CALL VIII

Project title: Development of sustainable management tools for the invasive pest, Fall Armyworm *Spodoptera frugiperda* (J.E. Smith) in maize

Project Code	:	8001
Duration of the project	:	November 2019 – October 2022
PI Name	:	Dr. J.C. Sekhar
CCPI Names	:	Dr. Kesavan Subaharan
	:	Dr. Vinay Kumari Kalia
	:	Dr. Jyothilakshmi Vadassery
Lead Centre	:	ICAR-IIMR, Hyderabad
Cooperating centres	:	ICAR-NBAIR, Bengaluru
	:	ICAR-IARI, Pusa Campus, New Delhi
	:	ICAR-NIPGR, New Delhi

Objectives:

➢ To identify fall armyworm (FAW) resistant germplasm and decipher mechanisms of FAW resistance in maize

➢ To develop potential bio-pesticides and semi chemicals for managing FAW

➢ To identify suitable agro-ecological techniques to manage FAW

➢ To identify the genomic regions determining resistance to FAW and introduce them in promising inbreds through MAS

➢ To explore RNAi-mediated management of FAW

Achievements

a) Publications:

➢ Soujanya L, Sekhar JC, Yathish KR, Chikkappa GK, Shankar RK, Suby SB, Jat SL Kumar B, Kumar KV, Jyothi LK, Subaharan, Patil J, Kalia VK, Dhandapani A, Rakshit S (2022) Leaf Damage Based Phenotyping Technique and Its Validation Against Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith), in Maize. Frontiers in Plant Science 13: 906207.

➢ Gopalakrishnan R, Kalia V (2022) Biology and Biometric Characteristics of Spodoptera frugiperda (Lepidoptera: Noctuidae) reared on different host plants vis-a-vis diet. DOI: 10.1002/ps.6830.

➢ Patil J, Vaddar Linga V, Vijayakumar R, Kesavan Subaharan K, Navik Om, Bakthavatsalam N, Priyank HM and Sekhar JC (2022). Biocontrol potential of entomopathogenic nematodes for the sustainable management of Spodoptera frugiperda (Lepidoptera: Noctuidae) in maize. Pest Management Science, 78: 2883–2895.

➢ Kumar S, Suby SB, Kumar N, Sekhar JC, Nebapure S, Mahapatro GK (2022) Insecticide susceptibility vis-à-vis molecular variations in geographical populations of invasive fall armyworm, Spodoptera frugiperda (JE Smith) in India.

➢ Soujanya LP, Sekhar JC, Suby SB, Kumari PAP, Divya S, Lava KRM, Jat SL, Rakshit S (2022) Life history and life-table parameters of fall armyworm [(J. E. Smith)] fed on maize in tropical Indian conditions. Indian Journal of Agricultural Sciences.

➢ Suby SB, Soujanya P L, Yadava P, Patil J, Subaharan K, Prasad GS, Babu KS, Jat SL, Yathish KR, Vadassery J, Kalia VK, Bakthavatsalam N, Shekhar JC, Rakshit S (2020) Invasion of fall armyworm (*Spodoptera frugiperda*) in India: nature, distribution, management and potential impact. Current Science 119(1):44-51.

b) Technology Developed:
➢ LC-MS/MS-based quantification method for estimation of major defence metabolite in maize, Benzoxazinoids

Project title: Genome editing for imparting PRSV resistance

Project Code   :   8002
Duration of the project :   November 2019 - October 2022
PI Name   :   Dr. Anirban Roy
CCPI Name   :   Dr. M. Krishna Reddy
Lead Centre   :   ICAR-IARI, New Delhi
Cooperating centre   :   ICAR-IIHR, Bengaluru

Objectives:

➢ Genome editing of papaya eIF4E gene using CRISPR-Cas9 system.

➢ CRISPR-Cas9 mediated editing of PRSV genome by transient delivery system.

Achievements:

➢ Developed and optimized advanced genetic engineering tools and transformation protocols for papaya, including CRISPR/Cas9 and LshCAs13a-based vectors, efficient in vitro regeneration systems, and successfully generated 440 genome-edited plants with confirmed transgene integration and seed collection for next-generation analysis.

Project title: Women Empowerment and Gender Sensitization – Developing a Model for Bridging Gender Gap

Project Code : 8003
Duration of the project : November 2019 - October 2022
PI Name : Dr. Kiran Singh
CCPI Name : Dr. Lipi Das
Lead Centre : CCSHAU, Hisar
Cooperating centre : ICAR-CIWA, Bhubaneswar

Objectives:

➢ To identify and assess gender gap indicators for analysing gender disparity in rural areas.

➢ To design Gender Sensitive Schematic Extension Model for addressing social and technological issues.

➢ To optimize technological interventions for drudgery reduction and promoting empowerment of rural women.

➢ To assess the impact of the interventions in bridging the gender gap.

Achievements

a) **Publications:**
➢ Rani N, Duhan K, Kumari P and Komal (2021) Lockdown impact: Domestic violence against women and girl. International Journal of Current Microbiology and Applied Sciences 10 (1): 259-263. https://doi.org/10.20546/ijcmas.2021.1001.031.

Project title: Generation of BMPR-1B gene edited goats using CRISPR/Cas9 technology to explore the functional role of BMPR-1B gene on goat reproduction

Project Code	:	8004
Duration of the project	:	November 2019 - October 2022
PI Name	:	Dr. Vikash Chandra
CCPI Name	:	Dr. Partho Roy
Lead Centre	:	ICAR-IVRI, Izatnagar
Cooperating centre	:	IIT, Roorkee

Objectives:

➢ Production of BMPR-1B gene knock out goat embryos using improved version of CRISPR/Cas9 gene editing system comprising of single guide RNA (SgRNA) and recombinant SpCas9-HF1protein.

➢ Generation of goat embryos with defined Booroola mutation in BMPR-1B gene using improved version of CRISPR/Cas9 gene editing system.

➢ Generation of BMPR-IB gene edited goats by surgical transfer of BMPR-1B gene edited (knock out or with Booroola mutation) embryos into recipient goats

➢ Monitoring of physiological parameters and reproductive performance of BMPR-1B gene edited Sirohi goats.

Achievements

a) Publications:

➢ Kumar S, Punetha M, Jose B, Bharati B, Khanna B, Sonwane A, jonathan A. Green, Whitwoth K and Sarkar M (2020). Modulation of granulosa cell function via CRISPR-Cas fuelled editing of BMPR-1B gene in goats (*Capra hircus*). Scientific Reports. 10: 20446.

➢ Tripathi MK, Jose B, Khanna S, Konda PK, Anjali, Chauhan VS, Sarkar M and Singh G (2021). CRISPR mediated BMP 15 gene knockout in *Caprine granulosa* cells. The Pharma Innovation Journal. 10(7): 252-255.

Project title: Development of electrochemical sensor tools for soil health analysis

Project Code	:	8005
Duration of the project	:	November 2019 - October 2022
PI Name	:	Dr. J. Mathiyarasu
CCPI Name	:	Dr. P. Kannan
Lead Centre	:	CSIR-CERI, Tamil Nadu
Cooperating centre	:	TNAU, Tamil Nadu

Objectives:

➢ Development of efficient, low cost, easy to use electrochemical (EC) sensor kit for assessing soil health conditions.

➢ Establishing electrochemical protocols for the estimation of soil health parameters (specifically soil macro nutrient contents) with the developed sensor kit.

➢ Validation and optimization of developed sensor kit equivalent to the methods already available in the laboratory / field practices.

Achievements

a) Publications:

➢ Subramanian P, Pakkiyam S, Pandian K, Chinnathambi S, Jayaraman M (2025) Preparation and modification of Prosopis juliflora biochar and Pb (II) removal from aqueous solutions. Biomass Conversion and Biorefinery15:421–435.

b) Patent:

➢ "A HAND-HELD KIT FOR SOIL HEALTH ANALYSIS" -Submitted to CSIR-URDIP for patentability search.

Project title: Understanding molecular basis of host-pathogen-environment interaction of Tilapia Lake Virus Disease

Project Code	:	8006
Duration of the project	:	November 2019 - October 2022
PI Name	:	Dr. P.K. Pradhan
CCPI Name	:	Dr. K.V. Rajendran
Lead Centre	:	ICAR-NBFGR, Lucknow
Cooperating centre	:	ICAR-CIFE, Mumbai

Objectives:

➢ To analyse genome-wide variation in Tilapia Lake Virus (TiLV) isolates from different geographical regions of India.

➢ To decipher the dynamics of gene expression involved in host defense.

➢ To determine the role of microbial co-infection in TiLV disease outbreaks.

