अनुसंधान सलाहकार समिति
की
छठवीं बैठक

6th MEETING
OF
RESEARCH ADVISORY COMMITTEE

12th July, 2021

ICAR-National Institute of Biotic Stress Management

Baronda, Raipur - 493225, Chhattisgarh

Telephone (0771) 2225352, Fax (0771) 2225351

Website: nibsm.icar.gov.in

CONTENTS

Introduction

The Veerappa Moily Oversight Committee on the implementation of the reservation in higher educational institutions for **expansion, inclusion and excellence,** recommended the establishment of a dedicated research institute of Deemed-to-be-University Status on Biotic Stress Management. This was included in the proposal on establishment of “National Institute of Biotic Stress Management” at Raipur put up by the Department of Agriculture Research and Education (DARE), Ministry of Agriculture to Cabinet in XII plan. The legal status of the National Institute of Biotic Stress Management (NIBSM) is Deemed-to-be-University.

The Expenditure and Finance Committee approved 12th five-year plan outlay of National Institute of Biotic Stress Management for Rs 121.10 cr. on 3rd March, 2012 and the Cabinet approval was subsequently granted in May, 2012. After the approval of EFC proposal for the 12th plan outlay of the Institute on 3rd March, 2012, the inspection visit of the identified land by the Site Selection Committee was done on 19th March, 2012. The Foundation Stone of the ICAR-NIBSM at Raipur (Chhattisgarh) was laid on 7th October, 2012 by the then Hon’ble Union Minister for Agriculture and Food Processing Industries, Shri Sharad Pawar in the presence of Dr. Raman Singh, then Hon’ble Chief Minister of Chhattisgarh.

Initially NIBSM office started at IASRI (sub campus of NCIPM) till May 2013. Later in June 2013, Administrative office was shifted from IASRI to DSW office of Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, where four rooms were allotted to run the NIBSM office. Meanwhile the Chhattisgarh government handed over 50.179 ha land of the erstwhile Dr. Richharia Research and Instructional Farm of IGKV located in the village Baronda, tehsil Tilda (Raipur) to ICAR-NIBSM. Dr. Radheylal Hirelal Richharia, Rice Specialist of the undivided Madhya Pradesh established this research centre that later came under IGKV. The land is fertile and has various edaphic and pedological characteristics that can be utilized in the biotic stress research on crops and animals. Subsequently, existing buildings at Baronda farm were put under renovation for sitting and laboratory space for scientists from where research and infrastructure development work is going on presently.

The Institute is located at Baronda village of district Raipur (Chhattisgarh) about 30 km from the Railway station, Raipur.

2. Action Taken Report on 5th RAC Proceedings

The recommendations of the 5th RAC meeting of the ICAR-NIBSM held on 21st November 2020 and the actions taken thereon:

S. No.	Recommendations	ICAR Comments	Action Taken
A. Infrastructure and manpower			
1	NIBSM should develop state-of-the art laboratory facilities to attract the researchers from other Institutes/universities as well. A model farm suitable to undertake novel biotic stress management research needs to be developed.	Agreed	The budget provisions have been kept in the new EFC (2021-26) for establishing state-of-the-art laboratories as well as the model farm development.
2.	Utmost importance be given to induct the sanctioned staff (Scientific, administrative and technical) which has been emphasized by RAC in its all meetings because this is related to quality research and education and timely delivery and expected outcomes. A follow-up with appropriate departments shall be taken up on priority.	Agreed	The case of creation of 183 posts of scientific, administrative & technical cadres has been pursued at appropriate level. Cadre for administrative posts has been finalized recently and NIBSM may get 39 different posts very soon. Immediate transfer of PS (DR) is also under negotiation with at ICAR HQ.
B. Research			
1.	NIBSM should shift its research and teaching from *Section-mode* to *School-mode* (as notified in the Cabinet note). This is also related to deployment of more scientific manpower to fulfill minimum scientific cadre strength in each school. Thrust areas for these schools needs to be precisely formulated and accordingly major research programmes need to be devised considering national priorities and recommendation of various committees (RAC, QRT, IRC). These must be of inter-disciplinary and inter-institutional in nature. Suitable	Agreed	The major programmes (3 flagship, 3 inter-institutional and 3 institutional) have been formulated for 4 schools of the Institute based on the recommendations of the committees, SDG's and national programmes. Considering the present scientific strength, a few programmes have been prioritized to be taken up are given below **Flagship programmes** 1. Forewarning and estimation of crop losses 2. Novel genes discovery and validation for pest resistance 3. Establishment of National Strategic Crop Health Monitoring Network (NSCHMN)

	provisions be included in the forthcoming EFC (2021-2026).		**Inter-Institutional Programmes** 1. Climate change effects on chemical ecology and One Health parameters 2. Ecological foundation of pest dynamics and their control in emerging production systems. These programmes have been presented in the ICAR EFC presentation and bears in-principle approval of the SMD and ICAR
2.	Work-load of the scientist may be reviewed. Projects should be proportionate with the available scientific manpower. Accordingly, prioritization and clubbing of the project be made.	Agreed	New programmes/projects are being formulated on priority and keeping scientific manpower in view. Most of the institute projects are concluding. Engagement of scientists in projects of forthcoming EFC programmes will revise the work load of Scientists to the general workload formula of 1PI + 2 Co-PI
3.	Basic studies must be taken up to understand common philosophy of stress tolerance (individual as well as combined effects of biotic and abiotic stresses) in group of crop plants, especially underutilized crops (dryland crops, pulses, oil seeds, millets, fodders etc.).	Agreed	Discussed to make Collaboration for identification of promoters and regulatory elements upon induction of biotic and abiotic factors and molecular mechanism with NIASM. The collaboration has been incorporated in the programmes of SCHBR (Ecological foundation of pest dynamics) and SCRSR (Novel genes discovery).
4.	The Institute should study the dynamics of biotic and abiotic stresses, resource availability effects and their interactions under emerging agriculture systems (eg. conservation agriculture, organic farming etc.).	Agreed	An inter-institutional project entitled Ecological foundation of pest dynamics and their control in emerging production systems has been prepared to be taken up from IRC 2021, including established systems of Conservation Agriculture and Organic farming (sites at Karnal, Delhi and Umiam).
5.	Detailed basic research need to be conducted on available leads with NIBSM, including the stress induced promoters, virus transmission, kairomones, silicon induced tolerance, endophytes, gene-editing, epigenetics, super-donors, etc. to understand their molecular basis. Emphasis should be given on pre-breeding and use of innovative methods like genome editing for development/utilization of elite mutants for stress tolerance.	Agreed	Detailed study on identification of stress induced promoters (*IFS1* in MYMIV resistant genotypes of soybean and mungbean), virus transmission efficiency of whitefly genetic groups, silicon induced tolerance against yellow stem borer in rice and pink stem borer in wheat, gene editing on *IFS1* gene in soybean, epigenetic regulation in chickpea dry root rot, super donors in rice is being continued as part of project activity, alternatively, they are included as resources and experimental material in the newly formed programmes/projects.

6.	Research projects may be taken up on areas targeting early and rapid diagnosis of biotic stresses in crop plants using novel and emerging technologies (such as gene-editing, acoustics, eNose etc.).	Agreed	Project has been started to take up gene editing on isoflavone synthase 1 in soybean for enhance tolerance to begomovirus., Additionally, a gene-editing and other novel technologies are being addressed in a project on validation and product development under Novel Gene discovery flagship project. To address ideas including acoustics and eNose etc., a programme on chemical ecology/plant volatiles is being developed in School of Crop Health Management Research. Additionally, Concept notes have been prepared for development of eNose with IIIT, Raipur. A brain storming session on "Recent approaches and prospects of utilizing plant volatiles for plant protection" was conducted on 24.06.21 having participation of seven institutes, including researchers working in the fields of crop biology, entomology, chemical ecology, electrochemistry, nano-technology, engineering and A.I.
7.	The institute should design programme on *One Health* concept and also on *Artificial Intelligence* (AI) as these are priority areas under India's national strategies.	Agreed	A flagship programme on Forewarning and estimation of crop losses using AI approaches is proposed in the EFC. Programme on One Health has been taken up as flagship programme on Climate change effects on chemical ecology and one health parameters.
8.	Collaborate research work in areas of mutual research interest viz; combined tolerance of abiotic and biotic stress, development of super donor, e-NOSE etc., especially with two contemporary institutes, ICAR-NIASM, Baramati and ICAR-IIAB, Ranchi. Both short-term as well as long-term projects may be formulated. This should also involve sharing of ideas, research and core resources (i.e. equipment, labs/facilities etc.), and conduct of regular meetings/workshops of participating researchers. Collaboration with IPFT, Gurugram having all modern facilities for product formulation development and testing of bio pesticides and other pesticides in larger scales as one of the testing centre would be useful.	Agreed	The collaboration with ICAR-NIASM for identification of promoters and regulatory elements between biotic and abiotic stress in crops, ICAR-IIAB for developing super donor in rice crop is being developed. Collaboration proposal accomplished with IPFT, Gurugram for developing formulation for Kairamone and analysis of compounds from Chromobacterium. MoU also signed collaborative research and teaching programmes with these institutes.

9.	In the years to come, NIBSM with required infrastructure and manpower facilities should come up as centre of excellence in plant protection research and education. Therefore, a proposal document on the Hub and Spoke model for 'Entrusting NIBSM with a role of nodal institute of plant protection research in ICAR' be immediately prepared and submitted to the ICAR.	Agreed	A proposal on the Hub & Spoke model for plant protection research in the country has been prepared and submitted to the SMD (CS) and ICAR, and is under discussion at various levels. Proposal also included and discussed in the EFC (2021-26) presentation.
10.	Policy research on biotic stress is very important and should be taken on priority. A policy document on agro-losses due to biotic stresses, biosafety of product and map of invasive pests in and around the country is necessary to initiate preparedness to counter biosecurity threats. Similarly, a document on Good Agricultural Practices (GAP) for various biotic stresses in agriculture should be prepared by the Institute.	Agreed	Establishing a National Strategic Crop Health Monitoring Network has been proposed in the EFC (2021-26) to monitor diseases and pests to keep ahead of the biotic challenges in view of the changing climate and pathogen/pest scenario as well as transboundary invasions. A project on pest-risk analysis shall be taken up from this year where mapping of potential invasive pests is one of the major objectives. Preparation of documents on GAP and losses from biotic stresses has been initiated.
C. Education			
1.	ICAR-NIBSM should expand education activities in post graduate courses in view of requirement of Multidiscipline Education and Research University (MERU) of new education policy of the government and prepare a roadmap to attain it by 2030.	Agreed	PG Courses started in 6 major disciplines related to biotic stress management. During academic session 2020-21. Compiled potential topics for diploma and certificate courses. An education roadmap-2030 will be finalised in consultation with peer group through a workshop.
2.	ICAR-NIBSM should conceive an Inter-University Centre for Biotic stresses to collaborate with various SAUs and research institutes.	Agreed	Internal discussion has been conducted to conceptualize the Inter-University Centre. The institute has collaboration with IGKV and CGKV, Raipur, JNKV, Jabalpur, Pandit Ravishanker University, Raipur. The concept on Inter-University Centre will be taken up once the state-of-the-art facilities are established.
3.	A committee may be formulated to strengthen the education system of NIBSM, NIASM and IIAB with an aim to develop new courses and detailed plan of implementation. New courses like molecular	Agreed	Board of Studies for ICAR-NIBSM has been constituted. Two new courses on Biotic stress management and Plant health management are conceptualized.

	diagnostics, biosecurity and biosafety, nanotechnology-based pesticides/ biopesticides, epidemiological studies on transboundary and emerging pests etc. which are compatible with Govt. policy, should be designed and executed. The approval of these unique courses should be sought from ASRB/ICAR for job opportunities.		Further necessary action in consultation with Board of Studies of NIASM and IIAB will be initiated.

3. Vision, Mission and Mandate

VISION

Effective mitigation of biotic stresses for enhancement of farm prosperity

MISSION

Alleviating biotic stresses for increased agricultural production

MANDATE

1. Basic, strategic and adaptive research on biotic stresses in agriculture.
2. Development of quality human resources for academic excellence, linkage with various stakeholders for technology management and policy support research.

4. Organization and Structure

The Institute is headed by the Director & Vice-Chancellor and have four schools. The four schools shall be headed by the Joint Directors which in addition to research, will also takeover post-graduate, doctoral and post-doctoral research and teaching. The overall research and teaching mandate shall be managed by Joint Director (Research) and Joint Director (Education), respectively. As per the Cabinet Approval, the Institute has following four schools:

School 1. Crop Health Management Research (CHMR)
School 2. Crop Health Biology Research (CHBR)
School 3. Crop Resistance System Research (CRSR)
School 4. Crop Health Policy-support Research (CHPR).

The Institute had recommendation of 200 posts from the Expenditure & Finance Committee. Out of these, so far 17 posts of scientists including Director (1), Joint Directors (6), and Principal scientists (10) have been approved and created. The rest 183 posts of different cadre including Scientists (50), Technical Staff (77) and Administrative Staff (56) are taken up with the Council and Department of Expenditure, Ministry of Finance for creation of the posts.

Present Staff position at the Institute

Presently, the Institute has two regular RMP posts filled, including the Director, and the Joint Director (Research), two Acting Joint Directors, viz. JD- JD-Education and JD-School of Crop Health Biology Research, as well as 18 Scientists representing different disciplines. ICAR has also given the additional charge of Senior Administrative Officer to SAO-CICR (Nagpur) and I/C FAO to a Principal Scientist (NIBSM).

Present available Scientific strength at NIBSM and their ARS disciplines

Cadre	Discipline	Number
Principal Scientist (7)	Plant Pathology	1
	Agricultural Entomology	2
	Agricultural Microbiology	1
	Agronomy	1
	Land and Water Engineering	1
	Agricultural Biotechnology	1
Senior Scientist (4)	Agricultural Biotechnology	1
	Veterinary Pathology	1
	Fish & Fisheries Science	1
	Veterinary Microbiology	1
Scientist (7)	Agricultural Biotechnology	1
	Agricultural Entomology	3
	Agricultural Extension	1
	Plant Biochemistry	1
	Animal Genetics & Breeding	1
	Total	**18**

Following the Cadre Review recommendations from the ICAR, the revised strength of the Scientific Cadre has been proposed for approval in the new EFC/SFC (2021-26)

S. No.	Discipline	Principal Scientist/ Professor*	Senior Scientist/ Associate Professor	Scientist/ Assistant Professor	Total
1.	Agronomy	1	1	2	**4**
2.	Agricultural Entomology	2	3	4	**9**
3.	Plant Pathology	2	3	4	**9**
4.	Nematology	-	-	2	**2**
5.	Agricultural Biotechnology	2	1	4	**7**
6.	Bioinformatics	1	1	1	**3**
7.	Agricultural Microbiology	1	1	1	**3**
8.	Plant Physiology	-	1	1	**2**
9.	Soil Sciences	-	1	-	**1**
10.	Agricultural Chemicals	-	1	1	**2**
11.	Plant Biochemistry	-	1	1	**2**
12.	Agricultural Statistics/ Agricultural Physics	-	-	2	**2**
13.	Genetics and Plant breeding	1	1	3	**5**
14.	Veterinary Microbiology	-	-	1	**1**
15.	Fisheries Resource Management	-	-	1	**1**
16.	Veterinary pathology	-	-	1	**1**
17.	Seed science and seed technology	-	1	-	**1**
18.	Agricultural Economics	-	1	1	**2**
19.	Vegetable Science/ Fruit Science	-	-	1	**1**
20.	Agricultural Extension	-	1	1	**2**
	Total	**10**	**18**	**32**	**60**

* 10 PS posts and disciplines already approved and created

5. Research initiatives, Projects and achievements

5.1 *Programme mode of research*: Four research programmes (divided into sub-programmes) were formulated for proper management of the research considering the thrust areas and the research mandate of the Institute and were undertaken in four sections *viz*., Entomology & Nematology, Pathology & Microbiology, Biotechnology, and Resource Management & Technology Transfer (earlier named as Analytical and weed science) till March 2021.

