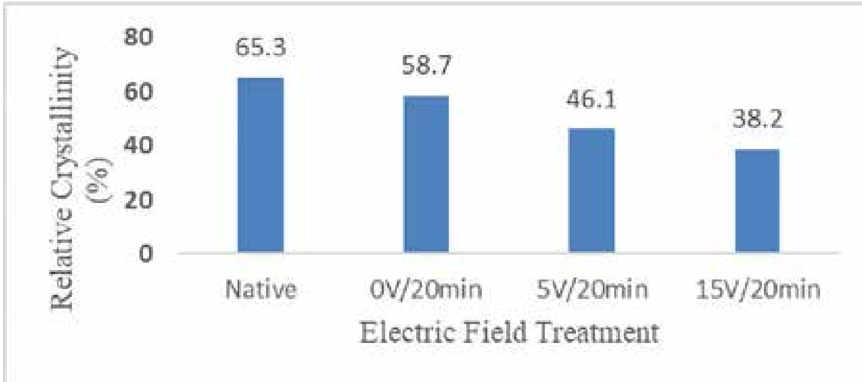


Fig 3.34 Relative crystallinity (%) vs electric field assisted treated starch

3. Livestock and fish production

Pig production in Hazaribagh district of Jharkhand

Villages like Kedaru, Bandarvella, Kutma and Kundwa under Hazaribagh district were surveyed to collect base line information on pig farming. Different categories of farmers were contacted, which included landless labourers and others having lands. Hazaribagh district possesses 45.16 thousand heads of pig. Livestock rearing practices in this district are very much ethnic group and location specific reported in other parts of Jharkhand state. However, pig rearing is popular in rural areas, particularly in tribal dominant villages. Indeed, among the various livestock species, pig is the most potential source of meat production and more efficient feed converters after broiler. Pig farming provides employment opportunities to seasonally employed rural farmers and supplement income to improve their living standards. Smallholder pig farming contributes to the livelihood in many ways- income from products, insurance against drought, emergency cash requirements, household nutrition, manure for crops etc. besides direct and indirect employment potential to the farmers. Pigs are kept confined in the home premises either by tethering or penning. In urban or peri-urban areas or areas having intensive crop cultivation, movement of pigs is restricted by tethering with a short rope in the home premises or in an enclosure made with locally available materials (Fig 3.35). This is mainly to avoid damaging of crops, which can be a cause of conflict between families. In areas with no cropping land nearby, pigs are let loose to scavenge in and around the home premises or on the road side. Indigenous and crossbred pigs had farrowing for the first time at 15-16 months and 12-14 months' age, respectively. Litter size of indigenous pigs was smaller (6-10) than crossbred pigs (10-14). There was a significant difference between the growth performance of indigenous (35 kg) and crossbred pigs (70 kg) at 12 months' age. A major contributing factor to the slow growth was the poor diet quality (low protein) because feeds were mainly the by-products of the rice and other crops. However, pig production was an attractive, profitable business because these and other local feed resources were of low or no opportunity cost and the labour for caring for the pigs was provided mainly by the women of the producer households.

Fig 3.35 Movements of pigs restricted by tethering with short rope

Indeed, inadequate scientific knowledge about feeding, health care and breeding management are the major limitations to improving the traditional system of pig production. Again poor knowledge on storage and handling of feed resources and the preventive and curative measures against diseases that need to be adopted in appropriate time are other limitations for tribal farming communities living in rural/underprivileged areas. In fact, tailor-made need-based, client-oriented programs, delivered using participatory methods, are required to improve the capacity of pig producers to make more effective use of available feed resources, to maintain their pigs in good health and to breed productive crosses.

Forage yield performance of hybrid napier genotypes

Four genotypes (Kamdhenu, CO1, CO5 and IGFRI-10) of hybrid napier were evaluated for forage yield performance. These varieties were cultivated in a 5 m x10 m area with row to row spacing of 1 m and plant to plant spacing of 50 cm maintained for all varieties. First harvest was done on 75 to 80 days after planting which was not counted for total yield and subsequent harvests were done at intervals of 60-90 days. Total weight of each fodder was measured after each cut. Tiller production (number per meter row length) and circumference (m) was measured on each cut of each genotype. Results revealed that percent increase for fodder production was maximum for IGFRI 10 *i.e,* 94% on second cut followed by CO1 (72%), Kamdhenu (68%) and CO5 (41%). Genotypes differed significantly for tiller production and circumference between different cuts, with maximum tiller production observed for Kamdhenu *i.e.,* 75. The circumference was highest for Kamdhenu *i.e.*, 1.9 m followed by CO5, CO1 and IGFRI 10. Kamdhenu performed better for forage production as it had maximum mean forage yield (77 kg). As the age progressed, Kamdhenu was found to be very good for forage yield production followed by CO1, CO5 and IGFRI-10. Therefore, it was concluded that among all genotypes, Kamdhenu is superior in forage yield production in all cuts.

Multiplication of fodder cowpea (Vigna unguiculata) varieties

Cultivation of fodder cowpea varieties *i.e.*, UPC-628, UPC-9202, MFC-08-14, UPC-622, MFC-09-1 and Bundel Lobia was done at 10 x 10 m plot for each variety with spacing of 30 cm row to row and 10 cm plant to plant under acidic soil condition. *Vigna unguiculata* is usually harvested at 60-80 days after sowing for green foliage, but here it was cultivated for seed production so it was harvested after 60-80 days until the pods become dry for seed collection. The total production of different varieties of cowpea *i.e,* UPC-628, UPC-9202, MFC-08-14, UPC-622, MFC-09-1 and Bundel Lobia was found to be 2.52 kg, 4.93 kg, 5.43 kg, 6.24 kg, 6 kg and 7.42 kg, respectively. The highest production yield was observed in Bundel Lobia, suggesting scope of exploiting this fodder variety in Jharkhand.

Data collection for providing location specific animal advisory services

In this investigation, data were collected from Hazaribagh district related to livestock problems. It was found that there is no defined breed rearing of cattle and goats by farmers. Some crossbreds are reared in large commercial farms. Due to lack of irrigation facilities no fodder cultivation and animals are allowed for open grazing. No other feed supplement is provided due to lack of knowledge about livestock nutrition. No proper shelter management, farmers keep livestock in traditional method *i.e.,* Macha system (Fig 3.36). The most prevalent disease in cattle is FMD, HS, BQ and in goat it is PPR, enterotoxaemia and FMD. Anoestrus and repeat breeding are also a major issue in cattle. Farmers practice indigenous technical knowledge for treatment and cure of livestock. However, farmers are aware about vaccination and deworming programme run by state animal husbandry department.

Fig 3.36 Traditional method of housing system (macha system)

Performance evaluation of important freshwater fish varieties

For research and developmental activities related to fisheries and aquaculture, the prototype of an experimental aquaculture farm was developed at ICAR-IARI, Jharkhand with a number of research units for nursery, rearing and grow-out activities of cultivable freshwater fish species. The scientifically designed fish farming model consisting of rectangular shaped earthen ponds was developed with site suitability assessment, layout and planning followed by construction of the units with inlet and outlet (monk structure with the provision for the fixing of metallic sheet and wire mesh screen) arrangements for proper passage of water (Fig 3.37-3.39). The soil texture was quite sandy with higher proportion of rocks, stones and pebbles, causing low water retention potential and seepage issues. Hence, suitable scientific design with innovative methodologies were adopted for maintaining proper shape and size of ponds, bottom slope of ponds, water depth and free board of the ponds, surrounding pond dykes/embankments with respect to top width, bottom width and slope (the inside/ water side slope is kept at higher magnitude than the outside/ land side slope). These interventions not only offer more stability and lower erosion rate but also linked with the improvement of natural productivity in fish ponds. In addition to these, somewhat clayey shoreline portion of the ponds left undug (during pond construction) in order to boost natural productivity and blooming of live food organisms.

Before the stocking of healthy cultivable fish species in experimental units, a field day was conducted on 27.02.2024 for the survey of fish farms (containing both hatchery as well as culture units for different life stages of fish) at Barhi and verified several fish stocks like Indian major carps, common carp, grass carp, pangas, tilapia, etc (Fig 3.40). For the experimentation, five carp varieties such as catla (*Catla catla*), rohu (*Labeo rohita*), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*) and black carp (*Mylopharyngodon piceus*) were stocked in the ponds in triplicates at varied proportions with cumulative stocking density of 4 nos./m^2 and fed with commercial floating pelleted feed @ 3% of their total biomass. For efficient feeding, rectangular floating bamboo frames were developed with indigenous design (ITK) which prevents the drifting of feeds due to water current.

