ICAR-IARI-Jharkhand

Annual Report 2023

ICAR-Indian Agricultural Research Institute, Jharkhand
Gauria Karma, Hazaribag-825405

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FORWARD

The green revolution in India, played a pivotal role in making India self-sufficient in food production, alleviating hunger and boosting the agricultural economy. While the initial green revolution largely focused on northern and north-westernregions, the eastern states, including Bihar, Jharkhand, Odisha and West Bengal have lagged behind in agricultural development. The inception of Indian Agricultural Research Institute-Jharkhand is rooted in the recognition of pivotal role agriculture plays in the socio-economic fabric of eastern India, a region endowed with diverse agro-climatic zones and a rich agricultural heritage with potential to bring a second green revolution in the country. The need for a specialized agricultural research institute became apparent to harness the untapped potential, address regional agricultural issues and contribute to the overall growth of the agricultural sector.

As a premier institute under the aegis of Indian Council of Agricultural Research (ICAR), IARI-Jharkhand is an extension of the renowned Indian Agricultural Research Institute, New Delhi. The establishment of ICAR-IARI-Jharkhand in 2015 marks a significant milestone in the pursuit of agricultural excellence and is dedicated to advancing agricultural science, technology and education to address the unique challenges and opportunities in agricultural landscape of India. The decision to establish this institute stems from the vision of Indian government and ICAR to decentralize agricultural research and extend the reach of cutting-edge technologies and innovations to different regions of the country.

With a commitment to fostering education, research and outreach programs, IARI Jharkhand aims to emerge as a hub for agricultural excellence in the region. The establishment of this institute underscores the importance of tailoring agricultural research to specific needs of Jharkhand, contributing to the state's agricultural growth and ensuring food security for its residents in particular and the country as a whole.

It is with great pleasure and a sense of accomplishment that I present to you the First Annual Report of the ICAR-IARI Jharkhand for the year 2023. As the Director of this esteemed institute, I am honoured to share with you the remarkable strides and achievements that our dedicated team has made in the pursuit of agricultural excellence.

The institute is mandated to focusona multidisciplinary research approach, encompassing crop improvement, sustainable farming practices, natural resource management, and technology dissemination in animal husbandry and fisheries. The institute strives to provide region-specific solutions to enhance agricultural productivity, alleviate farmer distress, and promote sustainable agri-business practices.

Our commitment to scientific research, technology transfer, and capacity building remains unwavering, and this report is a testament to the tireless efforts of our researchers, scientists, and staff of this institute. The institute began its academic programme as PG Outreach institute under Post Graduate School, IARI-New Delhi in its inception in 2015. As of now, a total of 132 students admitted to M.Sc./M. Tech. courses at ICAR-IARI-Jharkhand in 8 academic years out of which 112 students have completed their degrees. The institute has started the undergraduate B. Sc. (Ag.) degree programme from academic year 2022-23 with an intake of 66 students. On the research front, a large number of germplasms of various agri-horti crops has been collected, procured and being evaluated at the research field. Eight in-house research projects and two NABARD-funded projects have been awarded to initiate the scientific research work at the institute along with other evaluation and co-ordinated research trials in Maize, Wheat, Lentil, Moong, Pigeonpea, Mustard and vegetable crops. Many pulse crop genotypes were also evaluated for their performance for Al-toxicity under acidic soil condition of Jharkhand. In collaboration with IARI New Delhi, high-end laboratory work on various aspects of molecular and qualitative evaluation was undertaken in cereal and vegetable crops, that reflected into some of the quality publications from this institute in its initial years of establishment.

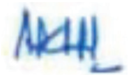
Throughout the pages of this report, you will find a comprehensive overview of our research work, teaching activities, collaborations, and outreach activities. From crop breeding research to successful extension programs reaching farmers in remote regions under various schemes like Scheduled Caste Sub Plan (SCSP), Tribal Sub Plan (TSP) and NEH activities, each section reflects our commitment to addressing the challenges facing Indian agriculture.

I would like to express my gratitude to the entire ICAR-IARI Jharkhand family for their hard work and dedication towards establishing a premier institution. Their passion for the establishment of a new institution, initiating agricultural research and their perseverance in the face of hidden challenges have been instrumental in our success.I warmly acknowledge and thank the staff of ICAR-IARI New Delhi for their unswerving commitment, guidance and relentless work towards creating various facilities at a remote location in Jharkhand.

I would like to thank Dr. T.R. Sharma, DDG (Crop Science) and Dr. D.K. Yadava, ADG (Seed), ICAR, for their constant support and guidance. I also thank Dr. Trilochan Mohapatra, Former Secretary, DARE and Ex-Director General, ICAR, and Dr. Himanshu Pathak, Secretary, DARE & Director General, ICAR for being the guiding force and generous support in all aspects of establishing a new IARI-like institution that will lead to the excellence in agricultural research and contribute to the prosperity of farmers and the agricultural sector.

I express my sincere admiration to the annual report editorial team for bringing out the annual report for the first time.

I look forward to more productive years ahead.



(Ashok K. Singh)
Director
ICAR-IARI-Jharkhand

PREFACE

I am pleased to present the First Annual Report of ICAR-IARI-Jharkhand, documenting the significant milestones and achievements of the institute since its establishment.

ICAR-IARI-Jharkhand was established with a vision to contribute to the agricultural development of Eastern India in general and Jharkhand in particular towards bringing second green revolution in the country. Since its inception in 2015 and effective functioning in 2020, the institute has made remarkable progress in various aspects of research, education and extension in agriculture and allied sector.

The research activities at ICAR-IARI-Jharkhand have been formulated robustly with focus on addressing the specific challenges faced by the agricultural sector in the region. Our scientists and researchers have conducted numerous baseline surveys and experiments largely aiming at improving crop yield and soil health, horticulture crop profitability and abiotic stress management. Notable breakthroughs and innovative practices have been developed to enhance the productivity and sustainability of agriculture in the area.Substantial efforts have been made in the development of institutional infrastructure to support cutting-edge research and education. The institute has erected an academic building, a separate boy's and girl's hostel, guest house, staff quarters and also developed nearly 400-acre research farm area to facilitate comprehensive research endeavours.

ICAR-IARI-Jharkhand is committed to nurturing the next generation of agricultural researchers, scientists, students and entrepreneurs through academic programs, specialized trainings and skill development courses.More than 100 students have been awarded Master's degree and currently more than 250 students have enrolled for various M.Sc. (Ag.) and B.Sc. (Ag.) courses. The institute has actively fostered collaborations with national research organizations, state agricultural agencies and industry partners. These partnerships aim to leverage collective expertise and resources for more impactful research outcomes and technology dissemination.

The institute recognizes the importance of engaging with the local community. Various extension activities, farmer training programs, seed distribution programs and awareness campaigns have been conducted to disseminate improved technologies and promote sustainable agricultural practices.

In conclusion, the passing year 2023 of ICAR-IARI-Jharkhand has been marked by significant accomplishments and a steadfast commitment to advancing agricultural research, education, and outreach activities. I express my gratitude to the dedicated team of scientists and other staff of this institute as well as staff of ICAR-IARI-New Delhi, ICAR, collaborators and other stakeholders who have played a pivotal role in the institute's success.

My sincere gratitude to Dr. Ashok Kumar Singh, Director and Vice-Chancellor, ICAR-IARI-New Delhi for his guidance and constant support in setting a bright path for development of ICAR-IARI-Jharkhand.

I look forward to your valuable insights and guidance as we continue to grow and contribute to the agricultural landscape of Eastern India.

(Vishal Nath)
Officer on Special Duty
ICAR-IARI-Jharkhand

Executive Summary

Academic

- **Post graduate programme:** IARI-Jharkhand started its academic programme as PG Outreach institute under Post Graduate School, IARI New Delhi from its foundation year 2015. As of now, total 132 students admitted in M.Sc./M. Tech. at ICAR-IARI-Jharkhand in 8 academic years out of which 112 students have completed their degrees.

- **Under graduate programme:** B. Sc. (Agriculture) degree programme has been started from academic year 2022-23 with intake of 66 students. Further 66 B.Sc. (Ag.) students of IARI Assam admitted during academic year 2022-23 are also undergoing their studies in IARI Jharkhand campus. The next batch of students in academic year 2023-24 with same number has been admitted.

Research

- Two MAGIC populations of pigeonpea (VM1 and VM2), received from IARI-New Delhi in early segregation generation and comprised of total 77 lines, were characterized and evaluated for yield and its associated traits under rainfed conditions. Based on their overall performance, 13 lines in VM-1 and 12 lines in VM-2 MAGIC population were selected and advanced to next generation.

- Aluminum toxicity is major challenge in lentil production under acidic soils. Six high yielding *viz.,* RIL 2-1, RIL 3-1, RIL 26-2, RIL 27-1, RIL 57-2 and RIL 69 and, six low yielding *viz.,* RIL 43-2, RIL 43-3, RIL 56-1, RIL 62, RIL 67 and RIL 68-1, recombinant inbred lines of the cross BM-4 x L-4608 were selected based on their yield and yield attributing traits under acidic soil conditions of IARI-Jharkhand during *rabi* 2020-21 and *rabi* 2021-22. Further, biochemical analysis will be carried out to understand aluminum toxicity tolerance in these lines.

- Two lentil varieties *viz.,* PDL-1 and PSL-9, developed at IARI, New Delhi and notified and released for cultivation under saline soil conditions of Haryana and Uttar Pradesh, showed good yield potential under agroclimatic conditions of Jharkhand. These two varieties have been subjected to multi-location yield trials in collaboration with BAU, Ranchi for promoting them to release under state varietal release committee.

- One hundred and thirty-nine mungbean germplasms has been classified into high, medium and low yielders categories based on a comparative study under optimum (pH-5.13 to 5.79 and available P-12.86 to 61.12 kg/ha) and low phosphorus (pH-5.08 to 5.61 and available P-5.51 to 8.29) conditions. In optimum P condition, seven genotypes were found to be high yielder, while in low P condition only one genotype was found high yielding. These genotypes could be further subjected to estimation of phosphorus use efficiency and efficient genotypes could be used in future breeding programme to develop promising mungbean cultivars for the specific soil condition

- Wheat variety HD 3443 has been registered as a new variety under Protection of Plant variety and Farmer's Rights Act, 2001 in collaboration with IARI-New Delhi.An awnless farmers' variety was also collected from Badkagaon, Hazaribag. Two superior lines, out of 45 were identified in terms of yield under acidic and limed soil conditions.One line, GK 16 was also identified to be superior to the check (HD 2967) out of 29 lined evaluated in station trial for yield.

- Three crosses *viz.,*Z21×LM 13, Z14×LM 13 and Z6×LM 13, developed by crossing 25 inbred lines with three elite lines (BML 6, UMI1200 and LM13) in L x T fashion, were identified to have higher maize grain yield than standard commercial check also showed positive significant SCA for the crosses.

- Nine experimental maize hybrids (normal as well as QPM) performing superior to the check during Kharif 2021 at ICAR-IARI, Jharkhand were evaluated for their yield performanceunder state trial at five locations in Jharkhand *i.e.* Hazaribag, Ranchi, Dumka, East Singhbhum and Palamu during Kharif 2022. It will be evaluated again for its yield performance and other traitsduring Kharif 2023 and the proposal for the state release of hybrids performing better under Jharkhand state will be submitted after the second year of evaluation.

- The institute has developed a makeshift nursery and mother block of various fruit crops in an area of approx. 8-hectare land as per the approved plan. Altogether more than 700 fruit plants of improved varieties and hybrids of Mango (15), Ber (8), Litchi (8), Guava (6), Bel (6), Citrus (6), Jackfruit (5), Aonla (4), Custard Apple (2), Jamun (2) and Minor fruits (20) have been planted in the mother block which are mainly grown and found suitable for the Eastern Plateau Region of the country.

- Three plant types of Papaya (JHP-4, JHP-5 and JHP-6) have been identified for higher yield and other horticulture traits in Jharkhand. JHP-4 yielded 40.59 kg fruits followed by JHP-5 (32.75 kg) and JHP-6 (19.38 kg). JHP-4 recorded an average fruit weight of 2.25 kg with saffron color pulp and 16.0 TSS.

- Heterosis evaluation of tomato performed on crosses obtained from Line (3) x Tester (5) mating designs revealed that out of 15 cross combinations, 8 crosses showed a substantial increase in total yield per plant compared to the superior parent. Studies of combining abilities showed that non-additive gene effects were predominant for the majority of the characters. Based on the percent disease index one hybrid (DT1504 X DT911) showed high resistance against Tomato Leaf Curl Virus disease, and six hybrid showed resistant reaction against bacterial wilt diseases.

- Evaluation of 35 genotypes of brinjal for yield-attributing traits and wilt disease resistance revealed that four genotypes were highly resistant and one as highly susceptible for bacterial wilt diseases.

- Soil physico-chemical map of research farm, IARI-Jharkhand has been drawn in ArcGIS after digitizing the farm map using the create shape file for line and polygon in the editor tool. Spatial distributions of soil organic carbon, EC, pH, available. N, P, K, S were identified by random forest technique.

- Both in rice and wheat crops, the highest grain yield was obtained under biochar amended soil followed by treatments with recommended dose of fertilizer and farmer's practices. The wheat (PBW 154) yield was about 2572kg/ha under treatment with biochar@10 t/ha + recommended dose of NPK, while under treatment with recommended doseof NPK without biochar, the yield was 1512kg/ha.

- An Integrated farming system model for one-hectare area has been planned. The model induces aquaculture (1800 m^2); animal, mushroom and apiculture component (1000 m^2), fruit trees (1200

m^2); vegetable (1000 m^2), upland crops (1500 m^2), medium land crops area (3500 m^2); spices (500 m^2) and low land crops area (4500 m^2).

- Twenty-five isolates obtained from soils, collected from ICAR-IARI Jharkhand, were screened for acidic, osmotic and dual stress tolerance. Among 25 bacterial isolates tested for tolerance to acidity and drought, five dual-stress-tolerant isolates were identified and evaluated for their effect on wheat seed germination and seedling vigour index, *in vitro* under dual acidic and osmotic stress condition. Inoculation with three of these isolates improved wheat seed germination and seedling vigor. Two most promising isolates, identified as *Bacillus rugosus* ANI4 and *Achromobacterkerstersii* NNI2, exhibited multiple plant growth-promoting attributes.

- Natural edible gums, gum arabic (GA), gum ghatti (GG), and herbal based, aloe vera gel (AVG) have been identified for plant based edible coating material for guava. The GA:GG:AVG combination in a ratio 35:35:30was found suitable for minimum weight loss and longer shelf life of guava during storage at ambient condition.

- Base line survey on goat farming in Hazaribag district of Jharkhand state indicated that semi-scavenging system of goat rearing is very popular in rural areas, particularly in vicinity of forest land or barren or uncultivable land. But majority of goat farmers are resource poor farmers and lacking in knowledge on scientific goat management and their health measures.

Introduction

The eastern region of the country, comprising of plains and plateau regions of Bihar, Jharkhand, West Bengal, Odisha, Chhattisgarh and Eastern Uttar Pradesh supports more than thirty percent population of India. Agriculture is the main source of livelihood to the rural population of this region. In spite of the enriched natural resources in terms of fertile soils, water resources and solar radiation, the land productivity and per capita income of the farmers in the eastern region is very low due to natural calamities, erratic climate variations, population explosion, land degradation, small and scattered land holdings, lack of quality seed and planting materials and poor extension mechanism. Indian Agricultural Research Institute (IARI), New Delhi is popularly known as the seat of the green revolution in India. However, the fruits of first green revolution were not realized by the eastern states of our country. The country needs a second green revolution to feed 160 crores population by 2030, which can happen from the eastern states of our country. In fact, the inherent potential of the Eastern part of our country has remained untapped and holds promise for a second green revolution, which can be accomplished through holistic management of land, water, crops, biomass, horticultural, livestock, fishery and human resources. Therefore, it is an opportune time to replicate the success of IARI, New Delhi in the eastern part of the country. The proposal was thus mooted to establish a state of the art Indian Agricultural Research Institute with Deemed University status in Jharkhand to cater the needs so as to harness the potential of agriculture, animal sciences, fisheries, horticulture and forestry. The Honourable Finance Minister, Shri Arun Jetly Ji in his maiden budget speech had announced the establishment of IARI like institutes in Jharkhand and Assam on July 10, 2014. Honourable Prime Minister of India, Shri Narendra Modi Ji then laid the foundation stone of IARI, Jharkhand on June 28, 2015 at 1000 acres of land in Gauriakarma village under Barhi block of Hazaribag district.

The objectives of establishing IARI, Jharkhand include promoting high standards agriculture education (under graduate and post graduate), research and outreach programs in agriculture and allied fields for the eastern parts of the country. This is a unique institution, which possesses all the hallmark identities as that of IARI, New Delhi including all sectors of agriculture like field crops, horticultural crops, agroforestry, animal husbandry, fisheries, poultry, silk and lac rearing, honey production etc. The institute is operating its research and outreach programmes conceptualized broadly under three schools *viz., School of Crop Sciences, School of Natural Resource Management, and School of Animal and Fishery Sciences* by undertaking cutting edge research in frontier areas (Fig 1). The institute has started functioning in its capacity to solve the agrarian challenges and complexities of eastern India with linkages to all existing Central/State Government R&D institutions and private sector enterprises. It has initiated research, education, and extension programmes in its mission towards developing quality human resources and generation of farmer-friendly technologies to enhance productivity, quality and profitability. The institute is mandated with conducting basic, strategic and anticipatory research in frontier areas of agriculture and allied sectors, and developing human resources for academic excellence.

The institute has 11 divisions and it has sanctioned staff strength of 74 comprising scientific (41), technical (22) and administrative (11) personnel. The revised budget estimates of the institute constituted a total amount of rupees 1770 lakh for the year 2022. ICAR-IARI Jharkhand is running its academic programme as PG outreach institute under Post Graduate School, ICAR-IARI, New Delhi from 2015-16 in 14 disciplines and started its UG courses for B.Sc. (Ag.) since 2022-23 session. 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.

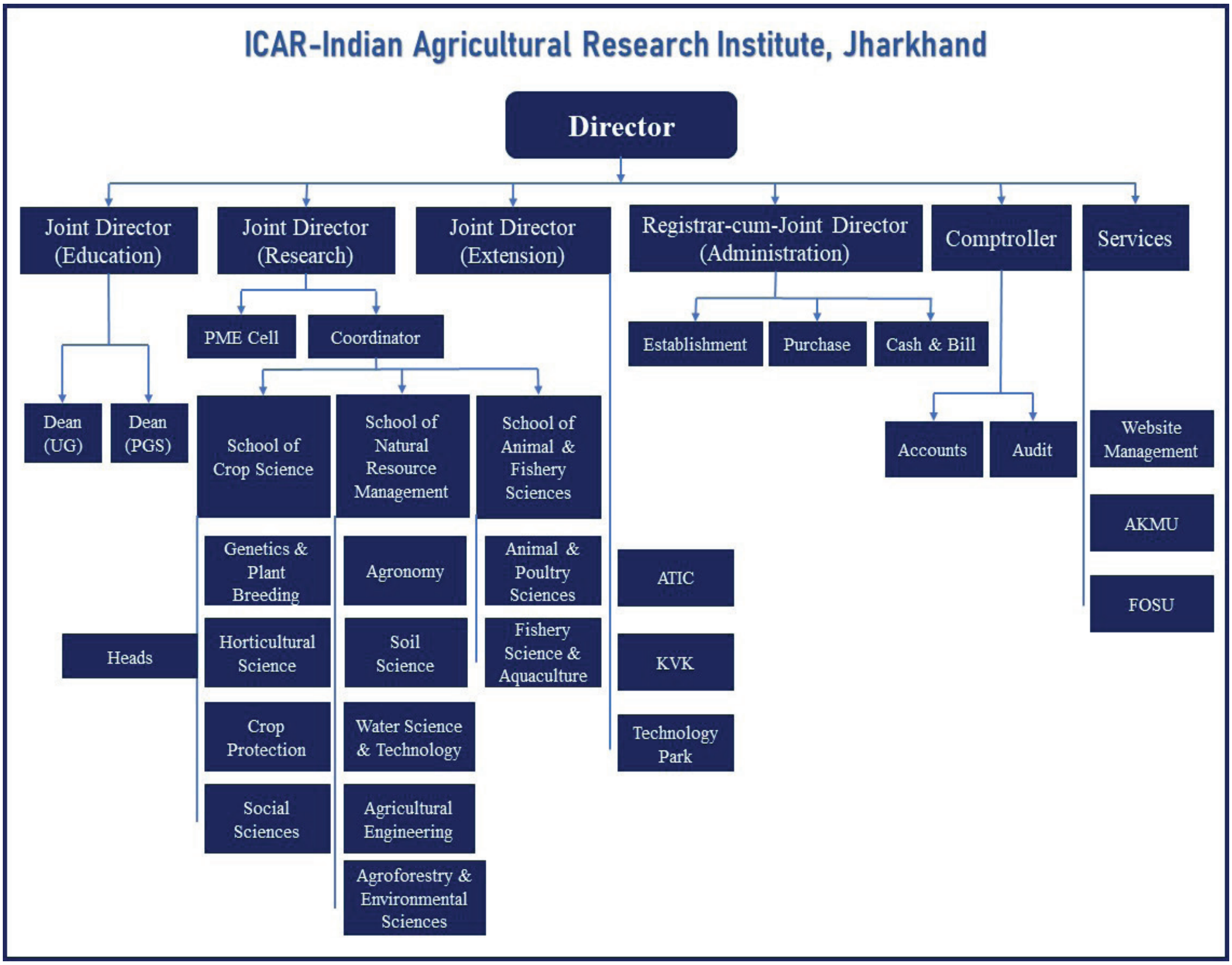


Fig 1. Organogram of the institute

Under graduate programme

The institute has started B.Sc. (Agriculture) degree programme from academic year 2022-23 with intake of 66 students. Further 66 B.Sc. (Ag.) students of ICAR-IARI, Assam admitted during academic year 2022-23 are also undergoing their studies in ICAR-IARI, Jharkhand campus.

Post graduate programme

IARI Jharkhand begun its academic programme as PG Outreach institute under Post Graduate School, IARI New Delhi from its foundation year 2015. As of now, total 152 students admitted in M.Sc./M. Tech. at ICAR-IARI Jharkhand in 8 academic years out of which 112 students have completed their degrees (Table 1).

Table 1. Academic year wise students' intake and award of degree in M.Sc./M.Tech

Students	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Total
Admitted	9	10	11	11	12	30	29	20	20	152
Passed out	-	-	9	10	11	11	12	30	28	111

During academic session 2022-23, twenty (20)M.Sc./M. Tech. students have been admitted in 10different disciplines, namely, Agricultural Engineering (SWCE), Entomology, Environmental Sciences, Fruit Science, Genetics & Plant Breeding, Microbiology, Plant Pathology, Seed Science and Technology, Soil Science and Agricultural Chemistry and Vegetable Science, whereas during 2023-24 students admitted in four disciplines (GPB, Fruit Science, Vegetable Science and Soil Science) and offline classes has started. During the academic year 2020-22, thirty (30) M.Sc./ M.Tech. students have completed their degree program in 12 different disciplines (Table 2) and awarded degree during 61st Convocation of Post Graduate School, IARI New Delhi. During academic year 2021-23, 28 students completed their M.Sc. (Ag.) degree and awarded degree in 62nd Convocation of Post Graduate School, IARI-New Delhi in which Mr. Satyam Rawat, M.Sc. (Agronomy) received IARI Merit Medal Award from the honorable President of India (Smt. Droupadi Murmu).

Table 2. List of M.Sc./M. Tech. students passed out during academic year 2020-22

S.N.	Name of student	Name of guide	Topic	Degreeawarded
1.	Abhijit Mandal	Dr. Teekam Singh	Effect of nano-urea and irrigation regimes on wheat	M.Sc. (Agronomy)
2.	Abhishek Paul	Dr. Santosh S Mali	Water footprints of major vegetable crops in eastern Gangetic Plains of India	M.Tech. (Agricultural Engineering)
3.	Bhavani Kumari	Dr. PriyaRanjan Kumar	Comparison between hard and soft wheat genotypes for seed traits and susceptibility to storage pests	M.Sc. (Seed Science and Technology)

S.N.	Name of student	Name of guide	Topic	Degreeawarded
4.	Vinodh Kumar P N	Dr. M G Mallikarjuna	SWEET gene family in maize (Zea mays L.): Identification, evolutionary analysis, and functional characterization under abiotic stresses	M.Sc. (Genetics and Plant Breeding)
5.	Soumyadar-shiMuduli	Dr. Kapila Shekhawat	Nitrogen management in wheat (*Triticumaestivum* L.) for acid soils of Jharkhand	M.Sc. (Agronomy)
6.	Ankit Kumar Verma	Dr. Namita Das Saha	Soil carbon, nitrogen pools and GHGs emission under different land use systems of Hazaribag, Jharkhand	M.Sc. (Environmental Science)
7.	SayakSaha	Dr. Nishi Sharma	Assessment of IARI's extension approaches for outscaling of improved agricultural technologies	M.Sc. (Agricultural Extension)
8.	Rayudu Sai Padmini	Dr. Jaipal Singh Choudhary	Population dynamics and biointensive pest management module of the litchi insect pest complex from flowering to fruit set stage	M.Sc. (Entomology)
9.	Amar B A	Dr. Kanhaiya Singh	Optimization of scion age and time of grafting in jackfruit (*Artocarpushetrophyllus* Lam.) under eastern Plateau Hill region	M.Sc. (Fruit Science and Horticultural Technology)
10.	ChanduAnagani	Dr. (Mrs) Amrita Banerjee	Molecular characterization of rice tungro virus from eastern India and development of a rapid diagnostic assay using recombinase polymerase amplification (RPA) technique	M. Sc. (Plant Pathology)
11.	Manoj BP	Dr. Krishna Prakash	Studies on combining ability for yield and disease resistance in tomato under Eastern Plateau region of India	M.Sc. (Vegetable Science)
12.	Abhishek E	Dr. Gopala Krishnan	Genetic and molecular characterization of tetra QTL pyramids of Pusa 44 with tolerance to reproductive stage drought stress	M.Sc. (Genetics & Plant Breeding)

S.N.	Name of student	Name of guide	Topic	Degreeawarded
13.	Deepashree A.	Dr. Manoj Chaudhary	Soil organic carbon pools and aggregate associated carbon under different orchards in Hazaribag, Jharkhand	M.Sc. (Soil Science and Agricultural Chemistry)
14.	VasanthVinay-akVara Prasad N	Dr. V. B. Patel	Understanding the fruit cracking mechanism in bael (*Aegle marmelos (L.) Correa*.) using biochemical and RNA-seq.	M.Sc. (Fruit Science and Horticultural Technology)
15.	Pooja Kumari	Dr. Jaipal Singh Choudhary	Temporal abundance and species diversity of pollinators associated with litchi flowering	M.Sc. (Entomology)
16.	Aravindh C	Dr. Arun Kumar Singh	Combining ability and heterosis studies for yield traits and bacterial wilt resistance in brinjal (*Solanummelongena*)	M.Sc. (Vegetable Science)
17.	Suraj Mishra	Dr. NiharikaMallick	Characterization of NILs carrying adult plant rust resistance genes in wheat	M.Sc. (Genetics and Plant Breeding)
18.	Komal	Dr. Amrita Banerjee	Phenotyping and molecular screening of rice landraces from north-eastern India for blast resistance	M. Sc. (Plant Pathology)
19.	Abshiba	Dr. Manoj Chaudhary	Assessment of soil quality in major cropping systems of Hazaribag plateau	M.Sc. (Soil Science and Agricultural Chemistry
20.	Surendhar P	Dr. Dipak Kumar Gupta	Quantification of greenhouse and ammonia gas emissions from different cattle manure management systems	M.Sc. (Environmental Science)
21.	AdarshaDivya-darshan	Dr. Sushanta Kumar Naik	Soil organic carbon pools and biological properties under different agricultural production systems in the eastern plateau and hill region	M.Sc. (Soil Science and Agricultural Chemistry)
22.	Saniya T K	Dr. RadhaPrasanna	Prospecting the diversity and abundance of diazotrophs in Jharkhand soils for the development of region-specific microbial inoculants	M.Sc. (Microbiology)

S.N.	Name of student	Name of guide	Topic	Degreeawarded
23.	SaikatBera	Dr. Bibhash Chandra Verma	Effect of different organic amendments on carbon and nitrogen mineralization in an acid soil of Jharkhand	M.Sc. (Soil Science and Agricultural Chemistry)
24.	S. Syam	Dr. Sangeeta Paul	Interactions between stress tolerant bacteria and wheat under simultaneous acidic and drought stress	M.Sc. (Microbiology)
25.	PriyabrataSahu	Dr. PriyaRanjan Kumar	Effectiveness of plant growth regulators in improving lodging resistance and their effect on seed traits in wheat	M.Sc. (Seed Science and Technology)
26.	Rachana K S	Dr. Rabi Shankar Pan	Evaluation of vegetable soybean [*Glycine max* (L.) Merrill] for horticultural and nutritional traits	M.Sc. (Vegetable Science)
27.	Abeer Ali	Dr. Bikash Das	Standardization of biomass mulching for improving fruit yield and quality of guava (*Psidiumguajava* L.) under rainfed uplands of Jharkhand	M.Sc. (Fruit Science and Horticultural Technology
28.	T. Nagaraju	Dr. Venu Lenin	An analytical study of the factors determining the adoption behaviour of hi-tech cultivation of rose in eastern dry zone of Karnataka	M.Sc. (Agricultural Extension)
29.	AbhijeetMud-hale	Dr. Somnath Roy	Assessment of genetic diversity and polymorphisms associated with key domestication genes in rice germplasm collected from riverine ecology of Assam	M.Sc. (Genetics and Plant Breeding)
30.	Rajat Kumar Nath	Dr. Nishi Sharma	Value chain analysis of cereal and horticultural crop varieties of IARI in NWPZ	M.Sc. (Agricultural Extension

1. Plant genetic resources and crop improvement

Pigeonpea germplasm procurement, collection and maintenance

The efforts were made to enrich pigeonpea germplasm through procurement from different institutes and collections to initiate pigeonpea improvement programme at ICAR-IARI Jharkhand. Initially, 40 numbers of germplasms were procured from Institute of Agricultural Sciences, BHU, Varanasi, Birsa Agricultural University, Ranchi and ICAR-IARI, New Delhi. Few germplasms were also collected from farmers' field. All procured and collected pigeonpea germplasms were sown and multiplied at ICAR-IARI Jharkhand farm during 2021-22 cropping season (Table 1; Fig 1). Similarly, new pigeonpea germplasms were procured and sown along with previous year germplasm collections during 2022-23 cropping season (Table 2; Fig 2). Evaluation will be done based on grain yield and associated traits like pods per plant, seeds per pod, pod length, number of primary/secondary branches, pod cluster per plant and hundred seed weight (data to be finalized after harvesting of crop and same will be included in Annual Report 2023).