Prog	Programme title	Sub-programme
1	Pest and pathogen genetic resources (PPGR) and their management	1.1 Collection, Cataloguing and Characterization 1.2 Screening 1.3 Differentials (development/procurement)
2	Molecular biology of biotic stress reaction	2.1 Host pathogen interactions 2.2 Molecular markers 2.3 Molecular approaches to understand gene functions and stress induced promoters
3	Genetic and molecular resources for stress tolerance	3.1 Germplasm screening for mapping biotic stress tolerance 3.2 Interspecific diversity and Alien introgressions 3.3 Novel biomolecules in biotic stress tolerance
4	Strategic and adaptive research in biotic stress management	4.1 Allelopathy and nano-biosensors 4.2 Management strategies for addressing Biotic stresses 4.3 Entomological aspects including pheromones/ kairomones

Research projects at ICAR-NIBSM, Raipur

A. Institute Funded Projects - Ongoing projects during 2020-21

S. No.	Programme	Project code	Project title	Duration
1	Pest and pathogen genetic resources (PPGR) and their management	1.3	Mapping of genetic groups of *Bemisia tabaci* in India and their begomovirus transmission efficiency	2018-21
		1.4	Identification and characterization of bacteriophages against rice bacterial leaf blight pathogen *Xanthomonas oryzae* pv. *oryzae*	2018-21
		1.5	Exploring host-microbial cross talk in agro-ecosystem of Bastar plateau zone of Chhattisgarh	2018-21
2	Molecular biology of biotic stress reaction	2.2	Identification of biotic stress induced promoters from resistance source plants	2017-22
		2.3	Development of super donors in rice carrying tolerance to multiple stresses (Bacterial leaf blight, Brown plant hopper and Blast)	2017-22
		2.4	Epigenetic regulation of microRNA genes in response to *Fusarium* stress in chickpea	2018-21

		2.5	Deciphering the role of isoflavones in differential reaction to yellow mosaic disease in soybean	2019-22
		2.6	Deciphering Silicon mediated defense against yellow stem borer in rice	2019-22
		2.7	Cytological and molecular basis of organ-specific resistance to blast disease in finger millet	2020-23
3	Genetic and molecular resources for stress tolerance	3.2	Isolation and characterization of secondary metabolites of *Chromobacterium* species for mitigation of biotic stress in agriculture	2018-21
4	Strategic and adaptive research in biotic stress management	4.2	Bio-ecology and management of pink stem borer in wheat	2016-21
		4.5	Isolation and Development of efficient native biocontrol agents of Chhattisgarh for management of lepidopteran pests	2017-21
		4.6	Evaluation of allelopathic potential in rice and selected weeds for weed management	2018-21
		4.7	Antimicrobial cyclic lipopeptides (AMLs) producing *Bacillus* for antagonistic activity	2020-22

B. External Funded Projects (On-going)

S. No.	Project Code	Project Title	Year	Funding Agency	Budget (Rs. In Lakh)
Ongoing					
1.	EF005	AICRP on nematodes in cropping systems	2014 onwards	ICAR	04.13 (2020-21)
2.	EF006	Socio-economic upliftment of tribal farmers through biotic stress management strategies in rice fallow pulse cropping system - An integrated farming approach (Farmer FIRST)	2016-22	ICAR	147.98
3.	EF008	Identification of host factors responsible for infection and development of nano-particle based dsRNA delivery system for imparting resistance to begomoviruses	2018-21	NASF	293.6
4.	EF009	Establishment of Biotech-KISAN Hub at ICAR-National Institute of Biotic Stress Management	2020-22	DBT	214.00
5.	EF010	In-situ diagnosis and digital cataloguing of plant-pathogenic fungi through Foldscope Microscopy - A frugal science approach	2020-23	DST	41.11
6.	EF011	Development of diagnostic kits for quick detection of CTV, HLB and Phytophthora rot diseases in Citrus of North East India	2021-24	DBT	66.968

7.	EF012	National Agricultural Innovation Fund-Component I	2020 onwards	ICAR	4.64
			Total		**772.428**

C. Projects submitted for external funding during 2020-21

S. No.	Project Title	Duration	Funding Agency	Budget (INR lakhs)
1.	Unravelling molecular network underlying bacterial endophyte mediated tolerance to soil borne fungal pathogen, *Sclerotium rolfsii* in chickpea	Three years	DST-SERB	58.30
2.	Investigation on physical and molecular mechanisms underlying farm chemicals induced resistance in rice brown plant hopper, *Nilaparvata lugens*	Three years	DST-SERB	53.35
3.	In-silico identification of disease resistant genes in the genetically distinct poultry breeds (Kadaknath and Cobb400)	Three years	DST-SERB	60.28
4.	Sniffer Drone: Smart Electronic Nose System for detection of plants' volatile organic compounds (VOCs)" with IIIT, Raipur as lead centre	Two years	DBT - BIRAC	18.00

D. Project proposals submitted for funding under NASF/AMAAS as a participating centre

S. No.	Project title	Lead Centre
1.	Simulating Diffusion of technologies using GIS based mapping resources and techno-socio-psycho-economic-ecological factors (NASF)	ICAR – NRRI, Cuttack
2.	Agripreneurship for Sustainable Agricultural Development: Technological and Institutional Innovations and Strategies (NASF)	ICAR- NAARM, Hyderabad
3.	Use of untapped native microbial resources of Chhattisgarh for biocontrol of key biotic stresses of chickpea (AMAAS)	ICAR-NBAIM, Mau

5.2 Reorientation of research and teaching in constituent Schools mode

Following the transition for research and education from Sections-mode to Schools-mode, research programmes have been formulated now in Schools-mode and accordingly proposed in the new EFC (2021-26) along with the establishment of the **state-of-art laboratories**

Programmes	Based on Relevance & recommendations
Flagship Programme (3)	

1.	National Strategic Crop Health Monitoring Network (NSCHMN)	RAC, SDG-2 &3
2.	Novel genes discovery and validation for pest resistance	RAC, SDG-2
3.	Forewarning and estimation of crop losses	RAC, Cabinet note, SDG-2 & 9
Inter-institutional programme (3)		
1.	Ecological foundation of pest dynamics and their control in emerging production systems.	RAC/Cabinet note, SDG – 2, 13 &15
2.	Climate change effects on chemical ecology and one health parameters.	RAC / Cabinet Note, SDG-3, 13, One health Govt Priority
3.	Dissecting tripartite interaction in crops affected simultaneously with biotic and abiotic stresses	RAC, SDG-2
Institutional programme (3)		
1	Characterization, conservation and sustainable use of Pathogen and Pest Genetic Resources (PPGR) for biotic stress management	QRT/Cabinet Note, SDG- 2, 3 & 15
2	Molecular biology of host-pest/pathogen interaction	RAC / QRT / Cabinet note, SDG- 1 &2
3	Bio-security for sustainable agriculture	QRT/RAC /Cabinet note, SDG-3 & 12

***5.2. Brief Research achievements in ongoing projects*:**

A total of 21 research projects were carried out during the period of the report (2020-21) including 14 Institute funded and 7 externally funded projects from ICAR-AICRP, ICAR-FFP, ICAR-NASF, DBT and DST. The information generated this year as added to our understanding of the mechanisms, as well as generated important material in appropriate projects.

The salient findings include:

<u>Germplasm and Genetic Resources</u>

1. A novel genetic stock, an induced *Tetraploid Rice* (Rice Tetra 5-40, 2n=4x=48) was developed and registered (INGR 20004) with NBPGR, New Delhi.
2. A rice germplasm mapping panel of 226 lines, representing local landraces, varieties and gene-introgressed lines, were screened against BLB pathogen under artificial inoculation field conditions for identification of novel BLB resistance gene(s). Ten lines were found to be highly resistant to BLB. Molecular analysis showed that these lines do not contain previously reported BLB resistance genes. These 10 lines were further evaluated under replicated trials for validation and being explored as a source for novel BLB resistance genes. Further, sixty-eight germplasm lines selected from this mapping panel, were screened for brown plant hopper (BPH) resistance by artificial release of BPH and four lines were identified as resistant/moderately resistant.

3. Controlled hybridizations were made to introgress BPH and Blast resistance genes in the IRBB66 background, including (i) IRBB66 x BPH resistant lines; (ii) IRBB66 x blast resistance lines in a process to develop super-donors in rice.

Genomic and Molecular resources

1. GenBank submission of sequences (67 in number) (Table 1).
2. Promoters for bacterial leaf blight resistance genes *xa13* and *Xa21* from resistance (Bamleshwari) and susceptible (TN-1) cultivars were isolated.
3. Promoter of *Isoflavone synthase 1* (*IFS1*) gene from soybean was characterized and activity in resistance and susceptible cultivars of soybean *Mungbean yellow mosaic India virus* (MYMIV) was demonstrated through histochemical assay.
4. CRISPR/Cas9 mediated genome editing was initiated for functional validation of genes imparting resistance to yellow mosaic disease in soybean. Transformation of DS9712 variety of soybean has been initiated using CRISPR constructs targeting IFS gene in soybean for genome editing.

Understanding diversity and mechanism of biotic stress reaction

1. During the period, 365 white fly (*Bemisia tabaci)* samples representing 10 states of India were collected. Molecular analysis of 180 samples from mt DNA of *B. tabaci* identified five genetic groups of *B. tabaci* namely, Asia 1, Asia I India, Asia II-5, Asia II-7, MEAM-1 and Asia III to be predominant in these areas.
2. Developed single whitefly transmission technique and epicotyls region agro-inoculation suitable for viral replication and infection of MYMIV and ToLCKV.
3. Identified differentially expressed transcripts upon infection of MYMIV on host (mungbean) and non-host (tomato). Dimerized agroinfectious clones of DNA A and DNA B of MYMIV infecting soybean were also developed.
4. Sixteen methylation-related genes were identified to be down-regulated in a Fusarium wilt susceptible chickpea variety, JG62 compared to a Fusarium wilt-resistant variety, Digvijay. GO analysis associated the genes with L-methionine salvage from methylthioadenosine and S-adenosylmethionine and steroid biosynthesis (p-value 0.001).
5. Co-expression analysis of FWS JG62 transcriptome with methionine S-methyl-transferase gene (MSM; TraesCS1A02G013800) resulted in 3-hydroxy-3-methyl-glutaryl coenzyme A reductase (HMGCR; TraesCS5A02G269300) which was negatively correlated (-1.00) with genes encoding pathogenesis-related (PR) and detoxification proteins and xylanase inhibitors (XI). GO analysis associated the genes encoding pathogenesis-related and detoxification proteins as well as xylanase inhibitors with methionine S-methyl transferase activity (p-value 0.001).
6. Expression levels of 3-hydroxy-3-methyl-glutaryl coenzyme A reductase (HMGCR) was higher (Log2 levels from 3.25 to 4.00) in pathogen inoculated compared to methionine S-methyl-transferase (MSM) (Log2 levels from 1.25 to 3.25) in mock-inoculated FW S variety, JG62.
7. Forty-three genes were found to be down-regulated by miR9678. These genes associated with responses to biotic stimulus and glucan endo-1,4-beta-glucanase in GO.

Biocontrol agents and action

1. Nineteen bacteriophages were isolated showing varying efficacy (up to 99.9%) against *Xanthomonas oryzae pv. oryzae* (*Xoo*), the rice bacterial blight pathogen. These bacteriophages were highly specific to various species of *Xanthomonas* and were lytic to only Xoo pathoypes. Morphological characterization by Transmission

Electron Microscopy, revealed that all phage isolates belonged to order Caudovirales (having head and tail), representing different families viz., Myoviridae (5 isolates), Siphoviridae (12 isolates), Podoviridae (1 isolate). The length of head and tail varied from 60 to 75 nm and 135 to 265 nm, respectively.

2. Bioefficacy of secondary metabolite of *Chromobacterium* sp. i.e. Violacein showed promising results against plant pathogenic fungi viz., *Fusarium oxysporum f. sp. Carthami, Macrophomina phaseolina, Sclerotium rolfsii*, *Aspergillus fumigatus* and animal helminths by reducing mycelia and conidia formation and inhibition of mycelial devlopment. As anti-protozoan and anti-heliminths/anti-coccidian activity, it also showed deformation of oocyst.
3. Twenty wild eco-types of *Trichogramma* (11 *T. japonicum* and 9 *T. chilonis*) were recovered from 22 districts of Chhattisgarh. The foraging activity of Tj 1 and Tc 19 under laboratory condition was 86% and 85%, respectively while it was 82 and 76% in NBAIR strains. The per cent parasitization of Tj 1-11 ranged from 78% to 86% while it ranged from 66% to 85% in Tc 12-20.
4. Combined application of kairomone and *T. japonicum* wasps reduced the dead heart and white ear damages caused by yellow stem borer to 38.05% and 34.40%, respectively in summer rice.
5. Twenty-six native *Bacillus thuringiensis* were isolated. Bioassay under laboratory condition against 3rd instar *Spodoptera litura* showed that NBT 18 caused the maximum mortality (86.7%) to 3rd instar of *S. litura* @ 5×10^8 CFU/ml which was at par with NBT 27, NBT 31 and VLBt.
6. About 80 putative Bacilli bacteria isolated from rhizosphere soil of chickpea and a few have shown antagonistic activities against fungal pathogens *Fusarium oxysporum* f.sp. *ciceris* and *Sclerotium rolfsii*.
7. Screening of rice cultivars/germplasm for weed suppression ability showed that seed germination of some of the weeds was significantly affected by the allelopathic effect of few test rice varieties. In other studies, treatment of organic root extract of *Malachara* delayed the seed germination of *Parthenium* by one to two weeks, and also showed lethal effect on the vegetative growth of *Parthenium*.
8. In bio-management of rice root-knot nematode, nursery bed treatment with *Pseudomonas fluorescens* @ 20 g/m^2 (2×10^8 CFU/g) was found to be the most effective in reducing nematode population (122 per 200 cc soil; 12.36 per 5g root), seedling height (34.4 cm), number of galls per seedling (10.55), RKI (1.74) and yield (7.4 t/ha). Similarly, neem cake application @ 1 t/ha + seed treatment with *P. fluorescens* @ 10 g/kg seed provided maximum control of bottle gourd root knot nematode.

<u>Extension and out-reach programmes</u>

1. Under the FFP, in the enterprise-based modules, income of Rs. 15320/- per farm families generated with the APC and Rs. 16860/ unit from mushroom production. Similarly, under livestock-based module, Rs. 1,53,166/- income generated per farm families. Cropping intensity increased by 126% due to introduction of pulses and other crops in rice fallow areas. Seasonal migration reduced by 35%.
2. Under DBT Biotech KISAN project, 150-acre area covered under biofortified rice variety (Zinco rice MS), Indira aerobic-1 and MTU-1010. In *rabi*, 112 acres covered under rabi pulses (chickpea, green gram and Lathyrus). Also, demonstrated low-cost protected cultivation of vegetables (such as coloured capsicum and tomato) Introduced low-cost drip irrigation system with poly mulching for vegetable cultivation. Pheromone trap technology introduced as an eco-friendly pest management and also various technological interventions such as line sowing,

transplanting of rice, seedling/seed treatment with biofertilizer, IPM, IWM, IDM, INM and post-harvest technology.

5.3 *Meetings, Trainings (conducted and received) and participation in conferences/ workshops*

During this period MANAGE, Hyderabad sponsored 02 trainings conducted, scientists have attended 3 training programmes including in virtual mode (Table 3 & 5) and Institute scientists participated in 16 conferences/workshop and meetings (Table 4).

5.4 *Publications and Awards*

1. **Summary of publications**: (Table 7)

- Research and review papers: 13 (Average NAAS score: 7.2)
- Book chapters: 03
- Extension folders: 16

2. **Awards to NIBSM scientists:** Various awards and recognition were received by the NIBSM Scientists (Table 8).

5.5 *New Joining*

1. Dr. Soumya Dash, Scientist (Animal Genetics & Breeding) joined ICAR-NIBSM, Raipur w.e.f 02-02-2021 on transfer from ICAR-NBAGR, Karnal.

6. Progress of Co-ordination Cell for Education

The following points highlight the progress made by Co-ordination Cell for Education during the 2020-21:

1. A total 9 students from 6 disciplines relating to biotic stress management have joined M.Sc. programme at ICAR-NIBSM, Raipur in affiliation with ICAR-IARI, New Delhi in the academic session 2020-21.

2. A virtual introductory meet under the Chairmanship of Director, ICAR-NIBSM along with NIBSM faculty with admitted students was organised on 30th January 2021. Associate Dean, ICAR-IARI also joined the meet.

3. Faculty of ICAR-NIBSM, Raipur was involved in teaching of various courses on virtual mode in collaboration with Course Instructors from IARI in first and/or second Semesters (2020-21).

4. The admitted students virtually participated in various seminars given by national and international speakers organised by ICAR-NIBSM.

5. M.Sc. research topics for students' dissertation in various disciplines were approved by the Dean & Joint Director Education (IARI, New Delhi).

6. Nine Scientists of ICAR-NIBSM, who were inducted as Research guides, were allotted students to carry out the M.Sc. Research in 6 disciplines, at ICAR-NIBSM, Raipur.

7. Linkages and Collaborations

Linkages and collaborations are being developed by the Institute with various institutions, and universities involved in agricultural research and education (Table 09). The collaborations are being done to develop research projects on areas of mutual interest and shall help in sharing of infrastructure and manpower facilities.

The institute has signed MoU for research and education with Indian Agricultural Research Institute (IARI, New Delhi), Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur (M.P.), Indira Gandhi Krishi Vishwavidyalaya, Amity University Chhattisgarh, ICAR-NBAIR, Bengaluru, ICAR-IIAB, Ranchi and ICAR-DWR, Jabalpur.

MoU with Institute of Pesticide Formulation Technology, Gurugram, National Institute of Plant Genome Research (NIPGR), New Delhi, Pt. Ravi Shankar Shukla University, Raipur, NEHU, Shillong, and other ICAR institutes is also in progress.

As a lead centre of the ICAR-National Agricultural Science Fund (NASF) sponsored research project, the ICAR-NIBSM conducting the research with its partner Institutes, NIPGR, New Delhi, ICAR-IARI, New Delhi and Indian Institute of Technology, Delhi. Collaboration have been made with CGIAR Institutes including IRRI, The Philippines; IITA, Nigeria; and ICRISAT, Patancheru, and also with ICAR-NBPGR, New Delhi and other institutes for introduction of wild species, core collection and germplasm of different crops.

The institute has been in active collaboration with Krishi Vigyan Kendras (KVKs) of Chhattisgarh to undertake its outreach programmes and projects such as Farmer FIRST programme and DBT-BIOTECH-KISAN. The Zonal Project Directorate (Zone VII) collaborated for capacity enhancement programme (CEP) of the subject matter specialists of the KVKs in Chhattisgarh state. Institute has a close collaboration with various departments of the Chhattisgarh state such as Department of Agriculture, Horticulture, Animal Husbandry and Veterinary Services, Fisheries, Rural Development Agencies and SAMETI to identify areas of research and extension activities. Scientists of the Institute participate in the training and extension programmes organized by the various state departments.

