CALL VI

Project title: Information dissemination system (s) for empowering farming community of Uttarakhand

Project Code	**:**	6001
Duration of the project	**:**	October 2016 - September 2019
PI Name	**:**	Dr. Shivendra Kumar Kashyap
CCPI Name	**:**	Dr. Kushagra Joshi
Lead Centre	**:**	GBPUAT, Pantnagar
Cooperating centre	**:**	ICAR-VPKAS, Almora

Objectives:

- To study the communication characteristics of farming communities in Uttarakhand.
- To identify the agricultural information needs of different stakeholders of the farming community.
- To design and develop need based agricultural information and media packages for different segments of the farming community.
- To study the impact of the developed packages on selected stakeholder groups and up-scaling for broader use.

Achievements:

a) Technology Development:

- Evaluated the existing Information dissemination system in low hills, mid hills and high hills
- Developed a model of integration of modified information dissemination system with prevalent ICT tools for enhancing accessibility of updated information swiftly and effectively.
- Generated knowledge database and knowledge repository in digital mode for easy access among farming community
- Generated and tested media package for hills
- Development of 23 audio programmes modules for knowledge development on following topics for different climatic zones of Uttarakhand
- Development of 25 video programmes modules for knowledge and skill development on following topics for different climatic zones of Uttarakhand
- Development of 25 print material (folder) for knowledge development on following topics for different climatic zones of Uttarakhand

Project title: Convergence and network analysis of extension organizations for enhancing their effectiveness in pluralistic extension regime

Project Code	**:**	6002
Duration of the project	**:**	October 2016 - September 2019
PI Name	**:**	Dr. R. N. Padaria
CCPI Names	**:**	Dr. R.P.Singh Ratan
	:	Dr. Prasant Pandey
	:	Dr. Pankaj Kumar Sinha
Lead Centre	**:**	ICAR-IARI, New Delhi
Cooperating centres	**:**	BAU, Ranchi
	:	ICAR-IGKV, Raipur
	:	ICAR RC for NEH Region, Umiam

Objectives:

- To analyze the effectiveness of pluralistic extension in service provisioning and livelihood security of farmers.
- To assess the existing nature and extent of convergence and linkages of institutions engaged in extension system and undertake related gaps and constraint analysis in different production systems.
- To conduct extension organizations network analysis and identify the determinants and mediating factors for effective institutional convergence and linkages.
- To devise as well as validate ICT mediated convergence-led extension model.

Achievement:

- Enhanced farmer awareness, skills, and capacity through demonstrations, convergence, and dissemination of improved, income-generating, and nutrition-focused agricultural practices, including hybrid rice and vegetable cultivation.

Project title: Addressing farmers' suicide issue through capacity building of farming families

Project Code	**:**	6003
Duration of the project	**:**	October 2016 - September 2019
PI Name	**:**	Dr. Sarabjeet Singh
CCPI Names	**:**	Dr. V. Sudha Rani
	:	Dr. D.N. Gokhale
	:	Dr. Harprit Kaur
Lead Centre	**:**	PAU, Ludhiana
Cooperating centres	**:**	PJTSAU, Hyderabad
	:	VNMKV, Parbhani
	:	PUP, Patiala

Objectives:

- To identify Peer Support Volunteers (PSVs) in educational institutions and design need-based interventions for their training through experts.
- To build capacity of selected PSVs for reducing agrarian stress.
- To analyse effect of the intervention through relevant psychological indices.
- To document case studies to establish a permanent peer support cell in educational institutions and assess the feasibility of this intervention at scale.

Achievements:

a) Publications:

- Kaur M, Kaur R and Singh S (2019) Depression and Suicidal Ideation among distressed farmers of Punjab. International Journal of Education and Management Studies 9(1):29-32.
- Kaur M, Kaur R and Singh S (2019) Farmers' suicide in Punjab: Analysis of reporting in print media. International Journal of Chemical Studies 7:3320-3323.
- Kaur H, Singh A and Kaur S (2019) Empathy and Moral Identity as Predictors of Peer Support Volunteerism for Preventing Farmer Suicide in Punjab. The International Journal of Indian Psychology 7:397-404.
- Kaur H and Singh A (2019) Suicide: Concepts and its Legal Implications. International Journal of Social Sciences Review 7:637-641.
- Singh A, Kaur H and Singh S (2019) Efficacy of Cognitive Behavioural Therapy (CBT) by Peer Support Volunteers (PSVs) for Suicide Prevention in Farmers of Punjab. Indian Journal of Psychology and Education 9: 26-32.

- Venkateswarlu B, Ahire R D and Kapse P S (2019) Farmers Suicides in Marathwada Region of India: A Causative Analysis. International Journal of Current Microbiology and Applied Sciences. 8(4):296-308.

- Bodke B G, Deshmukh P R and Naganikar S G (2019) Relationship between selected characteristics of suicide farmers with their identified risk factors of suicide in Nanded district. International Journal of Chemical Studies 7:2505-2508.

- Rani V S, Reddy S Y and Kumar T V (2019) Profile characteristics of suicide committed farmers of Mahabubnagar district of Telangana State. Multilogic in Science 9:156-159.

- Kaur R, Rishi H and Singh S (2018) Well-being in relation to Cognitive distortion, Resilience and Depression among farmers of Punjab. Indian Journal of Positive Psychology 8:443-447.

- Kaur M and Kaur R (2018) Using the 12-item General Health Questionnaire (GHQ-12) to assess the Mental Health of Farmers of Punjab. International Journal of Pure & Applied Bioscience 6:905-912.

- Khokle R B, Kadam R P and Dhulgand V G (2018) Socio-economic, psychological and situational profile of farmer suicide in Jalna district (MH). International Journal of Chemical Studies 6:1503-1505.