Table 1. Germplasm maintained during 2021-22 cropping season

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

Table 2. Germplasm maintained during 2022-23 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

S.N.	Germplasm	S.N.	Germplasm	S.N.	Germplasm
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		
15	ICPR 2671	32	Farmer Variety - 5		
16	MA 433	33	Rajiv Lochan		
17	ICPR 3772	34	IPA 203		

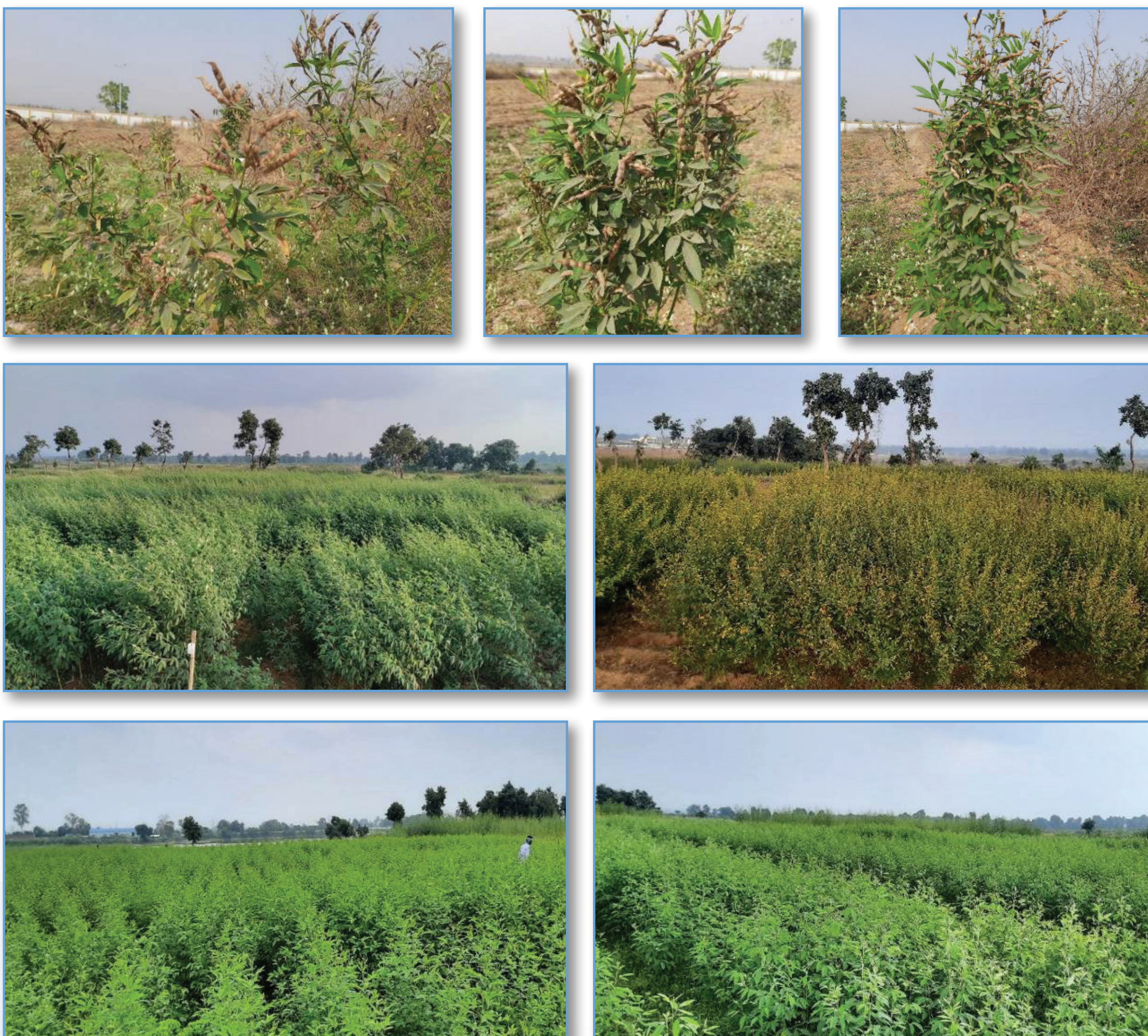
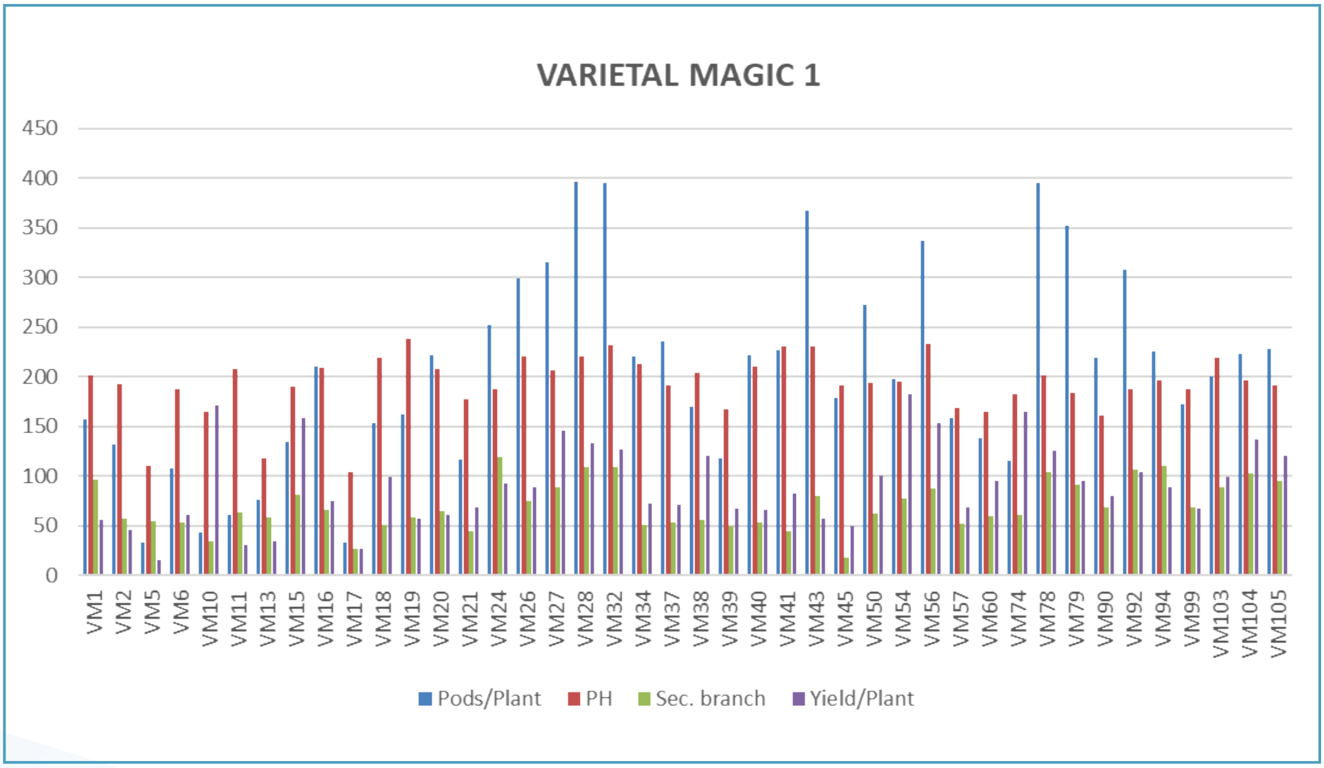


Fig 1. Pigeonpea germplasm maintained and breeding materials being evaluated at ICAR-IARI Jharkhand during 2021-22 cropping season

Fig 2. Pigeonpea germplasm and breeding materials being evaluated at ICAR-IARI Jharkhand during 2022-23 cropping season

Evaluation and screening of pigeonpea breeding lines in rainfed conditions

The early segregating generation MAGIC populations derived from eight founder parents were received from Genetics Division, IARI, New Delhi. The MAGIC populations consisted of two sets: first set named Varietal Magic-1 (VM1) consisting of 42 lines and second set named Varietal Magic-2 (VM2) consisting of 35 lines, and thus total 77 MAGIC lines were characterized under rainfed conditions in upland farm area of IARI Jharkhand during 2021-22 cropping season. The both MAGIC populations were evaluated for yield and yield associated traits (Fig 3-4). On evaluation, it was observed 10 lines with >150 g per plant (avg. of 5 plants yield), 31 lines with ≥13 g/100 seed weight, 13 lines with >300 pods per plant, 28 lines with 5 seeds per pod, 20 lines with 7-centimeter pod length, 15 lines with ≥25 nos. of primary branch, 12 lines with ≥100 nos. of secondary branch, 13 lines with ≥220-centimeter plant height and 11 lines with ≥11 pod cluster per plant. The MAGIC populations were screened for grain yield and associated traits and based on its performance, 13 and 12 lines in VM-1 and VM-2, respectively were selected and sown in 2022-23 cropping season. The advance selected lines from both MAGIC populations (VM1 and VM2) were sown for evaluation based on yield and other yield determining traits during 2022-23 cropping season. The research plot selected in IARI Jharkhand farm for evaluation was characterized for various soil parameters and recorded for soil acidity with pH <5.5, EC-0.12 ds/m and soil organic carbon 0.38%. The surface soil (0-15 cm) properties of initial soils were as follows: 110 kg ha^{-1} available N, 4.69 kg ha^{-1} available phosphorus, 151 kg ha^{-1} available potassium, sandy clay loam soil texture and 1.64 g cm^{-3} bulk density.



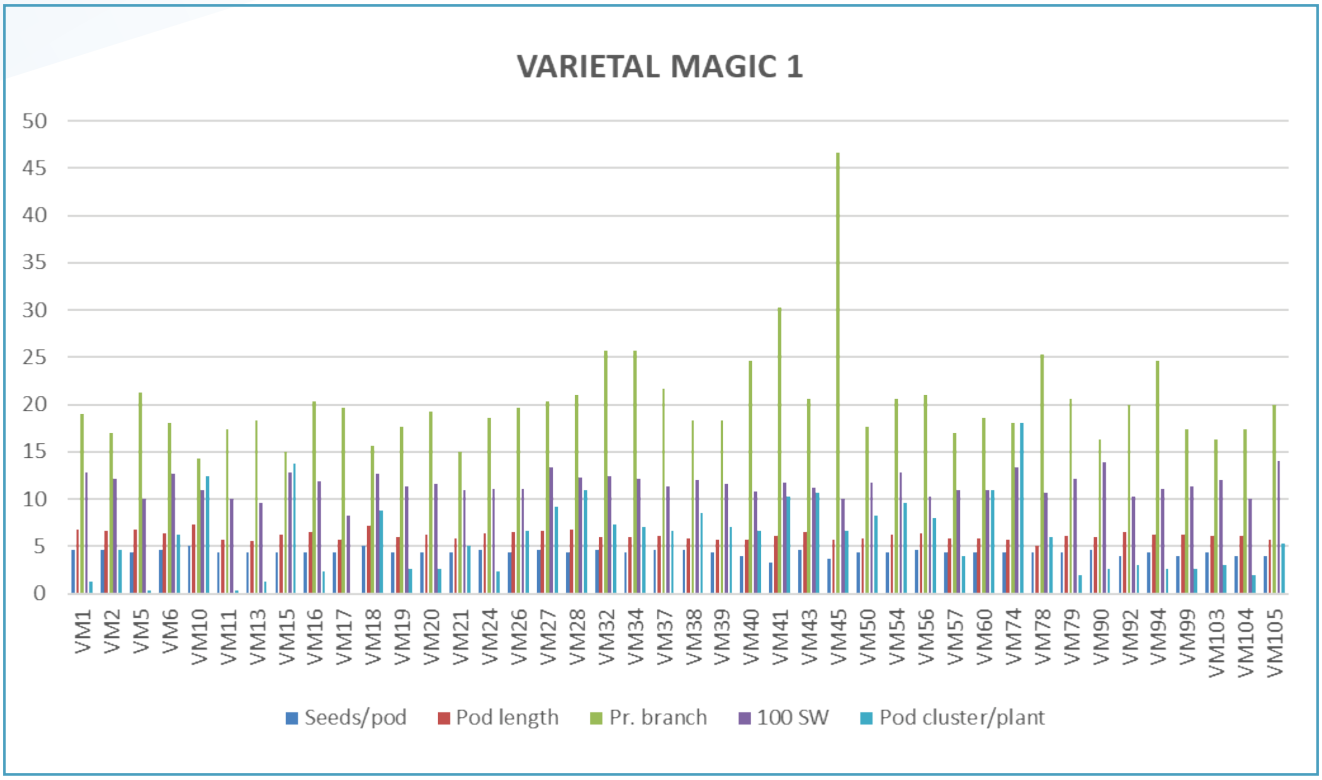
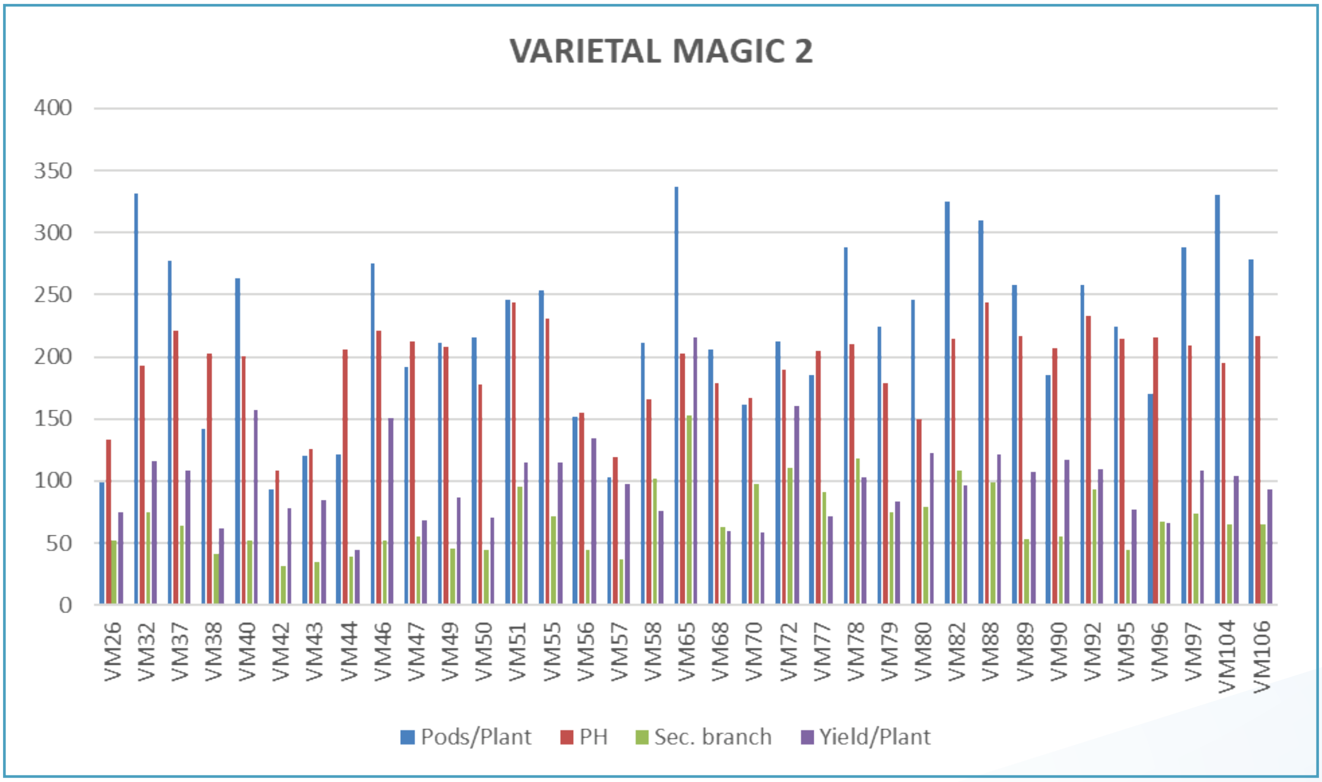


Fig 3. Graphical presentation on yield and associated traits recorded in varietal magic population-1 (42 lines)



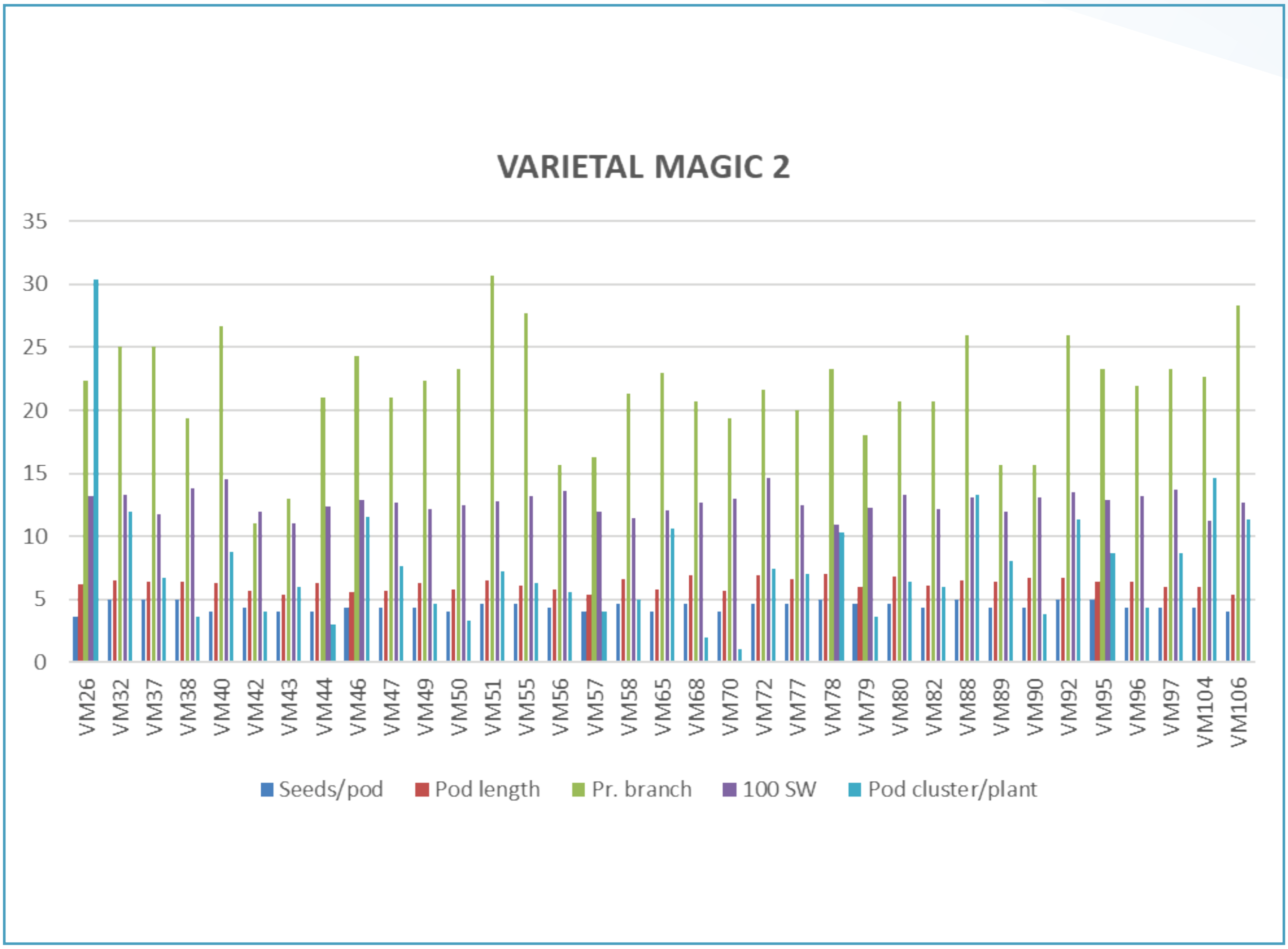


Fig 4. Graphical presentation on yield and associated traits recorded in varietal magic population-2 (35 lines)

Evaluation of lentil germplasm for yield and associated traits in acidic soils

Lentil is highly sensitive to low pH or acidic soils. The acid soils are mainly characterized by a deficiency of major nutrients and toxicity of metals, such as manganese (Mn), iron (Fe) and Al; with toxicity of Al being the main limiting factor for plant growth in acid soils. Aluminum solubilizes at low pH (<5.0) to release phytotoxic, monomeric Al^{3+} which is easily absorbed by plants and inhibit root elongation even at micromolar concentrations within a few minutes of exposure. As a secondary effect, deficiency of phosphorous (P), magnesium (Mg) and calcium (Ca) is induced in shoots. One hundred and fourteen genotypes of lentil were evaluated and characterized under acidic soil condition with pH < 5.0, EC -0.11 to -0.21 ds/m and soil organic carbon 0.35% during *rabi* 2020-21 for yield and associated traits (Fig 5; Table 3). The soil was sandy clay loam with 1.60 g cm^{-3} bulk density and the initial surface soil contained 143 kg ha^{-1} available N, 23 kg ha^{-1} available phosphorus, 144 kg ha^{-1} available potassium.