➢ To develop high-throughput diagnostic assay for TiLV.

➢ To evaluate the susceptibility of important fish species including carps to TiLV infection, and potential for vertical transmission of TiLV.

Achievements

a) Publications:

➢ Rajendran KV, Sood N, Rao BM, Valsalam A, Bedekar MK, Jeena K, Pradhan PK, Paria A, Swaminathan TR, Verma DK, Sood NK (2024). Widespread occurrence of Tilapia parvovirus in farmed Nile tilapia *Oreochromis niloticus* from India. Journal of Fish Diseases doi: 10.1111/jfd.13871.

➢ Paria A, Yadav SC, Verma DK, Mishra A, Rastogi A, Ravindra, Swaminathan TR, Rajendran KV, Sood N, Pradhan PK (2023). Susceptibility of selected tropical non-tilapine ornamental cichlids to *Tilapia tilapinevirus* following experimental infection, Aquaculture 739224.

➢ Thangaraj RS, Nithianantham SR, Narendrakumar L, Johny TK, Sood N, Pradhan P K and Lal KK (2022) Cichlids endemic to India are not susceptible to Tilapia Lake virus infection. Aquaculture 548, 737589.

➢ Yadav MK, Rastogi A, Verma DK, Paria A, Kushwaha B, Rathore G, Swaminathan TR, Pradhan PK, Sood N (2022) Establishment and characterization of a continuous cell line from caudal fin of *Labeo calbasu* (Hamilton, 1822). Cell Biology International, 1–6.

➢ Rastogi A, Yadav MK, Criollo Joaquin MP, Verma DK, Swaminathan TR, Kushwaha B, Paria A, Pradhan PK, Sood N (2022) Development of cell lines from brain, spleen and heart of ornamental blood parrot cichlid and their susceptibility to

Tilapia tilapinevirus. Aquaculture, 561, 738711.

➢ Verma DK, Sood N, Paria A, Swaminathan TR, Mohan CV, Rajendran KV, Pradhan PK (2022) Reassortment and evolutionary dynamics of tilapia lake virus genomic segments, Virus Research, 308,198625

➢ Rao M, Kumar S H, Kumar S, Bedekar M K, Tripathi G and Rajendran K V (2021) Microbiological investigation of Tilapia Lake virus (TiLV)-associated mortalities in cage-farmed *Oreochromis niloticus* in India. *Aquaculture International*, 29, 511– 526**.**

➢ Yadav M K, Rastogi A, Joaquin M P C, Verma D K, Rathore G, Swaminathan T R, Paria A, Pradhan P K and Sood N (2021) Establishment and characterization of a continuous cell line from heart of Nile tilapia *Oreochromis niloticus* and its susceptibility to tilapia lake virus. Journal of Virological Methods 287, 113989**.**

➢ Pradhan P K, Verma D K, Yadav S C, Dev A K. Swaminathan T R, Paria A, Rajendran K V and Sood N (2021) Carps, *Catla catla*, *Cirrhinus mrigala* and *Hypophthalmichthys molitrix* are resistant to experimental infection with Tilapia Lake virus (TiLV). Fishes 6, 56.

➢ Sood N, Verma D K, Paria A, Yadav S C, Yadav M K, Bedekar M K, Kumar S, Swaminathan T R, Mohan C V, Rajendran K V and Pradhan P K (2021) Transcriptome analysis of liver elucidates key immune-related pathways in Nile tilapia *Oreochromis niloticus* following infection with tilapia lake virus. Fish Shellfish Immunology 111:208-219.

Project title: Exploiting encapsulated nanoparticle conjugated phytochemicals to combat antimicrobial resistance in poultry

Project Code	:	8007
Duration of the project	:	November 2019 - October 2022
PI Name	:	Dr. Deepak B Rawool
CCPI Names	:	Dr. Nitin Vasantrao Kurkure
	:	Dr. Jess Vergis
Lead Centre	:	ICAR-NRC on Meat, Hyderabad
Cooperating centres	:	NVC, MAFSU, Nagpur
	:	CVAC, KVASU, Kerala

Objectives:

➢ To identify specific phytochemicals against multi-drug resistant (MDR) pathogens (*E. coli* and non-typhoidal *Salmonella*) in poultry.

➢ To conjugate and/or encapsulate phytochemicals using appropriate nanoparticles and polymer for their targeted delivery.

➢ To evaluate the phytochemicals for their antibacterial efficacy against targeted MDR-pathogens employing *in vitro* and *in vivo* models and to validate in poultry.

Achievements

a) **Publications:**

➢ Abishad PM, Niveditha, Varsha U, Vergis J, Kurkure NV, Chaudhuru S, Rawool DB, Barbuddhe SB (2021) In silico molecular docking and *in vitro* antimicrobial efficacy of phytochemicals against multi-drug-resistant enteroaggregative *Escherichia coli* and non-typhoidal *Salmonella* spp. Gut Pathogens, 13:46. https://doi.org/10.1186/s13099-021-00443-3

Project title: Delineating the effector biology of phytoplasma affecting selected crop taxa in India with special emphasis on sesame (*Sesamum indicum* L.)

Project Code	:	8008
Duration of the project	:	November 2019 - October 2022
PI Name	:	Dr. Suman Lakhanpaul
CCPI Name	:	Dr. V. Dinesh Kumar
Lead Centre	:	Delhi University (DU), Delhi
Cooperating centre	:	ICAR-IIOR, Hyderabad

Objectives:

➢ Characterisation of the selected effector molecule namely SAP54 from Phytoplasma affected sesame plants and its interacting partners (IP) in sesame and its wild allies.

➢ *In planta* validation of interaction between SAP54 and its interacting partners in sesame, *Nicotiana benthamiana* as well as periwinkle (*Catharanthus roseus*).

➢ Identification of the host genes and the pathways targeted by effector molecules for phyllody development.

➢ Analysis of genetic diversity in the SAP54 from diverse groups of Phytoplasma affecting sesame crop and its associated taxa in different parts of India.

Achievements

a) Publications:

➢ Kalla S, Verma P, Lakhanpaul S (2021) Understanding the evolution of SAP54 a phyllody-associated phytoplasma effector gene through phylogenetic network analysis. Phytopathogenic Mollicutes, 11(1):36-44. https://doi.org/10.5958/2249-4677.2021.00005.0

➢ Verma P, Singh A, Kalla S, Lakhanpaul S (2021) Occurrence of CpG islands in differentially methylated loci in sesame upon phytoplasma infection. Phytopathogenic Mollicutes, 11(1):45-50. https://doi.org/10.5958/2249-4677.2021.00006.2

Project title: Pork Marketing Chains in North East India for Sustainable Livelihood of Tribal Women (Assam, Meghalaya and Nagaland)

Project Code	:	8009
Duration of the project	:	December 2019 - November 2022
PI Name	:	Dr. Mahua Bhattacharjee
CCPI Names	:	Dr. Kadirvel Govidaswamy
	:	Dr. Mahak Singh
	:	Dr. Misha Madhavan M.
Lead Centre	:	Amity University, Noida
Cooperating centres	:	ICAR-RC for NEH Region, Meghalaya
	:	ICAR-NRCP, Rani, Guwahati

Objectives:

➢ To analyse pig/pork price determinants and to estimate the critical points to indicate the efficiency of the value chain.

➢ Assessment of the factors that pose challenges/ health risks to women in participating in pork value chain.

➢ Formulate an action plan and framework for tribal women to generate sustainable livelihood and economic empowerment with the family by participating in pork value chain.

➢ Design customized knowledge products and implement on pilot scale in one district of each state and assess their outcome.

Achievements

a) Publications:

➢ Bhattacharjee M, Mehta S, Singh P, Kadirvel G, Singh M, Saha AR, Pongener N, Paul P (2022) Economies of marketing chain for small-scale pig producers and bio-security practices: Evidence from North-east states (Assam, Meghalaya and Nagaland). International Journal of Agricultural and Statistical Sciences 18(02)

➢ Singh M, Pongener N, Talimoa RM, Kadirvel G, Bhattacharjee M, Rajkhowa DJ, Khandpal BK (2021) Balance sheet of pork production and consumption in Nagaland: Implications for strengthening of pork value chain in the state. Indian Journal of Animal Sciences. 91(4):313-317.

Project title: Identification of QTLs for subcomponent traits of WUE through strategic utilization of whole genome sequences and accurate phenotyping in rice

Project Code	:	8010
Duration of the project	:	December 2019 - November 2022
PI Name	:	Dr. M.S. Sheshshayee
CCPI Names	:	Dr. M. Raveendran
	:	Dr. Prasanta Dash
Lead Centre	:	UAS, Bengaluru
Cooperating centres	:	TNAU, Tamil Nadu
	:	ICAR-NIPB, New Delhi

Objectives:

➢ Assemble a panel of germplasm from the 3K set based on differences in WUE ($\Delta^{13}C$) and genomic diversity.