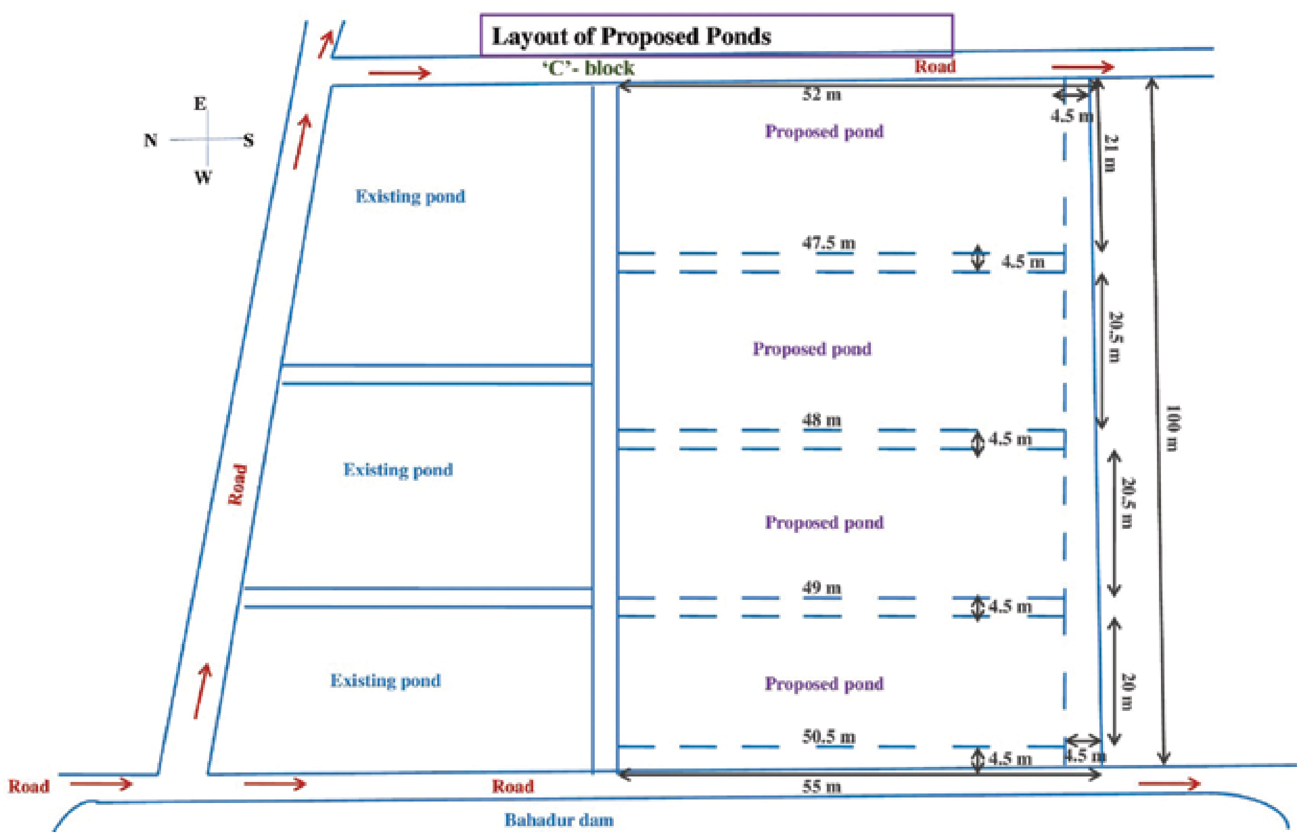


Fig 3.37 Mapping and layout of aquaculture units

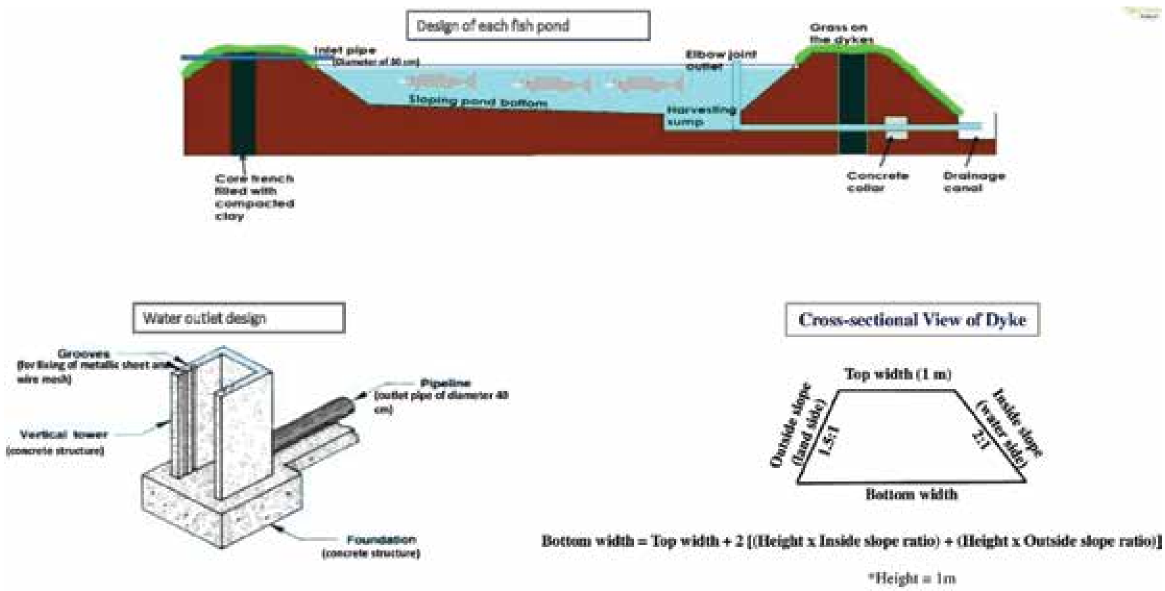


Fig 3.38 Design of pond and dyke including inlet, outlet and top drain water channels

Fig 3.39 Construction of experimental aquaculture units

Fig 3.40 Survey of fish farms for the procurement of healthy fish seeds

4

Outreach Programmes

Scheduled caste sub-plan (SCSP)

During 2024 ICAR-IARI Jharkhand has implemented SCSP project very effectively for scheduled caste beneficiaries of Jharkhand especially Hazaribagh district. Several one day activities like kisan goshthi, awareness camp, demonstration programmes were organised at the institute as well as various locations to make aware of the institute activities and scheme for the benefit of the farmers. Based on the demands of farmers' quality seeds of improved varieties of major crops were distributed free of cost to the scheduled caste farmers (Table 4.1 A - D) as per their season. During the year 2024 approx. 1400 quintals of quality seeds and 11000 packets of vegetable seed kits were distributed among more than 20000 farmers in Hazaribagh, Bokaro, Chatra, Ramgarh Koderma and Giridih districts of Jharkhand, mostly covering all 14 blocks of Hazaribagh. Selected farmers were also equipped with small farm tools and implements during the farmer's training programmes like knapsack sprayer, water can, spade, sickle, fawda, vermi-bed, khurpi, portray, pots etc. To tackle the rising demand of growing fruit crops in Jharkhand condition and fulfil the demand of quality planting materials of important fruit crops, a mother block has been established at ICAR-IARI Jharkhand which will provide the required plant saplings to the needy farmers. Under SCSP activities nine numbers of scheduled training programs were organised on improved technologies related to various aspects of agriculture, horticulture, natural resource management, animal husbandry, poultry and fisheries for the category farmers in which total 685 scheduled caste farmers received their training certificates. To promote backyard poultry production among schedule caste households, 323 selected beneficiaries belonging to 21 villages of 4 blocks of Hazaribagh district benefitted with improved Vanraja chicks where total 12950 chicks were distributed freely with training on the proper management practices.

Table 4.1 Quality seed distribution to farmers during 2024

A. Seed distribution

Sl. No.	Crop season	Crop seeds and quantity distributed	Distribution locality (No. of blocks)	Farmers Benefitted
1.	Summer season	Moong (25 Q), Maize (12 Q), Vegetable kits (2000 Nos.)	Hazaribagh (8), Chatra (4), Bokaro (2)	2770
2.	Kharif season	Paddy (300 Q), Arhar (30 Q), Maize (40 Q), Moong (20 Q) Vegetable kits (3000 Nos.)	Hazaribagh (12), Chatra (2), Bokaro (2), Ramgarh (1), Koderma (1)	9500
3.	Kharif season	Millet crops- Jowar, Ragi, Barnyard and Foxtail millet (8.65 Q)	Hazaribag (6)	120
4.	Rabi season	Wheat (430 Q), Mustard (178 Q), Lentil (70 Q), Chickpea (50 Q), Vegetable kits (6000 Nos.)	Hazaribag (14), Chatra (4), Bokaro (2), Koderma (1), Giridih (1), Ramgarh (1)	10500

B. Kishan goshthi cum seed distribution program

1. अनुसूचित जाति के किसानों को उच्च उत्पादकता प्राप्ति हेतु वैज्ञानिक पद्धति द्वारा खरीफ़ फसलों की खेती का प्रशिक्षण एवं बीज वितरण (4 जून -15 जून, 2024)

Sl. No.	Target block/ district	Resource person/ organising committee
1.	Barhi,	Dipak Kumar Gupta, Asharani Patel, Sougata Bhattacharjee
2.	Barkatha, Dadi	Manoj Chaudhary, Monu Kumar, Nuzaiba PM
3.	Barkagaon, Churchu	Abhay Kumar Giri, Shannon N. Sangama, Narendra Singh
4.	Bishnugarh, Padma	Monu Kumar, Pavithra M., Shantesh R. Kamath
5.	Chauparan, Katkamdag	B. N. Mandal, Dipak Kumar Gupta, Himani Priya,
6.	Daru, Hazaribag Sadar	Anima Mahato, Priti Tigga, Saheb Pal,
7.	Ichak, Katkamsandi	Shilpi Kerketta, Sougata Bhattacharjee, Akash A.A.
8.	Keredari, Tatijhariya	Santosh Kumar, Saheb Pal, Monika M.
9.	Blocks of Chatra district	Niranjan Kumar, Priti Singh, Kashinath Teli
10.	Blocks of Koderma district	Asha Kumari, Kashinath Teli, Priti Tigga
11.	Blocks of Ramgarh district	Pankaj Kumar Sinha, Narendra Singh, Pavithra K.N.
12.	Blocks of Bokaro district	Manoj Chaudhary, Shannon N Sangama, Shantesh R. Kamath

2. अनुसूचित जाति के किसानों को उच्च उत्पादकता प्राप्ति हेतु वैज्ञानिक पद्धति द्वारा रबी फसलों की खेती का प्रशिक्षण एवं बीज वितरण (19 अक्टूबर- 21 नवम्बर, 2024)

Sl. No.	Target place (village/panchayat / block)	Resource person/ organising committee
1	Rasoiya Dhamna (Barhi)	Dr. Krishna Prakash, Sh. Dilip Roy
2	Barkattha ,Malkoko,Gayapahadi	Dr. Krishna Prakash, Mr. Arun Kumar Rajak
3	Dadi, Gidi, Daru	Dr. Saheb Pal, Dr. Priti Tigga, Mr.Arun Kumar Rajak
4	Keredari, Badkagaon	Dr. Abhay Kr. Giri, Dr. Narendra Singh, Mr. Arun Kumar Rajak
5	Chauparan, Amjhar, Mayurhand, Karma (Chatra)	Dr. B.N. Mandal, Dr. Himani Priya , Dr. Akash A., Mr. Arun Kumar Rajak
6	Chandwara (Koderma), Bahera (Chauparan), Mayurhand (Chatra)	Dr. Dipak Kr. Gupta, Dr. Kashinath Teli, Mr. Arun Kumar Rajak
7	Tatijhariya, Bishnugarh	Dr. Shanon N. Sangma, Dr. Asha Kumari, Dr. Shantesh Kamath, Mr. Arun Kumar Rajak
8	Padma, Ichak, Barsot	Dr. Monu Kumar, Dr. Asha Kumari, Dr. Sougata Bhattacharjee, Mr. Arun Kumar Rajak
9	Katkamsadi	Dr. Anima Mahto, Mr. Arun Kumar Rajak
10	Badkagaon	Dr. Asha Kumari, Dr. Shantesh Kamath, Mr. Arun Kumar Rajak


ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE-JHARKHAND
"अनुसूचित जाति उप-परियोजना"
किसान संगोष्ठी एवं बीज वितरण कार्यक्रम


समुदाय :- अनुसूचित जाति

400 किसानों के बीच बीज वितरण

अनुसूचित जाती के किसानो के बीच रवि फसल बीज का वितरण

हजारीबाग (आजाद सिपाही)। पीजीएसबी फार्मर प्रडुसर कम्पनी लिमिटेड के द्वारा सदर प्रखण्ड के 4 पंचायत सखिया, बहरी, गुरहेत तथा पौता के 100 अनुसूचित जाती के किसान सदस्यों को अनुसूचित जाती उप-परियोजना के अंतर्गत भारतीय कृषि अनुसंधान संस्थान गौरिया कर्मा द्वारा प्राप्त रबी फसल बीजों का वितरण किया गया। जिसमे प्रति किसान 10 किलो गेहू, आधा किलो मसूर, 1 किलो सरसो तथा 10 प्रकार के सब्जी बीज दिया गया। इस कार्यक्रम मे पौता पंचायत की मुखिया रीना देवी, कृषक मित्र डेगन राणा, कम्पनी सी ई ओ मासूम राजा, अकाउंटेंट इस्तियाउल अंसारी, कम्पनी के चेयरमैन तथा बोर्ड ऑफ डाइरेक्टर तथा कलस्टर आधारित व्यवसायिक संगठन मार्ट ग्लोबल से राहुल कुमार उपस्थित थे।

फार्मर प्रोड्यूसर कंपनी ने बांटे खरीफ बीज

हजारीबाग (आजाद सिपाही)। फार्मर प्रोड्यूसर कंपनी लिमिटेड के द्वारा सदर प्रखंड के चार पंचायत सखिया, बहरी, मरहेत और पौता के 142 अनुसूचित जाति के किसान को अनुसूचित जाति उप परियोजना के अंतर्गत भारतीय कृषि अनुसंधान संस्थान गोरिया करमा द्वारा प्राप्त खरीफ फसल बीजों का वितरण किया गया। जिसमे धान, सब्जी किट, मक्का, पालक और मूली बिज का वितरण सदर ब्लाक बीएओ टेकलाल प्रसाद के नेतृत्व मे किया गया। इस कार्यक्रम मे उपस्थित पौता के किसान मित्र डेगन राणा, मरहेता के कमलकांत, कंपनी अकाउंटेंट इस्तियाऊल अंसारी, कंपनी के चेयरमैन रिजवान अंसारी, बोर्ड आफ डायरेक्टर हनीफ अंसारी, पवन कुजूर और क्लस्टर आधारित व्यवसाय संगठन मार्ट ग्लोबल से दीपक रजक उपस्थित थे।

दैनिक भास्कर हजारीबाग 01-07-2024

केरेडारी में कृषि यंत्र व बीज वितरण

C. Training cum chicks distribution (during September-October, 2024)

S. No.	Target villages/ panchayat	Blocks of Hazaribagh	Households benefitted
1	Dulmaha, Kajra	Barhi	35
2	Bahera	Chauparan	42
3	Dudhpani, Barsot, Kariyatpur	Barhi	28
4	Rasoiya Dhamna, Purhara	Barhi	26
5	Amjhar, Basariya, Machla	Chauparan	38
6	Hadari, Kaladuar	Ichak	35
7	Gaiyapahadi	Barkattha	35
8	Khonra Ahar, Kundwa, Karso	Barhi	30
9	Bela, Akurwa	Chauparan	30
10	Karso, Kewal	Barhi	24


हजारीबाग 06

अनुसूचित जाति के किसानों को सशक्त बनाने की पहल, 325 किसानों को वितरित किए गए बनराजा मुर्गी के चूजे

D. Capacity building/training programs organised

(अनुसूचित जाति के कृषकों की आय वृद्धि हेतु कृषि, बागवानी, पशु एवं मत्स्यपालन संबंधित विविध उन्नत कार्य प्रणालियों पर तीन दिवसीय प्रशिक्षण कार्यक्रम)

No.	Training modules	Course directors	Date of training
1.	Backyard poultry farming	Monika M.	March 13-15, 2024
2.	Scientific goat farming practices	Shilpi K.	March 13-15, 2024
3.	Protected cultivation of vegetable crops	Saheb Pal	March 18-20, 2024
4.	Nursery management of horticultural crops	Narendra Singh	March 19-21, 2024
5.	Seed treatment with chemical and biological agents	Akash A	March 20-22, 2024
6.	Pesticide doses and poisoning awareness	Niranjan Kumar	March 21-23, 2024
7.	Fish farming for production of table size fish	Abhay K. Giri	March 26-28, 2024
8.	Vermicomposting of agricultural waste	Dipak K Gupta	March 27-29, 2024
9.	Use of microbial biofertilizers	Himani Priya	March 18-20, 2024

Tribal sub plan (TSP)

One 3-Days Residential Training program on 'Backyard Poultry Farming' for the Scheduled Tribe Farmers of Jharkhand was organized during 16th-18th December 2024 at ICAR-Central Avian Research Institute, Izzatnagar, Bareilly, Uttar Pradesh in which 25 nos. of ST farmers from Barhi, Bishnugarh, Namkum, Dhurwa and Churchu Block of Jharkhand were participated. After that they were provided with 50 nos. of poultry chicks with some feed, medicine and mineral supplements to promote adoption of improved breed of dual-purpose poultry for increasing their livelihood and income security. This training program was organized by ICAR-IARI-Jharkhand under the Tribal Sub Plan (TSP) Project of the institute.

NABARD funded projects

Sustainable intensification of pulses in rice fallow ecosystem

I. Establishment of seed cluster/ seed village

Seed production of two varieties of lentil, PDL-1 and PSL-9 was carried out during *Rabi* 2023-24 in Jharaiya village at Barhi block in coordination with the NABARD sponsored FPO, Barhi Farmer Producer Company Ltd.

Crop	Clusters	Village	Variety	No. of farmers	Area
Lentil	Cluster I	Jharaiya	PDL 1	25	3.5 ha
	Cluster II	Jharaiya	PSL 9	7	1.0




During Rabi 2023-24, initiatives were also undertaken to produce quality seeds of chickpea varieties, Pusa 3062 and Pusa Manav in Khaira and Shahpur village of Barhi in coordination with the NABARD sponsored FPO, Barhi Producer Company Ltd.

Crop	Clusters	Village	Variety	No. of farmers	Area
Chickpea	Cluster I	Khaira	Pusa 3062	5	2.5 ha
	Cluster II	Shahpur	Pusa Manav	5	2.5 ha

During spring/ summer 2024, initiatives were taken to produce quality seeds of mungbean varieties, Virat and Shikha in 8 villages of Chatra and Hazaribagh districts in coordination with the NABARD.

Crop	Variety	Clusters	No. of farmers	Village	District	Area
Mungbean	Virat	Cluster I	13	Gidhaur	Chatra	~ 3.6 ha
		Cluster II	12	Dwari		~ 2.0 ha
	Shikha	Cluster III	12	Khelari		~1.7 ha
		Cluster IV	9	Ichak		~ 0.5 ha
		Cluster V	5	Jamua		~ 1.0 ha
	Virat	Cluster VI	32	Padarima	Hazaribagh	~ 9.0 ha
	Shikha	Cluster VII	9	Padarima		~ 2.5 ha
		Cluster VIII	14	Padarima		~ 4.0 ha

II. Increase in cropping intensity

Significant area was brought under pulse cultivation during *rabi* and *spring/summer* season through timely supply of quality seeds of improved varieties of lentil, chickpea and mung bean. The cropping intensity was found to be increased for the farmers directly involved in pulse cultivation and seed production. Farmers adopted high yielding short duration/climate resilient varieties. But its sustainability and expansion to larger area will only be achieved by strengthening the seed production chain of the Jharkhand state. Total area covered under the project was ~78 ha.

Cropping season	Crop	Variety	Area	Seed used	Total area
Spring/Summer 2023	Mungbean	Hum 16	2 ha	40 kg	5 ha
		Shikha	3 ha	60 kg	
Rabi 2023-24	Chickpea	Pusa Manav	1 ha	125 kg	2 ha
		Pusa 3062	1 ha	125 kg	
	Lentil	PDL 1	8.5 ha	140 kg	10 ha
		PSL 9	1.5 ha	60 kg	

Cropping season	Crop	Variety	Area	Seed used	Total area
Spring/summer 2024	Mungbean	Virat	20 ha	4.5 q	43 ha
		Shikha	20 ha	4.5 q	
Rabi 2024-25	Lentil	IPL 220	12 ha	4.5 q	12 ha
	Chickpea	Sabour chana 1	6 ha	4.5 q	6 ha
Total	Lentil			2.0 q	22 ha
	Chickpea			2.5 q	8 ha
	Mungbean			9.0 q	48 ha

Popularization of Pusa HQPM-5 improved hybrid

Under the initiative to popularize biofortified maize hybrids, a total of 200 demonstrations and field days were successfully conducted on the Pusa HQPM-5 improved hybrid across 200 villages in Hazaribag district. Demonstrations were undertaken in farmers' fields, and field days were strategically organized during the grain filling stage of the crop to ensure the most impactful visualization of the hybrid's performance. Farmers from respective village were invited to the demonstration plots, where they observed first-hand the superior yield potential and vigorous crop performance of Pusa HQPM-5 improved hybrid compared to local varieties. During these field days, scientists and technical experts also provided detailed briefings to the farmers about the nutritional advantages of quality protein maize (QPM), particularly its higher lysine and tryptophan content which is essential for improving human and animal nutrition. The demonstrations played a significant role in creating awareness among farmers regarding the importance of adopting biofortified maize hybrids for ensuring better productivity, enhanced nutritional security, and improved farm income.

