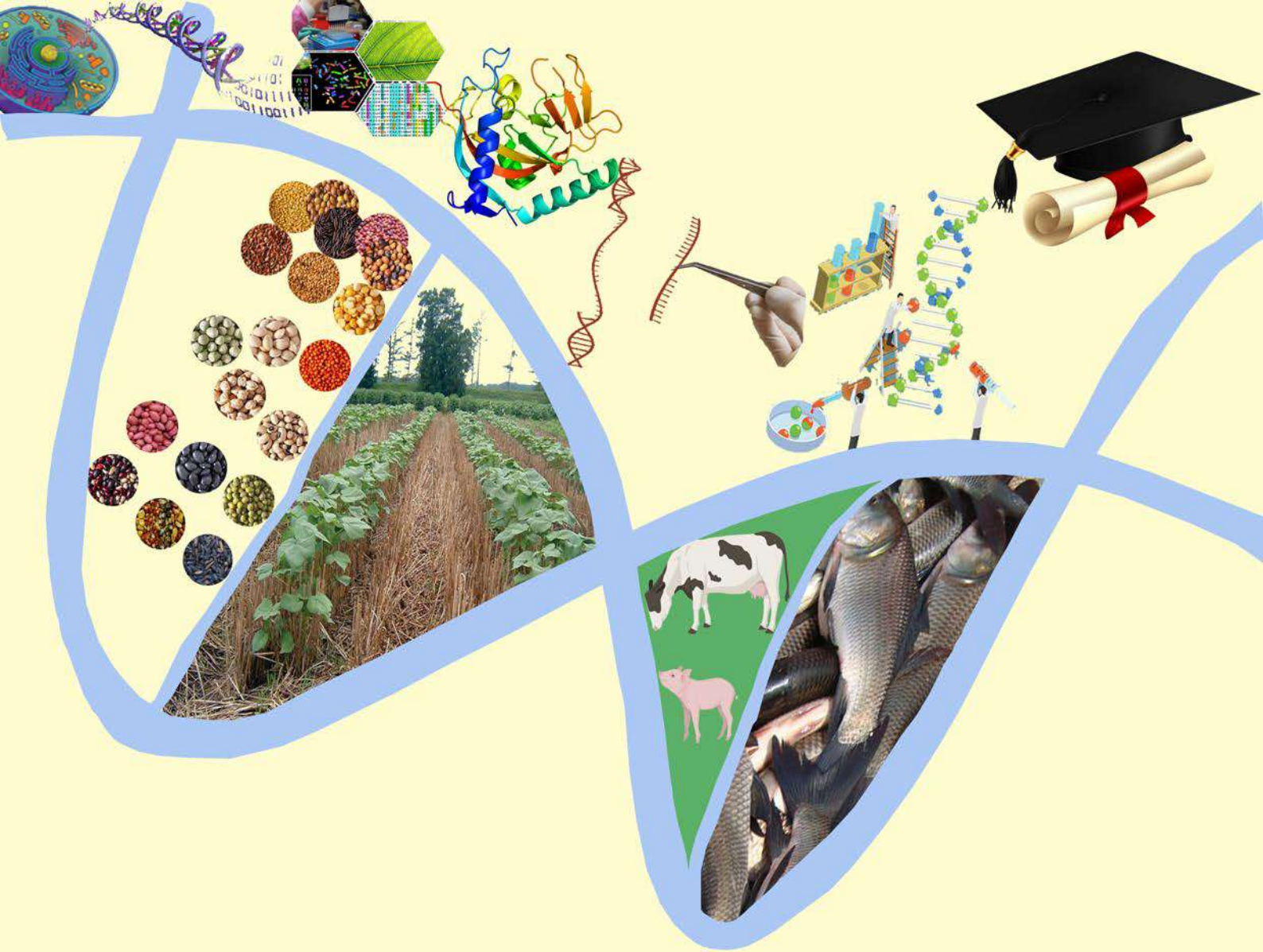

DRAFT ANNUAL REPORT

2020

ICAR-INDIAN INSTITUTE OF AGRICULTURAL BIOTECHNOLOGY

DRAFT ANNUAL REPORT

वार्षिक प्रतिवेदन

2020

ICAR - Indian Institute of Agricultural Biotechnology
भा.कृ.अनु.प. - भारतीय कृषि जैवप्रौद्योगिकी संस्थान
(*Deemed to be University*)
Garhkhatanga, Ranchi - 834 003 (Jharkhand)
गढखटंगा, रांची - 834 003 (झारखण्ड)

Annual Report 2020

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PREFACE

Agriculture is the primary source of livelihood for about 58 per cent of India's population. Gross value added by agriculture, forestry and fishing is estimated at Rs 19.48 lakh crore in the financial year 2020. India is expected to achieve the ambitious goal of doubling farm income by 2022. The agriculture sector in India is likely to generate better momentum in the next few years due to increased investments in agricultural infrastructures, and growing use of improved crop varieties suitable for various agroclimatic regions of the country. The Indian Council of Agricultural Research (ICAR) has played a pioneering role in Indian agriculture through its research and technology development that has enabled the country to increase the production of food grains by 5.6 times, horticultural crops by 10.5 times, fish by 16.8 times, milk 10.4 times and eggs 52.9 times since 1951, which made a visible impact on the national food and nutritional security. It has also played a vital role in promoting excellence in higher education in agriculture.

Recent developments on advanced molecular tools and understanding of complex molecular biology of traits and biological processes have enabled scientists to develop crop cultivars or animal breeds with more precision. During the 12th plan, ICAR has initiated "Genomics Platform" to comprehensively consider different plants, animal, fish and microbial species for genome analysis across the domains. In this context, ICAR-Indian Institute of Agricultural Biotechnology (IIAB), which is a multi-disciplinary institute, is playing a key role in achieving the national goal. The establishment of IIAB envisages the dream and task of meeting the demand for products, processes and technologies, as well as building world-class human resources for research in frontier areas through post-graduate teaching in all domains of agricultural biotechnology.

At present, the institute is operating from a camp office established at the Process and Demonstration Unit (PDU) campus of ICAR-IINRG located at Namkum, Ranchi with fourteen scientists from different disciplines. Although, the institute is still in its incipient stage, developmental activities are taken up on priority and research programmes undertaken in significant areas of Genomics and Bioinformatics, Translational Research for Crop Improvement and Fish Health Management, with modest research facilities available at the Institute. Annual report 2020 of ICAR-IIAB describes the research activities undertaken and outlines the significant achievements of the year 2020.

I wish to heartily congratulate all the staff of ICAR-IIAB engaged in scientific, administrative and financial activities and accord my gratefulness to all who contributed to this report. I sincerely express my appreciation to the members of the Editorial Board for their tireless efforts in preparing and bringing out this report.

I am thankful and express my gratitude to Dr. T. Mohapatra, Secretary, DARE, Government of India and Director General, ICAR; Dr. T.R. Sharma, Deputy Director General (Crop Science) and Dr. D.K. Yadav, Assistant Director-General (Seeds), ICAR for their constant supervision and guidance.

Ranchi
April, 2021

A. Pattanayak
Director, ICAR-IIAB

CONTENT

About the Institute

The ICAR-Indian Institute of Agricultural Biotechnology (IIAB), Ranchi, established under the Indian Council of Agricultural Research (ICAR), New Delhi, is a national institute for agricultural biotechnology, which envisages harnessing the immense potential of the advanced technologies in all aspects of agricultural biotechnology for enhancing the agricultural productivity and growth of the country. The chief mandate of the institute is basic and strategic research in agricultural biotechnology and imparting excellence in academics through improving the quality human resources. The institute works at the interface of plant, animal, fish and microbial biotechnology and integrates high-quality basic and applied research as well as conducts teaching and training programmes at master, doctoral and post-doctoral levels in all these frontier areas of agricultural biotechnology to form the mission of the institute. ICAR-IIAB aims to enhance agricultural development of the country at a revolutionary pace, through application of modern scientific tools and techniques for cutting-edge research in the field of agricultural biotechnology.

ICAR-IIAB conducts need-based research and can make paradigm shifts in its research agendas to address the pertinent constraints in the field of agriculture and to primarily focus on achieving self-sufficiency in food production and enhanced income for a self-reliant farming community. The research programmes of the institute encompass marker-assisted selection (MAS), identification of novel genes/alleles and promoters or cis-regulatory regions of genes from the vast and diverse biological resources in the country and to genetically engineer crops with novel traits for tolerance or resistance to biotic and abiotic stresses, enhanced productivity and nutrient-use efficiency. Development of molecular diagnostics for identification of diseases in plants, animals and fish and prophylactic measures for their control as well as generation, management and analysis of biological resources such as high throughput genomic/sequence data of biological organisms also are areas of research activities of the institute. Nanotechnology and its immense potential to develop detection systems for pests and diseases, and for nano-delivery of pesticides, vaccines, nutrients or hormones and genes, shall be explored. The institute shall also provide technical support and service in terms of tools, techniques and protocols in biotechnology, sequencing, bioinformatics, database management, safety studies, products and knowledge, thereby serving as a biotech hub under the National Agricultural Research and Education System (NARES). Though the institute is presently operating from a camp office established at the Process and Demonstration Unit (PDU) campus of ICAR-IINRG located at Namkum, Ranchi, it has built its new sprawling campus located at Garhkhatanga, on Ranchi Ring Road and is scheduled to shift there soon.

MANDATE

1) Basic and strategic research in agricultural biotechnology
2) Development of quality human resources for academic excellence in agricultural biotechnology and policy support

Cadre Strength

Category of Staff	Sanctioned	Filled	Vacant
RMP	8	2	6
Scientific	10	13	-
Technical	01	0	01
Administrative	02	01	01
Skilled Supporting	-	-	-
Total	21	16	8

Executive Summary

ICAR - Indian Institute of Agricultural Biotechnology was established in 2012 with the mandate of basic and strategic research in the frontier areas of agricultural biotechnology, development of quality human resources for academic excellence in agricultural biotechnology and policy support. The institute is presently functioning from a camp office established at the Process and Demonstration Unit (PDU) campus of ICAR-IINRG, Namkum, Ranchi. With its modest research facilities, the institute is working on three major areas namely, Genomics and Bioinformatics, Translational Research for Crop Improvement and Biotechnological Interventions for Fish Health Management. The progress of work done during the year 2020 is summarized below:

- Nano-encapsulated folic acid feed mixture prepared using soya lecithin and oleic acid was screened in different ratios using various compatible solvents. The size of developed nano-folic acid was recorded as 126nm with 89.19% encapsulation efficacy. Nano-folic acid enriched feed was formulated through standardized method at different experimental doses for further trials on Indian major carp.
- Rice genotypes differed for content of their bran oil and resistant starch (RS). The time of cooking, phenolics content and addition of oil before steam cooking could alter the RS content in rice.
- Full length coding DNA sequence (CDS) of major Class I and II genes of Swine Leucocyte Antigen (SLA) amplified and cloned, and characterization is presently underway.
- Traditional methods of enrichment tested for sex-specific segregation of bovine spermatozoa yielded varying results.
- Sixteen rice genotypes were screened to investigate zinc distribution/localization within brown rice using metallochromic indicator zincon and five genotypes (Chhattisgarh Zinc rice-1, CR DHAN-310, CR DHAN-311, DRR DHAN-49 and Pokkali Type 1) were identified having higher Zn content in their aleurone layer and embryo.
- Lentil genotypes JL3, Arun, Noori and HUL57 were screened for drought stress tolerance at vegetative stage and genotype HUL57 was found to be relatively drought tolerant as observed by qRTPCR analysis of drought marker genes.
- In groundnut, heat stress transcription factors (HSF) such as HSFA2, HSFC1, etc. and small molecular heat shock proteins (smhsps) were found to be associated with the heat stress (HS) response. Many chloroplast transcripts related to carbohydrate metabolism were reported to be differentially regulated in contrasting groundnut genotypes during heat stress.
- A computational analysis was performed for the first time to identify the toll like receptors (TLR) repertoire in the Siluriformes species, *Clarias batrachus*. The results indicated that positive selection and diversification of TLR repertoire of teleosts is an indication for the specific adaptations undergone by the species to survive the pathogenic interactions within its species.
- Hydroponic conditions were standardized for chickpea where pH 5 was identified to be the best for plant growth.

IIAB-CBB-01: Genomics and Bioinformatics

High throughput or next generation sequencing technology has revolutionized the pace of our understanding the way genome functions in response to different biotic and abiotic factors. The integration of recent advances in genomics, bioinformatics and molecular biology tools has enabled generation of knowledge regarding biochemical networks or gene regulatory pathways operating in plant and animal systems that has greatly facilitated in the development of strategies to improve the resilience of agricultural commodities to ill effects of global climate change. Changing climate poses serious threats to enhancement in crop productivity in a scenario of declining crop yields. Annotation of genome sequences has revealed that more than 25% genes code for unknown or hypothetical proteins. Thus, functions of such unknown proteins need to be unraveled. The following institutional projects were implemented in the research area "Genomics and Bioinformatics" at ICAR-IIAB, Ranchi to identify, characterize and annotate functions of known and unknown genes or proteins in both animals and plants, especially in pulse crops.

Identification and characterization of drought-responsive genes in wild chickpea (*Cicer microphyllum*)

Cicer microphyllum, one of the perennial wild relatives of the cultivated chickpea *C. arietinum*, is a characteristic species of the dry alpine vegetation in Himalayan and the trans-Himalayan regions. It is known for its remarkable tolerance against the extreme ecological conditions of cold desert. To identify the underlying candidate gene imparting drought tolerance, RNA-Seq analysis was employed which involved *de novo* transcriptome assembly of the Next Generation Sequence reads of control and dehydration stress-treated plant tissue samples. Comprehensive annotation of *C. microphyllum* transcriptome assembly was done using databases like non-redundant protein databases, UniProtKB, Swissprot, Pfam, KEGG (Kyoto Encyclopedia of Genes and Genomes), EC (enzyme commission) and PlantTFDB or Plant transcription factor database (**Table 1.1**). The most abundant annotated protein domains were found to be Protein Kinase (PF00069), PPR (pentatricopeptide) (PF01535), Leucine Rich (PF12799) repeats, RNA-binding motif (RRM, PF00076) and WD40 (PF00400, Zinc finger domains (PF00097), p450 (PF00067), MYB (myeloblastosis) DNA binding domain (PF00249), 50S ribosome binding GTPase (PF01926), Tetratricopeptide Repeat (PF07719) and Ras (PF00071). The most abundantly annotated transcription factors belonged to the families of protein bHLH (basic helix–loop–helix), bZIP (Basic Leucine Zipper Domain), ERF, MYB (myeloblastosis), WRKY, NAC (N-acetylcysteine), acetylene, C3H, B3 and ARF.

Table 1.1: Summary of annotation of the *Cicer microphyllum* transcriptome assembly

Total no. of transcripts with Gene Ontology (GO) terms assigned	58278
Biological GO terms	46394
Cellular GO terms	48449
Functional GO terms	49014
Transcripts with PFAM annotation	44109
Transcripts annotated by NR database	71044
Transcripts annotated with SwissProt	49045
KAAS (KEGG Automatic Annotation Server) annotation	33151
EC annotation	15896

Analysis of differential expression of genes was performed to determine significantly up- and down-regulated transcripts due to early and late dehydration. The enriched gene ontology (GO) terms involving major biological processes influenced by the stress conditions such as response to water deprivation (GO: 0009414), response to oxidative stress (GO: 0006979), cellular response to stress (GO: 0033554), cell wall organization (GO: 0071555), hormone-mediated signaling pathways (GO: 0009755) and response to unfolded proteins (GO: 0006986) that were derived from singular enrichment analysis on the sets of up-regulated transcripts under early and late dehydration that provide insights into the adaptive mechanism of *C. microphyllum*. To further determine pathway-specific adaptive responses, mapping of differentially expressed transcripts (DETs) was done onto pathways of Kyoto Encyclopedia of Genes and Genomes (KEGG) database that showed modification in expression of components of various pathways including those involved in the biosynthesis of secondary metabolites, plant-hormone signal transduction, photosynthesis, peroxisomes and Mitogen-activated protein kinase (MAPK) signaling pathway. DETs of major transcription factors and osmoprotectants such as Late Embryogenesis Abundant (LEA) proteins and Heat Shock Proteins (HSPs) were also analysed to identify the up-regulated members of the protein families. Seven thousand nine hundred genic SSR markers (excluding mononucleotide SSRs) were identified in 6782 transcripts which might be useful in studying genetic diversity and population structure analysis of the chickpea species.

Understanding the mechanisms of tolerance to aluminum (Al) toxicity in chickpea, linseed and finger millet

Seeds of 223 chickpea varieties and 160 landraces were procured from ICAR-IARI, New Delhi. In addition, 49 genotypes of chickpea were procured from ICRISAT, Hyderabad. In order to standardize the concentration of $AlCl_3$ inhibiting 50% root growth, seeds of genotype ICC4958 were soaked and germinated seeds were transferred to hydroponics in Magnavaca's media. After seven days, the seedlings were subjected to different concentrations of $AlCl_3$ *viz.,* 0, 25 µM, 50 µM, 100 µM, 150 µM and 200 µM. The Al accumulation was screened using Hematoxylin stain (2% hematoxylin; 0.002% potassium iodate) after 3h and 24h of stress, respectively. Destaining was done by rinsing with MilliQ water thrice for 15 min each. The root tips were observed under stereo-zoom microscope. Significant accumulation was observed after 3 h of stress.

Decoding the molecular mechanisms of molybdenum and boron metabolism in chickpea (*Cicer arietinum* L.) under acidic soil conditions

The micronutrients molybdenum (Mo) and boron (B) are important for growth and yield of chickpea. Molybdenum is limiting under acidic pH, while boron is deficient in soils of Jharkhand. Hence, the project was formulated to decipher the molecular mechanisms involved in the metabolism of the micronutrients Mo and B in chickpea under acidic soil conditions.

Pot culture experiments were conducted during *rabi* (post-rainy) season 2019-2020 (December to February) using pots (30 cm diameter and height) and four cultivars DJ 1, KJK 1, DJ 13 and DJ 31 (from ICAR-IIPR, Kanpur) with six treatments of Mo and B (0.5, 1.5 and 2.5 kg/ha each) along with respective controls. Six replications per treatment with three plants per replication / pot were used. Treatments were applied twice at the vegetative stage and before flowering. Treatment effects varied with genotypes. Control was comparable or better in growth rate and dry mass in the four varieties especially in cv. KJK 1. Single treatment of micronutrients at vegetative stage improved growth and nodulation, than the treatments at vegetative and flowering stages (13 and 28 days after sowing respectively) (**Fig. 1.1 i, ii**). High concentration of Mo and B (2.5 kg/ha) were inhibitory to shoot growth in cvs. DJ1 and KJK1. In general, Mo and B @ 1.5 kg/ha improved growth, Mo @ 1.5 kg/ha improved nodulation (**Fig. 1.2**) after the first treatment; Mo (0.5 kg/ha) and B (1.5 kg/ha) improved bud formation, while B @ 1.5 kg/ha increased pod setting though it was slightly toxic, and B @ 2.5 kg/ha was highly toxic.

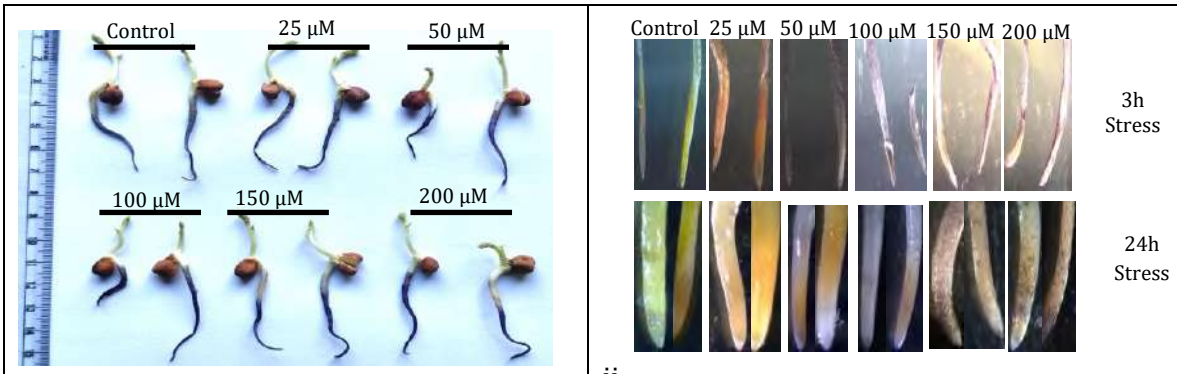


Fig. 1.1: Hematoxylin staining of root tips of chickpea seedlings treated with Aluminium after 3 h and 24 h of stress

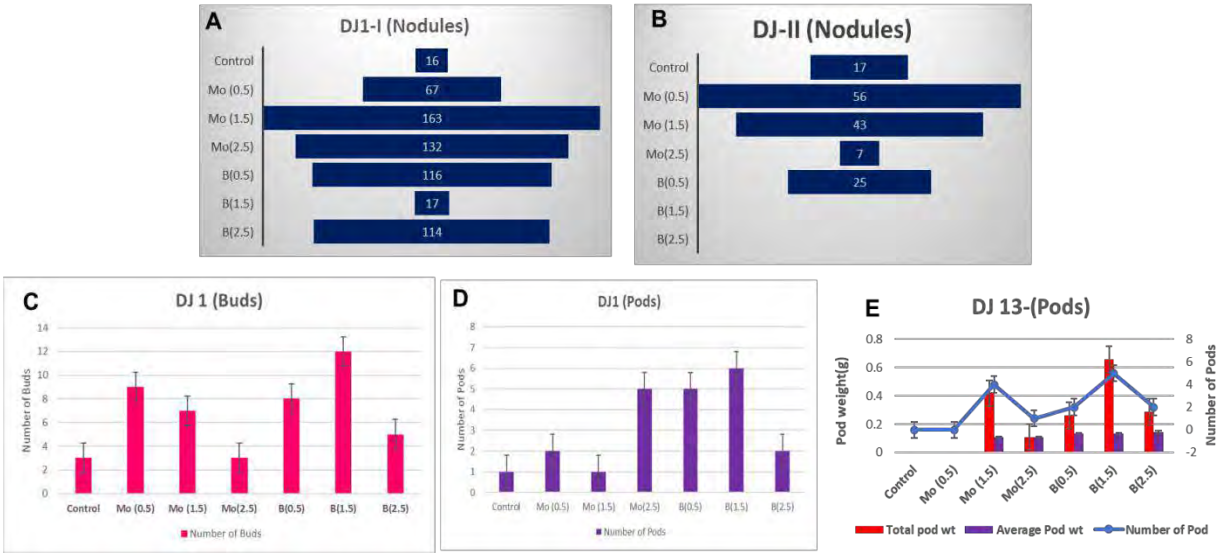


Fig. 1.2: Effects of micronutrient (Mo and B) treatments on chickpea. A: Nodulation in cv. DJ1 single treatment of Mo and B at vegetative stage; B: Two treatments at vegetative and flowering stages. Effect of micronutrient treatments on bud formation (C) and pod formation (D) of cv. DJ 1. E: Effect of micronutrient treatments on pod weight of cv. DJ 13. Treatments: 0.5, 1.5 and 2.5 kg/ha of Mo and B, respectively.

Pot culture experiments were repeated with genotypes JK9 and P37 (from IARI) with the five treatments (B and Mo @ 1.5 and 2.5 kg/ha each) including control, each replicated four times with three plants per replication / pot. Treatment with B @ 1.5 kg/ha improved bud formation and pod setting in both varieties (**Fig. 1.3 A, B**). RNA was isolated from shoot and roots of plants (three replications) from various treatments and control (**Fig. 1.3 C**).