➢ Identification of QTLs regulating WUE and its component traits through GWAS

➢ Validation of haplotypes of specific WUE component traits using trait specific bi-parental mapping populations to develop breeder friendly markers for genetic enhancement.

Achievements

a) **Publications:**

➢ Dhande VN, Williams M, Ranjani RV, Sakthi AR, Sudha M, Raveendran M (2023) Identifcation of superior haplotypes for CCD8 regulating tiller number and grain yield in rice. Electronic Journal of Plant Breeding 14(1), 148-153.

➢ Mohanavel V, Rajagopalan VR, Manickam S, Raveendran M (2023). Haplotype analysis of Xa21, a major Bacterial Blight Resistant gene in rice. The Pharma Innovation journal 12(2):2599-2601.

➢ Topno A, Williams M, Sakthi AR, Bharathi A, Ranjani R V, Suresh R, Sudha M, Boopathi N M, Raveendran M. (2023). Exploitation of Allelic Variation and Superior Haplotypes for OsMIT3 Regulating Tiller Number in Rice. International Journal of Plant & Soil Science, 35(20), 375–382.

Project title: Improving rural livelihood security of tribal and resource constrained farmers of North Bihar through low-cost technology of Animal Husbandry and allied sector

Project Code	:	8011
Duration of the project	:	December 2019 - November 2022
PI Name	:	Dr. Pankaj Kumar
CCPI Name	:	Dr. Sanjeev Kumar
Lead Centre	:	BASU, Patna
Cooperating centres	:	ICAR-CARI, Izatnagar

Objectives:

➢ To study the change in basic behavioural components as a consequence of adopting low-cost technology and value addition in animal husbandry and allied sectors.

➢ To assess the differential effect of the adoption of low-cost technology across different categories of farmers and promotion of paravets.

➢ To study the different training modules for improving the adoption level of tribal and non-tribal farmers in animal husbandry and the extent of veterinary extension services

➢ To study the constraints faced by tribal and non-tribal farmers for the adoption of different AH practices and suggest measures to mitigate the problems.

➢ Documentation of Traditional Knowledge and establishment of market linkages for tribal/resource-constrained farmers and FPOs.

Achievements

a) Publications:

➢ Kumar P, Rajak SK, Jha AK, Singh PK (2023) Extent of adoption of improved poultry Farming practices among the poultry farmers in north Bihar. The Pharma Innovation, 12 (6): pp. 395-397.

➢ Kumar P, Rajak SK, Jha AK, Singh PK (2023) A study on knowledge level of the poultry farmers and its correlation with socio-personal factors in Bihar. The Pharma Innovation, 12 (6): pp.398-400.

➢ Kumar P, Rajak SK, Jha AK, Singh PK (2022) Perceived effectiveness of satawar root (*Asparagus racemosus*) towards improving the productive and reproductive performance of dairy animals. Frontiers in Crop Improvement 10 (7): pp. 3684-3686.

➢ Kumar P, Rajak SK, Jha AK, Singh PK (2022) Attitudinal orientation of livestock owners towards breeding practices in Muzaffarpur district of Bihar. Frontiers in Crop Improvement, 10 (3): Pp. 1687-1689.

Project title: Farmer-led extension strategy for enhancing farmers' income through millets-based farming system in hilly and tribal areas

Project Code	:	8012
Duration of the project	:	December 2019 - November 2022
PI Name	:	Dr. Rajendra R. Chapek
CCPI Name	:	Dr. E. D. Oliver King
Lead Centre	:	ICAR-IIMR, Hyderabad
Cooperating centre	:	MSSRF, Chennai

Objectives:

➢ To identify millet farmer facilitators (MFFs) and study their characteristics in view of performing effective extension services in hilly and tribal areas.

➢ To empower MFFs through group approach, on-farm trainings and mobile-based information and communication technologies (ICTs) for enhancing the income of millet farmers.

➢ To strengthen decision-making of millet farmers and introduce suitable millets-based farming systems comprising millet intercropping, livestock and bee keeping for livelihood security of millet farmers.

➢ To assess the effectiveness of MFFs, ways, avenues for extension services and the MFFs' characteristics desired by millets farmers in hilly and tribal areas.

➢ Mobile-based advisory to strengthen the extension services of MFFs with updated information.

➢ Linkages with local extension agencies and entrepreneurs for effective extension services at village level.

➢ Suitable location-specific farmers-led extension model for faster transfer of millet technologies in hilly and tribal areas.

➢ Building faith among local farmers on services of extension agents and confident for adoption of millet technologies.

➢ Strengthen decision making process supported with timely advisory services and updated knowledge.

➢ A validated farmer-led extension model for hilly and tribal areas emphasizing on nutritional standard.

Achievements

a) Publications:

➢ Chapke RR, Bharat King OE, Parida P, Tonapi VA (2022) "Socio-Personal and Agro-Economic Factors Towards Perceived Advantages of Millets Cultivation in Tribal Area", International Journal of Applied and Advanced Scientific Research, 7(1): 77-82. https://doi.org/10.5281/zenodo.6589685

➢ Chapke RR, Bharat and Tonapi VA (2022) Socio-economic characteristics of tribal farmers vis-à-vis perception about advantages of millets cultivation in hilly area, India. International Journal of Chemical Studies 10(2): 39-45

➢ Bharat, Chapke RR, Kammar S (2022) Farmers' Perception about Climate Change and Response Strategies. Indian J. of Ext. Educ.58 (1): 1-5.

➢ Bharat, Chapke RR, Kammar S (2021) Farmers' Perception on Climate Change and Agricultural Adaptation Strategies. International J. of Ext. Educ., 16: 99- 108.

Project title: Leveraging Institutional Innovations for Inclusive and Market led Agricultural Growth in Eastern India

Project Code	:	8013
Duration of the project	:	December 2019 - November 2022
PI Name	:	Dr. Pramod Kumar
CCPI Names	:	Dr. P.S Badal
	:	Dr. Biswajit Mondal
	:	Dr. Ranjit K Paul
		Mr. Sathyendra Kumar
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centres	:	BHU, Varanasi
	:	ICAR-NRRI, Cuttack
	:	ICAR-IASRI, New Delhi
	:	NIAM, Jaipur

Objectives:

➢ To analyze farmers' access and inclusiveness to input and output markets and to identify critical intervention points for the improvement of farmers'-based institutions for enhancing income.

➢ To develop expert system using artificial intelligence techniques for the dissemination of market intelligence to various stakeholders.

➢ To develop Village Agri-Knowledge Centres (VAKC) to bring resilience in the existing farmer-based institutions like FPOs, Farmers' club etc.

➢ Identification of location-specific technological and institutional innovations.

➢ Strategies to scale up the institutional innovations for efficient agricultural input & output market.

➢ Development of price forecasts for selected commodities based on different models integrating empirical and judgmental forecasts integrating advances in machine learning and artificial intelligence.

➢ Development of "Scientists-Farmers-Markets Linkage Model" for providing information needs for enhancing farmers income and welfare.

Achievements

a) Publications:

➢ Kumar P, Badal PS, Paul RK, Jha GK, Venkatesh P, Kamalvanshi IT, Kamalvanshi V, Blasubramanian M, Anbukkani P (2021) Empowering farmers through future price information: A case study of price forecasting of brinjal in Eastern Uttar Pradesh. Indian Journal of Economics and Development, 16(4):479-488.

➢ Kumar P, Badal PS, Paul RK, Jha GK, Venkatesh P, Kamalvanshi V, Anbukani P, Balasubramanian M, Patel P (2021) Forecasting onion price for Varanasi market of Uttar Pradesh, India. Indian Journal of Agricultural Sciences. 91 (2): 249–53.

➢ Kumar P, Badal PS, Paul RK, Jha GK, Venkatesh P, Kamalvanshi V, Balasubramanian M, Anbukkani P, Patel P (2021) Enabling Informed Resource Allocation Decision by Vegetable Growers of Varanasi, Uttar Pradesh: Price Forecasting using ARIMA. Agricultural Situation in India. 78(10):16-24.