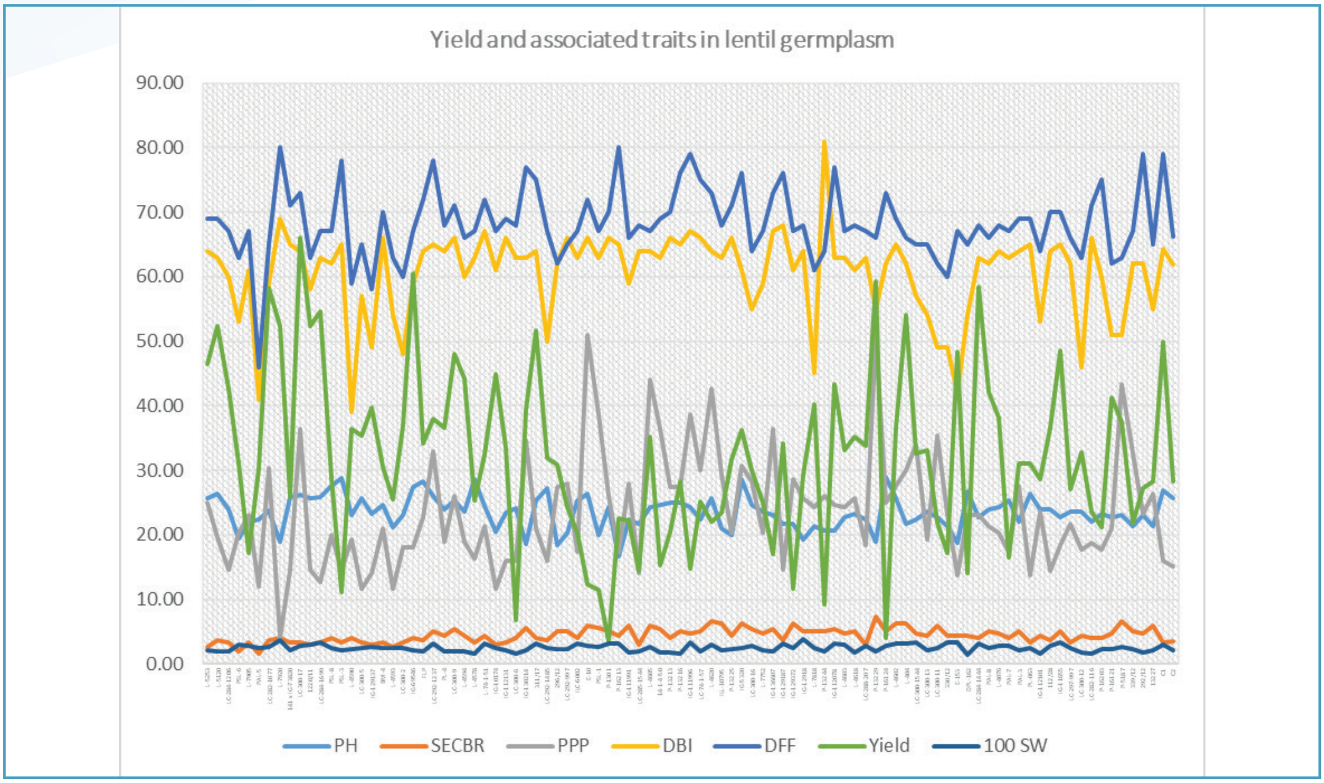


Fig 5. Graphical representation of yield and associated traits in lentil germplasm

Table 3. Yield and associated traits of lentil germplasm population during *rabi* 2021-22

S.N.	Genotypes	PH	SECBR	PPP	DBI	DFF	Yield	100 SW	LF	PGH	Seed size
2	L-5253	25.60	3	25	64	69	46.51	2.13	3	1	5
3	L-5120	26.40	4	20	63	69	52.42	1.98	3	1	3
4	LC-284-1206	24.00	3	15	60	67	42.64	1.94	3	1	3
5	PSL-6	19.40	2	20	53	63	31.10	3.03	3	1	9
6	L-7905	22.00	3	23	61	67	17.21	2.80	3	3	7
7	PAL-5	22.40	2	12	41	46	30.33	2.55	3	1	7
8	LC-282-1077	23.80	4	30	59	65	58.22	2.68	3	1	7
10	L-7920	19.00	4	4	69	80	52.32	3.60	3	3	3
11	141 x IG-73820	25.80	3	15	65	71	25.84	2.09	5	1	9
12	LC-300-17	26.20	3	36	64	73	66.00	2.80	3	3	5
13	1220/11	25.60	3	15	58	63	52.31	3.07	3	3	7
14	LC-284-1699	25.80	3	13	63	67	54.62	3.28	5	1	9
15	PSL-8	27.60	4	20	62	67	28.80	2.39	5	1	9
16	PSL-3	28.80	3	15	65	78	11.16	2.09	3	1	5
18	L-4590	23.00	4	19	39	59	36.45	2.31	3	3	5
19	LC-300-5	25.60	3	12	57	65	35.46	2.54	3	1	5
20	IG-129137	23.20	3	14	49	58	39.77	2.58	3	1	7
22	BM-4	24.60	3	21	66	70	30.53	2.43	5	1	7
23	L-4593	21.20	3	12	54	63	25.54	2.52	5	3	5

S.N.	Genotypes	PH	SECBR	PPP	DBI	DFF	Yield	100 SW	LF	PGH	Seed size
24	LC-300-2	23.00	3	18	48	60	36.92	2.54	3	3	7
25	IG-69546	27.40	4	18	59	67	60.56	2.07	5	1	7
26	FLP	28.20	4	23	64	72	34.24	1.93	5	3	5
27	LC-292-1237	26.00	5	33	65	78	38.00	3.24	3	3	3
28	PL-4	24.00	4	19	64	68	36.56	1.91	3	1	9
29	LC-300-9	25.40	5	26	66	71	47.97	1.92	3	3	3
30	L-4594	23.60	4	19	60	66	44.17	1.86	3	1	3
32	L-4578	28.60	3	16	63	67	25.37	1.55	3	3	3
33	L-74-1-51	24.40	4	21	67	72	32.36	3.10	3	1	3
34	IG-10174	20.40	3	12	61	67	44.88	2.48	3	3	9
35	IG-112131	23.40	3	16	66	69	33.50	2.07	5	1	5
36	LC-300-6	24.20	4	16	63	68	6.88	1.62	3	1	5
38	IG-130214	18.60	6	35	63	77	39.33	2.20	3	3	3
39	311/17	25.40	4	21	64	75	51.74	3.24	3	1	5
40	LC-292-1485	27.20	4	16	50	67	31.95	2.38	5	3	9
42	296/12	18.33	5	27	62	62	30.94	2.25	3	1	5
43	LC-292-997	20.33	5	28	66	65	24.34	2.32	3	1	5
44	ILC-6002	25.33	4	17	63	67	20.37	3.20	3	1	5
45	E-10	26.33	6	51	66	72	12.40	2.77	5	3	9
46	PSL-1	20.00	6	39	63	67	11.51	2.66	5	1	7
47	P-1301	24.33	5	26	66	70	3.59	3.17	3	1	7
48	P-16213	16.67	4	17	65	80	22.51	3.16	3	3	9
49	IG-111991	22.33	6	28	59	66	22.27	1.82	3	1	9
50	LC-285-1544	21.67	3	14	64	68	14.41	1.94	5	1	3
51	L-4605	24.33	6	44	64	67	35.15	2.65	3	1	3
52	14-1-4-50	24.67	5	36	63	69	15.31	1.73	5	3	7
53	P-13213	25.00	4	27	66	70	20.52	1.84	3	1	3
56	P-13216	25.00	5	27	65	76	28.25	1.65	3	1	3
57	IG-111996	24.33	5	39	67	79	14.75	3.27	3	1	3
58	LC-74-1-57	22.33	5	30	66	75	25.22	1.91	3	1	9
59	L-4620	25.67	7	43	64	73	21.99	3.01	3	1	3
60	ILL-10795	21.00	6	29	63	68	23.51	2.18	5	3	9
61	P-13225	20.00	4	20	66	71	31.73	2.32	3	3	5
63	IG-5320	28.67	6	31	61	76	36.32	2.41	5	3	5
64	LC-300-16	24.67	5	28	55	64	30.08	2.84	3	3	5
65	L-7752	23.67	5	20	59	67	25.03	2.11	3	1	7
68	IG-136607	23.00	5	36	67	73	17.03	1.91	3	1	5
69	IG-129187	21.67	4	15	68	76	34.09	3.22	3	1	3
70	IG-129372	21.67	6	29	61	67	11.66	2.49	3	1	9
71	IG-12918	19.33	5	26	64	68	29.31	3.80	5	3	5
72	L-7818	21.33	5	24	45	61	40.18	2.42	5	1	9
73	P-13244	20.67	5	26	81	64	9.27	2.01	3	1	5
74	IG-112078	20.67	5	25	63	77	43.28	3.23	3	3	5

S.N.	Genotypes	PH	SECBR	PPP	DBI	DFF	Yield	100 SW	LF	PGH	Seed size
75	L-4603	22.67	5	24	63	67	33.04	3.06	3	1	9
76	L-4618	23.33	5	26	61	68	35.18	1.79	3	1	9
77	LC-288-207	22.33	3	18	63	67	33.84	2.73	3	1	3
78	P-13229	19.00	7	51	55	66	59.20	1.94	3	1	7
79	P-16124	29.00	5	25	62	73	3.99	2.86	3	1	3
80	L-4602	25.67	6	28	65	69	36.56	3.18	5	1	7
81	L-404	21.67	6	30	62	66	54.14	3.13	3	1	9
84	LC-300-1544	22.33	5	34	57	65	32.53	3.25	3	1	9
85	LC-300-13	23.67	4	19	54	65	33.20	2.20	5	1	9
86	LC-300-11	22.67	6	35	49	62	21.81	2.39	3	1	5
87	330/12	21.33	4	23	49	60	17.26	3.31	3	3	5
89	E-153	18.67	4	14	42	67	48.31	3.26	5	1	9
92	DPL-162	26.67	4	23	54	65	14.12	1.47	5	3	9
93	LC-284-1444	22.67	4	23	63	68	58.46	3.23	3	1	3
94	PAL-8	24.00	5	21	62	66	42.07	2.45	3	1	9
95	L-4076	24.33	5	20	64	68	38.21	2.82	3	1	5
96	PAL-7	25.33	4	17	63	67	16.58	2.82	5	3	7
97	PAL-3	22.00	5	28	64	69	30.98	2.11	5	3	7
98	PL-063	26.33	3	14	65	69	31.12	2.40	3	3	5
99	IG-112101	24.00	4	24	53	64	28.54	1.61	3	1	5
100	112/28	24.00	4	14	64	70	36.60	2.85	3	1	3
101	IG-11655	22.67	5	18	65	70	48.47	3.30	3	3	7
102	LC-297-997	23.67	3	22	62	66	27.07	2.44	3	1	9
103	LC-300-12	23.67	4	18	46	63	32.86	1.81	3	1	5
104	LC-282-116	22.00	4	19	66	71	23.61	1.53	3	1	3
108	P-16203	23.33	4	18	60	75	21.24	2.22	3	1	3
109	P-16121	22.67	5	21	51	62	41.35	2.26	3	1	5
110	P-5187	23.00	7	43	51	63	37.41	2.58	3	3	5
111	339/12	21.33	5	33	62	67	21.82	2.30	5	3	7
112	292/12	23.00	5	23	62	79	27.16	1.71	3	1	5
113	13227	21.33	6	26	55	65	28.30	2.13	3	3	3
114	C1	27	3	16	64	79	49.91	3.07	3	1	5
115	C2	26	4	15	62	66	28.30	2.13	3	1	8

PH: Plant height; SECBR: No. of secondary branches; PPP: Pods per plant; DBI: Days to bud initiation; DFF: Days to 50% flowering; Yield; 100 SW: 100 seed weight; LF: Leaflet size; PGH: Plant growth habit; Seed size

Screening of RIL population for aluminum toxicity tolerance

A total of 70 recombinant inbred lines derived from a cross betweeon BM-4 x L-4602, were evaluated for yield and yield attributing traits in acidic soil condition with pH 5.15-5.52. The observations were made on yield and associated traits (Table 4). A comparative performance of RILs in terms yield and associated traits were also recorded (Fig 6). Based on the two years yield performance of RILs, six high and six low yielding RILs were identified (Fig 7).

Table 4. Yield and associated traits recorded in RILs during rabi 2021-22

S.N.	Genotypes	DFF	PH	SBR	PPP	Y/m² (g)	BM		S.N.	Genotypes	DFF	PH	SBR	PPP	Y/m² (g)	BM
1.	RIL-1	68	19.0	5	37	16.01	46		36.	RIL-39	67	23.6	3	13	19.20	67
2.	RIL-2-1	68	20.0	3	30	31.30	114		37.	RIL-40	66	22.4	3	22	21.23	83
3.	RIL-2-2	69	18.4	7	47	21.63	76		38.	RIL-41	66	22.2	4	20	20.28	68
4.	RIL-3-1	66	17.2	3	18	21.98	80		39.	RIL-43-1	66	19.2	2	10	17.83	62
5.	RIL-3-2	64	19.0	6	50	26.17	91		40.	RIL-43-2	66	17.4	4	22	20.00	34
6.	RIL-5	67	20.4	5	35	21.17	77		41.	RIL-43-3	66	13.3	6	10	0.00	10
7.	RIL-7-1	66	19.0	6	20	28.92	97		42.	RIL-45	66	18.0	3	16	13.28	39
8.	RIL-7-2	66	17.6	4	26	25.85	86		43.	RIL-46	66	21.8	3	17	19.10	66
9.	RIL-8-1	66	17.6	6	43	17.53	61		44.	RIL-47-2	67	18.2	2	5	13.86	36
10.	RIL-9-1	63	20.6	6	32	30.43	116		45.	RIL-48	65	18.8	3	18	22.68	72
11.	RIL-11-1	65	21.6	5	36	29.20	101		46.	RIL-49-1	64	17.8	4	25	22.73	74
12.	RIL-11-2	69	19.8	4	20	18.12	63		47.	RIL-50	64	17.2	3	14	22.43	83
13.	RIL-12-1	68	20.0	4	23	15.81	46		48.	RIL-52	66	17.4	3	14	21.79	69
14.	RIL-14-1	71	17.6	4	20	18.09	55		49.	RIL-53	65	18.8	2	13	25.14	84
15.	RIL-14-2	72	18.2	5	51	14.05	44		50.	RIL-54	67	22.4	2	13	25.79	82
16.	RIL-16	67	22.4	4	19	16.26	49		51.	RIL-55	65	19.2	3	16	25.95	84
17.	RIL-17-1	68	27.0	5	47	21.11	78		52.	RIL-56-1	68	17.0	3	10	14.94	37
18.	RIL-18-1	67	22.6	4	21	24.39	91		53.	RIL-56-2	66	19.2	2	13	24.25	81
19.	RIL-19	76	25.0	5	26	27.17	101		54.	RIL-57-1	66	19.4	3	13	23.89	80
20.	RIL-21	67	20.8	4	17	17.20	55		55.	RIL-57-2	66	18.8	2	12	30.72	101
21.	RIL-22-1	67	21.0	5	40	27.27	93		56.	RIL-57-3	66	19.2	3	14	14.10	30
22.	RIL-22-2	69	20.2	5	30	23.97	70		57.	RIL-58-1	63	18.0	4	35	26.55	81
23.	RIL-25-1	65	20.2	5	25	20.22	69		58.	RIL-58-2	63	19.2	3	18	22.14	71
24.	RIL-26-1	67	24.0	5	34	21.85	74		59.	RIL-70	63	17.8	4	37	20.44	73
25.	RIL-26-2	67	24.2	5	45	23.71	79		60.	RIL-60-1	63	18.2	4	37	21.39	65
26.	RIL-27-1	68	21.0	4	24	28.68	105		61.	RIL-60-2	63	19.6	4	29	20.41	59
27.	RIL-28-2	67	18.6	4	28	21.95	69		62.	RIL-61-2	64	20.6	3	19	23.06	79
28.	RIL-30	65	20.8	4	21	20.21	61		63.	RIL-62	68	18.4	3	24	11.30	31
29.	RIL-31-1	67	19.8	4	25	21.64	77		64.	RIL-64	66	17.4	3	18	17.09	50
30.	RIL-31-2	67	17.6	4	29	25.28	94		65.	RIL-65	72	18.0	4	25	16.00	47
31.	RIL-33	66	21.6	4	44	18.02	53		66.	RIL-67	67	17.4	2	11	14.27	43
32.	RIL-34	66	19.2	4	20	17.76	60		67.	RIL-68-1	69	16.8	3	30	15.82	47
33.	RIL-35	65	18.2	4	17	22.82	68		68.	RIL-68-2	66	18.6	4	20	29.75	94
34.	RIL-37-2	68	24.8	2	9	29.70	103		69.	RIL-12-2	62	20.2	2	10	23.99	75
35.	RIL-38	66	20.6	2	8	21.33	93		70	RIL-69	62	20.4	4	24	25.83	88

DFF: Days to 50% flowering; PH: Plant height; SBR: Number of secondary branches; PPP: Pods per plant; Y/m²: Yield/m²; BM: Biomass

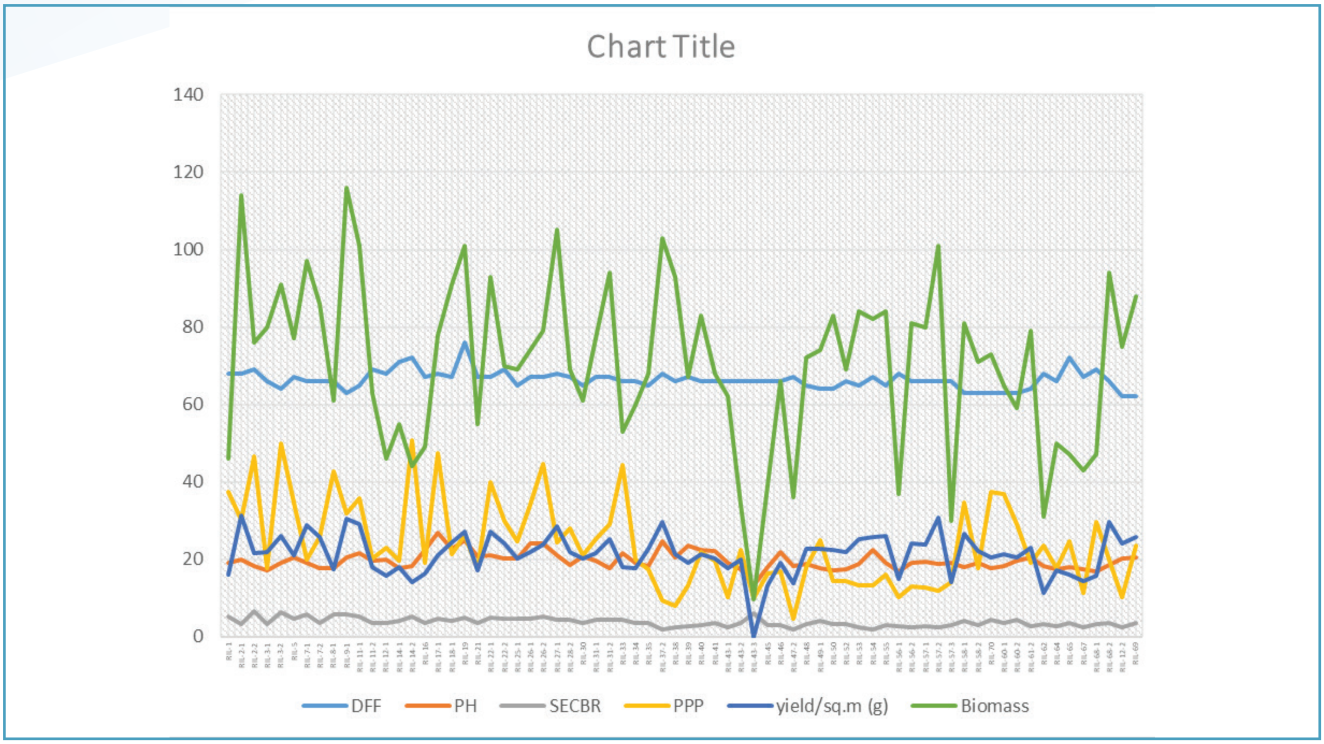


Fig 6. Comparative performance of RILs in terms yield and associated traits during 2021-22

(a) RIL 2-1	(b) RIL 3-1	(c) RIL 26-2	(d) RIL 27-1	(e) RIL 57-2	(f) RIL 69

(g) RIL 43-2	(h) RIL 43-3	(i) RIL 56-1	(j) RIL 62	(k) RIL 67	(l) RIL 68-1

Fig 7. Images of high yielding RILs (a-f) and low yielding RILs (g-l)

The 70 recombinant inbred lines, derived from a cross betweeon BM-4 x L-4602, were subjected to single plant selection during *rabi* 2021-22. From each plot ~ two healthy plants were selected and harvested separately. Approximatelry 152 recombinant inbred lines were isolated and maintained. Eleven advance breeding lines, as received from Genetics Division, IARI, New Delhi, were also evaluated for agro-morphological and yield traits in acidic soils with pH range 5.15-5.52 (Fig 8). These 11 cross combinations were categorized in two sub-groups based on their similarity in terms of maturity and seed size to either of the parents. Observations were recorded for yield and yield attributing traits to identity the high yielding crosses. Large scale and multi-location evaluation of all these lines will be carried out in coming years to identify the potential lines.

Table 5. List of crosses

S.N.	Name of cross	Characteristics
	PDL 1 x L-4618 (A)	Similar to PDL 1
	PDL 1 x L-4618 (B)	Similar to L-4618
	IPL-316 x PDL-2 (A)	Similar to IPL-316
	IPL-316 x PDL-2 (B)	Similar to PDL-2
	L-4590 x PAL-6 (A)	Similar to L-4590
	L-4590 x PAL-6 (B)	Similar to PAL-6
	VL-507 x L-4602 (A)	Similar to VL-507
	VL-507 x L-4602 (B)	Similar to L-4602
	VL-507 x PSL-9 (A)	Similar to VL-507
	VL-507 x PSL-9 (B)	Similar to PSL-9
	BM-4 x PAL-6 (A)	Similar to BM-4
	BM-4 x PAL-6 (B)	Similar to PAL-6
	L-4590 x L-4078 (A)	Similar to L-4590
	L-4590 x L-4078 (B)	Similar to L-4078
	L-4076 x 330/12 (A)	Similar to L-4076
	L-4076 x 330/12 (B)	Similar to 330/12
	L-4147 x L-4078 (A)	Similar to L-4147
	L-4147 x L-4078 (B)	Similar to L-4078
	JL-3 x PAL-6 (A)	Similar to JL-3
	JL-3 x PAL-6 (B)	Similar to PAL-6
	PL-5 x L-4602 (A)	Similar to PL-5
	PL-5 x L-4602 (B)	Similar to

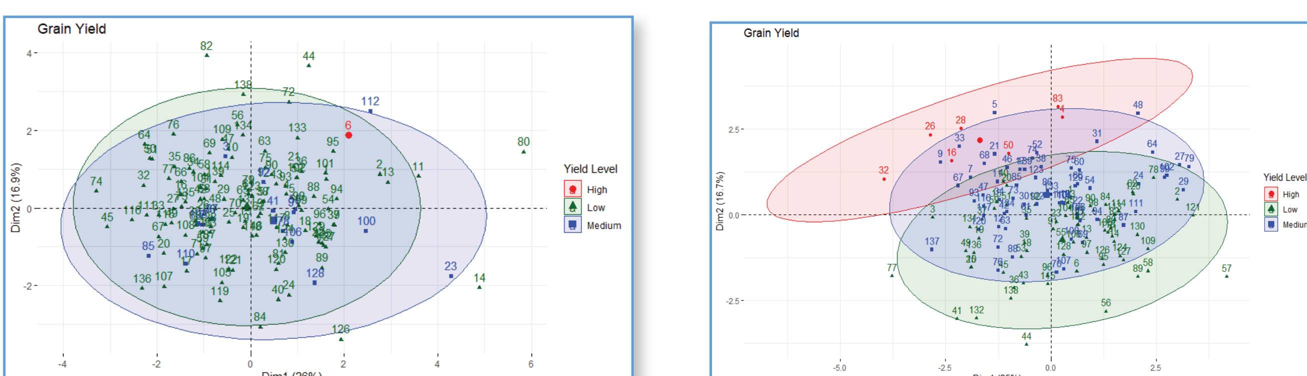
Fig 8. Advance breeding lines of lentils

Genetic variability for agro-morphological and yield traits in mungbean

Phosphorus (P) is an essential macromolecule critical for crop productivity of mungbean and other grain legumes across the world especially under acidic soil conditions. Plants respond to phosphorus scarcity by activating a range of mechanisms exhibiting a remarkable variation in root and other agromorphological traits for higher uptake of phosphorus from soil. The study was designed to characterize such variations in 139 mungbean genotypes under two different soil conditions (Field I: pH-5.13 to 5.79 and available P-12.86 to 61.12 kg/ha; Field II: pH-5.08 to 5.61 and available P-5.51 to 8.29) during *kharif* 2022. Observations were recorded on plant count, days to 50% podding, plant height, no. of clusters per plant, no. of pods per cluster, grain yield, 100 seed weight, root volume, root length and no. of root tips. Analysis of variance revealed significant variation for all the traits under individual as well as across the environment (Table 6). The principal component analysis (PCA) revealed that first two principal components (PC1 and PC2) contributed almost 43% and 42% under red soil and neutral soil, respectively. Inter-trait associations and contribution of traits under studied soil conditions were shown in PCA biplots (Fig 9). Based on grain yield under both the soils, the test genotypes were grouped in three categories *viz.,* high, medium and low yielders. In field I, seven genotypes were found to be high yielder while in field II only one genotype was reported to be high yielding and those could be used in future breeding programme to develop promising mungbean cultivars for the specific soil condition.

Table 6. Analysis of variance for yield and associated traits under low and optimum phosphorus conditions during *kharif* 2022

Traits	Mean sum of square				Mean		CV	
	Genotype		Environment					
	138		1					
	OP	LP	OP	LP	OP	LP	OP	LP
DFF	5.12**	11.50*	0.46	7.26	38.40	73.80	1.77	3.65
PC	56.30**	48.60**	27.00	27.00	21.60	26.30	24.00	19.80
PH	237.00**	83.80**	91.10	38.20	70.80	34.30	13.50	18.00
CLS	3.27	5.90*	2.66	3.61	5.93	5.65	27.50	33.60
PPCL	0.35	0.35	0.29	0.26	3.12	2.78	17.40	18.20
GY	52.80**	32.80	593.00	460.00	52.80	32.30	46.10	66.30



(a) (b)

Fig 9. PCA biplot of mungbean genotypes under (a) low and (b) optimum phosphorus condition

Evaluation of wheat germplasm/variety

The variety HD 3443 has been registered as a new variety under Protection of Plant variety and Farmer's Rights Act (2001) with following characteristics (Table 7a-d). Indeed, the candidate variety HD3443 was genetically uniform and had stable expression for the traits of agronomic importance.

Table 7a. Characteristics of the candidate variety

SN	Characters	Description
1	Flag leaf : Anthocyanin coloration of auricle	Absent
2	Time of ear emergence	Medium
3	Plant length	Medium
4	Awn or scurs: Presence	Awns present
5	Outer glume: Pubescence	Medium
6	Ear : Colour	White
7	Season type	Spring
8	Grain hardness	Soft

Table 7b. Distinguishing characteristics (descriptive or elaborate)

SN	Characteristics	Characteristics of HD 3443
1	Coleoptile : Anthocyanin colouration	Absent
2	Plant : Growth habit	Erect
3	Foliage : Colour	Green
4	Flag leaf : Anthocyanin colouration of auricles	Absent
5	Flag leaf : Hairs on auricle	Absent
6	Plant : Flag leaf attitude	Semi-erect
7	Ear : Time of emergence	Medium
8	Flag leaf : Waxiness of sheath	Strong
9	Flag leaf : Waxiness of blade	Strong
10	Ear : Waxiness	Strong
11	Culm : Waxiness of neck	Weak
12	Flag leaf Length	Short
13	Flag leaf Width	Narrow
14	Plant Length (Height)	Medium
15	Ear : Shape in profile	Parallel sided
16	Ear : Density	Medium
17	Ear : Length	Long
18	Awns or scurs (Presence)	Awns present
19	Scurs	Absent
20	Awns Length	Medium
21	Awn : Colour	White
22	Awn : Attitude	Spreading
23	Outer glume Pubescence	Medium

SN	Characteristics	Characteristics of HD 3443
24	Ear : Colour	White
25	Lower glume : Shaller width	Narrow
26	Lower glume: Shaller shape	Round
27	Lower glume : Beak Length	Very short
28	Lower glume: Beak shape	Straight
29	Peduncle Length	Medium
30	Spike attitude at the time of maturity	Bent
31	Grain: Colouration with phenol	-
32	Grain Colour	White
33	Grain Shape	Oblong
34	Grain Germ width	Wide
35	Brush hair Length	Medium
36	Seed : Size (weight of 1000 grains)	Medium (38-41gm)
37	Season Type	Spring type
38	Grain: Hardness	Soft

Table 7c. Characteristics between candidate denomination and reference variety

Characteristics	Remarks					Characteristics of reference varieties		
	Measured value etc.							
	1	2	3	4	5	HD3443	HD 3086	HD 3226
50% Flowering	5	5	5	5	5	Medium (5)	Medium (5)	Medium late (7)
Foliage colour	5	5	5	5	5	Green (5)	Green (5)	Green (5)
Ear shape	2	2	2	2	2	Parallel sided (2)	Parallel sided (2)	Tapering (1)
Ear waxiness	7	7	7	7	7	Strong (7)	Medium (5)	Medium (5)
Ear length	7	7	7	7	7	Long (7)	Short (3)	Medium (5)
Grain shape	3	3	3	3	3	Oblong (3)	Oblong (3)	Oblong (3)
Brush hair length	5	5	5	5	5	Medium (5)	Medium (5)	Medium (5)
Grain colour	1	1	1	1	1	White (1)	Amber (2)	Amber (2)
Grain hardness	3	3	3	3	3	Soft (3)	Hard (7)	Semi- hard (5)

Table 7d. Statement of distinctness of candidate variety

DUS No.	Claimed distinct characteristics	Candidate variety: HD3443	Reference variety: HD 3086	Reference variety: HD3226
5	Flag leaf: hair on auricles	Absent	Moderate	Present
7	Time of ear emergence (50% flowering)	Medium	Medium	Medium late

DUS No.	Claimed distinct characteristics	Candidate variety: HD3443	Reference variety: HD 3086	Reference variety: HD3226
8	Flag leaf: Waxiness of sheath	Strong	Medium	Strong
9	Flag leaf: Waxiness of blade	Strong	Medium	Strong
10	Ear waxiness	Strong	Medium	Weak to medium
16	Ear Shape	Parallel sided	Parallel sided	Tapering
17	Ear length	Long	Short	Medium long
32	Grain colour	White	Amber	Amber
38	Grain hardness	Soft	Hard	Semi-Hard

Evaluation of maize germplasm/variety

Maize QPM+ provit A. enriched composite variety development

For the development of QPM+provit A. enriched composite variety, a half-diallel cross was made between ten elite QPM+provit. A enriched inbred lines procured from ICAR-IARI, New Delhi (Rabi 2020-21). The 45 F1s were raised during Kharif 2021 and again bulk pollination was made to set the seeds. During Rabi 2021-22, open pollination was used to raise the S1 generation. It was advanced to the next generation through open pollination in isolation during Kharif 2022. The selfed seeds of the selected 120 plants have been sent for evaluation for the presence of CrtB1 gene. The half of the seeds have been kept for further sowing after getting the confirmation of the presence of CrtB1 gene. These plants have to be sown in next season for further evaluation and maintenance under open pollination in isolation.