Success story of Vanraja poultry bird

Backyard poultry farming is vital for rural livelihoods in Jharkhand, offering income, nutrition, and women's empowerment. To boost productivity, the dual-purpose 'Vanaraja' bird was introduced which is well-suited for free-range rearing, it grows faster and lays more eggs than native breeds, meeting local preferences and demands. ICAR-IARI, Jharkhand, under its Scheduled Caste Sub Plan (SCSP), successfully introduced improved backyard poultry practices by training SC farmers and distributing Vanaraja chicks- a robust, dual-purpose poultry variety. The initiative focused on scientific rearing, feeding, and healthcare management to ensure minimal mortality and enhanced productivity. Though initially reluctant, farmers gradually embraced the Vanaraja breed, impressed by its superior performance. Compared to local birds, Vanaraja showed significantly better growth (1.5-2.2 kg at 5-6 months) and higher egg production (100-120 eggs per year), along with stronger resistance to disease and environmental stress. The adoption of Vanaraja not only boosted household income through the sale of eggs and birds but also strengthened food security by increasing the availability of poultry products for self-consumption. Many farmers also expanded their flocks through natural brooding, creating a sustainable model. This initiative stands as a testament to the potential of introducing location-suited, improved poultry varieties. It empowered marginalized communities, enhanced rural livelihoods, and demonstrated the transformative impact of scientific interventions in backyard poultry farming.

The adoption of Vanaraja significantly improved household incomes. Farmers began selling surplus eggs and mature birds in local markets at better prices than native breeds. With each bird fetching Rs 900-950 and eggs selling at approx. Rs 20 each, even small-scale rearers earned an additional Rs 4,000 per cycle per household, which is a significant income boost compared to indigenous breeds. Some farmers reinvested profits to expand their flocks, while others used the income to support household expenses, children's education, or nutrition needs. Overall, the shift to Vanraja not only improved poultry productivity and survivability but also led to a ***notable increase in household income and economic resilience***, empowering farmers and making backyard poultry a more profitable venture.

S. No	Parameters studied	Vanaraja bird	Indigenous/ Desi bird
1	Adult body weight (kg)	2-2.5	1-1.3
2	Total egg production (No./year)	200-220	90-120
3	Gross income generated through selling live birds (Rs/bird)	900-950	650-750
4	Revenue generated through egg selling* (Rs)	4000	1800

*Selling eggs @ Rs 20/-

5

Training and Capacity Building

I. Training/workshop program organized

- Dr. Saheb Pal, Sc., coordinated a farmers' training programme on ***'Export Marketing and International Trade Opportunities in Vegetable Crops'*** sponsored by CCS National Institute for Agricultural Marketing, Jaipur at ICAR-IIVR, Varanasi, during February 6-8, 2024. A total of 60 farmers from five different districts of Jharkhand were taken to ICAR-IIVR and trained.

- Dr. Santosh Kumar, Scientist organised a three-day training program titled 'गुणवत्तायुक्त प्रोटीन मक्का के संकर बीज उत्पादन और मूल्य संवर्धित उत्पाद बनाने के उन्नत तकनीकें विषय पर त्रिदिवसीय युवा कृषक प्रशिक्षण कार्यक्रम' during May 17-19, 2024 at ICAR-IARI, Jharkhand under the NABARD-funded Fortified Maize project. The program

aimed at empowering farmers with scientific knowledge, promoting the adoption of biofortified maize technologies, and encouraging entrepreneurship development for enhancing rural livelihoods. A total of 63 farmers participated actively and get benefitted with the scientific lectures and exposure visit to the hybrid maize seed production fields.

- Dr. Santosh Kumar, Scientist organized a three-days on-farm training program on *'क्वालिटी प्रोटीन मक्का: महत्त्व, वैज्ञानिक पद्धति से मक्का उत्पादन और संकर बीज उत्पादन की तकनीकें'* during September 26-28, 2024 under NABARD-funded project. The training was conducted at multiple locations- Patratu, Rikwa, Dadi, and Gidhich, covering different farming clusters. A total of 300 farmers participated and were trained during this extensive outreach activity. The program emphasized the nutritional and economic importance of quality protein maize (QPM), scientific methods for improving maize cultivation, and hybrid seed production technologies. The training included experts' lectures and practical demonstrations on improved agronomic practices, seed production techniques, pest and disease management, and value addition. The program successfully enhanced farmers' technical knowledge and encouraged the adoption of scientific maize production practices for sustainable livelihood improvement in Jharkhand.


- Dr. Shantesh Kamath organized a ***'200-hour (25 days) certificate course for gardeners',*** sponsored by District Horticulture Office, Hazaribagh/Ramgarh, at ICAR-IARI, Jharkhand during September 05 to October 05, 2024 at ICAR-IARI-Jharkhand.
- Dr. Dipak Kumar Gupta, Sr. Scientist coordinated two ***'Sensitization workshop on virtual reality modules'*** organised online by NAHEP PMU Team, as nodal officer during January 8-12, 2024 and June 12-14, 2024 for the students of IARI Jharkhand. Total 60 B.Sc. (Ag) II[nd] year students of IARI-Jharkhand and IARI-Asam and total 36 B.Sc. (Ag), I[st] year students of IARI-Jharkhand successfully participated in online sensitization workshop for students of agricultural universities to experience virtual reality modules.


- Dr. Saheb Pal, Dr. Narendra Singh, Dr. Shantesh R. Kamath, and Dr. Kashinath G. Teli jointly coordinated an exposure visit cum training programme on 'Drip and sprinkler irrigation in horticultural crops' for 70 farmers from Dumri Development Block, Jharkhand during September 28-29, 2024.

II. Field days/ field visits organised

- Mr. A.K. Giri, Scientist (SS) organised a field day at fish farm of Mr. Raju Nishad located at Barhi on February 27, 2024 for survey of healthy fish seeds for the grow-out farming of fish farmers. There were Chinese circular hatchery for fish seed production as well as grow-out culture ponds stocked with Indian major carps, common carp, grass carp, pangas and tilapia. Monitored the water quality parameters including the growth and health status of farmed fishes.
- Mr. A.K. Giri, Scientist (SS) organised a field day cum scientific farm advisory service on September 20, 2024 at a fish farm, jointly owned by Mr Nandkishor Mehta and Mr Raju Gurung (Bangaon, Gauria Karma). As there was mass mortality of stocked carps, hence on-farm testing of water parameters like temperature, pH and TDS were conducted and accordingly appropriate management measures were suggested. The water samples were also brought to the lab and the parameters such as DO, dissolved CO_2, ammonia, total hardness and total alkalinity were analysed.
- Farmers' field day on rabi pulses (रबी दलहन - कृषक प्रक्षेत्र दिवस) cum seed distribution was organized on March 05, 2024 under NABARD funded project entitled 'Sustainable intensification of pulses in rice fallow ecosystem for nutritional and livelihood security in Jharkhand' at Research Farm of ICAR-IARI, Jharkhand.

- Farmers' field day on pigeonpea (अरहर - कृषक प्रक्षेत्र दिवस) cum seed distribution was organized on December 05, 2024 under NABARD funded project entitled 'Sustainable Intensification of Pulses in Rice Fallow Ecosystem for Nutritional and Livelihood Security in Jharkhand' at Research Farm of ICAR-IARI, Jharkhand.

III. Training/ conference/ seminar/ symposium/ workshop attended

Personnel	Training/ conference/ seminar/ symposium/ workshop	Duration	Institute
Dr. Vishal Nath	Reorienting extension services for horticulture through digital management in NCPDDHFNE	May 28th -31st, 2024	Junagarh Agricultural University, Junagarh, Gujarat
	Seminar cum debate on sakshar bharat: chunautiyan evam sambhavnayen	Sept 1st, 2024	Town Hall, Barhi, Hazaribagh, Jharkhand
	19th Kishan sangoshthi on dynamics for accelerated development of banana and other horticulture crops	Nov 15th, 2024	AMRIT, ASM Foundation, Pusa, Bihar
	Brain storming session on custard apple cultivation in Jharkhand: ways and forwards	Oct 7th, 2024	ICAR-RCERCHPR, Plandu, Ranchi
Dr. Sanat Kumar Mahanta	Online training programme on 'Ecosystem modelling and ecosystem service analysis in coastal ecology'	Oct 14th - 18th, 2024	ICAR-Central Coastal Agricultural Research Institute, Ela, Old Goa
Dr. Priya Ranjan Kumar	5 days training in 6th batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Apr 1st - 5th, 2024	National Academy of Agricultural Sciences, New Delhi
	63rd All India wheat and barley research workers' meet	Sept 11th -13th, 2024	ANDU of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh
	National conference on 'Farmers' orientation towards climate change and upgradation to sustainable agriculture'	Dec 23rd - 24th, 2024	Dhanbad, Jharkhand
Dr. Manoj Chaudhary	9th International Agri-horti technology conference and expo (NAHEP- 2024)	Dec 20th - 22nd, 2024	ICAR-Central Institute of Agricultural Engineering, Bhopal, MP
	Global soil conference -2024 on 'Caring soils beyond food security: climate change mitigation & ecosystem services'	Nov 19th - 22nd, 2024	Indian Society of Soil Science at NASC Complex, New Delhi
Dr. Dipak Kumar Gupta	National seminar on alternative fertilizers for environmental smart agriculture	Sep 26th, 2024	Indian Society of Soil Science, New Delhi
	Global soil conference -2024 on 'Caring soils beyond food security: climate change mitigation & ecosystem services'	Nov 19th - 22nd, 2024	Indian Society of Soil Science at NASC Complex, New Delhi
Dr. Monu Kumar	5 days training in 4th batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Jan 29th - Feb 2nd, 2024	National Academy of Agricultural Sciences, New Delhi
Mr. Abhay Giri	2nd international conference on 'Computational and mathematical methods in applied sciences (ICCMAS-2024)' in virtual mode	March 29th - 30th, 2024	School of Applied and Life Sciences (SALS), Uttaranchal University, Dehradun (Uttarakhand)
	International webinar on 'The big benefits of small indigenous fish (SIF): food, income and environment' in virtual mode	June 20th, 2024	NERAQ (Protection and sustainable management of aquatic resources in the north-eastern Himalayan region of India) project, jointly implemented by MoEFCC and GIZ