Project title: Development and Validation of Need Based Technology Delivery Model through Farmers' Producer Organisation for the Eastern Region of India

Project Code	:	8014
Duration of the project	:	December 2019 - November 2022
PI Name	:	Dr. Anirban Mukherjee
CCPI Names	:	Dr. Virendra Kumar Yadav
	:	Dr. Shubhadeep Roy
	:	Dr. Kausik Pradhan
Lead Centre	:	ICAR-RCER, Patna
Cooperating centres	:	ICAR-RCER (RC), Ranchi
	:	ICAR-IIVR, Varanasi
	:	UBKV, West Bengal

Objectives:

➢ To develop and strengthen Farmers Producer Organisations in the study area.

➢ To develop need-based Technology Delivery Model through the Farmers' Producer Organisations in the eastern region of India.

➢ To study the effectiveness and factors influencing the successful functioning of the model.

➢ To suggest policy implications for upscaling of the model.

Achievements

a) Publications:

➢ Saha S, Pradhan K, Mukharjee A, Roy S, Yadav VK, (2023) Association of farmers' producer organization (fpo) farmers' progressiveness with socio-economic characters: a case study of sub himalayan region. Journal of community mobilisation and sustainable development 18(2): 365-372.

➢ Mukherjee A, Kumar U, Singh DK, Shubha K, Atheequlla GA, Sinha PK, Singh P. (2022). Assessing the performance of horticultural farmers producer companies: a comparative case study. J. Hortl. Sci. 17(2): 520-529.

➢ Yadav VK, Mukharjee A, Roy S, Pradhan K, Pan RS, Kumar U, Yadav DK, Kumar A, Singh AK, Raghav DK (2022). Analysing the constraints as perceived by the board of directors in the initial development phase of the farmer producer organizations. Indian research journal of extension education. 22 (3) 170-175.

➢ Mukherjee A, Roy S, Yadav VK, Pradhan K, Shubha K, Singh DK, Kumar U (2022). Problems faced by the vegetable-based-farmers producer companies: a descriptive analysis. Vegetable science 49(1): 96-100.

➢ Adhikary A, Pradhan K, Chouhan JK, Reddy S (2021). Analysing the perceived impact of farmers' producer organization (FPOs) on sustainable economic development. Indian research journal of extension education. 21 (2&3): 80-82

Project title: Development of biosensors for the detection of fish pathogenic bacteria and hazardous metalloids in selected water bodies

Project Code	:	8015
Duration of the project	:	March 2020 – February 2023
PI Name	:	Dr B.K. Behera
CCPI Names	:	Dr. D. Pradhan
	:	Dr. Souvik Pal
Lead Centre	:	ICAR-CIFRI, Barrackpore
Cooperating centres	:	IIT, Kharagpur
	:	C-DAC, Kolkata

Objectives:

➢ To develop biosensors for detection of hazardous metalloids such as arsenic and chromium.

➢ To develop biosensors for detection of fish pathogenic bacteria such as *Aeromonas veroni*.

➢ To develop working prototypes of hand-held nano-biosensing device and validation at selected waterbodies.

Achievements

a) Publications:

➢ Dei J, Bhattacharyya S, Ghosh K, Sarkar S, Pal S, Mukherjee S, Sarkar DJ, Ghosh A, Bandyopadhyay R, Das BK, Behera BK (2024) Development of field portable potentiostat using electrochemical aptasensing technology for detection of Cr (VI) in aquatic environment. Current Research in Biotechnology p.100193.

➢ Dei J, Mondal S, Biswas A, Sarkar DJ, Bhattacharyya S, Pal S, Mukherjee S, Sarkar S, Ghosh A, Bansal V, Bandhyopadhyay R (2024) Cr-Detector: A simple chemosensing system for onsite Cr (VI) detection in water. Plos one 19(1), p.e0295687.

➢ Sarkar DJ, Behera BK, Parida P, Aralappamavar VK, Mondal S, Dei J, Das BK, Mukherjee S, Pal S, Weerathunge P, Ramanathan R (2022) Aptamer-based NanoBioSensors for seafood safety. Biosensors and Bioelectronics, p.114771.

➢ Mukherjee S, Ghosh K, Bhattacharyya S, Behera BK, Singh OK, Pal S (2022) A Review on Recent Trends in Advancement of Bio-Sensory Techniques Toward Pesticide Detection. Food Analytical Methods 1-19.

b) Patent:

➢ Indian Patent Filed: "Sensor device to detect toxic metalloids in water and thereof" filed on 29 December 2022. The application number: 202231076888.

➢ Indian patent application on "Handheld colorimetric biosensing device for prognosis of hazardous elements, pathogens and thereof" (presently with institute Patent attorney)

c) Technology developed:

➢ Device developed: IMAGinE (Colorimetric sensing device)

➢ Device developed: Sens-E (Electrochemical sensing device)

Project title: Developing precision nutrient management protocols for rice-wheat and rice-maize systems in Indo-Gangetic Plains

Project Code	:	8016
Duration of the project	:	March 2020 – February 2023
PI Name	:	Dr. Anchal Dass
CCPI Names	:	Dr. S. Mandal
	:	Dr. R.P. Mishra
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centres	:	ICAR-RCER, Patna
	:	ICAR-IIFSR, Meerut

Objectives:

➢ To assess the variability in crop and soil conditions for delineating homogeneous agricultural management zones in IGP for rice-wheat and rice-maize cropping systems.

➢ To analyse the production-limiting resources and develop optimum nutrient stewardship.

➢ To develop precision nutrient management protocols through simulation of nutrient dynamics in the soil-plant system.

➢ To develop a spatial DSS for enhancing nutrient-use efficiency under specified cropping systems of IGP.

Achievements

a) Publications:

➢ Singh A, Dass A, Sudhishiri S, Singh VK, Shekkhwat K, Meena MC, Sahoo RN, Soora NK, Upadhyay PK et al. (2024) Dry matter partition, root characteristics, N remobilization, productivity and NUE of maize under SSDF of N and residue incorporation Nutr. Cycling in Agro-ecosystems.

➢ Singh A, Dass A, Dhar S, Sudhishiri S, Shekhawat K, Meena MC, Sahoo RN, Nitin A, Devi D. (2024) SSDF of N coupled with crop-residue incorporation leads to improved growth and yield in maize in alluvial soils. Indian J. Agron. 69(2): 144-150.

➢ Mondal S, Kumar R, Mishra JS, Dass A, Kumar S, Kumar VV, Kumari M, Khan SR, Singh VK (2023) Grain N and productivity of rice and maize under variable doses of fertilizer N. Heliyon. https://doi.org/10.1016/j.heliyon.2023.e17321.

➢ Dass A, Nagargade M, Tyagi V (2023) SSDF: a potential precision technology for improved productivity, quality and input-use efficiency in agri. Indian J. Agron.: S51-S64.

➢ Bamboriya SD, Dhar S, Upadhyay P., Dass A, Meena RP, Garg K (2023) Evaluation of maize genotypes under different N levels in a TGP region. Indian J. Agron. 68 (4): 368-372.

➤ Sudharshan S, Shekhawat K, Rathore SS, Singh R, Kumar V (2022) N-management options for different crop-establishment methods in wheat under rice-wheat cropping system. Indian J.Agron 67(2):197-200.

➤ Sudarshan S, Shekhawat K, Rathore SS, Singh RK, Das A, Nagargade M (2022) Crop establishment and nitrogen management effects on growth, physiology and productivity of wheat under rice-wheat system. Annals of Agricultural Research. 43(2): 119-126.

➤ Hasnain M, Singh VK, Rathore SS, Shekhawat K, Singh RK, Dwivedi BS, Bhatia A, Upadhyay PK (2021) SSNM under CA-based spring wheat in TGP of India. Indian J. Agric. Sci. 91(5).

b) Technology Developed:
➤ N-management Mobile App (Ekka, U., Upadhyay, P.K., Dey, A., Roy, H.S., Dass, A., Shekhawt, K. et al. 2021. Mobile Sensor: A nutrient management and recom. tool)

Project title: Dendritic cell platforms for in vitro and in vivo studies of antigen processing and presentation in cattle for combined vaccine antigens using Foot-and-Mouth Disease Virus and *Pasteurella multocida* as model

Project Code	:	8017
Duration of the project	:	March 2020 – February 2023
PI Name	:	Dr. Bhanu Prakash
CCPI Names	:	Dr. Praveen Kumar Vemula
	:	Dr. Saravanan Subramaniam
Lead Centre	:	ICAR-IVRI, Bengaluru
Cooperating centres	:	InStem, Bengaluru
	:	ICAR-DFMD, Mukteswar

Objectives:

➢ To develop novel adjuvants consisting of *P. multocida* Bacterial Ghosts (BGs) and Outer Membrane Vesicles (OMVs) and FMDV antigens attached to nano delivery systems for targeting antigen to bovine dendritic cells (DCs).