8. Tables

Table 1: NCBI Genbank submissions

S. No.	Details	Accession nos.
1-3	DNA A/B partial sequences of Mung bean yellow mosaic India virus infecting cowpea (3 sequences)	MT276258-60
4-8	DNA A/B partial sequences of Mung bean yellow mosaic India virus infecting soybean (4 sequences)	MT276265-67 MT276271
9-12	DNA A/B partial sequences of Tomato Leaf curl New Delhi virus infecting Ridge gourd (4 sequences)	MT276261-64
13-15	DNA A/B partial sequences of Tomato leaf curl New Delhi virus infecting tomato (3 sequences)	MT276268-70
16-23	Partial nucleotide sequence of DNA A of Mungbean yellow mosaic India virus, Tomato leaf curl Karnataka virus isolate, Tomato leaf curl New Delhi virus isolate; Alphasatellite associated with tomato leaf curl disease	MN026265-MN026272
24-53	16S ribosomal DNA sequences; *Lathyrus sativu*s bacterial endophytes (30 sequences)	MW423828-MW423857
54-67	16S ribosomal DNA sequences; Pigeonpea bacterial endophytes (14 sequences)	MW423421-MW423434

Table 2 Extension & Outreach Programmes - 2020-21

S. No.	Activities	SCSP	TSP	NEH
1.	Total farm families covered	723	513	400
2.	Total villages covered	35	22	30
3.	Total Districts covered	03	03	3
4.	Capacity building programmes organized	06	08	1
5.	Total farmers benefitted under capacity building	80	100	120
6.	Agricultural interventions	Minor agricultural implements Poultry rearing, pig rearing, Fish farming, duckery, Vegetable and horticulture crop production	Poultry rearing, pig rearing, Fish farming, duckery, Vegetable and horticulture crop production	7

		Establishing 18 small piggery units and 5 poultry units at selected farmer's field for doubling their income	Establishing 11 small piggery units and 2 poultry units at selected farmer's field for doubling their income	-
	Total allocation (INR lakhs)	• 100 Lakh in Capital head • 80 Lakh in General head Total= 180 Lakh	40 Lakh in General head	Rs. 60 lakhs

Table 3: Trainings received by the Scientists

S. No.	Name of scientist (Dr/Mr/Ms)	Training	Duration	Organized by
1.	Dr. S.K. Jain	MDP on Implementation of Access and Benefit Sharing Regulations in Agriculture Research: Awareness and sensitization workshop (On-line)	July 07-10, 2020	ICAR-NAARM, Hyderabad
2.	Dr. P.N. Sivalingam Dr. B.K. Choudhary Dr. Lalit Kharbikar	Intellectual Property Rights in Agricultural Research & Education in India (on-line)	September 12-28, 2020	NAHEP & IPTM Unit, ICAR, New Delhi
3.	Dr. Anil Dixit, Dr. S.K. Jain	Role of Technology in Community Level Disaster Mitigation" (for Scientists & Technologists)	November 23-27, 2020	Centre for Disaster Management, Lal Bahadur Shastri National Academy of Administration, Mussoorie, Uttarakhand

Table 4: Seminars/Conferences/Workshops attended

S. No.	Name of seminar /Symposia/Conference	Duration	Organized by	Participant
1.	Global Symposium on Soil Biodiversity	April 19-22, 2021	FAO	Dr. S.K. Sharma
2.	International Workshop on Policy Initiatives for Attracting Youth and Preventing Attrition in Agriculture	April 6-8, 2021	Asian Productivity Organization (APO), Japan at Indonesia	Dr. P. Mooventhan
3.	Annual International e-Conference on Microbial World: Recent Development in Health, Agriculture and Environmental Sciences	February 3-5, 2021	Association of Microbiologist of India (AMI) in collaboration with INSCR, TERI, DU, IARI and INSA	Dr. Lata Jain
4.	International Conference on Agricultural extension and advisory services: Innovation to Impact	November 25-27, 2020	MANAGE, Hyderabad	Dr. P. Mooventhan
5.	National conference on Agriculture Resource Management for Atmanirbhar Bharat	July 17-19, 2020	CAU, Imphal	Dr. P.N. Sivalingam

Table 5: Webinars attended (virtual meetings)

S. No.	Title of webinars	Period	Organized by	Name of scientist
1.	Citizen Science, talk on Genome sequencing in search of vaccine for Coronavirus	12-13.5.2020	DST, Govt. of India and DST, Govt. of Gujarat	Dr.Vinay Kumar, Dr. Lata Jain
2.	Next Generation Genomics and Integrated Breeding for Crop Improvement (VII-NGGIBCI) on Genomics for food, health and nutrition	14.5.2020	CEGSB, ICRISAT, Hyderabad	Dr.Vinay Kumar
3.	Agriculture and Food during COVID-19 Pandemic	30.5.2020	Society for World Environment, Food and Technology (SWEFT)	Dr.Lata Jain Dr.Vinay Kumar
4.	Opportunities in Fisheries Sector Post Lockdown	04.6.2020	Agrivision India	Dr.B.K. Choudhary
5.	Panel discussion on "Agri Microbiomes: Role and relationship with crop plants for higher productivity & sustainability”	13.06.2020	NAS complex, PUSA Campus, New Delhi	Dr.P.N. Sivalingam
6.	Monoclonal antibodies as therapeutics	29.6.2020	Nanaji Deshmukh Veterinary University, Jabalpur	Dr.B.K. Choudhary Dr.Mamta Choudhary
7.	Emerging scenario of zoonoses and its public health significance	6.7.2020	College of Veterinary Science & A. H., SDAU, Sardarkrushi-nagar, Gujarat on July 6, 2020.	Dr.Lata Jain
8.	Technological Advances to Revolutionize Cancer Diagnosis	7.7.2020	CGKV, Durg	Dr.B.K. Choudhary Dr.Mamta Choudhary
9.	Export challenges and mitigation strategies for fresh and processed F & V in COVID-19	08.8.2020	Department of Agriculture and Environmental Sciences, NIFTEM, Sonipat	Dr.R.K. Murali Baskaran Dr.P. Mooventhan
10.	Hematopathology and field diagnosis of commonly prevalent tick-borne diseases of bovines in India	8.8.2020	GADVASU, Punjab and Carus laboratories	Dr.B.K. Choudhary Dr.Mamta Choudhary
11.	Immunology in 21st century for improvising one health	8.08.2020	Society of Immunology and Immunopathology, India; SVPUAT, Meerut and DAHD, GOI, New Delhi	Dr.Lata Jain
12.	Digital Discourse Series - 2020 on Gender and Pandemic: Challenges and Opportunities	10-12.08.2020	ICAR-ATARI, Bengaluru and Farmer FIRST Programme of ICAR-CPCRI, Kayamkulam, ICAR-NIANP & ICAR - IIHR, Bengaluru and	Dr.P. Mooventhan

			ICAR-CIFT, Kochi.	
13.	World Humanitarian day and the international locust crisis	19.8.2020	FAO	Dr.R.K. Murali Baskaran
14.	One Health Approach to control and elimination of Rabies in India	29.9.2020	Department of Veterinary Public Health and Epidemiology, College of Veterinary Sci. & A. H., Anand	Dr.Mamta Choudhary
15.	Regional Expert Consultation on Agriculturally Important Microorganisms	28.10.2020	APARI, Bangkok, Thailand and NBAIM, Mau, India	Dr.S.K. Sharma
16.	Wild Life Health Management	10-11.11.2020	Veterinary Science and Animal Husbandry, OAUT, Bhubaneswar, Odisha	Dr.Mamta Choudhary
17.	MANAGE Dialogue 2020: Future of Agricultural Extension and Advisory Services	18-20.11.2020	MANAGE, Hyderabad	Dr.P. Mooventhan
18.	A Climate for Change's 2020 Annual General Meeting	29.11.2020	Climate for Change Australia	Dr.Lalit L. Kharbikar
19.	9th Agrochemicals Conference 2020	1.12.2020	FICCI Agrochemicals, New Delhi	Dr.R. K. Murali Baskaran
20.	Gene editing for agriculture, society and sustainable development: Prospects and perspectives	15.12.2020	Tata Institute for Genetics and Society (TIGS), Bengaluru in partnership with Biotech Consortium India Ltd., New Delhi	Dr.R. K. Murali Baskaran, Dr.S.K. Sharma, Dr.J. Sridhar, Dr.Ashish Marathe
21.	Alternative therapies to mitigate microbial resistance	23-24.02.2021	ICAR-Indian Veterinary Research Institute, Izatnagar-243122, Bareilly, UP,	Dr.Lata Jain
22.	GCM 2.0: WDCM 10 K Sequencing Projects for Type Strains	15.05.2021	Institute of Microbiology, Chinese Academy of Science	Dr. S.K. Sharma
23.	FEMS Microbiology Ecology on Sustainable Agriculture	20.05.2021		Dr. S.K. Sharma

Table 6: Lectures delivered by International Scientists (Virtual mode)

S. No.	Title of the Lecture	Date	Delivered by
1.	Interaction between *Pseudomonas* species and their host plants	09.11.2020	**Dr. Jacob Malone**, Group Leader (Plant Health), The John Innes Centre, Norwich Research Park, Norwich, UK
2.	Innovative Detection methods to support plant health diagnostics	18.11.2020	**Dr. Peter Bonants**, Team Health Manager, Wageningen University & Research, Netherland
3.	Epigenetic Control of Seed Development	27.01.2021	**Dr. Mary Gehring,** Whitehead Institute, Dept. of Biology, MIT, Cambridge, MA 02142
4.	Biotic and abiotic stress	10.02.2021	**Dr. Kiran Mysore**, Professor, Noble Research

	tolerance: A roadmap for sustainable agriculture		Institute, Ardmore, Oklahoma, USA
5.	Novel components of the polycomb group pathway and their roles in plant development	10.03.2021	**Dr. Sara Farrona**, Plant Development and Epigenetic Lab, The Ryan Institute Aras de Brun, ADB-2008, National University of Ireland, Galway
6.	Recent advances in Weed Science Research	06.04.2021	**Dr. Muthukumar Bagavathiannan,** Associate Professor, Department of Soil and Crop Sciences, Texas A&M University; Mail Stop 2474, College Station, Texas, United States
7.	Harnessing plant microbiome to manage biotic and abiotic stresses in agriculture	19.04.2021	**Dr. Brajesh Singh**, Director , Global Centre for Land-based Innovation & Professor, Hawkesbury Institute for the Environment, Western Sydney University, Australia
8.	Adaptive trait diversity, molecular mechanisms, herbicide resistance evolution, response to climate change and management of Italian ryegrass	24.05.2021	**Dr. Aniruddha Maity**, Department of Soil and Crop Sciences, Texas A&M University, College Station, United States
9.	A genomics perspective for biotic stress management	15.06.2021	**Dr. Rajeev Varshney,** Global Research Program Director - Genetic Gains; & Director, Center of Excellence in Genomics & Systems Biology, ICRISAT, Hyderabad

Table 7: Details of Publications

S. No.	Authors	Title	Journal	Details	NAAS score
2021					
1.	Murali-Baskaran, R.K., S. Senthil-Nathan and W.B. Hunter	Anti-herbivore activity of soluble silicon for crop protection in agriculture: a review	Environmental Science and Pollution Research	28: 2626–2637	**9.06**
2.	Murali Baskaran, R.K., J. Sridhar, K.C. Sharma and L. Jain	Kairomone gel formulations enhance biocontrol efficacy of *Trichogramma japonicum* Ashmead on rice yellow stem borer, *Scirpophaga incertulas* Walker	Crop Protection	146 (12): 105655.	**8.38**
3.	Murali-Baskaran, R.K., K.C. Sharma, J. Sridhar, L. Jain and J. Kumar	Multiple releases of *Trichogramma japonicum* Ashmead for biocontrol of rice yellow stem borer, *Scirpophaga incertulas* (Walker)	Crop Protection	141: 105471.	**8.38**
4.	Sahu, B., N. Dokka, M.M. Mahajan, K.C. Sharma, H.K. Singh, A. Marathe, B.P. Devangan, P. Mooventhan, Y. Yele, J. Sridhar, V.	Begomoviruses affecting pulse and vegetable crops are unevenly distributed in distinct agroecological zones of the Eastern India.	Journal of Phytopathology	169 (4): 209-228	**7.18**

	Kumar, P.N. Sivalingam, J. Kumar, P. Kaushal and P.K. Ghosh				
5.	Kumar, J., R.K. Murali Baskaran, S.K. Jain, P.N. Sivalingam, A. Dixit, J. Mallikarjuna, and P.K. Ghosh	Biotic stresses of agricultural crops in India: re-visiting national status and mitigation strategies	Current Science	120: 264-265.	**6.73**
6.	Kumar, J., R.K. Murali-Baskaran, S.K. Jain, P.N. Sivalingam, Mallikarjuna, J., V. Kumar, K.C. Sharma, J. Sridhar, P. Mooventhan, A. Dixit and P.K. Ghosh	Emerging and re-emerging biotic stresses of agricultural crops in India and novel tools for their better management	Current Science	accepted	**6.73**
2020					
7.	Bera, B.C., M. Choudhary, T. Anand, N. Virmani, K. Sundaram, B. Choudhary and B.N. Tripathi	Detection and genetic characterization of porcine circovirus 3 (PCV3) in pigs in India.	Transboundary and Emerging Diseases	67(3):1062-1067.	**10.19**
8.	Sahu, P.K., R. Sao, S. Mondal, G. Vishwakarma, S.K. Gupta, V. Kumar, S. Singh, D. Sharma and B.K. Das	Next Generation Sequencing based forward genetic approaches for identification and mapping of causal mutations in crop plants: a comprehensive review.	Plants	9 (10):1355.	**8.76**
9.	Murali Baskaran, R.K., J. Sridhar, K.C. Sharma, L. Jain, S. Senthil Nathan, W.B. Hunter, J. Kumar and P. Kaushal	Kairomones effect on parasitic activity of *Trichogramma japonicum* against rice yellow stem borer, *Scirpophaga incertulas.*	Journal of Applied Entomology	144 (5): 373-381.	**7.83**
10.	Kumar, V., L. Jain, S.K. Jain, S. Chaturvedi and P. Kaushal	Bacterial endophytes of rice (*Oryza sativa* L.) and their potential for plant growth promotion and antagonistic activities.	South African Journal of Botany	134: 50-63	**7.79**
11.	Baruah A., P.N. Sivalingam, U. Fatima and M. Senthil Kumar	Non-host resistance to plant viruses: What do we know?	Physiological and Molecular Plant Pathology	111: 101506.	**7.65**
12.	Jeer, M., Y. Yele, K.C. Sharma and N.B. Prakash	Exogenous application of different silicon sources and potassium reduces pink stem borer damage and improves photosynthesis, yield and related parameters in wheat.	Silicon	13**:** 901–910.	**7.5**

13.	Jain, L. and V. Kumar	Leptospirosis as neglected re-emerging zoonoses in India: An overview	Journal of Animal Research	10 (6): 853-858	**6.4**
Book chapters					
1.	Choudhary, M., B.K. Choudhary and R.C. Ghosh	Pathological changes associated with natural outbreak of swine pasteurelosis. In: Pests, Weeds and Diseases in Agricultural Crop and Animal Husbandry Production (eds. D. Kontogiannatos, A. Kourti and K. F. Mendes), 235-247 pp.	Intech Open Ltd., London, SW7 2QJ, UK	Doi:10.55772/intechopen.94849	
2.	Kumar, V., L. Jain, P. Kaushal and R. Soni	Fungal endophytes and their applications as growth promoters and biological control agents. In: Fungi Bio-prospects in Sustainable Agriculture, Environment and Nano-technology Vol-1.(V.K. Sharma, M.P. Shah, S. Parmar and A. Kumar Eds)	Elsevier publisher	DOI: doi.org/10.1016/B978-0-12-821394-0.00012-3	
3.	Sridhar, J., K.K. Kumar, R.K. Murali-Baskaran, S. Senthil-Nathan, S. Sharma, M. Nagesh, P. Kaushal and J. Kumar	Impact of climate change on communities, response and migration of insects, nematodes, vectors and natural enemies in diverse ecosystems. In: Global Climate Change: Resilient and Smart Agriculture (V. Venkataramanan et al. eds.)	Springer Nature Singapore Pt. Ltd.	doi.org://10.1007/978-981-329856-9_4	

Extension Folders (2020-21)

S. No.	Title of the Extension Folder (in Hindi)	PME/ Institute Publication Number
1.	अजोला उत्पादन तकनीक	NIBSM/EF/2021-39
2.	कृशि कीटों का जैविक नियंत्रण	NIBSM/EF/2021-40
3.	धान में तनाछेदक कीट, जानकारी एवं नियंत्रण	NIBSM/EF/2021-41
4.	सब्जियों के लिए नर्सरी (पौध ाला) उत्पादन तकनीक	NIBSM/EF/2021-42
5.	पैरा म ारूम उत्पादन तकनीकी	NIBSM/EF/2021-43
6.	तिवड़ा (लाखड़ी) उत्पादन तकनीक	NIBSM/EF/2021-44
7.	गृह वाटिका द्वारा पोशण सुरक्षा	NIBSM/EF/2021-45
8.	कृशि रसायनों का सुरक्षित उपयोग एवं रखरखाव	NIBSM/EF/2021-46
9.	हेचरी यूनिट में अण्डे की हेचिंग	NIBSM/EF/2021-47
10.	केंचुआ खाद उत्पादन तकनीक	NIBSM/EF/2021-48
Authors - पी.मूवेन्थन, अनिल दीक्षित, एम.ए.खान, जी.एल.भार्मा, प्रवीण वर्मा, लोके ा वर्मा, उत्तम सिंह, भीशमकुमार एवं सती ा खाखा		

Bilingual Extension Folder		
11.	Nematode pests of Solanaceous vegetable crops and their management / सोलैनेसियस सब्जी फसलों में पाए जाने वाले सूत्रकृमि नाशीजीव और उनका प्रबंधन	NIBSM/EF/2021-49
12.	Integrated management of Root-knot nematode (*Meloidogyne graminicola)* in Rice / धान की खेती में जड़.विगलन सूत्रकृमि (*मेलोइडोजाइन ग्रामिनिकोला*) नाशीजीव का एकीकृत प्रबंधन	NIBSM/EF/2021-50
13.	Nematode pests of pulse crops and their management दलहन फसलों की खेती में सूत्रकृमि नाशीजीव और उनका प्रबंधन	NIBSM/EF/2021-51
14.	Management of nematode pests in protected/polyhouse cultivation संरक्षित / पॉलीहाउस के तहत खेती में सूत्रकृमि नाशीजीवों का प्रबंधन	NIBSM/EF/2021-52
15.	Nematode pests of important fruit crops and their management महत्वपूर्ण फल फसलों की खेती में सूत्रकृमि नाशीजीव और उनका प्रबंधन	NIBSM/EF/2021-53
16.	Nematode pests of cucurbitaceous vegetable crops and their management कद्दूवर्गीय सब्जी फसलों की खेती में सूत्रकृमि नाशीजीव और उनका प्रबंधन	NIBSM/EF/2021-54
Author: Mallikarjuna J.		