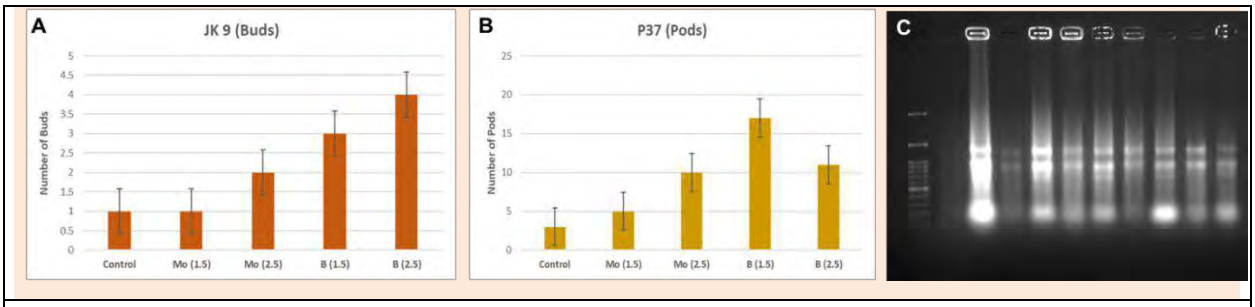


Fig. 1.3 : Effect of micronutrient treatment on bud and pod formation in pot culture studies. A. Effect of micronutrient treatment on bud formation in cv. JK9; B. Effect of micronutrient treatment on pod formation in cv. P37; C. RNA isolated from shoot and root tissues of cv. JK9 (treatments: 1.5, 2.5 kg/ha of Mo and B, respectively).

Hydroponics was standardised in chickpea to evaluate the effect of micronutrients on growth under acidic conditions (pH 5) and repeated for cv. DJ1 (**Fig. 1.4 A**). Hydroponic experiments were conducted at six different concentrations of micronutrients (B and Mo at 0.02, 0.2 and 2 mg/L) which were tested along with three controls (all nutrients, B: 0 and Mo: 0 mg/L) in each pH with six replications per treatment. In the second set of experiments, four different treatments (B and Mo at 0.2 and 2 mg/L) were tested with three controls each at pH 5 and pH 7, and with five replications per treatment. Growth of chickpea was inhibited at acidic pH 5 and was better at pH 7. At acidic pH 5, shoot growth of cv. DJ1 was higher in solution without molybdenum and boron, than with all nutrients (Mo and B), while root growth was inhibited in solution without boron. At neutral pH 7, Mo and B did not have significant effect on growth (**Fig. 1.4 B**). Low concentrations of boron (0.2 mg/l) and high concentrations of Mo (2 mg/l) improved shoot growth and number of buds. At neutral pH 7, solution with all nutrients (with Mo and B) was better than other controls and treatments. B and Mo @ 0.2 mg/l improved shoot growth and dry matter, while B @ 2 mg/l and Mo @ 0.2 mg/l increased root growth; control with all nutrients and B @ 0.2 mg/l increased the number of buds (**Fig. 1.4 C**).

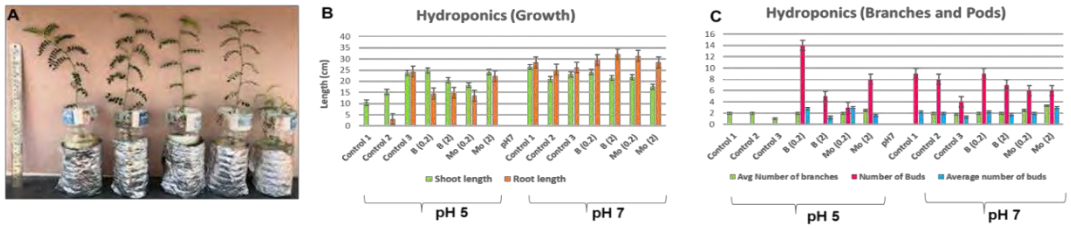


Fig. 1.4 : Hydroponics to evaluate effect of acidity on growth of chickpea. A: Effect of treatments compared in five replications. Effect of micronutrients in acidic and neutral pH on growth of shoot and root (B) and number of branches and pods (C). (treatments: B and Mo @ 0.2 and 2 mg/L with respective controls

Microbial population from soils under various treatments (Mo and B @ 0.5, 1.5 and 2.5 kg/ha each) were isolated on YEMA medium (**Fig. 1.5 A**). Gram staining was performed and candidate gram-negative rhizobial colonies were identified (**Fig. 1.5 B**). Number of colonies were higher in Mo @ 1.5 kg/ha while the number of white colonies (N fixing bacteria or *Rhizobium sp*) were higher in B @ 0.5 kg/ ha in rhizosphere of cv. DJ1 (**Fig. 1.5 C**). Genomic DNA was isolated from the candidate gram negative white colonies for characterisation by 16S sequencing (**Fig. 1.5 D**). Isolation of rhizosphere microbes under various treatments were carried out for cv. DJ1 and other cultivars (KJK1, P37, JK9).

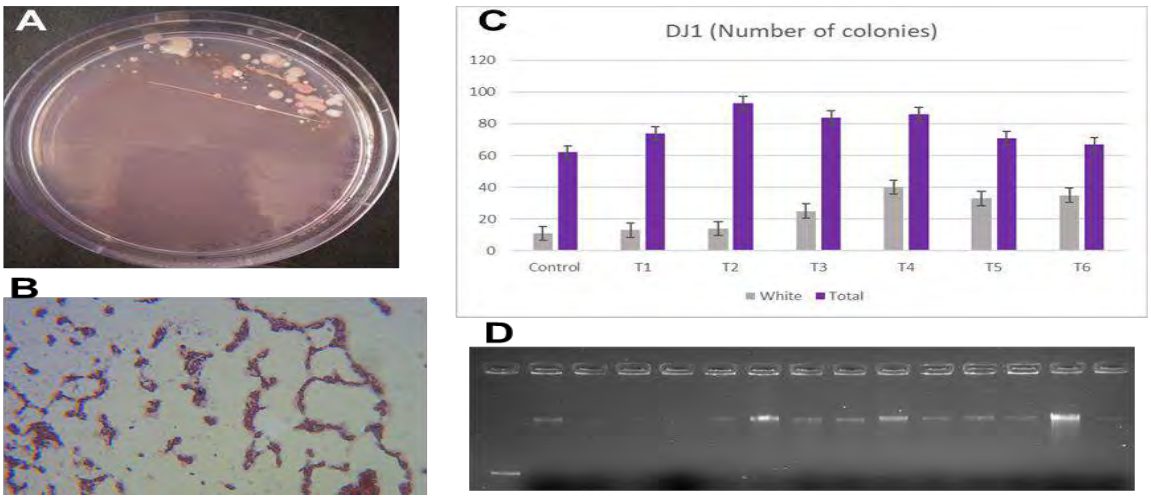


Fig. 1.5: A. Isolation of rhizosphere microbes from pot culture studies on YEMA medium; B. Gram negative bacteria from rhizosphere of cv. DJ1; C. Effect of treatment on total number of colonies and white colonies in cv. DJ1. (treatments: Mo and B @ 0.5, 1.5 and 2.5 kg/ha); D. Genomic DNA isolated from various gram negative bacterial colonies from rhizosphere of cv. DJ1.

IIAB- TRCI -01: Translational Research for Crop Improvement

ICAR-IIAB has undertaken nine research projects related to marker-assisted convergence on drought and phosphorus uptake towards identification of novel genes/QTLs for phosphorus use efficiency and zinc homeostasis in rice, molecular and biochemical basis of climate resilient rice with low glycemic index, identification of genotypes which are early/ short duration and with high biomass in horse gram and lentil. Analysis of available data in omics and molecular biology as related to improvement of agronomical traits has been targeted to enable address issues related to food security and sustainable agriculture.

Molecular breeding for development of rice varieties with inbuilt resistance/tolerance to drought, low soil P and blast

This project aims to introgress *Pup1,* a major QTL for P-uptake, *DTY*2.2 and *DTY*4.1 (QTLs for yield under drought) and blast resistance genes for developing rice varieties adapted to acidic soils under rainfed conditions in blast endemic areas. During *kharif* (rainy) season, positive F1 and BC1 plants for *Pup1* and *DTY* QTLs were crossed with blast donors possessing *Pi2, Pi9, Pi54* and *Pita*. In addition, three-way crosses were also attempted among *Pup1* and *DTY* donors and newly released new plant type varieties possessing high biomass and sturdy culm viz., cvs. MTU 1210, MTU 1121, MTU 1018. F2 seed segregating for *Pup1* and *DTY*s were harvested from seven cross combinations. A highly drought-tolerant accession of *Oryza rufipogon* was crossed with Swarna, BPT 5204 and Lalat with an objective to map novel QTLs/genes for drought tolerance. Overall more than 150 cross combinations were attempted during *kharif* 2020 for producing sufficient F1 seeds (**Fig. 2.1**).

Fig. 2.1: Rice Crossing Block

Development of transcriptome-based resources for indigenous agri-horticultural crops of eastern India

Prediction of microRNAs in jackfruit through integrative transcriptome analysis

MicroRNAs (miRNAs), a subclass of small RNAs (sRNAs), play a crucial role in the post-transcriptional regulation of developmental genes and a wide array of stress responses in plants. Until now, there is no report on miRNAs in jackfruit (*Artocarpus heterophyllus*). We attempted to predict the potential miRNAs in jackfruit using the *in-silico* approach. We pooled the RNA-seq data generated in our laboratory (SRR7250836) and two other publicly available jackfruit RNA-seq datasets to predict the unigenes using Trinity Software and an inhouse perl script. The predicted 64,215 unigenes were analyzed using the psRNATarget online web server. As a result, 30,327 unigenes were identified as targets for 6,513 miRNAs available at the plant miRNA database (PMRD). From the 6,513 miRNAs, we removed 93 dead (non-coding) miRNAs (as per the updated miRBase registry) and considered the remaining 6,420 miRNAs targeting 30,247 jackfruit unigenes for further study. Out of the 6,420 miRNAs, we selected 598 miRNAs showing '0' expectation value (maximum stringency) in the psRNATarget analysis for the initial study. These miRNAs belonged to 11 miRNA families from 58 different plant species. After the removal of cross-species redundancy, the number of miRNAs was further narrowed down to eighty-five. These unique miRNAs were queried against the jackfruit genome to identify their coding sequences. We identified the scaffold sequences showing a complete match for miRNA precursor sequences and put them in MFold server to predict the precursor sequences with miRNA-like-foldback structure. The results revealed the presence of coding sequences for at least 26 conserved miRNAs in the jackfruit genome. A representative miRNA was identified in jackfruit (**Fig. 2.2**); the miRNAs are detailed (**Table 2.1**). Available literature suggests that these miRNAs mostly target known transcription factors regulating leaf development, hormone signalling and several other fundamental biological processes in different plant species. We have designed primers for the miRNAs and their corresponding target sequences. Their validation using qRT-PCR-based expression analysis is in progress.

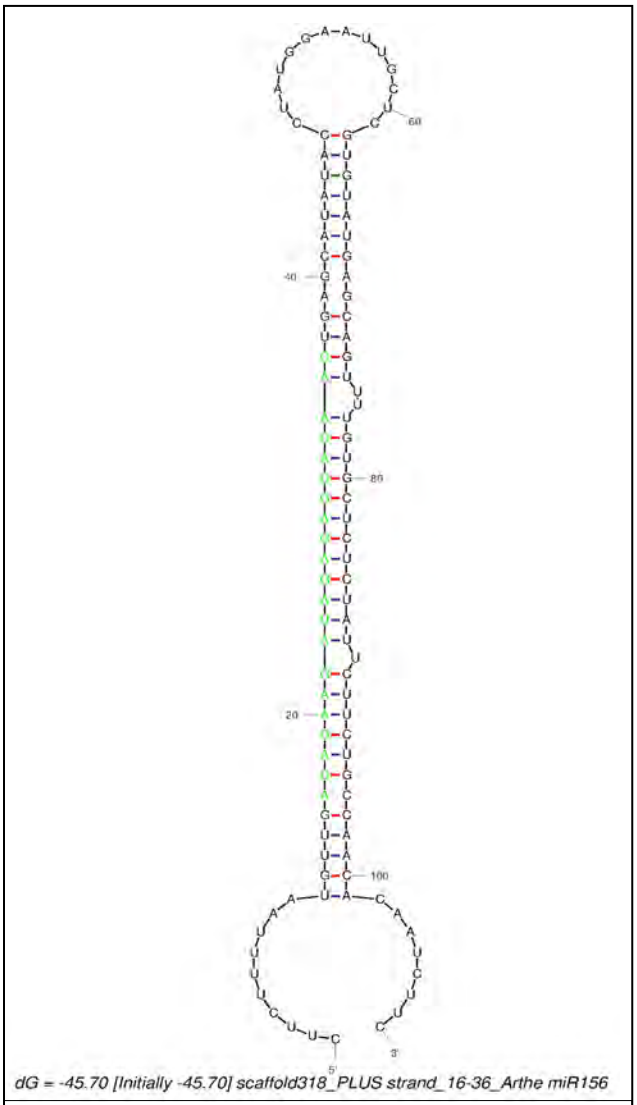


Fig. 2.2: *Artocarpus heterophyllous* precursor miRNA sequence similar to conserved miRNA (miR156). The green colour represents the mature miRNA sequence of jackfruit.

Table 2.1: Mining of miRNA from RNA-seq data of jackfruit.

S. No.	miRNA	miRNA sequence (5'-3')	Target unigene	Target description
1	ptc-miRf10523-akr	ACCGGGUUCCGGGUUGACCC	CDS_29301_Unigene_65744	XP_010109771.1hypothetical protein L484_008447
2	aqc-miR529	AGAAGAGAGAGAGCACAACCC	CDS_10518_Unigene_34239	XP_015883292.1 squamosa promoter-binding-like protein 6
3	pta-miR156b	CAGAAGAUAGAGAGCACAAC	CDS_47414_Unigene_92202	#N/A
4	ptc-miRf10192-akr	CGGACCAGGCUUCAUUCCCC	CDS_19851_Unigene_50156	#N/A
5	ptc-miRf10509-akr	GAUUGAGCCGCGCCAAUAUCACUU	CDS_14501_Unigene_41064	XP_010088896.1hypothetical protein L484_020885
6	csi-miR160	GCCUGGCUCCCUGUAUGCCAU	CDS_26327_Unigene_60997	XP_010104267.1Auxin response factor 18
7	osa-miRf10132-akr	GCGAGCUUCUCGAAGAUGUCGUUGA	CDS_37668_Unigene_78152	CAB88668.1 histone H2B
8	aly-miR396b	GCUCAAGAAAGCUGUGGGAAA	CDS_32400_Unigene_70266	#N/A
9	vun-miR396b	GCUCAAGAAAGCUGUGGGAGA	CDS_32400_Unigene_70266	#N/A
10	aly-miR166a	GGAAUGUUGUCUGGCUCGAGG	CDS_19851_Unigene_50156	#N/A
11	aly-miR2111a	UAAUCUGCAUCCUGAGGUUUA	CDS_24210_Unigene_57492	XP_010112355.1F-box/kelch-repeat protein
12	vvi-miR166a	UCGGACCAGGCUUCAUUCC	CDS_19851_Unigene_50156	#N/A
13	aly-miR166a	UCGGACCAGGCUUCAUUCCCC	CDS_19851_Unigene_50156	#N/A
14	sit-miR58-1-npr	UCGGACCAGGCUUCAUUCCCCU	CDS_19851_Unigene_50156	#N/A
15	gma-miR166q	UCGGACCAGGCUUCAUUCCCG	CDS_19851_Unigene_50156	#N/A
16	crt-miR166a	UCGGACCAGGCUUCAUUCCCGU	CDS_19851_Unigene_50156	#N/A

17	csi-miR166d	UCGGACCAGGCUUCAUUCCCU	CDS_19851_Unigene_50156	#N/A
18	crt-miR166b	UCGGACCAGGCUUCAUUCCCUU	CDS_19851_Unigene_50156	#N/A
19	aqc-miR166c	UCGGACCAGGCUUCAUUCCU	CDS_19851_Unigene_50156	#N/A
20	aqc-miR166a	UCGGACCAGGCUUCAUUCCUC	CDS_19851_Unigene_50156	#N/A
21	ahy-miR156a	UGACAGAAGAGAGAGAGCAC	CDS_18806_Unigene_48456	XP_010091609.1Squamosa promoter-binding-like protein 6
22	aly-miR160a	UGCCUGGCUCCCUGUAUGCCA	CDS_26327_Unigene_60997	XP_010104267.1Auxin response factor 18
23	vvi-miR396b	UUCCACAGCUUUCUUGAACU	CDS_32400_Unigene_70266	#N/A
24	aly-miR396b	UUCCACAGCUUUCUUGAACUU	CDS_32400_Unigene_70266	#N/A
25	ahy-miR156c	UUGACAGAAGAGAGAGAGCAC	CDS_41457_Unigene_83668	XP_010102696.1Squamosa promoter-binding-like protein 12
26	ahy-miR156b-5p	UUGACAGAAGAUAGAGAGCAC	CDS_47419_Unigene_92206	XP_010112387.1Squamosa promoter-binding-like protein 16

Elucidating the molecular and biochemical basis of climate resilient rice with low glycemic index

Rice genotypes differed for bran oil content

Five contrasting rice cultivars with low (cvs. Sampada, Improved Samba Mahsuri/ ISM, Swarna) and high (cvs. MTU 1010 and Abhishek) Glycemic Index (GI) were evaluated for rice bran oil (RBO) content using gravimetric method. Briefly, rice bran (about 5 g) passed through a sieve (to ensure the absence of any broken seeds) was mixed with 10 ml hexane and vortexed vigorously. Then it was kept on a shaker at 200 rpm for 24 h, centrifuged and the supernatant was collected. The pellet was again suspended in 10 ml hexane and the process was repeated. The supernatant was pooled and dried to 1ml in a hot water-bath. The hexane containing the oil was transferred to a 1.5 ml eppendorf tube and the oil was collected from the extract by completely removing the hexane in a sample concentrator. The weight of the oil was measured and expressed as % (g oil per 100g bran). The

experiment was replicated thrice. The result showed that the low GI rice contained comparatively higher rice bran oil than that of high GI rice. Highest RBO content (21.6%) was observed in cv. Sampada followed by cv. ISM (20.1) where as cvs. MTU1010 and Abhishek had 18% and 19.6%, respectively. However, the cultivar Swarna, although reported to have low GI was found to have the lowest RBO content (17.3 %).

Time of cooking affects the RS content in brown rice

To study the effect of duration of cooking on resistant starch (RS) content, approximately ten gram of brown rice (cvs. ISM and MTU1010) kernels was soaked in water for 30 min and then drained completely. Now the rice was steam cooked on a rice steamer and samples were collected at 0, 10, 20, 30, 40, 50 and 60 min. The sample was allowed to cool at room temperature for 2 h. Based on moisture content of the cooked rice kernels, 100 mg of sample on dry weight basis was evaluated for RS content as per the manufacturers' protocol using megazyme kit (K-RSTAR, Megazyme Ltd., Ireland). The RS content in the cooked rice was enhanced to its maximum after different time of cooking for the studied genotypes (**Fig. 2.3**). For cv. MTU1010 (having high GI), the RS content was enhanced with increase in duration of cooking upto 40 min and thereafter there was decline of the same. However, for cv. ISM (having low GI), the maximum content of RS was realised after 50 min cooking and after that the content was reduced. The lipid molecules present in the bran of brown rice was supposed to form lipid-amylose complex, which resulted in higher RS content in the retrograded rice kernels. However, the higher lipid content in cv. ISM suggested a comparatively higher content of RS after certain time of cooking.

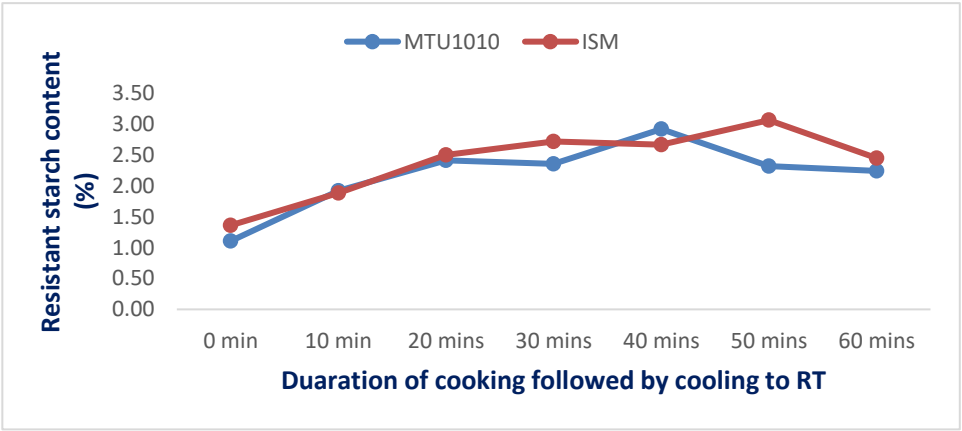


Fig. 2.3: Percentage enhancement of RS content in brown rice kernels when cooked for different time and allowed to cool for 2 hrs at room temperature. The RS content in the cooked rice kernel was enhanced to its maximum at 40mins and 50 mins of cooking time in MTU1010 and ISM, respectively.

Addition of different types oil before steam cooking can enhance resistant starch content in cooked white rice

In the present study, brown rice (whole grain, 0% polish) was milled to separate out the bran layer to produce polished white rice (refined grain) devoid of bran, germ constituents and contained only the starchy endosperm. Hence, in the present experiment attempt was made to enhance resistant starch (RS) content in white rice upon cooking with different types of oil followed by retrogradation. Addition of oil to rice starch has been reported to show V-type peak in X-ray diffractograms, indicating the formation of amylose-lipid complex, i.e., type 5 resistant starch (RS 5), which in turn reduces *in vitro* starch digestibility and GI. About 1 g of white rice of cvs. ISM and MTU1010 were thoroughly mixed with 200 µl of olive, coconut, bran oils and kept overnight at room temperature. The next day, the rice kernels were cooked in a rice steamer for 42 min, kept at room temperature for 2 h for retrogradation of starch and 100 mg of sample on dry weight basis was evaluated for RS content as per the manufacturers' protocol using megazyme kit (K-RSTAR, Megazyme Ltd., Ireland). For control, samples were prepared following the same procedure without adding oil to the white rice.

The results showed that addition of oil to white rice before steam cooking significantly enhanced the RS content in kernel of both genotypes (**Fig. 2.4**). However, the extent of enhancement was comparatively higher in cv. MTU1010 compared to cv. ISM. For instance, addition of coconut oil to cv. MTU1010 and cv. ISM increased the RS content by 2.7 and 1.8 folds over control, respectively; whereas, addition of olive oil was unable to enhance the RS content to that extent in both genotypes. It seems that oil rich with short chain saturated fatty acids as in coconut oil had a pronounced effect on enhancement of RS content in cooked rice kernel compared to that of oil having rich unsaturated fatty acids as in case of olive oil in the present study. The composition of rice kernel and bran oil also indicated significant effect on improving RS content in cooked white rice. In the study, it was found that addition of bran oil of cv. ISM to both cvs. ISM and MTU1010 (high GI) enhanced the RS content by 1.3 and 2.6 folds, respectively. However, addition of bran oil of cv. MTU1010 to either of the genotypes could not significantly change the RS content. The findings need further validation with a greater number of rice varieties.