➢ To develop dendritic cells platform to investigate the role of dendritic cells in HS, FMD antigen processing and presentation in vitro.

➢ To evaluate innate and adaptive immune responses elicited by the developed HS-FMD virus antigen platforms in cattle.

➢ Duration of immunity studies and evaluation of cellular memory related markers /cytokines for the developed HS-FMD antigen model systems.

Achievements:

➢ Advanced vaccine development by characterizing targeted ligands for bovine dendritic cells and creating innovative nanoformulation conjugation methods, resulting in highly specific and efficient antigen delivery.

Project title: Paddy straw residues management through in-situ and ex-situ microbial decomposition and mechanical interventions

Project Code	:	8018
Duration of the project	:	March 2020 – February 2023
PI Name	:	Dr. Paneerselvam
CCPI Name	:	Dr. P. K. Sahoo
	:	Dr. Sandeep Sharma
	:	Dr. R.S. Garhwal
Lead Centre	:	ICAR-NRRI, Cuttack
Cooperating centres	:	ICAR-IARI, New Delhi
	:	PAU, Ludhiana
	:	CCSHAU, Hisar

Objectives:

➢ To develop microbial consortium for rapid *in-situ* decomposition of paddy straw.

➢ To study the design values for efficient c.utting, conveying, chopping mechanisms and their integration for *in-situ* decomposition of rice residues.

➢ To standardize microbial package for paddy straw residues management through incorporation of residues in soil and residues retention with zero tillage.

➢ On farm evaluation and validations of microbial technology with mechanical interventions for *in situ* paddy straw residue management in different locations in Punjab and Haryana.

Achievements

a) Publications:

➢ Panneerselvam P, Senapati A, Mitra D, Priyadarshini A, Shadangi S, Behera S, Kumar U, Kumar A, Shahid M, Sharma S, Garhwal RS (2024) Enhancing soil quality and yield through microbial-assisted in-situ residue management in rice-rice cropping system in Odisha, Eastern India. Journal of Environmental Management 1;358:120916.

➢ Sagarika MS, Parameswaran C, Senapati A, Barala J, Mitra D, Prabhuksrthikeyan SR, Kumar A, Nayak AK, Panneerselvam P (2022) Lytic polysaccharide monooxygenases (LPMOs) producing microbes: A novel approach for rapid recycling of agricultural wastes. Science of the Total Environment 806: 150451.

➢ Kumar A, Nayak A K, Sharma S, Senapati A, Mitra D, Mohanty B, Prabhukarthikeyan SR, Sabarinathan KG, Mani I, Rajendra SG, Thankappan S, Sagarika MS, Sergio de los Villalobos S, Panneerselvam P (2021) Recycling of rice straw: A sustainable approach for ensuring environmental quality and economic security. Pedosphere https://doi.org/10.1016/j.pedsph.2022.06.036.

➢ Shivashimpar A, Parrary RA, Mani I, Kushwaha HL, Lande S, Mizakhaninafchi H, Khura T, Sarkar S and Pandey R. On farm cropping sensor-based smart device for cutting energy measurement of cereal crops. Agronomy

b) Technology Developed:

➢ Decomposing microbial consortium formulation

➢ Prototype machine for *in-situ* paddy straw residue management

➢ Integrated in-situ paddy straw management practices

Project title: Molecular biological studies on porcine reproductive & respiratory syndrome (PRRS) virus in pig population of North East Region of India for development of sustainable diagnostics and vaccine

Project Code	:	8019
Duration of the project	:	March 2020 – February 2023
PI Name	:	Dr. Tridib Kumar Rajkhowa
CCPI Names	:	Dr. Madhuri Subbiah
	:	Dr Seema Rani Pegu
Lead Centre	:	CVSc & AH, CAU, Selesih, Aizawl
Cooperating centres	:	NIAB, Hyderabad
	:	ICAR-NRCP, Rani, Guwahati

Objectives:

➢ Extensive sero-surveillance, clinico-pathological studies and molecular diagnosis of PRRS in pig population of North East Region of India (NER, India) for a period of three years.

➢ Isolation of PRRSV from field outbreaks.

➢ Full genome sequencing of the field isolates of PRRSV through next generation sequencing.

➢ Development of pen side diagnostics for rapid detection of PRRS and DIVA ELISA for differentiating vaccinated versus infected animals.

➢ Development of a killed PRRSV and a recombinant chimeric PCV1-2 expressing PRRSV antigen(s) DIVA vaccine and testing their immunogenicity in pigs.

Achievements

a) **Publications:**
➢ Rajkhowa TK, Lalnunthanga, Hauhnar L, Zodinpui D, Subbiah M (2021). Molecular detection and characterization of highly pathogenic porcine reproductive and respiratory syndrome virus from a natural outbreak in wild pigs, Mizoram, India. Transboundary and Emerging Diseases. https://doi.org/10.1111/tbed.14296.

Project title: Development of white grub (*Holotrichia serrata*) resistance in sugarcane and groundnut by deploying novel cry toxin holotype genes

Project Code	:	8020
Duration of project	:	August 2020 - July 2022
PI Name	:	Dr. C. Appunu
CCPI Names	:	Dr. Pooja Bhatnagar Mathur
	:	Dr. Harish, G
Lead Centre	:	ICAR-SBI, Coimbatore
Cooperating centres	:	ICRISAT, Patancheru
	:	ICAR-DGR, Junagard

Objectives:

➢ Isolation and purification of individual *cry8* toxins (*cry8Sa1* and *cry8Ib*) from native *Bacillus thuringiensis* 62 isolate.

➢ Cloning and expression of *cry8* toxin (*cry8Sa1* and *cry8Ib*) genes in *cry* negative (acrystalliferous) strain *B. thuringiensis* HD73$^-$ and/or *E.coli* system.

➢ Bioassay of individual toxins and determination of LC50 against all instars of whitegrub (*H. serrata*).

➢ Transgenic development in sugarcane and groundnut with most potent *cry* gene driven by constitutive/root-specific promoters.

Achievements

a) Publications:

➢ Srikanth J, Singaravelu B, Crickmore N, Mahesh P, Sankaranarayanan C, Suresha GS, Appunu C, Nirmala R, Om Prakash M, Athira KM (2024). Laboratory evaluation of ascarabid-specific isolate of *Bacillus thuringiensis* against white grub *Holotrichia serrata*. Bio Control 69: 53–64 https://doi.org/10.1007/s10526-023-10220-7.

➢ Naveenarani M, Suresha GS, Srikanth J, Hari K, Sankaranarayanan C, Mahesh P, Nirmala R, Swathik CP, Crickmore N, Bakshi Ram, Appunu C, Singaravelu B. (2022) Wholegenome analysis and functional characterization of a novel *Bacillus thuringiensis* (Bt 62) isolate against sugarcane white grub *Holotrichia serrata* (F). Genomics 114(1):185-195 https://doi.org/10.1016/j.ygeno.2021.12.012.

b) Patent:

➢ "Novel lepidopteran active toxin gene(s) from Indigenous *Bacillus thuringiensis* and itsuse thereof" by B. Singaravelu, G.S. Suresha C. Appunu, J. Srikanth, K. Hari, C. Sankaranarayanan P. Mahesh, R. Nirmala and M. Rajeshkumar (27-11-2021).

➢ Original culture deposit for Bacillus thuringiensis Bt 62, Allotted accession Number:NAIMCC-IDA-3 dated 06-01-2022, was made in compliance with the BUDAPEST treaty on the international recognition of the deposit of microorganisms for the purposes of patent with National Agriculturally Important Microbial Culture Collection (NAIMCC), NBAIM, Maoby B. Singaravelu, P. Mahesh, J. Srikanth, K. Hari, K.P Salin, C. Sankaranarayanan, G.S.Suresha, C. Appunu, R. Nirmala and M. Rajeshkumar

Project title: Risk assessment of nanoparticle accumulation in soils: Effects of metal oxide nanoparticles on soil bacterial communities, soil microbial processes and evaluation of phytotoxicity using genomic approaches

Project Code	:	8021
Duration of the project	:	August 2020 - July 2023
PI Name	:	Dr. Sheeja TE
CCPI Name	:	Dr. V. Sajith
Lead Centre	:	ICAR-IISR, Kozhikode
Cooperating centre	:	NIT, Calicut

Objectives:

➢ To determine the effects of metal oxide NPs (ZnO, SiO$_2$, CaO) on key microbial endpoints (Microbial biomass-C, -N, -P, enzyme activities) involved in soil nutrient cycling.

➢ To study the effects of metal oxide NPs (ZnO, SiO$_2$, CaO) on abundance and diversity in bacterial community and associated bacterial community shifts in soils of varying organic C levels (low, medium and high).