Project title: Developing agribusiness models linking farmers groups and farmer produce organizations to markets through value chain management

Project Code	**:**	6004
Duration of the project	**:**	October 2016 – September 2019
PI Name	**:**	Dr. S D Sivakumar
CCPI Names	**:**	Dr. K. Mahendran
	:	Dr. T.N Balamohan
Lead Centre	**:**	ADAC & RI, Tiruchirapali
Cooperating centres	**:**	TNAU, Coimbatore
	:	TNAU, Madurai

Objectives:

- To analyze and develop relevant agribusiness strategy, agribusiness model and business process for selected Farmers Groups and FPOs in Tamil Nadu
- To assess the linkages among various functions and stakeholders and design value chain
- To develop entrepreneurs among rural women for undertaking various activities in value chain
- To assess the resource requirements for implementation of business model
- To develop and implement capacity building programs for farmers for effectively managing Farmers Groups and FPOs and value chain management

Achievements:

- Strengthened institutional and human resource capacities through assessment, capacity building, financial planning, and promotion of women entrepreneurship to enhance the functioning of Farmers Clubs, FIGs, and FPOs.
- Developed sustainable, market-oriented business models and value chain strategies focused on value addition, direct marketing, and equitable benefit distribution across farmer-based organizations.

Project title: Phenomics of moisture deficit stress tolerance and nitrogen use efficiency in rice and wheat – Phase II

Project Code	:	6005
Duration of the project	:	January 2017- November 2020
PI Name	:	Dr. Viswanathan Chinnusamy
CCPI Names	:	Dr. Anil Rai
	:	Dr. Brejesh Lall
	:	Dr. Padmini Swain
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centres	:	ICAR-IASRI, New Delhi
	:	IIT, Delhi
	:	ICAR-NRRI, Cuttack

Objectives:

- To develop trait prediction models, Integrated Analysis Platforms (IAPs) and phenome data bank for high throughput estimation of phenotypic traits from various imaging sensors.

- To understand the physiological and phenological dynamics of component traits for moisture-deficit stress tolerance and NUE in rice and wheat using phenomics.

- To understand genetic dynamics and identify QTLs/ genes for component traits of moisture deficit stress tolerance and NUE using image based dynamic phenotypic data from phenomics and end-point field phenotypic data.

Achievements:

a) Publications:

- Smita S, Katiyar A, Lenka SK, Dalal M, Kumar A Mahtha SK Yadav G, Chinnusamy V, Pandey DM, Bansal KC (2020) Gene network modules associated with abiotic stress response in tolerant rice genotypes identified by transcriptome meta-analysis. Functional & Integrative Genomics 20: 29–49.

- Santosh Kumar VV, Verma RK, Yadav SK, Yadav P, Watts A, Rao MV, Chinnusamy V (2020) CRISPR-Cas9 mediated genome editing of drought and salt tolerance (OsDST) gene in indica mega rice cultivar MTU1010. Physiology and Molecular Biology of Plants. 26(6):1099–1110.

- Misra T, Arora A, Marwaha S, Jha RR, Chinnusamy V, Rao AR, Jain R, Sahoo RN, Ray M, Kumar S, Raju D, Nigam A, Goel S (2020) Spike Seg Net-A deep learning approach utilizing Encoder-Decoder Network with Hour Glass for spike segmentation and counting in wheat plant from visual imaging. Plant Methods. 16, 40. https://doi.org/10.1186/s13007-020-00582-9.

- Mahmoud D, Pandey R, Sathee L, Dalal M, Singh MP, Chinnusamy V (2020) Regulation of expression of genes associated with nitrate response by osmotic stress and combined osmotic and nitrogen deficiency stress in bread wheat (*Triticum aestivum* L.). Plant Physiology Reports 25(2): 200–215.

- Krishna G, Sahoo RN, Singh P, Bajpai V, Patra H, Kumar S, Dandapani R, Gupta VK, Viswanathan C, Ahmad T, Sahoo PM (2019) Comparison of various modelling approaches for water deficit stress monitoring in rice crop through hyperspectral remote sensing. Agricultural Water Management. 213:231–244.

- Krishna G, Sahoo RN, Singh P, Patra H, Bajpai V, Das B, Kumar S, Dhandapani R, Vishwakarma C, Pal M, Chinnusamy V (2019) Application of thermal imaging and hyperspectral remote sensing for crop water deficit stress monitoring. Geocarto International. doi.org/10.1080/10106049.2019.1618922.

- Das B, Sahoo RN, Pargal S, Krishna G, Verma R, Chinnusamy V, Sehgal VK, Gupta VK (2019) Comparative analysis of index and chemometric techniques-based assessment of leaf area index (LAI) in wheat through field spectroradiometer, Landsat-8, Sentinel-2 and Hyperion bands. Geocarto International. doi: 10.1080/10106049.2019.1581271.

- Misra T, Arora A, Marwaha S, Ray M, Raju D, Kumar S, Goel S, Sahoo RN, Chinnusamy V (2019) Artificial neural network for estimating leaf fresh weight of rice plant through visual-NIR imaging. Indian Journal of Agricultural Sciences. 89: 1698–1702.

- Sahoo RN, Viswanathan C, Krishna G, Das B, Goel S, Dhandapani R, Kumar S, Viswakarma C, Swain P, Dash SK (2019) Next generation phenotyping for developing climate resilient rice varieties. Oryza. 56(Special Issue): 92-105.

- Verma RK, Santosh Kumar VV, Yadav SK, Pushkar S, Rao MV, Chinnusamy V (2019) Overexpression of ABA Receptor PYL10 gene confers drought and cold tolerance to indica rice. Frontiers in Plant Science. doi: 10.3389/fpls.2019.01488.

