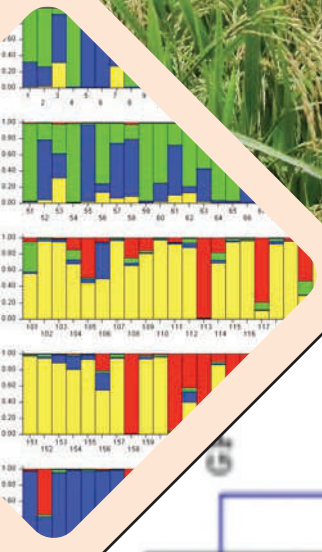
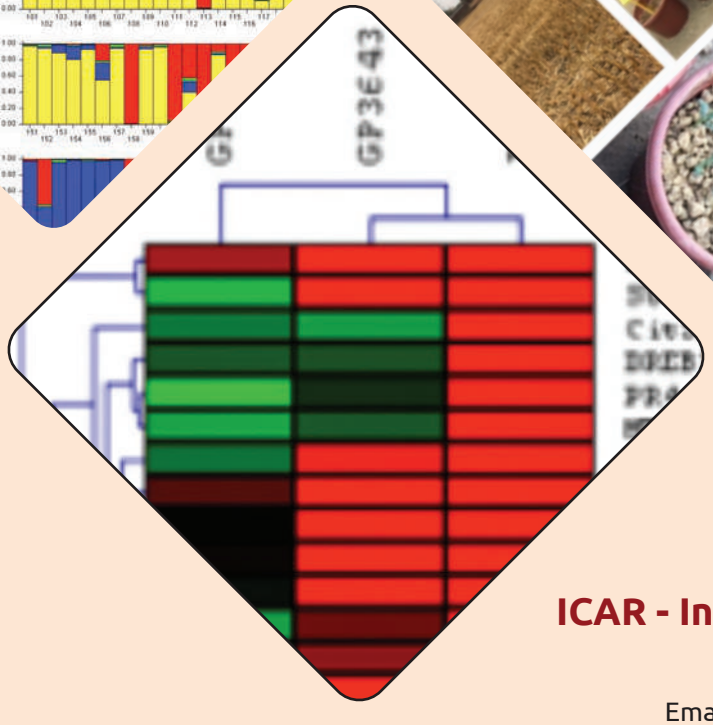
ANNUAL REPORT
वार्षिक प्रतिवेदन

2018-19





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Annual Report 2018-19

Published by

Dr. T. R. Sharma
Director

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Horsegram genotype IC261281
Screening of chickpea varieties
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Structure plot of jackfruit

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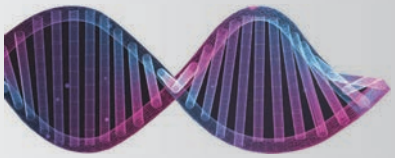

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Preface

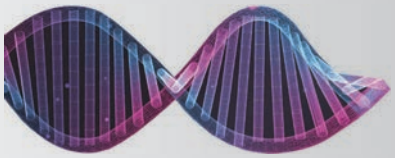
Nutritional security and food production to feed the ever-burgeoning population, anticipated to reach an alarming 1.5 billion by 2050, is a major challenge of Indian agriculture. Dwindling natural resources, shrinking arable land and global climate change make the task of "food for all" even more daunting and slacken the pace of achieving this goal. Technological interventions in agriculture are imperative and need-of the hour, amidst the challenges, to attain the target of providing adequate as well as quality food. ICAR- Indian Institute of Agricultural Biotechnology (IIAB) was established at Ranchi by the Indian Council of Agricultural Research (ICAR), to improve crop and animal productivity and facilitate the efforts to attain National food security through R& D support. IIAB foresees the dream and task of meeting the demand for biotechnology products, processes and technologies, as well as building world-class human resources in frontier areas and undertaking 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. Presently, the building of infrastructure is being undertaken, on priority basis.With modest research facilities available at the Institute at present, research work is been undertaken in the areas of Genomics and Bioinformatics, Translational Research for Crop Improvement and Fish Health Management. IIAB has also made a significant impact on the livelihood of local beneficiaries, through its outreach programmes. The Annual report 2018-19 of ICAR-IIAB describes the research activities undertaken and outlines the significant achievements made including annual accounts of the financial year 2018-19.

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

I am thankful and would like to express my gratitudeto Dr. T. Mohapatra, Secretary, DARE, Government of India and Director General, ICAR; Dr. A. K. Singh, Deputy Director General (Crop Science) and Dr. D. K. Yadava, Assistant Director-General (Seeds), ICAR for their constant supervision, guidance and support.

Ranchi
July 2019

T. R. Sharma
Director



About The Institute

A premier national institute working under the aegis of Indian Council of Agricultural Research (ICAR), New Delhi, the ICAR-Indian Institute of Agricultural Biotechnology (IIAB), located at Ranchi, was established with a broader vision of harnessing the potential of biotechnology to accelerate the pace of agricultural growth. The mission of the institute is to strengthen as well as conduct high-quality basic and applied research in plant, animal, fish and microbial biotechnology, in an integrated manner and to develop excellent human resources by undertaking teaching and training programmes at master, doctoral and post-doctoral levels in all the frontier areas of agricultural biotechnology. Basic and strategic research in agricultural biotechnology and development of quality human resources for academic excellence in agricultural biotechnology form the chief mandate of the institute. The focus is to provide a revolutionary impetus to agricultural development in the country, through cutting-edge research in biotechnology and application of modern scientific tools and techniques.

Self-sufficiency in food production and self-reliant farming community with enhanced farm income is the prime goal of agricultural development programmes. ICAR-IIAB has the mandated responsibility to critically assess the needs of the hour and to make a need-based paradigm shift in research agendas. ICAR-IIAB aims to achieve its goals through marker-assisted selection (MAS), an integral part of all breeding programmes which also supplements them, through the search for or identification of novel genes/alleles and promoters or cis-regulatory regions of genes from the vast and diverse biological resources in the country and application of genetic engineering to manipulate biochemical processes for effective stress response, enhanced productivity and input-use efficiency. Development of designer crops suited to the preference of stakeholder, is one of the priority research agendas of the institute. Generation of genomic/sequence data in large-scale and strengthening the management as well as analysis of such data, will be a regular research activity of the institute. Development of molecular diagnostics for precise identification of significant diseases in plants, animals and fish and prophylactic measures for their control will be another focus area of the institute. Advances in nanotechnology shall be explored and exploited by the institute, to device ultrasensitive detection system for disease as well as pest management and nanodelivery of pesticides, vaccines, nutrients/hormones, genes etc.

The institute shall serve as a hub for biotech research activities undertaken under the National Agricultural Research and Extension System (s) (NARES), by providing technical support and service facility for tools, techniques, protocols, database, sequencing, bioinformatics, safety studies, products and knowledge. With its modest facilities, IIAB has already initiated research in the areas of molecular breeding, for guided integration of known QTLs for drought tolerance and phosphorus-uptake in rice and to search for novel QTLs/genes for enhancing phosphorus and zinc uptake as well as utilization efficiency in rice. The drought-responsive genes from wild chickpea (*Cicer microphyllum*) were identified and studies undertaken on genes responsible for heat tolerance in lentil. Efforts are undertaken for development of oral vaccine which is nanoparticle-based recombinant protein and for characterization of genes responsible for immune response in fish. Augmentation of the germplasm resources through exploration and collection of landraces as well as wild species of crops, characterization of germplasm and enhancing the crop gene pool for use in crop improvement, are also among the significant activities taken up by ICAR-IIAB. Recently, the institute has also taken up pilot projects on the development of genomic resources, in few highly remunerative agro-horticultural crops, endemic to eastern India. In addition, ICAR- IIAB is also actively involved in undertaking taking possible

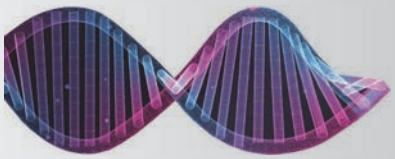
measures to empower the tribal farmers and in implementing central schemes for farmer's welfare.

Mandate

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

Cadre Strength

Category of Staff	Sanctioned	Filled	Vacant
RMP	8	1	7
Scientific	10 + (19)	14	15
Technical	01	0	01
Administrative	02	02	Nil
Skilled Supporting	Nil	Nil	Nil
Total	40	15	25



Executive Summary

ICAR-Indian Institute of Agricultural Biotechnology (IIAB) 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 at present is 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 2018-19 is summarized below:

- RNA-seq analysis of wild chickpea (*C. microphyllum*) under drought stress using high-throughput sequencing lead to identification of differentially expressed genes and SSR markers.
- Full-length HSF genes from lentil were cloned using RACE technique. Stably expressed housekeeping genes were identified in various lentil varieties under different leaf developmental stages and abiotic stresses. Genes *RPL2, Tub* and *Rbcl* were found to be stably expressedunder abiotic stress conditions.
- Twenty-six lentil genotypes were screened for drought tolerance using physiological, biochemical and molecular parameters. Based on these parameters, lentil genotypes GP3643 and IC248956 were classified as drought tolerant, while GP3690 was classified as drought susceptible.
- Twenty genotypes/ accessions of chickpea were collected from different sources and 5 varieties were screened for micronutrient (boron and molybdenum) response in acidic soil (collected from rice-fallows) in pots in poly house. Nine genotypes of chickpea were screened for thermotolerance and effect of micronutrient on thermotolerance was verified in 5 genotypes. Micronutrient treatment was found to impart thermotolerance in chickpea.
- Positive plants for *Pup1* transferred from Swarna and Vandana developed in the background of MTU-1010, IR-64 and Improved Samba Mahasuri were crossed with IR-64-*Drt1* (source for *DTY2.2* & *DTY 4.1*) for combining *Pup1* and *DTY* QTLs.
- Oil content in rice kernel found to be more compared to un-parboiled rice, suggesting the possibility of enhancement of resistant starch content in the later.
- 160 rice germplasm lines were phenotyped both in field as well and in pot culture. These lines were evaluated for seed Fe and Zn content using Atomic Absorption Spectrophotometer (AAS). The Fe content ranged from 11.7 to 530 ppm with a mean value of 76.45 ppm; and Zn content ranged from 10.8 to 126.3 ppm with a mean value of 29.2 ppm.
- Four horse gram accessions *viz.* IC-547543, IC-489212, IC-489216, and HPKM-317 were identified for early vigor and short duration while eight horse gram accessions *viz.* IC-262129, IC-262074, IC-469266, IC-489216, IC-426464, IC-313361, IC-426576, IC-469254 were identified for their high susceptibility to powdery mildew disease.
- Molecular screening of sixty-two putative rice blast resistant rice germplasm lines, showed three lines *viz.* IIABR-265, SD-80 and SD-82 possessing 11 blast resistance genes, 14 lines such as IIBR-374, IIABR-418, IIABR-139, IIABR-422, SD-103, IIABR-286, IIABR-312, IIABR-262, SK-1, JD-35, JD-82, IIABR-397, IIABR-277 and JD-57 possessing 10 blast resistance genes.

- A set of primer sequences from SSR flanking regions were identified for the validation of SSRs in a jackfruit germplasm set. Primer sets for 200 genic-SSRs have been custom synthesized in jackfruit for their validation, and molecular characterization of the 224 jackfruit accessions collected primarly from Jharkhand was carried out using these SSR markers.
- A total of 81 alleles were detected in 224 jackfruit accessions by using 27 SSR markers. The number of alleles ranged from 2 to 4, with an average of 3 alleles per locus. In population structure studies significant genetic admixing observed in the jackfruit accessions.
- Significant modulation in the expression of *TLR-22* (Toll like receptors), *β-2M* (Beta-2-microglobulin), *IFN-γ* (Interferon-gamma) and *TGF-β* (Transforming growth factor-beta) in the liver, kidney, gill and intestine of *Aeromonas hydrophila* infected *Labeo rohita* fingerlings was observed in a time dependent manner with dietary supplementation of microbial levan.
- A preliminary trail of 75-days was carried out to delineate the impact of biofloc rearing system on growth and immune responses of *Cirrhinus mrigala* and results recorded significantly higher specific growth rate (SGR) and feed conversion ratio (FCR) compare to the control group.
- Application of gold nanoparticle as fluorophore probe for DNA sensing and its potential in bio- imaging at molecular level was revealed. This optical imaging technique has significant prospect for understanding the biological processes at the molecular level.
- Results of experiment conducted using combination of copper and silver nanoparticles were shown to have better impact against the bacterial blight of rice after two applications than using individual copper or silver nanoparticle. Outcome of trial on *Xanthomonas oryzae* pv. *oryzae* using ZnO nanoparticles suggested the possibility of enhancing Zn content in seed.
- Impacts of silver nanoparticles (Ag-NPs) composite on wound healing efficiency of *Labeo rohita* was studied that resulted in significant reduction in the wound size after 14 days of application.

Research Accomplishment

Institute Research Projects

IIAB-CBB-01: Genomics and Bioinformatics

Ensuring food and nutritional security to rapidly growing world population is a major challenge in agricultural research. During last five decades, crop productivity has significantly increased and hunger has been mitigated, mainly through use of high yielding varieties and not so encouraging application of high doses of chemical fertilisers. However, atleast in the ensuing fifty years, the challenging task will be to increase crop productivity, under the scenario of global climate change, when the CO_2concentration is estimated to be 100% more than that in pre-industrial era and the global temperature to rise by 6°C by the end of 21st century, posing a great threat to sustainable agriculture. Recent advances in genomics such as high-throughput sequencing or Next Generation Sequencing (NGS) technologies can be used to improve resilience of crops to climate change and for sustainable intensification of agriculture. Three projects with special emphasis on pulse crops are undertaken under Genomics and Bioinformatics at ICAR-IIAB, Ranchi.

IXX12585: Identification and characterization of drought-responsive genes in wild chickpea (*Cicer microphyllum*)

Cicer microphyllum, a wild relative of cultivated chickpea (*C. arietinum*) is naturally adapted to harsh environmental conditions of cold deserts of Ladakh and Lahaul and Spiti in India. Considering this, a project is being carried out to identify drought responsive genes from *C. microphyllum*. RNA-seq analysis of *C. microphyllum* under drought stress was performed using high-throughput Illumina sequencing system leading to identification of differentially expressed genes and transcription factors. Assembled transcriptome data was used for identification of SSR markers using MIcroSAtellite identification tool (MISA). More than 8500 genic SSR markers were identified. Out of these, most prevalent type SSRs were mono-nucleotide (51.7%) followed by tri-nucleotide (27.4%), and di-nucleotide (18.9%). The developed SSR markers may be utilized for studying polymorphism in *C. microphyllum* genetic pool.

IXX12644: Identification of genes/QTLs for heat tolerance in lentil

The *HSF* gene isoforms were found to be expressed in lentil. However, the gene sequences used for primer designing were homologous sequence from soybean, thus in order to confirm their sequence identity, the amplicons from lentil cDNA were cloned through insTA clone PCR cloning kit and positive clones were confirmed by colony PCR and restriction digestion by *Eco*RI and *Bam*HI (Fig 1a). The resulting clones were sequenced and aligned through NCBI BLASTn and results were analyzed. In order to clone full-length genes, RACE technique was employed using SMARTer RACE kit (Clontech). Successful amplification of *HSF34* and

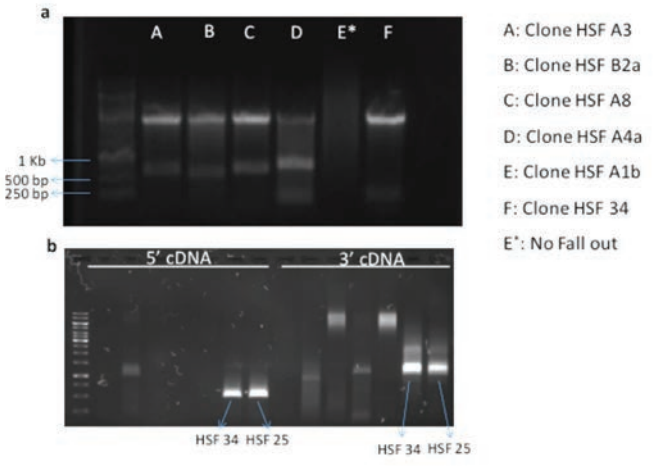


Fig 1. (a) Restriction digestion of HSFs cloned in TA cloning vector (b) mplification of 5 and 3 ends of HSF 34 and HSF 25 using RACE kit.

HSF25 was obtained from 5' and 3' ends (Fig 1b). Further cloning and nucleotide sequencing is being performed.

Eight candidate reference genes from lentil i.e. *actin, 18S, GAPDH, EF1α, HSP70, Mat K (Maturase K), Rbcl, Tub,* and *RPL2 (Ribosomal Protein L2)* were screened for their stable expression under abiotic stresses and at different leaf developmental stages in lentil. Initially, qRT-PCR parameters (correlation coefficient and PCR efficiency) of these genes were determined. The Ct (cycle threshold) values of these genes were then determined through qRT-PCR, under different abiotic stress conditions (cold, drought salinity, heat, methyl viologen and abscisic acid) and at leaf developmental stages. Comprehensive ranking of stable genes was calculated using different software (Bestkeeper, geNorm, Norm-Finder and Ref Finder) (Table 1). As a result, the genes were ranked according to their stability. The validation of results was also performed under abiotic stress condition, where expression of *PR4* and defensin was screened using different reference genes (Fig 2). *RPL2* was observed as top ranking under all experimental conditions by all the softwares, hence it was used further for data normalization.

Table 1: Compiled results of stably expressing genes as per statistical analysis.

Rank	All sample type				Abiotic stress conditions				Developmental stages			
	Best Keeper	geNorm	Norm-Finder	Ref-Finder	Best Keeper	geNorm	Norm-Finder	Ref-Finder	Best Keeper	geNorm	Norm-Finder	Ref-Finder
1	RPL2	RPL2	RPL2	Rbcl	RPL2	RPL2	RPL2	RPL2	Rbcl	RPL2	RPL2	HSP70
2	GAPDH	Rbcl	mat K	Mat K	18S rRNA	Tub	Tub	Rbcl	RPL2	Mat K	Tub	RPL2
3	Rbcl	EF1α	Rbcl	RPL2	GAPDH	GAPDH	GAPDH	Tub	18S rRNA	EF1α	18S rRNA	Rbcl
4	EF1α	Mat K	18S rRNA	EF1α	Rbcl	Rbcl	Rbcl	GAPDH	Tub	Tub	Mat K	18S rRNA
5	Mat K	GAPDH	Tub	GAPDH	Tub	EF1α	EF1α	18S rRNA	EF1α	Rbcl	Rbcl	Tub
6	18S rRNA	18S rRNA	GAPDH	Tub	EF1α	18S rRNA	18S rRNA	Mat K	HSP70	GAPDH	HSP70	Mat K
7	Tub	Tub	EF1α	18S rRNA	HSP70	Mat K	Mat K	EF1α	Mat K	Hsp70	GAPDH	EF1α
8	HSP70	HSP70	HSP70	HSP70	Mat K	HSP70	HSP70	HSP70	GAPDH	18S rRNA	EF1α	GAPDH

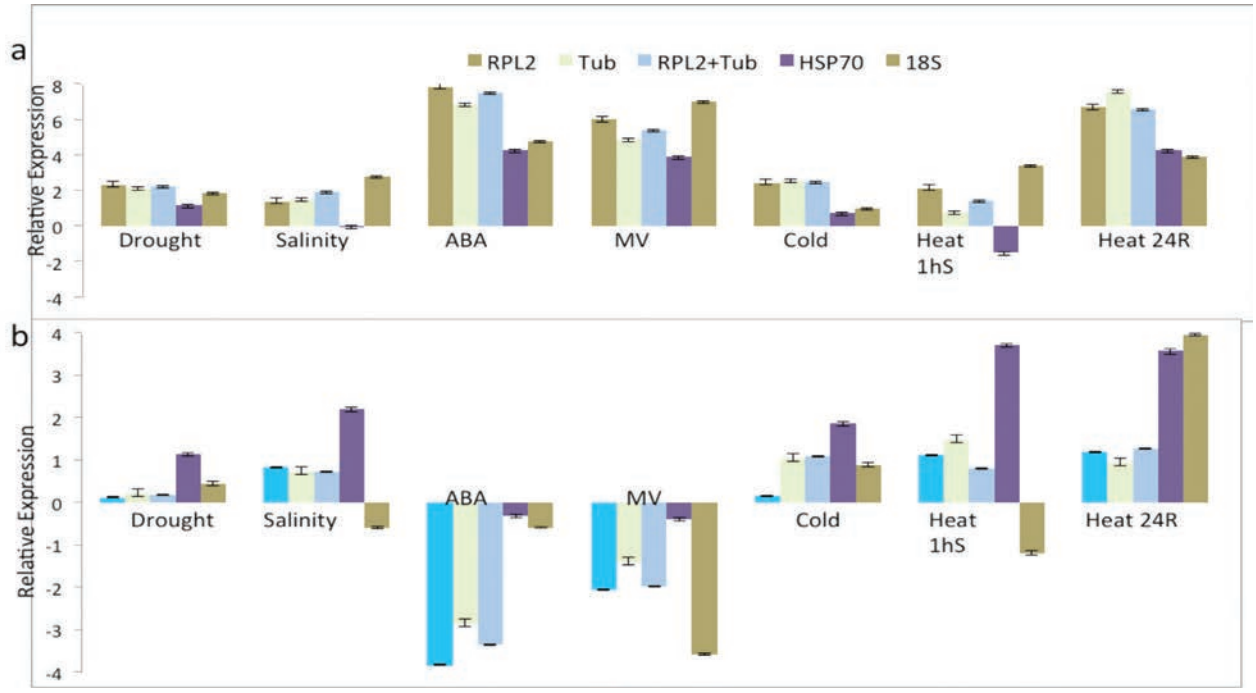


Fig 2. Validation of reference genes under abiotic stress conditions. Relative expression of defensin (a) and PR4 (b) genes as determined by ΔΔCt method under six abiotic stress conditions, and datanormalization was done using stable candidate reference genes: RPL2, Tub, RPL2, Tub and least stable candidate reference genes:HSP70 and 18S rRNA. Error bars represent standard error

IXX14646: Decoding the molecular mechanisms of molybdenum and boron metabolism in chickpea (*Cicer arietinum* L.) under acidic soil conditions

India is the largest producer and consumer of chickpea in the world. In Jharkhand, monocropping of rice is practised whereas chickpea is grown as *rabi* pulse in acidic rice fallows. A major limitation to chickpea grown on residual soil moisture after the harvest of rice, is acidic surface soil, where nutrients especially the micronutrient molybdenum, involved in nitrogen fixation and enhancing growth and yield of chickpea becomes unavailable or becomes the limiting factor. Soils of about 45% of Jharkhand are inherently deficient in available boron. To understand the molecular mechanisms involved in the metabolism or utilisation of the micronutrients Mo and B in chickpea, the chickpea varieties were screened for Mo and B response in acidic soils.