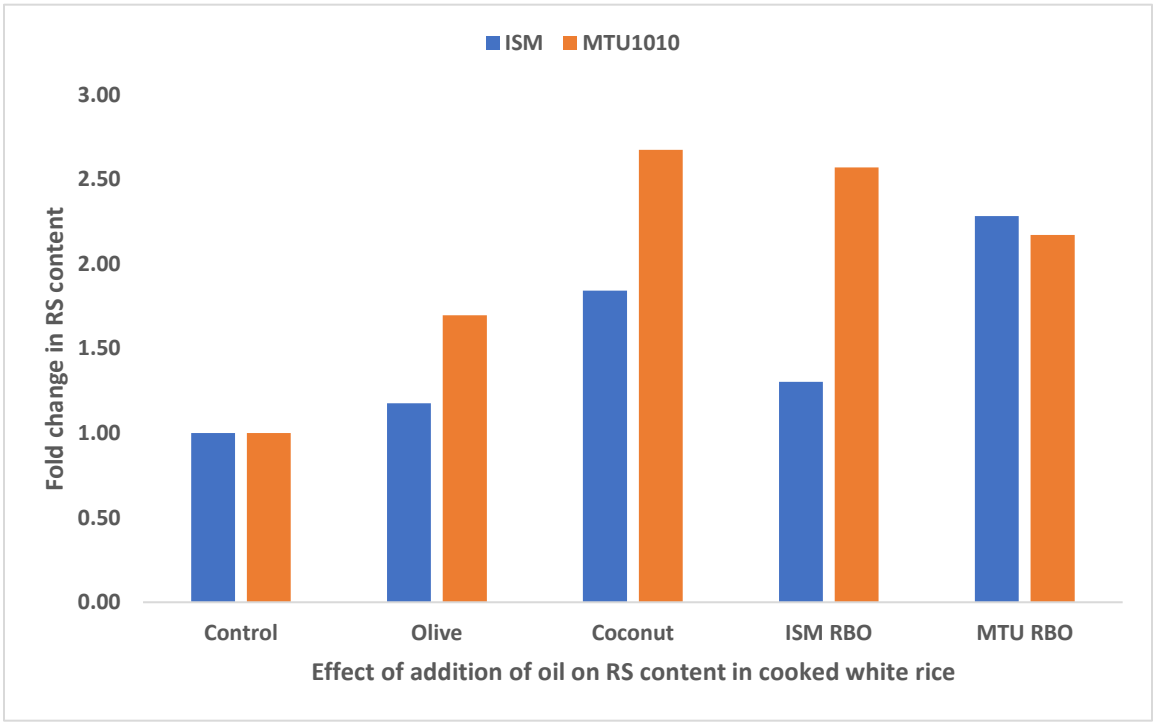


Fig. 2.4 :Enhancement of resistant starch content in cooked white rice kernels pre-treated with oil followed by cooling under room temperature, control: cooked without oil; cv. ISM RBO: Cooked with bran oil from cv. ISM; MTU RBO: Cooked with bran oil from cv. MTU1010

Phenolics of black rice resist the enzymatic starch hydrolysis

Manipur Black rice or *Chak-hao* is black, scented glutinous rice, shown to have high anthocyanin and phenolics content and strong antioxidant activity. To understand the effect of phenolics content on rate of starch hydrolysis, 1 g of *Chak-hao* rice kernel was mixed with 5 ml of 80% methanol, vortexed and kept in a shaker for 12 h at room temperature. For control, 1 g of rice kernel was mixed with water and the same procedure was repeated. Then the supernatant was discarded and the kernel was dried to constant moisture. 100 mg of the powdered rice sample was studied for rate of starch hydrolysis (rate of release of soluble starch). Briefly, the rice flour was incubated in a shaking water bath with pancreatic α-amylase and amylo-glucosidase (AMG) at 37°C to hydrolyse non-resistant starch to D-glucose. The reaction was terminated by addition of ethanol after 5, 20, 40, 60 and 120 min incubation and samples were collected to estimate the released D-glucose content using GOPOD reagent. The amount of starch released (free glucose) at 0 min of incubation was calculated and deducted from starch released at each time point.

The result showed that the presence of pigment compounds, particularly phenolics resist the release of starch molecule from the matrix of the black rice kernel. Upon removal of the phenolics

from the black rice kernel, the amount of the released soluble starch molecules became almost three times (14%) even after 1 min of enzymatic hydrolysis in discolured rice compared to partly discoloured rice i.e., 5.2 % (**Fig. 2.5**). At all the time of points, the released soluble starch was significantly higher in discoloured rice kernels with very less or almost no free phenolics than that of the partly discoloured kernels. The result suggests that the phenolics of black rice play an important role in rate of starch hydrolysis, which probably explains its diabetic-friendly nature.

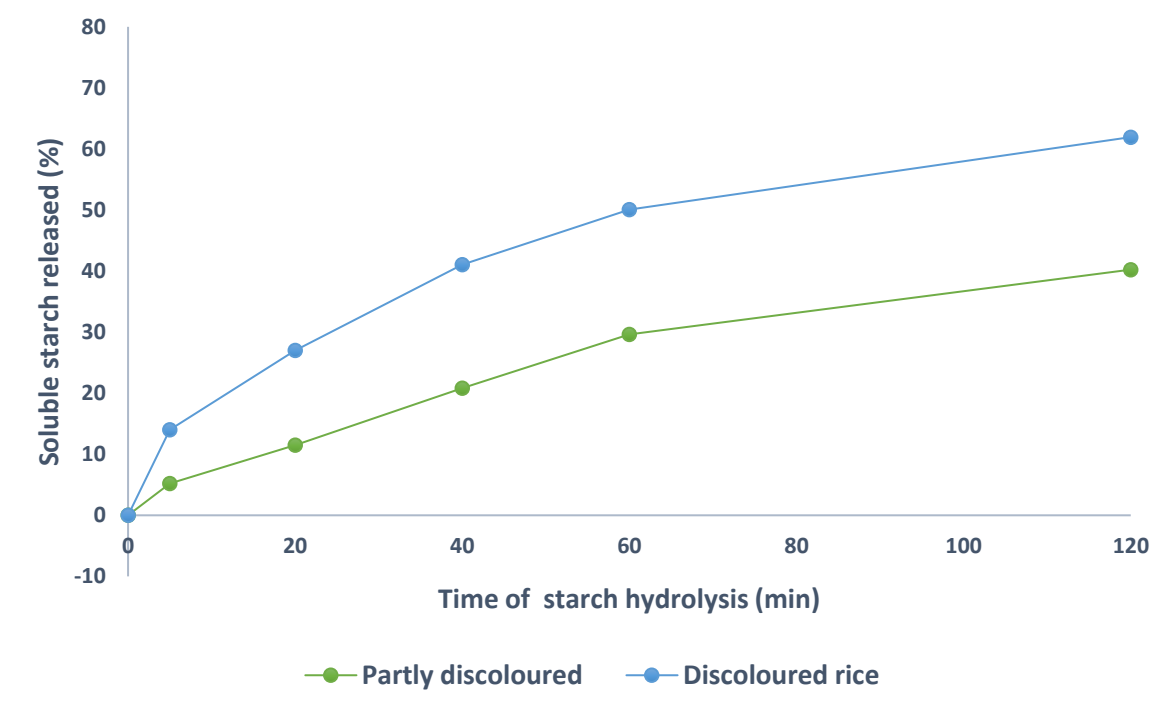


Fig. 2.5 : Enhancement of enzymatic starch hydrolysis from Manipur black rice kernel upon complete discolouration of pericarp by 80% methanol for 12 h compared to partial discolouration by water

Ideotype breeding in horse gram for Jharkhand region

Evaluation of horsegram accession for agro-morphological, yield and yield attributing traits

238 no. of horsegram germplasm accessions were evaluated at ICAR-IIAB Farm B, Garkhatanga Ranchi in augmented block design with four Checks, cvs. Birsa Kulthi -1, HPKM-317, Dorma and Jaltanda. The accessions were grown in *rainfed* conditions. The experimental plot consisted of 2 ridges, 3 m long and 45 cm apart, spacing between plants at 5 cm. Data was recorded from five randomly selected competitive plants on various agro-morphological, maturity, yield and yield contributing traits. In each block the checks were allotted randomly. The results revealed that, there were significant differences among tested genotypes and the check cultivars for all studied characters (**Table 2.2**). Twenty-six genotypes were recorded for higher yield or did not significantly differ than

the productivity of four checks. Nine accessions were reported to be earlier for days to 50% flowering than the early maturing check (cv. HPKM-317). Based on this result, selected accessions will be tested in next ensuing season under randomized block design to identify promising lines for preliminary yield trial.

Table 2.2: Yield and yield attributes of 238 horse gram genotypes

Traits	Mean ± SD	Range	CV (%)
Plant height (cm)	58.33 ±15.9	25-125	17.12
Days to 50% flowering	50.63 ±5.17	34-64	7.01
Days to maturity	101.54 ±8.75	66-120	5.86
No. of pods per plant	36.12 ±12.12	17-58	18.94
No. of seed per pod	4.74 ±0.45	3.4-6.0	6.67
Pod length (cm)	5.09 ± 0.53	3.8-6.6	7.87
100 seed weight (g)	2.62 ± 0.31	1.8-3.9	9.19
Seed yield per plant (g)	3.19 ±0.56	1.7-5.2	12.89

Crossing programme on horse gram

Hand emasculation and artificial crossing in horsegram are difficult because of its small and fragile flowers, early hour of flowering, short flowering duration and poor pod setting. In order to create variability, large number of inter-varietal crosses have been attempted between early and late accessions (**Fig. 2.6**) and we have successfully recovered 43 number of F_1 seed (IC-561036 x IC-23475, IC-489165 x IC-561036, IC-489165 x IC-19449, , IC-561031 x IC-561026, IC-561031 x IC-23475, IC-26840 x IC-561036, IC-139367 x IC-22797, IC-120830 x IC23475, IC-120830 x IC-561036, IC-23475 x IC-139460, IC-26840 x IC-561036, IC-26840 x IC-561036, IC-139367 x IC-22797, IC-139367 x IC-467863, IC-11284 x HPKM-11-56, IC-139460 X IC-23475, IC-139460 x IC-19449, IC-139367 x IC-561026, IC-22751 x HPKM-11-56, IC-22751 x IC-44010, IC-120830 x IC-44008, IC-120830 x IC-22797, IC-120830 x IC-26136, IC-120830 x IC-32760, IC-123022 x IC-23475, IC-139367 x IC-19449, IC-139367 x IC-105785, IC-23022 x IC-44010, IC-123022 x IC-23475, IC-123022 x IC-23476, IC-139367 x IC-32760, HPKM-317 x IC-32760, HPKM-317 x IC-22797, HPKM-317 x IC-19449,

HPKM-317 x IC-26136, IC-23486 x IC-32760, IC-16946 x IC-32760, IC-23486 x IC-22812, IC-16946 x IC-26136, IC-16946 x IC-19449, IC-23489 x IC-561017, IC-23486 x IC-32760, IC-23489 x IC-19449).

Fig. 2.6: Crossing block at ICAR-IIAB Namkum Ranchi

Identification of ideal plant type in horse gram germplasm

Identification of an ideal plant type in horsegram (IC-19432) having better (**Table 2.3**) compact canopy, semi erect growth habit, deep green foliage with smooth leaf surface, determinate grwoth habit, mid-early duration (85: days to maturity) and it will be very much suitable for dense planting. This line looks promising for further improvement regarding synchronus pod maturity, higher productivity, and resistance to anthracnose and leaf spot.

Fig. 2.7 : IC-19432: Ideal plant type horsegram

Table 2.3: Yield and yield attributing traits for IC-19432

Plant height (cm)	35
Days to 50% flowering	48
Days to maturity	95
Pods per plant	30
Seeds per pod	4.2
Pod length (cm)	5.2
100- seed weight (g)	2.05
Seed yield per plant (g)	2.96

Identification of genes/QTLs for tolerance to pod borer (*Helicoverpa armigera*) in pigeon pea

Cajanus scarabaeoides is the closest wild relative of *Cajanus cajan* known for its higher levels of drought tolerance, high seed protein content, and higher levels of resistance to insect-pests. The presence of higher level of resistance to pod borer makes it a better candidate as a parent in crossing programme for development mapping population to map the genes/QTLs for pod borer tolerance in *C. cajan*. The development of BC_2:F_2 mapping population through interspecies crossing of *C. cajan* and *C. scarabaeoides* for mapping of genes/QTLs for pod borer tolerance is under progress. The crossing between *C. scarabaeoides* var. ICPL15695 and *C. cajan* var. ICPL87; *C. cajan* var. ICP20338 and *C. scarabaeoides* var. ICPL15695; *C. cajan* var. Asha and *C. scarabaeoides* var. ICPL15695; and *C. cajan* var. ICPL332 (pod borer tolerant) and *C. cajan* var. ICPL87 (pod borer susceptible) was performed in the *kharif* (rainy) season (**Table 2.4**).

Table 2.4: Parents involved in the crossing and number of successful crosses

Sr. No	Parents	Number of successful crosses
1.	*C. scarabaeoides* var. ICPL15695 X *C. cajan* var. ICPL87	No seed set
2.	*C. cajan* var. ICP20338 X *C. scarabaeoides* var. ICPL15695	9
3.	*C. cajan* var. Asha X *C. scarabaeoides* var. ICPL15695	13
4.	*C. cajan* var. ICPL332 X *C. cajan* var. ICPL87	33

Identification of genes responsible for Zinc homeostasis in rice

Screening of rice genotypes for Zn localization and distribution in the seed tissues by histochemical staining using Zincon dye

Sixteen rice genotypes were screened to investigate zinc distribution/localization within brown rice in embryo, aleurone layer and endosperm. The screening method was based on histochemical staining techniques using a metallochromic indicator zincon which forms blue-coloured complex with seed Zn. The intensity of the colour formed was directly proportional to the Zn content of the seed which was observed under stereo microscope (Zeiss, model Stemi 508). Both longitudinal and transverse section of seed were analysed to study the Zn accumulation pattern in embryo, aleurone layer and endosperm and based on that genotypes were grouped as low, medium and high Zn accumulator (**Fig. 2.8**). The results showed relative seed Zn concentration among rice genotypes and accordingly five genotypes (Chhattisgarh Zinc rice-1, CR DHAN-310, CR DHAN-311, DRR DHAN-49 and Gene Bank Pokkali Type 1) having higher, four genotypes (BKS-23, BKS-09, BKS-97 and BKS-45) having low and seven genotypes (IIABR-78, BKS-94, BKS-89, Gene bank IR-64, Pokkali type 2, DRR DHAN-45 and Sahabhagi) having medium Zn content in their aleurone layer and embryo were identified. Further the rice genotypes were studied for relative localization/accumulation of seed Zn in their respective embryo, aleurone layer and endosperm (**Table. 2.5**).

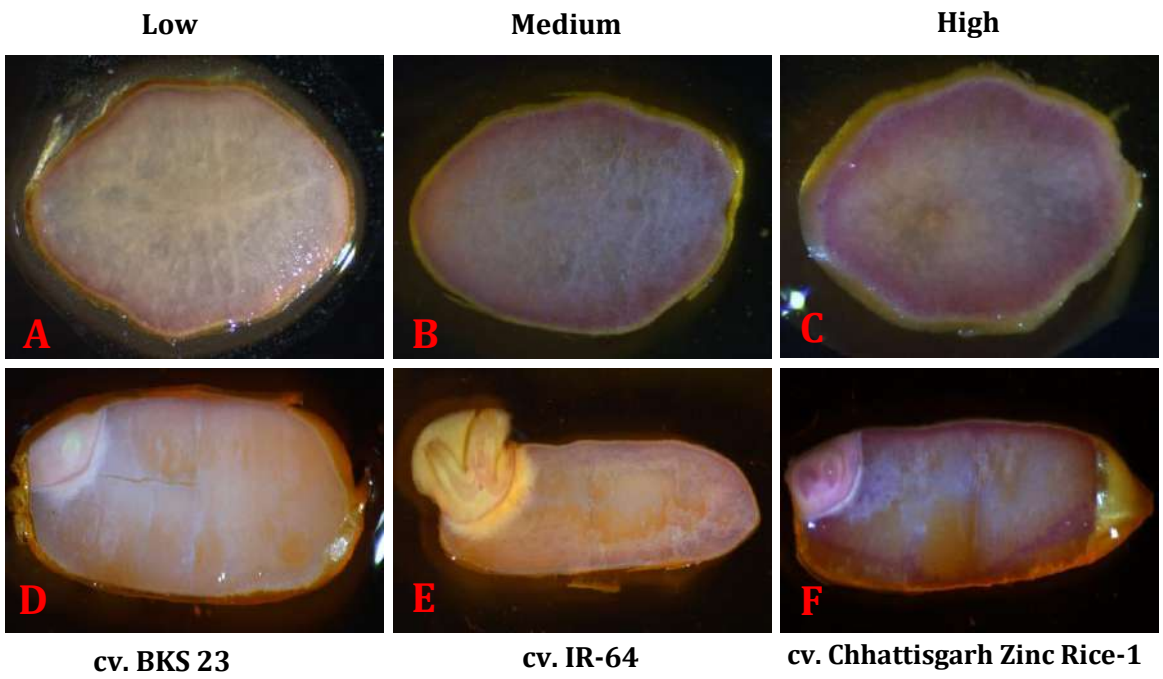


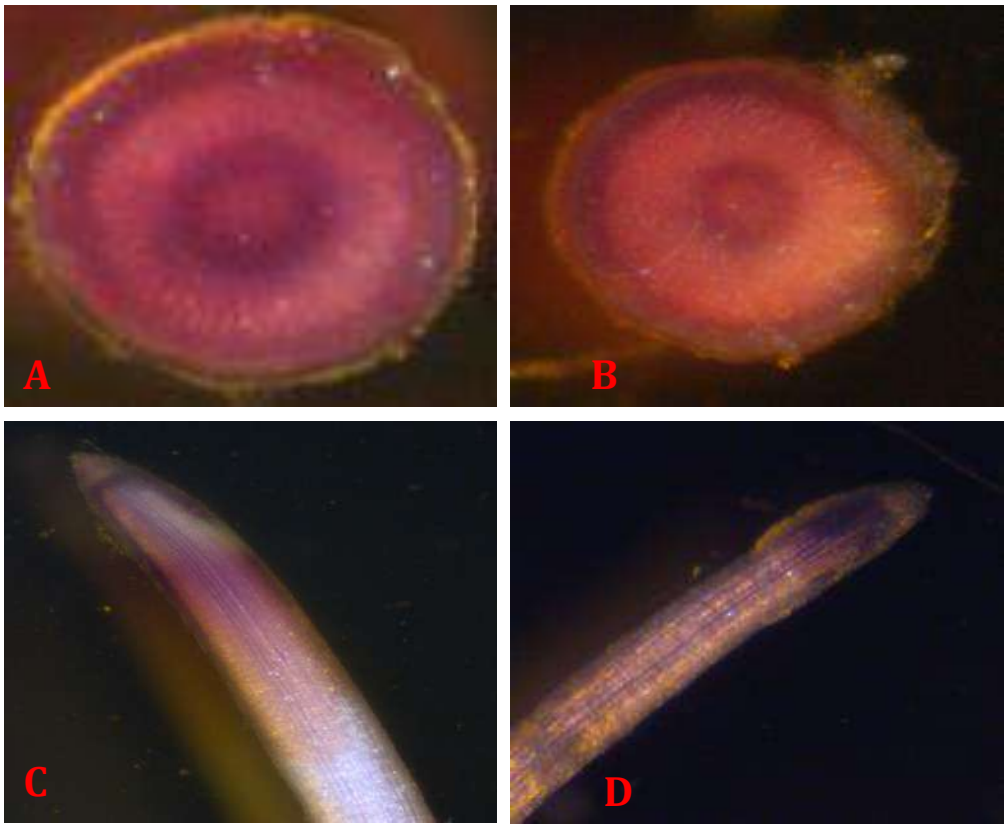
Fig. 2.8 : Representative image of transverse (A-C) and longitudinal (D-F) section stained with metallochrome indicator *Zincon,* showing low, medium and high accumulation of Zn in different parts of the brown rice seed

Table 2.5: Relative accumulation and spatial distribution of seed Zn in embryo, aleurone layer and endosperm of brown rice

SN.	Germplasm	Embryo	Endosperm	Aleurone layer
1	BKS-09	Low	Low	Medium
2	BKS-23	Low	Low	Medium
3	BKS-45	Low	Low	Low
4	BKS-89	Medium	Medium	Medium
5	BKS-94	Medium	Medium	High
6	BKS-97	Low	Low	Medium
7	Chhattisgarh zinc rice-1	High	Medium	High
8	CR Dhan-310	High	Medium	High
9	CR Dhan -311	Medium	Low	Medium
10	DRR Dhan -45	High	Medium	Medium
11	DRR Dhan -49	High	Medium	High
12	IR64	Low	Medium	Medium
13	IIABR-78	Low	Low	Low
14	Pokhali type 1	High	Low	High
15	Pokhali type 2	High	Medium	Low
16	Sahabhagi	High	Low	Medium

Seed Zn mobilizes towards apical root tips during germination

To understand the pattern of Zn mobilization from seed tissues to growing root tips during seed germination and early growth of rice, few selected genotypes were further studied. Briefly, the root tips of the germinated seeds were stained using the metallochrome indicator *Zincon* and the intensity of Zn accumulation was studied based on the intensity of the blue colour developed. The result showed that during the process of germination, the Zn got mobilized from the seed to the growing tissues, which was evident from the presence of deep colour around 3-6 mm of the root tips (**Fig. 2.9**), and the pattern was observed in all the genotypes. This might be due to being precursor of the plant hormone auxin that is essential for its biosynthesis in the root tip, which in turn promotes root growth and development. The longitudinal section showed that mostly Zn accumulated in the zone of root elongation region as compared to the zone of maturation region. While, the transverse section of root tip indicated that the seed Zn mobilizes mainly through central region (xylem and phloem) and outer exodermis cell layer compared to middle cortex region. Based on Zn mobilization pattern it can be proposed that the genotypes having better mobilization efficiency may act as better Zn homeostasis line as compared to other genotypes.



cv. BKS 45 **cv. Pokkali Type 1**

Fig. 2.9: Representative image of root tip, transverse section (A-B) and intact root tip (C-D) stained with metallochrome indicator *Zincon,* showing the movement of Zn toward root tip during germination.

IIAB-FHM-0l: Biotechnological Interventions for Fish Health Management

Nutritive and medicinal value, taste and easy availability of fishes have only enhanced their demand in the food industry during the past decade. Increasing demand and decreasing natural habitats for rearing of fishes attract the intervention of biotechnological tools to cater to yield, quality and sustainability of aquaculture systems. The aquaculture sector incurs major losses due to pathogenic infections and diseases. Conventional disease management systems mostly target pathogens and are not quite effective in combating the infectious diseases. Rapid detection and identification of pathogens are keys to the adoption of targeted curative measures which has been achieved through multiplex testing systems. These multiplex systems are not only helpful in disease diagnosis but also in screening possible epitopes for designing strategies towards vaccine and diagnostic kit development. Prevention at the host's end is equally important in this aspect which paves a way to immunomodulation via dietary manipulation.

Nanotechnology and nanobiotechnology has emerged as an alternative approach with innovative material and protocols to solve persisting issues in fish health management. The antimicrobial and prophylactic properties of nanomaterial from nanosilver, zinc oxide, copper oxide, etc. are exploited to reduce the pathogenic load in the aquaculture system. The nanomaterial are non-specific, universal and widely applicable. Nano-delivery of drugs in aquaculture is credited with novel properties like sustained release, regulation of size, shape, dispersity of targeted material, location-specific, multi-route delivery processes and regulated degradability of nanocarrier. Delivery of drugs through liposome, PLGA is opening new vistas in fish disease management. Taking these into account, the ongoing projects in the school are targeting the aspects of fish health management via multi-omics and nanobiotechnology approaches for sustainable aquaculture development. An attempt was also made to develop nano-lime supplement for mungbean culture.

Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp

Method for developing nano-encapsulated folic acid enriched feed for delivery in fish model

Folic acid is an essential nutrient for animals including fish. Folic acid deficiency is consistently characterized by megaloblastic anemia with anorexia and associated low weight. Due to its water solubility, folic acid is leached from fish feed. Hence, it is necessary to encapsulate folic acid to deliver its multiple benefits to fish in normal and stressed conditions. For preparation of encapsulated folic acid, mixture of Soya Lecithin and Oleic acid was screened in different ratios using various compatible

solvents followed by homogenization to obtain a yellowish coloured product which denotes the end of encapsulation process. The size of nano-folic acid was 126 nm (approx) using a particle analyser of a particular size (**Fig. 3.1**). Current method denoted an 89.19% encapsulation efficacy. Further, characterization of nano-encapsulated folic acid will be carried out by using Cryo-TEM and High Performance Liquid Chromatography (HPLC). For nano-folic acid enriched feed development, Abis Acuastar (32/6) 1 mm size commercial feed was purchased as basic fish feed material from the local market. Feed was ground to a fine powder. Control (without folic acid), folic acid and nano-encapsulated folid acid were mixed in different doses (10 mg, 7.5 mg, 5 mg and 2.5 mg per kg) of fish feed, respectively. Thereafter, water was added to prepare dough. The formed noodles were broken manually in to small uniform sized pellets followed by drying at room temperature which were secured in air-tight jars (**Fig. 3.2**).

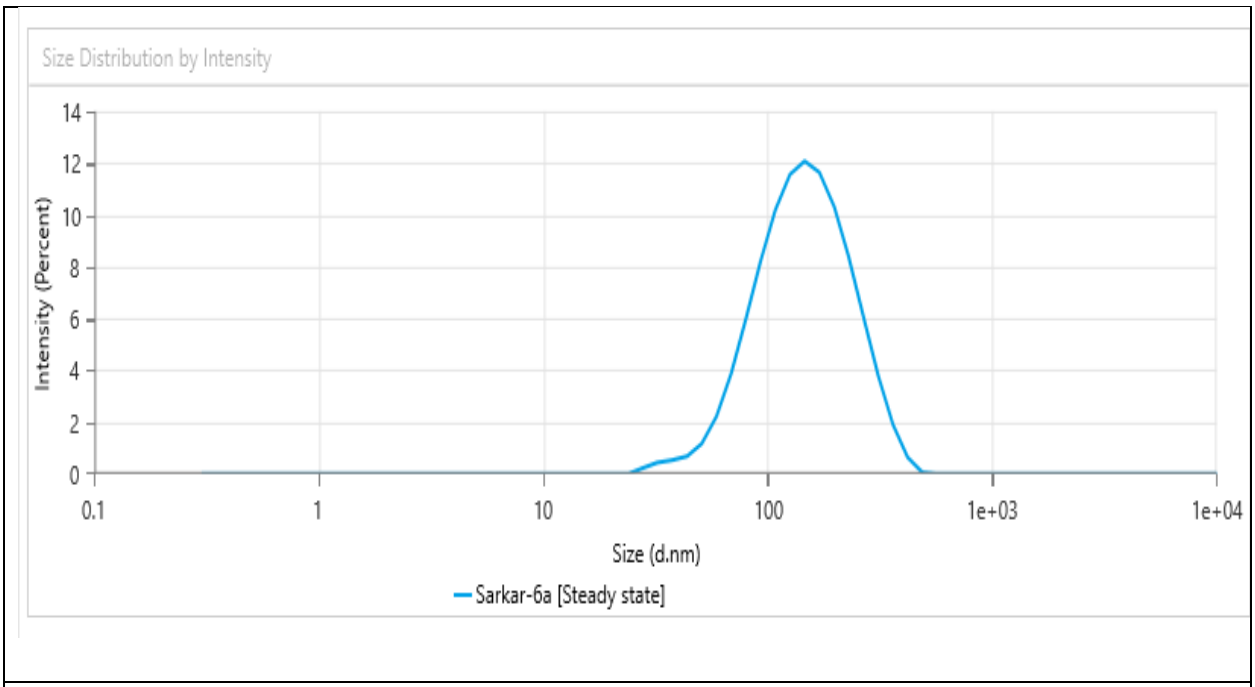


Fig. 3.1: Particle size of nano-encapsulated folic acid measured under particle size analyzer

Fig. 3.2 : Developed fish feed formulations (Control, normal folic acid enriched fish feed and nano-encapsulated folic acid enriched fish feed)

Development of calcium carbonate nanoparticles (Nano-lime) for its application in mungbean cultivation

Lime is inevitably an important component for cultivating crops especially in acidic soil. But lime in nanoscale form appears as innovative new material to add its value in minute application. Calcium carbonate nanoparticles were synthesized using modified co-precipitation method. Calcium carbonate ($CaCO_3$) cores were prepared by 100 ml of 0.33 M aqueous solution calcium chloride ($CaCl_2$) to 100 ml of 1% w/v Carboxy Methyl Cellulose (CMC) followed by stirring for some period. Afterwards, 100 ml of 0.33 M of sodium carbonate (Na_2CO_3) was added slowly under vigorous stirring at room temperature for an hour (**Fig. 3.3 A**). The sample was centrifuged at 5000 rpm for 10 min. Then, the precipitate was separated from the supernatant and washed twice with distilled water to remove unreacted species. Precipitate was dried in hot air oven at 105°C until constant weight was reached to remove any residual water. The product was then kept under vacuum for further use (**Fig. 3.3 B**). The yield of the nanoparticles was assessed by weighing the dried product

which was in the range of 50-55%. The synthesized $CaCO_3$ nanoparticle was characterized by FT-IR spectroscopy (**Fig. 3.4**).

Fig. 3.3: A. Reaction set up for the synthesis of $CaCO_3$ nanoparticle, B. Synthesized $CaCO_3$ nanoparticle

Experimental trials were initiated to evaluate the efficiency of calcium carbonate nanoparticles on growth and yield of mung bean (*Vigna radiata*) that was analyzed in acidic soils of Jharkhand. The application of calcium in both lime ($CaCO_3$) and nano calcium forms showed significant increase in plant height and number of pods per plant in mungbean in preliminary trials.

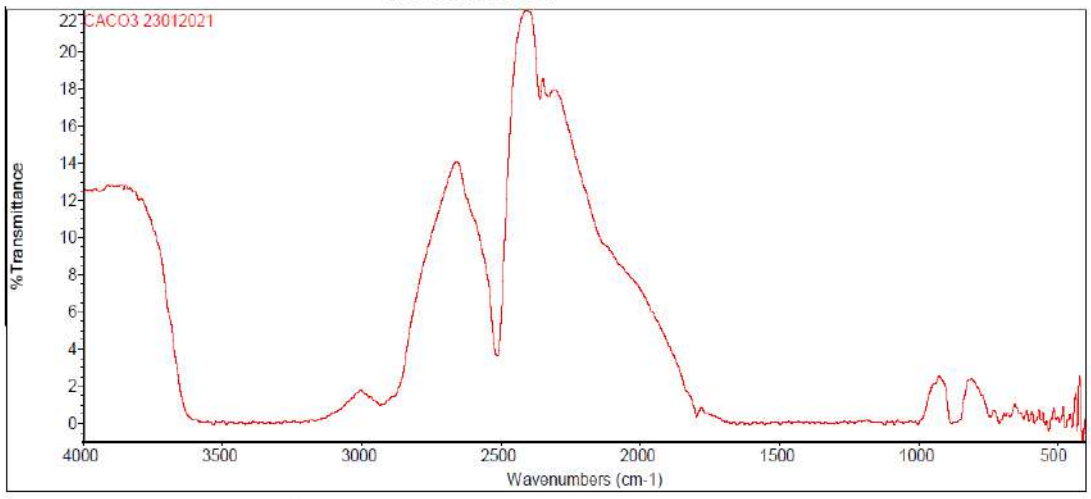


Fig. 3.4: FT-IR spectra of synthesized CaCO3 nanoparticle

Evaluation of extrinsic and intrinsic parameters for sustainable breeding and culture of *Clarias magur* in captivity

Clarias batrachus is an air-breathing catfish from the Indian sub-continent, belonging to the order *Siluriformes*. Despite its high economic and nutritive value, it is enlisted as an endangered species on the International Union for Conservation of Nature red list. Having dealt with the phylogeny analyses and selection constraint variations on Toll-like receptors (TLRs) in *Clarias magur* in the previous year, in 2020 our aim was to further corroborate these evolutionary findings with more evidence at the structural level. To the best of our knowledge, this is the first study reporting the *C. magur* TLR repertoire and its evolutionary placement among other teleost TLRs.

Structure based comparison and co-evolution analysis

The primary sequence of the most divergent TLRs among those studied (TLR 1 and 7), was used to predict the three TLR domains viz., extracellular domain (ECD), transmembrane (TM) domain and toll/ interleukin-1 receptor domain (TIR) across the four *Siluriformes* species (*C. magur, Ictalurus punctatus, Tachysurus fulvidraco, Pangasianodon hypophthalmus*) using Simple Modular Architecture Research Tool (SMART) (http://smart.embl-heidelberg.de/) (**Fig. 3.5**). Comparative domain analysis showed a strong conservation in the intracellular TIR domain of the respective orthologues of both TLR1 and 7. A contrasting trend was however seen with respect to the extracellular domain (ECD), where variation in LRRs was noticed across the orthologues. This variation may be responsible for imparting the diversifying trend of evolution in case of TLR1 and 7.

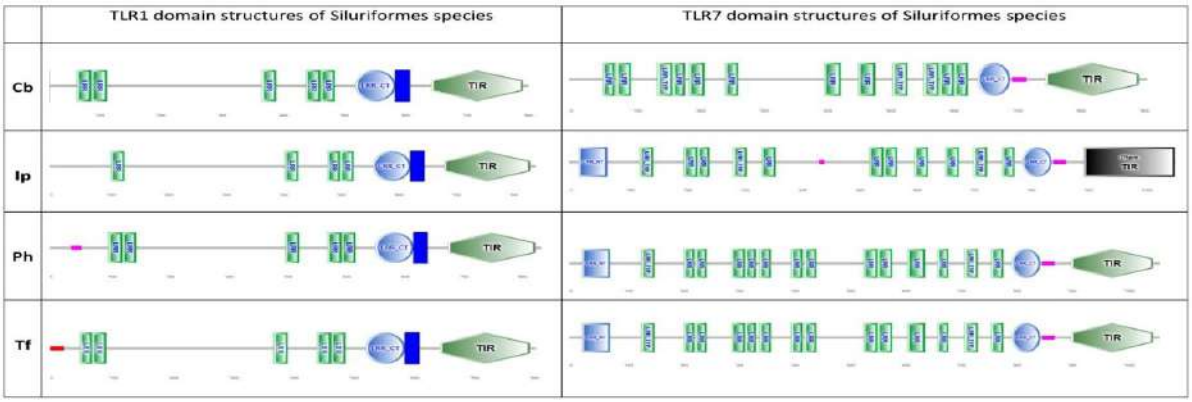


Fig. 3.5: Comparative domain analysis of TLRs1 (Toll like receptors 1) and 7 of *Siluriformes* species (*Clarias batarchus (Cb), Ictalurus punctatus (Ip), Tachysurus fulvidraco (Tf), Pangasianodon hypophthalmus (Ph))*. (Domains predicted using SMART; a simple modular architecture research tool)

The co-evolving residues were predicted for the ten TLR (TLR1, 2, 3, 5, 7, 8, 9, 13, 21, 22) amino acid alignments via BlS2 Analyser and were mapped on the I-TASSER predicted 3D structures (**Fig. 3.6**). Further, the prediction of leucine-rich repeats (LRRs) within the ECD of the TLRs was carried out using LRRfinder against both tLRRdb and TLR1/7-specific databases. Only the LRRs deduced in both the searches were considered for depiction on the structures. Maximum number of coevolving clusters was predicted for TLR3 and 5, and the minimum was for TR 1 and 8. The mapping of co-evolved and positively and negatively selected residues showed the dominance of the positively selected sites within the ECD of TLR1 and 7. Overall, the mapping of these residues showed the presence of positively selected residues within the functional domains of TLR (LRR and TIR) (**Fig. 3.7**). These findings suggest the dynamic nature of evolution to accommodate the survival fitness of the organism while maintaining the stability of structure and function of the receptor at molecular level. These nuances are responsible for promiscuity of ligand recognition amongst the TLR orthologues and lead to species-specific ligand recognition.

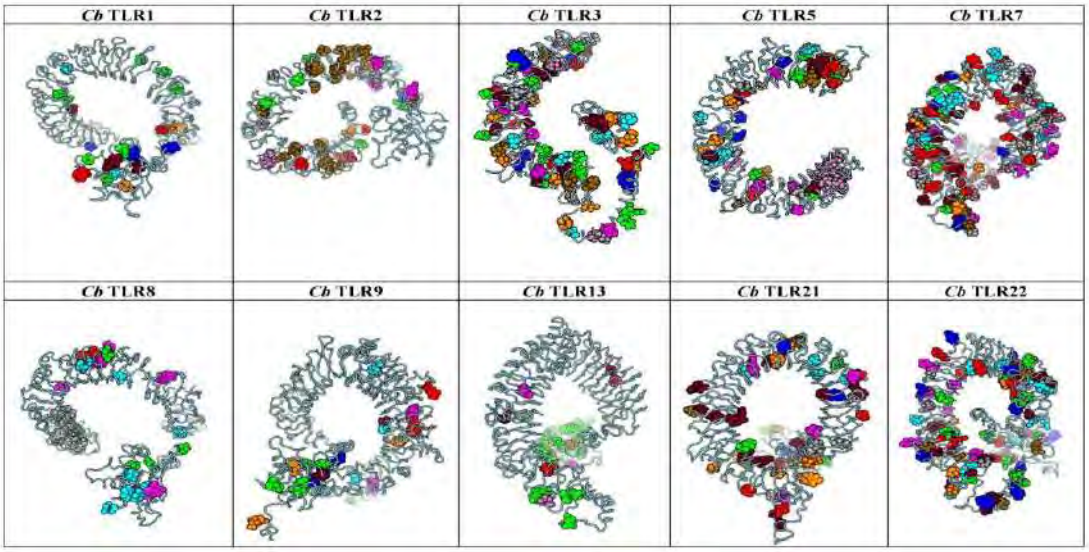


Fig.3.6: Mapping of predicted co-evolved clusters by Blocks in Sequences (BIS2 analyzer; which is online tools for analysis of coevolving amino-acid pairs in protein sequences, and identification of residue networks) to the 3D structures of *Clarias batrachus (Cb) TLRs* (Toll like receptors) by Iterative Threading ASSEmbly Refinement (I-TASSER) which is a bioinformatics tool for predicting three-dimensional structure model of protein molecules from amino acid sequences.

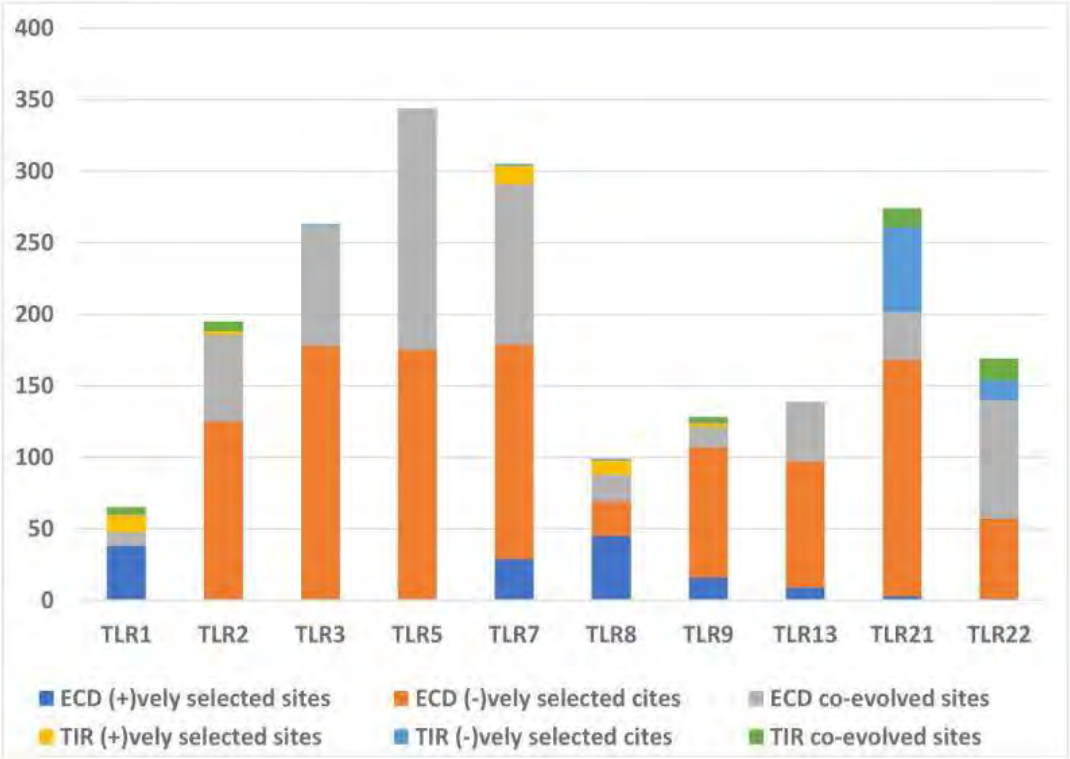


Fig. 3.7: Localization of positively selected, negatively selected and co-evolved residues in the extracellular domain (ECD) and toll/interleukin-1 (TIR) domains of *Clarias batrachus (Cb)* Toll like receptors

Testicular transcriptome sequencing of C. magur

The RNA-sequencing of testis from the spawning and pre-spawning/ preparatory phase of *C. magur* was availed commercially and the data is currently being analysed. The differential gene expression analysis of spawning *V/s* pre-spawning phase showed 5215 and 6636 up and down-regulated genes. Gene enrichment predictions suggest the upregulation of approximately 117 KEGG pathways. Further analysis of this data is underway in the laboratory and validation of DEG data would be carried out using qPCR.

Externally Funded Projects

Proteomics and phosphoproteomics to understand drought stress perception and response in lentil genotypes (*Lens culinaris*)

India is third largest lentil producing country, and it is one of the major pulse crops being consumed in India. However, drought is the major abiotic stress challenging annual yield of the lentil crop. Raising drought tolerant varieties may be a possible solution; however breeding techniques require drought tolerant genotype, which is a big limiting factor in the present scenario. Thus, the project focuses on evaluating drought tolerance potential in the locally grown lentil genotypes viz. HUL 57, Arun and Noori, when compared with a known susceptible variety JL3.

The plants for all four genotypes were grown under controlled conditions (**Fig. 4.1**) and drought stress was imposed primarily at vegetative stages to score drought tolerance ability. For drought stress, watering was withheld and saturation level was maintained at 20-30% whereas control was watered normally, upto near 100% saturation. When drought symptoms like drooping of leaves, slight yellowing of leaves were visible, then leaf samples were harvested and stored in liquid nitrogen.

Fig. 4.1: Representative images of lentil genotypes: JL3, HUL57, Arun and Noori, growing in Polyhouse conditions to be subjected to drought stress at vegetative stage

RNA was extracted from these samples for qRT-PCR analysis of drought marker genes: DREB1A, DREB2A, DREB1C, RD22 and ERD. As can be seen in **Fig. 4.2**, HUL57 showed a constant higher expression of these genes, as compared to Arun and Noori, with respect to JL3 (susceptible variety). Hence, it was concluded that genotype HUL57 showed a superior tolerance potential over Arun and Noori genotypes. Hence, genotypes JL3 and HUL 57 were continued for downstream analysis.

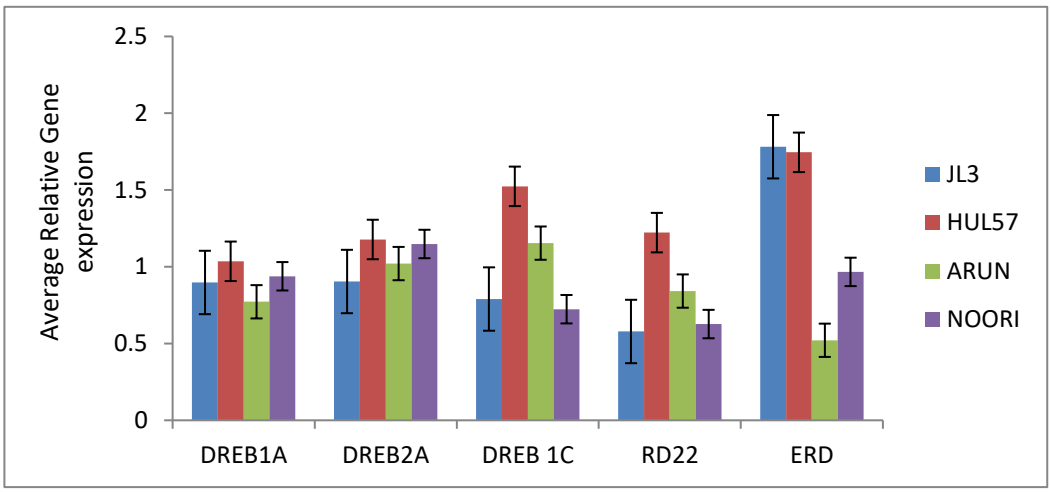


Fig. 4.2: Average relative expression of drought marker genes DREB1A, DREB2A, DREB1C, RD22 and ERD in four lentil genotypes: JL3, HUL57, Arun and Noori

Since only genotype HUL57 showed initial drought tolerance potential, hence, it was continued alongwith JL3 (drought susceptible variety) till reproductive stages and drought stress was imposed after initiation of budding (**Fig. 4.3**). These plants were monitored regularly, and samples like leaves, buds, flowers and immature pods were harvested and stored in liquid nitrogen for further analysis.

Fig. 4.3: Drought stressed and well watered (control) plants of JL3 (left panel) and HUL57 (right panel) at reproductive stages

The experiments reported above were performed under the project 'Quantitative Proteomics and Phosphoproteomics to understand drought stress perception and response in lentil (*Lens culinaris*)' funded by the Department of Biotechnology, Government of India under BioCARe scheme.

Heat-stress responsive transcriptome analysis and gene regulation study in groundnut

To study the mechanism of tolerance and/or adaptive strategy in contrasting groundnut (*Arachis hypogaea*) genotypes to heat-stress (HS), total RNA was isolated from two contrasting groundnut genotypes differing in their characteristics to HS and subjected to NGS-based transcriptome analysis. Four RNA-seq pair-end libraries (DRG 1_C, DRG 1_HS, ICGS 44_C and ICGS 44_HS) were generated using Illumina TruSeq Stranded mRNA library preparation kit. The libraries were then sequenced on a HiSeq 2500 in Illumina Platform, generating ~5 GB data per sample. A reference guided transcript assembly was performed through mapping to the diploid ancestral genomes of *groundnut*, i.e., *Arachis duranensis* and *Arachis ipaensis*. Differentially expressed transcripts of the groundnut were determined by comparing transcript expression levels encoded from *A. duranensis* and *A. ipaensis* using the DESeq2 package in R (v1.2.10) and Fragments per Kilobase of transcript per Million (FPKM) were generated. Additional filtering was employed in DESeq2 to remove lowly expressed transcripts with FPKM ≤ 0.2 based on normalized counts. Transcripts were considered differentially expressed if they had a *p* value less than 0.05 after accounting for a 5% false discovery rate (FDR), i.e., negative $\log_{10}$ *p* values according to the Benjamini-Hochberg procedure and if $\log_2$ fold change was greater than 1. Volcano plots (**Fig. 4.4 A-D**) were made to display the transcripts with high statistical significance.

The numbers of differentially expressed transcripts were highlighted through the Venn diagram (**Fig. 4.4 E-F**). Heatmap was prepared using *pheatmap* package from R software using $\log_{10}$ (FPKM values) and the transcript descriptions as id. 951 and 287 differentially expressed transcripts were identified from *A. duranensis* mapping in DRG 1 and ICGS 44, respectively in response to HS treatment as compared to the control. Two hundred and two transcripts were found to be associated with both DRG1 and ICGS 44 from the *A. duranensis* genome. *A. ipaensis* genome analysis reflects 911 and 299 transcripts are differentially expressed in DRG 1 and ICGS 44, respectively to HS treatment and 192 transcripts common to both the genotypes. Top 50 significantly expressed transcripts were represented in the form of a heatmap (**Fig. 4.5 A-D**).