Table 8 Awards/Recognitions received by Scientists of NIBSM

S. No.	Scientists (Dr./Mr./Ms.)	Name of Awards/ Recognition	Name of Organization /conference/society
1.	Anil Dixit	Outstanding Agricultural Scientist ward 2020	Dr. B. Vasantharaj David Foundation, Chennai
2.	S.K. Sharma	PERAL Foundation Best Scientist Award	PEARL- A Foundation for Educational Excellence, Madurai, Tamil Nadu
In-house awards from the ICAR-NIBSM, Raipur on Foundation Day (7th October 2020)			
3.	Anil Dixit	Excellence Award	
4.	P. Mooventhan	Best Scientist Award	
5.	R.K. Murali Baskaran, K.C. Sharma, J. Sridhar, Lata Jain	Best Research Paper Award	

Table 9 Collaborations and linkages

S. No.	Participating Institutes	Area
1.	AICRP networks	Nematodes, AICRPs on other crops
2.	NIPGR, New Delhi, ICAR-IARI, New Delhi & IIT, Delhi	National Agricultural Science Fund (NASF) sponsored research project, NIBSM as Lead centre
3.	ICAR-NRRI, Cuttack	Pyramiding and stacking of genes in rice
4.	ICAR-NIASM, Baramati	Biotic-abiotic interaction effects, Stress induce promoters
5.	ICAR-IIAB, Ranchi	Development of super donor(s) in rice with multiple stress tolerance; Transcriptom analysis and identification of genes for stress tolerance in finger millet.
6.	ICAR-IGFRI, Jhansi	Alien introgressions and ploidy effects on improving fodder traits and stress tolerance in pearl millet and guinea grass.
7.	ICAR-NBAIR, Bengaluru	Identification of Insect-pest resources
8.	ICAR-NBAIM, Mau	Proposed for inclusion in AMAAS project
9.	MANAGE, Hyderabad	Training and Extension for technology transfer
10.	CAU, Umiam, ICAR-IARI, IIT, Guwahati, IASST, Guwahati,	DBT funded project on “Development of diagnostic kits for quick detection of CTV, HLB and Phytophthora rot diseases in Citrus of North East India”

9. Budget and Finance

a. Budget Allocation

S. No.	Head	Allocation (Rs. in Lakh)				
		Other than NEH & TSP	**TSP**	**NEH**	**SCSP**	**Total**
1.	G-I-A- Capital	2312.88	40.00	60.00	180.00	**2922.40**
2.	G-I-A- Salary	551.38	0.00	0.00	0.00	**551.38**
3.	G-I-A- General					
	(1) Pension	0.0	0.00	0.00	0.00	**0.00**
	(2) Others	329.52	0.00	0.00	0.00	**329.52**
Grand Total		**3193.78**	**40.00**	**60.00**	**180.00**	**3473.78**

b. Budget Expenditure

S. No.	Head	Expenditure (Rs. in Lakh)				
		Other than NEH & TSP	**TSP**	**NEH**	**SCSP**	**Total**
1.	G-I-A- Capital	2302.99	0.00	0.00	0.00	**2302.99**
2.	G-I-A- Salary	550.99	0.00	0.00	0.00	**550.99**
3.	G-I-A- General					
	(3) Pension	0.0	39.99	59.75	104.69	**204.43**
	(4) Others	326.92	0.00	0.00	0.00	**326.92**
Grand Total		**3180.90**	**39.99**	**59.75**	**104.69**	**3385.33**

10. Summary of individual project progress till date

A. Institute Projects

Project: 1.3: Mapping of genetic groups of *Bemisia tabaci* in India and their begomovirus transmission efficiency

(J. Sridhar, R.K. Murali Baskaran)

Duration: 2018- 2021

Objectives:

1. To characterize genetic groups of whiteflies (*Bemisia tabaci*) occurring and distributing in India using molecular markers.
2. To determine the begomovirus transmission efficiencies of the dominant genetic groups of *B. tabaci*.

Progress:

1. Collected/procured 1225 *B. tabaci* samples from 18 states of India.
2. Isolated and amplified mitochondrial DNA from 485 individual and generated 340 sequences of *B. tabaci*.
3. Identified eleven distinct genetic groups of *B. tabaci*, Asia 1, Asia I India, Asia II-1, Asia II-3, Asia II-5, Asia II-6, Asia II-7, Asia II-8, Asia II-11, Asia III, MEAM-1 of which Asia II-3, Asia II-6 & Asia III new to India and reported for the first time.
4. The begomovirus transmission efficiency of Asia II-7 was found 50-55% while MEAM-1 was 80-85% in tomato.

Project: 1.4: Identification and characterization of bacteriophages against Bacterial leaf blight pathogen *Xanthomonas oryzae* pv. *oryzae* in rice

(Lata Jain, S.K. Jain and Vinay Kumar)

Duration: 2018- 2021

Objectives:

1. Isolation of bacteriophages against *Xanthomonas oryzae* pv. *oryzae.*
2. To characterize bacteriophages using physico-chemical, biological and molecular approaches.

Progress:

1. A total of 146 rice field water and soil samples were collected from 26 districts of Chhattisgarh the adjoining seven states, out of which a total of 19 bacteriophages (14 from Chhattisgarh, one Madhya Pradesh and one from Telangana state) were isolated against Xoo.
2. Presence of phages were indicated by clear round plaques (size 2 to 10 mm in dia), and clearance of bacterial growth around streaked lines.
3. Xoo-Phages were highly genus and species specific not even having lytic activity for X. campestris.
4. Xoo-Phages can survive in environment in temperature range of 4-50 °C ; pH range of 5-9, and direct sunlight for 1 hour.

5. In-vitro efficacy studies in liquid culture medium shows up to 99.99% bactericidal activity for the host bacteria.
6. On Transmission Electron Microscopy, all phages were found to belong in order Caudovirales (having head and tail), and families Myoviridae (5), Siphoviridae (12), Podoviridae (1) and Unclassified (1). The length of head and tail varies from 60 to 75 nm and 135 to 265 nm, respectively.

Project 1.5: Exploring host-microbial cross talks in agro-ecosystem of Bastar plateau zone of Chhattisgarh
(Mamta Choudhary, B.K. Choudhary, L.L. Kharbikar)

Duration: 2018-2021

Objectives:

1. Isolation, identification and characterization of resident and transient microorganism of agroecosystem of Bastar plateau zone of Chhattisgarh.
2. Investigation of interactions of plant and animal pathogenic microorganisms.

Progress:

1. Agro-ecological samples were collected from different IFS models from 7 districts in different seasons and more than 600 bacterial isolates have been purified. A total of 1145 microbial isolates have been recovered.
2. Maximum recovery of 435 bacterial isolates was made from forest based agro-ecosystem, followed by 366 from crop based and 344 isolates from animal based agro-ecosystems. This pattern indicates that the microbial diversity and density remains high in forest ecosystem. Similarly, Maximum (605) bacterial isolates were recovered from the samples collected during the monsoon followed by 322 from the samples collected during winter season and 218 isolates from summer seasons.
3. The predominant isolates recovered belong to genus/species *Enterobacter* spp., *Aeromonas* spp., *Pseudomonas* spp., *Serratia* spp., *Myroides* spp., *Bacillus* spp., *Corynebacterium* spp., *Rhodococcus* spp, *Micrococcus* spp., *Staphylococcus* spp.; and fungal isolates *Fusarium* spp., *Aspergillus* spp., *Rhizopus* spp., *Candida* spp.
4. Common isolates recovered from Crops and animal system are Enterobacteriacae group of bacteria, *Aeromonas* spp., *Pseudomonas* spp, *Bacillus* spp., *Corynebacterium* spp., *Micrococcus* spp., *Staphylococcus* spp. and fungi *Aspergillus* spp., *Rhizopus* spp. and *Candida* spp.
5. Sequencing of 100 bacterial isolates was completed and bio-informatic analysis is in progress.

Project: 2.2: Development of super donors in rice carrying tolerance to multiple stresses (Bacterial Leaf Blight, Brown Plant Hopper and Blast)

(Vinay Kumar, P. N. Sivalingam, S.K. Jain and Mallikarjuna J.)

Duration: 2017-2022

Objectives:

1. Pyramiding and stacking of genes for multiple biotic stresses BLB, Blast and BPH.
2. To confirm presence of resistance genes in the recipient genome.
3. To study the effect of gene interaction among the multiples stress responsive genes.
4. Attempt the study the master regulator genes which regulates multiples biotic stresses.

Progress:

1. A total of sixty eight (68) rice germplasm lines were screened for brown plant hopper (BPH) resistance in rice by using standard seed box technique. Out of 68 lines 3, 1, 10 and 54 lines were found resistant, moderately resistant, susceptible and highly susceptible, respectively.
2. Crosses were made to introgress BPH and Blast resistance genes in the IRBB66 background namely (i) IRBB66 x BPH resistant lines; (ii) IRBB66 x blast resistance lines and developed seeds were harvested for further confirmation of presence of resistance genes. Backcrosses with MTU 1010 for generation advancement of BC1F1 and seed were harvested.
3. In order to identify novel BLB resistance gene, 226 rice germplasm consisting of local landraces, varieties and gene introgressed lines obtained from NRRI, Cuttack were screened two years under field conditions. Ten lines were found to be highly resistant to BLB. Molecular analysis showed that these lines do not contain previously reported BLB resistance genes. These 10 lines were further evaluated under replicated trials for validation and same will be explored as a source for isolation of novel BLB resistance genes.
4. Multiplication of wild species of rice namely, *Oryza nivara; O. minuta; O. glumaepatula, O, grandiglumis, O. rufipogon* and *O. longistaminata* and of donor rice lines for BPH, BLB and blast diseases for further use.
5. Registered Tetraploid Rice (Rice Tetra-5-40, 2n=4x=48) germplasm with NBPGR, New Delhi with registration number INGR 20004.

Project 2.3 Identification of biotic stress induced promoters from resistant source plants

(P.N. Sivalingam, S.K. Jain, Vinay Kumar, L.L. Kharbikar, Ashish Marathe**)**

Duration: 2017-22

Objectives:

1. To identify upregulated transcript/genes upon infection by pathogen by transcriptome profiling
2. To identify possible promoters and regulating elements by *in silico* analysis
3. To study functional analysis of promoter elements in model plant system

Progress:

1. Infectious clones of begomovirus infecting soybean and mungbean has been developed. Resistance and susceptible lines of soybean have been selected from the minicore screening.
2. Standardization of agroinoculation, whitefly transmission and *Xanthomonas oryza* inoculation techniques have been standardized for challenge inoculation.
3. Transcriptome data upon begomovirus infection to mungbean developed and the DEGs identification are in progress.
4. Isolation of promoters for bacterial leaf blight resistance genes *xa13* and *Xa21* from resistance (Bamleshwari) and susceptible (TN-1) cultivars. Promoter of IFS1 gene from soybean has been characterized.
5. Activity of promoter of IFS1 gene in resistance and susceptible cultivars to *Mungbean yellow mosaic India virus* (MYMIV) in soybean has been demonstrated through histochemical assay. This promoter activity was also demonstrated with mungbean against MYMIV.

Project: 2.4: Epigenetic regulation of microRNA genes in response to *Fusarium* stress in chickpea

(L.L. Kharbikar, Ashish Marathe)

Duration: 2018-2021

Objectives:

1. To map the available information from different sources on DNA methylation, chromatin-related proteins and sRNAs on *Fusarium* responsive genes (FRGs).
2. To characterize the FRGs based on a number of molecular features (gene ontology, proteome).
3. To validate the epigenetic features that is regulated by miRNAs and plays a role in *Fusarium* response.

Progress:

1. Sixteen methylation-related genes were identified to be down-regulated in a Fusarium wilt susceptible variety, JG62 compared to a Fusarium wilt-resistant variety, Digvijay, and GO associated these genes with L-methionine salvage from methylthioadenosine and S-adenosylmethionine and steroid biosynthesis (p-value 0.001).
2. Co-expression analysis of this FW S JG62 transcriptome with methionine S-methyl-transferase gene (MSM; TraesCS1A02G013800) resulted in 3-hydroxy-3-methyl-glutaryl coenzyme A reductase (HMGCR; TraesCS5A02G269300) which was negatively correlated (-1.00) with genes encoding pathogenesis-related (PR) and detoxification proteins and xylanase inhibitors (XI).
3. GO analysis associated the genes encoding pathogenesis-related and detoxification proteins as well as xylanase inhibitors with methionine S-methyl transferase activity (p-value 0.001).
4. Expression levels of 3-hydroxy-3-methyl-glutaryl coenzyme A reductase (HMGCR) was higher (Log2 levels from 3.25 to 4.00) in pathogen inoculated compared to methionine S-methyl-transferase (MSM) (Log2 levels from 1.25 to 3.25) in mock-inoculated FW S variety, JG62.
5. Forty-three genes were found to be down-regulated by miR9678. These genes associated with responses to biotic stimulus and glucan endo-1,4-beta-glucanase in GO.

Project: 2.5: Deciphering the role of isoflavones in differential reaction to yellow mosaic disease in Soybean

(Ashish Marathe, P.N. Sivalingam, L.L. Kharbikar)

Duration: 2019-2022

Objectives:

1. To screen mini core germplasm of soybean for differential reaction to yellow mosaic disease.
2. To estimate the isoflavone content in lines with contrasting reaction to YMD.
3. To optimize CRISPR/Cas9 for targeted mutagenesis in gene(s)/ microRNA involved in isoflavone biosynthesis.

Progress:

1. Minicore germplasm lines of soybean were screened for reaction to yellow mosaic disease as per severity disease scale were further grouped into various categories.
2. Differential expression of *Isoflavone synthase 1* gene was analysed with higher expression in the resistant line. Absolute quantification of viral titre was assessed in *Nicotiana benthamiana* to demonstrate the antiviral nature of isoflavones against ToLCKV.
3. CRISPR/Cas9 mediated genome editing was initiated for functional validation of genes imparting resistance to yellow mosaic disease in soybean. Transformation of DS9712 variety of soybean has been initiated using CRISPR constructs targeting IFS gene in soybean for genome editing.
4. Dimerized agroinfectious clones of DNA A and DNA B of MYMIV infecting soybean were developed.

Project: 2.6: Deciphering silicon mediated defense against yellow stem borer in rice

(Mallikarjuna, J and Vinay Kumar)

Duration: 2019-2022

Objectives:

1. Identification of Si induced differentially expressed genes in rice infested with YSB using transcriptomics approach.
2. Validation of selected differentially expressed genes in the transcriptome using Real time PCR.
3. To study the morphological changes in rice plants and histopathological changes in YSB larvae upon Si application.

Progress:

1. Standardized methodology for yellow stem borer larval rearing, stage of larva for infestation, Si dose and sampling time in rice variety Swarna for transcriptome studies to understand Si-mediated resistance

Project: 2.7: Cytological and molecular basis of organ specific resistance to blast disease in finger millet

(S.K. Jain, Mamta Choudhary, Ashish Marathe)

Duration: 2020-2023

Objectives:

1. Comparison of the *Pyricularia grisea* infection process in different organs in finger millet by cytology and histo-chemical analysis.
2. Elucidate the role of reactive oxygen species and other factors in organ-specific response.
3. Expression analysis of defense-related genes in organ-specific response in finger millet- *P. grisea* interaction.

Progress:

1. Cultures of *Pyricularia grisea* from blast infected finger millet samples (collected from Raipur, CG & Ranchi, Jharkhand) have been isolated. Standardized the

technique for profuse sporulation of the fungus on Oat meal agar (OMA) medium as getting sufficient sporulation of *P. grisea* is difficult.

2. Standardized the inoculation method for leaf infection (spray method) and neck infection (injection inoculation) for even infection for sampling. Finger infection inoculation method is being tested.
3. Under artificial inoculation, genotype GEC 61 was confirmed susceptible and GEC 164 was found resistant. For neck infection, susceptible reaction was observed in Udru Millage (susceptible check), GEC 61 and GEC 244, however, R/MR reaction in GEC 164 need to re-confirmed.

Project: 3.2: Isolation and characterization of secondary metabolites of *Chromobacterium* species for mitigation of biotic stresses in agriculture

(B.K. Choudhary, Mamta Choudhary, R.K. Murali Baskaran, J. Sridhar, S.K. Sharma)

Duration: September, 2018-2021

Objectives:

1. Isolation, Extraction, purification and characterization of purple pigment.
2. Screening of Bio-efficacy of purple pigment for therapeutic properties against major Agricultural Insect pest and pathogens.
3. Validation of bacterial metabolites for pharmacological and toxicological properties using suitable host system as alternate therapeutic agents in crop and livestock ailments.