Soils from rice-fallows of farmers field from Lalkhatanga, Ranchi was collected during December, 2019 and the nutrient status were analysed (Fig 3A). The soils were strongly acidic (pH: 4.94-5.02), low in organic carbon, electrical conductivity, N and P, medium to sufficient in K, Ca, Mg and S deficient in boron (below detection limit) and with high or very high contents of molybdenum (100 times than normal levels) and Fe (10,000 times). Seeds of chickpea (20 varieties/ accessions) were obtained from different sources (IIPR, Kanpur; Division of Genetics, IARI and Birsa Agricultural University, Ranchi). Pot experiments were conducted in CRD in poly house at ICAR-IIAB, Namkum, Ranchi, using 5 varieties and 4 treatments (Control: Water control, no micronutrients; T1:boron (1 kg/ha), T2: molybdenum (1 kg/ha) and T3: both boron and molybdenum @ 1 kg/ha each) with 3 sets (12 pots each in each treatment and 2- 3 plants per pot (Fig 3B-C). Micronutrient treatments were given twice, at vegetative and flowering or pod setting stage. Observations were recorded on growth rate, wet and dry weight, flowering, pod setting, mortality etc. and samples collected at 2 regular intervals after treatments, from atleast 2-3 replications for transcriptome sequencing and wet or dry mass estimation (Fig 3D). Growth rate and dry weight varied between varieties for treatments. Control was better than or comparable to treatments in two varieties (DJ-1 and KJK-1), whereas treatments were better in three varieties tested (PD 30, DJ-14 and BG-18) (Fig 4). Marginal necrosis in middle leaves was observed in T1 and T3. Nutrient analysis of soil and plant samples from T1 indicated higher levels of B and K, and lower levels of Ca and Zn in shoots of treated (T1: Boron) plants when compared to control plants. Boron had accumulated to toxic levels in shoots of B-treated plants (T1) resulting in toxicity symptoms in T1 and T3.

Fig 3. Screening of chickpea varieties to micronutrient response in acidic soils. (A) Soils (acidic) of rice fallows used for pot culture experiments. (B, C) Pot culture experiments for screening of chickpea varieties for micronutrient (molybdenum and boron response). (D) Chickpea plants collected at intervals from pots for transcriptome sequencing or growth estimation.

The temperature in polyhouse was higher by 7-10 °C from April to mid- June, 2019.Temperature rise due to global warming may decrease the productivity of rabi pulse crops such as chickpea. Nine desi varieties were tested for high temperature tolerance by pot culture experiments undertaken inside and outside (control) the poly house.The temperatures inside and outside poly house were monitored at 10 AM, 1 PM and 3 PM during the growth period and

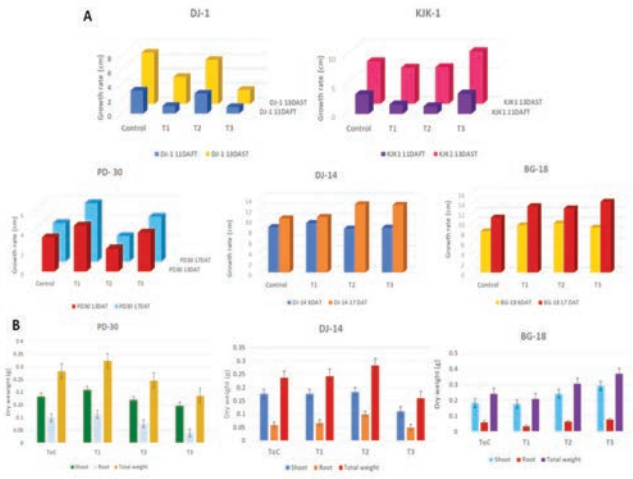


Fig 4. Response of chickpea to micronutrients. (A) Effect of micronutrients treatments on growth rate of chickpea (B) Effect of micronutrient treatments on dry weight of chickpea. DJ-1, KJK-1, PD-30, DJ-14 and BG 18 are varieties/ accessions of chickpea. Control/ ToC: Non-treated water control, T1: Boron, T2: Molybdenum and T3: boron and molybdenum @1 kg/ ha each.

the peak temperatures were observed at 1 PM (Fig 5A). GG2 did not survive outside the polyhouse; hence observations taken were not included in comparisons. Plants grown inside the polyhouse were stunted, with reduced root and shoot growth,

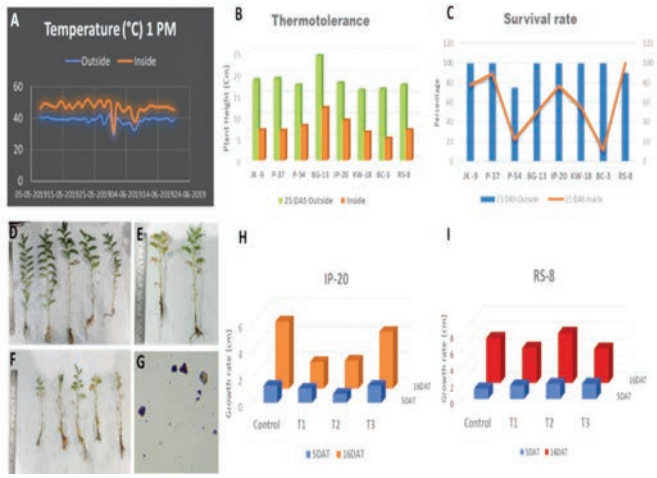


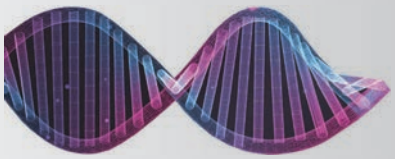
Fig 5. Screening for thermotolerance and effect of micronutrients on thermotolerance in chickpea. (A) Temperature profile inside and outside polyhouse at 1PM (B) Effect of high temperatures on growth rate of chickpea 25 days after sowing (DAS). (C) Survival rate of chickpea varieties at high temperatures inside polyhouse (D) Growth of JK-9 outside poly house (E, F) Stunting of JK-9 and IP-20 at high temperatures inside polyhouse (G) Pollen fertility studies using acetocarmine stain showing fertile (red) and sterile (colourless) pollen (H, I) Effect of micronutrients on growth at high temperatureof IP-20 and RS-8, at 6 and 16 days after first treatment. Growth before treatment (12 DAS) was compared with growth after treatment. Control: Non-treated water control, T1: Boron, T2: Molybdenum and T3: boron and molybdenum @1 kg/ ha each.

unhealthy, exhibited yellowing and did not flower. BG-13, IP-20 and P-54 exhibited better response in growth inside polyhouse at high temperature conditions, though the survival rate of P-54 was low. Based on growth rate and survival rate IP-20 P-37, JK-9 and KW-18 were found to be thermo tolerant (Fig 5B-F). However, the varieties BG-13, P-54, P-37and RS-8 grown outside polyhouse exhibited flowering at high temperature in summer although pollen fertility was low (P-54: 3.42%, P-37: 35.44%, RS-8: 38.83%), as verified by acetocarmine staining (Fig 5G). BG-13 exhibited early flowering and pod setting than other varieties at high temperature conditions, in summer outside the poly house.

The effect of micronutrients on temperature tolerance of chickpea was initially verified in BG-18 and DJ-14. Micronutrient-treated plants had better tolerance to high temperature than control (non-treated) plants in BG-18. Thermotolerant (IP20 and JK-9) and thermosensitive (BC-3 and RS-8) varieties identified in the study were further used to verify if micronutrient treatment enhances thermotolerance in pot culture experiments in summer (May-June) inside polyhouse high temperature, with 2 treatments at 12 and 22 days after sowing (DAS) respectively. Treatments were better than control in IP20, RS-8 and BC-3, 5 days after first treatment, while 16 days after first treatment (6 days after second treatment), control was comparable to treatments in IP20 and Rs-8 but better than treatments in BC-3 (Fig 5H, I).

IIAB-CBB-01: Translational Research for Crop Improvement

Translation of the extensive data generated in genomics and molecular biology during the past decades, to improve the agronomical traits and performance of crops is of utmost importance for food security and sustainable agriculture. At ICAR-IIAB, six research projects are undertaken for marker-assisted convergence of known QTLs for drought and phosphorus uptake, 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 have been undertaken.

IXX12649: Introgression of genes/QTLs for drought tolerance and efficient phosphorus uptake in rice using MAS

High input costs accompany the increase in crop yield, there by negating the profits of the farmer and rendering farming a non-remunerative occupation. In addition, depleting water resources and soil minerals make food production in a sustainable manner from shrinking land area for agriculture, to feed ever-increasing population in future, a tougher task. This challenge can be overcome by developing resource-use efficient and climate-smart crop varieties. The project aims to introgress *Pup1* a major QTL for P-uptake and combinations of *DTY 2.2* and *DTY4.1* (QTLs for drought tolerance) for developing varieties which will be capable of giving high yield under drought in soils which are inherently low in phosphorus availability. During kharif 2018, plants carrying *Pup1*(transferred from Swarna and Vandana) developed in the background of MTU-1010, IR-64 and Improved Samba Mahasuri were crossed with IR-64-*Drt1* (source for *DTY2.2* & *DTY 4.1*) for combining *Pup1* and *DTY* QTLs. F_2 will be raised during kharif 2019 and selection will be made for plants carrying both the QTLs.

IXX12651: Identification and mapping of novel genes/QTLs for phosphorus uptake and use efficiency in rice

Two RIL populations derived from the crosses Rasi × RPBIO-226 and Wazuhophek × RPBIO-226 have been obtained from ICAR-IIRR, Hyderabad. These RIL populations are being evaluated at ICAR-IIAB for PUE. Moreover, hydroponics protocol is also being standardized for the comparative analysis of parents involved in the crosses for understanding the PUE mechanism in the phosphorus use efficient (Rasi & Wazuhophek) and phosphorus use non-efficient (RPBIO-226) genotypes of rice. All the three parents involved in the crosses are devoid of *Pup1* locus known for better uptake of phosphorus in rice.

IXX14638: Elucidating the molecular and biochemical basis of climate resilient rice with low glycemic index

Rice varieties possessing slowly digestible starch {higher amylose content and more resistant starch content (RS)} can be used for the management of diabetes, a dreaded disease. The resistant starch in rice is (type 5 RS) starch, wherein the amylose component forms complexes with lipids (amylose–lipid complex), that makes it more thermally stable, compared to other types. This is because, the amylose–lipid complex in type 5 RS restricts swelling of the starch granule during cooking, making it resistant to hydrolytic enzymes. Thus, an increase in the amount of type 5 RS could make rice safer for people with diabetes or for those who simply would like to avoid the extra calories. According to the findings of a recent study by Zhou et al., (2016), RS content in rice can be enhanced, by diverting ADP-Glc in the plastid for simultaneously increasing amylose and lipid content. Further, it has been reported by various researchers that cooking rice with lipid (Ghee/oil) can increase RS content through a process called lipid complexation, which in turn can lower the glycemic Index (GI) of rice. So it is hypothesized that rice genotypes inherently having higher oil content may have low GI and are preferably better option for consumption by the diabetic.

In the present study, two popular rice genotypes, Swarna (GI: 61) and Pooja (GI: 68) were evaluated for oil content. Two sets of experiment were conducted; in first set, seeds were soaked for 1 hr, dried over night in hot air oven and the husk was removed using a palm rice husker, samples were collected as whole seed (T1), husk (T2), and brown rice (T3) and in the second set the overnight-soaked

seeds were cooked in microwave for 40 mins (20 +20 min), dried overnight, and the husk (T4) and seeds (T5) were collected. The samples were evaluated for oil content in triplicate using Soxhlet apparatus.

There was a significant difference in oil content between the genotypes studied where Swarna (low GI) possessed higher amount of oil than Pooja (High GI); Further, cooking followed by cooling resulted higher oil content compared to the uncooked riceseed. Hence it is believed that parboiling of rice may result an increase in oil content in the seed, which in turn may enhance RS content compared to the non-parboiled rice. So there is a need to screen popular rice cultivars to find the suitable cultivar, in which parboiling enhances RS content.

IXX12645: Identification of genes responsible for Zinc homeostasis in rice

During the preceding *kharif* season (2018-19), more than 160 rice germplasm lines were grown in field as well as in pot under similar conditions. Phenotyping or morphological characterization of rice genotypes was done for various qualitative traits such as leaf, stem, ligule, auricle and collar region anthocyanin colorations, leaf pubescence, culm attitude, flag leaf attitude and quantitative traits such as days to 50% flowering, flag leaf length, plant height, panicle length etc. Further, the seeds harvested from these lines were dehusked gently using a palm dehusker. The di-acid method of digestion was followed for estimation of micronutrients; Zn and Fe using atomic absorption spectrophotometer (AAS). The concentration was expressed in parts per million (ppm). Wide variation in Fe and Zn content was observed in the germplasm. The Fe concentration ranged from 11.7 ppm to 530 ppm, with a mean value of 76.45 ppm and Zn concentration ranged from 10.8 ppm to 126.3 ppm with the mean value of 29.2 ppm.

IXX13896: Ideotype breeding in horse gram for Jharkhand region

Horse gram [*Macrotyloma uniflorum* (Lam.) Verdc.] commonly known as Kulthi or Madras gram is a hardy and drought-tolerant legume crop used as food and fodder in India. Owing to its drought-tolerant nature and ability to grow in problematic soils, there is an ample scope of its cultivation in Jharkhand. However, there is a need to breed varieties possessing traits like early vigor and short duration

Fig 6. (a) Evaluation of Horsegram accessions at ICAR-IIAB Namkum

for its popularization and intensive farming in the area. Assessment of variability in these traits in the available germplasm would be helpful in identifying the suitable parents for initiating effective breeding

Fig 6. (b) Determinate type horsegram plant

programmes. Given this, a total of 550 horesgram germplasm (Procured from NBPGR New Delhi and HPKV, Palampur) were characterized for agro-morphological traits (qualitative and quantitative). Under the project, early vigor and short duration genotypes were identified: IC-547543, IC-489212, IC-489216, and HPKM-317. We have selected 31 germplasm of determinate plant type horsegram for further use in crossing programme. Screening for disease reaction was done for powdery mildew, *Cercospora* leaf spot and anthracnose. Majority of accession were observed for moderate tolerant to

Fig 6. (c) Horsegram accession heavily infected with powdery mildew

powdery mildew. High susceptible reaction for powdery mildew was observed for accessions: IC-262129, IC-262074, IC-469266, IC-489216, IC-426464, IC-313361, IC-426576 and IC-469254.

IXX13895: Molecular mapping of QTLs for early plant vigour, early maturity and harvest index traits in lentil

The scope of pulses cultivation particularly lentil in the rice-fallow areas of eastern states of India is very high. For successful cultivation of lentil in rice-fallow land there is a need to develop a variety with early vigour, high harvest index and short duration. QTL mapping of these traits will be helpful in developing varieties with these desired traits with the help of marker assisted selection. In view of this, we have screened a total of 235 germplasm during 2017-18 and 2018-19.

Wide variations for various agronomic traits were recorded among lentil accessions (Table 2). Accessions *viz.* EC 225495 and EC 267710 were found promising as early maturing genotypes. Identified genotypes will be used in crossing programme for developing mapping population in next season.

Table 2: Descriptive statistics for the studied traits in lentil germplasm

Descriptive Statistic	Minimum	Maximum	Mean	Standard deviation
Days to 50% flowering	48	100	78.68	14.87
No. of secondary branches	10	41	23.69	6.190
Plant height (cm)	16	43	30.95	4.98
Pods per plant	18	189	88.88	37.78
Seeds per pod	1	2	1.747	0.39
Days to 80% maturity	94	132	114.42	6.71
100 seed weight (g)	1.10	5.02	2.312	0.868

IXX12951: Understanding host-pathogen interactions and identification of novel blast and false smut resistance gene(s) in rice

Rice (*Oryza sativa* L.) is a major staple food in the Indian subcontinent. Rice is grown as a rainfed crop in Jharkhand, one of the eastern states of India. Several biotic and abiotic stresses affect paddy cultivation, out of which blast disease of rice caused by *Magnaporthe oryzae*, is the most prominent one, that results in 10-30% yield loss. Under this research project, extensive phenotyping for blast resistance was carried out for 764 rice germplasm at nursery stage, out of them 62 were highly resistant and the remaining were moderately resistant to susceptible.

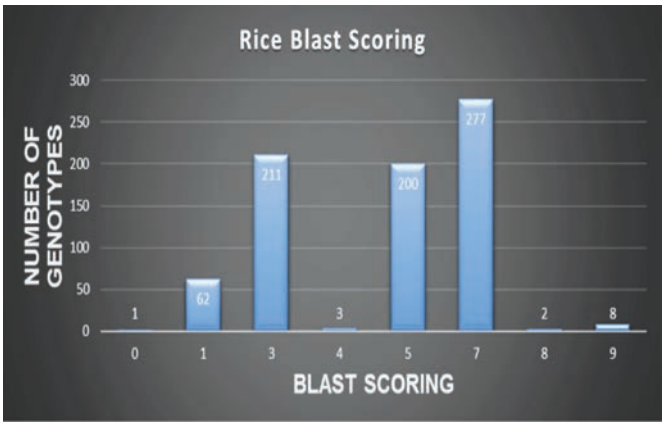


Fig 7. Phenotypic screening for 764 rice germplasms, out of which 62 genotypes having score of 1 (Highly Resistant) in scale of (0-9) {SES IRRI, 1996}.

Further, molecular screening using SSR/ SNP markers was carried out in these resistant lines. Molecular screening was done for 13 major rice blast resistance genes namely, *Pi-z, Piz-t, Pi-1, Pi-9, Pi5, Pi2, Pi-b, Pi-33, Pi-2i, Pik, Pik-p, Pik-h* and *Pi-ta* for these 62 germplasms showing resistance to blast disease. Out of these, the *Pi-b, Pi-9* and *Pi-1* appeared to be omnipresent and gave positive results. As the second dominant, *Pi-33, Pi5, Pik* and *Pi-ta* genes were second category based on dominance and had gene frequencies of 96.7%, 93.33%, 90.5% and 88.3% respectively. *Piz-t* and *Pik-h* gene frequencies were 11.66% and 30.0% respectively where as *Pi2* and *Pi-2i* gene frequencies were 58.33% and 95.0% respectively. *Piz* and *Pik-p* genes were absent in these germplasms. During this study, out of the sixty-two germplasms, three germplasms namely IIABR-265, SD-80 and SD-82 were positive for 11 blast resistance genes, 14 germplasms (IIBR-374, IIABR-418, IIABR-139, IIABR-422, SD-103, IIABR-286, IIABR-312, IIABR-262, SK-1, JD-35, JD-82, IIABR-397, IIABR-277 and JD-57) were found positive for 10 blast resistance genes, and the rest were found positive for five to eight blast resistance genes. There sults suggest that presence of numerous blast resistance genes is responsible for imparting broad-spectrum resistance against blast in the resistant germplasm.

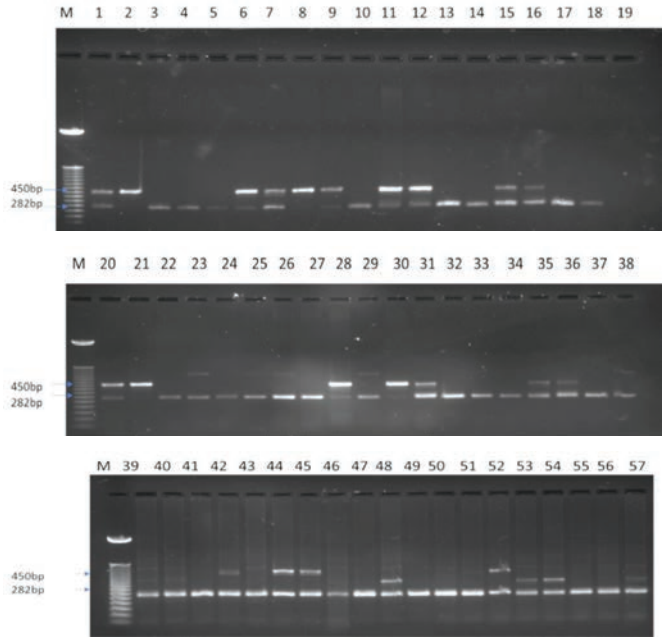


Fig 8. SSR based amplicons of Pi2i- blast resistance gene (282/450 bp) in 60 rice germplasm

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

A total of 224 jackfruit accessions collected from Jharkhand, Odisha, Bihar and North East India characterized using morphological descriptors and SSR markers (Table 3).

Table 3: Geographic distribution of jackfruit accessions used in this study

Sl. No.	State/ Region	No. of accessions
1	Jharkhand	
	Western plateau zone	115
	Central and NE plateau zone	33
	South eastern plateau zone	25
2	Bihar	23
3	Odisha	19
4	North East India	9

Fig 9. Variations in qualitative descriptors use to characterize jackfruit accessions

Striking variations were recorded for all the sixteen qualitative descriptors like leaf blade shape, leaf apex shape, leaf colour, leaf base shape, inflorescence colour, fruit bearing habit, fruit rind colour, fruit clustering habit, fruit shape, fruit base colour, fruit bracteole, pulp (flake flesh) colour, flake shape, pulp juiciness, seed coat colour and seed shape (Fig 9). The variability present in fruit and seed related descriptors may be used in future to improve the fruit quality in jackfruit.

Wide variations for various quantitative descriptors like number of fruits per plant, number of fruits per cluster, fruit length (cm), fruit diameter (cm), fruit girth (cm), peduncle length (cm), peduncle diameter (cm), fruit base length (cm), fruit base diameter (cm), weight of flakes per kg fruit (g), flake length (cm), flake width (cm), rachis (fruit core) length (cm), rachis (fruit core) diameter (cm) and 100-seed weight (g) were recorded among the jackfruit accessions (Table 4) .