Preliminary analysis showed many heat-stress transcription factors (HSF) such as HSFA2, HSFC1, etc. and small molecular heat shock proteins (smhsps) are associated with the HS response. The analysis also reports many chloroplast transcripts related to carbohydrate metabolism are differentially regulated such as *Ribulose bis-phosphate carboxylase oxygenase* (*Rubisco*), *Chlorophyll a/b binding protein* coding transcript, *granule bound starch synthase* (*GBSS*) and many more in response to HS when compared with DRG 1 and ICGS 44.

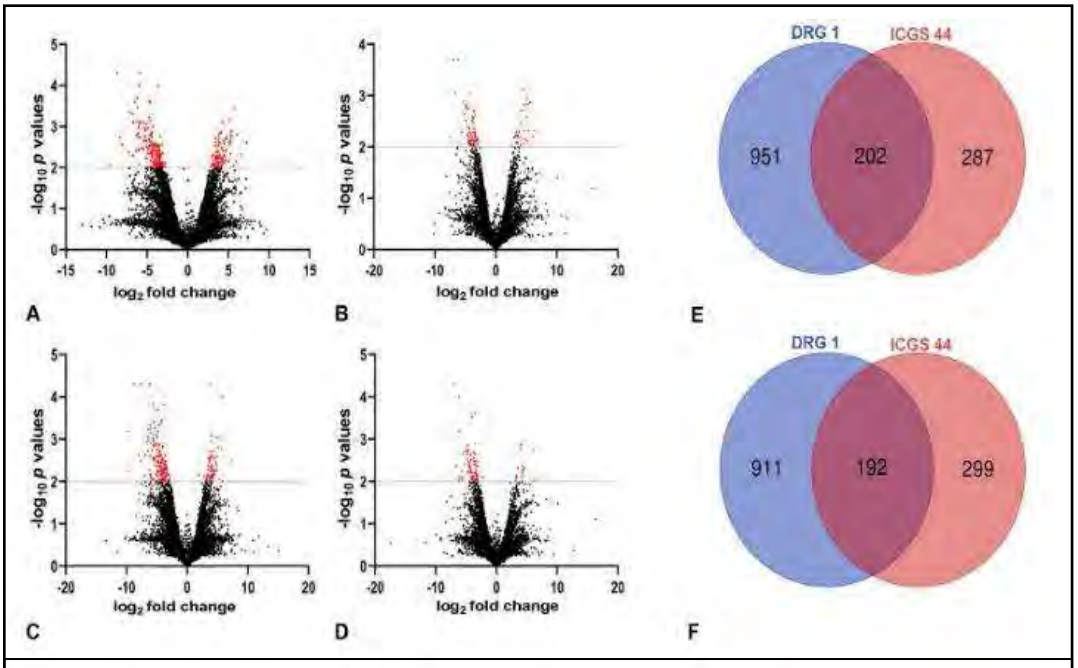


Fig. 4.4: Volcano plots showing the differentially expressed transcripts (red colour represents *p* value less than 0.05) (A-D) and Venn diagram (E-F) showing the number of differentially expressed transcripts compared with control and heat-stress induced RNA-seq libraries of DRG 1 and ICGS 44; A: *Arachis duranensis* genome encoded transcripts in DRG 1, B: *Arachis duranensis* genome encoded transcripts in ICGS 44, C: *Arachis ipaensis* genome encoded transcripts in DRG 1, D: *Arachis ipaensis* genome encoded transcripts in ICGS 44.

The data generated in this study will be crucial to understand the basic molecular signaling and gene regulation mechanism in response to HS effect in groundnut. Transcripts with higher expression and higher induction on tolerant genotype than susceptible genotype will have some implication in heat-stress tolerance/adaptation in groundnut. The research project will be helpful to develop an effective genetic improvement program for the breeding/development of novel heat-tolerant groundnut genotypes.

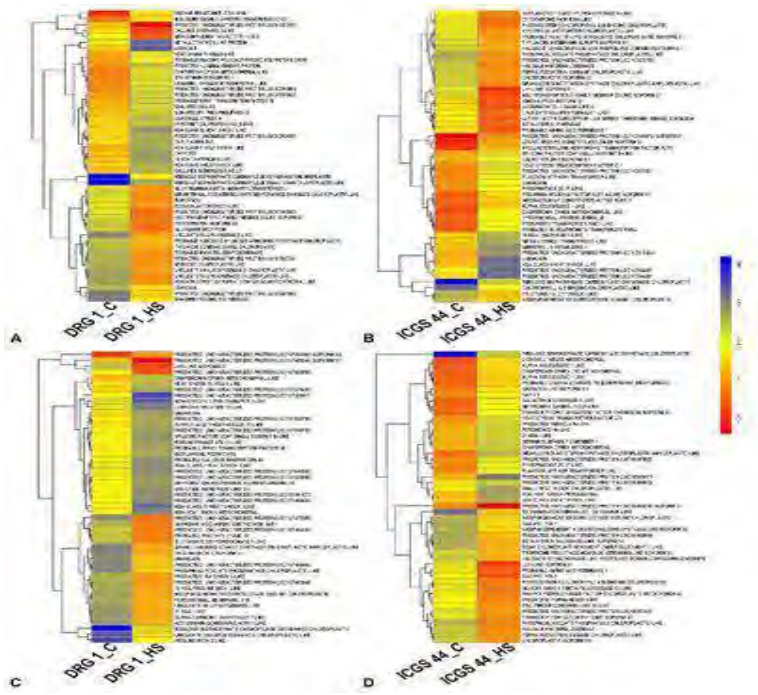


Fig. 4.5: Heat map depicting 50 significantly expressed transcripts in the control and heat-stress induced transcript libraries of DRG 1 and ICGS 44; A: Log2 fold changes of *Arachis duranensis* genome encoded transcripts in DRG 1, B: *Arachis duranensis* genome encoded transcripts in ICGS 44, C: *Arachis ipaensis* genome encoded transcripts in DRG 1, D: *Arachis ipaensis* genome encoded transcripts in ICGS 44

The experiments reported above were performed under the project 'Heat stress responsive transcriptome analysis and gene regulation study in groundnut' Funded by Science and Engineering Research Board (Department of Science and Technology, Government of India) under National Post Doctoral Fellowship scheme.

Exploring cell surface biomarkers of cattle spermatozoa for sex-specific segregation through proteomic and genomic approach

Semen sexing, involving the separation of X- from Y-chromosome bearing sperms, implies its application in cattle breeding programs, leading to the possibility to plan matings for a specific sex. At present, the only proven method for producing a significant enrichment of X- and Y-chromosome bearing spermatozoa in mammals is the cell sorting by flow cytometry, based on DNA content difference. The traditional methods (other than the flow cytometer) with some modifications were performed to enrich the X and Y spermatozoa from the unsorted semen samples. These methods have

demonstrated varying level of enrichment. Two different types of nanoparticles were also synthesized, and tested for their effect on enrichment. In addition to this, a modified protocol for extraction of DNA from the enriched semen samples was standardized.

Enrichment of chromosome-specific sperm from the unsorted bovine semen using Modified Swim-Up Method (MSU)

The MSU works on the basis of differential mobility of X and Y spermatozoa due to their differences in size. The capacitation media containing cryopreserved unsorted semen were incubated followed by separation of upper and lower fractions in separate tubes which were further processed for extraction of the genomic DNA. The enrichment level was validated using qPCR. For this purpose, PLP and SRY genes were used as markers. The results revealed that there was no significant enrichment of X sperm, although significant ($P<0.05$) enrichment of Y sperm was noted.

Enrichment of chromosome-specific sperm from the unsorted bovine semen using percoll density gradient method

In this experiment, seven different percoll gradients (80%-40%) were prepared and carefully layered in a centrifuge tube. The unsorted semen sample was layered at the top and centrifuged. The upper and lower fractions were collected in separate tubes after centrifugation which was further processed to extract genomic DNA. Validation of enrichment level was done by qPCR as mentioned above. The results revealed non-significant enrichment of the X and Y spermatozoa.

Enrichment of chromosome-specific sperm from the unsorted bovine semen using zinc and calcium nanoparticles through MSU

The experiment was designed based on the differences in zeta potential of X and Y spermatozoa. It was hypothesized that the interaction of nanoparticles and X and Y sperms might show some varying binding pattern which should help in enrichment.

The synthesized nanoparticles were characterized for their zeta potential and other attributes, and uniformity in their size was obtained. The zinc and calcium oxide nanoparticles were tested for three different concentrations (50-200 ng/ml) along with appropriate controls in sperm suspended media. The MSU outlined above was followed to further enrich the X and Y spermatozoa (**Fig. 4.6**). Validation of enrichment level was done by qPCR (**Fig. 4.7**). The results revealed non-significant enrichment of the X and Y spermatozoa.

In addition, a modified protocol for extraction of DNA from the semen samples has been developed based on PCI method.

Fig. 4.6: Performing MSU method

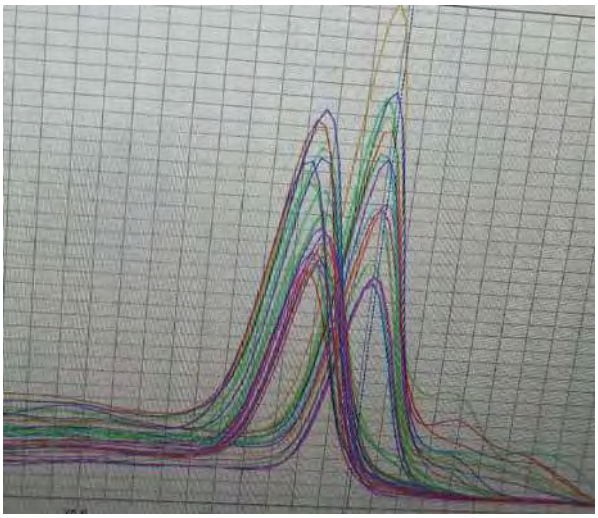


Fig. 4.7: Validation of enrichment by qPCR

The experiments reported above were performed under the project 'Exploring cell surface biomarkers of cattle spermatozoa for sex-specific segregation through proteomic and genomic approach' funded by Science and Engineering Research Board (Department of Science and Technology, Government of India).

Transcriptomic profiling of testes from hormone-induced *Clarias batrachus* v/s breeding phase testes from *C. batrachus* to evaluate the constraints for milting in induced conditions

The reproductive cycle in vertebrates is essentially under the regulation of the hypothalamus-pituitary-gonadal axis. The pituitary gonadotropins act in co-ordination with the sex steroids to maintain the cyclicity of testicular stages in seasonally breeding vertebrates like *C. batrachus*. The androgen 11-keto testosterone (11KT) is said to be the prime candidate regulating the spermatogenesis, especially in its later stages. The negative feedback of testosterone (T) on gonadotropin-mediated steroidogenesis maintains the T: 11KT ratio in plasma that drives the progression of spermatogenesis. Estrogen exerts a negative feedback effect on the neuroendocrine axis and also acts via paracrine mechanisms within the testis.

The sample (blood, testes, brain, pituitary, spleen and kidney) collection for all the four reproductive phases of *Clarias batrachus* was completed within the year. The testes of the four reproductive stages (resting, pre-spawning, spawning and post-spawning) were processed for tissue histology to validate the stage-specific tissue morphology (**Fig. 4.8 A-C**). The testes fixed in 10% neutral buffered formalin were embedded in a wax block and sectioned at 6 µm thickness using a microtome. These sections were stained using hematoxylin and eosin before microscopy.

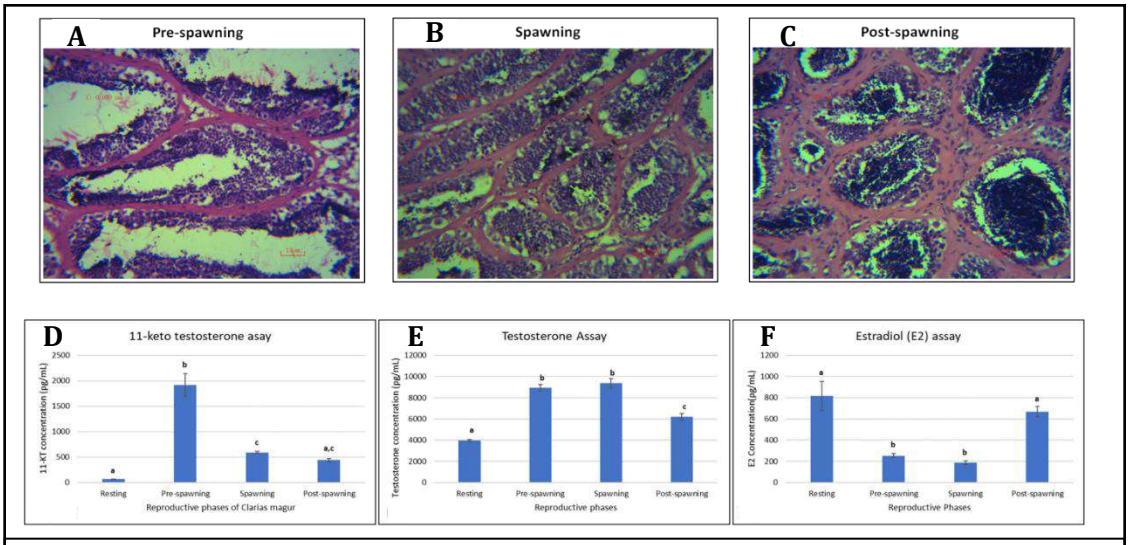


Fig. 4.8: (A-C) Morphological and histological progression of seminiferous tubules from pre-spawning to post-spawning stage of *Clarias batrachus* testis. (D-F) Graphs depicting variation in blood plasma levels of steroids 11-keto testosterone, testosterone and estradiol across the annual reproductive cycle of *C. batrachus*. Bars with different alphabet annotation denote significant difference at $p<0.05$.

The blood of the individual animals collected via heparinised syringes was centrifuged to separate plasma which was further used for steroid extraction. For steroid extraction, plasma and ethyl acetate were mixed in a ratio of 1:3 and allowed to settle for phase separation. The organic phase was separated and the process was repeated thrice. The solvent was allowed to evaporate, leaving behind only steroid. This steroid was used for carrying out ELISA for T, 11KT and estradiol. Reproductive stage-dependent profiles of the afore-mentioned steroids were generated which seemed to align with the histological observations (**Fig. 4.8 D-F**).

The experiments reported above were performed under the project 'Transcriptomic profiling of testes from hormone-induced *Clarias batrachus* v/s breeding phase testes from *C. batrachus* to evaluate the constraints for milting in induced conditions' funded by the Department of Biotechnology, Government of India under the Research Associateship Program In Biotechnology and Life Sciences.

Scheduled Tribe Component (STC)

Hands-on Training on Scientific Farming and Piggery and Duckery Units for the Farmers of Gumla, Khunti and Ramgarh

A hands-on training programme on "Scientific Pig Farming" for five-day duration (15-19 Mar 2020) was organized at the Birsa Agricultural University, Ranchi under the Tribal Sub-Plan (TSP) scheme of the the Government of India for skill development of 53 stakeholder farmers from Block Raidih (Dist. Gumla), Gola (Dist. Ramgarh) and Torpa (Dist. Khunti), Jharkhand. Dr(s) S Naskar, BK Singh, A Pandey and Sudhir Kumar coordinated the programme and acted as resource persons from the Institute. Mr. Devendra Kumar and Mr. VK Mishra actively assisted the programme.

Fig. 5.1 Glimpses of training on Scientific Pig Farming including field visit under the Tribal Sub-Plan (TSP) scheme

Establishment of 53 units of piggery and duckery in Gumla, Khunti and Ramgarh

A. Raidih, Dist. Gumla: Twenty-eight units of piggery, each consisting of one male and two female piglets, compound feed for each piggery unit for one-month period for supplementation purpose and 28 units of duckery, each consisting of eight ducklings and compound feed for each duckery unit for two-month period for supplementation was provided by the ICAR-IIAB.

B. Gola, Dist. Ramgarh: Nine units of piggery, each consisting of one male and one female piglet, compound feed for each piggery unit for 45-day period for supplementation purpose and nine units of duckery, each consisting of 13 ducklings and compound feed for each duckery unit for two-month period for supplementation was provided by the ICAR-IIAB.

C. Torpa, Dist. Khunti: Sixteen units of piggery, each consisting of one male and two female piglets, compound feed for each piggery unit for one-month period for supplementation purpose and 16 units of duckery, each consisting of 10 ducklings and compound feed for each duckery unit for two-month period for supplementation was provided by the ICAR-IIAB.

Table 5.1: Piggery and duckery units developed in Jharkhand under Tribal Sub-Plan scheme (March 2020)

		Raidih (Dist. Gumla)	Gola (Dist. Ramgarh)	Torpa (Dist.K hunti)
Piggery Unit (weaned piglets, avg. live wt. 10 kg)	Unit Nos.	28	9	16
	Male piglet (no./unit)	1	1	1
	Female piglet (no./unit)	2	1	2
	Compound feed (45 kg/bag)	1	1	1
Duckery Unit (age > 6 week, avg. live wt. 600 g)	Unit Nos.	28	9	16
	Ducklings (no./unit)	8	13	10
	Compound feed (30 kg/bag)	2	2	2

The pig grower feed and compound duck feed provided to fifty-three (53) farm-families of Block Raidih (Dist. Gumla), Gola (Dist. Ramgarh) and Torpa (Dist. Khunti), Jharkhand became a great help to the farmers for their livestock and poultry units during the lock-down period, based on the feedback responses received.

Training on Scientific Pig Farming at Mungadih, Angara

ICAR-IIAB, Ranchi in association with Birsa Agricultural University, Ranchi organized a hands-on training on "Scientific Pig Farming" on 14 October 2020 for skill development of the stakeholder farmers of Mungadih village under Angara block of Ranchi district. The programme was organized under Tribal Sub-Plan (TSP). Nineteen (19) farmers who were practicing traditional pig husbandry with limited knowledge of scientific and profitable farming were oriented on different aspects like feeding, management, health care, etc. with focus on entrepreneurship development. Sixty one (61) numbers of weaned improved varieties of piglets, suitable for the region, were provided to the farmer stakeholders. The distributed animals were vaccinated against prevalent diseases. Area-specific mineral mixture for livestock (100 kg) was also provided to the farmers for supplementation purpose to ensure optimum growth and switchover to field condition. The pig variety, provided to the farmers, can gain approximately 80 kg bodyweight at slaughter age of 8-10 months, more than double the bodyweight of local variants. It can produce 8-12 piglets in each farrowing with two farrowing each year, at par with the exotic improved varieties. This variety has widely been validated in farmers' fields. It is expected to enhance farmers' income and contribute to their nutritional and livelihood security.


Kisan Gosthi

A *Kisan Gosthi* was organized at Lalkhatanga (Block: Namkum, Dist: Ranchi) on 15 October 2020 for entrepreneurial skill development of tribal farm-women. Simultaneously, an awareness programme and input distribution (mustard seeds, and mineral mixture for livestock and poultry) was organized for scientific and profitable farming.

Farmers' training programme

A farmers' training programme was organized by the Institute on 18 Nov 2020 in collaboration with Jharkhand State Livelihood Promotion Society (JSLPS) Ranchi and Transform Rural India - Jharkhand (Tata Trusts) Ranchi at Lepsar village (Block Angara, Dist. Ranchi, Jharkhand) under the TSP scheme. Fifty (50) farmers from Lepsar and its neighbouring villages viz. Kamta, Dokad and Sirka were trained on improved agricultural and animal husbandry practices, and inputs like minor agricultural implements (one set per farmer), mineral mixture for livestock (150 kg), etc. were provided to the participating farmers.


Farmers-Scientists interface

A farmers-scientist interface was organized by the Institute on 22 December 2020 in collaboration with the Faculty of Veterinary Science and Animal Husbandry, Birsa Agricultural University, Ranchi at Brambey village (Mandar Block, Ranchi District, Jharkhand). Inputs viz., piglets (40 nos.) and area-specific mineral mixture for livestock and poultry (40 kg) was provided to stakeholder farmers for establishment of 10 units of piggery, each consisting of two male and two female piglets, for promotion of entrepreneurial skill and scientific animal husbandry practices. The programme was organized under the TSP scheme.

Fish seed distribution and Farmer-Scientist interaction program

A fish seed distribution program was organized under TSP scheme by the institute on 23 July 2020. Six thousand fish fingerlings were distributed for stocking into the ponds of 06 tribal fish farmers of village Lowatoli, Kharsidag and Lakhatanga of Namkum block, Ranchi. The quality of seed is crucial towards ensuring maximum survival during the aquaculture operation. Twenty marginal farmers of different villages were also educated on the technical know how of upgraded mixed carp culture and sceintifc management of aquaculture practices to enhance the overall production. During the interaction, the role of nutritionally balanced feed was also highlighted by Dr Sanjay K. Gupta, Scientist ICAR-IIAB.

Representative photograph of fish seed distribution

Scheduled Caste Sub-Plan (SCSP)

During the year 2020, ICAR-IIAB enthusiastically implemented Scheduled Caste Sub-Plan (SCSP) initiated by the Government of India. Under this programme, ICAR-IIAB supported more than 600 Scheduled Caste beneficiaries of Latehar, Khunti, Hazaribagh, Ramgarh, Giridih and Chatra districts by providing critical agricultural inputs. Promotion of cultivation of drought-tolerant high yielding rice varieties viz., IR64*drt1* and Sahbhagi Dhan and Indian mustard in rice-fallow land, besides other interventions like piggry, fishery, and backyard poultry has been the focus of the Institute. The major interventions taken up under SCSP during 2019 were as follows:

Promoting quality seed production in rice for increasing productivity and food security

Rice is a major crop in Jharkhand state. However, the productivity is less as compared to other regions. Under SCSP program ICAR-IIAB distributed 110 quintals of high yielding rice varieties like IR64*drt1*, Sahbhagi Dhan and TRC 15-5. For encouraging farmers to produce and store quality seed, farmers-scientist interaction/ training cum input distribution programs on quality seed production in rice were organized.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Promotion of Farm Mechanization

The level of agricultural mechanization in Jharkhand is very low (<12%). There is tremendous scope to improve the yield and sustain the growth of the farming sector by increasing the level of farm mechanization. With the above in view, ICAR-IIAB procured and distributed 15HP power tillers with accessories (30 Nos.), 5HP water pumps with accessories (30 Nos.), 3000 meter canvas hose pipes, solar driers (03 Nos.), paddy threshers (38), etc., besides a large number of small farm tools set that were distributed to promote the use of farm implement and machinery by the farmers belonging to scheduled caste category.

Impact of livestock intervention under SCSP (2019-20) during lockdown periods owing to COVID-2019

Piggery units provided to the farmers during June 2019 started production (birth of piglets) by Mar-Apr 2020 (when lockdown started due to COVID-2019). Majority of the units received average litter size of eight. For example, there have been births of 42 piglets from five farrowings between 24 Mar and 14 Apr 2020 in the piggery unit of Sh. Saroj Baitha, village: Tati Mishra Toli, Dist. Ranchi. This returned him good income after two-three months period (Jun-Jul 2020) when the piglets were sold @ Rs. 2,500/- per piglet (min.). The intervention significantly offset the losses incurred during pandemic owing to COVID-2019 due to reduction in labour opportunities to these landless and marginal farmers.

Poultry and duckery units provided to 100 farm-families at Soparam and Somersoth villages (Block: Balumath, Dist. Latehar, Jharkhand) during September 2019 have been producing in full-scale starting February 2020 and became a good source of income during the lock-down period through sale of eggs (mean: Rs. 850/- per month per household). The eggs were mostly collected from farmers' households by buyers. It has also resulted in increased home-consumption of eggs by the farm-families.

Compound animal feed provided to farmers of Soparam village (Dist. Latehar)

Twenty-five (25) quintals of compound pig grower feed were provided to 17 piggery units (developed during financial year 2019-20) owned by 17 farm-families of Soparam village (Block Soparam, Dist. Latehar) during lockdown periods on account of COVID-2019 that was perceived by the farmer stakeholders as great help addressing the acute scarcity of livestock feed and fodders during the period.