Progress:

1. Molecular characterization, anticidal, anti-fungal, anti-helminthic activity of secondary metabolite from *Choromobacterium* spp have been studied.
2. Secondary metabolite of *Chromobacterium* voilacin pigment @ 1000 ppm caused 35% mortality of chickpea pod borer, *Helicoverpa armigera* 3rd instar larvae which also inhibited the adult emergence from treated pupae by 29.3%.
3. Screening of bioefficacy of Violacein showed promising results against plant pathogenic fungi viz., *Fusarium oxysporum* f. sp. *Carthami, Macrophomina phaseolina, Sclerotium rolfsii, Aspergillus fumigatus* and animal helminthis by reducing mycelia and conidia formation and inhibition of mycelial development.
4. Screening of bioefficacy of Violacein showed promising results as anti-protozoan and anti-heliminth/anti-coccidian activity by deformation of oocyst.

Project 4.2: Bio-ecology and management of pink stem borer in wheat

(K.C. Sharma, Mallikarjuna J. and Yogesh Yele)

Duration: 2016-2020

Objectives:

1. To record seasonal incidence of pink stem borer in Chhattisgarh and adjacent region.
2. To screen different popular wheat varieties/germplasm for tolerance/resistance against pink stem borer.
3. To study the perpetuation and biology of pink stem borer.
4. To study nutritional (K and Si) basis of resistance against pink stem borer.

Progress:

1. High PSB infestations were recorded in late sown wheat crop as compared to timely sown crop.
2. Field screening of diverse germplasm lines led to identification of 6 varieties and 19 germplasm lines as resistant to PSB. Additionally, three genotypes from core germplasm subset that were found highly resistant and 18 as resistant to PSB
3. Significant effect of P levels has been reported on 1000 grain weight, no. of grains/spikes and spike length, photosynthetic rate, transpiration rate and WUE
4. Significant effect of Si levels has been found on photosynthetic rate, transpiration rate, stomatal Conductance, WUE and intercellular CO_2 concentration.
5. Soil application of diatomaceous earth @ 150 kg/ha reduced the damage caused by pink stem borer significantly as compared to control.
6. The maximum total sugar, total phenols and defense enzymes *viz.*, peroxidase, polyphenol oxidase, phenylalanine ammonia lyase and Beta1-3 glucanase were found in treatment - (Soil application of DE (300 kg ha^{-1}).

Project: 4.5: Isolation and evaluation of native biocontrol agents for management of lepidopteran pests

(R.K. Murali Baskaran, K.C. Sharma, J. Sridhar, Lata Jain)

Duration: 2016-2020

Objectives:

1. To isolate and characterize native *Trichogramma* spp. and *Bacillus thuringiensis* from various eco-systems.
2. To find out efficient/virulent *Trichogramma* spp. and *Bacillus thuringiensis* through *in vivo* bioassay.
3. To optimize field dose of efficient *Bacillus thuringiensis* against lepidopteran pests of tomato and chickpea.
4. To develop and evaluate kairomone formulation to enhance field activity of *Trichogramma* spp. against rice yellow stem-borer and leaf-folder.

Progress:

1. During survey in 18 crop and non-crop ecosystems belonging to 22 districts of Chhattisgarh, 20 wild eco-types of *Trichogramma* were recovered. Out of them, 11 eco-types were identified as *T. japonicum* and eight as *T. chilonis*. *T. japonicum* and *T. chilonis* are predominantly prevailing species in Chhattisgarh. The foraging activity of Tj 1 and Tc 19 under laboratory condition was 86% and 85%, respectively while it was 82 and 76% in NBAIR strains. The per cent parasitization of Tj 1-11 ranged from 78% to 86% while it ranged from 66% to 85% in Tc 12-20.
2. A total of 26 native *Bacillus thuringiensis* were isolated and bioassayed under laboratory condition against 3rd instar *Spodoptera litura*. Out of 26 isolates, NBT 18 caused the maximum mortality of 86.7% to 3rd instar of *S. litura* at 5×10^8 CFU/ml which was on par with NBT 27, NBT 31 and VL*Bt*.
3. Combined application of kairomone and *T. japonicum* wasps reduced the dead heart and white ear damages caused by yellow stem borer to 38.05% and 34.40%, respectively in summer rice.

Project: 4.6: Evaluation of allelopathic potential in rice and selected weeds for weed management

(Anil Dixit, B.K.Choudhary, S. Das)

Duration: 2018-2021

Objectives:

1. To screen the rice varieties for weed suppression ability confirming possible allelopathic effect.
2. To study the interaction effect between selected weeds *Parthenium* and *Malachra capitata.*
3. Characterization of chemical for confirming the allelopathic potential/factors in plants.

Progress:

1. 250 rice genotypes in augmented paired row screened against the weeds for possible allelopathic potential of rice lines.
2. The experimental field was infested with *Ammannia baccifera, Ludwigia parviflora, Alternanthera sessilis, Fimbristylis miliacea, Eriocaulon sieboldianum, Leptochloa chinensis, Commelina benghalensis, Echinochloa colona* weeds. Some of the weed seed germination was significantly affected by the allelopathic effect of few test rice varieties
3. The seeds of *Parthenium hysterophorous* and *Malachra capitata* were sown individually and in combinations. The seeds were exposed to different cultures for making them germinated. The treatments of hot water and scarification could make some impact of germination
4. In the allelopathic studies the treatment of organic root extract of Malachara delayed the seed germination of Parthenium by one to two weeks, and also has lethal effect on the vegetative growth of Parthenium. Further studies are underway to explore the mechanism of cidal/static effects.

Project 4.7: Antimicrobial cyclic lipopeptides (AMLs) producing *Bacillus* for antagonistic activity

(S.K. Sharma, Lata Jain)

Duration: 2020-2022

Objectives:

1. Selection of antagonistic *Bacillus* having cyclic lipopeptide production ability isolated from different ecosystems

2. Characterization and identification of cyclic lipopeptide produced by *Bacillus* species

Progress:

1. Collected around 30 soil samples from chickpea growing regions of Chhattisgarh and Madhya Pradesh.
2. Approximately 80 putative bacilli isolated from rhizosphere soil of chickpea cultivated in Bemetra and Kawardha districts of Chhattisgarh.

3. Some of the bacillus isolates were found antagonistic to *Fusarium oxysporum* f.sp. *ciceris* and *Sclerotium rolfsii*.
4. Few *Sclerotium rolfsii* isolates recovered from diseased roots of chickpea.

B. Externally funded Projects

Project: EF005: All India Coordinated Research Project on Nematodes in Cropping Systems-Raipur Center

(Mallikarjuna J.)

Duration: 2014 onwards

Objectives:

1. To study the population dynamics and diversity of plant parasitic nematodes in Chhattisgarh state
2. To screen crop varieties for resistance against plant parasitic nematodes.

Progress:

1. In bio-management of rice root-knot nematode, nursery bed treatment with *Pseudomonas fluorescens* @ 20 g/m^2 (2 × 10^8 CFU/g) was found to be the most effective in reducing nematode population (122 per 200 cc soil; 12.36 per 5g root), seedling height (34.4 cm), number of galls per seedling (10.55), RKI (1.74) and yield (7.4 t/ha).
2. The treatment neem cake @ 1 t/ha + seed treatment with *P. fluorescens* @ 10 g/kg seed provided maximum control of bottle gourd root knot nematode.

Project: EF006: Socio-economic upliftment of tribal farmers through suitable agricultural enterprises integration in rice fallow pulse cropping system - A participatory approach for doubling the farmer's income.

(P. Mooventhan, Anil Dixit, Praveen Varma, Lokesh Varma, M. A. Khan)

Duration: 2016-2022

Objectives:

1. To study the existing rice fallow pulse cropping system, livelihood pattern, problem identification, priority setting, information need, perceived constraint and socio-economic profiling of the resource poor farmers.
2. To augment the capacity building at field level for farmer-participatory research and extension in adoption and expansion of selected interventions on crop, livestock, horticulture and NRM based enterprises.
3. To develop, establish and evaluate the sustainability of integrated livelihood generating farming models for resource poor rural farmers.
4. To evolve suitable up scalable farm technologies for women farmers to address drudgery reduction, income enhancement and livelihood security.
5. To develop and test the effectiveness of Educational Multimedia Training Modules (EMTMs) on biotic stress management technologies in rice fallow pulse cropping system.

Progress:

1. Total 634 tribal farmers covered which includes 215 (34%) women and 292 (46%) youth farmers.
2. 02 Farmer Communication Center (FCCs) established
3. 05 Custom Hiring Center (CHCs) established
4. 01 Village Level Soil Testing unit established
5. 05 Kadaknath farming cum hatchery units established
6. 54 agricultural technological interventions introduced, monitored, evaluated, and sustained at farmer's field
7. 07 agricultural enterprises units established
8. More than 126 Capacity Building Programme organized and 9750 farmers benefited
9. 122 hectare of rice fallow area covered with pulses
10. 35% of farmers migration reduced
11. Cropping intensity increased by 122% (22% additional)
12. Rs. 118.75 lakhs of additional income generated
13. 06 structures (Polyhouse and Poultry shed) established
14. 04 small scale Agro-processing Centers (APCs) established
15. 11 technology inventories prepared
16. 08 success stories documented
17. 634 tribal farmer's feedback on recommended farm technologies has been reported to ICAR-NAARM, Hyderabad

Project EF008: Identification of host factors responsible for infection and development of nano-particle based dsRNA delivery system for imparting resistance to begomoviruses

(P.N. Sivalingam, J. Sridhar, Vinay Kumar, L.L. Kharbikar**)**

Lead centre : ICAR-NIBSM
Co-operating centres: NIPGR, ICAR-IARI and IIT-Delhi

Duration: 2018- 2021

Objectives:

1. To understand the host factors responsible for infection and replication in the identified hosts and non-hosts to begomoviruses (NIBSM & NIPGR)

   Activity 1: Developing infectious clones of MYMV/ MYMIV and ToLCNDV/ begomovirus infecting tomato
   Activity 2: Technique to identify virus replication and movement in hosts and non-hosts
   Activity 3: Localization of virus in different tissue to track the virus in host and non-host
   Activity 4: Molecular analysis of host factors interacting with begomovirus infection in the host and non-host species upon inoculation of selected begomovirus
   Activity 5: Plant gene silencing by VIGS and functional validation of involvement of plant factors in virus infection/multiplication/spread

2. To develop efficient delivery system of dsRNA conjugated with nano materials (IARI & IIT-D).
3. To study efficiency of ds RNA conjugated with nanoparticles in vector transmission

and begomovirus infection (IARI & IIT-D).

Progress:

1. Infectious clones of *Mungbean yellow mosaic India virus* (MYMIV) and *Tomato leaf curl Karnataka virus* (ToLCKV) have been developed. MYMIV has bipartite genome, DNA A and DNA A and ToLCKV has monopartite genome, DNA A and betasatellite.
2. Embryonic axis agroinoculation method was standardized in mungbean to understand non-host resistance mechanism.
3. Micro-cage method of single whitefly inoculation technique has been standardized for transmission of begomovirus in a localized tissue area of 1.57 cm^2.
4. Transcriptome sequence and differential expression of genes in host and non-hosts species to MYMIV suggest that the potential genes involving in host susceptibility. Identified differentially expressed transcripts upon infection of MYMIV on host (mungbean) and non-host (tomato).
5. Validation of selected differentially expressed transcripts is in progress.

Project EF009: Establishment of Biotech-KISAN Hub at ICAR-National Institute of Biotic Stress Management

(P. Mooventhan, Anil Dixit, R.K. Murali Baskaran**)**

Duration: 2020-2022

Progress:

1. Total 150 farmers benefited from five cluster of villages from three Aspirational Districts
2. Total 150 acres covered under biofortified rice variety and 112 acres covered under rabi pulses
3. Total 07 crops varieties were introduced.
4. Total 21 demonstrations, 27 farmers training, 01 Exposure visit cum educational visit and 01 scientist training conducted. Total 2789 farmers were benefited.
5. Established 05 poly house and introduced high value horticulture crops.
6. Introduced low cost drip irrigation system with poly mulching for vegetable cultivation.
7. Introduced improved goat breed - Sirohi.

Project EF009: In-situ diagnosis and digital cataloging of plant pathogenic fungi through Foldscope Microscopy- A frugal science approach"
(Dr. P. Mooventhan, H.K. Singh)

Duration: 2020-2023

Progress:

1. As a field application, foldscope identified as a novel tool to identify plant pathogenic fungal diseases viz. powdery mildew, Leaf blight, Leaf spot and post-harvest diseases etc.

*2.*Total 16 fungal diseases and their organism were identified based on morphological structure of pathogen and host species. Such as *Golovinomyces cichoracearum, Erysiphe polygoni, Erysiphe cichoracearum, Leveillula taurica, Penicillium digitatum, Ustilago tritici*, *Albugo bliti*, *Fusarium oxysporum, Alterneria sp and Rhizophus sp.*

3.As a capacity building initiative, 04 Foldscope demonstration cum hands on training on diagnosis of plant pathogenic fungal diseases organized, and total 102 farmers benefited including 39 women and 12 rural youth.

4.01 rural youth trained as village level trainer to demonstrate the Foldscope microscopy as diagnosis tool at village level

5.It is found that foldscope as useful tool to diagnose plant diseases at field level.

11. Reorienting research programmes under *School-mode*

The ICAR-NIBSM, Raipur has four schools namely, Crop health management research (CHMR), Crop health biology research (CHBR), Crop resistance system research (CRSR) and Crop Health policy-support research (CHPR) for which aims, thrust areas have been defined.

School	Crop Health Management Research (CHMR)	Crop Health Biology Research (CHBR)	Crop Resistance System Research (CRSR)	Crop Health Policy-support Research (CHPR)
Aim	*Holistic crop health management issues*	*Understanding the biology of crops as influenced by biotic stresses*	*Utilizing modern frontier science-based plant resistance sourcing and its exploitation*	*Develop policies for biotic stress management in Agriculture*
Thrust areas	1. Management and the inter – relationships between the host plant, the pest and the agroecology, 2. IPM, biocontrol, need based chemical control, 3. To evolve novel technology of biotic stress management with respect to climate change and biorisk fervour in the WTO and IPR regimes	1. Systematics of pests/pathogens, life cycles, 2. Adaptations (modes of survival, perpetuation), 3. Responses to the interactions with other organisms of economic importance (host plants, biocontrol agents and endophytes	1. Identification of novel host resistance/ defense genes and their deployment 2. Understanding Resistance/tolerance mechanisms 3. Novel molecular approaches for understanding and stress mitigation	1. To address contextual policy frameworks that the system demands in crop health research. 2. To implement guidelines and recommendations under the auspices of Sanitary and Phytosanitary Measures (SPS measures) for plant health
Flagship	Forewarning and estimation of crop losses	-	Novel genes discovery and validation for pest resistance	National Strategic Crop Health Monitoring Network (NSCHMN)
Inter-institutional programme	Climate change effects on chemical ecology and one health parameters	Ecological foundation of pest dynamics and their control in emerging production systems.	-	-

New research programmes have been prepared to be taken up in next 5-10 years in above mentioned 4 schools and have been projected in the EFC (2021-26).

	Programmes	Based on Relevance & recommendations
Flagship Programme (3)		
1.	National Strategic Crop Health Monitoring Network (NSCHMN)	RAC, SDG-2 &3
2.	Novel genes discovery and validation for pest resistance	RAC, SDG-2
3.	Forewarning and estimation of crop losses	RAC, Cabinet note, SDG-2 & 9, Vision 2050
Inter-institutional programme (3)		
1.	Ecological foundation of pest dynamics and their control in emerging production systems.	RAC/Cabinet note, SDG – 2, 13 &15
2.	Climate change effects on chemical ecology and one health parameters.	RAC / Cabinet Note, SDG-3, 13, One health Govt Priority
3.	Dissecting tripartite interaction in crops affected simultaneously with biotic and abiotic stresses	RAC, SDG-2
Institutional programme (3)		
1	Characterization, conservation and sustainable use of Pathogen and Pest Genetic Resources (PPGR) for biotic stress management	QRT/Cabinet Note, SDG-2, 3 & 15
2	Molecular biology of host-pest/pathogen interaction	RAC / QRT / Cabinet note, SDG- 1 &2
3	Bio-security for sustainable agriculture	QRT/RAC /Cabinet note, SDG-3 & 12

These programmes have been further placed in different schools as per thrust areas and only following programmes will be undertaken on priority as per existing strength. Remaining inter-institutional and institutional programmes may be taken up with the availability of fund and manpower as per creation.

Details of the programmes

A. Flagship Programmes (FS)

FS-Programme 1: Novel genes discovery and validation for pest resistance

Biotic stresses caused by bacteria, virus and fungal pathogens are the potential threat to global food security. The origin of new pathogens and insect races due to climatic and genetic factors is a major challenge for plant breeders in breeding biotic stress resistant crops. It is imperative to breed crops that carry a diversity of resistance genes and/or to plant a diversity of varieties, as this approach minimizes the ability of pathogens to overcome resistance. It is quite evident that modern cultivars, varieties are less tolerant to biotic and abiotic stresses as compared to their wild relatives and available land races because of genetic erosion of useful genes during the course of evolution and selection for high yield. The genetic variability available in cultivated landraces and varieties is also limited to breed varieties durable resistance to disease and combat the emerging challenges. As sources of new genetic diversity, crop wild relatives (CWR) the wild cousins of cultivated plant species have been used for many decades for plant breeding as these plants have survived in repeated and extreme environmental challenges. Crop wild relatives have been undeniably beneficial in sustaining modern agriculture by providing plant breeders with a diverse genetic pool of potentially useful traits. The resilience and adaptive capacity of CWRs remain largely untapped and poorly understood due to insufficient genetic and phenotypic information about most of the holdings in genebanks. A wealth of genetic information has been left behind throughout the history of plant domestication and scientific crop improvement. It must now be characterize and deployed mitigating the emerging challenges.