- Krishna G, Sahoo RN, Singh P, Bajpai V, Patra H, Kumar S, Dandapani R, Gupta VK, Viswanathan C, Ahmad T, Sahoo PM (2019) Comparison of various modelling approaches for water deficit stress monitoring in rice crop through hyperspectral remote sensing. Agricultural Water Management 213: 231–244.

- Gupta MK, Sharma V, Lenka SK, Chinnusamy V (2019) In silico study revealed major conserve architectures and novel features of pyrabactin binding to Oryza sativa ABA receptors compare to the Arabidopsis thaliana. Journal of Biomolecular Structure & Dynamics 9:1-14. Doi: 10.1080/07391102.2019.1654922.

- Sakhare AS, Kumar S, Kumar RR, Bainsla NK, Gaikwad K, Sharma RK, Chinnusamy V (2019) A facile and cheaper method to measure root angle of rice and wheat. Indian Journal of Agricultural Sciences 89: 934-939.

- Das B, Sahoo RN, Biswas A, Pargal S, Krishna G, Verma R, Chinnusamy V, Sehgal VK, Gupta VK (2018) Discrimination of rice genotypes using field spectroradiometry. Geocarto International doi.org/10.1080/10106049.2018.1506507.

- Das B, Sahoo RN, Pargal S, Krishna G, Verma R, Chinnusamy V, Sehgal VK, Gupta VK, Dash SK, Swain P (2018) Quantitative monitoring of sucrose, reducing sugar and total sugar dynamics for phenotyping of water-deficit stress tolerance in rice through spectroscopy and chemometrics. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. 192: 41-51.

- Anupama A, Bhugra S, Lall B, Chaudhury S, and Chugh A (2018) Assessing the correlation of genotypic and phenotypic responses of indica rice varieties under drought stress. Plant Physiology and Biochemistry 127: 343-354.

- Das B, Sahoo RN, Pargal S, Krishna G, Verma R, Chinnusamy V, Sehgal VK, Gupta VK, Dash SK, Swain P (2017) Comparison of different uni-and multi-variate techniques for monitoring leaf water status as an indicator of water-deficit stress in wheat through spectroscopy. Biosystems Engineering. 160: 69-83 https://doi.org/10.1016/j.biosystemseng.2017.05.007.

Project title: Epigenetic regulation of host-pathogen genetics in leaf rust resistance of wheat

Project Code	**:**	6006
Duration of the project	**:**	January 2017 - December 2020
PI Name	**:**	Prof. P. K. Gupta
CCPI Names	**:**	Dr. Neelu Jain
	:	Dr. Pramod Prasad
Lead Centre	**:**	CCSU, Meerut
Cooperating centres	**:**	ICAR-IARI, New Delhi
	:	ICAR-IIWBR, Regional Station, Shimla

Objectives:

- Deciphering the role of microRNA mediated regulation in differential expression of genes and identification of miRNA target genes involved in interaction of a pair of NILs [resistant (HD2329 +Lr28) and susceptible (HD2329)] with leaf rust (*Puccinia triticina*) race 77-5.

- Identification of genes in resistant (HD2329 +Lr28) and usceptible (HD2329) NILs undergoing epigenetic modifications at DNA and histone levels following pathogen invasion, using bisulphite sequencing (for DNA methylation) and ChIP-seq/or ChIP-PCR (for histone modifications).

- Identification and validation of leaf rust (Puccinia triticina) race 77-5 avirulence genes functional in compatible/incompatible reactions with the host.

- Discovering the cross-interactions between miRNA transcriptome, histone modifications, methylome and transcriptome (already available from another project) involved in host-pathogen (i.e. (HD2329 +Lr28)/ HD2329- *Puccinia triticina* race 77-5) interactions and validation of identified resistance/susceptibility specific induced genes and their epigenetic modifications through transient expression or VIGS.

Achievements:

a) Publications:

- Saripalli G, Singh K, Gautam T, Kumar S, Raghuvanshi S, Prasad P, Jain N, Sharma PK, Balyan HS, Gupta PK (2020) Genome-wide analysis of H3K4me3 and H3K27me3 modifications due to Lr28 for leaf rust resistance in bread wheat (*Triticum aestivum*). Plant Molecular Biology. 104:113 136.

- Jain N, Rani S, Sharma C, Sinha N, Singh A, Sharma JB, Prasad P, Saripalli G, Sharma PK, Balyan HS, Gupta PK, Prabhu KV (2020) Large-scale stage-expression regulation of gene expression during host-pathogen interactions in CSP44 bread wheat carrying APR gene Lr48. Functional Plant Biology. 7(3) 203-225. doi.org/10.1071/FP18336.

- Saripalli G, Sharma C, Gautam T, Singh S, Jain N, Prasad P, Joy JK, Sharma JB, Sharma PK, Prabhu KV, Balyan HS, Gupta PK (2019) Complex relationship between

DNA methylation and gene expression due to Lr28 in wheat-leaf rust pathosystem. Molecular Biology Reports. 47(2):1339-1360. doi.org/10.1007/s11033-019-05236-1.

- Gautam T, Saripalli G, Gahlaut V, Kumar A, Sharma PK, Balyan HS, Gupta PK (2019) Further studies on sugar transporter (SWEET) genes in wheat (*Triticum aestivum*). Molecular Biology Reports. 46:2327-2353 doi:10.1007/s11033-019-04691-0.

- Sharma C, Kumar S, Saripalli G, Jain N, Raghuvanshi S, Sharma JB, Prabhu KV, Balyan HS, Gupta PK. (2019) H3K4/K9 acetylation and Lr28-mediated expression of six leaf rust-responsive genes in wheat (*Triticum aestivum*). Molecular Genetics and Genomics. 94:227-241.