➢ To study the effects of metal oxide NPs (ZnO, SiO$_2$, CaO) on abundance and diversity in bacterial community and associated bacterial community shifts in soils of varying pH (acidic, near neutral to neutral and alkaline).

➢ Transcriptome profiling and differential gene expression analysis *vis a vis* NP mediated phytotoxicity and impact on biosynthetic pathways in turmeric and rice.

➢ Understanding on the molecular mechanism of nanoparticle-mediated phytotoxicity and impact on key biosynthetic pathways is essential for developing genotypes with improved performance under NP stress conditions.

➢ The information will be vital to support policy decisions on fixing critical limits for safe intake when large scale application of NPs in agriculture is considered.

Achievements

a) Publications:

➢ Dinesh R, Sreena CP, Sheeja TE, Charles S, Srinivasan V, Sajith V, Subila KP, Haritha P (2023). Metagenomics indicates abundance of biofilm related genes and horizontal transfer of multidrug resistant genes among bacterial communities in nano zinc oxide polluted soil. Science of the TotalEnvironment859,160032.

➢ Dinesh R, Sreena CP, Sheeja TE, Vijesh Kumar IP, Praveena R, Charles S, Srinivasan V, Jayarajan K, Sajith V, Subila KP, Haritha P (2023). Soil polluted with nano ZnO reveals unstable bacterial communities and decoupling of taxonomic and functional diversities, Science of the Total Environment 889,164285.

➢ Dinesh R, Sreena CP, Sheeja TE, Vijesh Kumar IP,Charles S, Srinivasan V, Jayarajan K, Sajith V, Subila KP, Haritha P, Anitha SJ (2023). New insights into bacterial zn homeostasis and molecular architecture of the metal resistome in soil polluted with nano zinc oxide Ecotoxicology and Environmental Safety, 263,115222.

Project title: Identification and validation of newer approaches for the management of whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae)

Project Code	:	8022
Duration of the project	:	August 2020 - July 2023
PI Name	:	Dr. T. Venkatesan
CCPI Names	:	Dr. S. Subramanian
	:	Dr. R. Asokan
	:	Dr. Vikas Jindal
Lead Centre	:	ICAR-NBAIR, Bengaluru
Cooperating centres	:	ICAR-IARI, New Delhi
	:	ICAR- IIHR, Bengaluru
	:	PAU, Ludhiana

Objectives:

➢ Evaluation of potential ds RNAi constructs against whitefly *B.tabaci*

➢ Characterization and validation of behaviour modifying chemicals of *B. tabaci* and developing nano dispensers for their release.

➢ Development, evaluation and validation of nano formulation of cognate dsRNA/s against *B. tabaci*.

Achievements:

a) Publications:

➢ Nebapure SM, Sarkar DJ, Suroshe SS, Rana VS, Shakil NA, Subramanian S (2021). Insecticidal activity of oil-in-water emulsion formulations of essential oils against white fly, *Bemicia tabaci* (Gennadius) (Homoptera: Aleyrodidae). Allelopathy Journal

➢ Nebapure SM, Shankarganesh K, Rajna S, Naga KC, Pandey D, Gambhir S, Praveen KV, Subramanian S (2022) Dynamic changes in Virus-induced volatiles in cotton modulate the orientation and oviposition behaviour of whitefly, *Bemisia tabaci*. Frontiers in Physiology

➢ Thakur S, Jindal V (2022) RNAi knockdown of CAPAr gene affects survival and fecundity of *Bemisia tabaci* (Gennadius). Journal of Asia-Pacific Entomology 25(3), p.101940 .

b) Patent:

➢ Designing of a Novel dsRNA vector (L4440) for *in vivo* and *in vitro* expression of dsRNA filed duly approved by ITMU, ICAR-NBAIR Bangalore.

Project title: Development of thermostable Peste des petits ruminants (PPR) vaccine using spontaneously assembling, biodegradable mesoporous silica nano-scaffolds

Project Code	:	8023
Duration of the project	:	January 2021 - December 2023
PI Name	:	Dr. Sonal
Lead Centre	:	ICAR- IVRI, Izatnagar

Objectives:

> ➤ To synthesize and characterize mesoporous silica nanoparticles (MSNs).

> ➤ To encapsulate PPR vaccine virus in MSNs and characterize for virus loading and release kinetics.

Achievements:

> ➤ Developed thermostable PPR vaccine by formulating it with mesoporous silica nanoparticles (MSN), significantly enhancing viral stability and vaccine efficacy under variable temperature conditions.

Project title: Fine mapping and marker-assisted breeding for alternative dwarfing genes Rht14 and Rht18 to develop semi-dwarf wheat genotype suitable for conservation agriculture

Project Code	:	8024
Duration of the project	:	January 2021 - December 2023
PI Name	:	Dr. Ravindra M. Patil
CCPI Name	:	Dr. Harikrishna
Lead Centre	:	MACS - ARI, Pune
Cooperating centre	:	ICAR-IARI, New Delhi

Objectives:

➢ Fine mapping of *Rht14* and *Rht18* loci in durum wheat using SNP and SSR markers.

➢ Analysis of expression of putative candidate genes within *Rht14* and *Rht18* loci by RNAseq and qRT-PCR using tissues of peduncle at different growth stages to gain insight into the participation of these genes in stem elongation.

➢ Marker-assisted introgression of GA-sensitive dwarfing genes *Rht14* and *Rht18* in the background of well adapted, high yielding bread wheat, durum wheat and dicoccum wheat varieties.

➢ Evaluation of *Rht14* and *Rht18* introgressed lines for early establishment traits under stubble retained conditions as well as moisture-stressed conditions.

➢ Promising introgression lines will be made available for wheat breeders for utilization in wheat improvement programme.

Achievements:

a) Publications:

➢ Thomas A, Sinha N, Krishna H, Patil R, Bhati PK, Kumar M, Rohit N, Basu SR, Vikhe P, Venkatesan S, Jain N, Singh PK and Singh GP. Introgression of ga-sensitive dwarfing gene *rht18* by marker assisted breeding in HD3086 (*Triticum aestivum* l.) and multi-environment trials of the improved lines under varying seedling emergence regimes. Communicated to frontiers in plant science (manuscript id: 1552339).

Project title: Production of double-muscled mass farm animals using CRISPR

Project Code	:	8025
Duration of the project	:	January 2021-December 2023
PI Name	:	Dr. Selokar Naresh Lalaji
CCPI Names	:	Dr. S.D. Kharche
	:	Dr. Riaz Ahmad Shah
	:	Dr. Dharmendra Kumar
Lead Centre	:	ICAR-CIRB, Hisar
Cooperating centres	:	ICAR-CIRG, Makhdum
	:	SKUAST, Kashmir
	:	ICAR-CIRB, Hisar

Objectives:

➢ Design of CRISPR vectors/complexes to mutate muscle growth controlling gene(s) against buffalo, goat and sheep genome.

➢ Validation of gene(s) mutation(s) and its function.

➢ Production of CRISPR edited farm animals.

Achievements:

a) Publications:

➢ Punetha M, Saini S, Chaudhary S, Whitworth K, Green J, Kumar D, Kues W (2024) Induced pluripotent stem cells in the era of precise genome editing. Current Stem Cell Research & Therapy. 19(3):307-315.

➢ Dua S, Bansal S, Gautam D, Jose B, Singh P, Singh MK, De S, Kumar D, Yadav PS, Kues W, Selokar NL (2023) Production of MSTN Gene-Edited Embryos of Buffalo Using the CRISPR/Cas9 System and SCNT. Cell Reprogram 25(3):121-127.

➢ Pathak J, Singh SP, Kharche SD, Goel A, Soni YK, Kaushik R, Kose M, Kumar A (2023) Cell culture media dependent *in vitro* dynamics and culture characteristics of adult caprine dermal fibroblast cells. Sci Rep. 22;13(1):13716.

➢ Punetha M, Kumar D, Saini S, Chaudhary S, Bajwa KK, Sharma S, Mangal M, Yadav PS, Green JA, Whitworth K, Datta TK (2023) Optimising electroporation condition for CRISPR/Cas-mediated knockout in zona-intact buffalo zygotes. Animals. 14(1):134.

➢ Punetha M, Saini S, Chaudhary S, S Yadav P, Whitworth K, Green J, Kumar D, Kues W (2023) Induced Pluripotent Stem Cells in the Era of Precise Genome Editing. Curr Stem Cell Res Ther 7. doi: 10.2174/1574888X18666230307115326.