Availability of adequate genetic variation is a prerequisite for genetic improvement of any crop species. Plant genetic resources (PGRs) and gene pools are the main contributing factor to future progress in developing new cultivars having desirable gene/ traits. Germplasm accessions collected and maintained in gene banks represent the vast genetic variation that can be utilized in crop improvement. However, the large number of accessions in the germplasm collections and lack of genotypic and phenotypic information often hinders their evaluation and utilization for specific breeding purposes. In order to explore, the full potential of gene pool/ PGRs, Core collection of respective crop need to be evaluated/ characterized. Core collection refers to as a collection which contains with a minimum of repetitiveness, the greatest possible genetic diversity of a crop species and its wild relatives. The core is composed of about 10%of the total collection, chosen to represent as much as possible of the diversity in the collection having the information data on the geographic origin, the genetic characteristics, and the possible value to breeders and other users of each accession in the collection. Core/ mini core resources are ideal for genome-wide association studies (GWAS) for identifying genes in quantitative traits at an unprecedented rate because 70% of the total variation is screened within 10% of whole collection.

Once disease resistance genes/ traits mapped or identified in the wild species or subset of germplasm, transferring a trait directly into cultivated varieties using wild species or landrace varieties is too risky, scientifically and economically. As it will now take at least 4–5 years of breeding to eliminate unwanted wild characters/ linkage drag to generate a new high-yielding variety and sometimes the negative trait is not eliminated. To circumvent the problem of linkage drag/ unwanted trait pre-breeding is required. It is a necessary first step in the use of diversity arising from wild relatives and other unimproved materials. Pre-breeding refers to all activities designed to identify desirable characteristics and/or genes from unadapted materials that cannot be used directly in breeding populations and to transfer these traits to an intermediate set of materials that breeders can use further in producing new varieties for farmers. Pre-breeding identifies and captures desirable characteristics from unadapted plants that cannot be directly used in breeding populations and transfers these genes into an intermediate stage that can be directly used by a breeder. This is necessary for accessions not adapted to a particular target environment, closely related wild species that can cross to the cultivated form, and for distant wild species that are difficult to cross. In recent years, there has been greater interest in interspecific hybridization for transferring desirable traits, including disease and insect resistance and resistance to abiotic and biotic stresses from CWR into cultivated lines to develop pre-breeding germplasms.

Crop varieties/ germplasm line with new combinations or variants of disease-resistance genes are developed for use against newly emerged virulent pathogens. A central goal of crop improvement programme is to breed varieties with broad-spectrum resistance (BSR) to pathogens/ multiple stresses. But most of the major resistance (R) genes identified to date confer race-specific resistance to their adapted specific pathogens, and their durability in the field is typically short due to mutations in the pathogen population that overcome the resistance. In order to develop more durable and enhanced resistance an alternative strategy of incorporating/ pyramiding multiple R genes against different pathogens into elite cultivars is being used. However, it is time-consuming and technically challenging, and usually results in a yield penalty as the crop diverts energy to implementing disease resistance. More recently, the concept of Super donor emerged and described as the stacking (or 'pyramiding') of multiple resistance genes with different recognition spectra/ different traits and environmental optima into a single genetic background is now a credible strategy for achieving more durable disease resistance which can be further used for developing disease resistance varieties. Nevertheless, assembling appropriate gene combinations in elite varieties of crops remains a challenge. Host-plant resistance is one of the most durable types of resistance to the ever- evolving pathogens. Broad-spectrum resistance (BSR) is highly preferred and can be achieved without significant yield penalties, or even with yield benefits. BSR genes have been identified in several crops including rice. However, a deeper understanding of the molecular, cellular and developmental pathways by which plants dynamically respond to and interact with their environment and pathogens, while maintaining growth, efficiency of nutrient use and fitness is essential required.

Molecular markers are mainly used for characterization of genetic diversity, identification, mapping tagging and isolation of genes for desired traits. Markers tightly linked with trait of interest is being used for Marker-assisted selection (MAS) in almost all crop breeding programs. Advances in next-generation sequencing technologies offered more sophisticated tools for sequencing- based mapping, allele mining and whole genome-wide selection. It became possible to explored genetic diversity at nucleotide-scale precision, using genome-wide association studies and other gene-mapping methods paired with advanced phenotyping systems. Genomic selection uses genome-wide DNA markers to predict the genetic merit of breeding individuals for complex traits. This technology was developed to understand complex traits, such as yield, that are affected by variants in a large number of genes and/or regulatory elements, typically each of which has a small effect. Integrating genomic selection facilities with automated high-throughput phenotyping platforms will further accelerate locus and gene discovery, and the characterization of effects of specific genes on plant growth and development. The integration of mechanistic understanding, genetic variation and genome-scale breeding towards technological solutions is essential developing/ breeding of crop resilience to environmental (abiotic) and pathogen (biotic) stress of paramount importance for feeding a growing global population.

Keeping in view, the importance of different components used for cisgenic breeding/ identification and deployment of genes for single and multiple biotic stresses for breeding of varieties resistance to multiple biotic stresses. The present study is proposed with the following objectives:

Objectives:

1. Pre-breeding using germplasm of crop plants for pest resistance
2. Identification, Cloning and characterization of genes / QTLs involved in pest resistance
3. Functional validation of identified genes and QTLs

Crops Targeted: Millets/small millets/vegetables/oats and fodder crops/Rice and legume crops (Chickpea/ Pigeonpea/other legumes)

Outcomes:

1. Collection and identification of accessions containing desirable genes/alleles and regulatory factors for various biotic stress tolerance.

2. Identification of effective resistance genes and/or gene combinations and broad spectrum resistance (BSR) genes against the major disease and insects for effective gene deployment for the management of the disease.
3. Development of genomic resources namely molecular markers linked with various pathotypes/isolates, stress induced promoters and other regulatory elements/ genes.
4. Development of Super donors having multiple resistance genes for pests and diseases and generation advanced line thorough pre-breeding

Possible Collaborating Institutes: ICAR-NBPGR, New Delhi; ICAR-NRRI, Cuttack; ICAR_NIPB, New Delhi; ICAR-NIASM, Baramati, ICAR-IIAB, Ranchi

FS-Programme 2: Forewarning and estimation of crop losses

Effective crop protection requires early and accurate detection of biotic stress. In recent years, remarkable results have been achieved in the early detection of weeds, plant diseases and insect pests in crops. These achievements are related both to the development of non-invasive, high resolution optical sensors (air/space borne remote sensing) and data analysis methods (pattern recognition, machine learning) that are able to cope with the resolution, size and complexity of the signals from these sensors. With the advent of hyperspectral radiometry, it has been possible to have insights into more details and better understanding of the crop stress induced by insect pests and diseases. It was also feasible to differentiate between biotic and abiotic stresses with reasonable accuracy using hyperspectral radiometry. Reflectance data obtained by ground based remote sensing provides vital information to understand spectral interactions between pests damage on the host plants and also to collect fundamental ground-truth information required for interpretation of remote sensing data obtained from spaceborne and airborne platforms. Satellite remote sensing provides sufficient data for large scale studies, but it has limitations such as temporal and spatial resolution, and more importantly, availability of cloud free data. On the other hand, airborne systems have a higher resolution and time flexibility and provide sufficient lead time for dissemination of crop protection advisory. Several methods of machine learning have been utilized for precision agriculture such as support vector machines and neural networks for classification and self organizing maps for clustering. These methods are able to calculate both linear and non-linear models that require few statistical assumptions and adapt flexibility to a wide range of data characteristics. Nevertheless, airborne and space borne remote sensing along with machine learning techniques can facilitate analysis of spatial variability of biotic stress and a synoptic view of the large area in a non-destructive and non-invasive way. Hence it can supplement many of the on-going field surveillance programs, which is often expensive, time consuming laborious and many a times error-prone. It has been proved that remote sensing technology can provide accurate and reliable information whereas machine learning techniques can provide faster analysis to guide decision-making in crop protection and hence have great potential for use in pest management. Therefore, this will be taken up as one of the flagship programme during the plan period.

Objectives

(i) To develop near real time surveillance technology for biotic stress management using spatial and machine learning techniques
(ii) To develop prognostic analysis infrastructure and capability for trans-boundary biotic stress management. The outcome of the project is expected to be forewarning of interstate/transboundary biotic stress and protection advisories.

Possible Collaborating Institutes: IIIT, Naya Raipur, ICAR-IIW&BR, Karnal, ICAR-IARI and BCKV, Kalyani, ICAR-NCIPM, New Delhi

FS-Programme 3: National Strategic Crop Health Monitoring Network (NSCHMN)

Aim :
Strategic Crop Health Monitoring – Survey and Surveillance for farm diseases and pests to keep ahead of the biotic challenges in view of the changing climate and pathogen/pest scenario as well as transboundary invasions.

Modus operandii: As national network project in collaboration with ICAR institutes, SAUs and other plant protection organization in the country.

Target: Monitoring of crop health problems in the country; virulence/pathotype/variant distribution; keeping vigil on new strains of causal agents and their distribution patterns; keeping watch on invasive pests and diseases which are not found in India but can be a threat to agricultural commodities if introduced in the country; anticipatory crop health issues and the diseases/pests of quarantine importance.

Possible Collaborating Institutes: ICAR–NCIPM, ICAR - NBAIR, ICAR - NBAIM, ICAR – NBPGR, DPPQ&S

Following are the main objectives of the collaborative multi-institutional network project:

1. Updating status on spatial and temporal distribution of nationally important diseases/pests of major crops for precision in resistant gene deployment strategy
2. Monitoring new variants of pests/pathogens of agricultural crops as consequent upon climate change and breakdown of resistant genes for strategizing preemptive breeding of resistant cultivars
3. Keeping track of foreign pests/pathogens invading into the country through natural dispersal, transboundary movements and quarantine procedures

Outcome

Breeding for disease/pest resistance or biotic stresses is a viable and ecologically safe option available to minimize loss due to various diseases/pests of agricultural crops. The management of biotic stresses in agricultural crops is possible by deploying the resistance genes. Information generated on distribution and intensity of pests/pathogens as proposed in the network project will be of utility to bring in the precision and rationale for gene deployment strategies while breeding for region specific resistant varieties of crops. By erecting suitable genetic barriers, it will be possible, to delay the spread of diseases/pests in the major cultivating areas. Also it will be possible to develop prediction systems of diseases and pests which are prerequisites and supplementary approaches for devising an efficient management strategy to manage biotic stresses of agricultural crops.

Work Plan
Project Activities: NIBSM will be nodal executive agency
1. Nationwide disease/ pest survey and surveillance including invasive pests/pathogens: NIBSM and DPPQ&S
2. Isolation and primary cultures of field isolates of causal agents : NIBSM and NCIPM

3. Repository of causal agents monitored and isolated in the project: NBAIM (Fungi, bacteria, virus, nematodes etc.), NBAIR (Insect, nematodes etc.)
4. Monitoring of quarantine pests in import/export consignments : NBPGR

B. INTER-INSTITUTIONAL PROJECTS (IIP)

IIP-Project 1: Climate change effects on chemical ecology and one health parameters

Climate change**,** periodic modification of earth's climate brought about as a result of changes in the atmosphere as well as interactions between the atmosphere and various other geologic, chemical, biological, and geographic factors within the Earth system. Climate changes impacts on both biological systems human population and Agriculture but their relationship is less understood. Each species responds to environmental changes differently, and in order to predict the movement of disease through ecosystems, we have to rely on expertise from the fields of veterinary, medical, and public health, and these health professionals must take into account the dynamic nature of ecosystems in a changing climate.

Climate change is influencing tri-trophic interaction in Agriculture and also impact on diversity and abundance of arthropods, geographical distribution of insect pests, population dynamics, insect biotypes, herbivour plant interaction, activity and abundance of natural enemies, species, extinction and efficacy of crop protection technologies. Global warming will also reduce the effectiveness of host plant resistance, transgenic plants, natural enemies, biopesticides and synthetic chemicals for pest management. Global warming enriches the spread of insect borne diseases and also encounters the invasive pests.

One Health refers to a collaborative, multi-sectoral and trans-disciplinary approach to achieve optimal health and well-being of plant, soil, animal, people, and their shared environment, recognizing their inextricable interconnections. The importance of One Health is to integrate the activities of the various organizations that play a role in addressing plant, animal, human and ecosystem health issues. Applying the One Health approach to the microbiome requires examination of both pathogenic and non-pathogenic microbial transfer between plant-soil-animal, human and their shared environment. These transmission relationships and implications of microbiome relationships between the environment and the health of the plant, soil, animal and human inhabiting an agro-ecology are less studied and it opens the potential for innovative and holistic approaches to diagnosis, treatment and intervention for biotic stress management in Agriculture. The role and importance of advanced research laboratories is focused on plant-soil- animal- human health under one health approach, especially in the diagnosis, prevention and control of infectious diseases and the prevention of zoonoses and phytonoses.

This programme aims at elucidating the interaction effects between the one-health parameters and the components of the climate change.

Objectives

1. Climate change influence on components tri-trophic interaction in Agriculture.
2. Study on population dynamics, adaptive and herbivory behaviour of sucking pests of crops under varied climate change parameters
3. Effects of climate change parameters on One health components (including zoonoses and phytonoses)

Major Activities:

1. Identifying effects of elevated CO_2 and temperature on population/predatory/parasitic activities of pests and their natural enemies

   Collaborating Institutes: CRIDA, Hyderabad, IARI, New Delhi, MS University, Tamil Nadu

2. Studies on population structure, growth and developmental changes/adaptations in sucking pests under elevated CO_2 and temperatures

   Collaborating Institutes: CRIDA, Hyderabad, IARI, New Delhi, IIHR, Bengaluru, ICAR-Complex for Eastern Region, Regional Centre, Ranchi

3. Surveillance, monitoring and epidemiology of zoonotic and phytonic diseases associated with changing climatic condition and exploring the global strategies for potential preventive measures to protect public health.

Collaborating Institutes**:** ICAR-IVRI, Izatnagar, ICAR-CIFE, Mumbai, ICAR-NRC on Meat, Hyderabad

Sub Project 2: Chemical ecology

Phyto-chemicals are experiencing a revival due to their eco-toxicological properties. Plants play pivotal roles in ecological systems and are potential alternatives to currently used chemical insecticides, because they constitute a rich source of bioactive chemicals. The plants used for pest insect control and found that there is a strong connection between medicinal and pesticidal plants. Secondary compounds from medicinal plants are being substituted for synthetic insecticides. However, the information on the presence of bioactive novel insecticidal bio-molecules is lacking which would be useful to enhance their utility in the field of pest management of crops also.

Objectives

1. Isolation, characterization and utilization of insecticidal bio-molecules of plants origin for management of economically important insect pests
2. Identification, isolation and characterization of semio-chemical molecules for management of insect pest of economic importance
3. Understanding the evolution of resistance mechanism of sucking pests affecting economically important crop plants

IIP-Project 2: Ecological foundation of pest dynamics and their control in emerging production systems

Intensive measures have been taken for crop protection against pests through the widespread use of chemical pesticides in order to reduce the loss of agriculture yield. Although crop protection practices have reduced the overall potential losses of 50 % to actual losses of about 30 %, crop losses due to pests still vary from 14 to 35 % according to the country. Moreover, consequences of this intensive agriculture are now well known with an important increase of atmospheric CO2 concentrations, water pollution and biodiversity loss.

Current challenge is thus to design alternative sustainable cropping systems which maintain food production while reducing externalities. Application of ecological principles to agroecosystems has been proposed for that purpose. Nonetheless, it is difficult since crop systems are characterised by frequent and high disturbances, high nutrient input and high pressure of human activities. The alternatives are emerging such as Conservation agriculture (CA) and organic farming (OF). CA has potential to improve productivity and soil quality, especially soil organic matter (SOM) build-up. In India, CA is mostly studied for crop and water productivity, economic profitability and few short-term effects on soil properties, primarily chemical and physical. The residue retention provides shelter to the pathogen but the reports of increased disease is not there in CA production system. The use of crop residues in cropping systems under CA might gives opportunity for transgression of pest from one crop to another and hence there could be chances of non-conventional pest in the succeeding crops. In contrast, the global report on the increased biodiversity might decrease the biotic stresses due to increased natural enemies in CA. With this background, we hypothesized that in new production system *should be studied thoroughly for biotic stresses in order to its enhanced adoption in India.* Hence, it is proposed to understand weed, insect and disease dynamics in conservation agriculture and in organic farming based new production systems in India.

Objectives:

1. To study pest dynamics under long-term conservation agriculture and organic farming
2. To develop prediction models of pest dynamics under long-term conservation agriculture and organic farming system

Expected outcome:

- Understanding dynamics of pests and natural enemies and prediction models for management of biotic stresses in crops

Possible collaborating Centres

ICAR-IARI, BISA, Ludhiana/ Jabalpur/ ICAR Research Complex for North Eastern Hill Region, Barapani

IIP-Programme 3: Dissecting tripartite interaction in crops affected simultaneously with biotic and abiotic stresses

Project: Dissecting tripartite interaction through system biology approach in crops affected with soil borne pathogen and moisture stress

Pulse, oilseed and vegetable crops are susceptible to a combination of biotic and abiotic stresses. These crops are susceptible to various diseases including those caused by soil-borne pathogens. The soil borne fungal pathogens from the genera *Fusarium, Sclerotium, Rhizoctonia* are the important pathogens of different pulse and vegetable crops causing enormous loss to the crop yield and it is further made worse by the abiotic stress such as moisture stress or drought which is likely to be the major effect of climate change.