Table 4: Variation observed for different quantitative descriptors in jackfruit accessions

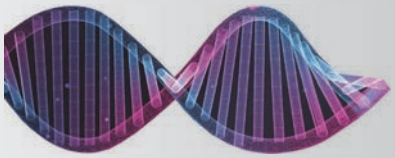
Quantitative traits	Minimum	Maximum	Mean	S.D.
No. of fruits per plant	1	98	15.66	16.64
No. of fruits per cluster	1	3	1.6	0.594
Fruit length (cm)	18	53	36.21	7.587
Fruit diameter (cm)	10.5	29	19.15	3.629
Fruit girth (cm)	41.5	101	65.31	11.46
Peduncle length (cm)	1	63	16.69	8.919
Peduncle diameter (cm)	0.9	3.2	1.857	0.474
Fruit base length (cm)	1	11.2	5.438	1.759
Fruit base diameter (cm)	1.2	4.2	2.37	0.549
Weight of flakes per kg fruit (g)	143.7	616.1	321.8	92.09
Flake length (cm)	3.6	8.44	5.864	1.267
Flake width (cm)	2	4.54	3.36	0.607
Rachis (fruit core) length (cm)	6.4	42	25.73	6.839
Rachis (fruit core) diameter (cm)	2	11.7	5.867	1.774
100-seed weight (g)	194.56	530.6	1054	5006

The analysis of assembled unigenes remitted in the discovery of a total of 21,903 SSRs in jackfruit. After discarding the complex SSRs and mononucleotide repeats, only 16,852 SSRs in jackfruit were considered for further analysis. For a given repeat unit, the number of reiterations ranged from 4 to 22, the most common being n= 4. Repeat motifs exceeding 12 repetitions were rare while SSR loci of 12 bp were most frequent. A set of primer sequences from SSR flanking regions were identified for the validation of SSRs in a jackfruit germplasm set. Primer sets for 200 genic-SSRs have been custom synthesized in jackfruit for their validation, and molecular characterization of the jackfruit accessions was carried out using these SSR markers.

A total of 81 alleles were detected in 224 jackfruit accessions by using 27 SSR markers. The number of alleles ranged from 2 to 4, with an average of 3 alleles per locus (Table 5). Shannon's information index was highest for IIAB/JFSSR-13, which reveals that this primer is most informative.

Table 5: Summary of genetic variation statistics for all 27 SSR loci

Marker	Allele No	Heterozygosity	PIC	Major Allele Frquency
IIAB/JFSSR-4	4	0.418	0.579	0.421
IIAB/JFSSR-12	2	0.075	0.069	0.963



IIAB/JFSSR-13	4	0.448	0.664	0.416
IIAB/JFSSR-18	4	0.877	0.585	0.427
IIAB/JFSSR-19	4	0.623	0.537	0.571
IIAB/JFSSR-20	4	0.649	0.418	0.676
IIAB/JFSSR-35	3	0.803	0.496	0.579
IIAB/JFSSR-39	2	0.524	0.312	0.738
IIAB/JFSSR-44	3	0.606	0.414	0.697
IIAB/JFSSR-45	3	0.449	0.573	0.390
IIAB/JFSSR-47	4	0.665	0.495	0.642
IIAB/JFSSR-48	3	0.718	0.442	0.641
IIAB/JFSSR-101	3	0.153	0.383	0.505
IIAB/JFSSR-104	3	0.468	0.334	0.766
IIAB/JFSSR-114	2	0.442	0.285	0.779
IIAB/JFSSR-116	3	0.449	0.323	0.775
IIAB/JFSSR-122	2	0.000	0.179	0.888
IIAB/JFSSR-126	3	0.384	0.551	0.470
IIAB/JFSSR-132	3	0.317	0.507	0.573
IIAB/JFSSR-134	3	0.165	0.462	0.573
IIAB/JFSSR-135	3	0.015	0.330	0.730
IIAB/JFSSR-141	2	0.421	0.302	0.754
IIAB/JFSSR-170	3	0.298	0.370	0.750
IIAB/JFSSR-172	3	0.359	0.276	0.821
IIAB/JFSSR-180	3	0.503	0.538	0.462
IIAB/JFSSR-181	2	0.401	0.269	0.800
IIAB/JFSSR-182	3	0.181	0.414	0.688
Mean	3	0.423	0.411	0.648

Model based clustering approach was employed to determine the optimum number of clusters in the population. The analysis detected the maximal ΔK at K=2 followed by K=4. Significant genetic admixing observed in the jackfruit accessions possibly due to its breeding behavior (Fig10).

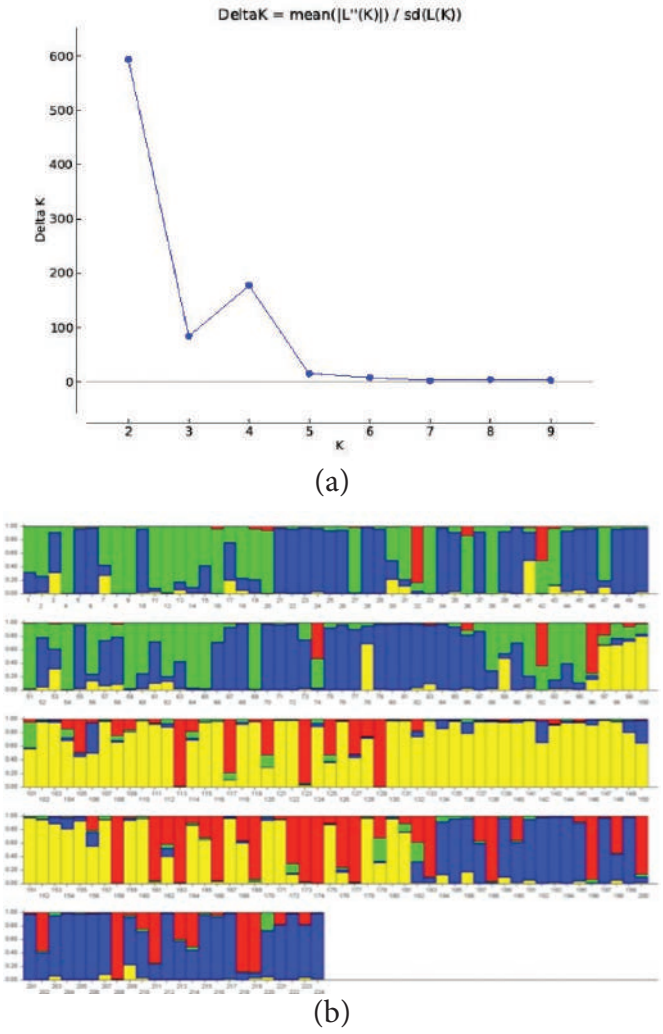


Fig 10. Genic-SSR based population structure of the Jackfruit accessions: (a)ΔK graph, (b) population structure at ΔK = 4

IIAB-FHM-01: Biotechnological Interventions for Fish Health Management

IXX12206: Identification and characterization of genes responsible for immune responses in *Labeo rohita* fingerlings

Expression profiling of some immune responsive gene in the pathogen-challenged Labeo rohita fingerlings post feeding of dietary levan

An investigation was conducted to delineate the expression profiling of immuno-responsive genes in a pathogen challenged rohu, after dietary supplementation of microbial levan. During the trial, methodology to characterize the expression analysis of important immune responsive genes was carried out. Incorporation of levan in the diet of *Aeromonas hydrophila* infected rohu fingerlings led to a significant modulation in the expression of *TLR-22* (Toll like receptors), *IFN-γ* (Interferon-gamma) and *TGF-β* (Transforming growth factor-beta) in the kidney and liver on different time points (6h, 12h, 24h, 48h, and 96h).

Expression analysis of TLR-22

Incorporation of levan in the diet of *A. hydrophila* infected rohu fingerlings led to significant changes

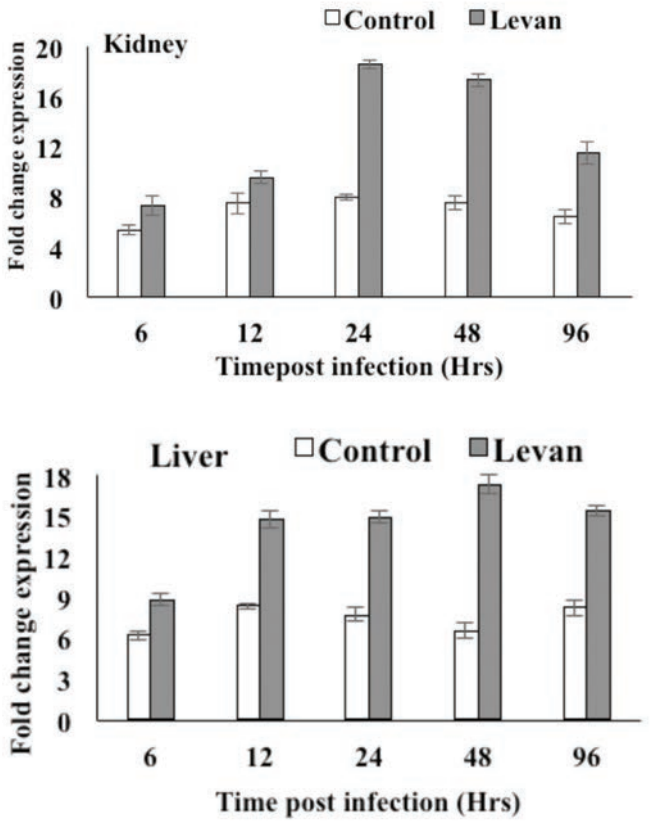


Fig 11. Expression of *TLR-22* in (a) kidney, (b) liver after feeding trial with microbial levan supplemented and levan non-supplemented (control) diet group at different time points *viz.*, 6h, 12h, 24h, 48h and 96h post challenge with *Aeromonas hydrophila* in *Labeo rohita* fingerlings.

in the expression of *TLR-22* in the kidney and liver (Fig 11). In the kidney cells, significant increase in expression of *TLR-22* was observed at all time points with maximum up-regulated expression of 2.35-fold and 2.32-fold at 24h and 48h, respectively (Fig 11a). In the liver cells, constant increase in the fold change expression was observed from 6 to 48h and then decrease at 96h. Significant, higher expression was noticed in hepatic cells was noticed at later time points of 24, 48 and 96h post challenge with the highest 2.66 fold observed at 48h (Fig 11b).

Expression analysis of IFN-γ

Noticeably increase in the expression of *IFN-γ* has been demonstrated in various immune organs of *A. hydrophila* aggravated *L. rohita* fingerlings at different time intervals (Fig 12). In the kidney and liver, the up regulation of m-RNA expressed *IFN-γ* was found during the entire duration of the study (Fig. 12a & 12b). Kidney cells exhibited remarkable increase of 2.6-fold at 24h. In the liver, maximum fold change expression of 3.4-fold and 2.9-fold was noticed at initial time points of 6 and 12h, whereas the lowest fold change expression of 1.6-fold was observed at the longest time point of 96h post challenge (Fig. 12b).

Expression analysis of TGF-β

Parallel to the *TLR-22, β-2M, IFN-γ, TGF-β* expression has also displayed the significant downregulation in the pathogen challenged rohu, after feeding with levan diet (Fig 13). The fold change expression of m-RNA expressed *TGF-β* in kidney and liver was found to be minimum at the earliest time points of 6h (Fig 13a & 13b). The significant decrease of 2.3-fold and 2.5 fold was noticed at 48h change in *TGF* expression in the kidney and liver (Fig 13a & 13b).

Up-regulation of pro-inflammatory cytokine genes

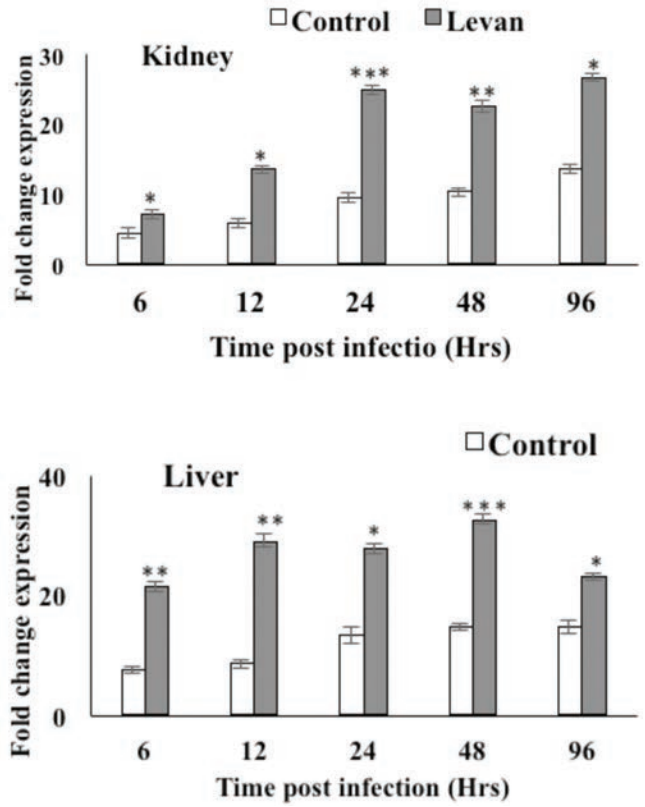


Fig 12. Expression of *IFN-γ* in (a) kidney, (b) liver after feeding trial with microbial levan supplemented and levan non-supplemented (control) diet group at different time points *viz.*, 6h, 12h, 24h, 48h and 96h post challenge with *Aeromonas hydrophila* in *Labeo rohita* fingerlings.

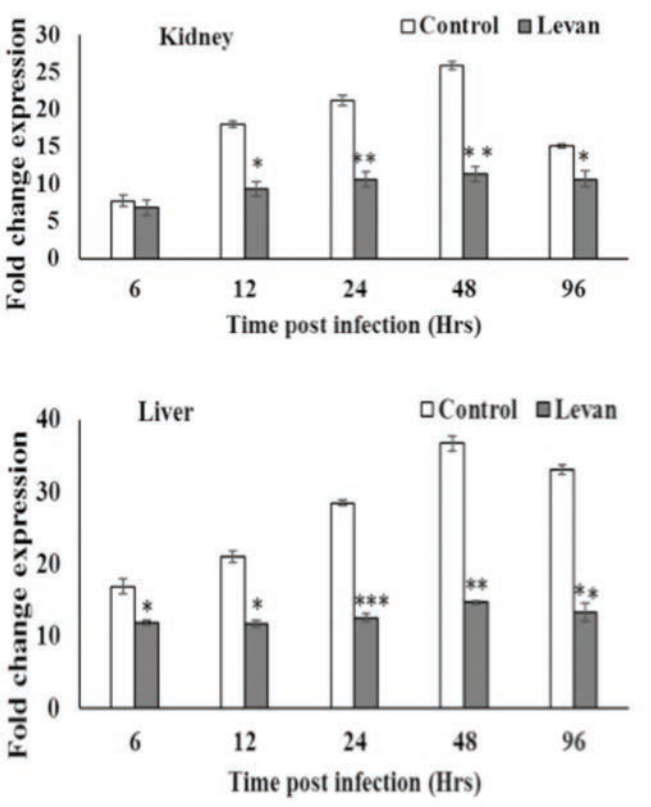


Fig 13. Expression of *TGF-β* in (a) kidney, (b) liver after feeding trial with microbial levan supplemented and levan non-supplemented (control) diet group at different time points *viz.*, 6h, 12h, 24h, 48h and 96h post challenge with *Aeromonas hydrophila* in *Labeo rohita* fingerlings.

and down-regulation of anti-inflammatory genes in lymphoid organs during various time periods of post infection indicates the immunogenic potential of microbial levan. In current evaluation, prebiotic levan which acts as a feed supplements and is shown to has potential role for promoting host health by reducing the chances of pathogenic outbreaks. Therefore, incorporation of levan in the diet might help in eradication of pathogen like *A. hydrophila* and thus provided protection.

Total immunoglobulin level and myeloperoxidase content

Total immunoglobulin level and myeloperoxidase content of *A. hydrophila* infected rohu increased with increasing time interval upto 24h in levan-fed group compared to the control (Fig 14). Although the higher level of immunoglobulin was observed at 24h in levan-fed rohu, but significant increase compared to control was noticed at 48h post challenge (Fig 14a). Contrary to the immunoglobulin results, remarkable increase in the myeloperoxidase content was found at all studied time points except at 24h (Fig 14b).

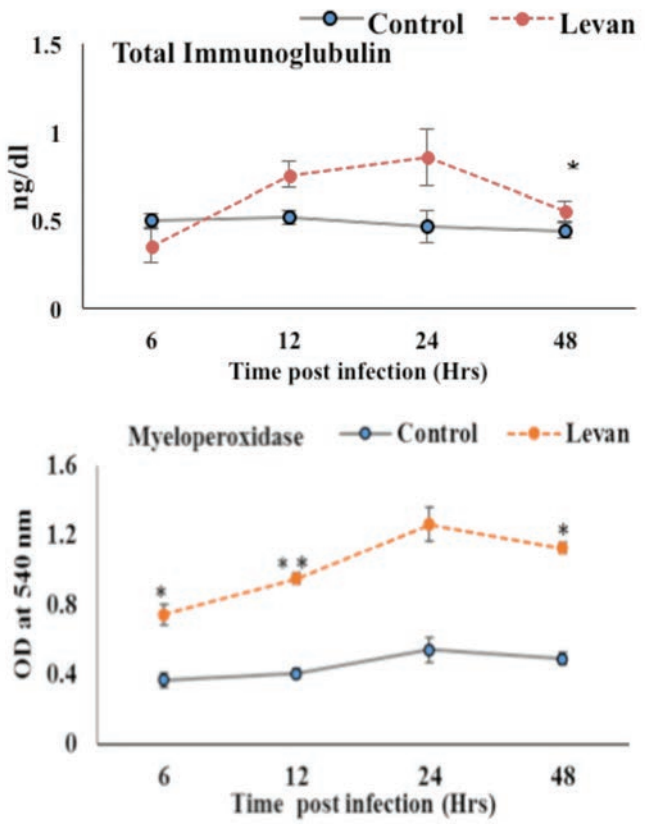


Fig 14. a) Level of immunoglobulin in levan-fed rohu compared to control b) Level of myeloperoxidase content in levan-fed rohu compared to control

Bioflocs affects growth and immune responses of Cirrhinus mrigala

Biofloc technology is a compliance method with zero water exchange. It is a low cost sustainable technique of enhancing water quality in aquaculture through balancing carbon and nitrogen in the system. Biofloc is a heterogenous aggregate of suspended organic particles and microorganism associated with extracelluar polymeric substances. A 75-days trial was carried out to delineate the impact of biofloc rearing system on growth and immune responses of *Cirrhinus mrigala* an important Indian major carp. Two hundred and forty fingerlings of mrigal having mean weight (8.50 ± 0.28 g) were randomly distributed in 12 circular tanks (300 L) with four different treatment groups in triplicates; (clean water) control T1; (wheat supplement as carbon source) T2; (corn supplement as nitrogen source) T3; (wheat + corn supplements) T4. Prior to the start of experiment, the biofloc system was completely established with the prepared inocula. For inocula formation, soil from bottom of pond was collected from Birsa Agriculture University, Ranchi. Inocula were formed in plastic tanks (5 L) by adding pond bottom soil under water aeration containing ammonium sulphate and different corbon sources. The suspension was incubated for 24h for the development of microbial growth. The prepared inocula were added to the respective experimental tanks. All the experimental fish were fed at 2% body weight once a day through out the experiemental period. Physico-chemical parameter like dissolved oxygen (DO), pH and temperature were recorded on daily basis. Total ammonia, nitrite and nitrate were analyzed weekly. The C/N ratios in each biofloc based unit were maintained efficiently to convert the inorganic nitrogen into microbial protein. All the biofloc treatments recorded significantly higher specific growth rate (SGR) and feed conversion ratio (FCR) compare to the control

group. Further analysis to study the expression profile of few immune responsive genes and histo-morphological architecture of the kidney, liver and intestine is under progress which would provide mechanistic insights into impact of biofloc system.

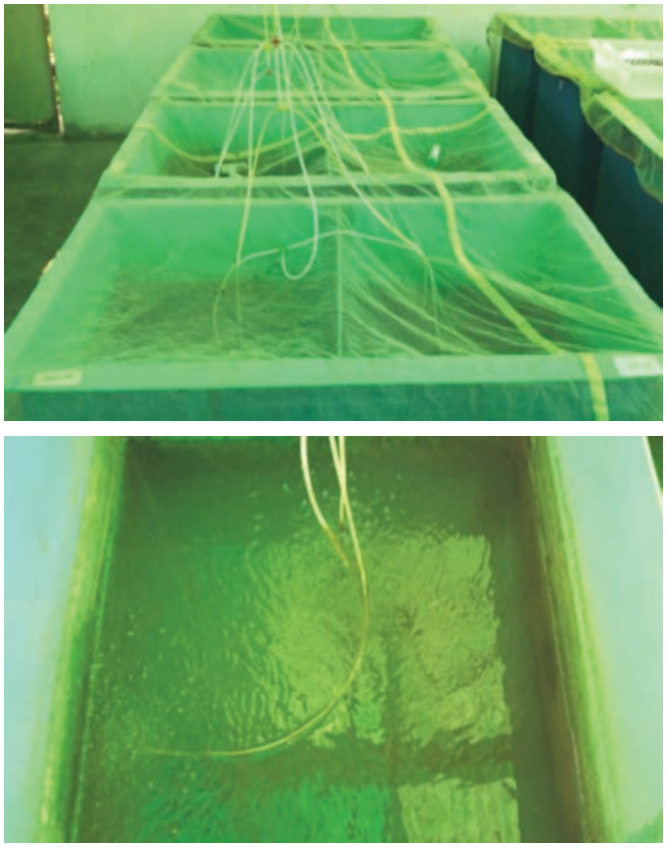


Fig 15. Biofloc based experimental trail conducted on mrigal

IXX12919: Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp

Evaluating the DNA binding property of Gold nanoparticles for exploring its bio-sensing application

Gold nanoparticle (AuNPs) is synthesized using green pathway and characterized using UV-vis, FT-IR and particle size analysis by DLS and stability by *zeta* potential. Gold nanospheres display a single absorption peak in the visible range between 520-550 nm due to its surface Plasmon resonance and show heavy absorption of visible light at 520 nm. This gives purple red color to gold nanoparticle. The particle size of gold nanoparticle was analyzed through dynamic light scattering (DLS) technique and found that the z-average diameter of the synthesized gold nanoparticle was 349nm and the zeta potential of the gold nanoparticle was 7.51 mV, which shows the moderate stability.