Quality paddy seeds and mineral mixture for livestock provided to farmers of Lalkhatanga block (Dist. Ranchi)

The Institute organized a farmer-scientist interface cum agri-input distribution programme on 06 June 2020, at its Garhkhatanga campus, located on Ranchi Ring Road. The program was conducted by the Institute jointly under the Tribal Sub-Plan (TSP)/STC and SCSP schemes of the Govt. of India.

During the program, five tonnes of foundation seed of high-yielding drought-tolerant rice varieties (IR-64-drt-1, Sahbhagi and Naveen) was provided to 305 stakeholder farmers of

Lalkhatanga, Garhkhatanga, Kharsidag, Nayi Bhusur villages under Namkum block of Ranchi district. Enthusiastic participation of the farmers was observed. The farmers were oriented on advantages of direct seeding of rice (DSR) *vis-à-vis* transplantation method that is traditionally and predominantly practiced, and system of rice intensification (SRI) method. Given the fact that the monsoon started at the expected time (second fortnight of June) and Jharkhand received almost normal precipitation, the input provided to the rice growers proved to be very timely for the resource-poor farmers.

On this occasion, the stakeholder farmers were also provided with 250 kg of area-specific chelated mineral mixture for the livestock and poultry. This mineral mixture has earlier been demonstrated to be significantly beneficial for improvement in livestock production, reproduction and health of livestock nd poultry in the Ranchi district. Since availability of feed and fodder for livestock and poultry have been compromised during the lockdown period due to COVID-2019, supplementation of mineral mixture benefitted the livestock and their keepers.

		
Photographs shall be stored in the camera of ITMU Cell.		

Quality paddy seeds and livestock feed supplement provided to Balumath farmers

The Institute organized a Farmer-Scientist Interface cum Agri-input Distribution Programme on 21 June 2020 at Soparam village, located under Chetag panchayat of Balumath block of Latehar district. The programme was conducted under Scheduled Caste Sub-Plan (SCSP) Scheme of the Govt. of India. Under this programme, 312 farmers from Chetag, Jogiyadinh, Olhepat, Pakri, Samarsot and Soparam villages under Balumath block were provided 5,000 kg of foundation seed of drought-tolerant high-yielding rice varieties like IR-64-*drt1*, Sahbhagi and Naveen. Mineral mixture as feed supplement for improvement of production and health of livestock and poultry was also provided on this occasion.

The agri-inputs provided to the farmers during the COVID period were perceived by the farmers to be of immense help.

The Institute has been working in Balumath block through its outreach programmes since last three years and implemented a number of agricultural technologies, like improved varieties of paddy, maize, horticultural crops, piggery and poultry for the benefit of the farmers. Earlier, fertilizers and animal feed have been provided on time. Importantly, self-help groups (SHGs) of farmers have been provided with agricultural pump sets and power tillers. The impacts of these interventions have already become visible in Soparam block, resulting in increase in income of farmers.

North-Eastern Hill scheme

During 2020, the North-Eastern Hill (NEH) scheme of the Government of India was implemented by the ICAR-IIAB in five districts of Manipur viz., Imphal West, Churachandpur, Tamenglong, Ukhrul and Chandel. The implementation was carried out in collaboration ICAR-Research Complex for NEH Region, Manipur Centre through *KVK*s in selected districts. In different districts, improved varieties of rice, maize, soybean, groundnut, rajmah, ricebean, black gram, etc were demonstrated at more than 460 farmers' fields. In addition, 12 capacity building programmes on scientific cultivation of high yielding varieties of different crops and vermicompost production were organized for the beneficiary farmers.

Mera Gaon Mera Gaurav

To undertake *Mera Gaon Mera Gaurav* programme of the Government of India, four multi-disciplinary teams were constituted involving scientists of ICAR-IIAB during 2020. Seventeen villages in four districts (Latehar, Chatra, Gumla and Ranchi) of Jharkhand were selected under the programme, to cover about 1006 farmers from different adopted villages. Majority of farmers were marginal and poor. Scientists identified the technical problem in field of crop husbandry, animal husbandry, fishery and post-harvesting management under the programme. General sensitization programme was done on *Swachhta Hi Seva*, climate change, crop insurance, prevention of burning of residue, importance of organic mulch, soil test-based application of fertilizer, importance of agroforestry crops/trees for sustainability, zero budget farming. Three training programmes were organized on various aspects of agriculture viz., scientific mustard cultivation, management of rice fallow land for increasing cropping intensity and importance of small farm equipment and tools for reducing drudgery in agriculture. Scientists under the programme highlighted the information on various farmers' welfare

schemes, programmes and new initiatives launched by the Government of Indiafor the farmers, etc. Specific awareness programme was launched for “Managing of Farm during COVID” under which special emphasis was laid on maintaining physical distance protocol on farmers’ fields, maintaining of safe work place, importance of cleanliness and hygiene, managing visitors and outsiders to farm land, etc. Technical supports were provided to villagers through meeting, focus-group discussions and mobile advisory on various aspects of farming viz., selection of suitable varieties of agricultural crops, quality seed production and safe storage of seed, utilization of improved farm implements and tools, integrated pest management, scientific fish farming and animal husbandry.

	
Farmer-Scientist Interaction programme at Mungadih, Angara block, Ranchi	Awareness programme on Management of Farm during COVID
	
Distribution of improved variety of Indian Mustard PM-27 at village Silalm, Raidhi, Gumla	Farmer Scientist Interaction programme at Chetag Panchayat, Balumath, Latehar

Institutional Activities

Personnel

Name Designation & E mail ID	Area of Research
Dr. Arunava Pattanayak, Director, ICAR-IIAB, Ranchi director.iiab@icar.gov.in	
Dr. Tilak R. Sharma, Joint Director (Res.), ICAR-IIAB, Ranchi jdr.iiab@icar.gov.in trsharma88@gmail.com	
School of Genomics and Molecular Breeding	
Dr. Vijai Pal Bhadana Pr. Scientist (Genetics & Plant Breeding) Bhadana.VP@icar.gov.in bhadanavijai@gmail.com	Molecular breeding in rice
Dr. Binay Kumar Singh Pr. Scientist (Agril. Biotechnology) Binay.singh@icar.gov.in binaybio@gmail.com	Genomics and molecular breeding for enhancing nutrient use efficiency in rice
Dr. Sujit Kumar Bishi Sr. Scientist (Biochemistry) Sujit.Bishi@icar.gov.in sujitbishi@gmail.com	Nutritional biochemistry and stress biology
Dr. Avinash Pandey Scientist (Genetics & Plant Breeding) Avinash.Pandey@icar.gov.in nashpgr@gmail.com	Molecular breeding in rice and lentil
Dr. Sudhir Kumar Scientist (Genetics & Plant Breeding) sudhir.kumar5@icar.gov.in sudhiraaidu2006@gmail.com	Molecular breeding in rice and horse gram
Dr. Madan Kumar Scientist (Plant Physiology) Madan.Kumar@icar.gov.in madan.9577@gmail.com	Genomics and molecular breeding for enhancing nutrient use efficiency in rice
Dr. Sujatha T.P. Scientist (Biotechnology), sujatha.parvathy@icar.gov.in hiisuj1@gmail.com	Functional genomics, cell and developmental biology, genetic engineering and transgenic crops

Dr. Kishor U. Tribhuvan Scientist (Agril. Biotechnology) kishor.tribhuvan@icar.gov.in kish.tribhuwan@gmail.com	Genomics and molecular breeding for abiotic stress tolerance in pulse crops
Sh. Shambhu Krishan Lal Scientist (Agril. Biotechnology) shambhu.lal@ icar.gov.in shambhumku@gmail.com	Genomics and molecular breeding for enhancing nutrient use efficiency in rice
School of Genetic Engineering	
Dr. Anil Kumar Singh Pr. Scientist (Agril. Biotechnology) anil.singh12@icar.gov.in anils13@gmail.com	Genomics and stress physiology of crops
Dr. Soumen Naskar Sr. Scientist (Agril. Biotechnology) Soumen.Naskar@icar.gov.in snrana@gmail.com	Major histocompatibility complex (MHC); assisted reproductive technologies (ART) in livestock species
School of Molecular Diagnostics, Prophylactics, and Nano-Biotechnology	
Dr. Biplab Sarkar Pr. Scientist (Nanobiotechnology) br.sarkar@icar.gov.in biplab_puru@yahoo.co.in	Development and application of nanoparticles in disease control, environmental remediation, and micronutrient induced fortification
Dr. Sanjay Kumar Gupta Scientist (Fish and Fisheries) SANJAY.GUPTA@icar.gov.in sanfish111@gmail.com	Aquaculture nutrigenomics and metagenomics
Dr. Rishikesh Kumar Scientist (Plant Pathology) rishiiari2011@gmail.com	Study on blast pathogen in rice
Administration and Finance	
Sh. Rishikant Singh afao.iiabranchi@gmail.com	Assistant Finance & Account Officer
Sh. Arun Kumar Tripathi aaoiiab.2018@gmail.com	Assistant Administrative Officer

Training and Capacity Building

The Annual Training Plan (ATP) of 2020-21 for ICAR-IIAB was prepared with preference for the scientists who were not included in the previous ATPs. Four scientists and five trainings on various subject areas of interest were included in the ATP of 2020-21. An online workshop was organised for various HRD Nodal Officers of ICAR which was duly attended by the Nodal Officer of ICAR-IIAB during May 2020. Revision of ATP after online submission of the plan was possible during December 2020. Reports on various aspects such as physical and financial targets 2019-20, employees who did not attend training during 2014-20, impact assessment of trainings of 2019-20 and other relevant information as desired by ICAR-HRM were compiled and submitted. The institute was rated as "Excellent" by HRM-ICAR in terms of all staff (100%) who attended trainings during the last six years (2014-2020). Due to the pandemic owing to COVID-2019 and the regulations thereof, the scientists had attended online training programmes during the year 2020.

मानव संसाधन प्रबंधन एकक

Annexure - I

भारतीय कृषि अनुसंधान परिषद

कृषि अनुसंधान भवन- II, नई दिल्ली

List of Institutes with Excellent Performance in providing training opportunities to employees during 2014-20

S. No.*	SMD	Name of Institute(s)	% employees trained during 2014-20	Category of employees trained 100% during 2014-20			
				Scientist	Technical	Admin.	SSS
Excellent Performance (95 - 100 %)							
13.	Crop Science	IIAB, Ranchi	100	Yes	NA	Yes	NA

The details of Nodal Officers, reporting and reviewing officers of HRD for the year 2020-21 at ICAR-IIAB are given below

Nodal Officer	Dr. Sujatha T.P. (Scientist, Ag. Biotechnology)
Reporting Officers	Heads- In charge of three schools Dr.VP Bhadana (School of Genomics and Molecular Breeding) Dr. Biplab Sarkar (School of Molecular Diagnostics and Prophylactics) Dr. AK Singh (School of Genetic Engineering)
Reviewing Officer	Director (ICAR-IIAB) Dr. Arunava Pattanayak
HRD fund (2020-21)	Rs. 2 Lakhs

Details of training programmes attended by the ICAR-IIAB staff during 2019

S No.	Name	Subject Area	Duration	Host Institute
1.	Dr. B Sarkar	Advanced training on 'Nanoparticles for agricultural application'	17 Feb – 08 Mar 2020	IIT Powai
2.	Mr KU Tribhuvan	Advanced bioinformatic techniques for mapping and GWAS using NGS data	06 Feb – 26 Feb 2020	ICAR-IASRI, New Delhi
3.	Dr. S Naskar	Online Training Programme on e-Office Implementation in ICAR Institutions	30 Apr 2020	ICAR-IASRI, New Delhi
4.	Dr. S Naskar	Online Course on "SciCom for Smart Scholars"	26 May – 08 June 2020	ICAR-CIFE, Mumbai

MoUs signed by IIAB during 2020

1. Dr Shyama Prasad Mukherjee University, Ranchi on 22 Jan 2020
2. Tezpur University, Assam on 28 Jan 2020
3. West Bengal University of Animal Science and Fisheries Sciences on 19 Feb 2020
4. Odisha University of Agriculture & Technology, Bhubaneshwar, Odisha on 04 Dec 2020
5. PG School of IARI on 27 July 2020

Important Meetings

Institute Research Council (IRC) Meeting

Two meetings of the Institute Research Council (IRC) were held during 18-19 May and 07 October 2020 through virtual mode (with the option to present physically) under the Chairmanship of the Director, ICAR-IIAB, participated by the Joint Director (Research) and Scientists. The *kharif* (rainy) season IRC meeting (May 2020) was followed up by a detailed discussion on work plan of the Institute-funded research projects during the month of June and July. Progress of the projects made by the scientists were presented, and reviewed thoroughly. The Chairman emphasized on quality research publications, impact-driven extension and outreach activities, strengthening of social visibility of the Institute, and contribution to the developmental work of the Institute. The Joint Director (Research) outlined the research priorities matching with the mandate of the Institute, asked the scientists for development and reorientation of research programmes and projects based on the priorities. Three new research projects (including one inter-Institutional with ICAR-NIBSM, Raipur) were approved in principle during the *kharif* meeting of the IRC, and the new research project was approved during *rabi* (post-rainy) season meeting of the IRC. A number of ongoing research projects were decided to be modified according to the proposed priorities as per EFC 2021-26 including closure of a few projects. Scientists were encouraged to seek external funding, and based on that a number of research proposals have been submitted by the scientists to the different national S&T funding agencies during the year.

Institute Management Committee Meetings

The fourth and fifth meetings of the Institute Management Committee of the ICAR-Indian Institute of Agricultural Biotechnology, Ranchi were held on 29 May and 29 Dec 2020, respectively.

During the fourth meeting of the IMC, apart from confirmation of the proceedings of the third meeting of the IMC held on 30 May 2018, action taken report on the recommendations of the same was discussed. Dr VP Bhadana, Principal Scientist & Chairman of Works Committee, ICAR-IIAB made a presentation about progress of infrastructure development and informed that work items as approved in the EFC of 2017-20 were taken up, to which the Committee agreed. Mr Rishi Kant Singh, AF&AO, ICAR-IIAB presented the financial report of the institute, wherein 100% utilization of funds available under GIA Capital and GIA General were possible, which received appreciation from the Director (Finance), ICAR. Dr Anil K. Singh, Sr Scientist and Chairman, Institute Purchase Advisory

Committee presented the progress made regarding procurement of capital items according to the approved EFC 2017-20, which was appreciated by the Committee. Discussion was also held about purchase of vehicle.

The fifth meeting of the IMC was attended by The Chairman (Dr A. Pattanayak, Director, ICAR-IIAB) and three Members (Dr TK Bhattacharya, Principal Scientist and National Fellow, ICAR-DPR, Hyderabad; Dr V. Dinesh Kumar, Principal Scientist, ICAR-IIOR, Hyderabad; Sh P. Vatsal, Editor, BAU, Ranchi) apart from the Member Secretary (Sh AK Tripathi, AAO, ICAR-IIAB) as also by five invitees (Dr TR Sharma, Jt Director-Research, ICAR-IIAB; Dr VP Bhadana, Principal Scientist, ICAR-IIAB; Dr B. Sarkar, Principal Scientist, ICAR-IIAB; Dr AK Singh, Principal Scientist, ICAR-IIAB; Dr A. Pandey, Scientist & I/c AFAO, ICAR-IIAB). After initial remarks by the Chairman and Member Secretary, the invitees provided an overview of mandate of ICAR-IIAB, achievements and progress in research. After confirmation of proceedings of the fourth meeting of the IMC, Action Taken Report was discussed in respect of the recommendations of the fourth meeting of the IMC. Discussion took place about construction of dedicated electrical sub-station by JBVNL, high-speed internet facility and leased line thereof, furniture and furnishing of buildings at the farm B, purchase of capital items, and fabrication of wet laboratory facilities for Fisheries Unit and creation of additional posts.

Research Advisory Committee (RAC) Meeting

The 8th Research Advisory Committee (RAC) meeting of the ICAR-IIAB, Ranchi was held through Video Conferencing on 27 May 2020. The meeting was Chaired by Prof. J.P. Khurana, Professor, Interdisciplinary Centre for Plant Genomics & Department of Plant Molecular Biology, University of Delhi, South Campus. The other members of RAC, Prof. R. Srinivasan, Prof. Asim K. Pal, Dr S.M. Deb, Dr D.K. Yadava, ADG (Seed), Dr. J.C. Rana, Dr. Arunava Pattanayak and Dr T.R. Sharma were present and participated in the deliberations. After thorough discussion on the Director's report and ATR, Principal investigators of different projects presented the progress in the respective projects.

It was recommended that academic programme should commence from the ensuing academic session in collaboration with IARI and possibility of MoU with IVRI, NDRI and CIFE should also be explored. It was also suggested that IIAB should immediately initiate work on transgenics. The Chairman advised that in addition to its own resources, IIAB should gather information on work already done elsewhere and build-up on available information to avoid research overlaps. While screening germplasm accessions, the previously available information, if any, should be taken into

account. Phasing and prioritisation of research and academic programmes for next five years was also suggested, keeping in view the availability of manpower and infrastructure.

Action taken report (ATR) on recommendations made during the seventh meeting of RAC was presented by Dr. T.R. Sharma (Member Secretary). Progress made on infrastructure development during the last year was appreciated and efforts made on action taken on the recommendations were also observed to be satisfactory by the RAC.

Glimpse of the 8th meeting of the Research Advisory Committee

Infrastructure Development

As per the approved Master Plan of ICAR-IIAB, construction works of the following infrastructure are in progress:

- Farm Office-cum-Field Lab, Godown and Farm Implement Shed & Threshing Yard of the Field Crop Research and Training Centre
- Farm Office-cum-Training Hall of Livestock Research and Training Centre
- Fish Wet Labs and ponds of Fisheries Research and Training Centre
- Developmental works including roads, rain water harvesting channels and water storage pond at Farm B
- Grid Interactive roof top solar photo voltaic power generation system (CAPEX Model) at different buildings
- All-in-one hybrid solar street lights on newly constructed road at Farm B
- Hostel building for lady students at Farm A
- Hostel building for lady students at Farm A
- Cafetaria Building for students at Farm A
- Residence of Director, ICAR-IIAB at Farm A
- Administrative/ Institute Building at Farm A
- Rainwater Harvesting Pond and Internal Road at Farm A
- Rainwater Harvesting Pond and Internal Road at Farm D

 Farm office cum field laboratory	 Godown

	
A. Farm implement shade cum threshing yard	B. Livestock Research and Training Centre farm office cum training hall
	
C. Fish feed mill	D. Fish pond
Glimpses of various infrastructure developmental activities at Farm B, ICAR-IIAB	

 A. Administrative Building	Fig. : Infrastructure developed at Farm A, ICAR-IIAB, Garhkhatanga, Ranchi
 B. Hostel building for lady students	 C. Hostel building for gent students
 D. Cafeteria building for students at ICAR-IIAB	 E. Residence of Director, ICAR-IIAB

Furnishing of laboratories

Laboratory furniture viz., island tables, laboratory stools, wall mounted covered storage racks and free standing almirahs for secure chemical storage have been procured for furnishing of the three laboratories in the upcoming Office-cum-Field Laboratories (two nos.) of the Crop Research and Training Centre (CRTC) and Office-cum-Training Hall (one no.) of Livestock Research and Training Centre (LRTC) at Farm B of the Institute at Garhkhatanga, Ranchi. The three field laboratories shall accommodate 48 researchers who could work together at any given time. The CRTC Field Lab has become fully functional.

Glimpse of Crop Research and Training Centre Field Lab at Farm B, ICAR-IIAB

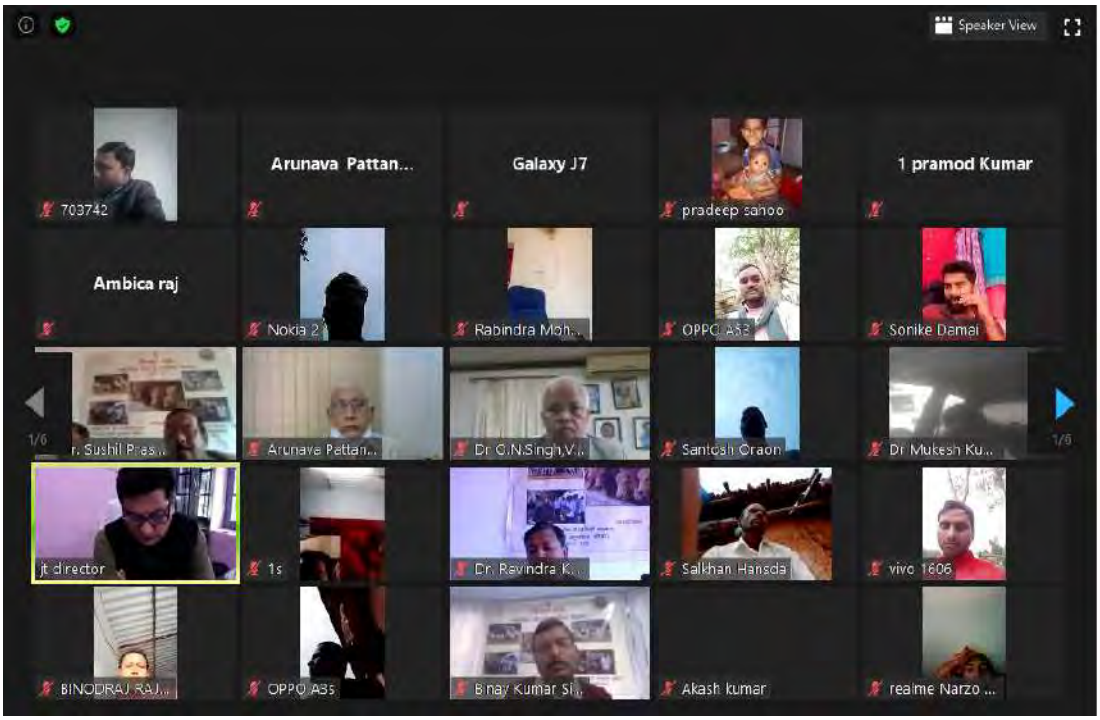
Procurement of laboratory equipment & Research Farm Development

Important equipment viz., Sample concentrator (Eppendorf), Electroporator (Bio-Rad), Micro volume spectrophotometer (nanodrop), Western Blotting System (Bio-Rad), Gel Drier (UniEquip), Cryocans (IOCL), Microprocessor-based electronic weighing balance (Shimadzu), Lyophilizer and Autoclave (Equitron), etc. have been procured. Systematic development of research-farm at ICAR-IIAB was undertaken by activities such as tilling and leveling. Around 10 ha of cultivable land was prepared, which was used for conducting field trials and seed multiplication. To ensure continuous availability of water for irrigation and farm related activities, a splinkler system has been established at Farm B.