There is extensive literature available on the response of plants to single stress, however, studies of plant response to combination of or multiple stresses are limited. These few studies revealed that plants grown under combined stresses act differently and evoke distinct networks, which could not be extrapolated from data of individual stresses, though, common features of stress responses were found in several studies. Moreover, the simultaneous occurrence of different stresses results in a high degree of complexity in plant responses, as the responses to the combined stresses are largely controlled by different, and sometimes opposing, signaling pathways that may interact and inhibit each other. Plant molecular responses to single abiotic stresses, such as drought as well as to biotic interactions, such as insect and pathogen attacks, have been gradually elucidated. These responses are modulated by a complicated network of signaling pathways induced by a variety of small molecules, including Ca^{+2}signaling, reactive oxygen and nitrogen species and phytohormones. Hormones and hormonal cross-talk play an important role in the molecular mechanisms that optimize plant responses to stresses which commonly occur simultaneously. The most information at the gene level comes from combined bioinformatics and experimental studies in which it is noted that cohorts of genes show responses to a diverse range of biotic and abiotic stresses suggesting that such genes play roles in response to combined stress.

With the increase in extreme weather events due to climate change and the constant pressure of diseases, there is an urgent need to develop crop varieties that can tolerate multiple stresses but for this to happen knowledge of how plants broadly respond to multiple stresses is essentially required. There is, therefore, a need to understand the similarities and differences among stress response pathways. The project aims to elucidate that how the genes, hormonal homeostasis and signaling pathways that contribute to the resistance or tolerance of crops towards combined biotic and abiotic stresses. Systems biology approaches facilitate a multi-targeted approach to identify regulatory mechanism in complex networks. Systems biology takes the molecular parts (transcripts, proteins and metabolites) of an interaction and attempts to fit them into functional networks to describe and predict the dynamic activities in different environments. In the proposed project one crop each from pulses and vegetables will be taken to study the interaction of two stresses moisture stress and Fusarium wilt disease. Thus, two host-pathogen combination viz. Chickpea- *Fusarium oxysporum* f.sp. *cicieri* and Tomato-*Fusarium oxysporum* f.sp. *lycopersicae*will be taken to study the tripartite interaction.

Objectives

1. Understanding the phenotypic effect of combined stresses of fusarium wilt pathogen and moisture stress in chickpea and tomato when applied simultaneously or sequentially.
2. To study the transcriptional changes induced by combined stress of pathogen and moisture stress (comparative transcriptomic analysis).
3. Global profiling of phytohormones changes and key metabolites in response to the pathogen and moisture stress in plants.
4. Functional validation of key gene(s) involved in phytohormones biosynthesis in response to the combined stress.

Expected outputs

1. The identification of genes from the pulse/vegetable crops with the ability to alter the interaction under moisture stress conditions and thus will lead to better understanding of the interaction of combined stresses.
2. Elucidating the gene regulatory networks underlying plant transcriptional responses to both biotic and abiotic stresses.
3. The study will be useful in the identification of genes which enhance the resistance/tolerance of plants to soil-borne pathogens under moisture stress or drought conditions.

4. Data from systematic combined stress studies can be used to predict the occurrence of stresses in the future for various drought-affected regions by simulation modelling to assist in the development of strategies to overcome the combined stress effect.

Possible Collaborating centres: ICAR-NIASM, Baramati, IGKV, Raipur

C. INSTITUTE PROJECT (IP)

IP-Project 1. Characterization and Sustainable Use of Pathogen and Pest Genetic Resources (PPGR) for Biotic Stress Management

A healthy biodiversity provides a number of natural services including ecosystem services, biological resources and social benefits like research, education and monitoring, recreation and tourism and cultural values. India has vast biodiversity of pathogen and pest which are responsible for huge loss of crop productivity. Globally, many countries including India have established collections of specific nature namely Department of Agriculture and Food, Western Australia Plant Pathology Collection (WAC), Australia; Culture of Phytopathogenic Fungi, Brazil; French Collection of Plant Associated Bacteria, France; Collection of Plant Pathogenic Bacteria, The Netherlands; Collection of Non-Pathogenic Microorganisms for Agriculture, Russia and South African Plant Pathogenic and Plant Protecting Bacteria (PPPPB), South Africa and Agricultural Pest Repository, Israel; National Agriculturally Important Microbial Culture Collection (NAIMCC), Mau, India; National Centre for Microbial Resource (NCMR), Pune, India; Indian Type Culture Collection (ITCC), New Delhi and National Fungal Culture Collection of India (NFCCI), Pune, India are of general nature holding all kind of microbes of agriculture, industry, medical importance but specialized collection for management of biotic stress is not available in the country. Further, only ICAR-National Bureau of Agriculturally Important Resources (ICAR-NBAIR) has developed a small repository of live insects. The ICAR-NIBSM, Raipur is a specialized institute-cum-Deemed to be University with mandate to study epidemiology of diseases caused by pathogen and pest, unravel mechanisms operating or induced by biocontrol agent to manage biotic stress in agriculture. In order to achieve this goal, the ICAR-NIBSM is planning to develop a collection of "*Pathogen and Pest Genetic Resource (PPGR) for Biotic Stress Management"* which may hold cultures of pathogen and pest procured from all over the country including Chhattisgarh state for their characterization, conservation and sustainable utilization in basic and strategic research at this institute and elsewhere in the country. The following objectives are being set to achieve goal set:

Objectives

1. Procurement, cataloguing, characterization and conservation of prevalent pathogen and pest genetic resources (biotypes/pathotypes/strains/insects) to develop a small collection.
2. Generating resources (genotypes/differentials/molecular markers) for rapid identification and characterization of PPGR in different crops in phase-wise manner.

Expected outcome

(1) New/novel taxa/strain/race/pathogen/differential/pest may be discovered.
(2) New niche/host may be identified for pathogen and pest.
(3) Invasive pathogen and pest may also be identified.
(4) Bar-code of pathogen and pest may be developed.

(5) Novel microbes with specific traits may be registered or submitted for any other IP assets.

Possible collaborating centres: ICAR-NIBSM may develop desired form of collaboration (MoU/SMTA/MTA) with National Centre for Microbial Resources, Pune, Maharashtra; National Bureau of Agriculturally Important Microorganisms, Mau, UP; ITCC, Plant Pathology Division, ICAR-IARI, New Delhi; ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka and National Fungal Culture Collection of India, Agarkar Research Institute, Pune and AICRP centres which are collecting desired pathogen and pest as and when required to carry out specific work.

IP-Project 2. Molecular biology of host-pest/pathogen interaction

Plant immunity is an elaborate, multi-layered system involving several lines of defense. In order to get access to nutrients from the plant and complete its lifecycle, a successful pathogen has to pass first the plant passive defense mechanisms. These include structural barriers such as the cuticle, the cell wall, and constitutively produced anti-microbial compounds. In addition to these passive mechanisms, plants possess a two layered actively induced immune system. The first layer of the immune response is termed pathogen-associated molecular-pattern (PAMP)-triggered immunity (PTI). PAMPs are broadly conserved microbial molecules that are perceived by plant surface-exposed receptors called pattern recognition receptors. In many cases, PTI is sufficient to fend off pathogen attacks and keep plants healthy. The second layer of plant defense, called effector-triggered immunity (ETI), is mediated by intracellular resistance (R) proteins that recognize molecules injected by pathogens into plant cells designated. By contrast to PTI, which confers resistance against a broad group of microorganisms, ETI is specific to isolates of microorganisms producing a given effector, and leads to a complete resistance response often accompanied by a rapid programmed cell death reaction called the hypersensitive response. Similarly, in case of insect damages plants species are well related to damage associated molecular-pattern (DAMP). The war between plants and microbe and their co-existence in nature led to evolution of several novel genes, defense mechanisms, emergence of new races/biotypes of pathogens to mitigate resistance imposed by plant for their survival. Many of the genes, regulatory elements, metabolites and pathways in plants have been identified till now. The mechanisms of these elements in disease pathogenesis or defense pathways in plants in total contributing to susceptibility and resistance are very limited to manage the crop pest and disease. These understanding are not sufficient to address the emergence and re-emergence of pest/pathogen in crop species and damaging in an epidemic proportion. Therefore, the institute will take up this programme for another five year period to understand molecular interaction between plant-microbe interaction studies with the following sub-programme mode. This programme specifically address identification of host susceptible factors and non-host factors contributing resistance mechanisms, endophyte-host interaction, epigenetic regulation of disease reactions, identification of biotic stress induced promoters and regulatory elements, development of novel donors for resistance genes in crops and utilizing genome editing techniques for enhance resistance to crop pest and pathogen.

For the past two decades, progress in molecular analyses of the plant immune system has revealed key elements of a complex response network. Current paradigms depict the interaction of pathogen-secreted molecules with host target molecules leading to the activation of multiple plant response pathways. Further research will be required to fully understand how these responses are integrated in space and time, and exploit this knowledge in agriculture. Systems biology is a promising approach to reveal properties of molecular plant–pathogen interactions and predict the outcome of such interactions. This has network and integrating multiomics data and predicts cell phenotypes, reconstruction of multiscale mechanistic models and the connection of host and pathogen models. To study this sub-programme need advance cytology, proteomics and metabolomics facilities in the institute. This approach will give more appropriate in understanding host-pathogen interaction and their outcome for management of the biotic stresses in crops. Therefore, the following two sub-programmes have been proposed with following objectives

Sub project 1: Molecular understanding of Host /Non-Host-Microbe interactions

Objectives

(1) To identify the molecular events and key regulatory elements lead to host susceptibility and resistance to various pathogens and microbes
(2) To identify the mechanism of non-host resistance/ plant immunity to various economically important pathogens/microbes
(3) To enhance tolerance to various biotic stresses in crops using genome editing tools.

Sub Project 2: Enhancement of multi-stress tolerance to crop plants

Objectives

(1) To identify master regulators and mechanism of multi-stress tolerance for important stresses to the selected crop plants
(2) To develop super donors for multiple biotic stress tolerance in the selected crop plants.

Sub Project 3: Genetic and Molecular Resources for Stress Tolerance

The resistance and susceptible varieties/ cultivars, germplasm lines, wild species are the potential genetic resources and base for studying the mechanism of tolerance and for developing donors containing resistance genes/ regulatory elements. These sources will link to other programmes to carryout advance studies. It has major roles are to procure only biotic stress related crop resources from national and international sources and routine maintenance of these plant genetic material and developing novel genetic base material for biotic stress tolerance to crops for further breeding or other programmes taken up by commodity based institutes. This programme will also identify novel molecules/ biochemical compounds involving in biotic stress tolerance in crops, characterization and utilization.

Objectives:

(1) To procure and maintain various genomic resources only related to biotic stress of crops
(2) To develop novel genetic material for developing stress tolerant varieties by commodity based institutes/SAUs
(3) To identify and characterize novel molecules/ biochemical involving in tolerance to crop pests and diseases.

Sub Project 4: System Biology Research for Understanding Biotic Stress tolerance

Objectives

(1) To develop omics core data base for analysis and understanding biotic stress tolerance
(2) To establish co-expression network analysis to understand gene expression and metabolite pathways linked to biotic stresses

12. List of RAC members of ICAR-NIBSM, Raipur

1.	Dr. C. D. Mayee Former Chairman (ASRB)	Chairman
2.	Dr. V. V. Ramamurthy Ex. Principal Scientist (Entomology), IARI, New Delhi	Member
3.	Dr. P. Ananda Kumar Ex. Project Director, ICAR-NRCPB, New Delhi	Member
4.	Dr. S. S. Singh Ex. Director, IIWBR, Karnal	Member
5.	Dr. M. Anandaraj Former Director, IISR, Calicut	Member
6.	Director ICAR-NIBSM, Raipur	Member
7.	ADG (PP&B) ICAR, Krishi Bhawan, New Delhi	Member
8.	Two persons representing agriculture/rural interests on the Management Committee of the Institute in terms of Rule 66 (a) (5) for the period of their membership of the Management Committee	Member
9.	Dr. Pankaj Kaushal Joint Director (Research), ICAR-NIBSM, Raipur	Member Secretary

Proceedings of the 5th meeting of the Research Advisory Committee (RAC)

ICAR-National Institute of Biotic Stress Management (ICAR-NIBSM)

Baronda, Raipur, Chhattisgarh

(21st November 2020)

Fifth meeting of the Research Advisory Committee (RAC), ICAR-NIBSM was held on 21st November, 2020 under the Chairmanship of Dr. C.D. Mayee, Former Chairman, ASRB, New Delhi. He attended the meeting physically at NIBSM campus alongwith Dr. P.K. Ghosh (Director, ICAR-NIBSM, Raipur) and Dr. P. Kaushal (Joint Director (Research) and Member Secretary (RAC), ICAR-NIBSM, Raipur). Other RAC members who attended the meeting on-line (video conferencing) included Dr. V.V. Ramamurthy (Ex-Principal Scientist, Division of Entomology, ICAR-IARI, New Delhi), Dr. S.S. Singh (Ex-Director, ICAR-IIWBR, Karnal), Dr. P. Ananda Kumar (Ex-Project Director, ICAR-NIPB, New Delhi), and Dr. Y.P. Singh (ADG - PP&B), (ICAR, New Delhi).

Dr. P.K. Chakrabarty (Member, ASRB and Ex-ADG (PP&B), ICAR), Dr Himanshu Pathak (Director, ICAR-NIASM, Baramati), Dr. A. Pattanayak (Director, ICAR-IIAB, Ranchi) and Dr. Jitendra Kumar (Director, IPFT, Gurugram) also attended the RAC meeting as special invitees through virtual mode. This meeting was also attended by NIBSM Joint Directors; Dr. Jagdish Kumar (JD-SCHBR), Dr. S.K. Ambast (Acting JD-Education), Section In charges; Dr. Anil Dixit, PS (Agronomy) & I/c Resource Management and Technology Management section, Dr. S.K. Jain, PS (Plant Pathology) & I/c Pathology and Microbiology Section, Dr. R.K. Murali Baskaran, PS (Agricultural Entomology) & I/c Entomology and Nematology Section and Dr. P.N. Sivalingam, PS (Biotechnology) and I/c Biotechnology Section. All other the scientists of the Institute also witnessed the meeting through virtual mode.

The Chairman attended the meeting by travelling to Raipur as he was keen to see the infrastructure and scientific progress physically and hence, took all necessary precautions against the pandemic and attended the meeting to encourage the scientists working under constraints. The Chairman along with the Director and Joint Directors visited the new facilities being developed as per the plan and appreciated the upcoming infrastructure of the Institute. He felt that the time is ripe for NIBSM to take up massive educational programme in some of the core areas of the institute mandate. Hostels, Labs, Library Admin Block is nearing completion and it is essential for ICAR to grant enough scientific and other staff to take lead in teaching and research projects.

The meeting started with the welcome address of Dr. P.K. Ghosh, Director, ICAR-NIBSM, Raipur. He also briefed about the development, establishment and achievements of the Institute. He thanked the RAC for their advice in formulating research programmes. The Director also appreciated all the JDs and Scientists for coming out with good research progress as well as for their contribution in the infrastructure development with limited manpower and facilities. However, a concern was also expressed on long-pending issue of posts creation which has significantly hampered the progress of establishment of the Institute. Further, he also proposed a detailed outline of unifying the plant protection research in India explaining a hub-and-spoke model on *'Entrusting NIBSM with a role of nodal institute of plant protection research in ICAR'*, whereby as per the mandate, basic and strategic research on biotic stress management will be carried out at NIBSM, while other PP institutes/AICRPs shall take over the applied aspects in a synergistic mode.

The Chairman, Dr. C.D. Mayee congratulated the founder Director on his joining and wished greater heights in the development of the institute with his wide experience. He also appreciated efforts of the past Director (Acting) Dr. Jagdish Kumar, Joint Director (SCHBR) for establishing the infrastructure. The Chairman also congratulated Dr. P. Kaushal, JD (Res) for his efforts on establishing and stream-lining research of the institute. He congratulated the staff members of the Institute for working under limited facilities with tremendous devotion. He emphasised to take immediate steps required for enriching the scientific and administrative manpower along with infrastructure establishment. He also appreciated the idea of inviting NIASM and IIAB Institutes for the RAC meeting and advocated to undertake collaborative research on combination of biotic and abiotic stress management. He further advised that this institute should concentrate on basic and strategic research along with enriching education system in an inter-university collaboration mode. Use of advance technologies (like CRISPR) was advocated to be developed for rapid disease diagnosis. In addition, the Institute should conduct basic research in biotic stresses while the validation and applied part be undertaken by the respective AICRPs. For this, active collaboration and coordination with AICRPs is required to be established. Further, the feasibility of NIBSM as nodal centre for plant protection research was discussed, and the programme, plan and the initiatives were appreciated. Dr Mayee further suggested that some basic research areas like molecular biology of HxP interaction, pest risks, bioterrorism, biosafety-biosecurity research, genome editing be initiated in due course of time which will strengthen the teaching also. In education he emphasized that the pattern adopted by CSIR-IISER, Pune can be suitably modified for our teaching program. He reiterated once again that NIBSM should have working labs where the teachers and researchers from SAU's or other Institutes could come and work for 4-6 months on Institutes projects or some linkage programmes. The member secretary already visited IISER-Pune the facility created at Inter-University centre in Astrophysics as a model to be used for NIBSM.