➢ Bajwa K, Singh, MK, Selokar NL (2023). Cutting age omics technologies to study early embryo-maternal interface in farm animals. ISSRF Newsletter 31, 128-135.

➢ Kharche SD, Singh SP, Soni YK, Pathak J, Yadav P. 2023. Embryo production: methods and strategies for improving production in goats. Recent Advances in Assisted Reproductive Technologies of Small Ruminants. pp 32 – 34, ISBN: 978-93-5996-342-6.

➢ Singh SP, Kharche SD, Soni YK, andPathak J. 2023. Reproductive biotechniques in goats. Recent Advances in Assisted Reproductive Technologies of Small Ruminants. pp 28 – 31, ISBN: 978-93-5996-342-6.

b) Patent:
➢ Filed a patent of MSTN gene editing in buffalo, and uses thereof (NDRI)

Project title: Captive Breeding of Hilsa, *Tenualosa ilisha*: Phase II

Project Code	:	8026
Duration of the project	:	March 2021 - February 2024
PI Name	:	Dr. Srikanta Samanta
CCPI Names	:	Dr. Debasis De
	:	Dr. Suvendu Adhikari
	:	Dr. S. Dasgupta
Lead Centre	:	ICAR-CIFRI, Barrackpore
Cooperating centres	:	ICAR- CIBA, Chennai
	:	ICAR- CIFA, Bhubaneswar
	:	ICAR-CIFE, Mumbai

Objectives:

➢ Development of captive hilsa brood stock through nutritional and environmental manipulations.

➢ Development of protocol for captive maturation and spawning of hilsa.

➢ Refinement of hilsa larval rearing technology.

Achievements:

a) **Publications**:
  ➢ Punetha M, Saini Hoque F., Adhikari S., Das A., Hussan A., Mandal R.N., Das A., Sarkar P., Paul B.N., Sahoo P.K. 2023. Co-infection of *Fusarium incarnatum* FHHS2 and *Acinetobacter bohemicus* FHHK1 in captive-reared Hilsa shad, *Tenualosa ilisha* (Hamilton, 1822). Aquaculture International. https://doi.org/10.1007/s10499-023-01212-6.

b) **Patent:**
  ➢ Ergonomically designed transportable Fish Anaesthetic Device for hilsa (*Tenualosa ilisha*) [CIFE Technology No. 23A/PD/0099, Dated 02.06.2023 (Sl. No. 1)]

  ➢ Rapid, non-lethal and non-invasive method of determining sex and maturity in hilsa (*Tenualosa ilisha*) using ultrasound imaging [CIFE Technology No. 23A/MD/0100, Dated 02.06.2023 (Sl. No. 2)]

Project title: Epidemiological studies and development of antiviral therapeutics against coronaviruses

Project Code	:	8027
Duration of the project	:	June 2021 - May 2024
PI Name	:	Dr. Naveen Kumar
CCPI Names	:	Dr Anamika Mishra
	:	Dr. Gaurav K Sharma
	:	Dr. K.P. Suresh
Lead Centre	:	ICAR-NRCE, Hisar
Cooperating centres	:	ICAR-NIHSAD, Bhopal
	:	ICAR-IVRI, Izatnagar
	:	ICAR-NIVEDI, Bengaluru

Objectives:

➢ To study the epidemiology and interspecies relatedness of coronaviruses.

➢ Evaluation of host-directed chemical inhibitors and medicinal plants for anti-CoV activity

➢ Understanding the role of cellular kinases, phosphatases and epigenetic modifiers in Coronavirus replication

➢ Understanding drug resistance against host-directed Coronavirus agents

Achievements

a) Publication:

➢ Borkakoti R, Karikalan M, Nehul SK et al. (2023). A retrospective study showing a high rate of seropositivity against SARS-CoV-2 in wild felines in India. Arch Virol 168, 109. https://doi.org/10.1007/s00705-023-05735-4.

Project title: Development of Diagnostics for Coronavirus infections

Project Code	:	8028
Duration of the project	:	June 2021 - May 2023
PI Name	:	Dr Praveen K. Gupta
CCPI Names	:	Dr. Nitin Virmani
	:	Dr. Naveen Kumar
Lead Centre	:	ICAR-IVRI, Izatnagar
Cooperating centres	:	ICAR-NRCE, Hisar
	:	ICAR-NIHSAD, Bhopal

Objectives:

➢ To develop array of diagnostic tools for sensitive detection of Coronavirus antigen and antibodies in clinical samples

➢ To develop nucleic acid-based diagnostic assay to detect Coronavirus infections

Achievements

a) Publications:

➢ Kumar N, Kaushik R, Zhang KYJ, Uversky VN, Sahu U, Sood R, Bhatia S.9 (2023)A novel consensus-based computational pipeline for screening of antibody therapeutics for efficacy against SARS-CoV-2 variants of concern including Omicron variant. Proteins. Jun;91(6):798-806. doi: 10.1002/prot.26467.

➢ Kumar N, Kaushik R, Singh A, Uversky VN, Zhang KYJ, Sahu U, Bhatia S, Sanyal A. Bayesian Molecular Dating Analyses Combined with Mutational Profiling Suggest an Independent Origin and Evolution of SARS-CoV-2 Omicron BA.1 and BA.2 Sub-Lineages. Viruses. 2022 Dec 12;14(12):2764. doi: 10.3390/v14122764.

➢ Kaushik R, Kumar N, Zhang KYJ, Srivastava P, Bhatia S, Malik YS (2022). A novel structure-based approach for identification of vertebrate susceptibility to SARS-CoV-2: Implications for future surveillance programmes. Environ Res. 212(Pt C):113303.

➢ Kumar, N., Kaushik, R., Tennakoon, C., Uversky, V. N., Mishra, A., Sood, R., Srivastava, P., Tripathi, M., Zhang, K., & Bhatia, S. (2021). Evolutionary Signatures Governing the Codon Usage Bias in Coronaviruses and Their Implications for Viruses Infecting Various Bat Species. Viruses, 13 (9), 1847.

➢ Maurya AK, Sharma P, Samanta P, Shami AA, Misra SK, Zhang F, Thara R, Kumar D, Shi D, Linhardt RJ, Sharp JS, Doerksen RJ, Tandon R, Pomin VH. (2023). Structure, anti-SARS-CoV-2, and anticoagulant effects of two sulfated galactans from the red alga Botryocladia occidentalis. Int J Biol Macromol. 238:124168.

b) Patent:

➢ Indian patent for Canine iELISA SARS-CoV-2 kit on 'Recombinant nucleocapsid protein based indirect ELISA kit for detection of antiSARS-CoV-2 antibodies in canines' (patent application no. 202111057358, dated 09-12-2021).

c) **Technology developed:**
  - **Can-CoV-2 ELISA Kit'-** a recombinant protein-based indirect ELISA kit for detection of antibodies against SARS-CoV-2 in canines with Sensitivity (95.83%) & Specificity (89.47%). The kit was formally released by the Hon'ble Minister of Agriculture Sh. Narender Singh Tomar ji on 9th June 2022.

  - **'CLA kit for canine COVID-19 serodiagnosis'** for detection of antibodies to SARS-CoV-2 nucleocapsid in dogs. Monoclonal antibody based **'Blocking ELISA kit'** for detection of antibodies to SARS-CoV-2 nucleocapsid in animals and human.

Project title: Studies on host pathogen interaction and development of vaccine against zoonotic coronaviruses

Project Code	:	8029
Duration of the project	:	June 2021 - May 2024
PI Name	:	Dr. Sandeep Bhatia
CCPI Names	:	Dr. C. Madhan Mohan
	:	Dr. B. C. Bera
Lead Centre	:	ICAR-NIHSAD, Bhopal
Cooperating centres	:	ICAR-IVRI, Izatnagar
	:	ICAR-NRCE, Hisar

Objectives:

➢ To conduct host pathogen interaction studies to identify molecular mechanisms of susceptibility/resistance to SARS-CoV-2 in different animal hosts.

➢ To develop vaccine candidates for SARS-CoV-2 using inactivated whole virus, Newcastle disease virus vector and mRNA-based platforms.

➢ Screening of animal models for suitability in vaccine challenge studies for SARS COV-2 and evaluation of the vaccine candidates for protective efficacy in the animal model.

Achievements

a) Publications:

➢ Kumar N, Kaushik R, Zhang KYJ, Uversky VN, Sahu U, Sood R, Bhatia S. (2023). A novel consensus-based computational pipeline for screening of antibody therapeutics for efficacy against SARS-CoV-2 variants of concern including Omicron variant. Proteins 91(6): 798–806

➢ Kaushik R, Kumar N, Zhang KYJ, Srivastava P, Bhatia S, Malik YS (2022). A novel structure-based approach for identification of vertebrate susceptibility to SARS-CoV-2: Implications for future surveillance programmes. Environmental research 212(Pt C), 113303.