- Sharma C, Saripalli G, Kumar S, Gautam T, Kumar A, Rani S, Jain N, Prasad P, Raghuvanshi S, Jain M, Sharma JB, Prabhu KV, Sharma PK, Balyan HS, Gupta PK (2018) A study of transcriptome in leaf rust-infected bread wheat involving seedling resistance gene Lr28. Functional Plant Biology 45:1046-1064. doi.org/10.1071/FP17326.

Project title: Characterization, mapping and transcriptome analysis of seed protein, β-carotene and mineral contents in chickpea (*Cicer arietinum* l.)

Project Code	**:**	6007
Duration of the project	**:**	January 2017 – September 2020
PI Name	**:**	Dr. Venkatraman Hegde
CCPI Names	**:**	Dr. P. K. Jain
	:	Dr. Satvir Kaur Grewal
	:	Mr. Biswajit Mondal
Lead Centre	**:**	ICAR-IARI, New Delhi
Cooperating centres	**:**	ICAR-NRCPB, New Delhi
	:	PAU, Ludhiana
	:	ICAR-IIPR, Kanpur

Objectives:

- Characterization of chickpea germplasm for seed protein concentration, β-carotene and minerals (Fe, Zn)
- Transcriptome analysis for identification of genes related with enhanced seed protein content, β-carotene and minerals (Fe, Zinc) and microRNA analysis for association of miRNAs with enhanced seed protein content
- Mapping QTLs for seed protein, β-carotene and minerals (Fe, Zn) concentration utilizing association panel and validation of the information so derived in biparental populations

Achievements:

a) Publications:

- Kalwan G, Priyadarshini P, Kumar K, Yadava YK, Yadav S, Kohli D, Gill SS, Gaikwad K, Hegde V, Jain PK. (2023): Genome wide identification and characterization of the amino acid transporter (AAT) genes regulating seed protein content in chickpea (*Cicer arietinum* L.). *International Journal of Biological Macromolecules*, *252*, 126324.
- Grewal SK, Sharma KP, Bharadwaj RD, Hegde, Venkatraman H, Sidhu SK, Singh S, Jain PK, Rasool S, Arya DK, Agrawal PK, Mondal B (2022): Characterization of chickpea cultivars and trait specific germplasm for grain protein content and amino acids composition and identification of potential donors for genetic improvement of its nutritional quality. *Plant Genetic Resources- Characterization and Utilization* 20: 383–393. doi:10.1017/ S147926212300028X

➢ Grewal SK, Sharma KP, Bharadwaj RD, Hegde, Venkatraman H, Tripathi S, Singh S, Jain P., Agrawal PK, Mondal B (2020): Understanding genotypic variation and identification of promising genotypes for iron and zinc content in chickpea (*Cicer arietinum* L.). Journal of Food Composition and Analysis 88:103458

Project title: Population diversity of banana streak viruses (BSV) and understanding the mechanisms of resistance to BSV in diploid seedy banana of north east India

Project Code	:	6008
Duration of the project	:	January 2017 – June 2021
PI Name	:	Dr. Susheel Kumar Sharma
CCPI Names	:	Dr. Virendra Kumar Baranwal
	:	Dr. Thangjam Robert Singh
Lead Centre	:	ICAR Research Complex for NEH Region, Manipur Centre, Imphal
Cooperating centres	:	ICAR-IARI, New Delhi
	:	Mizoram University, Aizawl

Objectives:

- To analyze the genetic diversity of Musa species/subspecies from North East India and integrated endogenous Badnavirus sequences to study possible co-evolution
- Characterization, genetic heterogeneity of episomal badnaviruses infecting diverse banana genotypes and their quasispecies evolution in North East India
- To study the selective advantage of endogenous badnaviruses in diploid seedy banana and role of small RNA based silencing machinery in virus resistance/pathogenicity

Achievements:

b) Publications:

- Rai R, Sharma SK, Anand YR, Monteshori S, Diksha D, Dubey SK, Dubey SK, Baranwal VK. (2023). Novel genetic variants of banana streak MY virus and banana streak IM virus infecting natural banana mats in an unexplored area of North East India. South African Journal of Botany 14(11): 277 DOI: 10.1007/s13205-024-04113-4

Project title: Chemotyping and molecular profiling of bioactive metabolites in *Hemidesmus indicus* and *Costus speciosus*, adapted to different phytogeographical zones and identification of candidate genes related to metabolic pathways

Project Code	**:**	6009
Duration of the project	**:**	January 2017 - December 2020
PI Name	**:**	Dr. Sharad Srivastava
CCPI Names	**:**	Dr. Narendra A Gajbhiye
	:	Dr. Krishna madhav Rai
	:	Dr. V. Sunderashan
Lead Centre	**:**	CSIR-NBRI, Lucknow
Cooperating centres	**:**	ICAR-DMAPR, Anand, Gujarat
	:	ICAR-NBPGR-RS, Bhawali, Nanital
	:	CIMAP-RC, Bangalore

Objectives:

- Bioresourse mapping of *Hemidusmus indicus* and *Costus speciosus* and, characterization of their metabolites adapted to different phytogeographical regions of India.
- Development of standardized agro techniques for elite chemotypes of *Hemidusmus indicus* and *Costus speciousus* for sustainable commercial cultivation.
- Molecular profiling and transcriptome analysis for the identification of candidate gene(s) of active secondary metabolite(s) and establishment of correlation between chemotypic and genotypic variations.
- Isolation, purification and bio-efficacy of active metabolites derived from elite chemotypes of *Hemidusmus indicus* and *Costus speciosus.*

Achievements:

a) Publications:

- Kumar M, Misra A, Srivastava A, Shukla PK, Tewari LM, Srivastava S (2020) Comparative Pharmacognostical and Pharmacological Evaluation of *Costus speciosus* (Koen) J.E. Sm. Germplasm Collected from Eastern Ghats of India. Pharmacog Journal. :12(1):150-6.
- Srivastava A, Kumar M, Misra A, Shukla PK, Agrawal PK, Srivastava S (2019) Evaluation of diosgenin content in *Costus speciosus* germplasm collected from Eastern Ghats of India and identification of elite chemotypes. Pharmacognosy Magazine. 15(66):462-467. DOI: 10.4103/pm.pm_72_19.