Personnel	Training/ conference/ seminar/ symposium/ workshop	Duration	Institute
Dr. Krishna Prakash	30 days international winter school on 'Navigating agricultural technologies for upgradation of rural excellence (NATURE-2024)' in virtual mode	Dec 2nd - 31st, 2024	Agri Meet Foundation Bharat in collaboration with Southern Federal University, Russia, CIMMYT, Mexico, ICRISAT, Hyderabad and others
Dr. Ranjit Singh	International Student Week in Applied Science (ISWIAS-2023)	June 19th - 25th 2023.	Ton Duc Thang University, Ho Chi Minh City, Vietnam,
	30th International Processing and Packaging Exhibition for Asia (PROPAKASIA)	June 14th -17th 2023.	The World Packaging Organisation (WPO), BITEC, Bangkok
	Oral presentation in the International Conference on Emerging Technologies in Food Processing -III (ETFP-2023)	Sep 26th -27th 2023	West Bengal, India
	Seminar on 'Novel application of gases for sustainable food processing and preservation'	Mar 26th, 2024	University of Queensland, Australia,
	Attended a day training on SWOT analysis of functional beverages containing botanicals	30th June 2023.	Thailand, Bangkok
	Attended Thaifex Anuga-2023, Asia's leading food and beverage trade show	July 5th to 6th, 2023.	Thailand, Bangkok
	Attended Healthy Food Asia- 2023	July 5th-6th 2023.	Thailand, Bangkok
	Participated in the Asian Food Waste Treatment Congress 2023	Oct 16th 2023.	Thailand, Bangkok
Dr. Himani Priya	IPS eastern zonal meet and national conference on 'Holistic approaches for biotic and abiotic stress management in crops for sustainable agriculture'	Nov 28th - 29th, 2024	Central Rainfed Upland Rice Research Station (ICAR-NRRI), Hazaribagh
	3rd Indian rice congress, 'An international conference on 5G enabled rice based agri food systems for nutrition and livelihood'	Dec 5th - 7th, 2024	ICAR-NRRI, Cuttack
	5 days training in 6th batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Apr 1st - 5th, 2024	National Academy of Agricultural Sciences, New Delhi
Dr. Anima Mahato	IPS eastern zonal meet and national conference on 'holistic approaches for biotic and abiotic stress management in crops for sustainable agriculture'	Nov 28th - 29th, 2024	Central Rainfed Upland Rice Research Station (ICAR-NRRI), Hazaribagh
	5 days training in 4th batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Jan 29th - Feb 2nd, 2024	National Academy of Agricultural Sciences, New Delhi
Dr. Santosh Kumar	National conference on 'Maize: a crop for food, feed, nutritional and bioenergy security with environmental sustainability,	Aug 23rd - 25th, 2024	Maize Technologists Association of India (MTAI), ICAR-IIMR, Ludhiana
	5 days training in 6th batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Apr 1st - 5th, 2024	National Academy of Agricultural Sciences, New Delhi

Personnel	Training/ conference/ seminar/ symposium/ workshop	Duration	Institute
Dr. Shilpi Kerketta	21 days winter school (through online mode) on 'Recent advances in agrostology cum pasture and forage research for doubling crop and livestock production' in virtual mode	Nov 9^{th} - 29^{th}, 2024	Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan (DUVASU) and National Agriculture Development Cooperative Ltd., Baramulla (J & K)
	3 days national symposium on 'Futuristic approaches for animal health, management and welfare: challenges and opportunities'	Nov 29^{th} - 30^{th}, 2024	College of Veterinary Science and Animal Husbandry, BAU, Ranchi (Jharkhand).
Dr. Shannon N Sangma	5 days training in 5^{th} batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Mar 4^{th} - 8^{th}, 2024	National Academy of Agricultural Sciences, New Delhi
Dr. Nuzaiba P M	3 month professional attachment training entitled 'Metabolomic profiling of ice-stored *Fenneropenaeus indicus*' as part of the ARS probationer foundation course	Feb 1^{st} - Apr 30^{th}, 2024	ICAR-Central Institute of Fisheries Technology, Cochin
Dr. Narendra Singh	5 days training in 7^{th} batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Apr 29^{th} – May 3^{rd}, 2024	National Academy of Agricultural Sciences, New Delhi
	3^{rd} Indian horticulture summit cum international conference on 'Technological intervention for boosting horticultural production'	Feb 1^{st} - 3^{rd}, 2024	S.K.N. Agriculture University, Jobner, Rajasthan
Dr. Monika M	CAFT in avian sciences on 'Commercial and diversified poultry production using modern innovation and value addition of its by-products'	Jan 31^{st} - Feb 20^{th}, 2024	Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu.
	5 days training in 7^{th} batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Apr 29^{th} - May 3^{rd}, 2024	National Academy of Agricultural Sciences, New Delhi
	39^{th} Annual conference and symposium of IPSACON 2024 on 'Shaping the Indian poultry sector for sustainable growth'	Oct 16^{th} - 18^{th}, 2024)	Nagpur Veterinary College, Maharashtra
Dr. Pavithra K N	5 days training in 5^{th} batch of pedagogy development programme on 'Enhancing pedagogical competencies for agricultural education'	Mar 4^{th} - 8^{th}, 2024	National Academy of Agricultural Sciences, New Delhi
Dr. Saheb Pal	7 days training programme on 'Decoding genomics & proteomics data using machine learning approach'	Feb 21^{st} - 27^{th}, 2024	ICAR-Indian Agricultural Statistics Research Institute, New Delhi.
	6 days training programme on 'Phenomics and high-throughput phenotyping: dissection of traits for abiotic stress tolerance'	Aug 25^{th} - 30^{th}, 2024	ICAR- Indian Agricultural Research Institute, New Delhi
	International conference on 'Plant protection in horticulture: advances and challenges'	Sept 25^{th} - 27^{th}, 2024	ICAR-IIHR, Bengaluru

Personnel	Training/ conference/ seminar/ symposium/ workshop	Duration	Institute
Mr. Shantesh Kamath	Online training programme on 'Basics of landscape design using CAD'	July 8th - 12th, 2024	Centre for e-Learning, Kerala Agricultural University, Thrissur
	National conference on 'Smart farming solutions for ornamental horticulture'	Nov 8th - 9th, 2024	Maharana Pratap Horticultural University, Karnal

IV. Invited lectures/talks in trainings

Personnel	Topic	Duration	Program
Dr B N Mandal	R: an overview	Jan 16th, 2024	Training on 'Recent advances in data analysis and applications' at ICAR-IASRI, New Delhi
	R: an overview	Mar 8th, 2024	Training on 'Quantitative methods for social sciences' at ICAR-NIAE, New Delhi
	R: an overview	Aug 13th, 2024	Training on 'Data analysis and interpretation' at ICAR-IASRI, New Delhi
Dr. Sougata Bhattacharjee	Ecosystem modelling and ecosystem service analysis in coastal ecology	July 30th, 2024	ICFRE-IFP, Ranchi (Hybrid mode)

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List of Publications

Research/review articles

Abassy, O., Balamurugan, A., Sahu, K.P., **Patel, A.**, Sheoran, N., Reddy, B., Gogoi, R., Singh, K.K. and Kumar, A. 2024. Pathogenicity and multigene sequence analysis reveal the widespread distribution of Alternaria alternata causing early blight in tomato. *Journal of Plant Pathology* 106(4): 1631-1639.

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Patents /product/technology/software

Goat breed registration: Registered non-descript goats of Bundelkhand as Breed with Accession Number INDIA_GOAT_2010_Bundelkhandi_06041. Worker: B P Kushwaha, **S K Mahanta,** D Upadhyay, K K Singh and Amaresh Chandra

Product developed and commercialised: CARI Meat Baddi. Developer: Jaydip J. Rokade, Ashok K. Tiwari, Sandeep saran, Iqra Rafiqm and **Monika M.**

Product developed: Divine Dough-Rich in Resistant starch, Iron, Zinc and fiber. Developer: Ranjeet R. Kumar, **Ashok Kumar,** Suneha Goswami, Vinutha, T, Ajeet Kumar, Navita Bansal, Shalini Rudra Gaur, Gyan Prakash Mishra, Veda Krishnan and Aruna Tyagi.

Software developed: Published an R package called slicedLHD on CRAN on 28 Feb 24. This package helps to generate sliced Latin hypercube Designs which are useful in computer experiments. Worker: **B N Mandal**

OpEnHiMR: Optimization Based Ensemble Model for Prediction of Histone Modifications in Rice was developed and published on CRAN on 30 th May 2024 (10.32614/CRAN.package.OpEnHiMR). Co-developer: **Sougata Bhattacharjee**

Patent application filed: CARI-Egg Peda-Egg based sweet product and a method of preparation thereof (Application No: 202411030499). Developer: Jaydip J Rokade, **Monika M,** Sonale Nagesh Sambhaji, Wadajkar Prasad Shivaji, Gauri Jairath, Ashim Kumar Biswas and A.K. Tiwari