Evaluation of experimental maize hybrids under acidic soil condition

The 25 inbred lines crossed with three elite inbred lines BML 6, UMI1200 and LM13 in L X T fashion during Rabi 2020-21 were evaluated during *Kharif*-2022 under acidic soil (Table 8). The same hybrids were also evaluated during *Kharif* 2021 under the normal soil condition and result obtained revealed that four cross combinations identified superior over check BIO-9544 (Fig 10). The same hybrids performed better than the standard commercial check during *Kharif* 2021 under soil with normal pH too. The seed of these crosses will be produced in the next generation and will be submitted for evaluation in the AICRP trial.

Table 8. Evaluation of maize hybrids

Crosses	ASI	DTM	GY (q/ha)		Crosses	ASI	DTM	GY (q/ha)
Z1×BML6	3	86	49.54132		Z13×LM13	4	88	46.96744
Z1×UMI1200	3	78	48.33004		Z14×BML6	4	83	67.15688
Z1×LM13	4	79	56.61601		Z14×UMI1200	3	82	64.13105
Z2×BML6	4	83	43.34803		Z14×LM13	4	81	71.83531
Z2×UMI1200	5	79	45.97928		Z15×BML6	3	86	41.676
Z2×LM13	4	82	40.7182		Z15×UMI1200	4	84	56.44995
Z3×BML6	3	85	60.1929		Z15×LM13	3	83	46.51177

Crosses	ASI	DTM	GY (q/ha)		Crosses	ASI	DTM	GY (q/ha)
Z3×UMI1200	3	81	50.19171		Z16×BML6	4	84	55.32776
Z3×LM13	5	82	48.24345		Z16×UMI1200	4	87	43.08024
Z4×BML6	4	81	40.98981		Z16×LM13	3	83	43.02463
Z4×UMI1200	4	79	50.06644		Z17×BML6	4	84	59.13222
Z4×LM13	4	89	44.0254		Z17×UMI1200	4	81	38.31128
Z5×BML6	3	85	52.00858		Z17×LM13	4	86	41.95988
Z5×UMI1200	4	81	58.2594		Z18×BML6	3	87	43.8175
Z5×LM13	4	83	55.36375		Z18×UMI1200	4	82	41.06047
Z6×BML6	3	86	67.10208		Z18×LM13	3	83	47.2413
Z6×UMI1200	3	84	65.6192		Z19×BML6	3	88	47.76654
Z6×LM13	3	85	72.59156		Z19×UMI1200	3	80	40.0055
Z7×BML6	4	86	58.57509		Z19×LM13	4	81	51.19773
Z7×UMI1200	3	77	42.618		Z20×BML6	4	85	46.12869
Z7×LM13	3	82	47.96494		Z20×UMI1200	4	78	47.11602
Z8×BML6	4	88	41.79141		Z20×LM13	3	83	55.51313
Z8×UMI1200	4	85	40.64771		Z21×BML6	4	86	68.904
Z8×LM13	4	79	38.85688		Z21×UMI1200	3	83	64.41641
Z9×BML6	3	85	49.385		Z21×LM13	3	83	75.14573
Z9×UMI1200	3	82	51.56452		Z22×BML6	4	83	57.16805
Z9×LM13	3	86	57.58278		Z22×UMI1200	3	89	38.58725
Z10×BML6	3	82	55.82922		Z22×LM13	3	85	49.8821
Z10×UMI1200	4	84	53.31588		Z23×BML6	3	83	43.14422
Z10×LM13	4	83	51.01525		Z23×UMI1200	4	83	56.59771
Z11×BML6	3	85	56.44628		Z23×LM13	3	83	42.41995
Z11×UMI1200	5	83	53.99167		Z24×BML6	3	85	52.90938
Z11×LM13	4	84	52.85591		Z24×UMI1200	4	85	41.3586
Z12×BML6	4	85	53.39219		Z24×LM13	3	86	55.52104
Z12×UMI1200	3	81	49.26094		Z25×BML6	4	84	55.70848
Z12×LM13	5	84	51.18344		Z25×UMI1200	3	87	38.09115
Z13×BML6	4	82	64.458		Z25×LM13	3	76	55.17539
Z13×UMI1200	4	80	49.96896		Check (BIO 9544)	3	85	68.1

	ASI	DM	GY
SD	0.594714	2.746353	9.034512
Mean	3.578947	83.36842	51.68989
CV (5%)	16.617	3.294237	17.47829

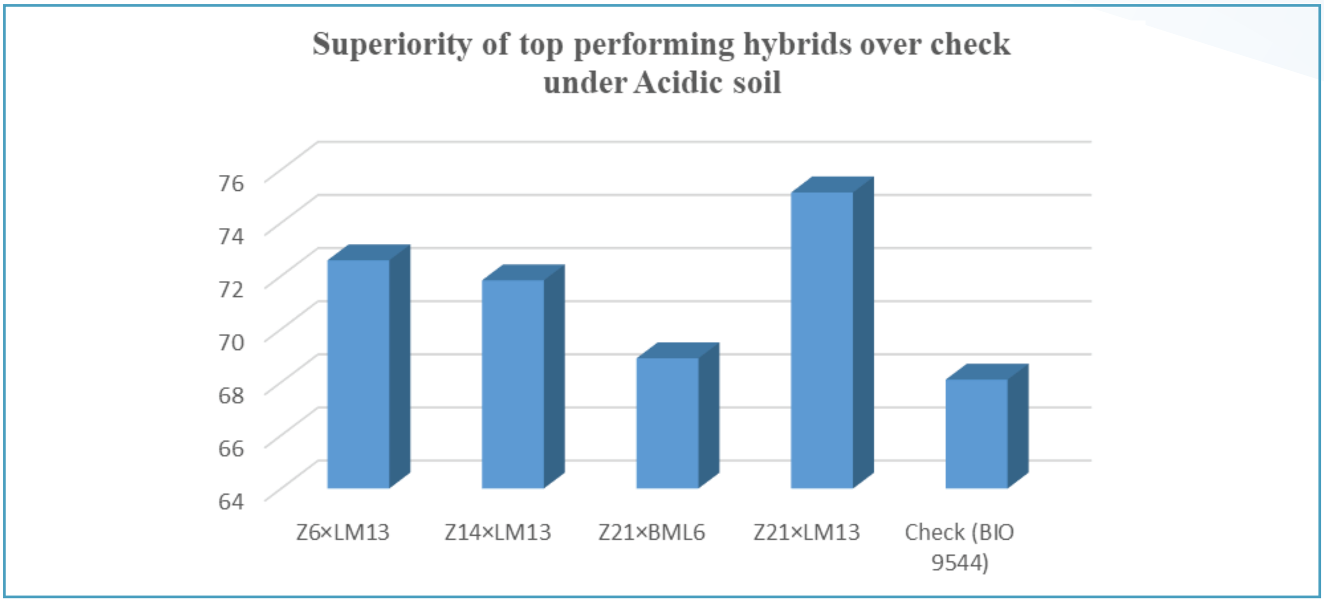


Fig 10. Superiority of top performing hybrids over check under acidic soil

Combining ability study of the 25 inbred lines with three testers BML 6, UMI 1200 and LM 13 was also conducted. The resulting 75 crosses along with 28 parents and check (BIO 9544) were evaluated during kharif 2022 in randomized block design in two replications. ANOVA for combining ability revealed significant mean squares for GCA and SCA for all the traits studied which indicated the presence of both additive and non-additive gene action in the inheritance of these traits. The parent Z21 followed by Z6 and Z14 were identified as best combiner for grain yield. Out of the 25 lines, nine showed the positive significant GCA for grain yield which could be utilized for development of medium maturity hybrid varieties. The crosses having grain yield higher than standard commercial check also showed positive significant SCA for the crosses Z21×LM 13, Z14×LM 13 and Z6×LM 13. These promising cross combinations identified in this study could be utilized for future breeding work as well as for release after confirming the stability of their performances observed in the current study.

Multi-location testing of maize hybrids in Jharkhand

Nine experimental maize hybrids (normal as well as QPM) performing superior to the check during Kharif 2021 at ICAR-IARI, Jharkhand were evaluated for their yield performance under state trial at five locations in Jharkhand *i.e.* Hazaribag, Ranchi, Dumka, East Singhbhum and Palamu during Kharif 2022. These hybrids were earlier tested up to the advance stage of AICRP trials. The data obtained from the Ranchi and Hazaribag were statistically analysed (Table 9). The data from other three locations are expected to be obtained shortly. These will be again evaluated during Kharif 2023 for their yield performance and other traits. The proposal for the state release of hybrids performing better under Jharkhand state will be submitted after the second year of evaluation.

Table 9. Evaluation of maize hybrids under Jharkhand state trials

Hybrid	GY (q/ha) (Ranchi)	GY (q/ha) (Hazaribag)	Mean yield
IMH 1527	47.9	52.4	50.15
DMRH 1410	58.9	72.5	65.7
DMRH 1419	58.3	70.35	64.325

Hybrid	GY (q/ha) (Ranchi)	GY (q/ha) (Hazaribag)	Mean yield
LQMH 1	39.5	59.74	49.62
IQPMH 2001	63.5	69.84	66.67
IQPMH 18-2	-	63.45	63.45
IQPMH 2111	66.6	69.38	67.99
IMH 101	53.1	60.74	56.92
DMRH 1417	64.5	73.72	69.11
HQPM 5 (Check)	56.5	58.63	57.565
DHM 121 (Check)	60.5	63.48	61.99
Mean	57.43636364	64.93	61.18318
SD	8.005532178	6.732993391	6.783147
CV (%)	13.93809021	10.36961865	11.08662

Development of new maize Inbred lines

In order to develop new inbred lines, the selection was made from the F_2 materials generated (Rabi 2021-22) from selfing of the materials received from the NBPGR, New Delhi, private sector hybrids and few locally collected landraces. These materials were selfed again to advance it to F_3 generation (Kharif 2022) and the F_4 generation obtained through selfing from the previous generation will be raised during spring 2023 for generation advancement and again selfing among the almost fixed elite genotypes.

Evaluation of maize hybrids under Jharkhand condition

The bio-fortified maize genotypes (621) including the hybrids for normal as well as the speciality corn sent by ICAR-IARI, New Delhi were evaluated for their yield performance under Jharkhand condition. Similarly, the biofortified maize hybrids (31) developed by ICAR-IIMR, Ludhiana was tested under Jharkhand condition for their yield performances.

Procurement and screening of maize inbred lines

An indent was placed for the 200 inbred lines having drought tolerance and drought+heat tolerance to ICAR-IIMR, Hyderabad. A total of 93 elite maize inbred lines were received from the ICAR-IIMR, Ludhiana and 101 maize inbred lines with different abiotic stress tolerance traits were also received from the CIMMYT India, Hyderabad. All these lines were sown for multiplication.

The 58 inbred lines received earlier from SKUAST, Kashmir; ICAR-IIMR, Ludhiana and CIMMYT India, Hyderabad were maintained and evaluated under the soil condition of normal and low pH (Table 10). The data were analyzed, and as per the scoring of performance of the lines, out of 58 lines, 11 lines were found to be performing well in soil with a low pH and 28 lines were also performed well with moderate effect of soil acidity. These lines have to be evaluated again for their performance in field as well as hydroponic conditions to confirm the result, and the biochemical analysis has to be done. These lines were also sown in normal soil conditions with a normal pH at ICAR-IARI, Regional station, Pusa, Samastipur.

Table 10. Evaluation of maize inbred lines under acidic soil condition

Lines	GY (N)	GY (A)	ASI (N)	ASI (A)	Lines	GY (N)	GY (A)	ASI (N)	ASI (A)
Z1	17.97	11.93	2	4	C5	20.23	13.82	3	4
Z2	18.79	13.28	3	5	C7	18.37	14.76	2	4
Z3	18.03	10.66	2	4	C8	19.21	14.70	2	4
Z4	20.61	13.49	2	5	C10	20.57	14.55	2	3
Z5	19.04	14.62	2	4	C11	22.86	13.52	2	4
Z6	21.87	15.31	2	3	C12	23.93	16.01	3	4
Z7	18.66	12.01	2	4	C13	20.88	10.03	2	3
Z8	20.22	13.95	2	4	C15	18.93	13.96	2	3
Z9	19.46	13.51	2	5	C16	19.91	12.95	2	3
Z10	19.26	13.68	2	4	C17	18.38	14.76	2	4
Z11	23.19	13.56	2	4	C22	23.02	14.80	2	3
Z12	17.51	11.42	2	4	C26	21.21	13.42	2	4
Z13	19.26	12.17	2	4	C28	21.26	14.07	3	3
Z14	22.10	16.72	2	3	C29	20.07	13.97	2	4
Z15	16.37	11.12	2	5	C31	21.21	11.99	2	3
Z16	16.57	11.77	2	4	C32	18.77	13.87	2	3
Z17	18.07	11.43	2	4	C33	20.64	15.51	2	3
Z18	16.35	10.55	2	5	C34	21.58	13.76	2	3
Z19	16.99	10.95	3	4	C36	20.40	15.84	2	3
Z20	18.44	12.38	2	4	C38	18.86	13.65	2	3
Z21	22.59	16.78	3	3	C39	20.04	14.66	2	4
Z22	21.47	12.84	2	4	PML9	23.31	15.96	2	3
Z23	18.74	11.35	2	4	DQL2070	20.17	13.55	2	4
Z24	17.32	10.10	2	4	PML5	23.83	15.46	2	4
Z25	18.84	10.81	2	5	CML451	21.48	13.29	2	4
BML6	19.94	17.06	2	4	IML 194	19.89	15.11	2	3
UMI1200	19.76	12.90	2	3	DQL2029-1	19.79	14.08	2	3
LM13	21.88	16.04	2	4	UMI1210	21.01	13.50	2	5
C1	19.08	13.03	2	3	LM14	21.29	18.36	2	4

ASI: Anthesis silking interval; GY: Grain yield (q/ha); N: Soil with neutral pH; A: Soil with low pH (5.5)

AICRP maize trial

ICAR-IARI, Jharkhand as the voluntary center of AICRP-Maize successfully conducted four AVT trials during Kharif-2022. Data recorded from the trials were submitted to the nodal institute (ICAR-IIMR, Ludhiana) of AICRP-Maize. The data generated under the trails have been appreciated and data have been included in AICRP maize Kharif report-2022.

Evaluation of mustard genotypes

Station trial of mustard crop

Exploratory trial on mustard is going on at ICAR-IARI, Jharkhand. Mustard station trials of 41 elite lines along with four checks were conducted during Rabi 2021-22. The data were recorded for the traits- days to 50% flowering, days to 50% maturity, plant height, number of primary branches, number of secondary branches, number of siliqua, siliqua length and grain yield. In terms of mean yield, five lines showed superiority over the best check. Nine F_2 materials were planted during rabi 2021-22 and selections were made from them and the seeds were harvested from the selected lines for generation advancement. Along with the station trial, 10 local materials collected from Jharkhand and west Bengal during 2021 were also evaluated. The F_2 generations from the crosses made between some good performing lines during 2020-21 were also evaluated and selections were made among them and seeds from the selected plants were harvested for generation advancement.

During rabi 2022-23, 89 elite advanced lines along with 45 elite lines (evaluated during 2021-22) along with four checks were sown. Along with the station trial, 10 local materials collected from Jharkhand and West Bengal during 2021, F_2& F_3 generations, respectively from the crosses made between some good performing lines during 2020-21 and 2021-22 were also sown for evaluation in second year and selections will be made among segregating generation materials.

Evaluation of papaya genotypes

The progeny raised from JHP-4, JHP-5, JHP-6 and 14 other materials collected from the different locations of Jharkhand during 2021 were planted in a marginal plot in nursery area (Table 11; Fig 11). Based on the yield potential, lines JHP-4, JHP-5, JHP-6 were selected among all. Initial growth of plants was recorded which depicted considerable variability. The data on the strength of the plants were recorded 25 days after transplanting and it varied from small and poor stem strength to taller and firm and good strength of the plants. During flowering stage, it was observed that all the strengthened plants recorded earlier were male plants. While the poor and medium strengthened plants were female or hermaphrodite type. The data on the days to 50% flowering were recorded and it ranged between 82 days to 113 days after transplanting. The crop was in fruiting stage and data on yield and other parameters were also recorded during fruit maturity stage.

Table 11. Evaluation of papaya lines/genotypes

Land races	Fruit weight/plant (kg)	Fruit weight (kg)	TSS	Flower type
JHP 1	0	0	0	Androecoius
JHP 2	16.57	2.08	14.5	Hermaphrodite
JHP 3	12.83	1.68	14.5	Gynoecious
JHP 4	40.59	2.25	16	Hermaphrodite
JHP 5	32.758	1.95	15.5	Gynoecious
JHP 6	19.38	2.05	16	Gynoecious
JHP 7	0	0	0	Androecoius
JHP 8	16.86	1.84	14	Hermaphrodite
JHP 9	0	0	0	Androecoius
JHP 10	9.21	1.4	13.5	Gynoecious

Land races	Fruit weight/plant (kg)	Fruit weight (kg)	TSS	Flower type
JHP 11	0	0	0	Androecoius
JHP 12	0	0	0	Androecoius

Fig 11. Papaya lines/genotypes in fruiting stage

Evaluation of heterosis and combining abilities in Tomato

Considering the potential of the tomato crop in eastern India and biotic stresses imposed, a line x tester mating design was planned with 8 parents (3 Lines and 5 Testers) and crosses were made during 2021. A total of 15 F1 hybrids and their 8 parents were evaluated for their combining abilities and heterosis for a total of 17 quantitative measurements including six fruit quality traits. Analysis of data for all the parameters pertinent to yield attributing traits and quality characteristics showed significant values for heterosis and combining ability. Significant mean sums of squares resulting from fruit yield and yield-attributing characteristics showed that the material examined for the improvement of various traits indicated a significant amount of variability. Combining ability showed that non-additive gene effects were predominant for the majority of the characters. Out of 15 cross combinations, 8 crosses showed a substantial increase in total yield per plant compared to the superior parent. All the parents were good general combiner for most of the characters. Female parent Pusa Ruby and DT1504, male parent DT911 and DT804 were shown to be a good general combiner for the majority of the investigated traits in a favourable direction. Hybrids DT1504 x DT806 possessed the desired (Fig 12), highly significant SCA effect for yield and important quality traits. The hybrid DT1504 X DT806 showed the most significant positive heterosis over the superior parent in terms of plant height (13.77%), number of flowers per cluster (49.73%), number of fruits per cluster (33.72%), and fruit output per plant (25.12%). Hybrid Pusa Ruby x DT804 was identified as an effective particular combiner for plant height, flowering and fruiting rates, average fruit weight, plant yield, pericarp thickness, TSS, and lycopene content. Hybrid Pusa Ruby X DT804 showed the highest heterosis improvement (28.89%) for fruit production per plant (68.38%), fruit per cluster (76.88%), number of fruits per cluster (88.98%), number of flowers per cluster (78.95%). Significant heterosis was seen in the desired direction for the parameters of days to 50% blooming (-2.65%), fruit yield per plant (24.90%), number of fruits per cluster (89.88%), and lycopene concentration in the hybrid Pusa Ruby X DT802 compared to the superior parent (12.16%). Based on the percent disease index for tomato leaf curl virus disease, one tomato genotype (DT1504 X DT911) displayed high resistance to the disease, nine genotypes being resistant while one genotype displayed high susceptibility. For bacterial wilt disease, one genotype exhibited high resistance to the disease, followed by six genotypes that were resistant, while two genotypes were recorded as susceptible one.

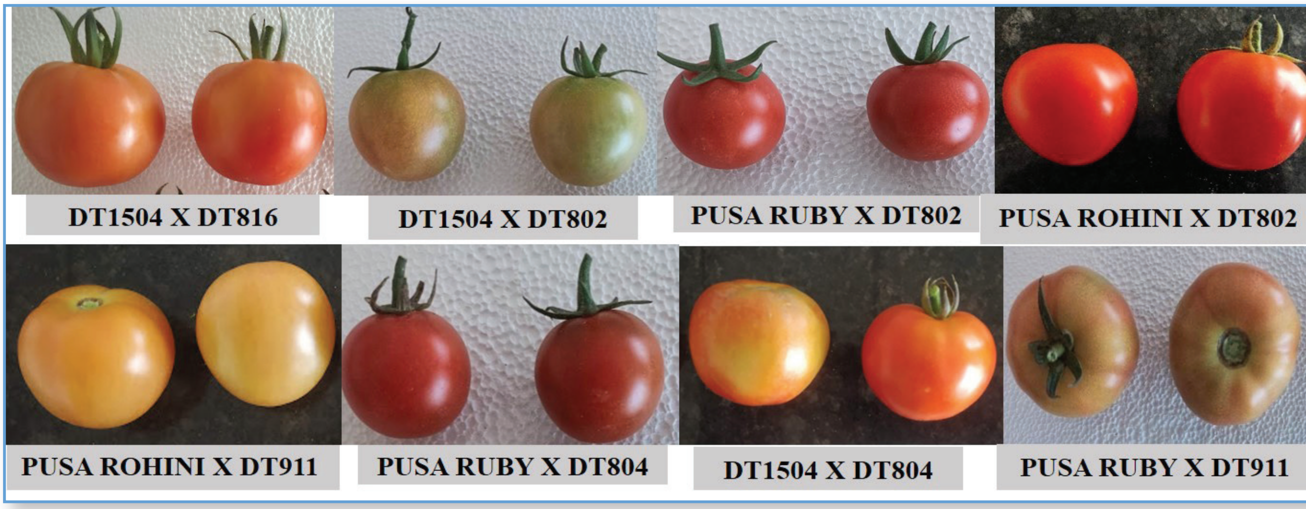


Fig 12. Best performing tomato hybrids

Evaluation of brinjal genotypes

A set of 35 selected genotypes of brinjal were evaluated for yield-attributing traits and disease resistance under natural epiphytotic conditions at the institute. The field data were recorded for 20 quantitative and qualitative traits and the analysis revealed a distinct variation in the observable characters among the genotypes (Fig 13). Day of transplanting to first flowering ranged from 29 to 52 days, number of fruits per plant ranged from 4.6 to 17.4 with an average of 12.8 fruits per plant. Bacterial wilt disease incidence (PDI, Percent Disease Index) ranged from 0 to 40 percent, indicating some genotypes as highly resistant (4) and some as highly susceptible (1) genotypes. Based on 15 quantitative traits data all the 35 genotypes grouped together into 4 major clusters and further into sub-clusters (Fig 14).

Fig 13. Variable genotypes of brinjal

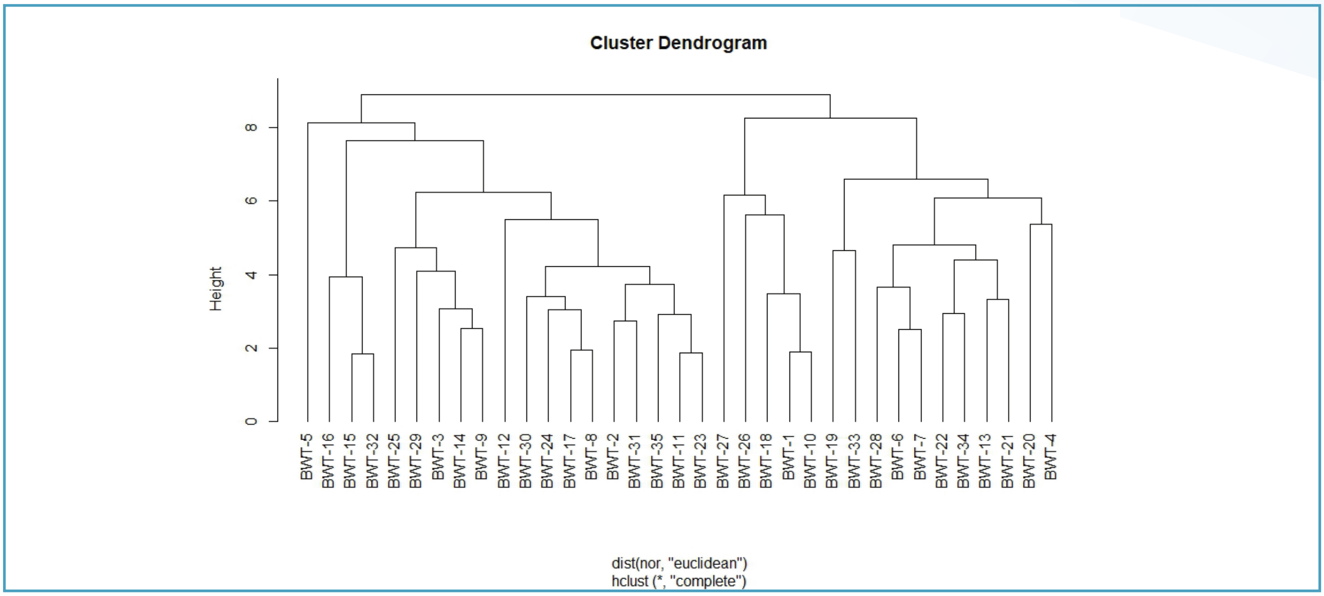


Fig 14. Clustering of 35 genotypes of brinjal based on morphological observations

Genetic improvement of parwal

A farmer survey was conducted and status report was prepared regarding the gene pool availability of pointed gourd in cultivated areas as well as research institutions for promising traits. It was concluded that the availability of quality planting material was the major limitation among the growers, early as well as late maturing variety was a demanding trait for the growers and enhanced keeping quality of the fruits was a desirable quality trait for the farmers. A total of eighteen pointed gourd germplasm were procured and collected from the farmer's fields and research institutions being maintained at the institute farm (Fig 15). Plant growth-related traits and floristic characteristics were studied. On the basis of preliminary evaluation, two genotypes were identified as having promising traits which could be used as a parent of generating variability and hybrid crosses. These genotypes were further evaluated for better results.

Fig 15. Representative sample of parwal fruits of different genotypes

2. Natural resources management and crop production

GIS based soil physico-chemical map of research farm

Soil samples (> 200) were collected from the selected area of agricultural research farm of ICAR-IARI, Jharkhand. Sampling of the surface soil (0-15cm) was done using GPS after harvesting of *kharif* crops and from uncultivated soils. The coordinates of the sample points were taken using GPS. A total of 51 representative soil samples were retained on grid basis for soil analysis. Each collected soil samples was assigned a unique ID. Soil samples so processed were analyzed for pH, EC, bulk density, total C, total N, organic carbon, available N, P, K, soil texture using standard methods of analysis at ICAR-IARI, New Delhi. The research farm of the institute was divided into multiple blocks where selected crops were grown according to the area under the project or according to the experimental material. Names of some of the blocks were A, B, C block, demonstration block and student trial block. Information on different blocks was obtained from Farm Incharge and Co-PI of the projects and did the repeated traversing of the farm at different times of the year. The map was drawn in ArcGIS (Fig 16) after digitizing the farm map using the create shape file for line and polygon in the editor tool.

Fig 16. Proposed map of different blocks of ICAR-IARI, Jharkhand

From the results (Table 12), it was found that majority of the selected study area had higher bulk density, low pH and EC, low organic carbon, low available nitrogen, phosphorus, potassium, sulphur and low total carbon and nitrogen. Soil texture varied from sandy loam, silty loam, loam to sandy clay loam. Therefore, it was concluded that the majority of the farm area under the study was poor in soil fertility. Soil properties were tabulated with sample number in Microsoft excel in .csv format and imported into the google earth engine and GIS software to show the sample points (Fig 17) on the working sheet for further data analysis.