Project title: Molecular mapping and identification of candidate genes for anthracnose fruit rot disease resistance in chilli (*Capsicum annuum* L.)

Project Code	**:**	6010
Duration of the project	**:**	January 2017-December 2019
PI Name	**:**	Dr. K. Madhavi Reddy
CCPI Name	**:**	Dr. Ponnam Naresh
Lead Centre	**:**	ICAR-IIHR, Bangalore
Cooperating centre	**:**	CHES, Bhubaneswar

Objectives:

- Molecular fine mapping of QTLs against anthracnose fruit rot in chilli by using mapping populations developed from contrast (susceptible and resistant) parents
- Identification of potential candidate genes that confer immunity in the resistant chilli genotypes against the anthracnose fruit rot

Achievements:

- Capsicum genotypes were screened for anthracnose fruit rot resistance, leading to the identification of major resistance loci on chromosomes 2 and 6 through GWAS; 19 significant SNPs were discovered, NBS-LRR resistance genes were identified, and validated molecular markers were developed for use in marker-assisted selection in AFRR breeding programs.

Project title: Transgenic overexpression of phosphite dehydrogenase: a comprehensive strategy to enhance phosphorus use efficiency with integrated weed and disease management for sustainable agriculture

Project Code	**:**	6011
Duration of the project	**:**	January 2017 – March 2020
PI Name	**:**	Dr. M. K. Reddy
CCPI Names	**:**	Dr. Aundy Kumar
	:	Dr. M. Srinivas Prasad
Lead Centre	**:**	ICGEB, New Delhi
Cooperating centres	**:**	ICAR-IARI, New Delhi
	:	ICAR-IIRR, Hyderabad

Objectives:

- Development of transgenic rice plants to metabolize Phosphite fertilizer for enhanced P use efficiency with integrated weed and pest management
- Evaluation of transgenic rice plants for P-use efficiency when phosphite fertilizer applied in acidic, neutral and calcareous soils; compared to the orthophosphate fertilizer.
- Evaluation of potential pre and post emergent herbicidal activity of phosphite based fertilizer on different weed species in transgenic rice crop.
- Evaluation of potential biocidal or elicitor activity of phosphite on fungal and bacterial diseases in transgenic rice crop.
- To decipher the effect of phosphite fertilizers on phyllosphere and rhizosphere microbiome composition and structure in transgenic rice

Achievements:

a) Publications:

- Achary VMM, Ram B, Manna M, Datta D, Bhatt A, Reddy MK, Agrawal PK (2017) Phosphite: a novel P-fertilizer for weed management and pathogen control. Plant Biotechnology Journal 15:1493–1508 DOI: 10.1111/pbi.12803.
- Manna M, Achary VMM, Islam T, Agrawal PK, Reddy MK (2016) The development of a phosphite-mediated fertilization and weed control system for rice. Scientific Reports. 6: 24941 doi: 10.1038/srep24941.
- Manna M, Islam T, Kaul T, Reddy CS, Fartyal D, James D, Reddy MK (2015) A comparative study of effects of increasing concentrations of phosphate and phosphite on rice seedlings. Acta Physiologiae Plantarum. 37:258 DOI: 10.1038/srep24941

Project title: Creating a fully characterized genetic resource pipeline for mustard improvement programme in India

Project Code	**:**	6012
Duration of the project	**:**	January 2017 - December 2019
PI Name	**:**	Prof. S. S. Banga
CCPI Names	**:**	Dr. D. K. Yadava
	:	Dr. Kunwar Harendra Singh
	:	Dr. Ram Bhajan
	:	Dr. A. R. Rao
Lead Centre	**:**	PAU, Ludhiana
Cooperating centres	**:**	ICAR-IARI, New Delhi
	:	ICAR-DRMR, Bharatpur
	:	GBPUAT Pantnagar
	:	ICAR-IASRI, New Delhi

Objectives:

- To assess the level of phenotypic diversity available within diversity fixed foundation set (DFFS).
- SNP genotyping of DFFS and all released mustard varieties.
- Association mapping for key economic traits.
- Low pass sequencing of *B. fruticulosa, Diplotaxis cardaminoids* and *Erucastrum abbysinicum* to identify SNP/ SSR markers. These species were used as wild donors for introgression lines included in DFFS.
- Develop database of phenotypic and genotypic information regarding DFFS and mustard varieties released in India.

Achievements:

- Established genomic resources and novel insights into candidate genes influencing key life history and productivity traits in mustard. The genotyping data and developed resources will serve as a valuable asset for Brassica researchers for years to come.

Project title: Synthetic endometrium: a novel model to study early embryonic development and uterine health in ruminants

Project Code	**:**	6013
Duration of the project	**:**	January 2017 - December 2019
PI Name	**:**	Dr. Sanjay Kumar Singh
CCPI Names	**:**	Dr. Rubina Kumari Baithalu
	:	Dr. Dharmendra Kumar
Lead Centre	**:**	ICAR-IVRI, Izatnagar
Cooperating centres	**:**	ICAR-NDRI, Karnal
	:	ICAR-CIRB, Hissar

Objectives:

- To develop an endometrium-like 3 3-dimensional cell culture system in buffalo.
- To study the interactions of synthetic endometrium with embryo and uterine pathogens/ Pathogen Associated Molecular Patterns.
- To undertake studies on repeat breeding cows and buffalo for enhancing their fertility based on the lead from in vitro experiments.