Optical imaging techniques provide great potential for understanding biological processes at the molecular level. Biological imaging with an optical technique however greatly relies upon the use of sensitive and stable optical labels. Colloidal gold nanoparticles have become an alternative consideration due to ease of synthesis, excellent biocompatibility and simplicity of conjugation chemistry. An experiment was formulated to find the traceability of DNA molecules present in a sample in very minute quantity using gold nanoparticle. The DNA of rice leaf was extracted using standard protocol. Then the DNA samples are added with gold nanoparticles in the ratio of 1:1 and mixture were incubated for certain interval and UV-vis spectra of the samples were recorded for the range of 200-700nm. The UV-vis spectra revealed that when the gold nanoparticle was attached with the DNA moieties the UV absorption of DNA-Gold nano-complex was increased several folds and a new peak around 290nm was evolved due to

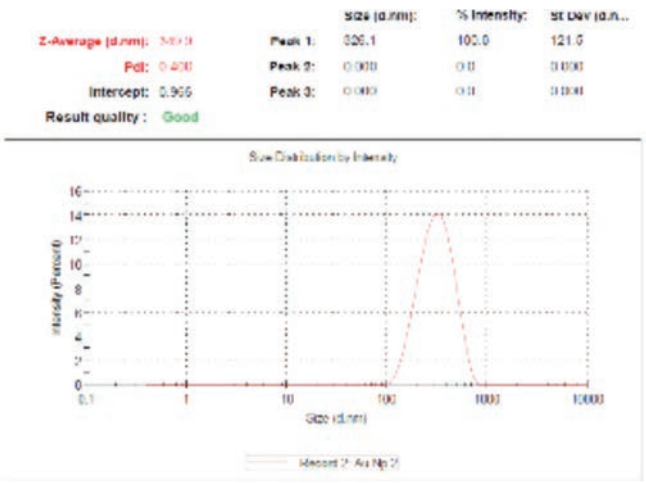


Fig 16. Particle size analysis of gold nanoparticle

Fig 17. Zeta potential of synthesized gold nano particle

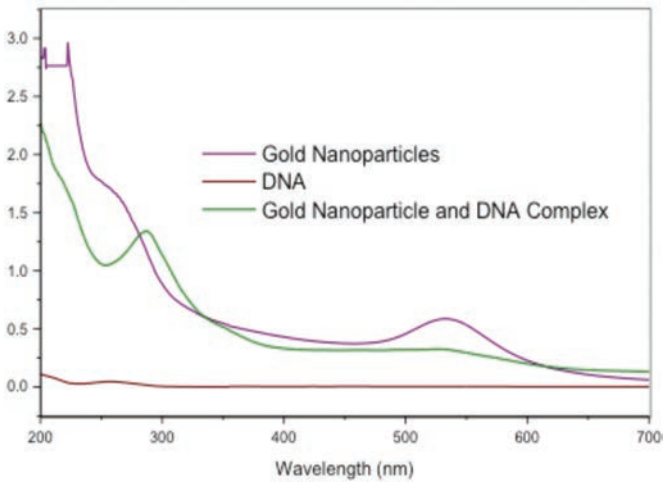


Fig 18. UV-vis spectroscopic analysis of binding of gold nanoparticle with rice DNA

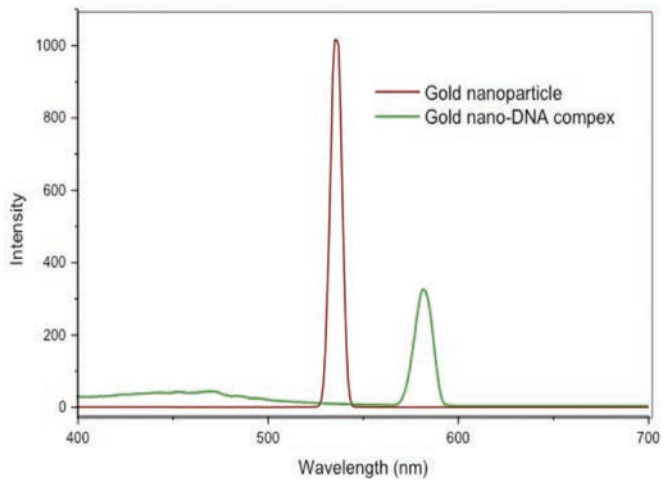


Fig 19. Fluorescence spectra of Gold nanoparticle and Gold nanoparticle-DNA complex

the formation of complex with gold nanoparticle. In spectrofluorometric analysis, gold nano and DNA-gold nano complex revealed that the gold nanoparticle labeled DNA molecule were given peak at 582 nm with diminished intensity due to the florescence quenching of gold nanoparticle. The results indicate that gold nanoparticle may be using as fluorophore probe for DNA sensing and have potential in bio- imaging at molecular level.

Effects of nano-formulations against Xanthomonas oryzae pv. oryzae in TN-1 cultivar of rice

Bacterial blight of rice caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) is the most important disease in both rainfed and irrigated condition in India. For experimentation, TN-1 cultivars were grown in pots with optimum growth and nutritional condition. For evaluation of the efficacy of copper and silver-nanoparticles, these formulations were sprayed at 100 ppm individually as well as in combinations on TN-1 plants in three replications. Nano-formulations were sprayed prior to the inoculation, and in another case, after 24h interval. Artificially plants were inoculated through leaf clipping method (Kauffman et al. 1973), where scissors were dipped in 1.0 O.D. bacterial suspension and about 1-2 cm of the leaf tips were cut and observations were recorded at 7d interval. Healthy and inoculated TN-1 plant were kept as

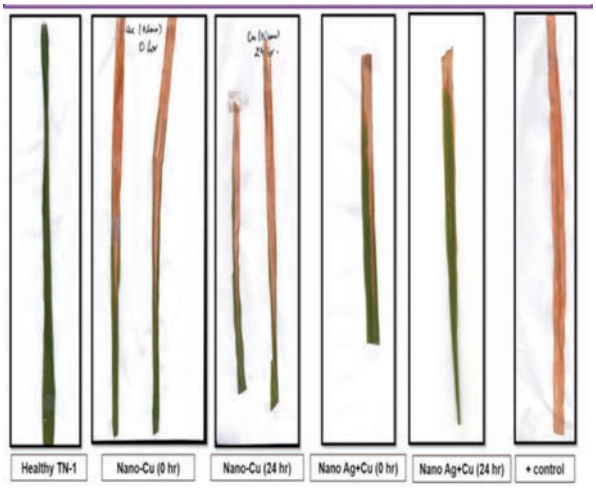


Fig 20. Efficacy of combination of Cu -Ag nanoformulation against bacterial leaf blight of rice on TN-1 cultivar of rice

negative and positive control respectively. It was seen that single application of copper-nanoparticle was not effective, but in combination with silver nanoformulation, effectiveness was increased. From this study, it can be inferred that two applications of the combination of copper and silver nanoparticles are more effective against the bacterial blight of rice than their individual use.

Investigating the effects of nanosized zinc on zinc bio-fortification in rice

An investigation was conducted to examine the effects of nanoscale zinc oxide particles (ZnO NP) on Zn bio-fortification in rice seeds. Seeds of two popular rice cultivars such as Naveen and Swarna were separately soaked overnight with different concentrations of ZnO NP (0, 50, 100, 150, 200, 250 and 500 ppm) and then the Zn content was measured by using AAS (Atomic Absorption Spectrophotometer). Enhancement of Zn content in the seed was observed in both the rice genotypes, however Naveen showed better result than Swarna. It was observed that seed Zn content in Naveen increased with increasing ZnO NP concentration, with the maximum (about 80% compared to control) observed at 250 ppm. Further increase in ZnO NP concentration did not result in seed Zn content enhancement. However in Swarna, the maximum increase in seed Zn content was 30% and 31% as compared to the control, at 250 and 500 ppm of ZnO NP. The report suggested the possibility of enhancing seed Zn content in rice using ZnO nanoparticles, however the genotypic differences and impact of these nanoparticles on human health need to be explored.

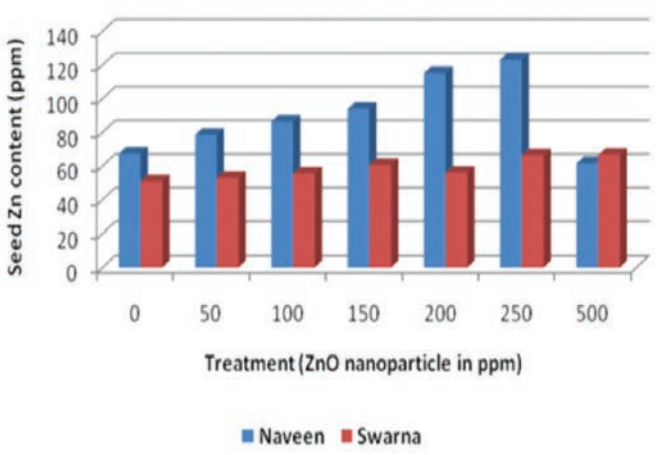


Fig 21. Enhancement of seed Zn content using ZnO nanoparticle

Assessing the impact nanosilver- composite on wound healing in fish

An experiment was conducted to define the impacts of silver nanoparticles (Ag-NPs) composite on wound healing efficiency of *Labeo rohita*. In the current study, ninety fingerlings of *L. rohita* (Average weight;

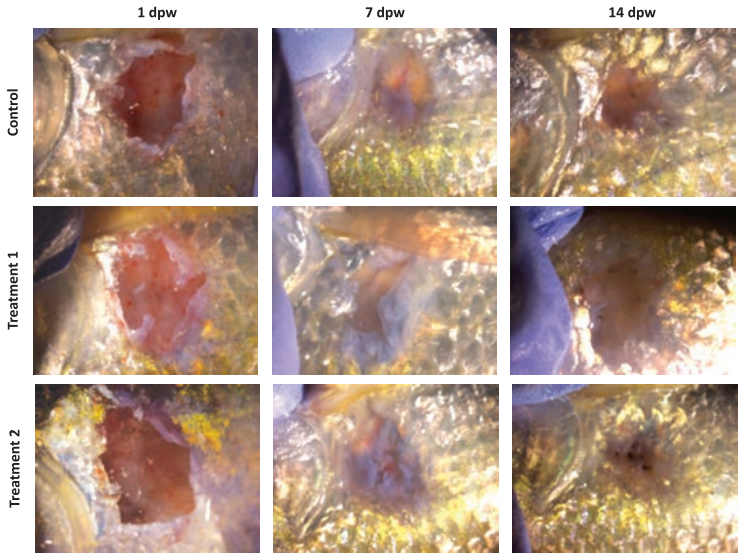


Fig 22. Impact of nanosilver composite on wound healing of *Labeo rohita* (Rohu) fingerlings (Treatment 1: -composite; Treatment 2: Nanosilver composite; dpw: day post wounding)

8.54 ± 0.32 g) were randomly distributed into three treatment groups (control, composite and nanosilver composite) with 3 replicates each. Prior to the commencement of experiment, incisional wounds were developed applying sterilized blade posterior to the base of pectoral fin. Composite and nanosilver-composite were directly applied to the wound site and images were captured with the help of STEMI 508 bifocal microscope (at a resolution of 50X) at 7 days interval up to a period of 14d and morphological characterizations were recorded accordingly. Wound size gradually decreased in control as well as experimental groups during 14d healing period, however significant reduction was observed in nanosilver-composite in comparison to composite and control.

Externally Funded Projects

Screening of various lentil (*Lens culinaris* L.) genotypes for drought tolerance using physiological and molecular approaches

India is world's second main lentil producing country; however its yield is severely compromised due to abiotic stresses, such as heat and drought. Therefore, selection of appropriate abiotic stress tolerant parental line is essential for breeding programmes. Thus, in order to select promising parental lines, various physiological, biochemical and molecular parameters have been used to identify drought tolerant genotypes. Twenty-six genotypes of lentil were kept for germination in green house conditions and exposed to osmotic stress by irrigating with PEG 6000 (18%) for 15 days. Eight genotypes (GP3690, LL1136, GP3643, IC248956, KLS218, PL230, NDL908 and L4076) were selected on the basis of their growth characteristics (plant height and leaf necrosis) and their response was assessed through physiological (stomatal density and relative water content); biochemical (chlorophyll, proline, anthocyanin and total soluble sugar contents) analysis and molecular analysis (qRT-PCR). Relative expression of drought marker genes (*DREBs* and *RDs*) was performed on these genotypes through qRT-PCR (Fig 23). Gene expression profiling for drought marker genes identified genotype GP3690 as drought susceptible (DS) and genotypes GP3643 and IC248956 as drought tolerant (DT). Further, expression profiling of forty-three drought responsive genes was performed on DS and DT genotypes, which explained the tolerant or susceptible behaviour of these genotypes. The result obtained in the present study might help in selecting genotypes for breeding drought tolerant cultivars. Also, the genes showing differential expression may serve as potential candidates for raising drought tolerant lentil genotypes.

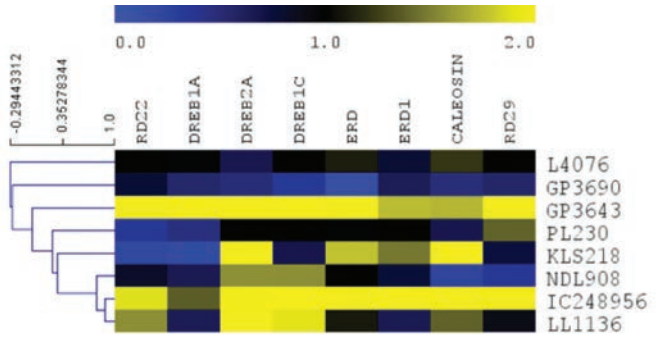


Fig 23. Heatmap depicting relative expression of drought stress marker genes in eight lentil genotypes under drought stress as compared to control. Bar at the top depicts relative expression values, whereby blue, black and yellow colors represent down-regulation, no change and up-regulation, respectively.

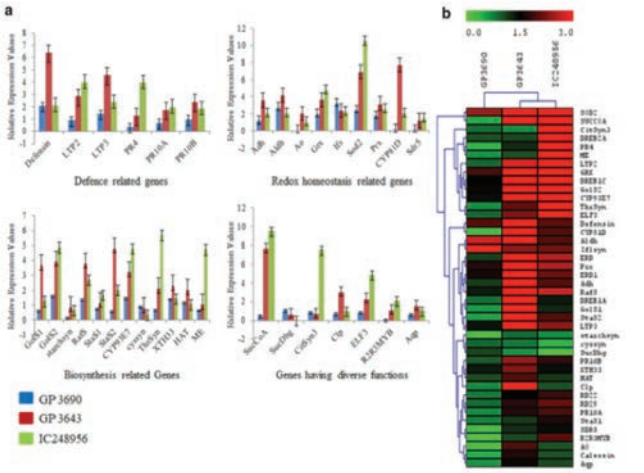


Fig 24. (a) Relative expression of genes related to various molecular functions in putative drought sensitive genotype (GP3690) and putative drought tolerant genotypes (GP3643 and IC248956), as compared to their respective control samples. (b) Heatmap of relative fold change of genes between putative drought sensitive genotype (GP3690) and putative drought tolerant genotypes (GP3643 and IC248956), as compared to their respective control samples

Characterization of molecular marker(s) associated with X- and/or Y-chromosome bearing spermatozoa in cattle (SERB (DST) funded)

Sperm sexing in cattle offers a favourable breeding strategy that shall help meet the increased requirement of food production. Currently used methods for sperm sexing suffer from lower accuracy, poor repeatability, and render low fertility. In view of this, research on development of the indigenous and innovative technology that increase the rate and purity of sperm sorting

without affecting its viability is crucial. To date, there is a lack of comprehensive understanding of the bovine sperm cell-surface proteins that may help in sex-sorting of bovine sperm. The present study aims to identify different plasma membrane proteins associated with X- and/or Y-chromosome bearing spermatozoa of cattle. Extraction of plasma membrane associated proteins was carried out from the plasma membrane fraction of unsorted semen of Sahiwal breed (indigenous) of cattle (sourced from BAIF, Ranchi) that was collected from the post-nuclear supernatant of homogenized sperm cells by high speed centrifugation. Total soluble protein was extracted from the non-enriched total cell lysate of the unsorted sperm cells for compositional comparison. Apart from the solubilisation issue, the hydrophobicity of the plasma membrane associated proteins restricted their entry into/movement in the gels during IPG-IEF, SDS-PAGE and blue native PAGE, for which gel-free approach, i.e. in-solution digestion with trypsin and lys-C, and nano LC-MS/MS was carried out and the proteins were identified. Plasma membrane associated proteins (Fig 25) were confirmed through bioinformatic analysis. Enrichment of plasma membrane associated proteins was found to be significant ($p<0.01$) in the plasma membrane enriched fraction than in non-enriched total cellular lysate fraction extracted in this study. Further, these experiments were carried out using sorted semen of Sahiwal cattle (sourced from PBGSBS, a Govt. of West Bengal organization) for identification of the plasma membrane associated proteins. Differentially expressed plasma membrane associated proteins were noted between the X and Y-sorted sperm cells (data not shown). To summarize, a novel extraction method has been developed for enrichment of plasma membrane proteins from bovine sperm cells. Though most of the differentially expressed proteins are known to be shared among the X and Y spermatids, through intercellular bridges, some of the differential proteins are expected to form the basis for possible variation in phenotypes of X and Y sperm. Hence, the proteins characterized in this study would provide better insight into the plasma membrane proteomics of spermatozoa of cattle and furnish data that might aid in identification of new targets and for development of technology for segregation of bovine sperms.

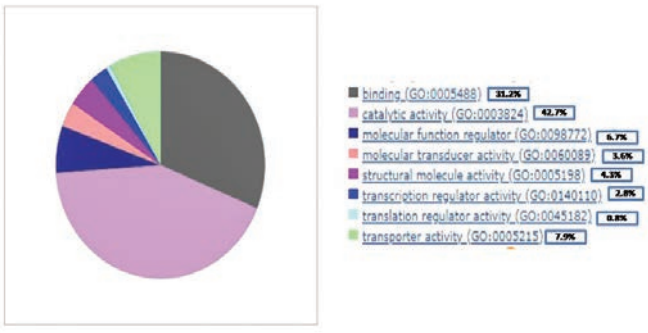


Fig 25. Graphical representation of functional category contributions of identified proteins in the plasma membrane enriched proteome

Scheduled Tribe Component (STC)

During the year 2018-19, under the Scheduled Tribe Component (STC), ICAR-IIAB supported a total of 1,008 tribal farm families from 10 villages of three districts of Jharkhand namely Latehar, Hazaribag, and Ranchi. Under STC, besides the critical agricultural inputs, ICAR-IIAB provide dimproved production technologies for field crop, horticulture, agroforestry, fishery, and backyard poultry to the tribal farmers.The interventions taken up under STC were (1) the promotion of the cultivation of drought-tolerant high yielding rice variety DRR - Dhan 42 along with the other high yielding rice varieties namely Sahabhagi Dhan, Abhishek and Lalat recommended for the state, (2) the promotion of the cultivation of high yielding Indian Mustard varieties namely NRCHB-101, PM-26 and PM-27 in the rice-fallows for increasing the cropping intensity and farm income, (3) the promotion of the cultivation of papaya, one of the most profitable horticultural cash crop, (4) the promotion and popularization of improved breeds of fish and poultry, and (5) the promotion of the cultivation of mahogany, a fast growing high value timber tree, as an agroforestry component for a long-term improvement of the livelihood of the tribal farmers. The critical inputs

like seeds, fertilizers, insecticides, fungicides, antibiotics, pheromone traps etc. for taking up 100 hectares each of rice and mustard cultivation; seedlings, fertilizers, anti-termite chemicals etc. for taking up high intensity papaya cultivation in 10-12 hectares of land; 2,000 saplings of mahogany for agroforestry interventions; 25,000 fish fingerlings for homestead ponds, and 150 Divyayan Red chicks and Khaki Campbell ducklings for backyard poultry were provided to the tribal farmers. Moreover, ICAR-IIAB organized a series of farmer-scientist interaction meetings, on-farm training, field days, on-farm trials, farmers' fair and outstation exposure visits, etc. for increasing the knowledge and awareness among the tribal farmers. Two short terms (4-5 days) training on mustard cultivation and Pisciculture at ICAR-DRMR, Bharatpur and Fish Farm Training Centre, Ranchi, respectively, were also organized for the tribal farmers. ICAR-IIAB provided specialized training on Farmer Producer Organization (FPO) to induce entrepreneurship among the tribal farmers. A multidisciplinary team of scientists from ICAR-IIAB, Ranchi regularly monitored the implementation of the STC programme (Fig 26-40).

Fig 26. One day training cum input distribution programme on "Quality seed production of rice" at Holycross KVK, Hazaribagh

Fig 27. One day Scientists-Farmers intraction cum input distribution programme on "Improved Technologies For rice Production" at Chetag Village, Balumath, Latehar

Fig 28. One day training cum input distribution programme on "Quality seed production of rice" at Chetag Village of Latehar district

Fig 29. Farmer recieving inputs from Director, ICAR-IIAB at Chetag Village of Latehar district

Fig 30. Distribution of Indian mustard seed at Munda tola Village of Latehar District

Fig 31. Distribution of Indian mustard seed at Banio Village of Latehar District

Fig 32. Distribution of Indian mustard seed at Tamad Village of Ranchi District

Fig 33. Distribution of Indian mustard seed at Chetag Village of Latehar District

Fig 34. Field day on cultivation of improved varieties of Indian Mustard

Fig 35. STC beneficiaries of ICAR-IIAB, Ranchi on a visit to ICAR-DRMR, Bharatpur (Rajasthan) for a 04 days' exposure cum training on mustard cultivation

Fig 36. STC beneficiaries of ICAR-IIAB, Ranchi attending 05 days' training programme on Pisciculture at the Fish Farmer Training Centre, Shalimar, Sector-II, Ranchi

Fig 37. Field visit at Chetag

Fig 38. STC beneficiary of ICAR-IIAB, Ranchi Sri Satendra Oraon of Chetag, Balumath (Latehar) receiving honour by the Hon'ble Governor of Jharkhand Smt. Droupadi Murmu at the state-level farmers' fair "Agrotech 2019 Kisan Mela" held at BAU, Ranchi

Fig 39. On Farm Trial of Divyayan Red and Khaki Campbell Birds

Fig 40. Distribution of fish feed and fingerlings

Scheduled Caste Sub-Plan (SCSP)

During the year 2018-19, ICAR-IIAB enthusiastically implemented Scheduled Caste Sub-Plan (SCSP) initiated by the Government of India. Under this programme, ICAR-IIAB supported more than 1000 Scheduled Caste beneficiaries of Latehar, Khunti, Hazaribagh, Ramgarh, Giridih and Deoghar districts by providing agricultural machineries like power tillers, pump sets, automatic spraying machines, etc. besides critical agricultural inputs like high-quality seeds, fertilizers, and insecticides. Like STC, the promotion of the cultivation of drought-toleranthigh yielding rice varieties like DRR–Dhan42 and Sahbhagi Dhan, besides other interventions like horticulture, agroforestry, fishery, and backyard poultry had been the focus of the Institute.