Table 12. Physico-chemical properties of soils

Soil properties	Range
pH	4.52-7.43
EC (ds/m)	0.11-0.54
OC (%)	0.12-0.77%

Soil properties	Range
Available N (kg/ha)	84-398
Available P (kg/ha)	2.81-23.81
Available K (kg/ha)	52-243
Total C (%)	0.18-1.22
Total N (%)	0.047-0.13
Sand (%)	18.8-60.2
Silt (%)	37-56
Clay (%)	1.6-21.6

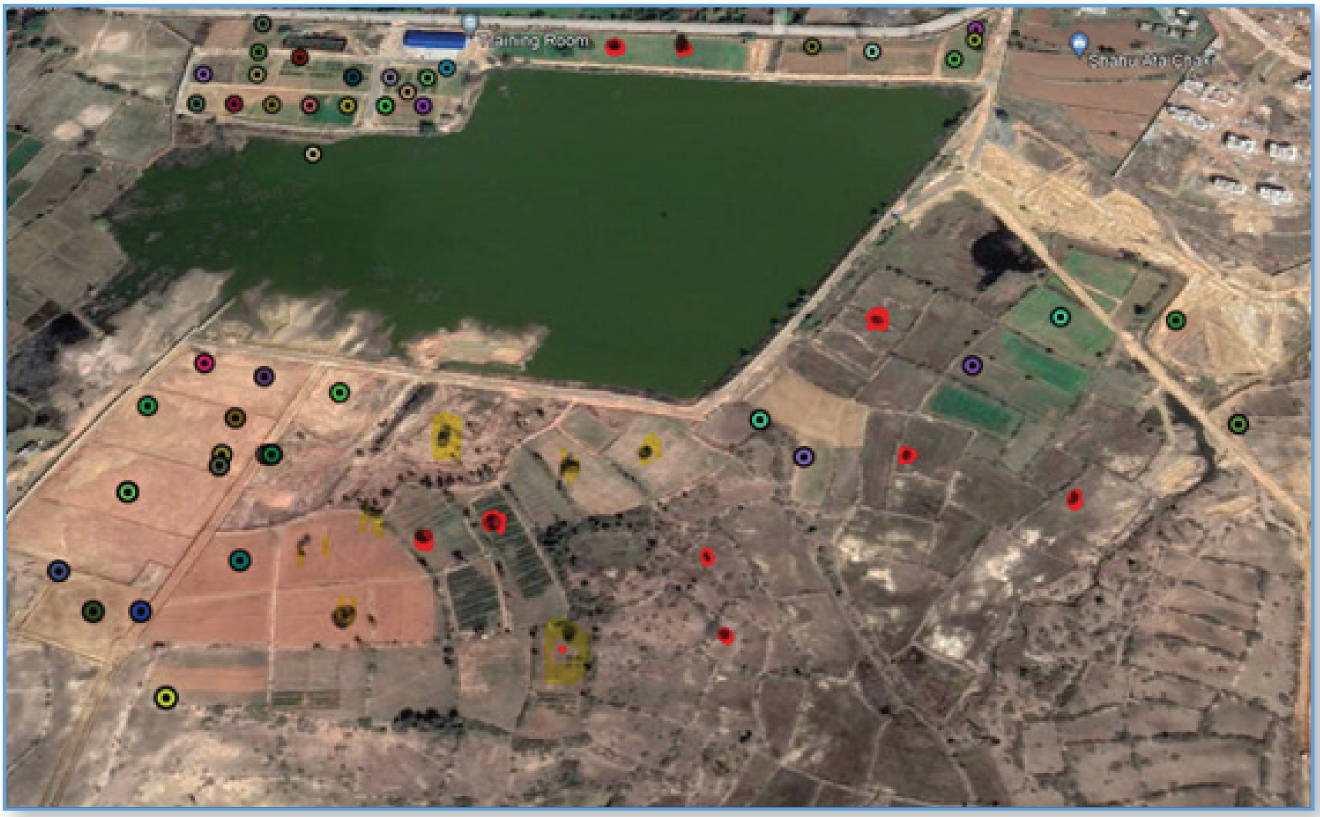


Fig 17. Sample points in google earth images

In this study, the random forest regression algorithm was used for classification. In the random forest regression algorithm, soil parameters were predicted for each 10x10 m grid using satellite derived images as proxy of soil forming factors (terrain, climate, and vegetation). ALOS PALSAR DEM (12.5 m) and its derivatives such as elevation, slope, valley depth, distance to channel network, multi resolution valley bottom flatness, slope length factor, etc were used as terrain predictors. Sentinel 2A images (10 m) with 11 bands and vegetation indices derived from them were used as vegetation predictors. Since the area was small, climate data were not used and it was assumed that climate for the entire study area was same. The random forest model was developed using 'random Forest' package (**Fig 18**). For training the model, a total of 51 samples were collected randomly in the study area and analyzed for soil properties. For each property separate models were created. Ten folds cross validation was used to check the accuracy of the model. For organic carbon, the r-squared was 0.88 and Lin's concordance correlation coefficient was 0.92.

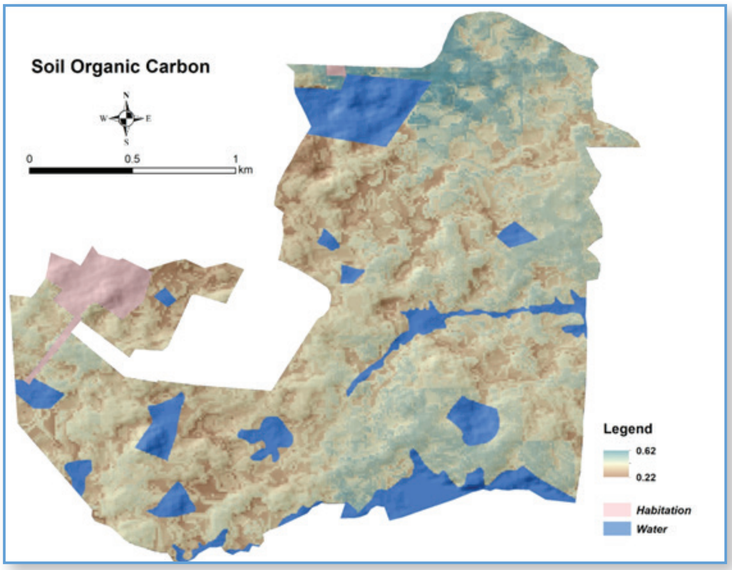


Fig 18. Spatial distribution of soil organic carbon as identified by random forest technique for whole research farm

Providing better soil fertility map, based on spatial-temporal sampling, was expected to improve the soil management outcome and assumed the detection of the spread patterns of different nutrients and soil characteristics (Fig 19). It was believed that integrated approaches that combine geospatial monitoring tools with robust forest model regressions and would be of great benefit for managing soil fertility. It was understood from the study that random forest model, developed using mentioned bands and indices in combination, was able to provide acceptable level of accuracy. Also, it would help in studying long term effects of different crop management practices on soil properties.

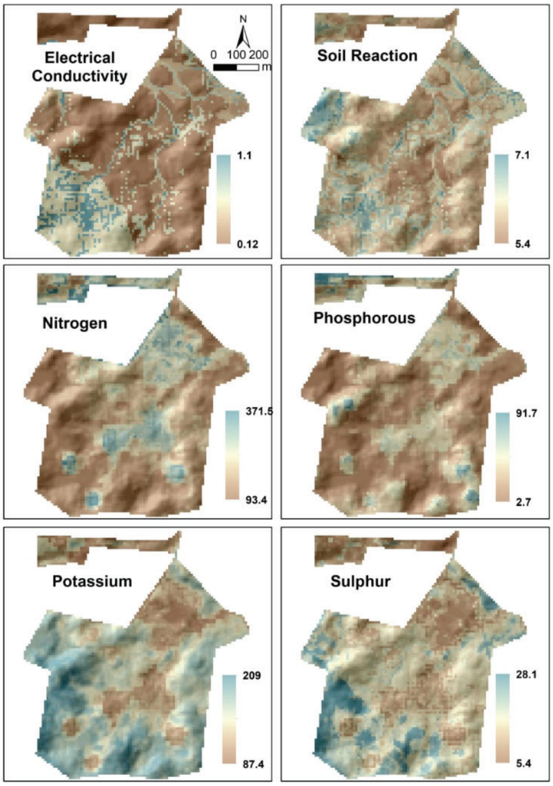


Fig 19. Spatial distribution of EC, pH, Available N, P, K and S identified by random forest technique

Mapping of natural resources

A shape file for delineating IARI-Jharkhand (IARIJ) farm boundary was developed using QGIS and its administrative boundary for the preparation land resource map. The google earth maps of IARIJ for the year 2019 and 2022 were developed. The map of IARIJ with administrative plot/khasara numbers, water ponds and channels and various blocks was developed (Fig 20a-c). The soil profile study of Block A, B and E has been started. The width of each horizon was recorded and soil samples were collected. A preliminary survey was done in Block F1 to identify existing tree and shrub diversity and demarcation of land for Arboretum (Fig 21).

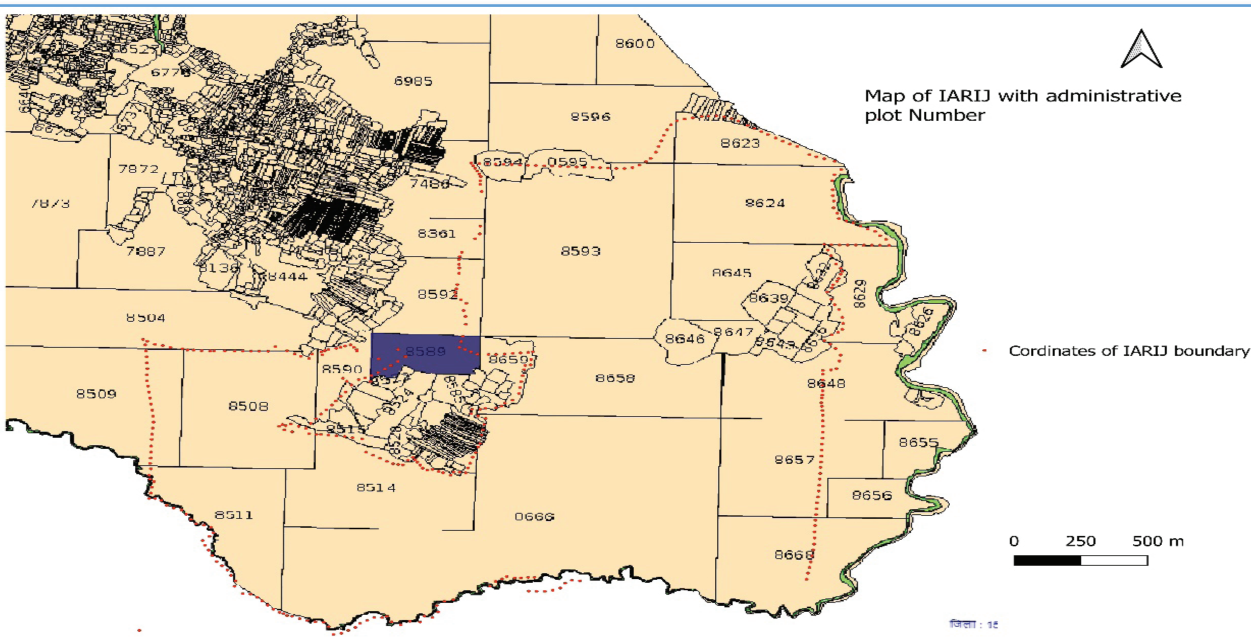


Fig 20a. Map of IARIJ with administrative plot numbers

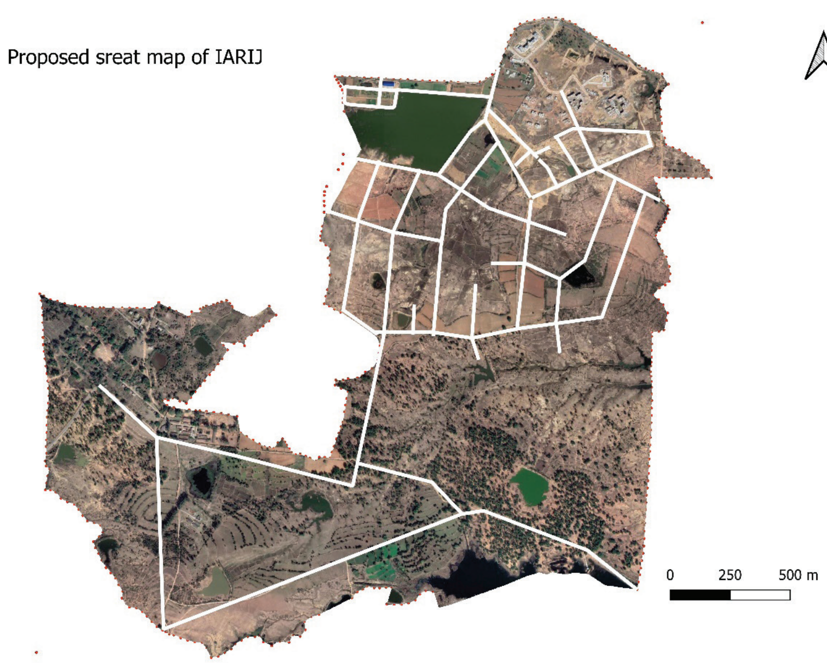


Fig 20b. Proposed sreat Map of IARIJ

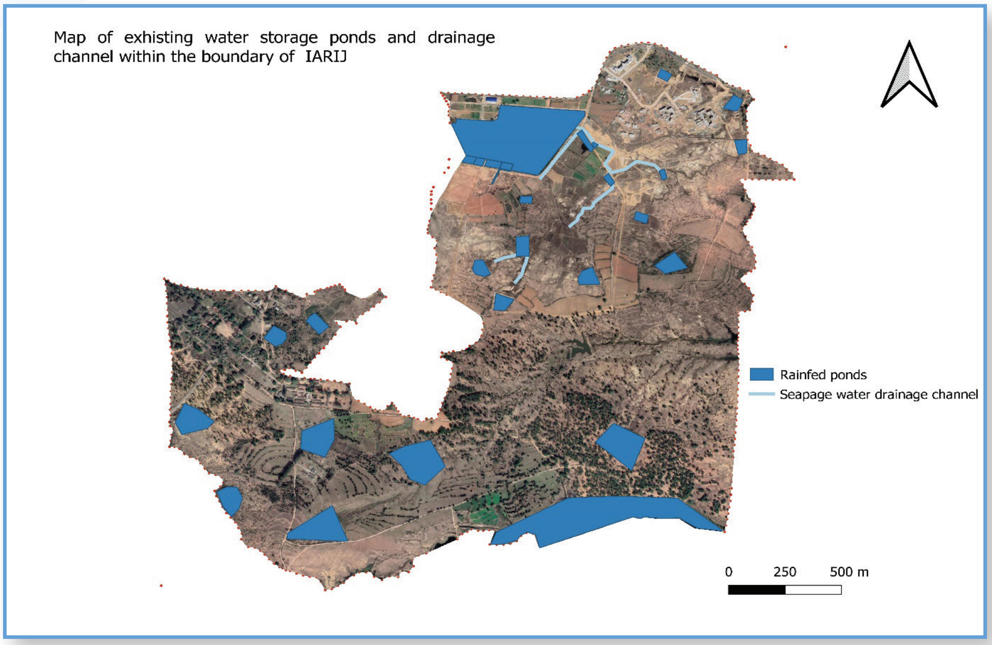


Fig 20c. Map of IARIJ with existing water bodies

Fig 21. Identification and shaping of tree and shrub diversity

About 2.3 hectares of land for conducting natural farming experiment was also demarcated in Block B as Natural Farming Block. The layout and measurement of the plots were completed. The evaluation of varietal performance of wheat, chickpea and mustard under natural farming practices has been started. Beejamrit, Ghanjeevamrit and Jeevamarit were prepared for their application in *rabi* crops (Fig 22).

Fig 22. Prepared Jeevamrit

Productivity of rice-wheat system under biochar amended soil

The second year experiment on biochar was conducted during 2021-22 to evaluate the impact of rice straw derived biochar on productivity of rice-wheat system in acidic soil. Similar to first year of experiment (2020-21), for both rice and wheat crops, the highest grain yield was obtained under biochar amended soil followed by treatments with recommended dose of fertilizer and farmer's practices. The obtained highest wheat (PBW 154) yield was about 2572±20 kg/ha under treatment with biochar@10 t/ha + recommended dose of NPK, while under treatment with recommended dose of NPK without biochar, the yield was 1512±22 kg/ha. Under rice season, the yield of rice crop (Arize 6444 Gold) was evaluated under various water regime condition *i.e.* continuously flooded rice (CFR), intermittent wetting and drying (IWD) and rain fed condition (RF). Rice yield was found slightly higher (3950-5800 kg/ha) under biochar amended soil as compared to recommended practices (3200-4700 kg/ha) under all the three water regime conditions. Among water regime conditions, highest rice yield was obtained under flooded treatment followed by IWD (intermittent wetting and drying) and rainfed treatments.

Fig 23. Biochar applied wheat field

Development of IFC model (1.5 ha)

An integrated farming system model for one-hectare area was planned. The model includes aquaculture (1800 m^2); animal, mushroom and apiculture component (1000 m^2), fruit trees (1200 m^2); vegetable (1000 m^2), upland crops (1500 m^2), medium land crops area (3500 m^2); Spices (500 m^2) and low land crops area (4500 m^2). The master plan and lay out of model has been developed and land development is under process. Water body has been developed and shade for ducks, poultry, small ruminant and lavage animals are under process from available resources. Fruit plants have been planted and vegetable and crops are being planted.

Rhizobacterial inoculant and lime application for chickpea production

Climate change prediction indicated an increased likelihood of precipitation variability and droughts. Drought stress is most important yield limiting factor for crops in eastern India. Chickpea is the most important pulse crop of India occupying an area of 46% of total pulses area. It is comparatively a hardy crop but water deficit has significant consequences on the growth, development and yield of chickpea. Previous studies demonstrated that microbial symbionts combined with supplementary irrigation along with lime application could mitigate climate change effects and boost chickpea production in low-fertile acidic soils. Therefore, the aim of this study was to investigate influence of seed inoculation in chickpea with selected promising osmotolerant rhizospheric bacterial cultures (MKS 6, MRD 17 and NRSSS-1) on biochemical parameters, growth and yield attributes of chickpea grown in acidic soil (pH 5.7). This was evaluated in combination with or without lime application and the treatment details (Fig 24) were; T_1: Uninoculated- lime (C_0L_0); T_2: Uninoculated + lime (C_0L); T_3: MKS 6- lime (C_1L_0); T_4: MKS 6 + lime (C_1L); T_5: MRD 17- lime (C_2L_0); T_6 : MRD 17+ lime(LC_2); T_7: NRSSS-1- lime (L_0C_3); T_8 : NRSSS-1+ lime (LC_3).

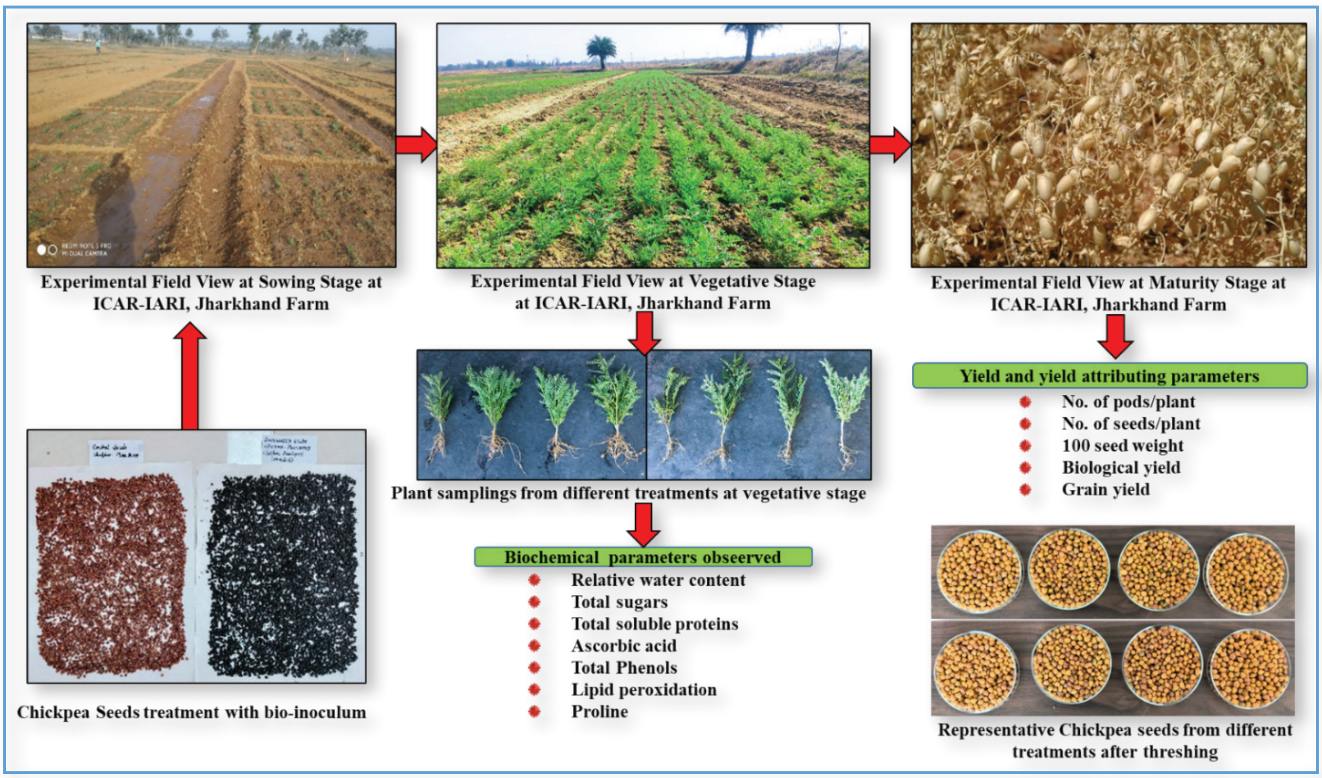
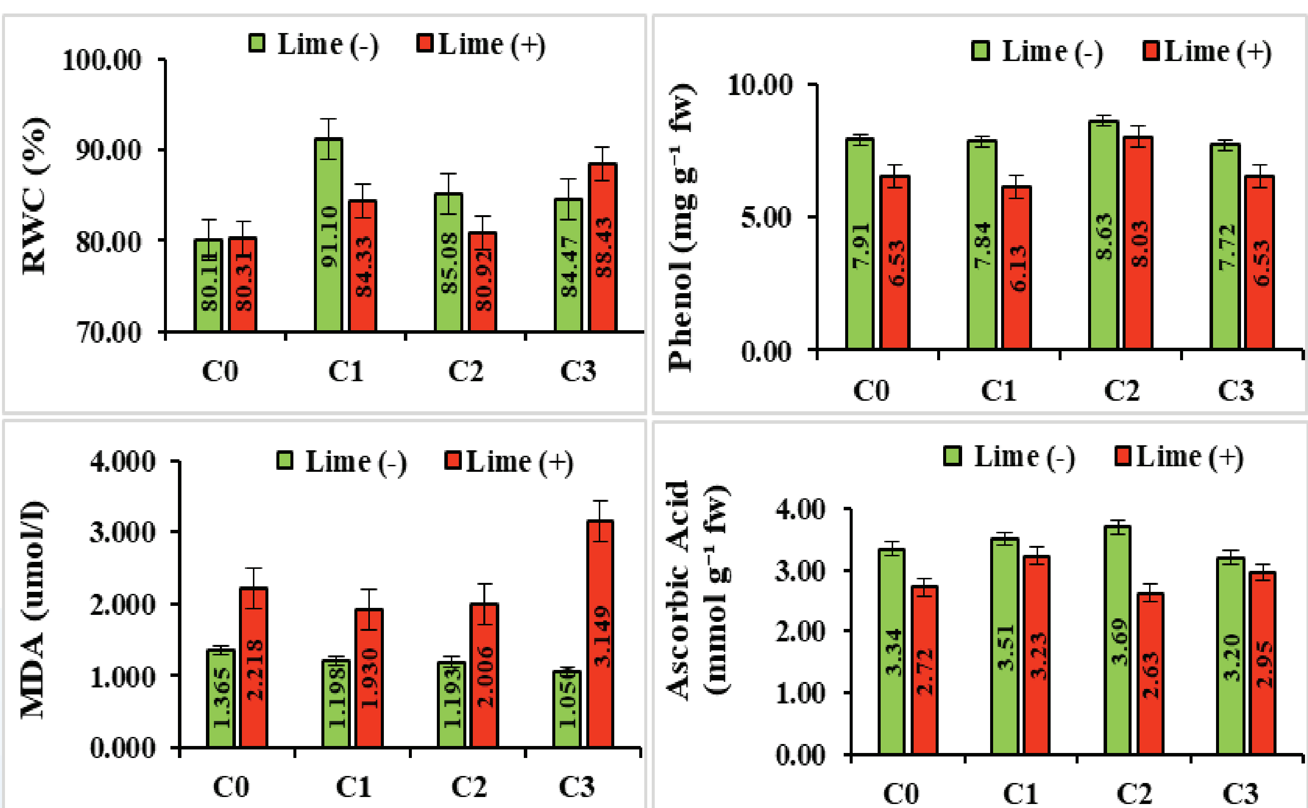


Fig 24. Flow chart of the experiment

Study indicated the influence of bio-inoculum and lime application on plant total soluble proteins, total sugars, total phenolics, lipid peroxidation, proline, ascorbic acid and relative water content as well as plant growth and yield attributes. Among biochemical parameters, relative water content (RWC) amongst different inoculated treatments recorded within the range of 80.11-91.10%. Highest RWC was observed in T_3; MKS 6- lime (C_1L_0) and lowest in treatment T_1: Uninoculated- lime (C_0L_0). On the other hand, phenol content amongst different inoculated treatments varied from 6.13-8.63mg g^{1} fw. Highest phenol content was found in T_5: MRD 17- lime (C_2L_0) and lowest in T_4: MKS 6 + lime (C_1L). MDA content increased with lime application in the presence of inoculum and ranged from 1.050 to 3.149 umol/l. In contrast, ascorbic acid content, total sugars and total soluble proteins decreased with lime application along with bio-inoculum and recorded in the range of 2.63-3.69 mmol/g frwt, 16.29-31.29 mg g^{-1} fw and 0.662-0.947 mg g^{-1} fw, respectively. Level of proline in different treatments showed variable response in the range of 1.11- 1.95 mg g^{-1} fw (Fig 25). However, bacterial culture inoculation with lime application showed significant effect on plant growth and yield attributes in chickpea. Number of pods $plant^{-1}$ and number of seeds pod^{-1} amongst treatments varied from 47.67 to 80.38 and 1.40 to 1.93, respectively, with highest values depicted by treatment, T_4 [MKS 6 + lime (C_1L)] with 68.62% and 20.63% increase over un-inoculated treatment, respectively. Similarly in case of yield parameters amongst inoculated treatments, biological yield (3474.30-4678.43 kg ha^{-1}), grain yield (1440.00-1906.47 kg ha^{-1}), and 100 seed weight (30.61- 41.61 g) were significantly varied amongst different inoculum as well as lime applications. Treatment, T_4 [(MKS 6 + lime (C_1L)] showed highest biological yield, grain yield and 100 seed weight with 11.90%, 13.03% and 29.60% increase over un-inoculated control, respectively (Table 13).