Achievements:

a) Publications:

- Ali A, Dar RR, Ahmad SF, Singh SK, Patra MK, Panigrahi M, Kumar H, Krishnaswamy N (2020) Curcumin inhibits lipopolysaccharide and lipoteichoic acid-induced expression of proinflammatory cytokines and production of PGE2 in the primary bubaline endometrial stromal cells. Molecular Biology Reports. https://doi.org/10.1007/s11033-020-05961-y.
- Dar RR, Ali A, Ahmad SF, Singh SK, Patramk, Panigrahi M, Kumar H, Krishnaswamy N (2019). Immunomodulatory effect of curcumin on lipopolysaccharide and flagellin-induced production of PGE2 and relative expression of proinflammatory cytokines in the primary bubaline endometrial stromal cells. Reproduction in Domestic Animals. 54(6): 917-923 doi: 10.1111/rda.13435.

Project title: Detection of peptide biomarkers and development of synthetic anti-microbial peptide hydrogels for bovine mastitis

Project Code	:	6014
Duration of the project	:	January 2017 – June 2020
PI Name	:	Dr. Sameer Shrivastava
CCPI Names	:	Prof. K. Chandrashekara
	:	Dr. K. Santhosh Kumar
Lead Centre	:	ICAR-IVRI, Izatnagar
Cooperating centres	:	UAS, GKVK, Bangalore
	:	Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram, Kerala

Objectives:

- To identify and characterize peptide biomarkers in bovine mastitic milk
- To develop immuno-biosensor assay for detecting biomarkers associated with bovine sub-clinical mastitis
- To isolate novel anti-microbial peptides (AMPs) from secretions/excretions of insects & amphibians and characterize for antimicrobial activity
- To develop synthetic AMP hydrogels for therapeutic management of bovine mastitis

Achievements:

a) Publications:

- Gogoi P, Shrivastava S, Shah P, Saxena S, Srivastava S, Gaur GK (2021) Linear and Branched Forms of Short Antimicrobial Peptide-IRK Inhibit Growth of Multi Drug Resistant *Staphylococcus aureus* Isolates from Mastitic Cow Milk. International Journal of Peptide Research and Therapeutics. 27:2149–2159. https://doi.org/10.1007/s10989-021-10243-7.
- Shah P, Shrivastava S, Singh RJ, Gogoi P, Saxena S, Srivastava S, Kumar N, Gaur GK (2021) Synthetic Antimicrobial Peptide Polybia MP-1 (Mastoparan) Inhibits Growth of Antibiotic-Resistant *Pseudomonas aeruginosa* Isolates from Mastitic Cow Milk. International Journal of Peptide Research and Therapeutics. https://doi.org/10.1007/s10989-021-10266-0.
- Gupta S, Abhishek, Shrivastava S, Singh RJ, Gogoi P, Kumar B (2021) Evaluation of antibacterial activity of magainin and mastoparan and its novel hybrid against MDR E. Coli isolates of neonatal calves. International Journal of Peptide Research and Therapeutics (2021) 27:1111–1119. https://doi.org/10.1007/s10989-020-10154-z.
- Sharma R, Shrivastava S, Singh SK, Kumar A, Saxena S, Singh RK (2021) Deep-ABPpred: identifying antibacterial peptides in protein sequences using bidirectional LSTM with word2vec, Briefings in Bioinformatics. bbab065. https://doi.org/10.1093/bib/bbab065.

- Sharma R, Shrivastava S, Singh SK, Kumar A, Saxena S, Singh RK (2021) AniAMPpred: artificial intelligence guided discovery of novel antimicrobial peptides in animal kingdom, Briefings in Bioinformatics. Bbab242. https://doi.org/10.1093/bib/bbab242.

- Singh RJ, Shrivastava S, Sonal, Shah P, Gogoi P, Srivastava S, Hussain S, Bisht D, Kodape S, Khandare R, Singh RK (2019) Biophysical characterization of chemically synthesized antimicrobial peptide 'mastoparan' and evaluation of its activity on *Staphylococcus aureus* isolated from mastitic milk. International Journal of Current Microbiology and Applied Sciences. 8(11): 368-374.doi:https://doi.org/10.20546/ijcmas.2019.811.046.

- Bhagavathula N, Meedidoddi V, Bourque S, Vimaladevi S, Kesavakurup S, Selvadurai D, Shrivastava S, Krishnappa C (2017) Characterisation of two novel antimicrobial peptides from the cuticular extracts of the ant *Trichomyrmex criniceps* (Mayr), (Hymenoptera: Formicidae). Archives of Insect Biochemistry and Physiology. 94(4):E21381. https://doi.org/10.1002/arch.21381.

b) Patent:

- Invention Disclosure document being prepared for filing patent application on the amino acid sequences of lead AMP molecules.