Fig 41. One day hands-on training on "Scientific Pig Farming" and distribution of piglets among the SCSP beneficiaries of ICAR-IIAB at Pig Farm, Birsa Agricultural University, Ranchi

Fig 42. Installation of Poultry Incubators cum Hatcheries at the village Belbarna, Sarath (Deoghar)

Fig 43. Distribution of inputsfor fisheries under SCSP programme

Inter-Institutional Collaborations

All India Coordinated Rice Improvement programme

Under Indian Institute of Rice Research, Hyderabad coordinated All India Coordinated Rice Improvement Project (AICRIP), two trials namely AVT-1 E-DS and IVT-E-DS were conducted under rainfed direct seeded conditions during kharif 2018 at ICAR-IIAB Research Farm at Garkhatanga.

Nomination of promising entries under AICRIP and State Co-ordinated trials

Based on the IVT- IME 2018 kharif trial IABR1-GSR IR1-DQ157-R6-D1 (Entry no. 1204; IET no. 27739) was promoted to AVT1- IME on overall basis and zone II. Whereas, based on the IVT- ETP 2018 kharif trial IABR2-GSR IR1-24-D5-Y1-L1-L1 (Entry no. 928; IET no. 27890) was promoted to AVT1-ETP in zone III and zone V. Besides these, four out of six entries which were nominated in state coordinated trial- kharif 2018 conducted by BAU, Ranchi advanced to second year of testing.

(a)

(b)

(c)

(d)

Fig 44. Monitoring of State Coordinated Trial- kharif 2018 conducted by BAU, Ranchi at (a) Chianki, (b) Dumka, (c) Darishahi and (d) Kanke

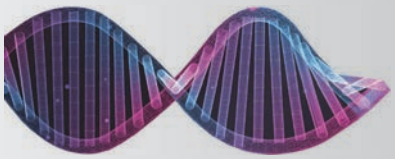
Frontline Demonstrations (FLDs)

During the year 2018-19, through Front Line Demonstration (FLD) Programme, ICAR-IIAB demonstrated a cafeteria of rice technologies in 30 hectares of rainfed upland area of 54 farmers from 14 villages of three districts of Jharkhand namely Latehar, Hazaribag, and Ranchi.Front Line Demonstrations organized during the year have been effective in creating awareness about the potential of drought-tolerant rice variety DRR-Dhan 42 under drought conditions. Since

protein-energy malnutrition is prevalent among the tribal children of Jharkhand, ICAR-IIAB also conducted a significant number of FLDs of two newly released high-protein rice varieties, namely CR Dhan 310 and CR Dhan 311. Although some of the tribal farmers seemed to be skeptical about these varieties, a recurrent motivation by the ICAR-IIAB scientists through a series of farmer-scientist interaction meetings, training, field days, etc. lead to general acceptance and interest in the varieties by the farmers. The FLD programme of ICAR-IIAB has been successful in convincing the farmers about the effectiveness of scientific crop management practices. The technologies demonstrated through FLDs recorded the average yield advantage of 11.8% over the farmers' practice. The FLDs revealed that there is tremendous scope to bridge the yield gaps in rainfed uplands of Jharkhand by large scale adoption of drought-tolerant high yielding rice varieties. A field day was organized on Nov 15, 2018 under the coordination of Dr. B.K. Singh and Dr. Avinash Pandey.

Fig 45. Selected photographs of FLD and Field day on rice

Fig 46. FLD beneficiary Sri Lal Santosh Kumar of Chetag, Balumath (Latehar) receiving honour by the Hon'bleVice-Chancellor of BAU, Ranchi at the state-level farmers' fair "Agrotech 2019 Kisan Mela" held at BAU, Ranchi



Institutional Activities

Personnel

Name Designation & E mail ID	Area of Research
Dr. Tilak Raj Sharma, Director, ICAR-IIAB, Ranchi iiab.ranchi@gmail.com/ trsharma88@gmail.com	
School of Genomics and Molecular Breeding	
Dr. Vijai Pal Bhadana, Pr. Scientist (GPB) bhadanavijai@gmail.com	Molecular breeding in rice
Dr. B. K. Singh, Sr. Scientist (Agril. Biotechnology) binaybio@gmail.com	Genomics and molecular breeding for enhancing nutrient use efficiency in rice
Dr. Sujit Kumar Bishi, Scientist (Biochemistry) Sujit.Bishi@icar.gov.in; sujitbishi@gmail.com	Nutritional biochemistry and stress biology
Dr. Avinash Pandey, Scientist (GPB) Avinash.Pandey@icar.gov.in	Molecular breeding for earliness and higher biomass in lentil
Dr. Sudhir Kumar, Scientist (GPB) sudhiraaidu2006@gmail.com	Molecular breeding in horse gram
Dr. Madan Kumar, Scientist (Plant Physiology) madan.9577@gmail.com	Genomics and molecular breeding for enhancing nutrient use efficiency in rice
Sh. K. U. Tribhuvan, Scientist (Agril. Biotechnology) kish.tribhuwan@gmail.com	Genomics and molecular breeding for abiotic stress tolerance in pulse crops
Sh. S. K. Lal, Scientist (Agril. Biotechnology) shambhumku@gmail.com	Genomics and molecular breeding for enhancing nutrient use efficiency in rice
School of Genetic Engineering	
Dr. A. K. Singh, Sr. Scientist (Agril. Biotechnology) anils13@gmail.com	Genomics and stress physiology of crops
Dr. S. Naskar, Sr. Scientist (Agril. Biotechnology) snrana@gmail.com	Major histocompatibility complex (mhc); assisted reproductive technology (art) in livestock species
Dr. Sujatha T.P., Scientist (Biotechnology), sujatha.parvathy@icar.gov.in, hiisuj1@gmail.com	Functional genomics, cell and developemetal biology, genetic engineering and transgenic crops
School of Molecular Diagnostics and Prophylactics	
Dr. B. Sarkar, Sr. Scientist (Nanobiotechnology) biplab_puru@yahoo.co.in	Development and application of nanoparticles in disease control, environmental remediation, and micronutrient induced fortification
Dr. S. K. Gupta, Scientist (Fish and Fisheries) sanfishlll@gmail.com	Fish nutrigenomics
Dr. Rishikesh Kumar, Scientist (Plant Pathology) rishiiari2011@gmail.com	Host-pathogen interactions in plant disease
Administration and Finance	
Sh. Rishi Kant Singh afao.iiabranchi@gmail.com	Assistant Finance & Account Officer
Sh. A. K. Tripathi aaoiiab.2018@gmail.com	Assistant Administrative Officer

Training and Capacity Building

Details of training attended by the ICAR-IIAB staff during 2018-19

Sl. No.	Name	Subject Area	Duration	Host Institute
1.	Dr. Sujatha TP	Analysis of experimental data	Sep 6-11, 2018	ICAR-NAARM, Hyderabad
2.	Dr. Madan Kumar	Phenomics, the Next Generation Phenotyping (NGP), for trait dissection and crop improvement	Oct 22 to Nov 1, 2018	Division of Plant Physiology, ICAR-Indian Agricultural Research Institute, New Delhi
3.	Dr. Rishikesh Kumar	Experimental Designs and Statistical Data Analysis	Jan 03-16, 2019	ICAR-IASRI, New Delhi
4.	Dr. Madan Kumar	Recent techniques and tools for nutritional quality assessment and enhancement of food cops	Jan 23 – Fab 12, 2019	Division of Biochemistry, ICAR-IARI, New Delhi
5.	Dr. Rishikesh Kumar	Modern Concepts in Plant Disease Management for Enhancing Quality and Productivity	Feb 08-28, 2019	GBPUAT, Pantnagar
6.	Dr. Soumen Naskar	Engineering Mammalian Cells with CRISPR Tools	Mar 25 - Apr 10, 2019	CSIR-Centre for Cellular & Molecular Biology (CCMB), Hyderabad

Important Meetings

Institute Management Committee (IMC) Meeting

The 3rd meeting of Institute Management Committee (IMC) was held on May 30, 2018. Dr. TR Sharma, Chairman IMC & Director, ICAR-IIAB, Ranchi; and members of IMC, Dr. DK Yadava, ADG (Seeds), ICAR, New Delhi; Dr. JC Rana, National Coordinator, United Nations Environment GEF Project, Bioversity International, Dr. Anil Rai, Head, Centre for Agricultural Bioinformatics, ICAR-IASRI, New Delhi; Dr. Vindhya Mohindra, Head, Fish Conservation Division, NBFGR, Lucknow; Dr. Kishor, Gaikwad, Principal Scientist, ICAR-NRCPB, New Delhi and Shri Kameshwar Oraon, AAO, ICAR-IIAB, Ranchi attended the meeting. Dr. VP Bhadana, Pr. Scientist, IIAB; Dr. Biplab Sarkar, Sr. Scientist, ICAR-IIAB; Dr. Anil K Singh, Sr. Scientist, ICAR-IIAB; Dr. Faheem Ansari, Sr. Scientist and In-charge, Finance and Accounts, IINRG also attended the meeting as invitee members. The IMC discussed about various management issues related to the institute.

Fig 47. Selected photographs of 3rd meeting of Institute Management Committee (IMC)

Organization of DISHA-2018

A two-day National Conference on Doubling Farmers' Income for Sustainable & Harmonious Agriculture (DISHA-2018) was organized by S & T SIRI, an NGO of Telangana, in collaboration with ICAR-IIAB, ICAR-RCER, Patna and ICAR-IINRG, Ranchi on 11-12 August, 2018 at Ranchi.

Institute Research Council (IRC) Meeting

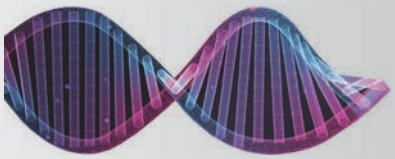
ICAR-IIAB conducted IRC meeting on August 18, 2018. The meeting was chaired by Dr. TR Sharma, Director. He emphasized that scientists should focus more on the local problems followed by regional problems, *i.e.* Eastern India in general and Jharkhand in specific in view of the envisaged Second Green Revolution and doubling of farmers' income. He stressed on development of interdisciplinary project proposals encompassing all three commodities, *viz.* Crop, Animal and Fish, to showcase the uniqueness of the Institute. He also stressed on surveying farmers' field for problem identification and analyze the research/ knowledge gap. Based on the recommendation of the RAC, formation of the third school of the institute, *i.e.* "School of Genetic Engineering" was approved. Review of the ongoing institute and externally-funded projects was done. The IRC approved two new research projects (IXX14638 and XX14646).

Fig 48. Institute Research Council (IRC) Meeting at ICAR-IIAB

Foundation Stone Laying Ceremony

Foundation stone of ICAR-IIAB Field Crop Research and Training Centre was laid by Dr. T Mohapatra, Secretary DARE and Director General, ICAR, New Delhi on Aug. 26, 2018. On this occasion, Dr. Anand

Fig 49. Laying of foundation stone at Farm B for Field Crops Research And Training Centre on 26th August, 2018



Kumar Singh, DDG (CS) ; Dr. DK Yadava, ADG (Seeds), Dr. RK Singh ADG (CC); Dr. TR Sharma, Director, IIAB and Directors of other ICAR Institutes in Ranchi and Vice Chancellor of Birsa Agricultural University, Ranchi were also present. At Farm B of the institute, different units of Field Crop Research and Training Centre, Livestock Research and Training Centre and Fisheries Research and Training Centre along with the developmental works including roads, rain water harvesting ponds etc. will be constructed as per approved master plan.

Research Advisory Committee (RAC) Meeting

The 6th RAC meeting of ICAR-IIAB, Ranchi was held during Nov 29-30, 2018 under the Chairmanship of Prof. VL Chopra, Former Secretary, DARE & Director General, ICAR. The RAC members who were present at the meeting were Prof. K Veluthambi, Former Head, Department of Plant Biotechnology, School of Biotechnology, Madurai Kamraj University, Madurai, Prof. HS Dhaliwal, Vice Chancellor, Eternal University, Baru Sahib, Sirmour, Himachal Pradesh, Prof. KR Koundal, former Joint Director (R), IARI, New Delhi & Scientist Emeritus, NRCPB, New Delhi, Dr. WS Lakra, Former Director, ICAR-Central Institute of Fisheries Education, Mumbai, Dr. BP Mishra, Joint Director (Research), ICAR-Indianb Veterinary Research Institute, Izzatnagar, Bareilly, Dr. TR Sharma, Director, IIAB, and Dr. VP Bhadana, Principal Scientist, IIAB & Member Secretary, RAC. During the meeting, Dr. TR Sharma made a presentation on progress in the establishment of IIAB. Dr. VP Bhadana presented the Action taken a report (ATR) on the recommendations of the previous RAC. During the meeting, Dr. VP Bhadana, Dr. Biplab Sarkar and Dr. AK Singh presented progress made under respective thematic areas in different research projects. Chairman and members of RAC expressed satisfaction on substantial progress in research on the relevant regional research gaps and thrust areas despite daunting constraints. Dr. TR Sharma, Director expressed his gratitude to the Chairman and members of RAC for their valuable suggestions. The major recommendations of RAC are as follows:

- Number of germplasm accessions in case of lentil and horsegram is very good and need to be evaluated critically for identification of suitable donors.
- In case of new project on glycemic index, scientist should review the project and define the objectives and activities accordingly.
- Rice accessions collected from Jharkhand need to be screened for the traits such as phosphate uptake, low Zn-adaptation and drought resistance.
- Group should make efforts to identify some suitable short duration drought tolerant crops after rice such as barley, mustard and minor millets to utilize rice-fallows.
- Need to establish tissue culture facilities and initiate work on plant transformation.
- Interaction studies on rhizobium and molybdenum need to be taken up in addition to the elucidation of role of molybdenum on the growth and performance of Chickpea.
- Testing of copper, zinc and iron based nano products against plant and fish diseases.
- Fisheries scientist needs to focus on addressing the local problems by taking project on nutrition and disease management.
- Screening the resistant lines of rice against different races of *M. griseae*.
- The ICAR should provide sufficient funds for development of minimum required infrastructure in phased manner. It was also strongly felt that approval for creation of scientific, technical and administrative posts be accorded and also direct recruitments of competent scientists as recommended earlier

also be made on priority basis.

- Institute should give more emphasis on application oriented biotechnology research cutting across agriculture, animal and fisheries with emphasis on region centric problems. There is a need to focus the research activities in the priority areas to achieve objectives of product development for the benefit of the end users. Strengthening of public-private-partnership in the relevant areas will be helpful for better outcomes of the envisaged projects of practical value.
- A brain storming session / discussion or workshop with a group of experts will help to redefine the role of IIAB and focus the research programmes of this institute in context to the local and regional needs as well as development of human resource in the field of agricultural biotechnology.
- Capacity building of fish farmers for entrepreneurship promotion for the unemployed youth has immense potential in Jharkhand. Therefore, ICAR-IIAB should make use of the schemes of National Fisheries Development Board for capacity building of fish farmers in aquaculture related activities in collaboration with state fisheries department.
- Suitable arrangements by signing MOUs should be made with other Universities/ organizations in the region as per guidelines of ICAR to attract PG and Ph.D students to take up basic research in conformity with IIAB mandate for human resource development. At the same time, the faculty members should provide continuity for applied research.

On Nov 30, 2018, chairman and members of RAC visited the Institute site at Garhkhatanga to review the progress in farm development and the research activities going at the farm.

Fig 50. Selected photographs of 6th Research Advisory Committee (RAC) Meeting

Quinquennial Review Team (QRT) Meeting

The first QRT meeting of ICAR-IIAB for the period 2012- 2017 was held during 11th-12th January, 2019 under the Chairmanship of Prof. Akhilesh K Tyagi, Department of Plant Molecular Biology, University of Delhi, South Campus. Other QRT members present in the meeting were Dr. R Srinivasan, Ex-Professor, ICAR-NRCPB, New Delhi; Dr. VG Malathi, Adjunct Faculty, TNAU, Coimbatore and Dr. Iddya Karunasagar, Senior Director (International Relations), NITTE, Mangaluru. The meeting started with the formal welcome address by the Member Secretary, Dr. Binay K Singh, Senior Scientist, ICAR-IIAB, Ranchi. Dr. TR Sharma, Director, ICAR-IIAB, presented the highlights of research programs and achievements for the period 2012-2017. The In-charges of the Schools of Genomics and Molecular Breeding, Genetic Engineering, and Molecular Diagnostics

and Prophylactics presented the achievements of their respective Schools. The Hon'ble Chairman and the Members of the QRT critically reviewed the achievements of the Institute and examined whether the research and development programs conform to the priorities of the ICAR. They also visited the laboratories, research farms, and interacted with the Scientists of the Institute. The Hon'ble Chairman and the Members of the QRT had the opinion that with its modest facility, ICAR-IIAB is doing reasonably well in terms of research and infrastructure development. However, work on infrastructure development should be hastened, and human resources should be strengthened. The Institute should have a relook at its priority crops and problems and based on that it should fine-tune its research projects for a more meaningful impact. The academic program of the Institute should also be initiated without further delay, at least, with a few M.Sc. students. The meeting ended with the formal vote of thanks by the Member Secretary of QRT.

Fig 51. 1st Quinquennial Review Team (QRT) Meeting at ICAR-IIAB

Infrastructure Development

As per approved Master Plan of ICAR-IIAB, construction of Farm Office-cum-Field Lab, Go-down and Farm Implement-shed & Threshing Yard of Field Crop Research and Training Centre, Farm Office-cum-Training Hall of Livestock Research and Training Centre and Fish Wet Labs and ponds of Fisheries Research and Training Centre along with the developmental works including roads, rain water harvesting channels and water storage pond is under progress.

Fig 52. Selected photographs of various infrastructure developemental activities

Procurement of Lab Equipments

Since the construction of laboratory building of ICAR-IIAB is yet to start at Garhkhatanga, Ranchi, two fully air-conditioned molecular biology laboratories were established in the current building provided by ICAR-IINRG in its PDU Campus situated at Namkum, Ranchi. Several equipments *viz.*, thermocyclers, Real time PCR machine, 2D-Electrophoresis System, Electrophoresis units, Gel doc system, ELISA reader, Deep freezers, incubators, refrigerated centrifuges, Seed germinator, Chlorophyll meter, EC meter, Millipore, FTIR, Plant growth chamber, Biological Safety Cabinet Class II/A2, CO2 incubator etc. have been procured.

Research Farm Development

Systematic development of research-farm at ICAR-IIAB was undertaken by activities such as tilling and leveling. A total of around 5 ha of cultivable land were prepared, which was used for conducting and screening field trials of paddy (AICRIP, INGER etc.) and for seed multiplication of paddy. To ensure continuous availability of water for irrigation and farm related activities, deep well boring was installed at six promising sites which are functional.

Fig 53. Installation of deep well boring at farm of ICAR-IIAB

Purchase of Office Vehicles

An office vehicle (Maruti Ciaz) and an utility vehicle (Bolero maxitruck) have been procured and are being used for office-related activities. Beside this, utility vehicle is also used for distribution of inputs to SC and ST farmers under STC and SCSP programs.

Fig 54. Newly purchased vehicles at ICAR-IIAB, Ranchi during FY 2018-19

Other Activities

Mera Gaon Mera Gaurav

To undertake Mera Gaon Mera Gaurav programme, during 2018-19 two multi-disciplinary teams were formulated incorporating 9 scientists (including the Nodal Officer). Six villages in two districts (Latehar and Ranchi) of Jharkhand were selected under the programme, to cover about 1000 farmers from different adopted villages. A benchmark survey was conducted. Majority of population (more than 65%) belonged to SC/ST communities. Non-availability of quality inputs, intermittent drought, lack of irrigation facilities, problematic soils, free-grazing (after *kharif*), marketing and storage of produce, lack of institutional credit etc. were major problems identified in all the adopted villages. Technical supports were provided through village meetings, literature, focus-group discussions and mobile advisory (telephonic conversation) with respect to plant protection measures, improved packages and practices, scientific pisciculture etc. About 30 visits have been made by different teams during 2018-19. Awareness programmes were organized for growing high value crops, protected cultivation etc. Training programme on improved packages and practices on agri-horticultural crops for economic boost was organised. Farmers from selected villages were also called for exposure visit in farmers fair organized jointly by ICAR-IIAB, Ranchi, ICAR-IINRG Ranchi and BAU, Kanke Ranchi.

Fig 55. One day training program on improved packages and practices of agri-horticultural crops at Chetag, Balumath, Latehar

Vigilance Awareness Week

Vigilance Awareness Week' was celebrated with grandeur at ICAR-IIAB, Ranchi, Jharkhand during 29th October to 3rd November, 2018. On 29th October, the Awareness Week was initiated with 'oath taking ceremony' by all staffs. An 'elocution competition' was organized on the given thematic area, 'Eradicate Corruption- Build a New India' participated by all staff members of the institute. Best speakers were given prizes which were decided by the panel members. The valedictory cum sensitization programmes were organized on 3rd November from 2.30 PM onwards. In this session, Mr. Sanjay Agarwal, DGM and Additional Chief Vigilance Officer SAIL-Research & Development, Ranchi, Jharkhand was invited as Chief-Guest of the programme to deliver a talk on important rules of vigilance practiced in the central government institutes. Dr. VP Bhadana, Principal Scientist, ICAR-IIAB mentioned about the importance of vigilance in the ICAR system. The programme concluded with comments from the Director, followed by vote of thanks from Dr. Biplab Sarkar, Senior Scientist and Vigilance Officer, ICAR-IIAB.

Fig 56. Selected photographs of celebrating 'Vigilance Awareness Week' at ICAR-IIAB

'Science Day' Celebration

The National Science Day celebrations of the year 2019 was organized on 28th February, at Albert Ekka Public School, Namkum, Ranchi.The theme of National science day for the year 2019 was "Science for people and people for science". The principal as well the science teacher of the school addressed the students.Quiz programmes were organized by the scientists of ICAR-IIAB, Dr. Sujith Kumar Bishi, Dr. Sujatha TP, Dr. Sanjay Kumar Gupta and Dr. Madan Kumar, for lower primary and upper primary school children in two sessions. The aim was to create awareness on science and scientific innovations, as well as to inculcate enthusiasm in young minds and encourage students to pursue education and career in science. Prizes were distributed to the winners. The students were actively participated in the quiz programme with much interest. The students visited the labs of ICAR-IIAB on 7th March, 2019 and familiarized with the lab work, research equipments etc.