Table 13. Influence of rhizobacterial inoculation and lime application on plant yield and yield attributing parameters

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})	100 seeds weight (g)
T_1: Uninoculated - lime (C_0L_0)	47.67	1.60	3474.30	1640	31.61
T_2: Uninoculated + lime (C_0L)	51.48	1.67	3644.67	1686.67	34.79
T_3: MKS 6 - lime (C_1L_0)	58.33	1.80	3915.38	1873.23	37.87
T_4: MKS 6 + lime (C_1L)	80.38	1.93	4078.43	1906.47	41.61
T_5: MRD 17- lime (C_2L_0)	53.67	1.60	3801.00	1626.21	36.09
T_6: MRD 17+ lime (LC_2)	54.23	1.67	3935.46	1836.36	37.95
T_7: NRSSS-1- lime (L_0C_3)	49.33	1.60	3752.00	1693.28	32.67
T_8: NRSSS-1+ lime (LC_3)	57.10	1.67	3854.62	1713.53	35.93



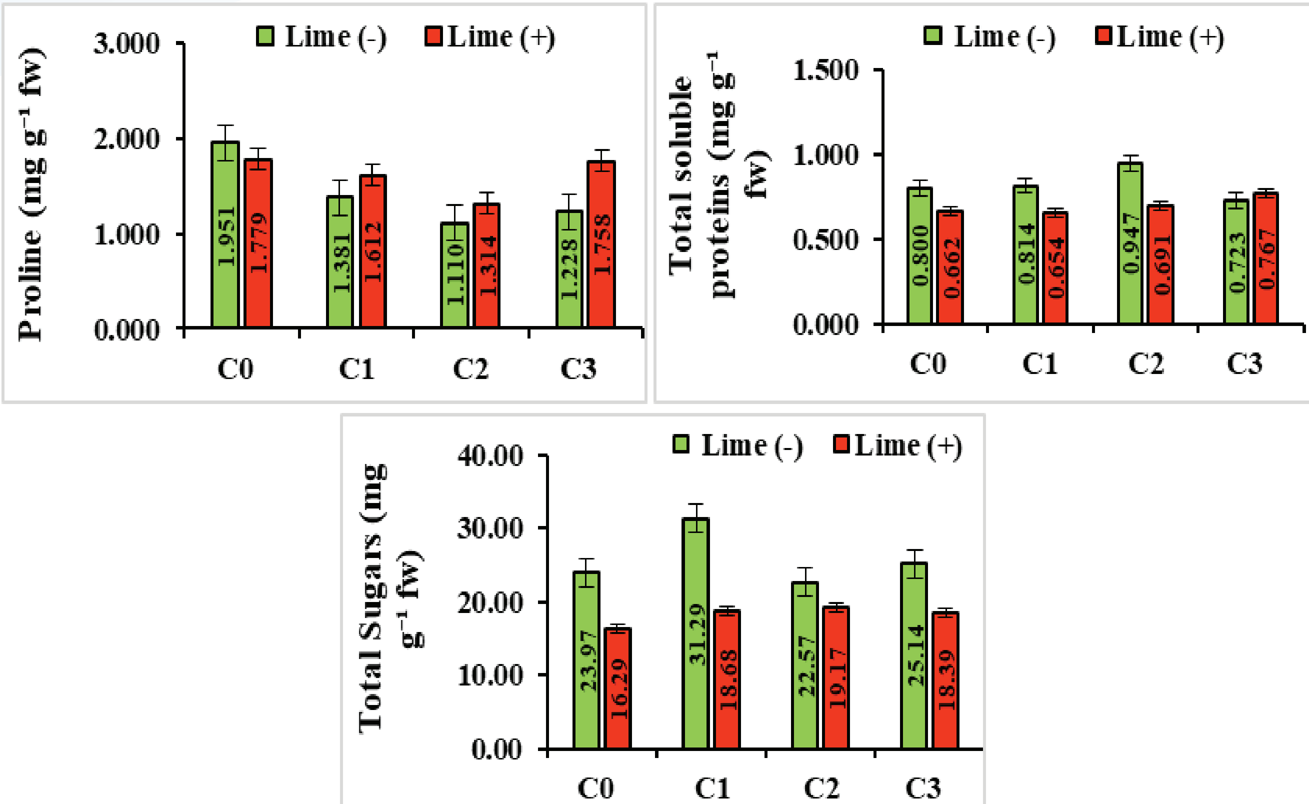


Fig 25. Influence of rhizobacterial inoculants on chickpea plant antioxidants

Interactions between stress tolerant bacteria and wheat crop

Drought and acidity stresses are important yield limiting factors in the Jharkhand state. Combined effects of soil acidity and drought stress cause physiological, physico-chemical, and morphological changes in plants, which negatively affect plant growth and productivity. Plant growth promoting bacteria may provide safe solution for enhancing crop growth and development under acidic and drought stress, allowing them to survive in stress conditions. In this study, Twenty-five isolates obtained from soils, collected from ICAR-IARI Jharkhand, were screened for acidic, osmotic and dual stress tolerance. Among 25 bacterial isolates tested for tolerance to acidity and drought, five dual-stress-tolerant isolates were identified and were evaluated for their effect on wheat seed germination and seedling vigour index, *in vitro*, under dual acidic and osmotic stress. Inoculation with three of these isolates improved wheat seed germination and seedling vigor under dual acidic and osmotic stress. Two most promising isolates, identified as *Bacillus rugosus* ANI4 and *Achromobacter kerstersii* NNI2, exhibited multiple plant growth-promoting attributes. A pot experiment was carried out with inoculating these two bacterial strains both as individually and as mixture of two in wheat crop grown under dual stress of acidity and moisture deficiency (Fig 26). Results showed inoculated plants had improved plant biomass with significant increase in photosynthetic pigments, photosynthetic rate, stomatal conductance and transpiration rate, under both acidic and dual stress. Plant proline, phenolic content, antioxidative enzymatic activities (catalase and ascorbate peroxidase) also increased significantly under acidic and dual stress. Hence, it was concluded that the selected bacterial strains had potential in mitigating acidic and dual acidic and drought stress in wheat crop.

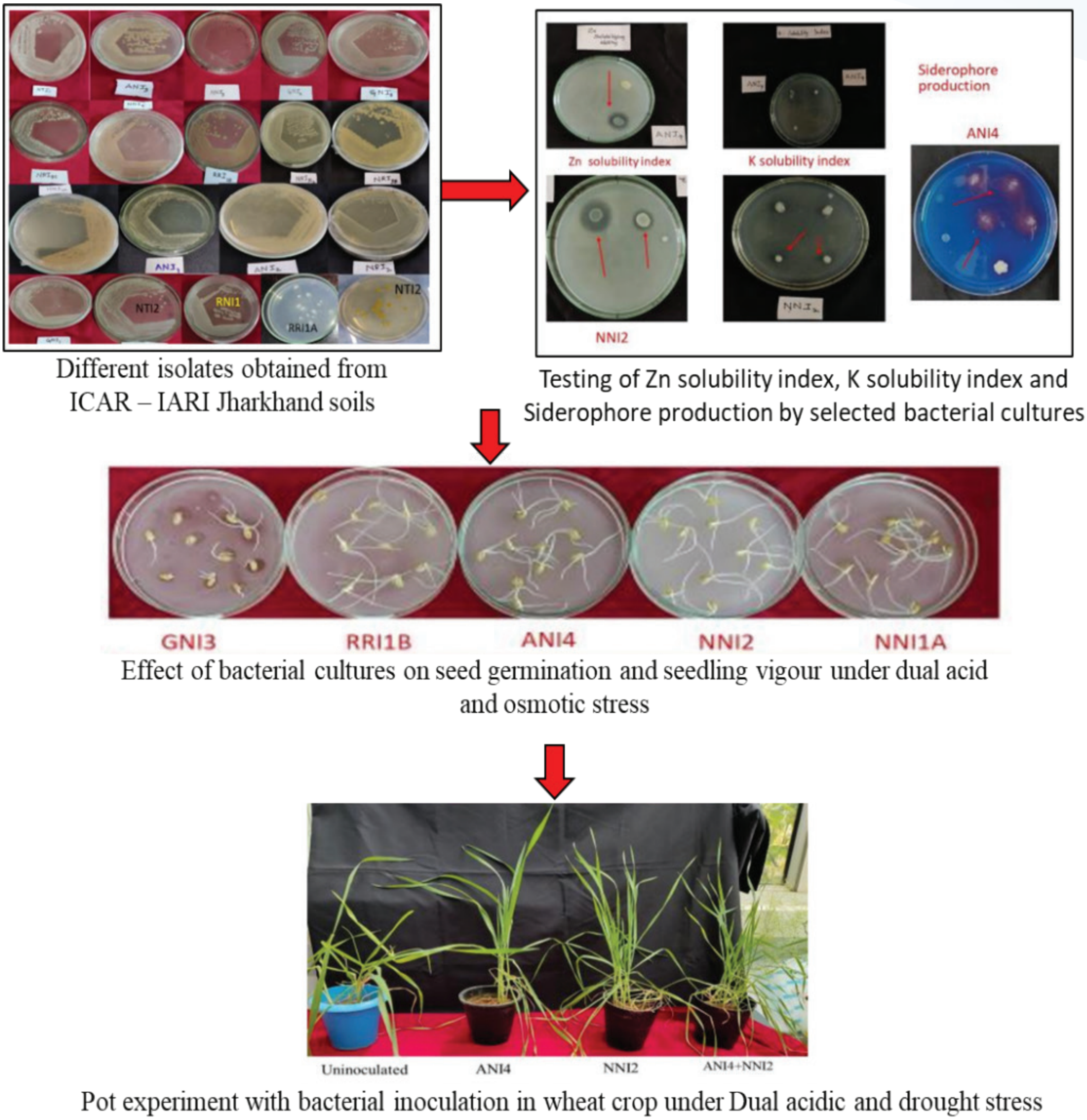


Fig 26. Flow chart of the experiment

Development of region-specific microbial inoculants (diazotrophs)

Nitrogen is an important nutrient for wheat crop; however, application of high doses of fertilizers leads to losses by leaching which causes environmental pollution.Therefore, the present investigation was directed towards exploring the diversity and abundance of diazotrophs in Jharkhand soil and evaluating the promising isolates in wheat crop. In the present study, soil samples were collected from different fields of IARI, Jharkhand Farm (Fig 27). Analyses of soil physico-chemical properties and nutrient availability indicated a wide variation among the soil samples and their acidic nature. PLFA (phospholipid fatty acid analyses) of the soil samples highlighted the wide range in microbial biomass and relative population of gram positive/ negative, actinobacteria, fungi etc from collected soils. Morphotypes

(95) of bacteria were isolated and purified. Further a set of 20 promising isolates (C1-C20), based on their higher nitrogen fixing potential were characterized, biochemically and for PGP traits (IAA, ARA, phosphate solubilization, seed germination assay). Amongst them 3 potential diazotrophic isolates (B1, B2, B3; identified as *Arthrobacter* sp., *Ochrobactrrum intermedium* and *Pseudomonas nitroreducens*) were selected for pot experiment with wheat crop. To evaluate the performance of the potential 3 isolates in sterilized soils of fields from both IARI Delhi and IARI Jharkhand, treatments included the use of individual cultures and combination of B1+B2, along with seed treatment with *Azotobacter* sp. and *Azospirillum* sp. individually as standard cultures routinely used for wheat. Sampling done at 4 and 8 WAS (weeks after sowing) and soil nutrient, microbiological and plant parameters were evaluated. Significant enhancement of 15-20 % in N availability and organic C in soil, as also in plant biometrical and physiological attributes illustrated the superior performance of B1and the combination of B1+B2. Interestingly, the enhancement in both plant and soil-related attributes were more distinct in Jharkhand soil, making them suitable as region specific microbial inoculants. Field level evaluation of these isolates towards development of region-specific inoculants for Jharkhand was envisaged as a future goal.

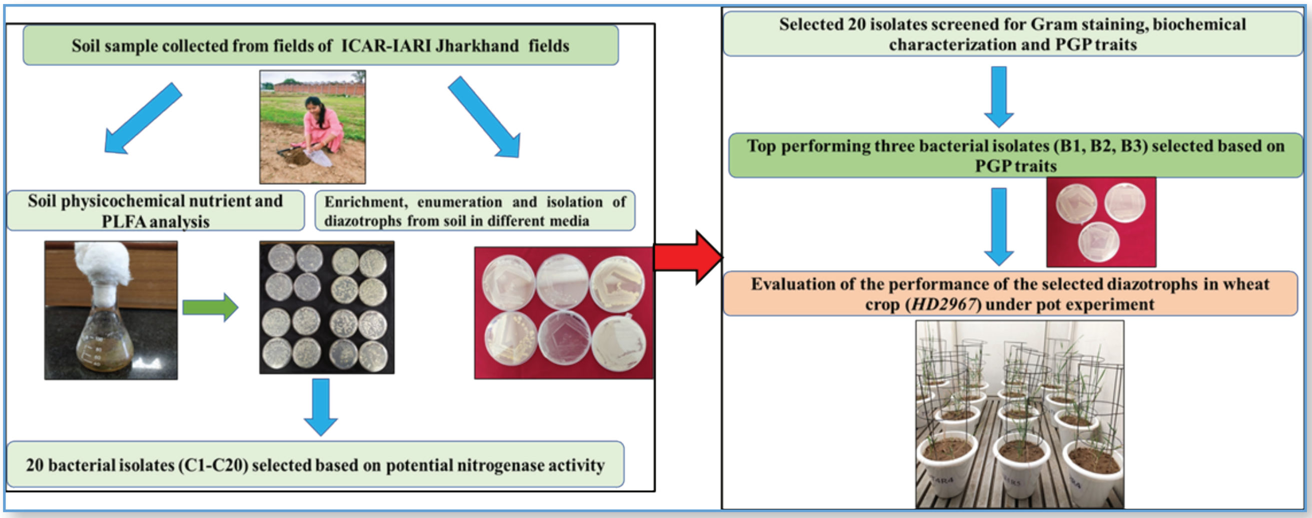


Fig 27. Flow chart of the experiment

Blue green algae/ Cyanobacterial culture

Blue green algae/ Cyanobacterial culture growth room facility has been established to maintain and conserve the germplasms of blue green algae (BGA) in Microbiology Section, IARI Jharkhand. Cyanobacteria commonly known as blue-green-algae are gram-negative prokaryotes, perform oxygenic photosynthesis, and also fix atmospheric N_2. They are ubiquitous in ponds, lakes, water streams, rivers, and wetlands. They are potentially useful organisms that could be used as food, feed, and fuel. They are also used in the treatment of industrial and domestic wastewater to use or remove ammonia, phosphates, and other heavy metals. Biomasses of Cyanobacteria are used as biofertilizers for the improvement of nutrient or mineral status and water-holding capacity of the soil. Cyanobacteria in rice fields are important microbial members that are employed as bio-inoculants for enhancing fertility, improving structure of soils and crop yields. More than forty cyanobacterial strains are being maintained in the culture room facility of ICAR-IARI, Jharkhand.

Fig 28. Cyanobacterial culture growing and maintained in BG-11 (-N) and (+N) medium

Plant based edible coating of guava (*Psidium guajava*L.)

Natural edible gums, gumarabic (GA), gum ghatti (GG), and herbal based, aloe vera gel (AVG) were identified as plant based edible coating material for guava. Gum arabic and gum ghatti tears were primary processed and macerated initially. Afterwards, the macerated gum ghatti solutions were filtered and stored in deep freezer at -20 °C for different combination of coating formulation according to the selected parameters. Different treatments (T_1, $T_{2,}$ $T_{3,}$ $T_{4,}$ $T_{5,}$ T_6 and T_7) combinations were used for coating of guava (Lalit). These combinations were T_1 (GA,100%), T_2 (GG,100%), T_3 (AVG,100%),T_4 (GA,100%), T_5 (GA+GG: 50%+50%), T_6 (GG+AVG: 50%+50%) and T_7 (GA+GG+AVG: 35%+35%+30%). Among the treatment combinations, T_7 (GA+GG+AVG: 35%+35%+30%) recorded minimum weight loss and longer shelf life during storage at ambient condition (Fig 29).

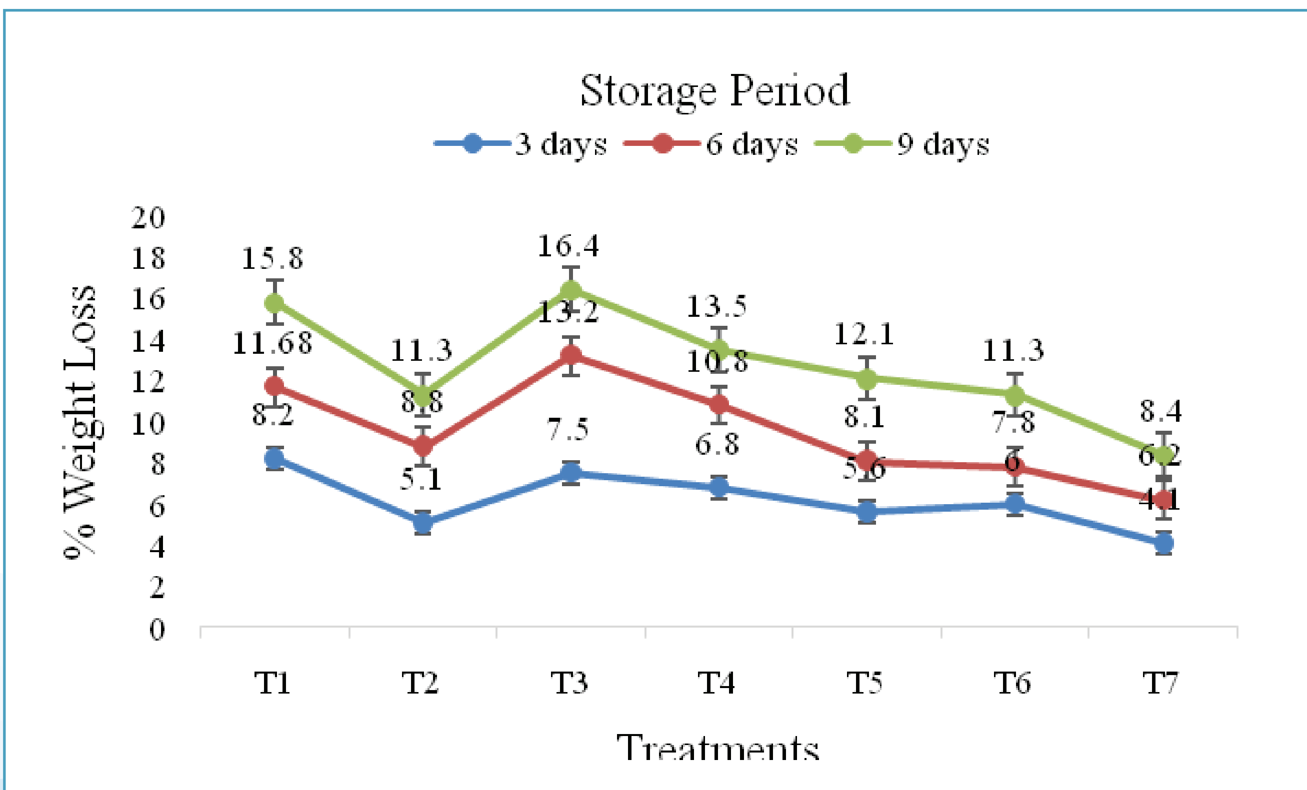


Fig 29. Percentage weight loss using different coating treatments with storage period

Indeed, effect of storage periods and treatments on physiological weight loss was significant. Physiological weight loss of guava fruits showed increasing trend with progressed period of storage. The weight loss of fruits coated with T_1, $T_{2,}$ $T_{3,}$ $T_{4,}$ $T_{5,}$ T_6 and T_7 was lower than control fruits irrespective of 9 days storage period. A significant difference in weight loss was observed between the coated and control fruits. At the end of 9 days period minimum weight loss (4.1%, 6.2% and 8.4%) was observed for the formulation of gum arabic, gum ghatti and aloe vera gel, $T_{7,}$ (GA:GG: AVG: 35:35:30) followed by 6.0%,7.8% and 11.3% weight loss observed for gum ghatti and aloe vera gel, T_6 (GG+AVG: 50+50) treated fruits, while in control fruits (18.5%, 21.2% and 24.4%) maximum weight loss was observed during storage of guava for 3, 6 and 9 days. Weight loss was more pronounced during initial 3 days of storage, after that comparatively steady loss was observed in both coated and uncoated fruits. The slow decline in weight loss of coated fruits was due to the formation of a semi-permeable barrier against gases like oxygen, carbon dioxide, moisture and other solute movement due to which it reduced respiration, moisture loss and oxidation.

3. Livestock and fish production

Status of goat production in Hazaribag district of Jharkhand

Four villages (Kedaru, Bandarvella, Kutma and Kundwa) under Hazaribag district were surveyed to collect base line information on goat farming. Different categories of farmers were contacted, which included landless labourers and others having lands. Indeed, Hazaribag district (4302 sq. km) is full of several plateaus, mountains and valleys. This district possesses 4.76081 lakh heads of goats. Livestock rearing practices in this district are very much ethnic group and location specific as observed in other parts Jharkhand state. However, goat rearing is very popular in rural areas, particularly in vicinity of forest land or barren or uncultivable land. People in urban areas find it difficult to rear goats due to lack of grazing lands. Goats are usually reared under semi-scavenging conditions, except for a very small number of introduced goats like Beetel, Sirohi, Barbari and Jamunapari. But goats are not put inside a shed throughout the day and night, rather they are tethered in home premises and offered different tree fodders, concentrates and kitchen waste etc. The villages with good access to community grazing land usually have higher number of goats or flock size. During grazing, goats are looked after by girls and women, aged people and youths. Kids are provided suckling twice a day (morning and evening) up to the age of 5-6 months. Kids born in a large flock, however, are weaned little early (2-3 months) and sent for grazing as a separate flock up to the age of 5-6 months and after that they are put in adult flock. Goats are reared primarily on grazing with little external inputs (Fig 30).

Fig 1. Rearing of goats by resource poor tribal farmers in Kundwa village

Indeed, the animals are kept in close housings as well as in open houses. In case of close housing, the roofs were made up of locally available materials like stovers, straws, tree leaves, dry grasses, wooden logs or plastic sheets/tiles and fenced with wooden or stone poles walls constructed with locally available materials. In open houses the goats were kept under trees, open areas and fenced with thorny bushes etc. Goats were also kept free in temporary enclosures made up of bamboo sticks or wooden logs. Majority of the farmers also used *kutcha* type of floors in goat houses. However, in small flocks (3-4 animals) there was no separate housing and goats live with the owner and share the houses. When flock sizes are large, it was found that farmers construct the shelters separately, otherwise farmers maintained shelters as part of their houses to safeguard the animals during night time.

Fig 31. Typical Black Bengal goat

Among the various meat-producing indigenous breeds of goats, owned by resource poor farmers, the black Bengal goat (*Capra hircus bengalensis*) is the most predominant (Fig 31). This breed is an important contributor to a sustainable agricultural system, particularly in Jharkhand including Hazaribag district. Black Bengal breed of goat produces usually 2 kids, mostly kidding thrice in two years. Live weight of an uncastrated male goat at 12 months' age was around 10 kg, while a castrated one had 12-15 kg. Bengal goats are highly prolific, are resistant to common diseases, thrive on meager feeding conditions, easy to sale and can produce excellent-quality meat. These factors have led to the realization of the need to pay more attention to this goat breed, whose genetic material has been exploited widely, but without any attention to the need to conserve it. The major problems/constrains identified under field conditions are-

- Majority of goat farmers are resource poor farmers
- Extensive system of goat production based on community pastures/grazing lands
- Presence of less number of breeding bucks in the flock
- Inbreeding and random mating of goats
- Lack of knowledge on scientific goat management and their health measures
- Low income from unorganised sale of animals (Fig 32)
- Degraded community pastures/grazing lands

But goat-rearing has tremendous potential for improving livelihood security of people in rural villages of Jharkhand, provided scientific management practices are adopted and potentials of Black Bengal goats are conserved.

Fig 32. Selling of goats in Bakari Hat, Barhi, Hazaribag district of Jharkhand

Performance of Bajra x Napier hybrid fodder varieties

Bajra x Napier hybrids are perennial fodder variety suitable for different agro climatic conditions. The fodder variety is best suited for round the year forage system for Jharkhand also. It possesses more tillers and leaves than napier grass and is more vigorous and better in fodder yield and quality. For one-hectare area, 40000 slips are required to plant. Different varieties of Bajra Napier hybrid *i.e.,* Kamdhenu, CO1, CO5, IGFRI-10 were cultivated in a 5x10 m area for each variety. Row to row spacing of 1 m and plant to plant spacing of 50 cm were maintained for all the varieties. First harvest was done on 75 to 80 days after planting and subsequent harvests at intervals of 40-60 days. Total weight of each fodder was measured after each cut. In present year three harvests were taken (Fig 1), however, fodder crop was not harvested during winter months due to lesser growth when compared to other seasons. The green fodder weight after harvesting for each variety was recorded and dry sample of each cut for each variety was stored for further analysis. The forage yield of genotype Kamdhenu and CO5 were fairly high when compared to other genotypes.

Multiplication of fodder cowpea (*Vigna unguiculata*) cultivars

Fodder cowpea is an annual crop predominantly grown under rain fed conditions. The foliage, green pods, immature seeds and flowers are fed to animals. The fodder is rich in proteins and other nutrients like fat, carbohydrates, calcium and iron making it excellent forage. Cultivation of fodder cowpea varieties *i.e.,* UPC-9202, UPC-628, UPC-622, Kohinoor, MFC-08-14, MFC-09-1, Bundel Lobia-1 and Bundel Lobia-2 was done at 10x10 m plot for each variety with spacing of 30 cm row to row and 10 cm plant to plant. *Vigna unguiculata* is harvested within 60-80 days after sowing for green foliage, but in the present study, it was mainly cultivated for seed production so it was harvested after the pods became for seed collection. *Vigna unguiculata* could be cultivated as potential fodder to meet the nutritional demand of livestock and to narrow the gap of demand and supply of green fodder in Jharkhand.

Outreach Activities

Schedule caste sub plan

In order to increase the income of the target population through various income generating schemes, skill development and infrastructure development, ICAR-IARI, Jharkhand has implemented the Schedule Caste Sub Plan (SCSP) for the benefit of schedule caste farmers of Jharkhand in an effective manner. Various developmental activities are underway for the creation of infrastructure facilities, conducting capacity building training programs and farm input supply for enhancing agricultural productivity. Under the farm-input supply component, seeds and planting materials of various agricultural and horticultural crops, fertilizers and other required input were distributed free of cost among the selected beneficiaries of the community as per the seasonal requirements. Direct input supply to the needy farmers helped in enhancing the standard of living of scheduled caste farmers by increasing their income through increased agricultural productivity. Efforts of the institute in supplying quality seeds under SCSP was highly appreciated by the benefitted farmers and there was a great demand for the quality seeds of various crops in all the cropping seasons. During *kharif* 2022, a four days 'Training cum seed distribution program of paddy for improved productivity' were organized during July 4-7, 2022 to impart knowledge of improved cultivation practices for cultivation of new improved rice varieties and 30 Q of paddy seeds were distributed among 220 number of beneficiary farmers of 4 villages of Barhi block, Hazaribag district (Fig 1). During Rabi 2022-23, 24 Quintals of wheat seeds was distributed among 300 scheduled caste farmers of 5 different villages in 3 panchayats of Hazaribag district during five days 'Training cum seed distribution program of wheat for improved productivity' during November 25-29, 2022. During the farmers training cum seed distribution program the farmers were actively interacted with crop-specific resource personnel of the institute. The aim of the farmer's training program was to provide brief insight into the scientific package of practices of different crops for higher productivity and consequently higher income.

Fig 1. Seed distribution to beneficiary farmers

Tribal sub plan

The tribal sub-plan (TSP) is a planning concept to channelize the flow of benefits from the central government for the development of tribal populations. As part of TSP, the ICAR-IARI, Jharkhand is actively engaged in enhancing the standard of living of tribal farmers by increasing their income through increased agricultural productivity. Under TSP, ICAR-IARI, Jharkhand conducted training programs on various topics for tribal farmers in the different blocks of Hazaribag district (Table 1). The objective of the training program was to provide insights of scientific package of practices of different crops for getting higher productivity and consequently higher income. Tribal farmers were also motivated for farming of rice, maize, specialty corn, vegetables, wheat, chickpea, green gram, horse gram and other crops of their region through adopting the improved practices. A total of around 2800 tribal farmers got benefitted from this training program (Fig 2). Seeds of improved varieties of rice, maize, vegetables, green gram and horse gram were also provided to the participants after the training programme.