7

Approved Ongoing Projects

Institute projects

- **CRSCIARIJSIL2021001XXXXX:** Genetic improvement of pigeon pea for yield and yield attributing traits under Jharkhand conditions [***Workers***: PI- Monu Kumar, Co-PIs- Kumar Durgesh, Anima Mahato, Preeti Singh, Dipak Kumar Gupta, Sougata Bhatacharjee]
- **CRSCIARIJSIL2021002XXXXX:** Genetic enhancement of maize for drought and soil acidity conditions [***Workers***: PI- Santosh Kumar, Co-PIs- Preeti Singh, Ashok Kumar, Pankaj Kumar Sinha, Akash A., S.N. Giri.]
- **CRSCIARIJSIL2021003XXXXX:** Genetic improvement for yield enhancement and resistance to abiotic stresses in mungbean and lentil [***Workers***: PI- Anima Mahato, Co-PIs- Gyan Prakash Mishra, Preeti Singh, Dharmendra Singh, Monu Kumar, Dipak Kumar Gupta, Krishna Prakash]
- **CRSCIARIJSIL2021004XXXXX:** Genetic improvement of papaya for yield and quality enhancement [***Workers***: PI- Vishal Nath, Co-PIs- Santosh Kumar, Krishna Prakash, Akash A., Narendra Singh, Pavitha K.N., Niranjan Kumar]
- **CRSCIARIJSIL2021005XXXXX:** Preparation of GIS based soil physico-chemical and biological map of ICAR-IARI, Jharkhand farm [***Workers***: PI- Preeti Singh, CoPIs- Manoj Chaudhary, Dipak Kumar Gupta, Pankaj Kumar Sinha]
- **CRSCIARIJSIL2021006XXXXX:** Performance evaluation of milch bovines and goats under different feeding and management systems in Jharkhand [***Workers***: PI- S.K. Mahanta, Co-PIs- Shilpi Kerketta, Pankaj Kumar Sinha, Manoj Chaudhary, Monika M, Nuzaiba P M, A.K. Giri, Pavithra K N]
- **CRSCIARIJSIL2021007XXXXX:** Improvement of wheat for quality and cropping system perspective (***Workers***: PI- Priya Ranjan Kumar, Co-PIs- K K Singh, Surya Prakash, Manoj Chaudhary, Himani Priya, Asha Kumari, Ashok Kumar, B, N. Mandal, Akash A., Pavitra K.N.]
- **CRSCIARIJSIL2021008XXXXX:** Genetic improvement of Parwal/Pointed Gourd for yield and quality enhancement [***Workers***: PI- Krishna Prakash, Co-PIs- Vishal Nath, Sougata Bhattacharjee, Ashok Kumar, Ranjit Singh, Saheb Pal, Narendra Singh, Akash A., Shanon Sangma]
- **CRSCIARIJSIL2022009XXXXX:** Assessment and mapping of natural resources of IARI-Jharkhand [***Workers***: PI- Dipak Kumar Gupta, Co-PIs- Vishal Nath, Manoj Chaudhary, Preeti Singh, Krishna Prakash, Pankaj Kumar Sinha, Shilpi Kerketta, Kashinath Teli, A.K. Giri]
- **CRSCIARIJSIL2022010XXXXX:** Development and evaluation of bio-inoculum for abiotic stress and nutrient management for acidic soil conditions of Jharkhand [***Workers***: PI- Himani Priya, Co-PIs- Manoj Chaudhary, Asha Kumari, Ranjit Singh, Akash A.]
- **CRSCIARIJSIL2022011XXXXX:** Identification of sustainable cropping systems under natural farming practices for medium land/upland of Jharkhand [***Workers***: PI- Dipak Kumar Gupta, Co-PIs- Anima Mahato, Shilpi Kerketta, Manoj Chaudhary, Himani Priya,

Shanon N Sangma, Pankaj Kumar Sinha, Kashinath Teli, Pavithra K.N., Narendra Singh, Saheb Pal]

- **CRSCIARIJSIL2022012XXXXX:** Development of ICT based location specific animal advisory service to livestock farmers of Jharkhand [***Workers***: PI- Shilpi Kerketta, Co-PIs- S K Mahanta, Pankaj Kumar Sinha, B N Mandal, Subrata Manna, Monika M., Nuzaiba P.M., A.K. Giri]
- **CRSCIARIJSIL2023013XXXXX:** Performance evaluation of fruit crops and varieties under edapho-climatic conditions [***Workers***: PI- Narendra Singh, Co-PIs- Vishal Nath, Krishna Prakash, Dipak Kumar Gupta, Akash A and B N Mandal]
- **CRSCIARIJSIL2023014XXXXX:** Genetic improvement of okra (*Abelmoschus esculentus*) [***Workers***: PI- Saheb Pal, Co-PIs- Krishna Prakash, Asharani Patel, Sougata Bhatterchjee and B N Mandal]
- **CRSCIARIJSIL2023015XXXXX:** Dissipation dynamics and residue analysis of Tembotrione and Pyroxasulfone in speciality corns [***Workers***: PI- Shanon N Sangma, Co-PIs- Kashinath G Teli, Niranjan Kumar, Santosh Kumar, Himani Priya, Dipak Kumar Gupta, Pavithra K N]
- **CRSCIARIJSIL2023016XXXXX:** Performance evaluation of important freshwater fish varieties under captivity conditions of Jharkhand [***Workers***: PI- A.K. Giri, Co-PIs- Nuzaiba P M, Shilpi Kerketta, D K Gupta, P.K. Sinha, Pavithra K N, Monika M, S K Mahanta]
- **CRSCIARIJSIL2023017XXXXX:** Evaluation of kharif potato-wheat cropping system in Jharkhand condition for productivity, biotic and abiotic stress tolerance [***Workers***: PI- Asha Kumari, Co-PIs- Sougata Bhattacherjee, Sarla Yadav, B N Mandal, Manoj Chaudhary, Chandan Maharana, Himani Priya, Priya Ranjan Kumar]
- **CRSCIARIJSIL2023018XXXXX:** Identification, characterization and validation of early flowering and determinacy trait-associated genes in pigeon pea' [***Workers***: PI- Sougata Bhattacharjee, Priya Ranjan Kumar, Monu Kumar, Durgesh Kumar, Asha Kumari, Debasis Pattanayak]

External funded projects

- **CRSCIARIJSOL2021001XXXXX (NABARD Funded):** Sustainable intensification of pulses in rice fallow ecosystem for nutritional and livelihood security in Jharkhand [***Workers***: Vishal Nath (Coordinator), Anima Mahato (PI), Monu Kumar, Santosh Kumar, Pankaj Kumar Sinha, Dipak Kumar Gupta, Krishna Prakash, Preeti Singh, Shilpi Kerketta]
- **CRSCIARIJSOL2021002XXXXX (NABARD Funded):** Popularization of biofortified maize hybrids (QPM+Pro Vit. A enriched) for sustainable nutritional security and up-scaling of entrepreneurship to boost up farmer's income in Jharkhand [***Workers***: Vishal Nath (Coordinator), Santosh Kumar (PI), Anima Mahato, Monu Kumar, Preeti Singh, Dipak Kumar Gupta, Pankaj Kumar Sinha, Krishna Prakash, Shilpi Kerketta, Ashok Kumar, Firoz Hussain]
- **CRSCIARIJSOL2021003XXXXX (DACFW/MOA Funded)**: Creation of Seed Infrastructure Facilities under SMSP for ICAR-IARI, Gauriakarma, barhi, Hazaribag, Jharkhand [**Workers**: Priya Ranjan Kumar (PI)]
- **CRSCIARIJSOL2023004XXXXX (Plan India (an Indian NGO) Funded)**: Providing consultancy and technological backstopping for Balika shivir: Accelerated learning centre for adolescent girls in Hazaribagh, Jharkhand [**Workers**: Pankaj Kumar Sinha (PI), Shilpi Kerketta, Vishal Nath, Dipak Kumar Gupta, Niranjan Kumar, Asharani Patel, Krishna Prakash]
- **CRSCIARIJCOP2022005XXXXX (ICAR-ATARI, Patna Funded)**: Agri-drone project [**Workers**: Pankaj Kumar Sinha (PI), Dipak Kumar Gupta, Monu Kumar, Krishna Prakash, Santosh Kumar, Ashok Kumar, Shanon N Sangma, Himani Priya]
- **CRSCIARIJCOP2021006XXXXX (AICMIP)**: All India Coordinated Maize Improvement programme, Voluntary Centre, IARI, Gauriakarma, Jharkhand [Workers: Santosh Kumar]

8

Events and Meetings

Republic day celebration

Republic Day on 26th January, 2024 was celebrated at ICAR-IARI, Jharkhand with great enthusiasm. On this occasion a small cultural event was organized by students of the institute. There after a competition of cricket match was organized between students and staff of the institute.

Celebrated international yoga day

ICAR-IARI, Jharkhand celebrated International Yoga Day on 21 June 2024. This event included the celebration of the physical and spiritual benefits of yoga all over the world. Staffs and students of the institute also joined in this event and practiced yoga as it is an important source of healthy spiritual activity and exercise.

Foundation day celebration

ICAR-IARI, Jharkhand celebrated its 10th foundation day on 28th June 2024. Dr S.C Dubey, Hon'ble Vice Chancellor, Birsa Agricultural University, Kanke, Ranchi was the Chief Guest of the function. Programme was attended by staff of the institute, FPO farmers and also by UG and PG students. On this occasion, a small documentary prepared by students was presented. Also a small cultural programme was organized by students of the institute.

Independence day celebration

Independence Day was celebrated at ICAR-IARI Jharkhand Campus with great passion among scientific, nonscientific staffs and students on 15 August, 2024. After flag hoisting a small cultural event and sports activity was organized on this occasion, which was actively participated by both staff members and students. For encouragement among students, mementos were distributed as token of love and appreciation by respected OSD, ICAR-IARI, Jharkhand.

Swachhata campaign

Swachhta hi Sewa was observed as a part of Swachh Bharat Abhiyan (theme Swabhav Swachhata-Sanskaar Swachhata) during September 15 to October 01, 2024 by IARI, Jharkhand with an objective to bring intense focus on the issues and activities related to Swachhta. This Swachhta campaign was planned date wise into different activities like Ek Ped Maa ke Naam, engagement with school children, formation of human chain, Access to local health facilities services etc. and conducted accordingly to make the programme successful at institute level.

Organized hindi saptah at ICAR-IARI

Hindi week cum workshop program was organized during 10 to 16 December, 2024. In which, activities like speeches by experts, workshops, competitions, debates etc. were organized to promote hindi. During this, discussions on social issues among the students, farmer seminars and training etc. were organized in the institute. A total of 31 scientists, 8 technical employees, and 5 administrative employees ensured their participation in the vocabulary, dictation and essay competition organized that day. This competition was organized under the aegis of Hindi Rajbhasha cell in which the Principal of Utkramit Madhya Vidyalaya, Khodahar, Dr. Sunil Kumar participated and extended commendable cooperation. A special one-day discussion was held by him on Hindi official language, its usage and grammar among the officers, staff and students of the institute. Hindi Saptah was celebrated by the scientific staff and students of institute under the chairmanship of OSD, ICAR-IARI, Jharkhand to highlight the importance of our national language Hindi in agriculture science. Hindi quiz, essay writing and hindi grammar competition were organized by members of Hindi Rajbhasha Anubhag which was actively participated by the staffs and students.