Project title: Chemical, structural and functional characterization of identified anti-tick lead phytochemicals and optimization of delivery matrix for effective application of natural formulation for the control of acaricide-resistant ticks

Project Code	:	6015
Duration of the project	:	January 2017 - December 2020
PI Name	:	Dr. Srikanta Ghosh
CCPI Names	:	Dr. Sharad Srivastava
	:	Dr. Rajesh Kumar
	:	Dr. Sanis Juliet
	:	Dr. Satyanshu Kumar
Lead Centre	:	ICAR-IVRI, Izatnagar, Bareilly
Cooperating centres	:	CSIR-NBRI, Lucknow
	:	ICAR-IARI, New Delhi
	:	COVAS, Pookode, Kerala
	:	ICAR-DMAPR, Anand, Gujarat

Objectives:

- To establish the seasonal/geographical variation if any, in identified chemical markers in different accessions of identified plants and its correlation with anti-tick properties.
- Further characterization of potent anti-tick compound(s) or their derivatives to increase anti-adult efficacy.
- To understand the possible mode of action of the identified lead compounds/combination of compounds or new lead having adulticidal property.
- Development of innovative formulations for efficient delivery of acaricides.
- Publication of research data in high quality peer reviewed journals, patents and technology.

Achievements:

a) Publications:

- Nagar G, Upadhaya D, Sharma A K, Kumar R, Fular A, Ghosh S (2021) Association between overexpression of cytochrome P450 genes and deltamethrin resistance in *Rhipicephalus microplus*. Ticks and Tick-borne Diseases. 12(2): 101610. https://doi.org/10.1016/j.ttbdis.2020.101610.
- Kumar R, Sharma AK, Ghosh S (2020) Menace of acaricide resistance in cattle tick, *Rhipicephalus microplus* in India: Status and possible mitigation strategies. Veterinary Parasitology. doi.org/10.1016/j.vetpar.2019.108993.
- Upadhaya D, Kumar B, Kumar S, Sharma AK, Fular A, Bisht N, Srivastava S, Boruah RR., Nagar G, Shakya M, Nath T, Nandi SP, Karivaradharaja S, Ghosh S (2020) Characterization of acaricide resistance in *Rhipicephalus microplus* populations

infesting cattle in north eastern India and assessment of local plant extracts for tick management. Veterinary Parasitology. 277:109011. doi: 10.1016/j.vetpar.2019.109011.

- Fular F, Gupta S, Sharma AK, Kumar S, Upadhaya D, Shakya M, Nagar G, Ghosh S (2020) Standardization of tick specific biochemical tools for estimation of esterases, monooxygenases and glutathione S-transferase for characterization of acaricide resistance. Pesticide Biochemistry and Physiology. https://doi.org/10.1016/j.pestbp.2020.01.008..

- Shakya M, Kumar S, Fular A, Upadhaya D, Sharma AK, Bisht N, Nandi A, Ghosh S (2020) Emergence of fipronil resistant *Rhipicephalus microplus* populations in Indian states. Experimental and Applied Acarology. https://doi.org/10.1007/s10493-020-00481-7

- Shah S, Dhanani T, Sharma S, Singh R, Kumar S, Kumar B, Srivastava S, Ghosh S, Kumar R., Juliet S (2020) Development and validation of a reversed phase high performance liquid chromatography-photodiode array detection method for simultaneous identification and quantification of coumarin, precocene-I, β-caryophyllene oxide, α-humulene, and β-caryophyllene in Ageratum conyzoides extracts and essential oils from plants. Journal of AOAC International. https://doi.org/10.1093/jaoacint/qsz038 .

- Kumar B, Manjunathachar H V, Ghosh S (2020) A review on Hyalomma species infestations on human and animals and progress on management strategies. Heliyon. 6(12): e05675.

- Ajith Kumar KG, Fular A, Chigure G, Sharma AK, Nagar G, Souza FF, Bechara GH, Ghosh S (2019) Comparative impact of coumaphos, amitraz and plant extract of Ageratum conyzoides on the oogenesis of *Rhipicephalus microplus*. Ticks and Tick-borne Diseases. 10: 1085–1095.

- Sreelekha KP, Leena C, Pious A, Kartha HS, Ravindran R, Juliet S, Nair SN, Ajithkumar KG, Ghosh S (2019) Molecular, histological and ultrastructural characterization of cytotoxic effects of amitraz on the ovaries of engorged females of *Rhipicephalus annulatus* (Boophilus). Experimental Parasitology, 204: Article 107732. https://doi.org/10.1016/j.exppara.2019.107732.

- Nimisha M, Jeena KD, Pradeep RK, Vidya P, Sruthi MK, Anu P, Prashant SK, Amrutha BM, Leena C, Deepa CK, Ajithkumar KG, Anju V, Juliet S, Dinesh CN, Suresh NN, Chandy G, Ghosh S, Ravindran R (2019) Ticks and accompanying pathogens of domestic and wild animals of Kerala, South India Experimental and Applied Acarology. 79:137–155.

- Panicker DR, Juliet S, Mahesh DM, Drisya K, Adarsh Krishna TP, Sunil AR, Nair SN, Ajith Kumar KG, Ravindran R, Suja Rani S, Sujith S, Nisha AR, Ranjith D (2019) Pharmaco-chemical characterization of terpenoid fraction of *Artemisia nilagirica* (Clarke) Pamp. from Western Ghats of Wayanad region of Kerala India. Journal of Pharmacognosy and Phytochemistry. 8(1): 1343-1348.

- Sagar SV, Saini K, Kumar Rinesh, Shakya M, Saravanan BC, Ghosh S (2019) Occurrence of unusually large *Hyalomma anatolicum* from Dewas district, Madhya Pradesh - case report. Journal of Veterinary Parasitology, 32: 95-98.