Table 1. Organization of training programmes under TSP

S. No.	Training programme and Seed distribution programme	Target area	Date	Organizing committee
1	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा धान की खेती	Block: Barhi, Hazaribag, Jharkhand	20.06.22-22.06.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. S. Kerketta, Dr. Ashok Kumar, Dr. Pankaj K. Sinha
2	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा धान की खेती	Block: Churchu, Hazaribag, Jharkhand	23.06.22-25.06.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Monu Kumar, Dr. S. Kerketta, Dr. Ashok Kumar
3	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा धान की खेती	Block: Dadi, Barkagaon, Keredari, Hazaribag, Jharkhand	27.06.22-29.06.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. S. K. Mahanta, Dr. Preeti Singh, Dr. Ashok Kumar
4	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा धान की खेती	Block: Barhi, Hazaribag, Jharkhand	04.07.22-06.07.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. P. R. Kumar, Dr. Dr. Ashok Kumar
5	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मक्का सब्जी एवं कुलथी की खेती	Block: Churchu, Hazaribag, Jharkhand	13.07.22-15.07.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Krishna. Prakash

S. No.	Training programme and Seed distribution programme	Target area	Date	Organizing committee
6	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मक्का एवं सब्जी की खेती	Block: Dadi, Barkagaon, Keredari,, Hazaribag, Jharkhand	16.07.22-18.07.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Asha Kumari, Dr. Krishna Prakash
7	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मक्का सब्जी एवं कुलथी की खेती	Block: Tatijhariya, Hazaribag, Jharkhand	19.07.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Dr. Ashok Kumar
8	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मक्का एवं सब्जी की खेती	Block: Vishnugarh, Hazaribag, Jharkhand	20.07.22-22.07.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Krishna Prakash
9	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मक्का सब्जी एवं कुलथी की खेती	Block: Barhi, Hazaribag, Jharkhand	23.07.22-25.07.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Krishna Prakash
10.	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा कुलथी की खेती	Block: Barkagaon, Hazaribag, Jharkhand	20.08.22	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. Preeti Singh, Dr. Ashok Kumar, Mr. Sushil Marandi
11.	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मूंग की खेती	Block: Dadi, Barkagaon, Keredari, Churchu, Hazaribag, Jharkhand	15.02.23-20.02.23	**Co-ordinator**: Dr. Vishal Nath **Organizing secretary**: Dr. Santosh Kumar **Co-organizing secretary**: Dr. P. R. Kumar, Dr. Preeti Singh, Dr. Ashok Kumar, Dr. Krishna Prakash, Dr. Shannon N Sangma

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अनुसूचित जनजाति उप योजना के तहत भारतीय कृषि अनुसंधान संस्थान द्वारा कृषि प्रशिक्षण सह बीज वितरण कार्यक्रम का हुआ आयोजन

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अनुसूचित जन जाति उप योजना के तहत भारतीय कृषि अनुसंधान संस्थान गोरियाकरमा झारखंड के वैज्ञानिकों के द्वारा बरही प्रखंड के खोड़ाहार पंचायत के कुण्डवा गांव में कृषक प्रशिक्षण सह बीज वितरण कार्यक्रम का आयोजन किया गया। इसमें संस्थान के वैज्ञानिकों द्वारा किसानों को फसलों के उत्तम प्रभेद तथा वैज्ञानिक पद्धति द्वारा खेती करने की सलाह दी गई। डॉ विशाल नाथ, विशेष कार्य अधिकारी के द्वारा किसानों को भारतीय कृषि अनुसंधान संस्थान की महत्वता के विषय में बताया तथा उन्हें इस संस्थान से ज्यादा से ज्यादा लाभ प्राप्त करने के लिए प्रोत्साहित किया।

डॉ संतोष कुमार, वैज्ञानिक ने किसानों को संस्थान के संपर्क में रहने की सलाह दी ताकि उन तक नवीनतम तकनीकों एवं प्रभेदों की जानकारी पहुंच सके एवं उनकी आय में वृद्धि की जा सके। डॉ संतोष कुमार (वैज्ञानिक एवं प्रभारी अनुसूचित जनजाति उपयोजना) ने किसानों को धान की वैज्ञानिक पद्धति द्वारा खेती करने के तरीके बताए एवं उसमें कीट एवं रोगों के प्रबंधन की जानकारी दी। इन्होंने किसानों को बीज उपचार करके ही किसी भी फसल को लगाने की सलाह दी। डॉ प्रीति सिंह वैज्ञानिक ने किसानों को मृदा की महत्वता के बारे में बताते हुए मृदा जांच अवश्य कराने की सलाह दी। उन्होंने खेत में कच्चा गोबर ना डालने की सलाह दी क्योंकि कच्चा गोबर डालने से खेत में दीमक का प्रकोप बढ़ जाता है एवं फसल को नुकसान पहुंचाता है। उन्होंने यूरिया को भी एक साथ ना दे कर फसल की विभिन्न अवस्थाओं पर टॉप ड्रेस करने की सलाह दी। डॉ शिल्पी करकट्टा वैज्ञानिक ने किसानों से उनके पशुओं के स्वास्थ्य के बारे में चर्चा की तथा उनके प्रबंधन के विषय में जानकारी दी। डॉ अशोक कुमार वैज्ञानिक ने किसानों को धान की फसल में अच्छी पैदावार के लिए उनके पोषण प्रबंधन के बारे में बताया। प्रशिक्षण के अंत में किसानों को धान का बीज (किस्म आईआर 64) वितरित किया गया। इस कार्यक्रम को बरही प्रखंड के प्रमुख मनोज रजक, खोड़ाहार के मुखिया प्रतिनिधि खिरोधर यादव ने भी संबोधित किया। प्रशिक्षण कार्यक्रम में 300 किसानों ने लाभ प्राप्त किया। संस्थान के वैज्ञानिकों ने किसानों को आईएआरआई संस्थान आकर या मोबाइल के माध्यम से भी खेती से जुड़े जानकारी प्राप्त करने की सलाह दी। मौके पर कई गणमान्य लोगों के साथ कृषक उप

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Fig 2. Training-cum-seed distribution to beneficiary farmers

NABARD funded project

A three day training program on the topic "झारखण्ड में गुणवत्तायुक्त प्रोटीन मक्का के एकल संकर मक्का बीज उत्पादन की तकनीक विषय पर त्रिदिवसीय युवा कृषक प्रशिक्षण कार्यक्रम" was organized under NABARD funded project on 'Popularization of bio fortified maize hybrids (QPM+ProVit.A enriched) for sustainable nutritional security and upscaling entrepreneurship to boost up farmers' income in Jharkhand' to train and motivate the youth farmers to produce the hybrid seeds of maize as there is huge demand of quality hybrid seeds of maize among the farmers of Jharkhand. The training was attended by 60 farmers of 10 Farmer Producer Organizations of Hazaribag district (Fig 3).


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भारतीय कृषि अनुसंधान संस्थान में किसानों को दिया गया तीन दिवसीय प्रशिक्षण, मक्का बीज उत्पादन की बारीकियों को जाना

संध्या प्रहरी : बरही

भारतीय कृषि अनुसंधान संस्थान झारखंड द्वारा नाबार्ड परियोजना अंतर्गत झारखंड में गुणवत्ता युक्त प्रोटीन मक्का के एकल संकर मक्का बीज उत्पादन की तकनीकि विषय पर त्रिदिवसीय युवा कृषक प्रशिक्षण कार्यक्रम का समापन किया गया। इस प्रशिक्षण कार्यक्रम में हजारीबाग जिले के 10 कृषक उत्पादक संगठन के कुल 60 किसानों ने भाग लेकर संकर मक्का बीज उत्पादन की तकनीकीयों को बारीकी से सीखा और समझा। इस कार्यक्रम को संबोधित करते हुए संस्थान के ओएसडी डॉ विशाल नाथ ने भारतीय कृषि अनुसंधान संस्थान झारखंड के बारे में बताते हुए किसानों को इस संस्थान से ज्यादा से ज्यादा लाभ प्राप्त करने के लिए प्रोत्साहित किया। उन्होंने किसानों को इस प्रशिक्षण कार्यक्रम से सीखे हुए तकनीकों को अपनाने की सलाह दी। डॉ सनत कुमार महंता प्रधान वैज्ञानिक ने किसानों को मक्का के बारे में तथा उनसे प्राप्त होने वाले पोषक तत्वों के बारे में किसानों को जानकारी दी तथा मक्के के चारे से पशुओं में होने वाले स्वास्थ्य लाभ के बारे में भी बताया। प्रेम प्रकाश सिंह, जिला विकास प्रबंधक नाबार्ड, हजारीबाग द्वारा कृषि अर्थव्यवस्था में कृषक उत्पादक समूह की भूमिका पर बताते हुए कृषकों को बताया कि अगर वे समूह में संगठित होकर किसी भी फसल की खेती करते हैं तो उसमें कम लागत के साथ–साथ ज्यादा लाभ प्राप्त होता है। डॉ प्रियरंजन कुमार प्रधान वैज्ञानिक ने किसानों से वार्तालाप करते हुए मक्का की उपयोगिता बताते हुए सही समय पर सही किस्मों का चयन करने की सलाह दी तथा उन्हें अपने गांव के स्तर पर ही बीज उत्पादन के लिए प्रोत्साहित किया। जिससे अच्छी गुणवत्ता के बीज किसानों को सही समय पर कम दामों में उपलब्ध हो सके। डॉ संतोष कुमार ने किसानों को गुणवत्ता युक्त प्रोटीन मक्का की विशेषताओं के बारे में अवगत कराया। उन्होंने बताया कि गुणवत्ता युक्त प्रोटीन मक्का की जैविक मूल्य करीब–करीब दूध के बराबर होती है। झारखंड में ग्रामीण परिदृश्य में गरीबी रेखा से नीचे वाले लोगों का मुख्य भोजन मक्का है, अगर वे सामान्य मक्का की अपेक्षा अगर गुणवत्ता युक्त प्रोटीन मक्का का सेवन करते हैं तो उन्हें सही पोषण मिल सकता है।

इस मक्का से मुर्गियों तथा पशुओं के स्वास्थ्य में भी काफी वृद्धि होती है। किसानों को भारतीय कृषि अनुसंधान संस्थान नई दिल्ली के प्रधान वैज्ञानिक डॉ फिरोज हुसैन एवं उनकी टीम द्वारा विकसित उच्च गुणवत्ता वाली प्रोटीन के साथ–साथ प्रोविटामिन युक्त मक्का के दो संकर किस्मो की विशेषता के बारे में अवगत कराकर उन्हें सामान्य मक्का की अपेक्षा इन गुणवत्ता युक्त प्रोटीन मक्का की खेती करने के लिए प्रोत्साहित किया। डॉ संतोष कुमार ने बताया कि हमारे झारखंड की मक्का की औसत उत्पादकता राष्ट्रीय औसत उत्पादकता से काफी कम है, जिसका मुख्य कारण सही किस्मों का सही समय पर उपलब्ध ना हो पाना है। उन्होंने किसानों को संकर मक्का बीज उत्पादन की तकनीक के बारे में विस्तृत जानकारी दी तथा उन्हें बीज उत्पादन के लिए प्रोत्साहित किया। उन्होंने किसानो को मक्का की वैज्ञानिक तरीके से खेती करने की भी जानकारी दी। जिससे की ज्यादा से ज्यादा उत्पादन करके लाभ प्राप्त किया जा सके। उन्होंने मक्का में लगने वाले प्रमुख कीट फॉल आर्मीवर्म एवं उनके प्रबंधन के बारे में भी विशेष रुप से जानकारी दी। डॉ प्रीति सिंह वैज्ञानिक द्वारा मक्का की वैज्ञानिक पद्धति द्वारा खेती एवं बीज उत्पादन फसल में पोषण प्रबंधन, जल प्रबंधन एवं खरपतवार प्रबंधन की विशेष रूप से जानकारी दी गई। उन्होंने किसानों को सिंचाई के बाद ही यूरिया का प्रयोग करने की सलाह दी, जिससे की पौधे ज्यादा समय तक उससे पोषण प्राप्त कर सकें। इस कार्यक्रम में डॉक्टर अनीमा महतो, डॉ अशोक कुमार, डॉ पंकज सिन्हा, डॉ दीपक गुप्ता, डॉ रंजीत कुमार, डॉ मनोज चौधरी, डॉ शिल्पी करकट्टा एवं डॉ हिमानी प्रिया भी मौजूद रहे।

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Fig 3. Organization of training programme under NABARD funded project

Following seed distribution, FLDs and field days were also organized-

- Seed distribution of 120 quintal paddy seeds (IR 64 and MTU 1010) to the tribal farmers under TSP
- Seed distribution of 25 quintal maize hybrid seeds (DHM121) to the tribal farmers under TSP
- Vegetable seed kit (1000 pkt.) distribution to the tribal farmers under TSP
- Seed distribution of 200 kg kulthi seeds (Birsa Kulthi 1) to the tribal farmers under TSP
- Demonstration of experimental hybrids of maize during kharif- 2022 at ICAR-IARI, Jharkhand.
- Front line demonstration (FLD) of maize hybrid DHM 121, improved rice variety IR 64 Drt1, MTU 1010, vegetables and horse gram in different villages of Hazaribag district (Table 2)
- Field day conducted for the innovative farmers to showcase the elite experimental maize hybrids during kharif- 2022 at ICAR-IARI, Jharkhand.
- Conducted Front line demonstration of QPM hybrids *viz*. Pusa HQPM-1 improved and HQPM-5 improved on farmers' field in 40 different villages of Hazaribag district under NABARD funded project (fortified maize project- 70-01).
- Conducted field day among the farmers of the village in which demonstration was conducted, to showcase the potential of the QPM maize hybrid (Pusa HQPM-1 improved and HQPM-5 improved). Field day was conducted in all the 40 villages, where demonstration of QPM hybrids were conducted (Table 3). The demonstrated QPM hybrids showed superiority over the traditional variety as well as the hybrids available in the local market.

Table 2. Organization of demonstrations/FLDs

S. No.	Crop/variety	Demonstration area	Team
1	Rice (MTU 1010)	Block: Barhi, Hazaribag, Jharkhand Number of villages: 10	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. S. Kerketta, Dr. Ashok Kumar, Dr. Pankaj K. Sinha, Dr. Vishal Nath
2	Rice (IR 64 Drt 1)	Block: Churchu, Hazaribag, Jharkhand Number of villages: 20	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Monu Kumar, Dr. S. Kerketta, Dr. Ashok Kumar, Dr. Vishal Nath
3	Rice (IR 64 Drt 1)	Block: Dadi, Barkagaon, Keredari, Hazaribag, Jharkhand Number of villages: 20	Dr. Santosh Kumar, Dr. S. K. Mahanta, Dr. Preeti Singh, Dr. Ashok Kumar, Dr. Vishal Nath
4	Rice (MTU 1010)	Block: Barhi, Hazaribag, Jharkhand Number of villages: 5	Dr. Santosh Kumar, Dr. P. R. Kumar, Dr. Ashok Kumar, Dr. Vishal Nath
5	Maize (DHM 121) Vegetables Horse gram (Birsa Kulthi 1)	Block: Churchu, Hazaribag, Jharkhand Number of villages Maize (DHM 121): 20 Vegetables: 20 Horsegram (Birsa Kulthi 1): 5	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Ashok Kumar, Dr. Krishna. Prakash, Dr. Vishal Nath
6	Maize (DHM 121) Vegetables	Block: Dadi, Barkagaon, Keredari,, Hazaribag, Jharkhand Number of villages Maize (DHM 121): 20 Vegetables: 20	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Krishna Prakash, Dr. Vishal Nath
7	Maize (DHM 121) Vegetables Horse gram (Birsa Kulthi 1)	Block: Tatijhariya, Hazaribag, Jharkhand Number of villages Maize (DHM 121): 10 Vegetables: 10 Horse gram (Birsa Kulthi 1): 2	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Ashok Kumar, Dr. Vishal Nath
8	Maize (DHM 121) Vegetables	Block: Vishnugarh, Hazaribag, Jharkhand Number of villages Maize (DHM 121): 12 Vegetables: 10	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Krishna Prakash, Dr. Vishal Nath,

S. No.	Crop/variety	Demonstration area	Team
9	Maize (DHM 121) Vegetables Horse gram (Birsa Kulthi 1)	Block: Barhi, Hazaribag, Jharkhand Number of villages Maize (DHM 121): 5 Vegetables: 10	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Dr. Ashok Kumar, Dr. Krishna Prakash, Dr. Vishal Nath
10.	Horse gram (Birsa Kulthi 1)	Block: Barkagaon, Hazaribag, Jharkhand Number of villages Horsegram (Birsa Kulthi 1): 5	Dr. Santosh Kumar, Dr. Preeti Singh, Dr. Ashok Kumar, Mr. Sushil Marandi, Dr. Vishal Nath
11.	Green gram (Pusa Vishal)	Block: Dadi, Barkagaon, Keredari, Churchu, Hazaribag, Jharkhand Number of villages Green gram (Pusa Vishal): 40	Dr. Santosh Kumar, Dr. P. R. Kumar, Dr. Preeti Singh, Dr. Ashok Kumar, Dr. Krishna Prakash, Dr. Shannon N Sangma, Dr. Vishal Nath

Table 3. Organization of field days and performance of QPM hybrids

S. No.	Blocks	No. of Villages	GY (Pusa HQPM-1 improved)	GY (Pusa HQPM-5 improved)	Yield of traditional variety	Yield of hybrid available in market
1.	Barhi	5	53.2	56.1	18.1	46.8
2.	Hazaribag	5	54.1	57.8	19.4	45.5
3.	Churchu	5	55.6	56.4	18.4	49.4
4.	Dadi	5	53.8	57.9	19.5	50.2
5.	Gidhi	5	57.5	58.5	18.6	52.1
6.	Ichak	5	56.9	58.7	18	48.6
7.	Vishnugarh	5	57.1	57.2	20.3	47.7
8.	Tatijhariya	5	56.4	59.2	17.9	49.2

Success story of maize hybrid cultivation

Maize is the second most important crop in Hazaribag district of Jharkhand next to rice yet the productivity of maize in the area is very low in comparison to national productivity. A substantial amount of dietary requirement for energy in this area is being fulfilled by maize. Adoption of bio-fortified maize with increased lysine, tryptophan and provit. A would contribute in attaining nutritional security in a more holistic approach. The hybrid Pusa HQPM 5 Improved developed by ICAR-IARI, New Delhi was demonstrated on farmers' field in Hazaribag district of Jharkhand and the performance of hybrids were found to be excellent in every locations and average grain yield of 56-59 q/ha was recorded (as per crop cutting from the area of 2 m x 2 m in five replications). There was huge demand of green cob among the people in Jharkhand and the green cob weight of 252-261 q/ha was recorded in comparison to 176-188 q/ha of the other locally available varieties grown by the farmers (Table 4).

Owing to the cob size, yield potentiality and quality of kernels in respect of quality protein, the farmers were keenly interested to adopt these hybrids for their maize cultivation (Fig 4). As a matter of fact, these hybrids have gained immense popularity among the cultivators that resulted in high demand of seed very rapidly. It is expected that other farmers in the district will also adopt the cultivation of this QPM hybrid shortly.

Table 4. Yield performance of maize varieties/ hybrid

Type of maize varieties/ hybrid	Grain yield (kg/ha)	Green cob yield (kg/ha)
Traditional	1,800-2,000	11,200-13,000
Hybrid available in local market	4,500-5200	22,500-23,500
PUSA HQPM-5 Improved	56,10-59,20	25,200-26,100
DHM 121	6,200-6,800	26,300-27,600

Fig 4. Cultivation of maize varieties/ hybrid

ICAR-IARI, Jharkhand also conducted the demonstrations of the Maize hybrid DHM 121 on the farmers' field, which showed promising results in terms of grain as well as green cob yields. The maize hybrid DHM 121 was distributed among the tribal farmers under tribal sub plan project. Training was also imparted to them on the scientific package of practices of maize cultivation for higher productivity and profitability. The farmers were initially skeptical about the new hybrid variety, but with the help of ICAR-IARI, Jharkhand, they were able to understand the benefits of the new varieties. Indeed, the Maize hybrid DHM 121 has a much higher yield potential than the traditional varieties. The grain yield was almost double, while the green cob yield was more than double. This led to an increase in income for the tribal farmers who adopted the new variety. The improved yield of the new variety also resulted in better food security in the region, as farmers were able to produce more maize for their families and sell the surplus in the market. In conclusion, the adoption of Maize hybrid DHM 121 by tribal farmers in Jharkhand was a success story, leading to an increase in yield, income, and food security in the region. After conducting demonstration, farmers were convinced to adopt the DHM 121 hybrid maize variety due to its high yield potential, good resistance to pests and diseases, and suitability for local weather conditions. Overall, the success of the DHM 121 hybrid maize variety in tribal areas demonstrated the importance of introducing improved varieties that are suitable for local conditions.

Other activities

- Organization of RAWE and RHWE for B. Sc. (Agri.) & B. Sc. (Hort.) students of College of Agriculture, Ranchi and College of Horticulture, Khuntpani of Birsa Agricultural University, Ranchi during 29th Nov. to 09th Dec. and 09th to 23rd Dec. 2022 at ICAR-IARI-Jharkhand.

- Organized one day Training-cum-Interaction Programme of Block Level Extension Officials (BAO's, BTMs & ATMs) of Hazaribag and Ramgarh district on 18th Feb. 2022 at ICAR-IARI-Jharkhand in collaboration with District Agriculture Office, Hazaribag, Dept. of Agriculture, Jharkhand.

- Dr. Pankaj Kumar Sinha delivered talk on 'Strategies for managing agribusiness through FPOs for increased effectiveness' during 3-days residential workshop of members of Board of Director & CEO 03rd February, 2022 organized by NABARD, Hazaribag at Balsagra village, Dadi Block of Hazaribag district.

- Dr. Pankaj Kumar Sinha delivered talk on 'Strategies for managing agribusiness through FPOs for increased effectiveness' during 3-days residential workshop of Directors & CEOs of FPOs (11th - 13th March, 2022) on 12th March, 2022 organized by NABARD, Hazaribag in Hotel Sri Vinayak, Hazaribag.

- Dr. Pankaj Kumar Sinha, Dr. Dipak Kumar Gupta and Dr. Krishna Prakash delivered talk on 'Strategies for promoting agri-business among farmers of Ramgarh district of Jharkhand' during the Krishi Mela organized on the occasion of Krishak Samagam by Dept. of Agriculture, Animal Husbandry & Cooperation on 12th Feb. 2022.

- Dr. Pankaj Kumar Sinha has rendered his service in Hello Kisan Program of Door Darshan on 'Natural Farming" on 27th May 2022.

- Dr Pankaj Kumar Sinha provided technical support & inputs for NABARD grants project to SARDA (NGO) in preparation of detailed project report, architectural layout for farm plan design for project implementation, site visit, scientific & technical inputs during project planning, preparation and implementation during 02 Nov, 2022 to 31 March, 2022.

- Dr. Vishal Nath, Dr. Dipak Kumar Gupta, Dr. Pankaj Kumar Sinha and Dr. Shilpi Kerketta was involved in organization of sensitization-cum-awareness program about agricultural education and their scope & significance in collaboration with D.A.V. Public School, Hazaribag on 28th April, 2022.

- Dr Pankaj Kumar Sinha delivered talk as resource person during the livelihood enterprise development program on mustard cultivation of NABARD on 17th Dec. 2022.

- Dr. Vishal Nath and Dr. Pankaj Kumar Sinha delivered talk as resource person during the livelihood enterprise development program on mustard cultivation of NABARD on 17th Dec. 2022.

- Dr. Dipak Kumar Gupta and Dr. Pankaj Kumar Sinha participated and delivered the expert talk in workshop-cum-exposure visit of bank, government offices and research institutes in collaboration with NABARD, Hazaribag to develop closer interface with farmers/SHGs organized by NABARD, Regional Office, Ranchi.