भारतीय कृषि अनुसंधान संस्थान, झारखंड में हिंदी सप्ताह का आयोजन, नवाचार और भाषा संवर्धन पर जोर


आईसीएआर में हिंदी सप्ताह के तहत विविध कार्यक्रम आयोजित

Celebration of world soil day

World Soil Day cum Farmer Training was organized on 05 December, 2024 at ICAR-IARI Jharkhand Campus with theme 'Caring for Soils: Measure, Monitor, Manage' under the chairmanship of Dr. S K Mahanta, Principal Scientist. In his presidential address, he described in detail the problems being caused in the soil due to the use of unbalanced chemical fertilizers to the farmers and laid special emphasis on the change in crop cycle, use of organic manure and biofertilizers. This technique could prove to be very effective for farmers in maintaining the health of soil and sustainable production. Our honorable guest, Mr. Subodh Kumar, Officer, Bageshwari Kisan Utpadak Sangathan, while addressing the scientists, students and farmer trainees, explained in detail the soil testing procedures, importance of soil health card, methods of taking soil samples and adviced that the use of this card will also reduce the cost of inputs of crop cultivation.

Organized one-day farmer's fair

A farmer's fair was organized on January 28, 2024 by ICAR-IARI, Jharkhand with the sponsorship of NABARD. The Chief Guest of the program was Honourable Member of Parliament and Chairman of Standing Committee of Finance, Govt. of India, Shri Jayant Sinhaji. Other ICAR and state department officials were also invited to organize their stalls and display exhibits to aware and sensitize farmers of the state on improved agricultural practices including livestock and fish farming

Organized kisan gosthi and farmer's fair

Kisan Gosthi cum Farmers fair was organized by ICAR-IARI, Jharkhand on 01/03/2024. The program was presided by Shri Arjun Munda, Union minister of Agriculture and Farmer's Welfare as Chief Guest. Inauguration of ICAR-IARI, Jharkhand Boys and Girls Hostel and Staffs Residential Quarters was done on this day.

Regional agriculture fair for eastern region

ICAR-IARI, Jharkhand also participated in agriculture fair organized by ICAR-NISA, Ranchi at KVK, Khunti during February 3-5, 2024. A stall was put for exhibition during the Kisan Mela cum Agricultural Exhibition for dissemination of IARI/ICAR technologies to farmers.

Interaction Programme with Honourable Union Agriculture Minister Sri Shivraj Singh Chauhanji

An interaction programme of scientists and farmers was organized by ICAR-IARI, Jharkhand on the Occasion of Gandhi Jayanti, October 02, 2024. On this programme Chief Guest Sri Shivraj Singh Chauhanji, Union Agriculture Minister emphasized on the importance of agriculture for farmers of Eastern region, the research gaps and various strategies need to be adopted to bridge the gaps so that agricultural productions can be improved leading to improvement in farm incomes.

NSS activities

NSS a non-gradial course is offered to students of IARI, Jharkhand. The course led students in conducting awareness programs on hygiene and the importance of women's education at the government schools in Gauriakarma village. These initiatives were aimed to sensitize school children and the local community about personal hygiene, sanitation practices, and the significance of educating girls for societal development.

AICRP-Maize monitoring team

To review and assess the AICRP Maize trials as well as research and stations trials at ICAR-IARI, Jharkhand, a team visited on October 02, 2024. The team members included Dr. R.P. Singh, Professor, GBUAT, Pantanagar, Dr. S. Jayasudha, Professor, BHU, Varanasi, Dr. Pramod Pandey, Assistant Professor, CAU, Barapani and Dr Hargilas Meena, Zonal Director Research, Borwat, MPUAT, Udaipur.

Project monitoring review committee meeting

A project monitoring review committee meeting for two NABARD projects- 'Sustainable intensification of pulses in rice fallow ecosystem' and 'Popularization of biofortified maize hybrids (QPM+Pro Vit. A enriched) for sustainable nutritional security and upscaling entrepreneurship to boost up farmers income in Jharkhand' was held to assess the projects final outcome and physical and financial implications. The meeting was headed by OSD, ICAR-IARI, Jharkhand, where other members like Mr. Mritunjay Bakshi, DDM-Chatra (Additional Charge Hazaribagh), Incharge, PME Cell and project leaders were present.

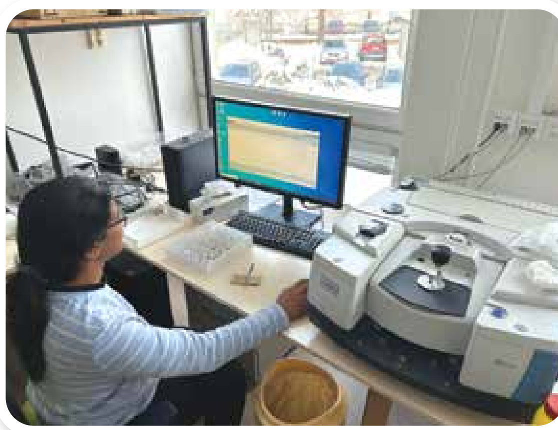
Visit of DDG (Crop Science) and Director ICAR-IARI, Jharkhand

To have an interaction and meeting with the staffs of ICAR-IARI, Jharkhand, Dr Tilak Raj Sharmaji, DDG (Crop Science) & Director ICAR-IARI, Jharkhand visited institute on July 31, 2024. During his visit, he was also accompanied by Dr Sujay Rakshitji, Director, ICAR-IIAB, Ranchi.

9

Awards and Recognition

- Dr Preeti Singh, Scientist (Soil Science) was awarded with **International Humic Substance Society, USA, Training Award 2023** for conducting three months training (05-11-2023 to 01-02-2024) under the guidance of Prof. Mgr. Ing. Jan Frouz, Director, Biology Centre CAS - ISBB Na Sádkách, České Budějovice, Czech Republic on topic 'Soil organic matter stability and microbial community in relation to different plant species in restored soil'.
- Mr. Ranjit Singh, Scientist (Agriculture Structure and Process Engineering) was awarded **1st Prize** for his exceptional contribution to the SDG Summer School organized by Entrepreneurship Centre, Asian Institute of Technology, Pathumtani, Thailand, on August 30, 2024.
- Mr. Ranjit Singh, Scientist (Agriculture Structure and Process Engineering) was awarded the prestigious **SDG Olympiad Award**, Event organized by Learning Planet Institute, Paris, France, during September 24-27, 2024.
- Mr. Ranjit Singh, Scientist (Agriculture Structure and Process Engineering) was awarded '**Best Oral Presentation Award**' during the international seminar on artificial intelligence technology in the food industry organized by AIT and Bitkub Thailand on January 31, 2024.



- Dr. Manoj Chaudhary, Sr. Scientist (Soil Science), received **'Emerging Scientist Award'** by Eco Fast Agri Solution in 9th International Agri-Horti Technology Conference and Expo (NAHEP- 2024), during 20th to 22nd December 2024 at Central Institute of Agricultural Engineering Ground, Bhopal, India.
- Dr. Manoj Chaudhary, Sr. Scientist (Soil Science) was awarded with **'Excellent in Research and Mentoring Award'** in International Conference on 'Innovation, entrepreneurship, incubation in agriculture science, commerce and social sciences' during 7th to 8th March 2025 at Janta College, Bakewar, Etawah, UP.
- Dr. Manoj Chaudhary, Sr. Scientist (Soil Science), received **Best Poster Award** in Global Soil Conference-2024 held at NAAS

Complex, New Delhi organized by ICAR, ISSS, IUSS and NAAS during November 19-22, 2024.

- Dr. Anima Mahato received, **Best Oral Presentation Award** on 'Studies on different selection indices for identification of phosphorus stress tolerant lines in mung bean' IPS East Zonal Meet and National Conference on 'Holistic approach for biotic and abiotic stress management in crops for sustainable agriculture' at Central Rainfed Upland Rice Research Station (ICAR NRRI), Hazaribagh, Jharkhand during November 28-29, 2024.

- Dr Asha Kumari, Scientist (Plant Physiology) received **Best Oral Presentation Award** at IPS Eastern Zonal Meet and National Conference on 'Holistic approaches for biotic and abiotic stress management in crops for sustainable agriculture' at Central Rainfed Upland Rice Research Station (ICAR-NRRI), Hazaribagh, Jharkhand during November 28-29, 2024.

- Dr. Himani Priya received, **Best Oral Presentation Award** on 'Potential of promising plant growth promoting rhizobacterial strains for improving growth and yield of wheat under different irrigation regimes' in IPS Eastern Zonal Meet and National Conference on 'Holistic approaches for biotic and abiotic stress management in crops for sustainable agriculture' at Central Rainfed Upland Rice Research Station (ICAR NRRI), Hazaribagh - 825301, Jharkhand during November 28-29, 2024.

- Dr. Asharani Patel, Scientist (Plant Pathology) received Best Oral Presentation Award for presentation on 'New Insights on rice endophytic microbacterium-assisted growth promotion and blast disease suppression' in conference on 'Plant health for food security: threats and promises' held at ICAR-Indian Institute of Sugarcane Research (IISR), Lucknow, Uttar Pradesh during March 1-3, 2024.

- Dr. Monika M. Scientist (Poultry Science), received **Best Poster Presentation Award**, during 39th Annual Conference and Symposium of IPSACON 2024 by Indian Poultry Science Association organised at Nagpur Veterinary College, Maharashtra during October 16-18, 2024)

- Dr Narendra Singh, Scientist (Fruit Science) received **Best Oral Presentation Award** for the presentation on 'Citrus Improvement for enhanced fruit quality and juice nutritional properties through interspecific hybridization (C. maxima [Burm.f.] Osbek × Citrus sinensis [L.] Osbek) in 3rd Indian Horticulture Summit cum International Conference 2024 held at S.K.N. Agriculture University, Jobner (Rajasthan) during February 1-3, 2024.