Fig 57. Glimpses of 'Science Day Celebration 'at Albert Ekka Public School, Namkum, Ranchi

International Women's Day

The International Women's Day was celebrated with great fervor and zeal at ICAR-IIAB on 8th March, 2019 on the theme for the year 2019, "Think Equal, Build Smart, Innovate for Change" to emphasise on innovation by women, to achieve gender equality. All women staff of ICAR-IIAB, including the supporting staff were greeted and felicitated by the Director, ICAR-IIAB. A short documentary on the women achievers of India in various fields were shown. Live telecast of Prime Minister's speech on

the occasion at Varanasi was watched by all the staff at the conference hall. All the staff of ICAR-IIAB fervently participated in the event and expressed their valuableviews and thoughts on women's day. The Director, ICAR-IIAB emphasised on women empowerment and acknowledged the contribution, as well as accomplishments of women, in various spheres. The chief guest Mrs. Somdutti Dutta expressed her views and shared her experiences as a professional and as a social worker. The chief guest was felicitated by the Director, ICAR-IIAB.

Fig 58. Glimpses of "International Women's Day" at ICAR-IIAB, Ranchi

Swachh Bharat Abhiyaan

Under Swachh Bharat Mission, ICAR-IIAB organized fortnight long programs during 15th September to 2nd October, 2018 under Swachhata hi Seva campaign and cleanliness drives during 16th -31st December, 2018. Swachhta pledge was taken by all the staff members. Shri Chhabilendra Roul,

Fig 59. Selected photographs of Swachhata hi Seva campaign at ICAR-IIAB

Special Secretary, DARE & Secretary ICAR planted trees at Garhkhatanga campus of ICAR-IIAB during this drive. 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.

Participation in ICAR-Zonal Sports Tournament for Eastern Zone

A 10-member sports contingent of ICAR-IIAB, Ranchi participated in the ICAR-zonal sports tournament for eastern zone hosted by ICAR-IINRG, Ranchi during 5th - 8th October, 2018. The team of ICAR-IIAB participated in the tournament with the coordination of Dr. Madan Kumar as Chief-De-Mission and Dr. B Sarkar as Team Manager. The zonal sports tournament was attended by 502 participants from 18 ICAR institutes located in 12 states of the Eastern zone. The Director congratulated the team of ICAR-IIAB for their sportsmanship spirit shown in the zonal sports tournament.

Fig 60. ICAR-IIAB staff during ICAR-zonal sports tournament for eastern zone

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 सरकारी कार्य में हिन्दी के प्रयोग को गति प्रदान करने के लिए निदेशक की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति गठित की गई है, जिसमें विभागों/अनुभागों के अध्यक्ष, सदस्य के रुप में शामिल हैं तथा प्रभारी अधिकारी, राजभाषा सदस्य सचिव हैं। राजभाषा कार्य के सूचारू संचालन के लिए वर्ष 2018–19 में निम्नलिखित कार्य किए गए।

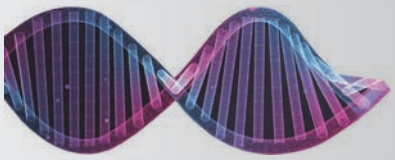
संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी तथा बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई। संस्थान के दैनिक कार्य में हिन्दी के प्रयोग में प्रगति एवं इसे सरल बनाने के लिए राजभाषा प्रकोष्ठ द्वारा निम्नलिखित कार्य सम्पादित होते हैं:

- संस्थान राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी एवं बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई।
- हिन्दी दिवस, हिन्दी चेतना मासएवं योजनानुसार नगर स्तरीय राजभाषा संबंधी, संगोष्ठी एवं कार्यशाला का आयोजन करना।
- संदर्भ साहित्य, हिन्दी पत्रिका, शब्दकोश, एवं तकनीकी शब्दावली के उपार्जन हेतु कार्य।
- हिन्दी में वैज्ञानिक गोष्ठी के साथ साथ प्रशासनिक तथा तकनीकी वर्ग के लिए कार्यशाला का आयोजन।

हिन्दी चेतना मास

राजभाषा अधिनियम के अनुपालन एवं कार्यालय कार्य में हिन्दी के प्रयोग में उत्तरोत्तर वृद्धि के लिए संस्थान में दिनांक–01.09.2018 से 30.09.2018 तक हिन्दी चेतना मास का पालन किया गया। इसके अन्तर्गत दिनांक–29.09.2018 को अपराह्न 02.15 बजे हिन्दी दिवस समारोह का आयोजन किया गया। हिन्दी दिवस समारोह के अवसर पर मुख्य अतिथि के रूप में श्री अमरकान्त, प्रबंध संपादक, खबर मंत्र, हिन्दी दैनिक, राँची तथा डॉ हीरानन्दन प्रसाद, साहित्यकार एवं सह प्राध्यापक, हिन्दी विभाग, राँची विश्वविद्यालय विशिष्ट अतिथि के रूप में उपस्थित थे। श्री अमरकान्त ने संस्थान के शोध और उपलब्धियों को हिन्दी में निकालने की बात कही, जिससे स्थानीय स्तर पर किसान और ग्रामीण उसे पढ़कर लाभान्वित हो सकें। उन्होंने कहा कि यह काफी सराहनीय बात है कि संस्थान के वैज्ञानिक बातचीत और अपने कागजाती कार्य में हिन्दी का ही प्रयोग करते हैं। विशिष्ट अतिथि डॉ हीरानन्दन प्रसाद ने अपने संबोधन में कहा कि मेडिकल साईंस और अन्य टेक्नोलॉजी की पढ़ाई के लिए अंग्रेजी में लिखी किताबों का हिन्दी में अनुवाद होना चाहिए, तभी छात्र–छात्राओं का रूझान इस ओर बढ़ेगा। संस्थान के निदेशक डॉ तिलक राज शर्मा ने हिन्दी दिवस समारोह के अवसर पर शुभकामनाएं दीं तथा संस्थान में हिन्दी के अधिक से अधिक प्रयोग संबंधी प्रयासों के बारे में बताया। कार्यक्रम का संचालन डॉ अन्जेष कुमार, वरिष्ठ तकनीकी अधिकारी ने किया।

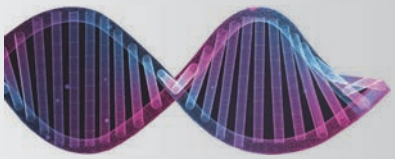
चित्र 61. हिन्दी दिवस समारोह के अवसर पर निदेशक महोदय का संबोधन



Participation In Conferences, Meetings, Seminars, Symposia and Workshops

Sl. No.	Event	Venue	Period	Participants
1.	National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario	ICAR-DGR, Junagadh	Apr 7-9, 2018	Dr. Sujit Kumar Bishi
2.	53rd Annual Rice Research Group Meeting	ICAR-IIRR, Hyderabad	Apr 13-16, 2018	Dr. VP Bhadana
3.	VIC Meeting	ICAR-IIRR, Hyderabad	Apr 14, 2018	Dr. VP Bhadana
4.	National seminar on "Road map of Vegetable Oil Production by 2022,	PJTSAU, Rajendranagar, Hyderabad	Apr 28-29, 2018	Dr. Sujatha TP
5.	Inaugural day Programme of 38th Kharif Research Council meeting	Birsa Agricultural University, Kanke, Ranchi	May 31, 2018	Dr. Biplab Sarkar
6.	Paryabaran Mela-2018	Audrey house, Ranchi	Jun 2-9, 2018	Dr. Biplab Sarkar, Dr. Avinash Pandey and Dr. Sudhir Kumar
7.	Attended a live telecast of Prime Minister's lecture on doubling of farmers' income and live interaction with farmers	ICAR-IINRG conference Hall, Namkum, Ranchi	Jun 20, 2018	Dr. TR Sharma, Dr. VP Bhadana and Dr. Biplab Sarkar
8.	9th International Rosaceae Genomics Conference	NAU, Nanjing, China	Jun 26-30, 2018	Dr. AK Singh
9.	International Conference on Plant Genetics and Genomics: Next Gen Crops for Sustainable Agriculture	Hotel Hometel, Chandigarh	Jul 19-20, 2018	Dr. AK Singh
10.	Workshop on Grant writing & Sensitization Programme on BIG Scheme	ICAR-IINRG, Ranchi	Jul 20, 2018	All Scientific Staff
11.	National conference on Doubling Farmers' income for sustainable and harmonious agriculture (DISHA)	ICAR-IINRG, Ranchi	August 11-12, 2018	Dr. TR Sharma, Dr. VP Bhadana, Dr. Biplab Sarkar, Dr. BK Singh, Dr. Sujatha TP, Dr. Avinash Pandey, Dr. Rishikesh Kumar, Dr. Madan Kumar, Dr. Sudhir Kumar and Dr. Sujit Kumar Bishi

Sl. No.	Event	Venue	Period	Participants
12.	Meeting of editors of Indian Journal of Plant Physiology	Division of Plant Physiology, ICAR-IARI, New Delhi.	September 29, 2018	Dr. AK Singh
13.	6th Plant Dormancy Symposium	Kyoto University, Kyoto, Japan	October 23-26, 2018	Dr. AK Singh
14.	Meeting with faculty of Kazusa DNA Research Institute (KDRI), Chiba, Japan	KDRI, Chiba, Japan	October 26, 2018	Dr. AK Singh
15.	Germplasm Field Day of Kulthi	Research farm of ICAR-NBPGR, Regional Station, New Bhusur, Namkum, Ranchi	November 19, 2018	Dr. TR Sharma, Dr. VP Bhadana, Dr. BK Singh, Dr. Sujatha TP, Dr. Avinash Pandey and Dr. Sudhir Kumar
16.	Orientation programme for establishing Agri Business Incubators under the "Rashtriya Krishi Vikas Yojana—Remunerative Approaches for Agriculture and Allied Sector Rejuvenation"	Krishi Bhawan, New Delhi	November 22, 2018	Dr. Sujatha TP
17.	Global Agriculture and Food Summit 2018	Department of Agriculture, Animal Husbandry and Co-operative, Govt. of Jharkhand	November 29-30, 2018	Dr. TR Sharma & Dr. AK Singh
18.	4th International Plant Physiology Congress 2018	CSIR-National Botanical Research Institute, Lucknow	December 2-5, 2018	Dr. AK Singh
19.	Meeting of editors of Indian Journal of Plant Physiology held during 4th International Plant Physiology Congress at Lucknow.	Indira Gandhi Pratisthan, Lucknow	December 3, 2018	Dr. AK Singh
20.	Utilization of Plant Genetic Resources (PGRs) towards Doubling Farmers Income	ICAR-NBPGR, Ranchi	December 6, 2018	Dr. TR Sharma, Dr. VP Bhadana, Dr. S Naskar, Dr. Sudhir Kumar, Dr. Sujatha TP and Dr. Madan Kumar,



Sl. No.	Event	Venue	Period	Participants
21.	4th Worldwide Universities Network (WUN) workshop on "Climate Resilient Open Partnership for Food Security"	Jawaharlal Nehru University, New Delhi	December 7-8, 2018	Dr. AK Singh
22.	1st National Genetics Congress	Indian Agricultural Research Institute, Pusa, New Delhi.	December 14-16, 2018	Dr. Sujatha TP
23.	Golden Jubilee International Conference on 'Trends in Zoology'	Department of Zoology, University of Burdwan, West Bengal	January 03-04, 2019	Dr. Biplab Sarkar
24.	Inaugural session of State Level Agricultural Fair (SLAF-2019).	Birsa Agricultural University (BAU), Kanke, Ranchi	February 3, 2019	Dr. Biplab Sarkar
25.	40th meeting of Plant Tissue Culture Association-India (PTCA-I) & International Conference on Trends in Plant Sciences and Agrobiotechnology-2019	Indian Institute of Technology, Guwahati	February 14-16, 2019	Dr. AK Singh
26.	XIV Agricultural Science Congress	NASC Complex, Pusa, New Delhi	February 20-23, 2019	Dr. Sujatha TP
27.	National workshop on competency framework for Agricultural Research and Extension Scientist	ICAR-IINRG, Ranchi	March 06, 2019	Dr. SK Gupta
28.	2nd International Conference on Frontiers in Biological, Environmental and Medical Sciences under PURSE Phase2 Programme, DST,Govt. of India	University of Burdwan, West Bengal	March 7 - 9, 2019	Dr. Biplab Sarkar and Dr. SK Gupta
29.	South Asia Biotechnology Conference-2019	South Asian University, New Delhi	March 14-16, 2019	Dr. AK Singh

Joining of New Staff

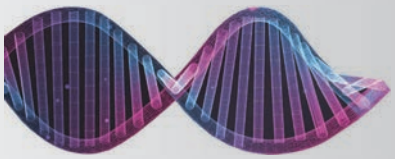
Name of staff	Designation	Date of Joining
Dr. Sujit Kumar Bishi	Scientist (Plant Biochemistry)	June 25, 2018
Dr. Sujatha T.P.	Scientist (Agricultural Biotechnology)	June 29, 2018
Sh. Arun Kumar Tripathi	Assistant Administrative Officer (Dep.)	January 22, 2019

Transfer of IIAB Staff

Name of staff	Designation	Place to Transfer
Sh. Kameshwar Oraon	Assistant Administrative Officer (Dep.)	ICAR-IINRG, Ranchi

Institute Funded Projects

Project Title	Date of Start	Principal Investigator	Co- Principal Investigator (s)
IIAB-CBB-OI: Genomics and Bioinformatics			
IXX12585: Identification and characterization of drought-responsive genes of wild chickpea (*Cicer microphyllum*)	Apr, 2016	Dr. AK Singh	Sh. Kishor U Tribhuvan Dr. VP Bhadana
IXX12644: Identification of genes/QTLs for heat tolerance in lentil	Apr, 2016	Dr. AK Singh	Dr. BK Singh Dr. VP Bhadana Sh. SK Lal
IXX12950: 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. SK Gupta Dr. S Banik
IIAB-TRCI-OI: Translational Research for Crop Improvement			
IXX12649: Introgression of genes/ QTLs for drought tolerance and efficient phosphorus uptake in rice using MAS	Apr, 2016	Dr. VP Bhadana	Dr. BK Singh Dr. Avinash Pandey Dr. Sudhir Kumar Dr. Madan Kumar Dr. Rishikesh Kumar
IXX12651: Identification and mapping of novel genes/QTLs for phosphorus uptake and use efficiency in rice	Apr, 2016	Dr. BK Singh	Dr. VP Bhadana Dr. Avinash Pandey Dr. Sudhir Kumar Dr. Madan Kumar
IXX12645: Identification and functional characterization of genes/QTLs responsible for zinc homeostasis in rice	Apr, 2016	Dr. Madan Kumar	Dr. BK Singh Dr. VP Bhadana Dr. Avinash Pandey Dr. Sudhir Kumar Dr. Rishikesh Kumar
IXX12951: Understanding host- pathogen interactions and identification of novel blast and false smut resistance gene(s) in rice	Sep, 2016	Dr. Rishikesh Kumar	Dr. BK Singh Dr. VP Bhadana Dr. Avinash Pandey Dr. Sudhir Kumar Dr. Madan Kumar



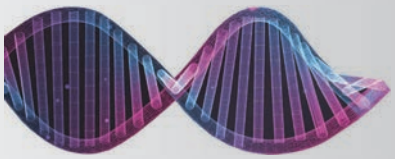
Project Title	Date of Start	Principal Investigator	Co- Principal Investigator (s)
IXX13895: Molecular mapping of QTLs for early plant vigour, early maturity and harvest index traits in lentil	Sep, 2017	Dr. Avinash Pandey	Dr. Sudhir Kumar Dr. Kuldeep Tripathy Dr. BK Singh Dr. Madan Kumar Dr. Rishikesh Kumar Dr. VP Bhadana
IXX13896: Ideotype breeding in horse gram for Jharkhand region	Sep, 2017	Dr. Sudhir Kumar	Dr. Avinash Pandey Dr. BK Singh Dr. VP Bhadana Dr. Madan Kumar Dr. Rishikesh Kumar
IXX14638: Elucidating the molecular and biochemical basis of climate resilient rice with low glycemic index	Sep, 2018	Dr. Sujit Kumar Bishi	Dr. Rishikesh Kumar Dr. Avinash Pandey Dr. Madan Kumar Dr. BK Singh Dr. Sudhir Kumar
IXX14646: Decoding the molecular mechanisms of molybdenum and boron metabolism in chickpea (*Cicer arietinum* L.) under acidic soil conditions	Aug, 2018	Dr. Sujatha T.P.	Dr. Rishikesh Kumar Dr. Avinash Pandey Dr. BK Singh Dr. VP Bhadana Dr. S Naskar Dr. AK Singh Dr. Madan Kumar
IIAB-FHM-OI: Biotechnological Interventions for Fish Health Management			
IXX12206: Identification and characterization of genes responsible for immune response in *Labeo rohita* fingerlings	Nov, 2015	Dr. SK Gupta	Dr. S Naskar Dr. B Sarkar
IXX12919: Development and evaluation of the efficacy of novel nanoparticles for enhancing yield in rice and Indian major carp	Jun, 2016	Dr. B Sarkar	Sh. Rishikesh Kumar Dr. SK Gupta Dr. BK Singh

Externally Funded Projects

Screening of various lentil (*Lens culinaris* L.) genotypes for drought tolerance using physiological and molecular approaches (N-PDF scheme)	Jul, 2016	Dr. Ragini Sinha	Dr. AK Singh (Mentor)
Characterization of molecular marker(s) associated with X- and/or Y-chromosome bearing spermatozoa in cattle (N-PDF scheme)	Apr, 2017	Dr. Laxmi Vandana Rongala	Dr. S. Naskar (Mentor)
Enhancing food, nutritional and livelihood security of marginal and small farmers in Jharkhand through need-based agricultural technologies (ICAR-Funded)	Jan, 2017		Dr. S Naskar Dr. SK Gupta
Heat stress responsive transcriptome analysis and gene regulation study in groundnut (N-PDF scheme)	Jul, 2018	Dr. B Pradhan	Dr. SK Bishi

Awards and Recognitions

- Dr. VP Bhadana received Outstanding Achievement Award conferred by S&T Siri Society, Warangal, Telangana duringNational conference on Doubling Farmers' income for sustainable and harmonious agriculture (DISHA) held at ICAR-IINRG during August 11-12, 2018.
- Dr. Biplab Sarkar Received 'Distinguished Scientist Award' on the occasion of National Conference on Doubling Farmers Income for sustainable and Harmonious Agriculture(DISHA 2018), 11-12 August, 2018 at Ranchi.
- Dr. BK Singh Received 'Distinguished Scientist Award' conferred by S&T Siri Society, Warangal, Telangana during National conference on Doubling Farmers' income for sustainable and harmonious agriculture (DISHA) held at ICAR-IINRG during August 11-12, 2018.
- Dr. AK Singh received invitation for delivering invited talk in 9th International Rosaceae Genomics Conference organized by Nanjing Agriculture University, Nanjing, China, during Jun. 26-30, 2018 with funding support for registration fee, accommodation and local travel by the organizers of the Conference.
- Dr. AK Singh received invitation for delivering invited talk in 6th Plant Dormancy Symposium organized by Kyoto University, Kyoto, Japan during Oct. 23-26, 2018 with funding support for registration fee, accommodation and local travel by the organizers of the symposium.
- Dr. AK Singh received invitation to visit Kazusa DNA Research Institute, Chiba, Japan during visit to Japan in Oct. 2018 for delivering a talk and discussion regarding collaboration in the area of plant genomics.
- Dr. AK Singh awarded financial assistance by Indian National Science Academy (INSA), New Delhi for participation in 9th International Rosaceae Genomics Conference held Nanjing Agriculture University, Nanjing, China, during Jun. 26-30.
- Dr. AK Singh awarded International Travel Support by science and Engineering Research Board (SERB), Dept. of Science and Tech., New Delhi, Govt. of India for participation in 6thPlant Dormancy Symposium organized by Kyoto University, Kyoto, japan during Oct. 23-26, 2018.
- Dr. AK Singh appointed as Guest Editor for special issue on "Plant Dormancy" in journal "Tree Physiology".
- Dr. AK Singh appointed as Handling Editor for special section on "Future Crops" in journal "PLoS ONE".
- Dr. AK Singh elected as member of the Plant Tissue Culture Association of India (PTCA-I).
- Dr. AK Singh acted as reviewer for several International peer reviewed journals with high impact factor.
- Dr. Sujit Kumar Bishi received Young Scientist Award at 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture held at ICAR-IINRG Ranchi during 11to 12th August 2018.
- Dr. SK Gupta received The Australia Awards–Endeavour Scholarships Research Fellowships and completed 6 months (June-December; 2018) Endeavor postdoctoral research program at Curtin University, Western Australia in the frontier areas of Fish biotechnology.
- Dr. Sujatha TP received Young Scientist Award at 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture held at ICAR-IINRG Ranchi during 11to 12th August 2018.
- Dr. Sudhir Kumar received Young Scientist Award at 2nd National Conference on



Doubling of Farmer Income for Sustainable and Harmonious Agriculture held at ICAR-IINRG Ranchi during 11to 12th August, 2018, conferred by DISHA-2018

- Dr. Madan Kumar received Young Scientist Award at 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture held at ICAR-IINRG Ranchi during 11 - 12th August, 2018, conferred by DISHA-2018.
- Dr. Rishikesh Kumar received Young Scientist Award at 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture held at ICAR-IINRG Ranchi during August 11-12, 2018.
- Dr. Rishikesh Kumar received a Gold Certificate as a buyer for completing the online assessment that covered advanced functionality of the Government e-Marketplace (GeM) portal.
- Dr. S Naskar appointed as Officer In-charge for Krishi Kalyan Abhiyan (KKA) phase-1 (01-15 August, 2018) and phase-2 (02 Oct.-25 Dec., 2018), a programme by the Ministry of Agriculture and Farmers Welfare, Govt. of India, for East Singhbhum district of Jharkhand.
- Dr. Avinash Pandey received Young Scientist Award conferred by S&T Siri Society, Warangal, Telangana duringNational conference on Doubling Farmers' income for sustainable and harmonious agriculture (DISHA) held at ICAR-IINRG during August 11-12, 2018.
- Dr. SK Gupta received certificate of outstanding contribution in reviewing for the recognition of the contributions made to the quality of the journal, conferred by editors of journal Aquaculture (Elsevier).
- Dr. SK Gupta received certificate of outstanding contribution in reviewing for the recognition of the contributions made to the quality of the journal, conferred by editors of journal Fish and Shell fish immunology (Elsevier)
- Dr. SK Gupta certificate of outstanding contribution in reviewing for the recognition of the contributions made to the quality of the journal conferred by editors of journal Regional studies in marine sciences (Elsevier).

Publications

Research Articles

Agalwe SB, Bangle U, Rama Devi SJS, Balija V, Bhadana VP, Kumar S, Prasad MS and Madhav MS. 2018. Characterization of *Akhanphou*, an unique landrace from north east India and its RILs population for rice leaf and neck blast resistance. *Current Trends in Biotechnology and Pharmacy* **12**(2): 118-127.