Dr. S.K. Ambast, JD (Education) presented the progress made in establishing the education system at NIBSM that included the measures taken up during the last one year, MoU with ICAR-IARI, New Education Policy (NEP) 2020 and its future impacts. A road map for establishing education system at NIBSM was presented highlighting the institutes' association with IARI for establishing and developing new curriculum, developing new courses and detailed plan of implementation for higher education, and accordingly the intake of students. The committee suggested that along with this institute, other two contemporary institutes viz., NIASM, Baramati and IIAB, Ranchi should concentrate on higher education (Master's degree and above). The members suggested that before implementing higher education to full capacity, priority must be given to achieve adequate staff strength of the institute and development of the required infrastructure. Research should be based on common philosophy of stress tolerance; effective collaboration with traditional universities and institutes be explored for harvesting maximum benefits in areas of basic research. While establishing all these areas, institute should develop unique and special courses involving latest technological interventions in crop biotic stresses to deal the biotic stresses at global level, such as epidemiology, biosecurity, registration and application of biopesticides, etc. Simultaneously, approval of unique courses should be sought from ASRB/ICAR for better job opportunities at national and international levels. The RAC further suggested to formulate a committee to address issues with the education system for NIBSM, NIASM and IIAB.

Dr. S.K. Jain, I/c PME presented the action taken report of the recommendation of the 4th RAC meeting. All points were discussed in detail and the members expressed their satisfaction on the ATR. They further advised to emphasise on the post-creation for Scientific, administration and technical staff in forthcoming interactions with the Council/Ministries. The Chairman mentioned that all recommendations of the 4th RAC meeting were accepted by the Council, except one regarding the change of mandate of the Institute. The ICAR had mentioned that a separate discussion meeting is required for this purpose and for the time being the Institute should work on the existing well-defined mandate, particularly thinking on designing and continuing programme on *One Health* concept. In this context the ADG (PP&B) mentioned that a meeting at SMD/ICAR level will be convened soon. The proceedings of the 4th RAC meeting was confirmed by the Committee.

Dr. P. Kaushal, Joint Director (Research), ICAR-NIBSM & Member Secretary, RAC presented the achievements of research and outreach programmes of the institute that also included publications, laboratory establishment, stream lining of research programmes and sections. It was also presented that new research programmes were formulated considering recommendations of various committees and the SMD; and SDG priorities/goals were included in the forthcoming EFC (2021-26) proposal. These included three flagship programmes, two inter-institutional programmes and four Institute programmes. The committee appreciated the novelty and scientific importance of the programmes proposed to attain the mandate of the NIBSM. After the detail presentation of research achievements, RAC commented that the research programmes are well designed, however, the projects should be made proportionate to scientific strength and suggested reducing the work load of scientists. RAC advised to have 3-4 major areas of research for better delivery. Programme should be of national/ international importance. The section-wise presentations on research and achievements were made by respective section in-charges. Achievements made under SCSP/TSP/NEH components were also presented by Dr. J. Kumar, JD (SCHBR).

After presentations, distinguished RAC members gave suggestions for future course of action. Dr. P. Ananda Kumar said that the Institute is in infancy stage and should collaborate with IARI and look for ways to provide joint degrees. Simultaneously, increase in the number of faculties by requesting ICAR and developing infrastructure for laboratories and other facilities is also required. Institute should work on the development of protocols for early detection of pests and pathogens. Number of research projects may be reduced or clubbed to address issues of common philosophy in biotic stress management. More importance needs to be given to research in programme mode using multidisciplinary and inter-institutional team of scientists. Repetition of research work already being undertaken by crop-based institutes should be avoided.

Dr. V. Ramamurthy emphasized for integration of research programmes to make it multidisciplinary. Identify the crops with more challenges in biotic stresses and detailed studies be made for entire spectrum of biotic stress and their interaction with abiotic factors. Identification of major research areas be made to carry out focussed basic and strategic research. Institute should develop inter-institutional education centre and reorient in multiple directions. As the infrastructure is now completed, in forthcoming sessions, the institute should shift research and education from *Sections-mode* to *Schools-mode*.

Dr. S.S. Singh congratulated the scientific staff of NIBSM for their contribution in research and development. He expressed that the Institutes' contributions in different areas of biotic stress as well as development of linkages and collaborations with various institutions and universities for agricultural research and education in a short time is appreciable. He also congratulated for establishing the infrastructure within the time frame. Keeping in view the shortage of staff for research, teaching and extension services, he proposed proactive efforts to be undertaken to fill up the vacancies. One post should be created for digital technology expert, as this technology will play a significant role in modernizing and organizing agricultural activities in rural India. Artificial intelligence (AI) can help in increasing productivity and profitability of farmers and it has been identified as one of the areas under India's national AI strategy. Projects on development of super donors should be taken up in other important food crops. These super donors should be developed for different agro-climatic zones of a crop carrying tolerance to multiple stress of that zone.

Dr. P.K. Chakrabarty expressed that recognition of 15 faculty members by the IARI is a welcome step. In the education programme, conventional courses must be avoided which are already being taken up by IARI and SAUs. However, new courses like molecular diagnostics, biosecurity and biosafety, nanotechnology-based pesticides/biopesticides etc. which are compatible with Govt. policy must be designed and executed. The Institute should also focus on biosafety, biosecurity, agro-terrorism and epidemiological studies on transboundary and emerging pests, nanotechnology-based fertilizers, pesticides, developing eNose and acoustics-based diagnostics, endophyte research collaborations with AMAAS, identification of potential targets for genome editing for disease resistance, herbicide tolerance (herbicide binding site modification), etc. He further emphasised that Policy research is very important and should be taken on priority. Initially, a policy document on agro-losses due to biotic stresses and map of invasive pests in and around the country may be documented to initiate preparedness to counter biosecurity threats.

Dr. Y.P. Singh, ADG (PP&B) stressed that a methodology and system is to be developed for all the three Institutes (IIAB, NIASM and NIBSM). A meeting can be organized with these institutes and DDG (CS) in this regard. He assured ICAR proactive support for the development, research and education of these Institutes.

Interactive session on identifying research collaboration areas between IIAB, IPFT, NIASM with NIBSM

An Interactive session on identifying areas for research collaboration involving NIASM Baramati, IIAB Ranchi, NIBSM Raipur and IPFT Gurugram was also organized during the meeting. This interaction started with brief introduction by the Director, ICAR-NIBSM, where he specifically mentioned that most of the RAC recommendations were included in the new EFC (2021-26). He emphasized that, in these institutes, the research and education should focus on understanding basic molecular mechanisms of biotic and abiotic stresses. Dr. P. Kaushal, JD (Res) made a presentation regarding collaborative programmes and projects submitted by ICAR-NIBSM, Raipur for funding under NASF and also which are proposed in the new EFC (2021-26). He also presented the two project proposals, in the collaboration with IIAB, which are in advanced stages of finalization.

Dr. H. Pathak, Director, ICAR-NIASM, Baramati stressed to develop information system for entire agriculture stresses using informatics tools, climate smart agriculture system for biotic and abiotic stresses, stress management on new and under-utilized crops. He emphasized that and all the three institutes should work under one umbrella on new education policy.

Dr. A. Pattanayak, Director, ICAR-IIAB, Ranchi briefed the progress made in establishing collaboration with NIBSM in developing super donor and transcriptomic studies in finger millet – blast interactions. He opined that the three institutes should collaborate in research areas like clear field technology, local races analysis to generate information with future impacts and also to formulate a mechanism for collaborations in education (teaching and research guides).

Dr. Jitendra Kumar, Director, IPFT, Gurugram expressed willingness to collaborate for product formulation development and testing of bio pesticides and other pesticides in larger scales. He emphasized potential of collaboration to explore the bio-diversity for bio control agents in Chhattisgarh. He also proposed extending the infrastructure/ facilities at IPFT to be utilized for research purposes by these three Institutes.

Some of the points to proceed further emerged included:

I. Formulating short-term (2-3 years) as well as long term projects (5-10 years) of common interest involving collaboration of three Institutes.
II. Formulation of teaching courses in emerging field of stress biology at national and global level, to address future issues.
III. Change from *Section-mode* to *School-mode* for research and education, as per the Cabinet note.
IV. More focus to be laid on underutilized and dryland crops such as pulses, oil seeds, small millets and fodders as compared to major crops.

At the end, Dr. P.K. Ghosh, Director, NIBSM expressed gratitude to Chairman and all the members and special invitees for their critical analysis, suggestions and assured for time-bound delivery of results with efficient collaborations.

The meeting ended with formal vote of thanks proposed by Dr. Jagdish Kumar, JD (SCHBR).

14.1.21

(P. Kaushal)
Member Secretary, RAC

(C. D. Mayee)
Chairman, RAC
(approval received by email, dt 14.01.21)

List of RAC members, special guest and invitees who attended the 5th RAC meeting held at ICAR-NIBSM, Baronda, Raipur, on 21st November 2020:

1. **Dr. C. D. Mayee**, Chairman RAC and Former Chairman ASRB.
2. ***Dr. S.S. Singh**, Member RAC, Ex-Director, ICAR-IIWBR, Karnal.
3. ***Dr. P. Ananda Kumar**, Member RAC, Ex-project Director, ICAR-NIPB, New Delhi
4. ***Dr. V.V. Ramamurthy**, Member RAC, Ex-Principal Scientist, Div of Entomology, ICAR-IARI, New Delhi.
5. **Dr. P. K. Ghosh**, Member RAC, Director, ICAR-NIBSM Raipur.
6. ***Dr Y. P. Singh**, Member RAC, Assistant Director General (PP&B), ICAR, New Delhi
7. ***Dr. P.K. Chakrabarty**, Special Invitee, Member, ASRB and Ex-ADG (PP&B) ICAR New Delhi.
8. ***Dr. A. Pattanayak**, Special Invitee, Director ICAR-IIAB, Ranchi
9. ***Dr. H. Pathak**, Special Invitee, Director ICAR-NIASM, Baramati
10. ***Dr. Jitendra Kumar**, Special Invitee, Director, IPFT Gururam
11. **Dr. Jagdish Kumar**, Joint Director (SCHBR), ICAR-NIBSM Raipur
12. **Dr. S. K. Ambast**, Joint Director (Education) (Acting), ICAR-NIBSM Raipur
13. **Dr. Anil Dixit**, PS, section I/c Resource Management and Technology Management, NIBSM Raipur.
14. **Dr. S.K. Jain**, PS, I/C PME & I/c Pathology and Microbiology Section, NIBSM Raipur.
15. **Dr. R.K. Murali Baskaran**, PS & I/c Entomology and Nematology Section, NIBSM Raipur.
16. **Dr. P.N. Sivalingam**, PS & I/c Biotechnology Section, NIBSM Raipur.
17. **Dr. P. Kaushal**, Joint Director (Research), Member Secretary, RAC, NIBSM Raipur.

* (attended through online/virtual mode)

Recommendations of the 5th RAC meeting

A.	**Infrastructure and manpower**
1.	NIBSM should develop state-of-the art laboratory facilities to attract the researchers from other Institutes/universities as well. A model farm suitable to undertake novel biotic stress management research needs to be developed.
2.	Utmost importance be given to induct the sanctioned staff (Scientific, administrative and technical) which has been emphasized by RAC in its all meetings because this is related to quality research and education and timely delivery and expected outcomes. A follow-up with appropriate Departments shall be taken up on priority.
B.	**Research**
1	NIBSM should shift its research and teaching from *Section-mode* to *School-mode* (as notified in the Cabinet note), this is also related to deployment of more scientific manpower to fulfil minimum scientific cadre strength in each school. Thrust areas for these schools needs to be precisely formulated and accordingly major research programmes need to be devised considering national priorities and recommendation of various committees (RAC, QRT, IRC). These must be of inter-disciplinary and inter-institutional in nature. Suitable provisions be included in the forthcoming EFC (2021-2026).
2	Work-load of the scientist may be reviewed. Projects should be proportionate with the available scientific manpower. Accordingly, prioritization and clubbing of the project be made.
3	Basic studies must be taken up to understand common philosophy of stress tolerance (individual as well as combined effects of biotic and abiotic stresses) in group of crop plants, especially underutilized crops (dryland crops, pulses, oil seeds, millets, fodders etc.).
4	The Institute should study the dynamics of biotic and abiotic stresses, resource availability effects and their interactions under emerging agriculture systems (eg. conservation agriculture, organic farming etc.).
5	Detailed basic research need to be conducted on available leads with NIBSM, including the stress induced promoters, virus transmission, kairomones, silicon induced tolerance, endophytes, gene-editing, epigenetics, super-donors, etc. to understand their molecular basis. Emphasis should be given on pre-breeding and use of innovative methods like genome editing for development/utilization of elite mutants for stress tolerance.
6	Research projects may be taken up on areas targeting early and rapid diagnosis of biotic stresses in crop plants using novel and emerging technologies (such as gene-editing, acoustics, eNose etc.).
7	The institute should design programme on *One Health* concept and also on *Artificial Intelligence* (AI) as these are priority areas under India's national strategies.
8	Collaborate research work in areas of mutual research interest viz; combined tolerance of abiotic and biotic stress, development of super donor e-NOSE etc. , especially with two contemporary institutes, ICAR-NIASM, Baramati and ICAR-IIAB, Ranchi. Both short-term as well as long-term projects may be formulated. This should also involve sharing of ideas, research and core resources (i.e. equipment, labs/facilities etc.), and conduct of regular meetings/workshops of participating researchers. Collaboration with IPFT, Gurgaon having all modern facilities for product formulation development and

	testing of bio pesticides and other pesticides in larger scales as one of the testing centre would be useful.
9	In the years to come, NIBSM with required infrastructure and manpower facilities should come up as centre of excellence in plant protection research and education. Therefore, a proposal document on the Hub and Spoke model for 'Entrusting NIBSM with a role of nodal institute of plant protection research in ICAR' be immediately prepared and submitted to the ICAR.
10	Policy research on biotic stress is very important and should be taken on priority. A policy document on agro-losses due to biotic stresses, biosafety of product and map of invasive pests in and around the country is necessary to initiate preparedness to counter biosecurity threats. Similarly, a document on Good Agricultural practices (GAP) for various biotic stresses in agriculture should be prepared by the Institute.
C.	**Education**
1	ICAR-NIBSM should expand education activities in post graduate courses in view of requirement of Multidiscipline Education and Research University (MERU) of new education policy of the government and prepare a roadmap to attain it by 2030.
2	ICAR-NIBSM should conceive an Inter-University Centre for Biotic stresses to collaborate with various SAUs and research institutes.
3	A committee may be formulated to strengthen the education system of NIBSM, NIASM and IIAB with an aim to develop new courses and detailed plan of implementation. New courses like molecular diagnostics, biosecurity and biosafety, nanotechnology-based pesticides/biopesticides, epidemiological studies on transboundary and emerging pests etc. which are compatible with Govt. policy, should be designed and executed. The approval of these unique courses should be sought from ASRB/ICAR for job opportunities.

Indian Council of Agricultural Research
Room No. 215, Krishi Bhawan, New Delhi – 110 001, India
Phone: 011-2338 4414 (O), FAX: 011-2338 4414 & 23382385
E-mail: adgpp.icar@nic.in

F. No. CS 13-1/2021-PP

Dated: 1st February, 2021

To,
The Director
ICAR-Indian Institute of Biotic stress Management,
Baronda, Raipur
Chhattisgarh 493225

Subject:- Proceedings of 5th RAC Meeting of ICAR-NIBSM , -regarding.

Sir,

Please refer to your e mail dated 22.01.2021 regarding cited subject above. In this context, it is to inform that the proccedings of 5th RAC Meeting of ICAR-NIBSM, Raipur have been approved by the competent authority of council.

This is issued with approval of competent authority of council.

Yours sincirely

1/02/2021
(S.C. Dubey)
Asstt. Director General (PP&B)

भारतीय कृषि अनुसंधान परिषद
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
कृषि भवन, डॉ0 राजेन्द्र प्रसाद मार्ग, नई दिल्ली–110 001
Krishi Bhawan, Dr. Rajendra Prasad Road
New Delhi 110 001

F.No.CS.19/7/2013-IA-III **Dated the: 20 July,2018**

OFFICE ORDER

Under the provisions of Rule 71(A)(a) of the Rules & Bye Laws of Indian Council of Agricultural Research Society, the Director General, Indian Council of Agricultural Research has been pleased to re-constitute the Research Advisory Committee of ICAR-National Institute of Biotic Stress Management (NIBSM), Raipur with the following :-

1.	Dr. C.D. Mayee, Former Chairman (ASRB). 602,Raviram Residency, 13/1 Chitale Marg. Dhantoli, Nagpur-44012, Maharashtra.	**Chairman**
2. i)	Dr. V.V. Ramamurthy, Ex. Principal Scientist (Entomology), IARI, New Delhi.	Member
ii)	Dr. P. Anand Kumar, Ex. Project Director, ICAR-NRCPB, New Delhi (**Biotechnology**). 13-18/24 Nakshatra, Siddhanti, Shamshabad, Hyderbad-501218.	Member
iii)	Dr. S.S. Singh, Ex. Director, IIWBR, Karnal.	Member
iv)	Dr.Anand Raj, Former Director, IISR, Calicut.	Member
3.	Director, NIBSM, Raipur	Member
4.	ADG (PP), ICAR, Krishi Bhawan, New Delhi	Member
5.	Two persons representing agricultural/ rural interests on the Management Committee of the Institute in terms of Rule 66 (a) (5) for the period of their membership of the Management Committee.	Member
6.	Dr. Pankaj Kaushal, Joint Director (Research), NIBSM, Raipur.	**Member Secretary**

The term of Chairman and other nominated members will be for a period of three years w.e.f. 15.7.2018 except the members nominated at Sl. No.5.

The functions, powers etc of the RAC will be as contained in ICAR notification No. 6(1)/93- CSC dated 10.7.94.

(Ashok Kumar Meena)
Under Secretary (CS)
Tele Fax: 23046422

Distribution:-

1. Director, NIBSM, Raipur.
2. All Members of the Committee: to be informed by Director, NIBSM, Raipur.
3. Adm. Officer, NIBSM, Raipur.
4. Sr. PPS to DG, ICAR
5. PPS to DDG (CS), ICAR
6. ADG (PP), ICAR
7. Section Officer (PP),
8. Spare copies(5)