Other Activities

Maiden virtual *Kisan Mela*

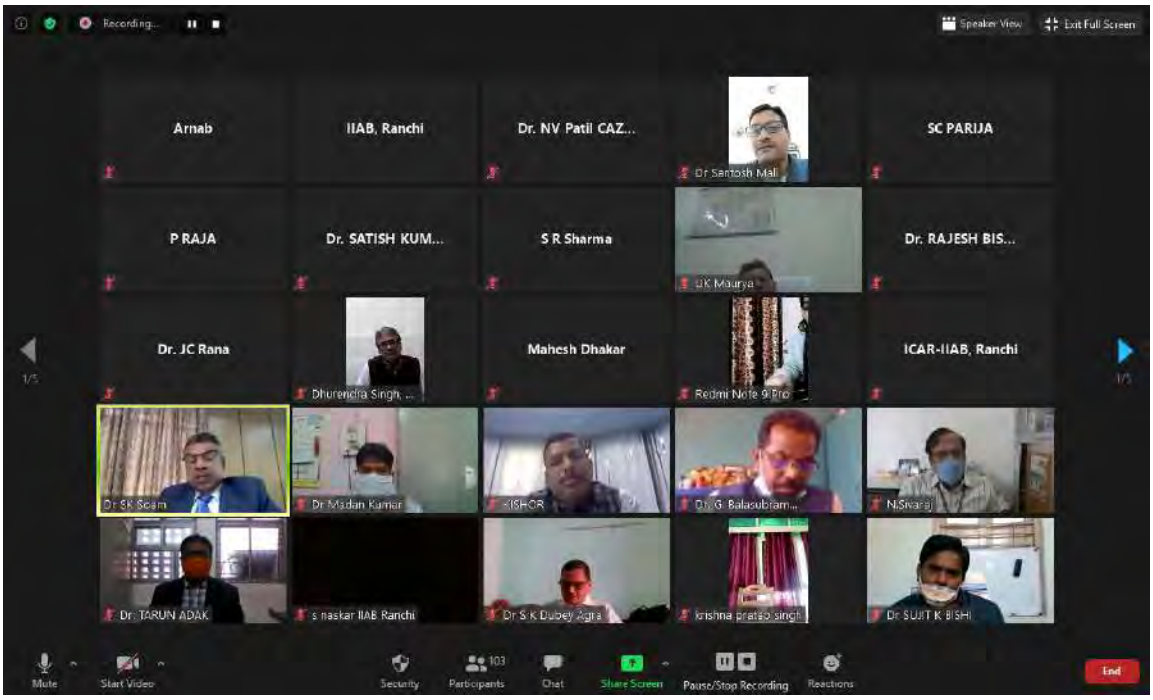
The ICAR-IIAB and Birsa Agricultural University (BAU), Ranchi jointly organized the first virtual *Kisan Mela* (Farmers' Fair) on 16 December 2020 on the theme "*Entrepreneurship development in Animal Husbandry sector*". More than 400 farmers and entrepreneurs participated in the event. Dr. O.N. Singh, Hon'ble Vice Chancellor, BAU and Chief Guest on the occasion in his inaugural address, indicated the immense scope of the livestock sector in Jharkhand. Dr. Arunava Pattanayak, Director, ICAR-IIAB emphasized on the contribution of small livestock and poultry in Jharkhand and opportunities for entrepreneurship development thereof. Dr. Tilak Raj Sharma, Joint Director (Research), ICAR-IIAB flagged the immediate requirement to address the gap of feed and fodder for livestock along with market linkages. Dr. Sushil Prasad, Dean, Faculty of Veterinary Science & Animal Husbandry, BAU presented an overview of the different schemes promoted by the Govt. of Jharkhand relevant to the sector that indicated emphasis of the State Govt. to address the issues of employment generation and livelihood security especially in view of the return of migrant labour to home state following COVID-2019 outbreak. On this occasion, farmers and entrepreneurs were oriented on various central schemes in dairy and animal husbandry aiming to double farmers' income (DFI) and opportunities for small holder farmers of Jharkhand for profitable livestock and poultry enterprises by the experts of ICAR-IIAB and BAU. It was followed by a *Kisan Gosthi* for farmer-entrepreneur-scientist interface that witnessed enthusiastic participation. The success of the event indicated that the farmers of Jharkhand have adopted the modern communication technology diligently which is envisaged to bolster with the spread of advanced agri-technologies by the ICAR and BAU in the times to come. The event was widely covered by the print and electronic media alike.



National workshop on Intellectual Property Management in Agriculture

A one-day National workshop on Intellectual Property Management in Agriculture under Institute Technology Management Unit (ITMU) was organized on 28 November 2020 by ICAR-IIAB, Ranchi. Two hundred and eighty-nine participants attended the workshop through virtual mode. Dr. SK Soam, Joint Director, ICAR-NAARM, Hyderabad; Dr Jai Chand Rana, Head, Division of Germplasm Evolution, ICAR-NBPGR, New Delhi; and Shri. Anjan Sen, Principal & Managing Patent Attorney

& Advocate, Kolkata, were resource persons for the workshop. Dr. Binay Kumar Singh, Senior Scientist and Organizing Secretary of the workshop briefed about the philosophy for organizing the workshop. On this occasion, Dr. A. Pattanayak, Director, ICAR-IIAB, Ranchi emphasized that the management of intellectual properties is the prime need in Indian agriculture to protect our innovations. The various aspects of Intellectual Property Rights (IPRs), viz., Patent Laws, Geographical Indications, Copyrights, Role of IPRs in biodiversity, filing of patent, etc., were discussed during the workshop.



Kisan Mela on "*Swatchh Kheti*"

A *Kisan Mela* on the theme *Swatchh Kheti* was organized on 22 Dec 2020 by the Institute in collaboration with the Faculty of Veterinary Science & Animal Husbandry, Birsa Agricultural University, Ranchi at Brambey village under Mandar Block of Ranchi district. About 300 farmers were oriented to clean practices for household, farm and field for overall improved farm health.

Farmers' Day

23 December 2020 was celebrated at Garhkhatanga campus of the Institute as Farmers' Day that witnessed enthusiastic participation of the farmers from the adjoining villages of the Institute under Lalkhatanga Panchayat. On this occasion, 80 farmers were provided with agricultural inputs like seed storage bags, mineral mixture for livestock and poultry (170 kgs), etc.

Swachh Bharat Abhiyaan

The *Swachhta Pakhwada* was organized at the ICAR-IIAB during 15 September - 02 October and 16-31 December 2020. Cleaning drive through the two fortnights was coordinated by Dr. Sanjay Gupta, Scientist and Nodal officer of the committee (SBM) and Dr. Madan Kumar Scientist (Member) under the guidance of the Director, ICAR-IIAB, Ranchi. During the *Pakhwada*, *Swacchhta* pledge was taken about the activities to be organized during the *Pakhwada* that was accomplished. Banners on the *Swachhta Pakhwada* were displayed at prominent places viz., at the main entrance gate, administrative block and office gate. On this occasion, Dr. Arunava Pattanayak, (Director) and Dr. T.R. Sharma, (Joint Director) along with all staff members led a cleanup drive in the ICAR-IIAB camp office premises. During the cleanliness drive in office premises junk material were assorted for proper disposal. This year, ICAR-IIAB implemented e-office successfully and all staff members were instructed to adhere to it. A review program was also conducted for weeding out old records, disposing of old and obsolete furniture. On 18 December 2020 a special sensitization program was targeted for school children and youth of Lalkhatanga village regarding importance of proper use of clean water, sanitation, disposal of waste material, etc.

ICAR-IIAB organized a cleaning programme all around the premises of the institute and the organic wastes were dumped in a composting pit. Water was sprinkled over the waste and *BOKASHI* powder was added for faster decomposition. A campaign was organized by the Scientists of ICAR-IIAB, Ranchi for increasing awareness on recycling of waste water after domestic use and for water harvesting for providing lifesaving irrigation during dry season in nearby village. Cleaning work was done in the institute campus and nearby school, public/tourist places. Awareness on importance of cleanliness, hygiene and waste disposal, etc. was imparted through various programs in nearby villages and schools. Cleanliness and sanitation drive was undertaken involving youth of Chipara village, Angaraha block, Ranchi. On the occasion, Scientists of the institute highlighted the importance of rain water harvesting not only in the agricultural fields but also emphasized on making arrangements for collection of water from roof tops of residential buildings. Mr. Ritesh Oraon (Mukhiya of local *Panchayat*) explained how water harvesting under different *Panchayat*s has led to rise in ground water level in the area. ICAR-IIAB organized a cleanup drive near Biodiversity park, Garhkahtanga, Ranchi, to sensitize the local youth about the importance of keeping the environment clean and green. On this occasion, special sensitization was targeted to youths regarding importance of using biodegradable bags for the health and safety of environment. A farmer-scientist interface was organized to increase the awareness about cleanliness among the farmers, farm women and

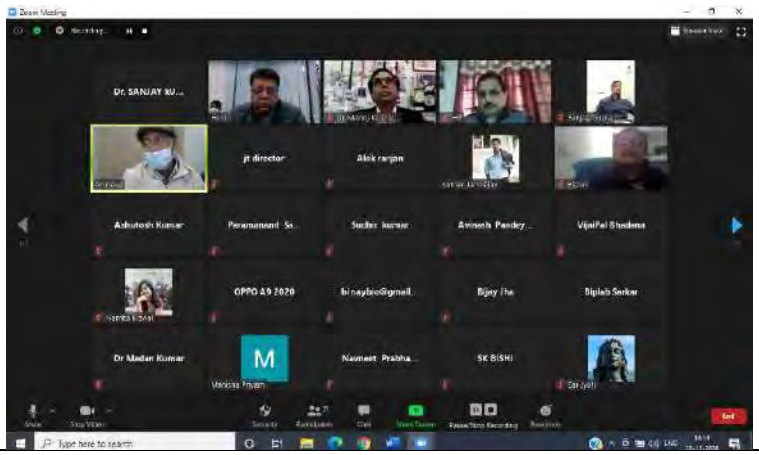
village youth at Chipra Village of Nagari block, Ranchi. Awareness lectures on implementation of *Swachh Bharat* Mission were delivered by the Scientists of ICAR-IIAB. Online quiz, debate, essay-cum-awareness programme, etc. were organized and interactive session was held among the students of the various schools. Prizes were distributed among the winners to encourage the students. More than 100 tribal farm women were sensitized about cleanliness and better sanitation habits. The scientists urged the farm women to make the surroundings clean for healthy living. The scientists also stressed on teaching the growing children the importance of personal hygiene from a young age. Inculcating healthy habits from a young age is critical to ensure that the children remain safe and healthy. A bottle of liquid detergent, phenyl, bleaching powder, and a pair of broom were provided to each household as a measure of inculcating a habit of using sanitizers. The farm women were also sensitized about the hygiene and health of farm animals, and each farm women were provided 2 kg of an area-specific mineral mixture as a feed supplement for the animals.

	
A. Staff of ICAR-IIAB taking *Swacchhta* pledge	B. The Director leading *Swachh Bharat Abhiyaan* at ICAR-IIAB
	

Selected photographs of *Swachhata hi Seva* campaign at villages, etc. around ICAR-IIAB

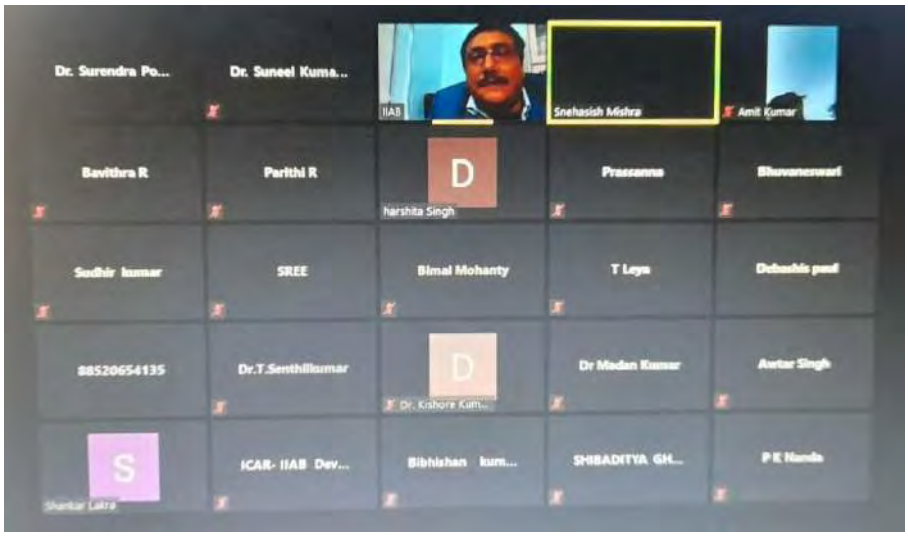
National Workshop on Integrated Waste Management: Turning Waste to Wealth

ICAR-IIAB, Ranchi organized a One-Day National Workshop on Integrated Waste Management: Turning Waste to Wealth on 22 December 2020. More than 300 participants from across India registered for participation in the workshop. Due to COVID-2019 pandemic, the event was organized through virtual mode. Dr. Anil Kumar Singh, Convener of the workshop welcomed the invited speakers and the participants. Dr. Tilak R. Sharma, Jt. Director (Research) emphasized on the problem of solid waste aggravating at an alarming rate. Dr. Arunava Pattanayak, Director expressed his concern about the rising landfills in big cities and suggested that proper management of solid waste is the need of hour to make our cities really smart. He congratulated the organizing committee for organizing national workshop on a very relevant topic. Invited speaker, Prof. Rajkumar Rampal, Head, Department of Environmental Sciences, University of Jammu, J&K emphasized the problem of rising solid waste generation by the communities. He indicated that a majority of solid waste can be recycled; but due to lack of awareness and proper infrastructure, it goes to landfills causing environmental pollution. He explained that vermi-technology can be very useful in converting solid waste to compost, which may be used as manure in farming system and can also develop entrepreneurship among citizens. Invited speaker, Dr. Manoj Kumar Tripathi, Principal Scientist, ICAR-Central Institute of Agricultural Engineering, Bhopal presented an overview of the problem of rising food waste and explained a number of ways by which such leftover can be converted into value-added products. At the end, Mr. SK Lal proposed the formal vote of thanks by expressing gratitude to all the speakers, Director, Jt. Director and all the participants.



National Workshop on Modern Interventions in Environmental Management

ICAR-IIAB, Ranchi organized a One-Day 'National Workshop on Modern Interventions in Environmental Management' on 30 December 2020. One hundred sixty-four participants registered for participation in the workshop. On the occasion, Dr. Biplab Sarkar, organizing secretary of the event welcomed the invited speakers and the participants. Dr. Tilak R. Sharma, Jt. Director (Research) flagged the problem of environment pollution and the need for continuous effort to keep it clean. Invited speaker, Dr. Kishore Kumar Krishnani, Principal Scientist and Head, Division of Aquaculture, ICAR-CIFE, addressed the audience on the role of environmental biotechnology for prevention of pollution. Invited speaker, Dr. Snehasish Mishra, Associate Professor, School of Biotechnology, Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar, Odisha provided insight into conversion of waste into energy. At the end, Mr. Kishor U. Tribhuvan proposed a formal vote of thanks by expressing gratitude to all the speakers, Director, Jt. Director and all the participants.



Vigilance Awareness Week

The Vigilance Awareness Week was celebrated with grandeur at ICAR-IIAB, Ranchi, Jharkhand during 27 October – 02 November 2020. On 27 October, the awareness week started with an 'oath taking ceremony'. In this ceremony, Director (Incharge), Dr. T.R. Sharma read out the given pledge and all staff (permanent, contractual, supporting staffs) took the oath to eradicate corruption. The valedictory cum sensitization programme was organized on 02 November 2020. In this session, Vigilance Officer, Dr. Biplab Sarkar emphasized on 'Scientific Integrity'. Asst. Administrative Officer (AAO) (Incharge) threw light on administrative rules and transparency in public life. Ms Anjali Bhadana (student, Vanasthali Vidyapeeth) was invited as key speaker, where she delivered a talk on role of vigilance in the development of the Nation. The programme concluded with comments from Director (Incharge), ICAR-IIAB, Dr. T.R. Sharma on 'Vigilant India, Prosperous India' and vote of thanks from Dr. Kishore Trivubhan.

Selected photographs of celebrating 'Vigilance Awareness Week' at ICAR-IIAB

Interaction of farmers with Hon'ble Prime Minister

On the occasion of Good Governance Day, which annually celebrated on 25 Dec being the birth anniversary of our former Prime Minister Late Sri Atal Bihari Vajpayee, ICAR-IIAB, Ranchi organized a program for farmers at Farm B, Garkhatanga. During this program more than 100 farmers virtually attended the event, during which Prime Minister Narendra Modi released over Rs 18,000 crore to more than nine crore farmer families under the '*Pradhan Mantri Kisan Samman Nidhi*' (PM-KISAN). Subsequently farmers also listen to the Hon'ble Prime Minister's address on this occasion. Dr. A. Pattanayak Director, ICAR-IIAB, Ranchi also addressed the farmers and make them aware about different welfare schemes of GOI for farmers.

Farmers attending Prime Minister virtual address on 25 December 2020

Week-long celebration prior to the 150th birthday (02 October 2020) of the Father of Nation, Mahatma Gandhi

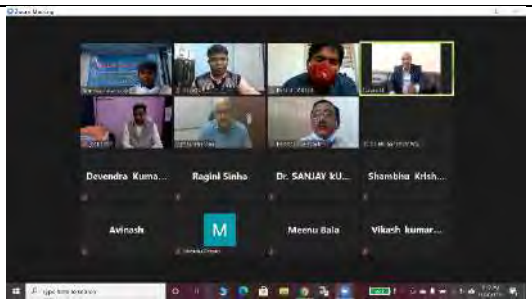
During the week-long celebration, staff of ICAR-IIAB participated in the workshop on "Gandhian Philosophy" on 25 September 2020 to commemorate the 150th Birth Anniversary of Father of the Nation, Sh Mahatma K. Gandhi. Dr. S.K. Chaudhary, DDG (NRM), ICAR was the guest speaker who delivered his talk through video-conferencing. An essay competition on the topic entitled "Celebrating 150th birthday of Mahatma Gandhi" was organised on 26 September 2020 in which twenty children below the age of 15 years participated. Another essay competition on the topic entitled "Cleanliness is next to Godliness" was organised among the 20 staff of ICAR IIAB on 29 September 2020. A painting competition was organised among 15 children of less than 15 years on the theme "*Ek Kadam Swacchhta ki Aur*" on 27 September 2020. Commendable response from the children of staff members of ICAR-IIAB was received with many beautiful painting sheets. Joint Director (Research), ICAR-IIAB acted as judge to critically evaluate the painting sheets and declared the winner of the competition. A debate contest was organised among the staff of ICAR-IIAB on the topic "Is *Swatch Baharat Abhiyan* a success or a failure" on 01 October 2020 using virtual platform. Evaluation of essays, paintings, debate was accomplished and the prizes were distributed among the winners on 02 October 2020. A reputed Yoga teacher Mrs. Renu Pandey from Harmu, Ranchi was invited to deliver a talk on Stress Management using Zoom platform on 28 September 2020. Twenty-five participants joined the session and also practiced some yoga related to alleviate stress. At the

end of session, some participants interacted with the guest speaker with pertinent questions. A well distinguished Professor, Dr. Dhirendra Tripathy from the Department of Political Science, Ranchi University was invited to deliver a talk on Gandhian Philosophy over virtual platform on 30 September 2020. During the program 55 participants were connected through Zoom wherein some participants interacted with the guest speaker related to Gandhian philosophy. In the Campus B of ICAR-IIAB, a grand celebration of 150th birth anniversary of the Father of the Nation was organised wherein, an invited talk from a young and vibrant student Ms. Anjali Bhadana was delivered on Gandhian Philosophy. On this occasion, various farm implements were distributed among 70 farmers of different districts of Jharkhand. A newly fabricated vermicomposting unit of ICAR-IIAB was released by the Director, ICAR-IIAB and distributed among the farmers. Plantation activities were carried out in the campus B by eminent personalities. The meeting ended with vote of thanks proposed by Dr. Sujit K. Bishi and Dr. Madan Kumar, Scientists.

Glimpses of celebration prior to the 150th birthday (02 Oct 2020) of the Father of Nation, Mahatma Gandhi

Celebration of Constitution Day

ICAR-IIAB, Ranchi organized webinar on the topic "*Constitutional values and Fundamental principles of the Indian Constitution*" on 26 November 2020 on the occasion of the Constitution Day. The lead lecture in the webinar was delivered by Dr. Pankaj Chaturvedi, Principal, Chotanagpur Law Collage, Ranchi. On this occasion Dr. A. Pattanayak, Director, ICAR-IIAB, along with all the staff of the Institute read the preamble of the constitution. Dr. A. Pattanayak (Director, ICAR-IIAB) also chaired the webinar session.



Group photograph on the occasion of the Constitution Day at the ICAR-IIAB

संस्थान की राजभाषा संबंधी गतिविधियां

भारत सरकार के राजभाषा विभाग; गृह मंत्रालय) द्वारा तैयार किए गए वार्षिक कार्यक्रम एवं राजभाषा अधिनियम व नियमों के संबंध में भारतीय कृषि अनुसंधान परिषद, नई दिल्ली से समय–समय पर प्राप्त निर्देशों पर अनुवर्ती कार्रवाई तथा कार्य में हिन्दी के प्रयोग को गति प्रदान करने के लिए निदेषक की अध्यक्षता में संस्थान की राजभाषा कार्यान्वयन समिति गठित की गई है, जिसमें विभागों/अनुभागों के अध्यक्ष, सदस्य के रुप में ामिल हैं तथा प्रभारी अधिकारी, राजभाषा सदस्य सचिव हैं। राजभाषा कार्य के सूचारू संचालन के लिए वर्ष 20119 में निम्नलिखित कार्य किए गए।

संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी तथा बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई। संस्थान के दैनिक कार्य में हिन्दी के प्रयोग में प्रगति एवं इसे सरल बनाने के लिए राजभाषा प्रकोष्ठ द्वारा निम्नलिखित कार्य सम्पादित होते हैं:

- संस्थान राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी एवं बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई।
- , हिन्दी चेतना मास एवं योजनानुसार नगर स्तरीय राजभाषा संबंधी, संगोष्ठी एवं कार्य
- संदर्भ साहित्य, हिन्दी पत्रिका, ाब्दकोश एवं तकनीकी ाब्दावली के उपार्जन हेतु कार्य।
- हिन्दी में वैज्ञानिक गोष्ठी के साथ साथ प्र ासनिक वर्ग के लिए कार्य ाला

हिन्दी दिवस समारोह–2020

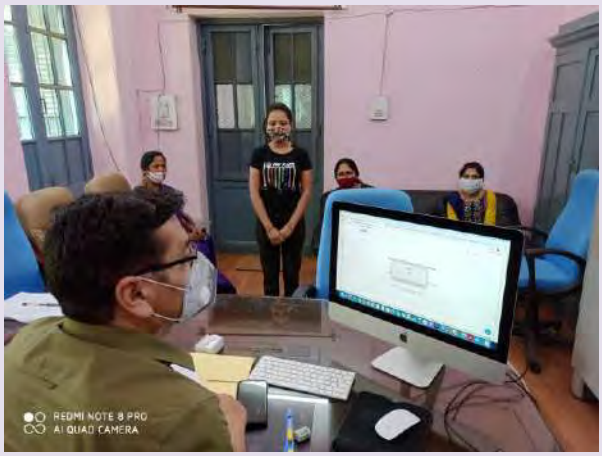
कृषि जैव प्रोदौगिकी संस्थान में राजभाषा अधिनियम के अनुपालन एवं कार्यालय कार्य में राजभाषा हिन्दी के निरन्तर वृद्धि के लिए संस्थान में दिनांक–01. . 20 . . 20 तक हिन्दी चेतना मास का पालन किया गया। इसके अन्तर्गत दिनांक–30. .2020 को अपराह्न 02.00 बजे हिन्दी दिवस समारोह का आयोजन किया गया।

हिन्दी दिवस समारोह के अवसर पर संस्थान के निदेषक डॉ अरुनव पट्टनायक द्वारा के से गया और उन्होनो कहा कि भाशा का विस्तार साहित्य और जीवन में आत्मसात करने से होता है। कार्यक्रम को संबोधित करते हुए संस्थान के संयुक्त निदेषक डॉ तिलक राज षर्मा ने हिन्दी दिवस समारोह के अवसर पर षुभकामनाएं देते हुए कहा कि विष्व की तीसरी सबसे ज्यादा बोली जाने वाली भाशा है। इसके बावजूद हम हिन्दी दिवस मनाते हैं। संस्थान में हाल के दिनों में सभी के प्रयासों से हिन्दी में काफी सुधार आया है।

हिन्दी चेतना मास की अवधि में हिन्दी टिप्पण, प्रारूप लेखन, निबंध, पर्याय एवं विपरीतार्थक शब्द प्रतियोगिताओं का आयोजन और विजेतायों को देकर सम्मानित