Anila M, MahadevaSwamy HK, Kale RR, Bhadana VP, Anantha MS, Hajira SK, Balachiranjeevi CH, AyyappaDass M, Bhaskar S, Dilip T, Pranathi K, Kousik MBVN, Harika G, Swapnil K, Chaitra K, LaxmiPrasanna B, Punniakotti E, Sinha P, Rekha G, Kumar VA, Balachandran SM, Madhav MS, Giri A, Viraktamath BC and Sundaram RM. 2018. Breeding lines of the Indian mega-rice variety, MTU 1010, possessing protein kinase OsPSTOL (*Pup1*), show better root system architecture and higher yield in soils with low phosphorus. *Molecular Breeding* **38**(12): 147.

Balachiranjeevi CH, Naik B, Kumar A, Harika G, MahadevSwamy HK, Hajira SK, Kumar D, Anila M, Kale RR, Yugender A, Pranathi K, Koushik MBVN, Suneetha K, Bhadana VP, Hariprasad AS, Laha GS, Rekha G, Balachandran SM, Madhav MS, Senguttuvel P, Fiyaz AR, Viraktamath BC, Giri A, Swamy BPM, Ali J and Sundaram RM. 2018. Marker assisted pyramiding of two major, broad spectrum bacterial blight resistance genes, *Xa21* and *Xa33* into an elite maintainer line of rice, DRR17B. *PLOS one* **13**(10): e0201271.

Bhuvaneswari S, Singh IM, Kumar S, Singh S, Leeda Mosang TS, Sharma SK, Singh G and Prakash N. 2018. *On-Farm* Multilocation Adaptability Trial of Promising Rice Genotypes across Manipur. *Indian Journal of Hill Farming* **31**(1): 165-167.

Chakraborty K, Bishi SK, Singh AL, Zala PV, Mahatma MK, Kalariya KA and Jat RA. 2018. Rapid induction of small heat shock proteins improves physiological adaptation to high temperature stress in peanut. *Journal of Agronomy and Crop Science* **204**(3): 285-297.

Chandra S, Patiyal RS, Gupta SK and Sarma D 2018. Study on age dependent breeding performance of rainbow trout (*Oncorhynchus mykiss*, Walbaum, 1792). *Journal of Cold Water Fisheries* **1**(1): 125-128.

Devi YS, Pandey A, Kumar A, Ansari MA, Tyagi W, Rai M and Das A. 2018. Genetic divergence, path coefficient and cluster analysis of ricebean (*Vigna umbellata*) genotypes in the mid-altitudes of Meghalaya. Indian Journal of Agricultural Sciences 88(7): 1054-1062.

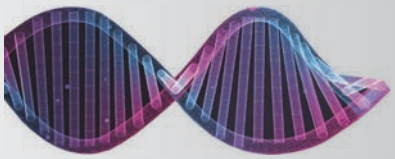
Dutta SS, Tyagi W, Pale G, Pohlong J, Aochen C, Pandey A, Pattanayak A and Rai M. 2018. Marker-trait association for low light intensity tolerance in rice genotypes from Eastern India. *Molecular Genetics and Genomics* **293**(6): 1493-1506.

Dutt S, Kirti S, Vaidya T, Parkash J, Kashyap S, Sharma N and Singh AK. 2018. External application of NADPH enhances biomass accumulation, seed germination and modulates expression of oxidative pentose phosphate pathway genes in Arabidopsis. *Indian Journal of Plant Physiology* **23**:748-59.

Foysal MJ, Fotedar R, Gupta SK and Chaklader MR 2019. Biological ball filters regulate bacterial communities in marron (*Cherax cainii*) culture system. *Letters in Applied Microbiology* **68**(5): 455–463.

Foysal MJ, Fotedar R, Tay CY, Gupta SK 2019. Dietary supplementation of black soldier fly (*Hermetica illucens*) meal modulates gut microbiota, innate immune response and health status of marron (*Cherax cainii*, Austin 2002) fed poultry-by-product and fishmeal based diets. *PeerJ* **7**:e6891 DOI 10.7717/peerj.6891

Goel P, Sharma NK, Bhuria M, Sharma V, Chauhan R, Pathania S, Swarnkar MK, Chawla V, Acharya V, Shankar R and Singh AK.2018.Transcriptome and



co-expression network analyses identify key genes regulating nitrogen use efficiency in *Brassica juncea* L. *Scientific Reports* **8**: 7451.

Gupta SK, B. Sarkar, S. Bhattacharjee, Neeraj Kumar, S. Naskar,Kiran Babu Uppuluri 2018. Modulation of cytokine expression by dietary levan in the pathogen aggravated rohu, *Labeo rohita* fingerlings. *Aquaculture* **495**: 496–505.

Kumar A, Imran M, Kumar SPJ, Kumar M**,** Singh AN and Srivastava AK 2018. Assessment of soil urease activity and its kinetic parameters in chilli rhizosphere under the influence of pesticides. *Biopesticides International* **14**(1): 47-57.

Mahatma MK, Thawait LK, Jadon KS, Thirumalaisamy PP, Bishi SK, Jadav JK, Khatediya N and Golakiya BA. 2018. Metabolic profiles of groundnut (*Arachis hypogaea* L.) genotypes differing in Sclerotium rolfsii reaction. *European Journal of Plant Pathology* **151**(2): 463-474.

Pham HD, Siddik MAB, Fotedar R, Nguyen CM, Nahar A and Gupta SK 2018. Total bioavailable organic selenium in fishmeal-based diet influences growth and physiology of juvenile Cobia *Rachycentron canadum* (Linnaeus, 1766). *Biological Trace Element Research* **190**(2): 541–549.

Saputra I, Foetdar R, Gupta SK, Siddik MAB and Foysal MJ 2019. Effects of different dietary protein sources on the immunological and physiological responses of marron, *Cherax cainii* (Austin and Ryan, 2002) and its susceptibility to high temperature exposure. *Fish and Shellfish Immunology* **88**: 567-577.

Sarkar B,Verma SK, Akhtar J, Netam SP, Gupta SK, Panda PK and Mukherjee K. 2018. Molecular aspect of Silver nanoparticles regulated embryonic development in Zebrafish (*Danio rerio*) by Oct-4 expression. *Chemosphere* **206**: 560-567.

Shafi A, Gill T, Zahoor I, Ahuja PS, Sreenivasulu Y, Kumar S and Singh AK. 2019. Ectopic expression of *SOD* and *APX* genes in Arabidopsis alters metabolic pools and genes related to secondary cell wall cellulose biosynthesis and improve salt tolerance. *Molecular Biology Reports* **46**: 1985-2002.

Shafi A, Zahoor I, Gill T, Ahuja PS, Kumar S and Singh AK. 2019. Ectopic co-expression of the SOD and APX genes enhanced callus growth and *in vitro* regeneration in Arabidopsis. *Plant Biotechnology Reports* DOI:10.1007/S11816-019-00535-2.

Sharma V, Goel P, Kumar S and Singh AK. 2019. An apple transcription factor, MdDREB76, confers salt and drought tolerance in transgenic tobacco by activating the expression of stress-responsive genes. *Plant Cell Reports* **38**: 221-41.

SheshuMadhav M, Aglawe SB, Bangale U, Devi SJSR, Balija V, Bhadana VP, Sharma SK, Kumar S and Prasad MS. 2018. Characterization of Akhanaphou, an unique landrace from North-East India and its RIL population for rice leaf and neck blast resistance. *Current Trends in Biotechnology and Pharmacy* **12**(2): 118-127.

Sikendra K, Prakash C, Chadha NK, Gupta SK, Kalaiselvan K, Jain P and Pandey PK 2018. Effects of dietary Alginic Acid on growth and Haemato-İmmunological responses of *Cirrhinus mrigala* (Hamilton, 1822) fingerlings. *Turkish Journal of Fisheries and Aquatic Sciences* **19**(5): 373-382.

Sinha R, Pal AK and Singh AK. 2018. Physiological, biochemical and molecular responses of lentil (*Lens culinaris* Medik.) genotypes under drought stress. *Indian Journal of Plant Physiology* **23**: 772-84.

Sinha R, Sharma TR and Singh AK. 2018. Validation of reference genes for qRT-PCR data normalisation in lentil (*Lens culinaris*) under leaf developmental stages and abiotic stresses. *Physiology and Molecular Biology of Plants* **25**: 123-34.

Sujatha TP, Singh BK, Bhadana VP and Sharma TR. 2019. CRISPR-Cas9: Editing the Entangled Patent Dispute. *Acta Scientific Agriculture* **3**(5): 63.

Vashi Y, Naskar S, Chutia T, Banik S, Singh AK, Goswami J and Sejian V. 2018. Comparative assessment of native, crossbred and exotic pigs

during different seasons (winter, spring and summer) based on rhythmic changes in the levels of serum cortisol, lactate dehydrogenase levels and PBMC HSP70 mRNA expression pattern. *Biological Rhythm Research* **49**(5): 725-734.

Yugandhar P, Nallamothu V, Panigrahy M, Tipireddy S, Bhadana VP, Voleti SR, Desiraju S, Mangrauthia SK and Neelamraju S. 2018. Nagina 22 mutants tolerant or sensitive to low P in field show contrasting response to double P in hydroponics and pots. *Archives of Agronomy and Soil Science* **64**(14): 1975-1987.

Books

Agrawal S, Yadav RDS, Verma OP, Sharma S, Kumar S, Pandey A, Gautam SC and Mishra GP. 2018. *Numerical examples in breeding and biotechnology*. Pp: 119. Waser Books Publications. ISBN: 978-3-96492-074-4.

Bhadana VP, Santosh GM, Ramesh AN, Kumar R, Kumar A and Kumar M. 2018. *Molecular and Breeding approaches for developing stress compatible genotype*. Pp. 188. Parmar Publisher and Distributors. ISBN: 978-93-84113-28-5

Bhadana VP, Santosh GM, Ramesh AN, Kumar R, Kumar A and Kumar M. 2018. *Molecular and breeding approaches for developing stress compatible genotype, pp*: 01-188. Parmar Publisher and Distributors ISBN: 978-93-84113-28-5.

Bhatt BP, Das B, Bhadana VP, Sinha NK, Mishra JS, Singh H, Giri SP, Kumari M, Ahire LM, Kumar A, Yadav BD, Rani V, Bharti A, Mariappan G, Kariyanna B, Lal M and Brajendra. 2018. *Doubling farmers income through sustainable and harmonious agriculture*. Pp. 239. Jaya Publishing House, New Delhi – 110089. ISBN: 978-93-87590-66-3.

Kumar A, Kumar P, Rani N, Prasad V, Chandra S, Mangrauthia KS, Paswan KA, Kumar R (eds). 2018. *Advances in plant disease management*. Pp: 1-161Waser Books Publications.

Rani V, Srivastava A K, Kumar M, Bahadur R, Kumar N, Kumar R, Jha S, Singh A K and Bara D P. 2018. *Objective Plant Physiology*, pp: 01-105 (First Edition-December, 2018). Weser Books, No. 79737 Aussere, Weberstr. 5702763, Zittau, Germany. ISBN: 978-3-96492-030-0.

Singh G, Rani N, Prasad V, Chandra S, Kumar A and Kumar R. 2018. *Major diseases of crops and their control measure*. Pp: 112. Waser Books Publications.

Sujatha TP, Kumar S, Pandey A, Kumar A, Kumar A and Mishra GP. 2018. *Model short and essay type questions and answers in Biotechnology*. Pp: 119. Weser Books Publications, Germany. ISBN: 978-3-96492-077-5.

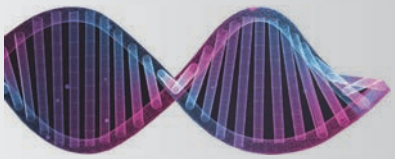
Book Chapters

Bhadana VP, Mahadevaswamy M, Sundaram RM, Kota S, Brajendra and Senguttuvel P. 2018. Breeding strategies for phosphorus management in rice. In: Molecular and Breeding approaches for developing stress compatible genotype. Bhadana VP, Santosh GM, Ramesh AN, Kumar R, Kumar A and Kumar M (eds.) Parmar Publisher and Distributors. Pp. 113-118.

Brajendra, Bhadana VP and Kumar M. 2018. Logistics of breeding for nutrient use efficiency. In: *Molecular and breeding approaches for developing stress compatible genotype*. Bhadana VP, Santosh GM, Ramesh AN, Kumar R, Kumar A and Kumar M. (Eds). Parmar Publisher and Distributors. Pp: 29-42

Brajendra, Bhadana VP, and Kumar M. 2018. Logistics of breeding for nutrient use efficiency. In: *Molecular and Breeding approaches for developing stress compatible genotype*. Bhadana VP, Santosh GM, Ramesh AN, Kumar R, Kumar A and Kumar M (eds) Parmar Publisher and Distributors. Pp. 29-42.

Devi EL, Kumar S, Devi CP, Singh TB, Ningombam A, Sharma SK, Tannia C, Akoijam R, Beemrote A, Singh KR, Singh IM and Prakash N. (2018). Conventional to new plant breeding mehods: A transformation towards precisions and efficient crop



improvement. In: *Protection of forest for sustainable development in Manipur.* Simte G, Infimate L, Hauzel V and Chothe LS (eds). Balaji Publication, pp. 6-13.

Giri SP, Brajendra and Kumar M. 2018. Key soil stresses and rice germplasm tolerance. In: *Molecular and breeding approaches for developing stress compatible genotype*. Bhadana VP, Santosh GM, Ramesh AN, Kumar R, Kumar A and Kumar M. (Eds). Parmar Publisher and Distributors. Pp: 07-17.

Krishnani KK, Kathiravan V, Meena KK, Sarkar B, Kumar S, Brahmane MP, Kumar N and Kailasam M. 2018. Bioremediation of Aquatic toxicants: application of multi-omic approaches, pp 371–398. *Advances in Fish Research*, Vol.-VII, Narendra Publishing House, Delhi, India.

Kumar A, Akhtar J, and Kumar R 2018. Soil solarization: an effective cultural management tool of IPM. In: *Advances in plant disease management*. Kumar A, Kumar P, Rani N, Prasad V, Chandra S, Mangrauthia KS, Paswan KA, Kumar R (eds).Waser Books Publications, pp: 66-76.

Kumar A, Azad CS, Kumar R, and Kumar R. 2018. Radio tracer technique and nanoparticle-based bio-barcode assay in stress management. In: *Advances in plant disease management*. Kumar A, Kumar P, Rani N, Prasad V, Chandra S, Mangrauthia KS, Paswan KA, Kumar R (eds). Waser Books Publications, Pp: 119-124.

Kumar A, Azad CS, Kumar R, and Kumar R. 2018. Trichoderma: a potential biocontrol agent for plant disease management. In: *Advances in plant disease management*. Kumar A, Kumar P, Rani N, Prasad V, Chandra S, Mangrauthia KS, Paswan KA, Kumar R (eds).Waser Books Publications, Pp: 91-95.

Kumar S, Devi EL, Sharma SK, Ansari MA, Roy SS, Ningombam A, Chanu NT, Phurailatpam S, and Prakash N. 2018. Recent advancement in tree improvement for sustainability and high productivity. In: *Protection of forest for sustainable development in Manipur*. Simte G, Infimate L, Hauzel V and Chothe LS (eds). Balaji Publication. Pp. 14-28.

Lal SK, Kumar S, Sheri V, Mehta S, Varakumar P, Ram B, Borphukan B, James D, Fartyal D and Reddy MK. 2018. Seed Priming: An emerging technology to impart abiotic stress tolerance in crop plants. In: *Advances in seed priming*. Rakshit and Singh (eds). Springer, Nature Singapore. Pp: 41-50.

Maharana C, Yashswani CH, and Kumar R. 2018. Role of atmospheric plasma in disease control. In: In: *Advances in plant disease management*. Kumar A, Kumar P, Rani N, Prasad V, Chandra S, Mangrauthia KS, Paswan KA, Kumar R (eds).Waser Books Publications. Pp: 86-90.

Mann A, Singh S, Gurpreet, Kumar A, Pooja, Bishi SK and Kumar B. 2019. Plant Ionomics: An important component of Functional Biology. *Metabolic adaptation in plants during abiotic stress*. Ramakrishna A and Gill SS (eds). CRC Press. Pp.147-154.

Mustaq R, Gill SS, Kaushik S, Singh AK, Ramakrishna A and Sirhindi G. 2019. Current understanding of the role of jasmonic acid during photoinhibition in plants. In: *Metabolic Adaptations in Plants during Abiotic Stress*. Ramakrishna A and Gill SS (eds.). Taylor and Francis Group.

Ningombam A, Basudha Ch, Sailo B, Roy SS, Singh TB, Akoijam R, Beemrote A, Devi ChP, Tania Ch, Kumar S, Sharma SK, Devi EL, Singh KhR and Prakash N. 2018. Conserving biodiversity for preserving ecosystem and a sustainable livelihood. In: *Protection of forest for sustainable development in Manipur*. Simte G, Infimate L, Hauzel V, Chothe LS (eds). Balaji Publication, Pp. 29-42.

P Senguttuvel, Suneetha Kota, Sarvan Raju, Revathi P, Kemparaju KB, Hariprasad AS, Brajendra, Bhadana VP, Padmavathi G, Sreedevi B, Mahendrakumar and Someshekar. 2018. Breeding strategies for aerobic and salinity management. In: Molecular and Breeding approaches for developing stress compatible genotype. Bhadana VP, Santosh

GM, Ramesh AN, Kumar R, Kumar A and Kumar M (eds) Parmar Publisher and Distributors. Pp. 18-28.

Pradhan B, Jangid K K, Sarwat M and Bishi S K. 2019. Role of Histones During Leaf Senescence. *Senescence Signaling and Control in Plants*, Maryam Sarwat and Narendra Tuteja (Eds). Academic Press, Amsterdam. Pp.187-197.

Sarkar B, Daware D, Tribedi P, Bhattacharjee S, Krishnani KK and Minhas PS 2018. Nanotechnology applications in fisheries and aquaculture. Advances in Fish Research Volume-VII, Narendra Publishing House, Delhi, India. Pp. 61–80.

Singh S, Kumar J, Imran M, Kumar M, Singh A N, Tripathi M K, Kumar A. 2018. Bioremediation of pesticides residues: a phycological approach. In: *The Role of Photosynthetic Microbes in Agriculture and Industry.* Tripathi K, Kumar N, Abraham G. (Eds). Nova Science Publishers. ISBN: 978-1-53614-033-0.

Patent

A Provisional patent (Application no. 201931008616) on 'Natural gum based nanocomposite hydrogel having antibacterial and wound healing effects and a method of preparation there of' by S Srivastava, A Roy Chowdhury, B Sarkar, S Bhattacharjee, and KK Sharma has been filed on 5th March, 2019.

Abstracts/ Invited talks in Conference/ Symposium Proceedings

Bhadan VP. 2018. Developing resource use efficient varieties- a step towards doubling farmers' income. National conference on Doubling Farmers' income for sustainable and harmonious agriculture (DISHA) held during August 11-12 at ICAR-IINRG.

Bishi SK, Mahatma MK and Vakharia DN. 2018. Tylose Formation: A Possible Mechanism of Stem Rot Tolerance in Groundnut (*Arachis hypoagaea* L.). Proceedings of 2nd National Conference on Doubling Farmers Income for Sustainable and Harmonious Agriculture (DISHA-2018) at ICAR-IINRG, 11th-12th August-2018.Ranchi.

Bishi SK, Mahatma MK, Thawait LK, Sushmita and Singh AL. 2018. Germination enhances nutritional quality of groundnut by reducing seed phytate. Proceedings of National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, Pg. 91, 7-9 April, 2018, Junagadh (Gujarat), India.

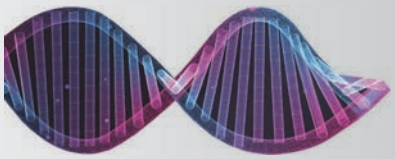
Goel P, Sharma NK, Bhuria M, Sharma V, Chauhan R, Pathania S, Swarnkar MK, Chawla V, Acharya V, Shankar R and Singh AK. 2018. Transcriptome and Co-Expression Network-Guided Identification of Key Regulators of Nitrogen Use Efficiency in *Brassica juncea*. Proceedings of 4th International Plant Physiology Congress 2018. P. 53 December 2018. Lucknow.

Gupta S, Santra L, Agarwal M, Naskar S, Bag S, Ghosh J, Kumar P and Dhara SK. 2018. Long term propagation of porcine mesenchymal stem cells. Proceedings of XXXIV Annual Convention of the Indian Society for Study of Animal Reproduction (ISSAR) and International Symposium on 'Productivity enhancement through augmenting reproductive efficiency of livestock for sustainable rural economy'. Dec 28-30, 2018. Anand Agricultural University, Anand, Gujarat.

Gupta SK, Sarkar B and Naskar S. 2019. Gut microbiota and immune responses in *Lates calcarifer* (Bloch,1970) fry fed a mixture of non-fish meal ingredients. 2nd international conference on frontiers in Biological, Environmental and medical research, March,7-9,2019

Kumar R, Lal SK, Singh BK, Kumar S, Pandey A, Kumar M, Kumari R, Sarkar B and Bhadana VP. 2018. Identification of novel resistance sources: a key to management of biotic stresses in rice. In: 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture, 11-12th August, 2018, Ranchi. P: 72.

Kumar S, Pandey A, Singh BK, Kumar M, Kumar R and Bhadana VP. 2018. Horsegram: Improving nutritional security in Jharkhand. In: 2nd National



Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture, 11-12th August, 2018, Ranchi. P: 118

Mahatma MK, Thawait LK, Jadav JK, Rathod KJ, Bishi SK, Singh AL, Rathanakumar AL and Kumar N. 2018. Identification of bioactive polyphenols in groundnut kernels using LC-MS/MS. Proceedings of International Conference on "Global Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2018) October 28-30, 2018, RARI, Durgapura, Jaipur (Rajasthan)

Puran A, Gupta SK, Kumar R, Jha BK, Kumar PR, Kumar N, Sinha NK, Das B and Naskar S. 2018. Enhancing food, nutritional and livelihood security of marginal and small farmers in Jharkhand through need based agricultural technologies. Proceedings of International Symposium and 8th Conference of Indian Meat Science Association (IMSACON-VIII) on 'Technological innovations in muscle food processing for nutritional security, quality and safety'. Nov 22-24, 2018. West Bengal University of Animal and Fishery Sciences, Kolkata.

Raval SS, Mahatma MK, Chakraborty K, Rathod V, Tomar RS, Nogiya R, Bishi SK, Singh AL, Golakiya BA. 2019. Transcriptomics of contrasting groundnut genotypes under varying temperature regimes. Proceedings of Food and Nutritional Conclave, Pp.25-27, 2019 MPKV, Rahuri.