- **Training/Conference/ Seminar/ Symposium/ Workshop Attended**

Personnel	Workshop/ Seminar/ Conference/ Symposium/ Training	Duration	Institute/ Place
Dr. Vishal Nath	National seminar on climate resilient horticulture: adaptation and mitigation strategies	Aug 13th –14th, 2022	Nalanda College of Horticulture, Noorsarai, Bihar
	National conference on landscape management for preventing flood and reservoir sedimentation (LMPFRS-2022)	Sep 22nd –24th, 2022	Birsa Agricultural University, Ranchi (Jharkhand)
Dr. S. K. Mahanta	Webinar meeting on use of gm crops and derivatives for dairy industry	Jan 31st 2022	Biotech Consortium India Limited and Animal Nutrition Society of India (Online mode)
	Agri based technological interventions for entrepreneurship development in semi-arid zone	Aug 22nd –26th, 2022	MANAGE, ICAR-DRMR, Bharatpur (online mode)
	National group meeting of AICRP on forage crops	Sep 26th – 27th, 2022	ICAR-IGFRI, Jhansi (online mode)
	Webinar meeting on DDGS for animal feed: opportunities and challenges	Nov 11th 2022	The Compound Livestock Feed Manufacturers Association of India (Online mode)
Dr. P. R. Kumar	National seminar on climate resilient horticulture: adaptation and mitigation strategies,	Aug 13th –14th, 2022	Nalanda College of Horticulture, Noorsarai, Bihar
	61st Annual workshop of AICRP (wheat and barley)	Aug 29th –31st, 2022	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (Online mode)
	National conference on digital organic interventions towards sustainable agriculture, horticulture and animal husbandry (DOISHA2022)	Oct 15th – 16th, 2022	ICAR-IIRR, Hyderabad (Online mode)
Dr. B. N. Mandal	Eighth international conference on statistics for twenty-first century-2022 (ICSTC-2022)	Dec 16th – 19th, 2022	International Statistics Fraternity (ISF), School of Physical and Mathematical Sciences and Department of Statistics, University of Kerala

Personnel	Workshop/ Seminar/ Conference/ Symposium/ Training	Duration	Institute/ Place
Dr. Dipak Kumar Gupta	National conference on landscape management for preventing flood and reservoir sedimentation (LMPFRS-2022)	Sep 22nd –24th, 2022	Birsa Agricultural University, Ranchi (Jharkhand)
	International conference on natural science and green technologies for sustainable development (NSTD-2022)	Nov 28th – Dec 2nd, 2022	Goa University, Taleigao Plateau, Goa
Dr. Monu Kumar	10th International conference on legume genomics and genetics – 2022 (10th ICLGG-2022)	Nov 8th 2022	ICRISAT, Hyderabad (Online mode)
	1st International symposium on cereals for food security and climate resilience	Jan 18th – 20th, 2022	ICAR-IIWBR, Karnal (Online mode)
Dr. Krishna Prakash	21 days winter school on underexploited vegetables: unexplored treasure trove for food, nutritional and economic security	Feb 2nd – 22nd, 2022	ICAR-IIVR, Varanasi
	6 days training program on plant taxonomy for plant genetic resources management	Mar 21st – 26th, 2022	NBPGR, Regional station, Thrissur, Kerala (Online mode)
	National conference on climate resilient and sustainable development of horticulture	May 28th –31st, 2022	CSUAT, Kanpur, UP
	National Seminar on Climate Resilient Horticulture: Adaptation and Mitigation Strategies	Aug 13th –14th, 2022	Nalanda College of Horticulture, Noorsarai
	National conference on plant genetic resource management (NCPGRM 2022)	Nov 22nd –24th, 2022	NASC Complex, New Delhi
Er. Ranjit Singh	Winter school (21 days) on recent advances in electronic devices, artificial intelligence and machine learning for precision agriculture	Feb 1st – 21st, 2022	ICAR-CIAE, Bhopal

Personnel	Workshop/ Seminar/ Conference/ Symposium/ Training	Duration	Institute/ Place
	National conference on millet for food and nutrition security (MFNS-2022)	Nov 14^{th} –15^{th}, 2022	Department of Food Processing Technology, Ghani Khan Choudhary Institute of Engineering and Technology, Malda, West Bengal
Dr. Himani Priya	Workshop on WDC - PMKSY 2.0 in watershed development	Apr 21^{st} –23^{rd}, 2022	Government of Bihar, Deptt. of Agriculture Bihar Watershed Development Society (SLNA), Bameti, Patna, Bihar
	VII^{th} International conference on GRISAAS-2022	Nov 21^{st} –23^{rd}, 2022	Birsa Agricultural University, Ranchi, Jharkhand
Dr. Anima Mahato	Training cum workshop on basics of data analysis using r studio (TW-BDAR)	June 13^{th} –17^{th}, 2022	Department of Economics, School of Management, Pondichery University (Online mode)
Dr. Santosh Kumar	65^{th} Annual maize workshop		ICAR-IIMR, Ludhiana (Online mode)
	National conference on maize for resource sustainability, industrial growth and farmers' prosperity	Feb 23^{rd} – 25^{th}, 2022	MTAI, Ludhiana (Online mode)
	Webinar on plant biotechnology for sustainable agriculture	Aug 17^{th} 2022	Society for Plant Research, Noida, Uttar Pradesh (Online mode
	21 days CAFT training on genome utilization and editing of plant for useful trait	Nov 30^{th} - Dec 20^{th}, 2022	ICAR-NIPB, New Delhi
Dr. Shilpi Kerketta	21 days summer school on recent trends in sustainable livestock and crop production technologies vis-a-vis climate change	June 18^{th} – July 8^{th}, 2022	Online mode
Dr. S. N. Sangma	15^{th} IUPAC international congress of crop protection chemistry	Mar 14^{th} -17^{th}, 2022	New Delhi

- **Invited Lecture/ Talks in Training**

Personnel	Topic	Duration	Program
Dr. Ranjit Singh	Value addition of watermelon	Apr 27th 2022	Evaluation of watermelon varietal performance in agroclimate condition of Hazaribag and Ramgarh district under Azadi ka Amrit Mahotsav, Kissan Bhagedari, Prathimatika Hamari
Dr. Himani Priya	Role of biofertilizers in improving soil health	Dec, 9th – 12th, 2022	Rural horticultural work experience program (RHWEP) for B.Sc. (Hort.), at ICAR-IARI, Jharkhand
Dr. Anima Mahato	मूंग में गुणवत्तापूर्ण बीज उत्पादन की तकनीक	Aug 16th - 18th, 2022	नाबार्ड सम्पोषित योजना झारखंड में पोषण एवं आजीविका सुरक्षा हेतु धान की परती पारिस्थितिकी तंत्र में दलहनी फसलों की सतत गहनता अंतर्गत त्रिदिवसीय किसान प्रशिक्षण कार्यक्रम ICAR-IARI, Jharkhand
Dr. Santosh Kumar	एकल संकर मक्का बीज उत्पादन की तकनीकें क्वालिटी प्रोटीन मक्का की विशेषताएं एवं उसका महत्व मक्का के फसल में फॉल आर्मी वर्म कीट का प्रबंधन	May 30th – June 1st 2022	झारखण्ड में गुणवत्तायुक्त प्रोटीन मक्का के एकल संकर मक्का बीज उत्पादन की तकनीक विषय पर त्रिदिवसीय युवा कृषक प्रशिक्षण कार्यक्रम ICAR-IARI, Jharkhand
	धान की वैज्ञानिक पद्धति द्वारा खेती धान के फसल में किट एवं रोग प्रबंधन	June 20th –29th, 2022	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा धान की खेती Block: Barhi, Hazaribag, Jharkhand (TSP) Block: Churchu, Hazaribag, Jharkhand (TSP) Block: Dadi, Barkagaon, Keredari, Hazaribag, Jharkhand (TSP)
	धान की वैज्ञानिक पद्धति द्वारा खेती धान के फसल में कीट एवं रोग प्रबंधन	July 4th – 6th, 2022	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा धान की खेती Block: Barhi, Hazaribag, Jharkhand (TSP)

Personnel	Topic	Duration	Program
	मक्का की वैज्ञानिक पद्धति द्वारा खेती मक्का के फसल में फॉल आर्मी वर्म कीट का प्रबंधन	July 13th - 25th, 2022	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा मक्का सब्जी एवं कुलथी की खेती Block: Churchu, Hazaribag, Jharkhand Block: Dadi, Barkagaon, Keredari, Hazaribag, Jharkhand Block: Tatijhariya, Hazaribag, Jharkhand Block: Vishnugarh, Hazaribag, Jharkhand Block: Barhi, Hazaribag, Jharkhand
	कुलथी की वैज्ञानिक पद्धति द्वारा खेती	July 20th, 2022	उच्च उत्पादकता हेतु वैज्ञानिक पद्धति द्वारा कुलथी की खेती Block: Barkagaon, Hazaribag, Jharkhand

List of Publications

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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, Santosh Kumar, Preeti Singh, Dipak Kumar Gupta]

- **CRSCIARIJSIL2021002XXXXX:** Genetic enhancement of maize for drought and soil acidity conditions [***Workers***: PI- Santosh Kumar, Co-PIs- Anima Mahato, Preeti Singh, Ashok Kumar**,** Pankaj Kumar Sinha]

- **CRSCIARIJSIL2021003XXXXX:** Genetic improvement for yield enhancement and resistance to abiotic stresses in mungbean and lentil [***Workers***: PI- Anima Mahato, Co-PIs- Gyan Prakash Mishra, Santosh Kumar, 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, Monu Kumar, Ashok 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]

- **CRSCIARIJSIL2021007XXXXX:** Improvement of wheat for quality and cropping system perspective (***Workers***: PI- Priya Ranjan Kumar, Co-PIs- Monu Kumar, Anju Mahendru Singh, Rajbir Yadav, K K Singh, Surya Prakash, Manoj Chaudhary, Asha Kumari, Ashok Kumar]

- **CRSCIARIJSIL2021008XXXXX:** Genetic improvement of Parwal/Pointed Gourd for yield and quality enhancement [***Workers***: PI- Krishna Prakash, Co-PIs- Vishal Nath, Santosh Kumar, Anima Mahato, Sougata Bhattacharjee, Ashok Kumar, Ranjit Singh]

- **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]

- **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]

- **CRSCIARIJSIL2022011XXXXX:** Identification of sustainable cropping systems under natural farming practices for medium land/upland of Jharkhand [***Workers***: PI- Dipak Kumar Gupta, Co-PIs- Vishal Nath, Anima Mahato, Krishna Prakash, Shilpi Kerketta, Manoj Chaudhary, Himani Priya, Shannon N. Sangma and Pankaj Kumar Sinha]

- **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]

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 center for adolescent girls in Hazaribag, Jharkhand [**Workers**: Pankaj Kumar Sinha (PI), Shilpi Kerketta , Vishal Nath, Dipak Kumar Gupta, Niranjan Kumar, Asharani Patel, Krishna Prakash; **Duration:** 2023-2024]

- **CRSCIARIJCOP2022005XXXXX (ICAR-ATARI, Patna Funded)**: Agri-drone project [**Workers**: Pankaj Kumar Sinha (PI), Dipak Kumar Gupta, Monu Kumar, Krishna Prakash, Santosh Kumar, Ashok Kumar, Shannon N. Sangma, Himani Priya]

- **Republic Day Celebration**

Republic Day on 26th January, 2022 was celebrated within ICAR-IARI, Jharkhand campus with great fervor. On this occasion a small cultural event was organized among institute staffs and master students enrolled here. Then after a competition of volleyball match was conducted between students and staff of institute.

- **Quiz for students and faculties**

Quiz was organized on the occasion of Basant Panchami to pray the Goddess of Knowledge on the occasion of Saraswati puja. Students, scientific and non-scientific staffs actively participated the programme. The winner team was felicitated with prize by respected OSD, ICAR-IARI, Jharkhand.

- **Teacher's Day**

Teachers Day celebration was organized at institute by M Sc students on 5th Sept 2022. The whole function was planned by the students. Students performed a scintillating cultural show to denote their love, respect, acknowledgement and recognition of the hard work put in by the teachers towards their development. Program concluded with OSD's address extending his heartiest thanks to all students on behalf of staff.

- **Independence Day Celebration**

Independence Day was celebrated at ICAR-IARI campus with great enthusiasm among scientific, nonscientific staffs and PG students of ICAR-IARI, Jharkhand August 15, 2022. 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 memento was distributed as token of love and appreciation by respected OSD, ICAR-IARI, Jharkhand.

- **Hindi Diwas**

Hindi diwas was celebrated on September 14, 2022 among the scientific staff and students of ICAR-IARI, Jharkhand under the chairmanship of OSD, ICAR-IARI, Jharkhand to highlight the importance of our national language Hindi in agriculture science. On this dayhindi quiz, essay writing and hindi grammar competition was organized by members of Hindi RajbhashaAnubhagwhich was actively participated by all the IARI staff and students.

- **Swachhata Campaign 2.0**

Swachhtacampaign 2.0 was organised as a part of Swachh Bharat Abhiyan from 02/10/2022 to 31/10/2022 at IARI, Jharkhand with an objective to bring intense focus on the issues and activities related to Swachhta. This Swachhtacampaign was categorized into different activities daily to conduct the programme at institute successfully. On the first day all the Scientists and Staff of the Office, took the "Swacchta" pledge led by OSD, ICAR-IARI, Jharkhand regarding cleanliness of institute farm and campus. He also briefed the list of activities to be organized/followed during the campaign.Later Swachhta Action Plan- 2022 was constituted and followed.

- **World Soil Day**

ICAR-IARI, Jharkhand organized a programme on World Soil Day on December 05, 2022 under the chairmanship of OSD, ICAR-IARI, Jharkhand. The programme was attended by scientific, administrative and Technical staff of institute. The Students of Birsa Agricultural University (BAU), Ranchi came for RAWE Training at institute also joined the programme.On this occasion OSD, emphasized on healthy life and addressed that if we want to stay healthy, then the soil exploitation and erosion must be avoided.In addition it was advised to make farmers aware about judicious application of fertilizer. Soil Scientistsin his remark explained the importance of micro nutrients of soil, proper usage of fertilizer and soil health card.A quiz competition was also organized which was actively participated by the students of BAU.

- **Foundation Day**

ICAR-IARI, Jharkhand celebrated its 8th foundation day on 28th June 2022 through hybrid mode.Dr. O.N. Singh, Vice-Chancellor, Birsa Agricultural University was the Chief Guest and Dr. Newton Tirkey, District Animal Husbandry Officer, Hazaribag was the Guest of Honor of the function.Programme was attended by staff of the institute, FPO farmers and also by students perusing M.Sc here. On this occasion, RajbhashaPatrika (BhadrikaPunj), Institute News Letter and a Training Manual on seed production of hybrid Maize were also released in order to outreach the stake holders.

- **Project Review Meeting**

To review various ongoing research projects and upcoming research projects both institutional and external funded, a meeting was held on 27th-28th September, 2022 under the Chairmanship of OSD, ICAR-IARI-Jharkhand. Progress of the approved ongoing projects were presented, and reviewed thoroughly. A number of ongoing research projects were decided to be modified as per suggestions provided by house during meeting. Eight new institute research projects were proposed in meeting to be started in coming year. In meeting scientist were encouraged to seek externally funded projects and outline the research priorities matching with the mandate of the institute.

- **First QRT in 2023**

The QRT meeting was held on 01.11.2023 in the Committee Room of Academic-cum-Administrative Building, ICAR-IARI-Jharkhand. The following dignitaries were present in the meeting-

» Dr. J.C. Katyal, Member QRT, ICAR-IARI, New Delhi
» Dr. S.S. Baghel, Member QRT, ICAR-IARI, New Delhi
» Dr. S.N. Puri, Member QRT, ICAR-IARI, New Delhi
» Dr. K.K. Narayanan, Member QRT, ICAR-IARI, New Delhi
» Dr. A.K. Singh, Director, ICAR-IARI, New Delhi
» Dr. C. Viswanathan, Joint Director Research, ICAR-IARI, New Delhi
» Dr. D.K. Singh, Professor and Chairman Works Committee, ICAR-IARI, New Delhi
» Dr. Vishal Nath, OSD, ICAR-IARI, Jharkhand

The Chief Administrative Officer (SG), the Co-ordinators of Schools, Crop Science, Natural Resource Management and Animal & Fishery Sciences, the entire scientific fraternity, administrative, financial and technical staffs of ICAR-IARI, Jharkhand were also present in the meeting.

The meeting started with ICAR Song. The OSD, ICAR-IARI-Jharkhand extended warm welcome to all the dignitaries. Thereafter, the meeting was proceeded with a welcome address by honourable Director, ICAR-IARI, Jharkhand and a presentation by OSD, ICAR-IARI, Jharkhand on last five years' progress of the institute. Discussions were held on various issues and the remarks made by the honourable QRT Members on academic, research and outreach activities, infrastructures/ facilities are as follows-

Dr. K. K. Narayanan:

» ICAR-IARI, Jharkhand has created very nice physical/infrastructure facilities and it has a potential to become leading academic institution in future. Now it needs to create intellectual facilities for working within a given system.

Dr. J. C. Katyal:

» The institute has shown excellent progress in shortest possible time.
» In 44 acres of residential campus with 25 quarters and two hostels, a residential doctor is needed to be hired for 24 x 7 or at least 5 days/week.
» Handover of a building/infrastructure should only be taken/ accepted after full satisfaction with the work to make it fully operational by staff and students.
» Green manuring with dhaincha@ 4 kg/ha should be done in all experimental plots of Research

Farmfor at least 2 years for improving the organic matter content of the soil, as the fertility status of soil is very poor.

- Soil characterization, profiling and capability classification etc should also be done in collaboration with ICAR-NBSSLUP, Nagpur. A topographic map for the farm area needs to be developed.
- There are many water bodies in the farm area, which need to be developed as pond for ground water recharge and irrigation, and the silts removed from these water bodies should be used in the fields (Research Farm) to improve organic matter contents in the soils.
- Automatic weather station needs to be installed in Research Farm on urgent basis.
- On the concept of selecting crops with purpose (economic and ecological importance), the honourable member suggested to include two more crops under crop research programmes *viz.,* Mehandi and Curry plant along with their value addition.
- Creation of Bench Marks in the region with characterization of soil and other physical resources, biodiversity etc. and this bench mark characterization needs to be conducted after every 5 years to convert it into a heritage in the long run.
- Need to set up different experiential learning modules (like Hybrid seed production, Nursery raising, Dairy farming etc) for the final year B.Sc. (Ag) students
- The institute should go for farmer led extension and also provide space for thinking of farmers

Dr. S.S. Baghel:

- Great satisfaction and achievements/ progress is praise worthy
- All scientists/researchers should spend as much time as possible in the field, participatory breeding approaches should be followed in selection/development of new varieties.
- Since the institute is involved in UG teaching, the level of students and their learning capability should be prime focus for effective teaching.
- Planning of research should go in inter-disciplinary/ multi-disciplinary mode
- The newly developed fields in the research farm of IARI, Jharkhand are highly heterogeneous and need testing soil fertility status before taking up an experiment.
- Prioritize development of laboratories for conducting UG practicals.
- Experimental farm needs to be properly developed with roads/ paths, irrigation network, drainage along with experimental plots for research and student trials.

Dr. S.N. Puri:

- IARI has started the UG program because many SAUs are not showing competitiveness up to the mark. We need to develop modern facilities including tissue culture laboratory for consolidation of UG program.
- At least 6experimental units *viz.,* poultry, dairy, fishery, protected horticulture, nursery raising, mushroom etc. should be developed for the experiential learning of B.Sc. final year students.
- Strengthening of library: Minimum six copies of each text book of all subjects should be kept in the library. Books for procurement should be selected by respective teachers. Journal/e-journals should be also kept in the library.
- Program to program concept should be followed while planning for student'sresearch.
- Crop cafeteria,in a location nearby from the gate, needs to be developed and maintained for UG students in all seasons.

- Maintenance of infrastructure and other facilities developed in the institute needs to be monitored on routine basis.

Dr. A. K. Singh:

- Development of all basic facilities for conducting UG practical on priority basis and provide hands on training to the students.
- An amount of Rs. 1 crore under the unified budget (capital) needs to be fully utilized for purchase of equipment and development of other laboratory facilities in next 4-5 months. All files should be processed within a day or two from each and every platform.

- **Monitoring of NABARD Funded Projects**

Project Monitoring and Review Committee (PMRC) meeting of NABARD Project was held on 1st July, 2022 to review the progress and work to be done in upcoming years. The meeting was headed by OSD, ICAR-IARI, Jharkhand, DDM, NABARD, Hazaribag and AGM, NABARD, RO, Ranchi were also present from NABARD side.

- **Breeder seed production Monitoring Team**

To strengthen the Breeder seed production at Institute, a monitoring team visited and conducted meeting on March 10, 2022. A Guest Lecture was also delivered by Sri Yogesh Kumar, Area Manager, NSC, Ranchi on various variety of breeder seed including fodder variety.


भाकृअनुप-भारतीय कृषि अनुसंधान संस्थान-झारखंड
पंचवर्षिक समीक्षा समिति
ICAR-INDIAN AGRICULTURAL RESEARCH INSTITUTE
JHARKHAND
Welcomes
Quinquennial Review Team
MILLETS


Dr. J.C. Katyal


Dr. Vishal Nath


सुरक्षा प्रहरी कक्ष
ECURITY GAURD ROOM


Administrative building


Residential quarters

Guest house

Girls hostel

Boys hostel

Class room


Smart class room

Scientist's sitting room

Administration and Accounts

1. Financial Statement (Rs. in Lakhs) of IARI, Jharkhand (2022-23)

Major heads	Sub-heads	BE 2022-23	RE-2022-23	Receipt	Expenditure	% Utilization of allocation
Main	Capital	1150.00	0.00	1150.00	1147.30	
	General	160.00	0.00	160.00	158.50	
	Total	1310.00	0.00	1310.00	1305.80	
NEH	Capital	0.00	0.00	0.00	0.00	
	General	0.00	0.00	0.00	0.00	
	Total	0.00	0.00	0.00	0.00	
SCSP	Capital	260.00	0.00	260.00	260.00	
	General	150.00	0.00	150.00	148.80	
	Total	410.00	0.00	410.00	148.80	
TSP	Capital	0.00	0.00	0.00	0.00	
	General	50.00	0.00	50.00	49.30	
	Total	50.00	0.00	50.00	0.00	
Grand Total		1770.00	0.00	1770.00	1763.90	99%

2. Staff strength as on 31.12.2023

Cadre	Sanctioned	In position	Vacant
Research management			
Scientist	41	30	11
Technical	12	1	11
Administrative	11	4	7
Total	64	35	29

3. New appointments/joining on transfer

Sl	Name	Joining date
1	Dr. B. N. Mandal, Senior Scientist	w.e.f. 2022
2	Dr. Niranjan Kumar, Scientist	w.e.f. 2023
3	Mr. Abhay Kumar Giri, Scientist	w.e.f. 2023
4	Dr. Asharani Patel, Scientist	w.e.f. 2023
5	Dr. Nuzaiba PM, Scientist	w.e.f. 2023
6	Dr. R. Bharathi Ratinam, Scientist	w.e.f. 2023
7	Dr. Saheb Pal, Scientist	w.e.f. 2023
8	Dr. Narendra Singh, Scientist	w.e.f. 2023
9	Mr. Akash A, Scientist	w.e.f. 2023
10	Mr. Kasinath G Teli, Scientist	w.e.f. 2023
11	Dr. Pavithra KN, Scientist	w.e.f. 2023
12	Dr. Monika M., Scientist	w.e.f. 2023
13	Mr. Dilip Roy, CAO (SG)	w.e.f. 2023
14	Mr. Rajnish Kumar, FAO	w.e.f. 2023
15	Mr. Sonu Kumar, AAO	w.e.f. 2023

Distinguished Visitors

Mr. Jayant Sinha
Honorable Member of Parliament
Hazaribag, Jharkhand

Dr. OnkarNath Singh
Vice-Chancellor
Birsa Agricultural University, Ranchi

Abhay Kumar Singh
AGM, NABARD
Ranchi, Jharkhand

Mr. Raushan Kumar
District Forest Officer
Hazaribag, Jharkhand

Dr. Y. K. Singh
Deputy Director
National Seed Corporation, Ranchi

Dr. Newton Tirkey
District Animal Husbandry Officer
Hazaribag, Jharkhand

Mr. Prem Prakash Singh
DDM, NABARD
Hazaribag, Jharkhand

Dr. D. K. Singh
Director,
ICAR-Indian Institute of Seed Science
Mau, Uttar Pradesh

Dr. D.K. Yadav
ADG (Seed)
ICAR, New Delhi

Dr. Indramani Mishra
Head, AE Division
ICAR-IARI, New Delhi

Dr. J.C. Katyal,
Ex- DDG (Education), ICAR, New Delhi
Ex- Vice- Chancellor, (CCS-Hissar)
Member QRT, ICAR-IARI, Jharkhand

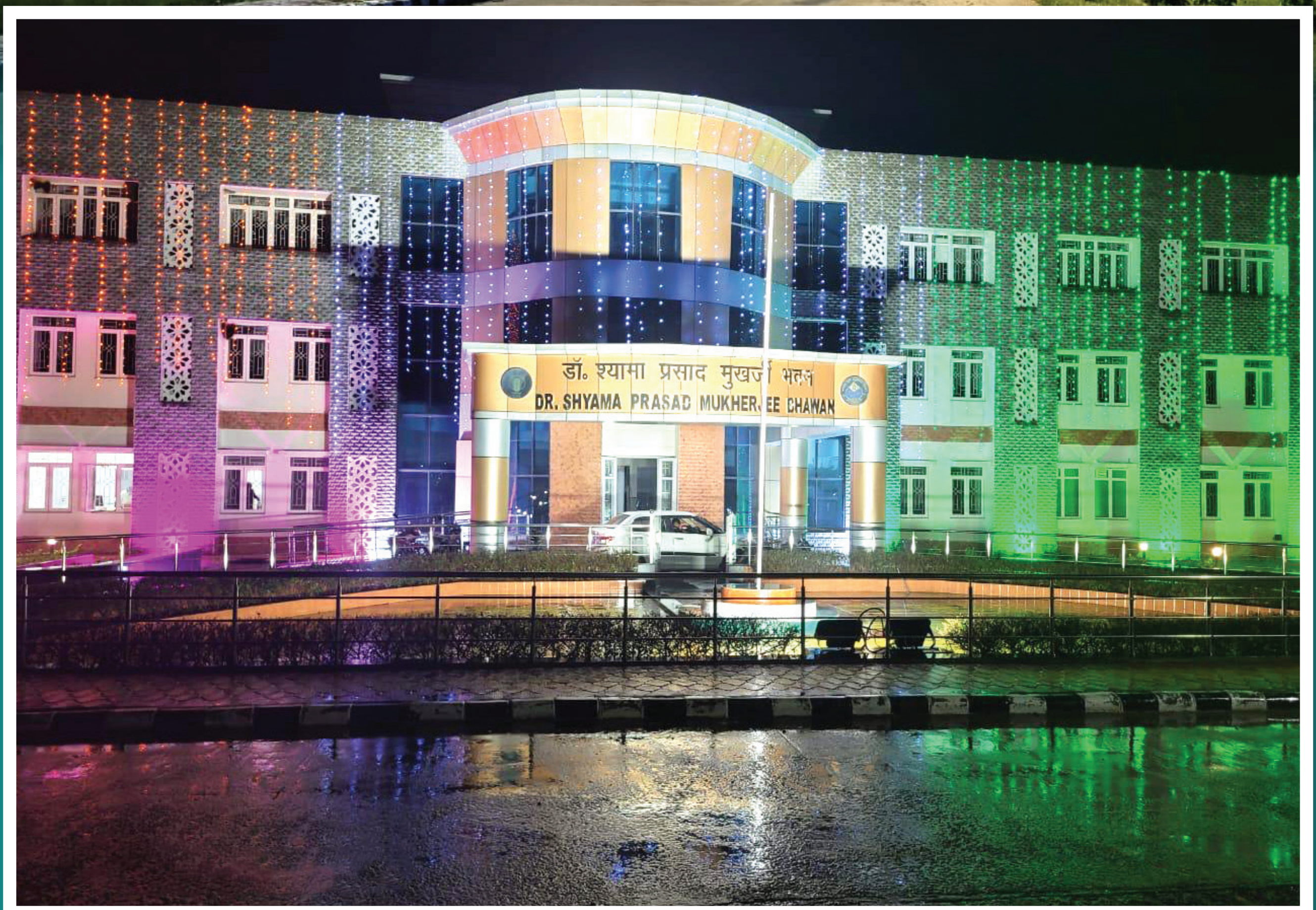
Dr. S.S. Baghel,
Ex- Vice- Chancellor, (CAU-Imphal & AAU-Jorhat)
Member QRT, ICAR-IARI, Jharkhand

Dr. S.N. Puri,
Ex- Vice- Chancellor, (CAU-Imphal)
Member QRT, ICAR-IARI, Jharkhand

Dr. K.K. Narayanan,
Director, Sthayika Seeds Private Limited, Bengaluru
Member QRT, ICAR-IARI, Jharkhand

List of Personnel

Name	Designation
Director	
Dr. A.K. Singh	Director (Additional charge)
Scientific	
Dr. Vishal Nath	OSD and Principal Scientist
Dr. Sanat Kumar Mahanta	Principal Scientist (Animal Nutrition)
Dr. Priya Ranjan Kumar	Principal Scientist (Genetics and Plant Breeding)
Dr. B. N. Mandal	Senior Scientist (Agricultural Statistics)
Dr. Manoj Chaudhary	Scientist (Soil Sciences)
Dr. Dipak Kumar Gupta	Scientist (Environmental Sciences)
Dr. Monu Kumar	Scientist (Genetics and Plant Breeding)
Dr. Krishna Prakash	Scientist (Horticulture)
Dr. Pankaj Kumar Sinha	Scientist (Agricultural Extension)
Dr. Himani Priya	Scientist (Agricultural Microbiology)
Dr. Anima Mahato	Scientist (Genetics and Plant Breeding)
Dr. Santosh Kumar	Scientist (Genetics and Plant Breeding)
Dr. Preeti Singh	Scientist (Soil Sciences)
Er. Ranjit Singh	Scientist (Agricultural Structure and Process Engineer)
Dr. Asha Kumari	Scientist (Plant Physiology)
Mr. Ashok Kumar	Scientist (Plant Biochemistry)
Dr. Shilpi Kerketta	Scientist (Livestock Production and Management)
Dr. Sougata Bhattacharjee	Scientist (Agricultural Biotechnology)
Dr. Shannon N. Sangma	Scientist (Agricultural Chemicals)
Dr. Niranjan Kumar	Scientist (Agricultural Chemicals)
Mr. Abhay Kumar Giri	Scientist (Aquaculture)
Dr. Asharani Patel	Scientist (Plant Pathology)
Dr. Nuzaiba PM	Scientist (Fish Nutrition)
Dr. R. Bharathi Ratinam	Scientist (Fish Health)
Dr. Saheb Pal	Scientist (Vegetable Science)
Dr. Narendra Singh	Scientist (Fruit Science)
Mr. Akash A	Scientist (Seed Science)
Mr. Kasinath G Teli	Scientist (Agronomy)
Dr. Pavithra KN	Scientist (Agricultural Economics)
Dr. Monika M.	Scientist (Poultry Science)
Technical	
Mr. Sushil Marandi	ACTO (Librarian)
Administrative	
Mrs. Sanjeevan Prakash	Comptroller
Mr. Dilip Roy	CAO (SG)
Mr. Rajnish Kumar	FAO
Mr. Surjeet Kumar	AAO
Mr. Sonu Kumar	AAO



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