- Dr. Saheb Pal, Scientist (Vegetable Science) was awarded **Best Oral Presentation Award** during the International Conference on 'Plant

Protection in Horticulture: Advances and Challenges' held at ICAR-IIHR, Bengaluru, from September 25-27, 2024. He made a presentation on 'Identification and refinement of two major loci conferring resistance to *Fusarium oxysporum* f. sp. *niveum* race 2 in cultivated watermelon through QTL-seq and QTL-mapping'.

- Dr Santosh Kumar, Scientist (Plant Genetics and Breeding) received **Best Oral Presentation Award** for 'Multivariate analysis and clustering of maize inbred lines for enhanced tolerance to low soil pH' during National conference on 'Maize: A crop for food, feed, nutritional and bioenergy security with environmental sustainability' organized by Maize Technologists Association of India (MTAI).
- Dr Shilpi Kerketta, Scientist (Livestock Production Management) received third **Best Oral Paper Presentation Award** in National Symposium on 'Futuristic approaches for animal health, management and welfare: challenges and opportunities', organized by College of Veterinary Science and Animal Husbandry, BAU, Ranchi (Jharkhand).
- **डॉ. संतोष कुमार,** वैज्ञानिक (पौधा आनुवंशिकी एवं प्रजनन) को भारतीय कृषि अनुसंधान संस्थान झारखण्ड द्वारा आयोजित हिंदी सप्ताह सह कार्यशाला (१०-१६ दिसम्बर २०२४) के दौरान श्रुतिलेख प्रतियोगिता में प्रथम पुरस्कार प्राप्त हुआ
- **डॉ. संतोष कुमार,** वैज्ञानिक (पौधा आनुवंशिकी एवं प्रजनन) को भारतीय कृषि अनुसंधान संस्थान झारखण्ड द्वारा आयोजित हिंदी सप्ताह सह कार्यशाला (१०-१६ दिसम्बर २०२४) के दौरान शब्दावली प्रतियोगिता में प्रथम पुरस्कार प्राप्त हुआ
- **डॉ. संतोष कुमार,** वैज्ञानिक (पौधा आनुवंशिकी एवं प्रजनन) को भारतीय कृषि अनुसंधान संस्थान झारखण्ड द्वारा आयोजित हिंदी सप्ताह सह कार्यशाला (१०-१६ दिसम्बर २०२४) के दौरान निबंध लेखन प्रतियोगिता में द्वितीय पुरस्कार प्राप्त हुआ।

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Administration and Accounts

1. Financial Statement (Rs. in Lakhs) of IARI, Jharkhand (2024-25)

Major heads	Sub-heads	BE 2024-25	RE-2024-25	Receipt	Expenditure	% Utilization of allocation
Main	Capital	1764.00	1564.00	1564.00	1564.00	100.00
	General	300.00	400.00	400.00	400.00	100.00
	Total	2064.00	1964.00	1964.00	1964.00	100.00
NEH	Capital	0.00	0.00	0.00	0.00	0.00
	General	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00
SCSP	Capital	418.00	418.00	418.00	417.85	99.96
	General	189.00	189.00	189.00	188.86	99.93
	Total	607.00	607.00	607.00	606.71	99.95
TSP	Capital	0.00	0.00	0.00	0.00	0.00
	General	20.00	20.00	20.00	19.61	98.05
	Total	20.00	20.00	20.00	19.61	98.05
Grand Total		**2691.00**	**2591.00**	**2591.00**	**2590.32**	**99.97%**

2. Staff strength

Cadre	Sanctioned	In position	Vacant
Research management			
Scientist	41	30	11
Technical	22	9	13
Administrative	11	7	4
Total	74	46	38

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Distinguished Visitors

- Shri. Shivraj Singh Chauhan
  Honourable Minister of Agriculture and Farmers' Welfare, Govt. of India
- Shri. Arjun Munda
  Former Hon'ble Minister of Agriculture & Farmers Welfare, Govt. of India
- Dr. Himanshu Pathak
  DG, ICAR and Secretary, DARE
  ICAR, New Delhi
- Dr. T. R. Sharma
  DDG (CS), ICAR and Director, IARI
  New Delhi
- Shri. Jayant Sinha
  Honourable Member of Parliament
  Hazaribagh, Jharkhand
- Shri. Sadananda Naskar
  IA&AS, Deputy Accountant General
  (AMG - II & AMG-IV)
- Dr. S. C. Dubey
  Vice-Chancellor
  Birsa Agricultural University, Ranchi
- Dr. C. Viswanathan
  Joint Director (Research)
  ICAR-IARI, New Delhi
- Dr. Abhijit Kar
  Director, ICAR-NISA,
  Ranchi, Jharkhand
- Dr. Sujay Rakshit
  Director, ICAR-IIAB,
  Ranchi, Jharkhand
- Dr. Dinesh Kumar Saxena
  IFoS, Chief Conservator of Forests
  Govt. of Jharkhand
- Dr. S. S. Sindhu, Emeritus Scientist, Division of Floriculture and Landscaping, ICAR-IARI, New Delhi
- Dr. V.P. Bhadana
  Joint Director (Research)
  ICAR-IIAB, New Delhi
- Prof. (Dr.) Sudhir Kumar Saxena
  Ex- Sr. Principal Scientist
  CSIR-CIMFR
  Guest Faculty, IIT-ISM, Dhanbad
- Shri. Mrityunjay Bakshi,
  DDM, NABARD, Hazaribagh
- Mr. Prem Prakash Singh
  DDM, NABARD
  Hazaribagh, Jharkhand
- Dr. Newton Tirkey
  District Animal Husbandry Officer
  Hazaribagh, Jharkhand

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List of Personnel

Director

S. No.	Name	Designation
1	Dr. Ch. Srinivasa Rao	Director (since December 2024)
2	Dr. T. R. Sharma	Director (July to December 2024)
3	Dr. A. K. Singh	Director (till June 2024)

Officer on Special Duty

S. No.	Name	Designation
1	Dr. Vishal Nath	OSD and Principal Scientist (Horticulture)

Scientific Staff

S. No.	Name	Designation
1	Dr. Sanat Kumar Mahanta	Principal Scientist (Animal Nutrition)
2	Dr. Priya Ranjan Kumar	Principal Scientist (Genetics and Plant Breeding)
3	Dr. B. N. Mandal	Senior Scientist (Agricultural Statistics)
4	Dr. Manoj Kumar Chaudhary	Senior Scientist (Soil Sciences)
5	Dr. Dipak Kumar Gupta	Senior Scientist (Environmental Sciences)
6	Dr. Abhay Kumar Giri	Scientist (Sr. Scale) (Aquaculture)
7	Dr. Monu Kumar	Senior Scientist (Genetics and Plant Breeding)
8	Dr. Krishna Prakash	Scientist (Sr. Scale) (Horticulture)
9	Dr. Pankaj Kumar Sinha	Senior Scientist (Agricultural Extension)
10	Dr. Himani Priya	Scientist (Sr. Scale) (Agricultural Microbiology)
11	Dr. Anima Mahato	Scientist (Sr. Scale) (Genetics and Plant Breeding)
12	Dr. Santosh Kumar	Scientist (Sr. Scale) (Genetics and Plant Breeding)
13	Dr. Preeti Singh	Scientist (Sr. Scale) (Soil Sciences)
14	Er. Ranjit Singh	Scientist (Sr. Scale) (Agricultural Structure and Process Engineer)
15	Dr. Asha Kumari	Scientist (Sr. Scale) (Plant Physiology)
16	Dr. Ashok Kumar	Scientist (Plant Biochemistry)
17	Dr. Shilpi Kerketta	Scientist (Livestock Production and Management)
18	Dr. Sougata Bhattacharjee	Scientist (Agricultural Biotechnology)

S. No.	Name	Designation
19	Dr. Shannon Sangma	Scientist (Agricultural Chemicals)
20	Dr. Niranjan Kumar	Scientist (Agricultural Chemicals)
21	Dr. Nuzaiba P.M.	Scientist (Fish Nutrition)
22	Dr. Asharani Patel	Scientist (Plant Pathology)
23	Dr. Saheb Pal	Scientist (Vegetable Science)
24	Dr. Narendra Singh	Scientist (Fruit Science)
25	Dr. Monika M.	Scientist (Poultry Science)
26	Mr. Akash A.	Scientist (Seed Science and Technology)
27	Dr. Pavithra K. N.	Scientist (Agril. Economics)
28	Dr. Kashinath Gurushidappa Teli	Scientist (Agronomy)
29	Dr. Priti Tigga	Scientist (Soil Physics)
30	Dr. Shantesh Kamath	Scientist (Floriculture)

Technical Staff

S. No.	Name	Designation
1	Mr. Sushil Marandi	ACTO (Librarian)
2	Mr Arun Kumar Rajak	T1 (Technician)
3	Mr Jay Prakash Narayan	T1 (Technician)
4	Mr Jitendra Kumar Mandal	T1 (Technician)
5	Mr Vikash Kumar	T1 (Technician)
6	Mr Satyam Kumar	T1 (Technician)
7	Mr Dharmendra Kumar Yadav	T1 (Technician)
8	Mr Rajendra Kumar Meena	T1 (Technician)
9	Mr Rahul	T1 (Technician)

Administrative Staff

S. No.	Name	Designation
1	Mr Prashant Kumar	Comptroller
2	Mr Subodh Neeraj	CAO
3	Mr Vikram Verma	AO
4	Mr Rajnish Kumar	FAO
5	Mr Surjit Kumar	AAO
6	Mr Sonu Kumar	AAO
7	Mr Omkar Pushp	Assistant

भा.कृ.अनु.प. – भारतीय कृषि अनुसंधान संस्थान - झारखण्ड

ग़ौरिया करमा (खेरौन), हजारीबाग– 825405, झारखण्ड , भारत

ICAR - Indian Agricultural Research Institute - Jharkhand

Gauria Karma (Kheron), Hazaribagh – 825405, Jharkhand , INDIA

276_(0625) Anapurna Press and Process 6287999194, e-mail : appranchi.1969@gmail.com