Sarkar B, Chowdhury AR, Gupta SK, Sheel R and Srivastava S. 2019. Silver nanoparticles: a silver lining in aquaculture research. 2nd International Conference on Frontiers in Biological, Environmental And Medical research during 7-9 March, 2019 at Burdwan, West Bengal. P. XV.

Sarkar B, Chowdhury AR, Gupta SK and Sheel R. 2019. Development and Evaluating the Immunomodulatory, photo-catalytic and anti-microbial role of zinc oxide nanoparticles in fish cultured at stressed conditions. Golden jubilee international conference Trends in Zoology during January 03-04, 2019 at Burdwan, West Bengal. P. 14.

Sarkar B, Kumar R, Choudhury AR, Gupta SK, Pandey A, Kumar S, Singh BK and Bhadana VP. 2018. Nanotechnology: A key to doubling farmer's income. In: 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture, 11-12th August, 2018, Ranchi. P: 143.

Singh AK, Kumar G, Gupta K, Arya P, Rattan UK,Swarnkar MK, Randhawa V, Pathania S, Acharya V. 2018. Chilling Mediates Major Transcriptional and Epigenetic Reprogramming During Bud Dormancy in Apple. Proceedings of 6th Plant Dormancy Symposium. P. 22 October 2018. Kyoto, Japan.

Singh AK, Kumar G, Gupta K, Swarnkar MK, Rattan UK, Arya P, Randhawa V, Pathania S, Acharya V. 2018. Understanding molecular regulators of chilling-mediated bud dormancy release in apple through genomics approaches. Proceedings of 9th International Rosaceae Genomics Conference. P. 26 June 2018. Nanjing, China.

Singh AK. 2018. Genomics-Guided Approaches for Climate Resilient Crops. Proceedings of 4th Worldwide Universities Network (WUN) workshop on Climate Resilient Open Partnership for Food Security. P. 19 December 2018. New Delhi.

Singh AK. 2018. Understanding plant response under climate change: a genomics perspective. Proceedings of International Conference on Plant Genetics and Genomics: Next Gen Crops for Sustainable Agriculture. P. 18 July 2018. Chandigarh.

Singh AK. 2019. Plant Tissue Culture and Genetic Transformation for Crop Improvement. Proceedings of 40th meeting of Plant Tissue Culture Association-India (PTCA-I) & International Conference on Trends in Plant Sciences and Agrobiotechnology-2019. P.February 2019. Guwahati.

Singh AK. 2019. Understanding Regulatory Network of Nitrate Uptake and Assimilation in *Brassica juncea*. Proceedings of South Asia Biotechnology Conference-2019. P. 29 March 2019. New Delhi.

Singh AL, Bishi SK, Sushmita, Chaudhari V and Patel CB. 2018. Climate resilient groundnut cultivars for various rain-fed situations in India. Proceedings of National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, Pg. 19, 7-9 April, 2018, Junagadh (Gujarat), India.

Singh AL, Chaudhari V, Sushmita, Patel, CB, and Bishi SK. 2018. Zn biofortification in groundnut through various Zn-sources. Proceedings of National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, Pg. 149, 7-9 April, 2018, Junagadh (Gujarat), India.

Singh DK, Pandey A, Choudhary SB, Kumar S, Kumar M, Kumar R, Bhadana VP and Singh BK. 2018. Relying on the natives: a key to sustainable income base for the tribal farmers of Jharkhand. In: 2nd National Conference on Doubling of Farmer Income for Sustainable and Harmonious Agriculture, 11-12th August, 2018, Ranchi. P: 62

Sujatha TP and Jayakrishna T. 2019. Epigenetic, cytogenetic and genetic regulation of sex expression in castor (Ricinus communis L). XIV agricultural Science Congress, Innovations for Agricultural Transformation. 20-23 February 2019, NASC complex, New Delhi.

Sujatha TP. 2018. Developmental alterations determining sex lability in castor (*Ricinus communis* L) in ISGPB 2018. Book of Abstracts, 1st National Genetics Congress on Genetics for Sustainable Food, Health and Nutrition Security. pp. 197. 14-16 December 2018, ICAR-Indian Agricultural Research Institute, New Delhi.

Sujatha TP. 2018. Differentially Expressed Genes involved in sex determination in Castor. in 2nd National Conference on Doubling Farmers Income for Sustainable and Harmonious Agriculture DISHA 2018, 11-12 August 2018, ICAR-IINRG, Ranchi

Thawait LK, Mahatma MK, Bishi SK and Dagla MC. 2018. Soaking and roasting alter sugar composition and bioactive compounds of groundnut. Proceedings of National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, Pg. 169, 7-9 April, 2018, Junagadh (Gujarat), India.

Vashi Y, Naskar S, Chutia T, Banik S, Singh AK, Goswami J and Sejian V. 2018. Physiogenomic comparison of native, crossbred and exotic pigs during different seasons. Proceedings of XXV Annual Convention and National Conference VIBCON-2018 on 'Innovative Biotechnological Approaches for Improving Animal Health and Productivity'. Oct 30 - Nov 1, 2018. ICAR-National Research Centre on Mithun, Medziphema, Nagaland.

Vashi Y, Naskar S, Chutia T, Banik S, Singh AK, Goswami J and Sejian V. 2018. Comparative assessment of native, crossbred and exotic pigs during different seasons based on levels of hormone and gene expression relevant to pig production. Proceedings of XXVII Annual Conference of Society of Animal Physiologists of India & National Symposium (SAPICON-2018) on 'Augmentation of Animal Productivity under Changing Socio-Economic Scenario'. Nov 27-28, 2018. ICAR-NDRI, Karnal.

Technical bulletin/ article

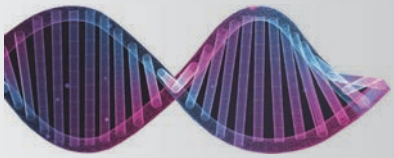
Pandey A, Kumar S, Kumar R, Sujatha TP, Kumar M, Singh BK and Bhadana VP. 2018. Rice Cultivation in Jharkhand. ICAR- Indian Institute of Agricultural Biotechnology, Garkhatanga. *ICAR-IIAB Technical Bulletin No. 01*. Pp: 01-31

Naskar S. 2018. Genomic selection in livestock: Indian context. In: Compendium of ICAR-sponsored Winter School entitled 'Climate change and pig production system: Impacts and mitigation strategies' (Nov 01-21, 2018). ICAR-National Research Centre on Pig, Guwahati.

Popular article

आशीष कुमार राउत एवं ऋषिकेश कुमार (2018). पर्यावरण डीएनए: पूर्वकालिक एवं वर्त्तमान जैवविविधता के संरक्षण की उभरती तकनीक. लाक्षा 10(1): 51–52.

Sujatha TP, Ahmad I, Singh BK, Kumar M, Kumar R,



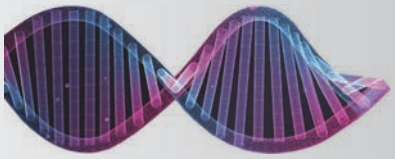
Kumar S, Pandey A, Bhadana VP, Srinivasan R, and Sharma TR. 2018. Genome editing using CRISPR-Cas 9: another band wagon or an essential tool for genetic improvement. ICAR-IIAB Newsletter, July-Dec, 2018. Pp: 08.

Paria A, Vinay TN, Gupta SK, Choudhury TG and Sarkar B. 2018. Antimicrobial Peptides: A Promising Future Alternative to Antibiotics in Aquaculture. *World Aquaculture*. Pp: 67.

Budget Allocation and Utilization

(Figure in lakhs)

Sl. No.	Head	Total allocation 2018-19	Expenditure 2018-19			Total expenditure
			TSP	SCSP	Other than NEH & TSP	
A.	**Capital** (Grants for creation of Capital Assets)					
1	Works					
	Building: Office building	2424.23		23.20	2191.95	2423.92
2	Equipments	120.41		25.90	94.26	120.16
3	Information Technology	5.50			4.56	4.56
4	Library Books and Journals	5.00			4.95	4.95
5	Vehicles & Vessels	12.00			11.89	11.89
6	Furniture & fixtures	5.00			4.82	4.82
	Total	2572.14	0	257.87	2312.44	2570.32
B.	**Establishment Expenses** (Salaries)					
	Establishment Charges	339.50			315.08	339.37
	Total	339.50	0	0	315.08	315.08
1.	T.A.					
	Domestic TA / Transfer TA	11.20			11.13	11.13
	Total	11.20			11.13	11.13
2.	Research & Operatinal Expenses					
	i. Research Expenses	8.85			7.37	7.37
	ii. Operational Expenses	25.85			24.13	24.13
	Total	34.70			31.51	31.51
3.	Administrative Expenses					
	A. Infrastructure	60.15			62.68	62.68
	B. Communication	0.80			0.68	0.68
	C. Repair & Maintenance					
	i. Equipments,Vehicles & Others	1.40			1.41	1.41
	ii. Minor Works	3.27			3.26	3.26
	D. Others (excluding TA)	25.60			26.36	26.36
	Total	91.22			94.41	94.41
4.	Miscellaneous Expenses					
	i. HRD	2.73			2.71	2.71
	ii. Publicity & Exhibitions	1.00			1.00	1.00
	iii. Other Miscellaneous	45.38	24.97	20.36	0	45.33
	Total	49.11	24.97	20.36	3.71	49.05
	Total -- Grants in Aid - General	186.23	24.97	20.36	140.77	186.11
	Grand Total (Capital + Establishment + General)	3097.87	24.97	278.24	2768.31	3095.81
5.	Swachh Bharat Mission					4.60



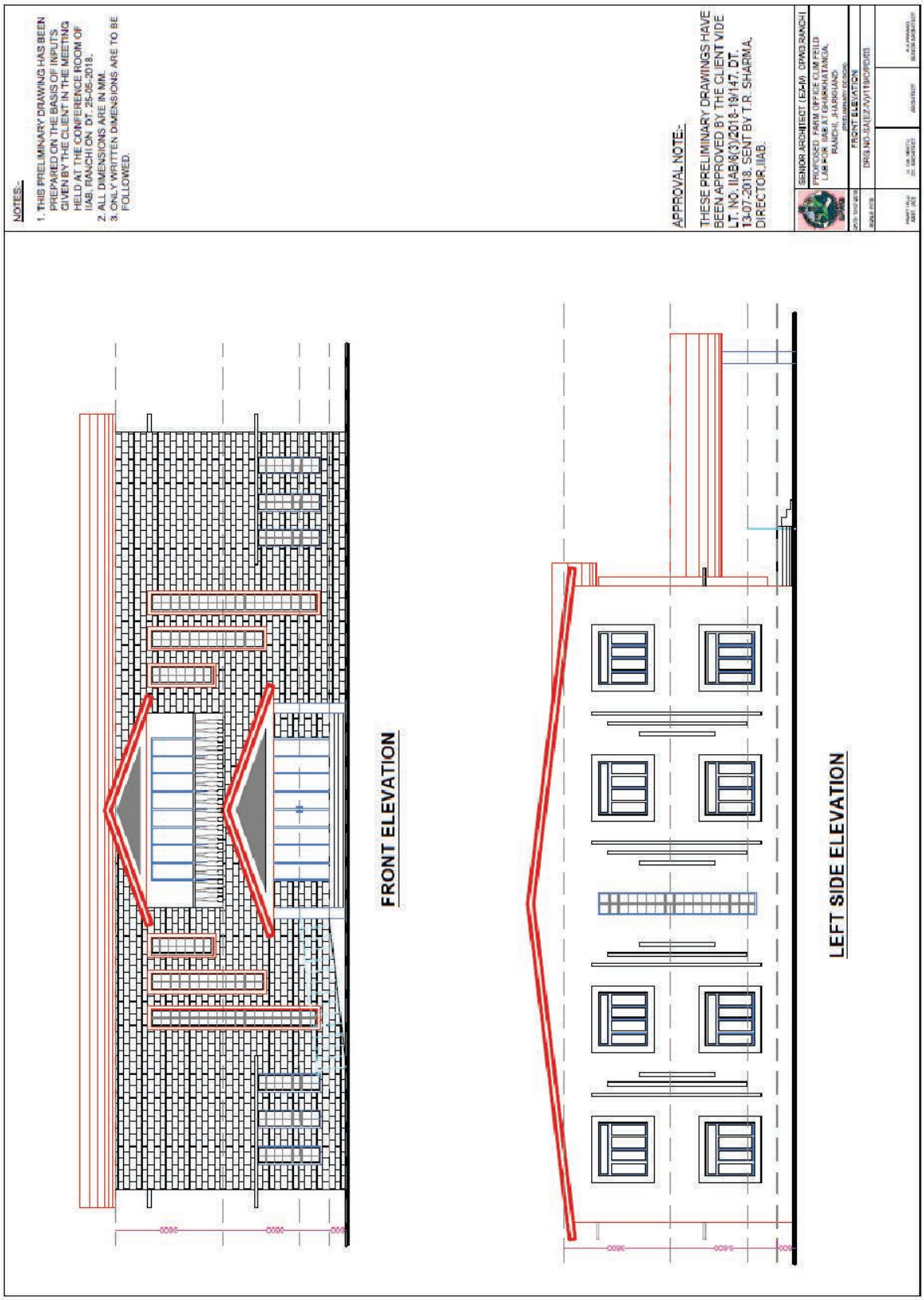
Important Committees

Research Advisory Committee	
Prof. VL Chopra, Former Secretary, DARE & DG, ICAR, New Delhi	Chairman
Prof. K Veluthambi, Former Head, Department of Plant Biotechnology, School of Biotechnology, Madurai Kamraj University, Madurai, Tamil Nadu	Member
Prof. KR Koundal, Former Joint Director (Research), IARI & Scientist Emeritus, NRCPB, New Delhi	Member
Dr. WS Lakra, Former Director, ICAR-Central Institute of Fisheries Education, Mumbai	Member
Dr. BP Mishra, Joint Director (Research), ICAR-Indian Veterinary Research Institute, Izzatnagar, Bareilly, UP	Member
Prof. HS Dhaliwal, Vice-Chancellor, Eternal University, Baru Sahib, Sirmour, Himachal Pradesh	Member
Dr. TR Sharma, Director, 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. VP Bhadana, Principal Scientist, IIAB, Ranchi	Member Secretary
Institute Management Committee (IMC)	
Dr. TR Sharma, Director, IIAB, Ranchi	Chairman
Dr. Kishor Gaikwad, Principal Scientist, NRCPB, New Delhi	Member
Dr. JC Rana, Head, Division of Germplasm Evaluation, NBPGR, New Delhi	Member
Dr. Vindhya Mohindra, Head, Fish Conservation Division, NBFGR, Lucknow	Member
Dr. Anil Rai, Head, IASRI, New Delhi	Member
ADG (Seeds) ICAR, New Delhi	Member Secretary
Institute Research Committee (IRC)	
Dr. TR Sharma, Director, IIAB, Ranchi	Chairman
All Scientific Staff of IIAB, Ranchi	Member
Dr. S Naskar, Sr. Scientist, IIAB, Ranchi	Member Secretary
Quinquennial Review Team (QRT)	
Prof. Akhilesh K Tyagi, Department of Plant Molecular Biology, University of Delhi, South Campus.	Chairman
Dr. R Srinivasan, Ex-Professor, ICAR-NRCPB, New Delhi	Member
Dr. VG Malathi, Adjunct Faculty, TNAU, Coimbatore	Member
Dr. Iddya Karunasagar, Senior Director (International Relations), NITTE, Mangaluru	Member
Dr. BK Singh, Sr. Scientist, IIAB, Ranchi	Member Secretary

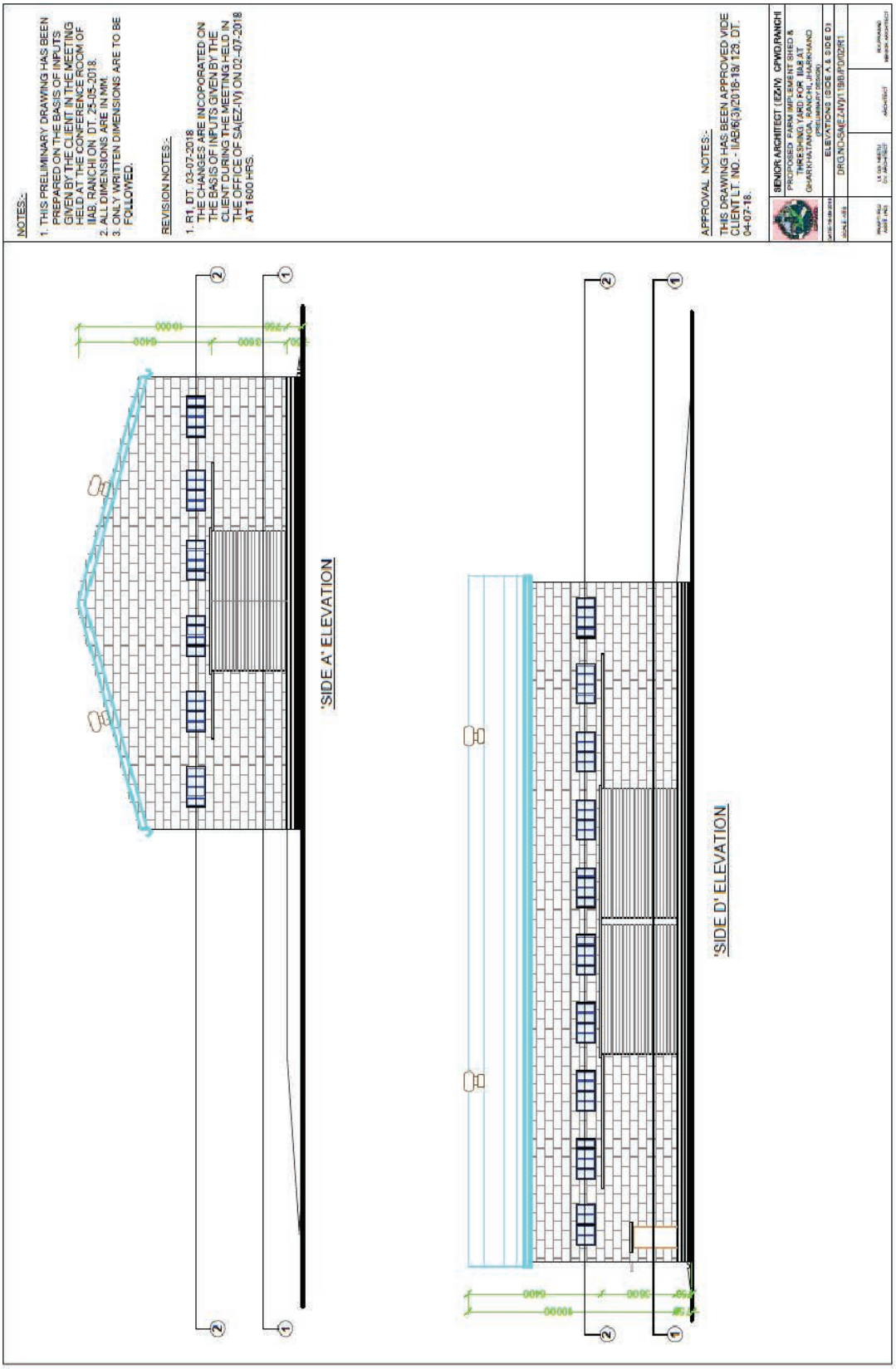
Distinguished Visitors

Sl. No.	Name	Designation	Date of Visit
1.	Dr. DKYadava	ADG (seeds) ICAR	30th May, 2018
2.	Dr. JC Rana	National Coordinator, United Nations Environment, GEF Project	30th May, 2018
3.	Dr. Kishor Gaikwad	Principal Scientist, NRCPB, New Delhi	30th May, 2018
4.	Dr. Vindhya Mohindra	Head, Fish Conservation Division, NBFGR, Lucknow	30th May, 2018
5.	Dr. Anil Rai	Head, ICAR-IASRI, New Delhi	30th May, 2018
6.	Dr. Trilochan Mohapatra	Secretary DARE and Director General, ICAR	26th Aug, 2018
7.	Dr. Anand Kumar Singh	DDG (CS and HS), ICAR	26th Aug, 2018
8.	Dr. DK Yadava	ADG (seeds), ICAR	26th Aug, 2018
9.	Dr. RK Singh	ADG, ICAR	26th Aug, 2018
10.	Dr. NP Singh	Director, ICAR-IIPR, Kanpur	13th Sept 2018
11.	Sh. Sanjay Agarwal	DGM and Additional Chief Vigilance Officer SAIL Research and Development, Ranchi	3rd Nov, 2018
12.	Prof. VL Chopra	Former Secretary, DARE & DG, ICAR, New Delhi	29th Nov, 2018
13.	Prof. K Veluthambi	Former Head, Department of Plant Biotechnology, School of Biotechnology, Madurai Kamraj University, Madurai, Tamil Nadu	29th Nov, 2018
14.	Prof. KR Koundal	Former Joint Director (Research), IARI & Scientist Emeritus, NRCPB, New Delhi	29th Nov, 2018
15.	Dr. WS Lakra	Former Director, ICAR-Central Institute of Fisheries Education, Mumbai	29th Nov, 2018
16.	Dr. BP Mishra	Joint Director (Research), ICAR-IVRI, Izzatnagar, Bareilly, UP	29th Nov, 2018
17.	Prof. HS Dhaliwal	Vice-Chancellor, Eternal University, Baru Sahib, Sirmour, Himachal Pradesh	29th Nov, 2018
18.	Dr. Kuldeep Singh	Director, ICAR-NBPGR, New Delhi	06th Dec 2018
19.	Dr. Jagdish Kumar	Director (Actg.) ICAR-NIBSM, Raipur	26th Dec 2018
20.	Prof. Akhilesh K Tyagi	Department of Plant Molecular Biology, University of Delhi, South Campus.	11th Jan, 2019
21.	Dr. R Srinivasan	Ex-Professor, ICAR-NRCPB, New Delhi	11th Jan, 2019
22.	Dr. VG Malathi	Adjunct Faculty, TNAU, Coimbatore	11th Jan, 2019
23.	Dr. Iddya Karunasagar	Senior Director (International Relations), NITTE, Mangaluru	11th Jan, 2019
24.	Dr. Santosh Kumar Singh	Senior Agricultural Specialist at the USDA/ Foreign Agricultural Service, New Delhi.	17th Jan, 2019
25.	Dr. Nitin Kulkarni	Director, Institute of Forest Productivity, Ranchi	18th Feb, 2019

Field Crop Research & Training Centre



Farm Implement Shed & Threshing Yard



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