कार्यक्रम का संचालन प्रभारी अधिकारी/राजभाषा डॉ विनय सिंह

इस अवसर पर अन्य संस्थानों के अतिथियों के अतिरिक्त संस्थान के सभी अधिकारियों/कर्मचारियों ने भाग लिया।



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हिंदी का विकासशील स्वरुप एक दिवसीय राश्ट्रीय कार्यषाला

हिन्दी देश की आत्मा है। एक भाषा के रूप में हिंदी न सिर्फ भारत की पहचान है बल्कि यह हमारे जीवन मूल्यों, संस्कृति एवं संस्कारों की सच्ची संवाहक, संप्रेषक और परिचायक भी है। बहुत सरल सहज और सुगम भाषा होने के साथ हिंदी विश्व की संभवतः सबसे वैज्ञानिक भाषा है जिसे दुनिया भर में समझने, बोलने और चाहने वाले लोग बहुत बड़ी संख्या में मौजूद हैं। यह विश्व में तीसरी सबसे ज्यादा बोली जाने वाली भाषा है जो हमारे पारम्परिक ज्ञान, प्राचीन सभ्यता और आधुनिक प्रगति के बीच एक सेतु भी है। हिन्दी देश की राजभाषा होने के बावजूद आज हर जगह अंग्रेजी का वर्चस्व कायम है। हिन्दी जानते हुए भी लोग हिन्दी में बोलने, पढ़ने या काम करने में हिचकने लगे हैं। इसलिए सरकार का प्रयास है कि हिन्दी के प्रचलन के लिए उचित माहौल तैयार की जा सके। भारत सरकार का राजभाषा विभाग केंद्र सरकार के अधीन कार्यालयों में अधिक से अधिक कार्य हिंदी में हो तथा वैज्ञानिक शोधों को सरल भाषा हिंदी में किसानों तक पहुँचाने के लिए इस दिशा में प्रयासरत है। इन्ही उदेश्यों को ध्यान में रखते हुए 18 दिसम्बर 2020 को उपर्युक्त विषय पर कार्यशाला का आयोजन सुनिश्चित किया गया । कार्यशाला परिषद् गीत के साथ हुआ तथा संस्थान के निदेषक डॉ अरुनव पट्टनायक द्वारा के से गया । कार्यकर्म को संबोधित करते हुए संस्थान के संयुक्त निदेषक डॉ तिलक राज षर्मा ने मुख्य अतिथि, अन्य अतिथियों, एवं ों, के प्रति आभार प्रकट किया तथा कार्यक्रम के बारे में जानकारी दी।

कार्यशाला के प्रथम तकनीकी सत्र में व्याख्यान देते हुए डॉ "संप्रेषक मूलक भाषा हिंदी में वैज्ञानिक शोधों का प्रचार एवं प्रसार" व्याख्यान दिया गया। संवाद करने के लिए जरुरी नहीं है कि शुद्ध भाषा का ही प्रयोग किया जाए अपितु साधारण बोलचाल कि भाषा जो आसानी से समझा जा सके का प्रयोग किया जाना चाहिए । कार्यशाला के द्वितीय तकनीकी सत्र जन जन कि भाषा हिंदी व्याख्यान दिया गया । ने हिंदी भाषा के पहलुयों और श्रोतायों को इस भाषा के महत्व को बताया । अंतिम तकनीकी सत्र में डा "राजभाषा हिंदी का विकाशील स्वरुप : पारिभाषिक शब्दावली के सन्दर्भ में विषय पर चर्चा कि गयी। कार्यशाला का संचालन आयोजन समिति के संयोजक एवं प्रभारी अधिकारी/राजभाशा, डॉ संजय

कुमार गुप्ता ने तथा धन्यवाद ज्ञापन वैज्ञानिक, डॉ शम्भू कुमार, भारतीय कृषि जैवप्रौद्योगिकी संस्थान, गढ़खटंगा, राँची या।

		
डॉ कमल कुमार बोस विभागाध्यक्ष; राजभाशाद्ध संत जेवियर कॉलेज, रॉची	उप निदेषक; सेवानिवृतद्ध सी वी आई सी, नई दिल्ली	डॉ सुरेंद्र कुमार उपाध्याय उपनिदेषक; राजभाशाद्ध उत्पादन अनुसंधान एवं प्र
. एक दिवसीय हिन्दी कार्यशाला के मुख्य वक्तागन		

Participation in Conferences, Meetings, Seminars, Symposia and Workshops

Sl. No.	Event	Host Institute	Date/Period	Participants
1	Selection Committee Meeting for various scientific positions as Visitor's Nominee	Tezpur Central University, Tezpur, Assam	6-13 Jan 2020	Dr TR Sharma
2	Selection Committee Meeting for various scientific positions as Visitor's Nominee	Tezpur Central University, Tezpur, Assam	28-29 Jan 2020	Dr TR Sharma
3	Global Potato Conclave, 2020,	Mahatma Mandir, Gandhinagar, Gujarat (Organized by ICAR-CPRI, Shimla)	28-31 Jan 2020	Mr KU Tribhuvan Dr BK Singh
4	41st Annual Meeting of Plant Tissue Culture Association (India) & National Symposium on Trends in Plant Biotechnology and Agriculture	Thapar Institute of Engineering and Technology, Patiala	06-08 Feb 2020	Dr AK Singh
5	National Conference on 'Emerging Trends in Plant Science Research (ETPSR 2020)	Ravenshaw University, Cuttack	01-03 Mar 2020	Dr AK Singh
6	One-day online workshop on Training Management Information System (TMIS) for HRD Nodal Officers of ICAR	Online workshop ICAR-HRM	08 May 2020	Dr Sujatha TP
7	Webinar on Application of Nanotechnology on Aquaculture Biotechnology	School of Life Science & Biotechnology, Adamas University, Kolkata	09 May 2020	Dr B Sarkar
8	Academic Council Meeting of PG School	ICAR-IARI, New Delhi	11 July 2020	Dr TR Sharma
9	National Webinar on Impact of Physio-Biochemical Research on Indian Agriculture-2020	Bihar Agricultural University, Sabour	28 Jul 2020	Dr AK Singh
10	National Webinar on Biotechnological Interventions for Improvement of Pulse Crops	Bihar Agricultural University, Sabour	07 Aug 2020	Dr AK Singh
11	National Webinar on Under-utilized Crops for Augmenting Farmers'	Organized by ICAR-NIASM & Society for Agricultural Research	10 Aug 2020	Dr AK Singh

	Income in Abiotic Stress Regions	on Abiotic Stress (SARAS), Baramati, Pune, Maharashtra		
12	Under-utilized crops for augmenting farmers' income in Abiotic stress regions	ICAR-NIASM, Baramati	10 Aug 2020	Dr A Pandey Mr KU Tribhuvan
13	International webinar on plant physiological paradigm towards agricultural sustainability under climate change	Bihar Agricultural University, Sabour, Bhagalpur	15 Sep 2020	Mr KU Tribhuvan
14	Future Perspectives in Agricultural Education	ICAR-IARI, New Delhi	05 Sep 2020	Dr A Pandey Dr Sudhir Kumar Sh SK Lal
15	Workshop on Genomics Assisted Strategies for Climate Resilient Crops	AKS University, Satna	12 Sep 2020	Dr AK Singh
16	Tackling Complex Traits In Plants - A Multiomics Approach	Bionivid Technology Pvt. Ltd	19 Sep 2020	Sh SK Lal
17	Meeting of Regional Advisory Group (RAG) of NABARD as Official Member	NABARD Regional Office, Ranchi	25 Sep 2020	Dr TR Sharma
18	Online training programme on Climate change: Challenges and Response (CCCR) for women scientists, DST, Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussoorie	Online training LBSNAA, Mussoorie	05-09 Oct 2020	Dr Sujatha TP
19	Online World CRISPR Day (Keynote lecture by Nobel Laureate Dr. Jennifer Doudna, UC, Berkeley)	Organized by SYNTHEGO	20 Oct 2020	Dr AK Singh
20	Distinguished Lecture Series of the World Bank Funded NAHEP project entitled CAAST-Advanced Centre for Livestock Health	ICAR-IVRI, Izatnagar	03 Nov 2020	Dr S Naskar
21	National workshop on Intellectual Property Management in Agriculture	Online workshop ICAR-IIAB, Ranchi	28 Nov 2020	Dr Sujatha TP
22	National Seminar on Crop Breeding for Wider Adaptation	Birsa Agricultural University, Ranchi in association with Indian Society for	12-13 Dec 2020	Dr AK Singh

		Genetics and Plant Breeding, New Delhi		
23	Workshop on Gender Sensitization to Celebrate Seventh Anniversary of Notification of The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013, ICAR	Online Workshop of ICAR	15 Dec 2020	Dr Sujatha TP
24	Gene Editing for Agriculture, Society & Sustainable Development: Prospects and Perspectives	Tata Institute for Genetics and Society (TIGS) and BCIL	15 Dec 2020	Dr Sudhir Kumar Mr SK Lal
25	National Workshop on Modern Interventions in Environmental Management	ICAR-IIAB	30 Dec 2020	Dr B Sarkar

Institute Funded Projects

Project Title	Date of Start	Principal Investigator	Co- Principal Investigator (s)
IIAB-CBB-Ol: Genomics and Bioinformatics			
Identification and characterization of drought-responsive genes of wild chickpea (*Cicer microphyllum*)	Apr, 2016	Dr. AK Singh	Mr. KU Tribhuvan Dr. VP Bhadana
Identification of genes/QTLs for heat tolerance in lentil	Apr, 2016	Dr. AK Singh	Dr. BK Singh Dr. VP Bhadana Sh. SK Lal
Molecular characterization of the Major Histocompatibility Complex (MHC) genes of indigenous pig (*Sus scrofa*)	Sep, 2016	Dr. S Naskar	Dr. AK Singh Dr. VP Bhadana Dr. S Banik
Development of Low Phytic Acid Maize through Gene Editing	July, 2020	Mr SK Lal	
IIAB-TRCI-Ol: Translational Research for Crop Improvement			
Introgression of genes/ QTLs for drought tolerance and efficient phosphorus uptake in rice using MAS	Apr, 2016	Dr. VP Bhadana	Dr. BK Singh Dr. A Pandey Dr. S Kumar Dr. M Kumar Dr. R Kumar
Identification and mapping of novel genes/QTLs for phosphorus uptake and use efficiency in rice	Apr, 2016	Dr. BK Singh	Dr. VP Bhadana Dr. A Pandey Dr. S Kumar Dr. M Kumar
Identification and functional characterization of genes/QTLs responsible for zinc homeostasis in rice	Apr, 2016	Dr. M Kumar	Dr. BK Singh Dr. VP Bhadana Dr. A Pandey Dr. S Kumar Dr. R Kumar
Understanding host- pathogen interactions and identification of novel blast and false smut resistance gene(s) in rice	Sep, 2016	Dr. R Kumar	Dr. BK Singh Dr. VP Bhadana Dr. A Pandey Dr. S Kumar Dr. M Kumar
Molecular mapping of QTLs for early plant vigour, early maturity and harvest index traits in lentil	Sep, 2017	Dr. A Pandey	Dr. S Kumar Dr. K Tripathy Dr. BK Singh Dr. M Kumar Dr. R Kumar Dr. VP Bhadana
Ideotype breeding in horse gram for Jharkhand region	Sep, 2017	Dr. S Kumar	Dr. A Pandey Dr. BK Singh Dr. VP Bhadana Dr. M Kumar

			Dr. R Kumar
Elucidating the molecular and biochemical basis of climate resilient rice with low glycemic index	Sep, 2018	Dr. SK Bishi	Dr. R Kumar Dr. A Pandey Dr. M Kumar Dr. BK Singh Dr. S Kumar
Decoding the molecular mechanisms of molybdenum and boron metabolism in chickpea (*Cicer arietinum* L.) under acidic soil conditions	Aug, 2018	Dr. Sujatha TP	Dr. R Kumar Dr. A Pandey Dr. BK Singh Dr. VP Bhadana
Identification of genes/QTLs for tolerance to pod borer (*Helicoverpa armigera*) in pigeon pea	Dec, 2019	Mr. KU Tribhuvan	
IIAB-FHM-Ol: Biotechnological Interventions for Fish Health Management			
Evaluation of extrinsic and intrinsic parameters for sustainable breeding and culture of *Clarias magur* in captivity	Oct, 2019	Dr. SK Gupta	Dr. B Sarkar Dr. R Kumar Dr. S Naskar
Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp	Jun, 2016	Dr. B Sarkar	Dr. R Kumar Dr. SK Gupta Dr. BK Singh

Externally Funded Projects

Project Title	Date of Start	Principal Investigator	Co- Principal Investigator (s)
Enhancing food, nutritional and livelihood security of marginal and small farmers in Jharkhand through need-based agricultural technologies (ICAR-Funded)	Jan, 2017	Dr. Bikash Das (ICAR RCER Plandu Ranchi)	Dr. S Naskar Dr. SK Gupta (Cooperating Centre)
Heat stress responsive transcriptome analysis and gene regulation study in groundnut (N-PDF scheme)	Jul, 2018	Dr. B Pradhan	Dr. SK Bishi (Mentor)
Transcriptomic profiling of testes from hormone-induced *Clarias batrachus* v/s breeding phase testes from *C. batrachus* to evaluate the constraints for milting in induced conditions (DBT RA scheme)	Jul, 2019	Dr. M Priyam	Dr. SK Gupta (Mentor)
Quantitative proteomics and Phosphoproteomics to understand drought stress perception and response in contrasting genotypes of horsegram (*Macrotyloma uniflorum*)	Jul, 2019	Dr. R Sinha	Dr. AK Singh (Mentor)
Exploring cell surface biomarkers of cattle spermatozoa for sex-specific segregation through proteomic and genomic approach (SERB-Funded)	Dec, 2019	Dr. S Naskar	

Awards and Recognitions

- Dr. TR Sharma is among the top 2% of Indian scientists in the world ranking in the field of Plant Biology (Biotechnology) in a recent study by Stanford University, USA which was published in PLOS Biology journal (Ioannidis JPA *et al.* 2020).
- Dr. TR Sharma has Co-Chaired Technical Session -V "Molecular Breeding for Crop Improvement" during National Seminar on Crop Breeding for Wider Adaptation" organised by the Indian Society of Plant Breeding & Genetics-Ranchi Chapter during 12-13 December 2020.
- Dr Sanjay Kumar Gupta was awarded with a Certificate of Excellence for reviewing in recognition for an outstanding contribution to the quality of the journal, Asian Journal of Research in Animal and Veterinary Sciences.
- Dr Sanjay Kumar Gupta was awarded with a Certificate of recognized reviewers by the Editors of Aquaculture Reports in recognition for the review contributed to the journal Aquaculture Reports.
- Dr Sanjay Kumar Gupta was awarded with Certificate of Appreciation in recognition for sharing valuable insight on "Aquaculture: The fastest growing food production sub sector" as a resource person in webinar organized by Jharkhand Rai University held on 31 Oct 2020.
- Dr Sanjay Kumar Gupta was awarded with a Certificate of Appreciation for serving as session moderator of technical session at the 7th ICFA (International Conference on Fisheries and Aquaculture), on "Fisheries and Aquaculture in the Global Food Systems: Quo Vadis?" organised by The International Institute of Knowledge Management, Sri Lanka, during 26-27 Nov 2020.
- Dr Sanjay Kumar Gupta was presented with a Certificate of Appreciation for serving as evaluation panel member at the International Virtual Conference of Agriculture and Aquaculture organized by The International Institute of Knowledge Management, Sri Lanka held on 28 July 2020.
- Dr S Naskar availed the INSA Fellowship under Bilateral Exchange Programme 2019 during Dec 2019 - Jan 2020 (Nepal).
- Dr S Naskar was assigned duty as External Examiner, Central University of Kerala, Kasargod.

Publications

Research Articles

Aeron A, Khare E, Jha CK, Meena VS, Aziz SMA, Islam MT, Kim K, Meena SK, Pattanayak A, Rajashekara H, Dubey RC, Mourya BR, Maheshwari DK, Saraf M, Choudhary M, Verma R, Meena HN, Subbanna ARNS, Parihar M, Shukla S, Muthusamy G, Bana RS, Bajpai VK, Han YK and Mahfuzar. 2020. Revisiting the plant growth-promoting rhizobacteria: lessons from the past and objectives for the future. *Archives of microbiology* **202**(4): 665-676.

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Abstracts/ Invited talks in Conference/Symposium Proceedings:

Bhadana VP. 2020. Development of nutrient use efficient crop varieties- a way to reduce the impact on the environment delivered an invited lecture on the topic. Delivered lecture in an International *Web-Conference On Climate Smart Agriculture for Sustainable Food and Nutritional Security'* held during 10-11 July 2020 by organized by Society of Upliftment of Rural Economy, Varanasi and Beni Singh College, Hatta, Chenari, Rohtas, Bihar.

Bhadana VP. 2020. Environmental impact of agriculture and mitigation strategies. Lecture delivered 28 Jan 2020 in Ministry of HRD sponsored Faculty Development Programme on 'Environment Protection and it Challenges in 21st Century' organized during 27 Jan – 02 Feb 2 2020 at DSPMU, Ranchi.

Bhadana VP. 2020. Genomics-Assisted Breeding for Improvement of Phosphorus Use Efficiency in Rice. Delivered invited lecture on 05 Feb 2020 in ICAR-sponsored Winter School on 'Current Applications, challenges and perspective of genomics assisted breeding for crop improvement, held during 16 Jan – 05 Feb 2020 at BAU, Sabour, Bihar.

Gupta SK. 2020. Biofloc fish culture techniques. Delivered invited talk as a resource person for the tribal fish farmers of Jharkhand at FFTC, Dhurwa, Ranchi on 06 Mar 2020.

Gupta SK. 2020. How to do fish culture through biofloc techniques. Delivered radio talk as a resource person Prasar Bharti Doordarshan Kendra, Ranchi on 16 Mar 2020.

Gupta SK. 2020. The fastest growing food production sub sector aquaculture. Delivered invited talk as a resource person in webinar organized by Jharkhand Rai University held on 31 Oct 2020.

Kumar S, Pandey A, Kumar R, Kumar M, Bishi S, Tribhuvan KU, Singh BK, Bhadana VP and Sharma TR. 2020. Screening of germplasm accession of horsegram (*Macrotyloma uniflorum*) against biotic stresses. In: Abstract proceeding book of National Seminar on Crop Breeding for Wider Adaptation (ISGPB, Ranchi), 22-23 March 2020, BAU, Ranchi (Jharkhand). p 47.

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Sarkar, B. 2020. Application of Nanotechnology on Aquaculture Biotechnology. Lecture delivered in Webinar organised by School of Life Science & Biotechnology, Adamas University, Kolkata on 09 May 2020.

Sharma TR 2020. Agro-biodiversity and next-generation plant breeding for sustainable food and nutritional security". Lecture delivered under *Lecture Series* organized by AgriVision-Himachal Pradesh.

Singh AK, Shafi A, Pal AK, Gill T, Kumar S, Ahuja PS. 2020. Engineering anti-oxidant pathway promotes cell wall biosynthesis and confers salt stress tolerance in plants. Invited talk delivered in 41st Annual Meeting of Plant Tissue Culture Association (India) & National Symposium on Trends in Plant Biotechnology and Agriculture, held at Thapar Institute of Engineering and Technology, Patiala during 06-08 Feb 2020.

Singh AK. 2020. Crop improvement for sustainable agriculture: the changing problems, the continuing quest. Keynote lecture delivered in National Webinar on Impact of Physio-Biochemical Research on Indian Agriculture-2020 organized by Bihar Agricultural University, Sabour on 28 Jul 2020.

Singh AK. 2020. Engineering antioxidant pathway for abiotic stress tolerance in plants. Invited talk delivered in National Seminar on Crop Breeding for Wider Adaptation organized by Birsa Agricultural University, Ranchi in association with Indian Society for Genetics and Plant Breeding, New Delhi on 13 Dec 2020.

Singh AK. 2020. Integrated omics approaches for understanding plant response under climate change. Invited talk delivered in Workshop on Genomics Assisted Strategies for Climate Resilient Crops organized by AKS University, Satna on 12 Sep 2020.

Singh AK. 2020. Next generation genomics approaches for understanding plant response under climate change. Invited talk delivered in National Conference on Emerging Trends in Plant Science Research (ETPSR 2020) organized by Ravenshaw University, Cuttack during 01-03 Mar 2020.

Singh AK. 2020. Omics approaches for pulse improvement. Keynote lecture delivered in National Webinar on Biotechnological Interventions for Improvement of Pulse Crops organized by Bihar Agricultural University, Sabour on 07 Aug 2020.

Popular Articles

आकृति गुप्ताए संजय कुमार गुप्ता ;2020द्ध कोरोना काल में मत्स्य पालन पर प्रभाव, निलेतिमा, नवम्बर, 2020 pp.14-16

Gupta A, Gupta SK, Sheel R, Sarkar B and Priyam M. 2020. Artificial intelligence: an emerging avenue to boost aquaculture production. *World Aquaculture Magazine*, Sept. issue, pp. 64-66

Panzade KP, Kale SS, Manoj ML and Tribhuvan KU. 2020. Progress of transgenic crops in India. *Food and Scientific Reports* 1(8): 45-46.

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Budget Allocation and Utilization
(2020-21)

(*Figure in lakhs*)

S. No.	Head	Institute	
		Fund Received	Total Expenditure
Grants for creation of Capital Assets (CAPITAL)			
1	Works (Office building)	2853.04	2853.04
2	Equipment	17.91	17.91
3	Information Technology	13.10	13.10
4	Library Books and Journals	0.45	0.45
5	Furniture & Fixtures	9.63	9.58
	Total-CAPITAL	**2894.13**	**2894.09**
Grants in Aid - Salaries (REVENUE)			
	Establishment Expenses		
1.	A. Salaries (Establishment Charges)	365.35	365.29
	Total-Establishment Expenses	**365.35**	**365.29**
Grants in Aid - General (REVENUE)			
1	Travelling Allowance		
	A. Domestic TA/Transfer TA	2.21	2.21
	Total - Traveling Allowance	2.21	2.21
2	Research & Operational Exp.		
	A. Research Expenses	133.27	133.27
	B. Operational Expenses	51.32	51.32
	Total - Res. & Operational Exp.	184.59	184.59
3	Administrative Expenses		
	Total - Administrative Expenses	139.47	139.47
5	Miscellaneous Expenses		
	Total - Miscellaneous Expenses	22.33	22.31
	Total Grants in Aid - General	**348.55**	**348.53**
	Total Revenue	**713.90**	**713.82**
	Grand Total (Capital + Revenue)	**3608.03**	**3607.91**
*	TSP	52.51	52.51
*	NEH	48.12	48.12
*	SCSP (Capital)	628.28	628.28
*	SCSP (General)	235.00	235.00
*	NAIF Component 1 (ITMU)	9.50	9.50
*	NAIF Component 2 (ABI)	23.00	23.00

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Prof. C Srinivasan Former Professor of Molecular Biology and Biotechnology, IARI, New Delhi and Project Director of NRC on Plant Biotechnology, New Delhi	Member
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Dr. A Pattanayak, Director, ICAR- IIAB, Ranchi	Member
ADG (Seed), ICAR, New Delhi	Member
Two persons representing agricultural/rural interests on the management committee of the Institute in terms of Rule 66(a)(5)	Member
Dr. TR Sharma, Joint Director (Res.), IIAB, Ranchi	Member Secretary
Institute Management Committee (IMC)	
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Dr. TR Sharma, Joint Director (Res.), IIAB, Ranchi	Member
Dr TK Bhattacharya, Principal Scientist and National Fellow, ICAR-DPR, Hyderabad	Member
Dr V Dinesh Kumar, Principal Scientist, ICAR-IIOR, Hyderabad	Member
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All Scientific Staff of IIAB, Ranchi	Member
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Distinguished Visitors

S. No.	Name	Designation	Date of Visit
1.	Dr Palak Chaturvedi	University of Vienna, Austria	20 Jan 2020
2.	Dr Arindam Ghatak	University of Vienna, Austria	20 Jan 2020