➢ Kumar N, Kaushik R, Singh A, Uversky VN, Zhang KYJ, Sahu U, Bhatia S, Sanyal A. (2022). Bayesian Molecular Dating Analyses Combined with Mutational Profiling Suggest an Independent Origin and Evolution of SARS-CoV-2 Omicron BA.1 and BA.2 Sub-Lineages. Viruses 14(12): 2764.

Project title: Harnessing haplotype diversity of genes controlling yield, stress tolerance and resource use efficiency traits in rice for accelerating genetic gains

Project Code	:	8030
Duration of the project	:	June 2021- May 2024
PI Name	:	Dr. M. Raveendran
CCPI Names	:	Dr. Ranjith Kumar Ellur
	:	Dr. C. Gireesh
	:	Dr. M.S. Sheshshayee
Lead Centre	:	TNAU, Coimbatore
Cooperating centres	:	ICAR-IARI, New Delhi
	:	ICAR-IIRR, Hyderabad
	:	UAS, Bengaluru

Objectives:

➢ To assess the genetic diversity in yield, stress tolerance and resource use efficiency traits in the Indian subset of 3K Genome Panel

➢ To survey the sequence diversity and identification of superior haplotype of major genes controlling yield and climate resilience traits in the Indian subset of 3K Genome panel

➢ Validation of superior haplotypes and developing markers for breeding applications

Achievements

a) Publications:

➢ Mohanavel W, Ramalingam AP, Ayyenar B, Rajagopalan VR, Mohanavel V, Subburaj S, Manickam S, Rajasekaran R, Chellappan G, Swaminathan M, Perumal R, Muthurajan R, Prasad PV (2025). Mining of Candidate Novel Alleles Using GWAS and Haplotype Identification for Rice Blast Resistance. Plant Pathology, 74(3), pp.873-883.

➢ Sivabharathi, R. C., Rajagopalan, V. R., Suresh, R., Sudha, M., Karthikeyan, G., Jayakanthan, M., & Raveendran, M.* (2024). Haplotype-based breeding: A new insight in crop improvement. Plant Science 112129.

➢ Dhande, V. N., Williams, M., Ranjani, R. V., Sakthi, A. R., Sudha, M., & Raveendran, M. 2023. Identifcation of superior haplotypes for CCD8 regulating tiller number and grain yield in rice. Electronic Journal of Plant Breeding 14(1), 148-153.

➢ Vignesh Mohanavel, Veera Ranjani Rajagopalan, Sudha Manickam, Raveendran Muthurajan. 2023. Haplotype analysis of Xa21, a major Bacterial Blight Resistant gene in rice. The Pharma Innovation journal12(2):2599-2601.

➢ Topno , A., Williams M., Sakthi A. R., Bharathi A., Ranjani R. , V., Suresh R., Sudha M., Boopathi N. , M., & Raveendran M. (2023). Exploitation of Allelic Variation and Superior Haplotypes for OsMIT3 Regulating Tiller Number in Rice. International Journal of Plant & Soil Science 35(20), 375–382

Project title: Development of nano sensor and its application through cloud-based network for real time irrigation to soil and plant

Project Code	:	8031
Duration of the project	:	June 2021 - May 2024
PI Name	:	Dr. Tapan Adhikari
CCPI Names	:	Dr. C. D. Singh
	:	Dr. Samir Kumar Pal
Lead Centre	:	IISS, Bhopal
Cooperating centres	:	ICAR-CIAE, Bhopal
	:	S N Bose NSBS, Kolkata

Objectives:

➤ Development of contact and non-contact nano sensors for moisture stress measurement in soil and crop.

➤ Development of nano sensor network to irrigate the field, based on real time in situ measurement for improving water use efficiency.

➤ Techno-economic analysis of developed nano sensor network system at field level.

Achievements

a) **Publications:**

➤ Singh CD, Kumar VS (2024). Effects on growth and yields of sweet corn using internet of things (IoT) based smart drip irrigation and ETc-based drip irrigation systems. RASSA Journal of Science for Society 5 (2and3), 87-95.

➤ Kumar V, Singh CD, Rao KVR, Kumar M, Rajwade YA, Babu B, Singh K (2023) Evaluation of IoT based smart drip irrigation and ETc based system for sweet corn. Smart Agricultural Technology (Elsvier). https://doi.org/10.1016/j.atech.2023.100248.

➤ Ghosh R, Bhattacharyya N, Banerjee A, Mukherjee D, Singh S, Chattopadhyay A, Adhikari T, Pal SK (2023). Sensing Critical Water Content of Granulated Matrices: A Combined Experimental and Computational Study. Biosensors 13 185. DOI: 10.3390/bios13020185.

➤ Kumar V, Singh CD, Rao KVR, Rajwade YA, Kumar M, Asha KR (2023) Development and Evaluation of Smart Drip Irrigation System for Egg Plant using Internet of Things: Smart drip irrigation for egg plant. Journal of Scientific & Industrial Research (JSIR) 83 (3), 300-308.

➤ Kumar VS, Singh CD, Rao KVR, Kumar M, Rajwade YA (2022). Development of a smart IoT-based drip irrigation system for precision farming. Irrigation and Drainage. https://doi.org/10.1002/ird.2757.

➤ Kumar SV, Singh CD, Upendar K (2021) Review on IoT Based Precision Irrigation System in Agriculture. Current Journal of Applied Science and Technology 39 (45), 15-26.

b) Patent:

➤ R. Ghosh, N. Bhattacharyya, S. Singh, T. Adhikari, S. K. Pal, Ajay Kumar, N. K. Sinha, A. K. Patra. Sensing Bioavailable Water Content of Granulated Matrices: A Combined Experimental and Computational Study. (Patent Application Number: 202311021215).

c) Technology developed:

➤ MEGH (Measuring Essential Good Hydration), IOT enabled irrigation system

Project title: Exploring *aus* rice for drought, submergence and phosphorus starvation tolerance: Mining superior alleles and deciphering mechanism of tolerance

Project Code	:	8032
Duration of the project	:	July 2021 – June 2024
PI Name	:	Dr. Somnath Roy
CCPI Name	:	Dr. Umakanta Ngangkham
Lead Centre	:	ICAR-NRRI-CRURRS, Hazaribag
Cooperating centre	:	ICAR-RC for NEH Region, Meghalaya

Objectives:

➢ To characterize *aus* varietal group (including *aus* and *boro*) for natural variation in tolerance to drought, submergence and phosphorus starvation (low-P) and identify highly adaptive accessions for targeted traits.

➢ Mining superior alleles for traits conditioning tolerance to drought, submergence and low-P through genome-wide association mapping by utilizing the *aus* rices.

➢ To decipher the underlying mechanism(s) of tolerance to (i) drought, (ii) submergence and (iii) P starvation in highly tolerant/ adapted *aus* accessions.

➢ To mine novel alleles of *Phosphorus starvation tolerance 1* (*PSTOL1*) and Submergence (*Sub1*) from *aus* germplasm conferring higher efficiency for stress tolerance.

Achievements:

a) Publications:

➢ Sar P, Gupta S, Behera M, Chakraborty K, Ngangkham U, Verma BC, Banerjee A, Hanjagi PS, Bhaduri D, Shi, S, Kumar J, Mandal NP, Kole PC, Purugganan MD, Roy S (2024) Exploring Genetic Diversity within aus Rice Germplasm: Insights into the Variations in Agro-morphological Traits. Rice (New York, N.Y.), 17(1), 20. https://doi.org/10.1186/s12284-024-00700-4

➢ Basha FTM, Sar P, Bhowmick PK et al. (2024) Genome-wide association study identified QTLs and genes underlying early seedling vigour in aus rice (*Oryza sativa* L.). Molecular Genetics and Genomics 299, 112. https://doi.org/10.1007/s00438-024-02204-8.

➢ Sar P, Aiswarya VS, Basha FT, Deo R, Verma BC, Bhaduri D, Roy S (2024). Exploring phosphorus starvation tolerance in as (*Oryza sativa* L.) rice: An analysis of stress tolerance attributes and understanding the effect of PSTOL1 gene. Plant Breeding 143,413-422. DOI: 10.1111/pbr.13173'

b) Technology developed:

➢ Trait-specific genetic stock: The application for registering 'Binnaful' as a multiple abiotic stress (drought, low-P, submergence and high Anaerobic Germination) tolerant genotype is in review for PGRC registration.