- Divya TM, Soorya VC, Amithamol KK, Darsana U, Sreelekha KP, Nair SN, Ajithkumar KG, Juliet S, Ravindran R, Ghosh S (2019). Acaricidal activity of crude ethanolic extract of *Sphaeranthus indicus*, its fractions and subfractions against *Rhipicephalus annulatus* (Boophilus)(Acari: Ixodidae). International Journal of Current Microbioliological and Applied Science.8(8): 787-797

- Sagar SV, Saini K, Sharma AK, Kumar S, Kumar R, Fular A, Shakya M, Upadhaya D, Nagar G, Shanmuganath C, Samanta S, Kumar S, Ghosh S (2019) Acaricide resistance in *Rhipicephalus microplus* collected from selected districts of Madhya Pradesh, Uttar Pradesh and Punjab states of India. Tropical Animal Health and Production. https://doi.org/10.1007/s11250-019-02048-0.

- Kumar B, Misra A, Kumar S, Rawat AKS, Rawat YS, Ghosh S, Srivastava S (2019) Antitick potential and chemical variability among *Ageratum conyzoides* L. germplasms collected from Eastern and Western Ghats of India. International Journal of Acarology. https://doi.org/10.1080/01647954.2019.1677772.

- Chigure GM, Sharma AK, Kumar S, Fular A, Sagar SV, Nagar G, Upadhaya D, Saravanan BC, Kumar R, Ghosh S (2018) Role of metabolic enzymes in conferring resistance to synthetic pyrethroids, organophosphates, and phenylpyrazole compounds in *Rhipicephalus microplus*. International Journal of Acarology. 44: 28-34.

- Nandi A, Sagar SV, Chigure GM, Fular A, Sharma AK, Nagar G, Kumar S, Saravanan BC, Ghosh S (2018) Determination and validation of discriminating concentration of ivermectin against *Rhipicephalus microplus*. Veterinary Parasitology. 250: 30-34.

- Ravindran R, Jyothimol G, Amithamol KK, Sunil AR, Chandrasekhar L, Lenka DR, Amritha A, Sreelekha K, Sathish N, Udayan D, Krishna TPA, Divya TM, Juliet S, Kumar KGA, Nair SN, Ghosh S (2018) *In vitro* efficacy of amitraz, coumaphos, deltamethrin and lindane against engorged female *Rhipicephalus annulatus* (Boophilus) and *Haemaphysalis bispinosa*. Experimental and Applied Acarology. 75(2): 241–253.

- Pradeep RK, Nimisha M, Sruthi MK, Vidya P, Amrutha BM, Prashant SK, KGA Kumar, Varghese A, Deepa CK, Dinesh CN, Chandrasekhar L, Juliet S, Pradeepkumar PR, Chintu R, Ghosh S, Ravindran R (2018) Molecular characterization of South Indian field isolates of bovine Babesia spp. and Anaplasma spp. Parasitology Research, 18(2):617–630 https://doi.org/10.1007/s00436-018-6172-4.

- Nagar G, Sharma AK, Kumar S, Saravanan BC, Kumar B, Gupta Suman, Kumar Satyanshu, Ghosh S (2018) Molecular mechanism of synthetic pyrethroid and organophosphate resistance in field isolates of *Rhipicephalus microplus* tick collected from a northern state of India. Experimental & Applied Acarology. 75: 319-331.

- Fular A, Sharma AK, Kumar S, Nagar G, Chigure G, Ray DD, Ghosh S (2018) Establishment of a reference multi-acaricide resistant tick line (IVRI-V) of *Rhipicephalus microplus*. Ticks and Tick-borne Diseases. 9: 1184–1191

- Ghosh S, Gupta S, Ajithkumar K G, Sharma A K, Kumar S, Nagar G, Kumar R, Paul S, Fular A, Chigure G, Nandi A, Manjunathachar H V, Mohammad A, Verma M R, Saravanan BC, Ray D D, (2017) Characterization and establishment of a reference deltamethrin and cypermethrin resistant tick line (IVRI-IV) of *Rhipicephalus microplus* (Boophilus). Pesticide Biochemistry and Physiology. 138: 66-77. DOI: 10.1016/j.pestbp.2017.03.002.

- Sreelekha K, Chandrasekhar L, Kartha H S, Ravindran R, Juliet S, Ajithkumar K G, Nair S N, Ghosh S (2017) Ultrastructural analysis of oocytes of *Rhipicephalus annulatus* (Boophilus) during postengorgement period as a tool to evaluate the cytotoxic effects of amitraz and deltamethrin on the germinative cells. Veterinary Parasitology. 247: 113-120. DOI: 10.1016/j.vetpar.2017.10.006.

- Ravindran R, Chithra N D, Deepa P E, Ajithkumar K G, Chandrasekhar L, Sreelekha K, Nair S N, Juliet S, Ghosh S (2017) *In vitro* effects of caffeic acid, nortriptyline, precocene I and quercetin against *Rhipicephalus annulatus* (Acari: Ixodidae). Experimental & Applied Acarology, 71(2): 183-193. DOI: 10.1007/s10493-017-0105-2.

- Sreelekha K P, Krishna T P A, Krishna T P A, Deepa P E, Darsana U, Juliet S, Nair S N, Ravindran R (2017) Pharmaco-chemical characterization of leaves of *Blumea mollis* (D. Don) merr. from Western Ghats of Wayanad region of Kerala, India. Journal of Pharmacognosy and Phytochemistry. 6(4): 319-323.

- Ravindran R, Julie S, Ramankutty S A, Sathish N, Nair S N, Ajithkumar K G, Chandrasekhar L, Ghosh S (2017) Effects of ethanolic extract of the leaves of Pongamia glabra and Gliricidia sepiumagainst *Rhipicephalus annulatus* (Boophilus). Advances in Animal and Veterinary Sciences. 5(1): 1-6. DOI: 10.14737/journal.aavs/2017/5.1.1.6

b) Patent:

- Anti-tick phyto-molecule for the management of acaricide-resistant ticks infesting livestock (Patent file no. 201711020314).

- Novel antitick phyto-pharmaceutical formulations (TK-5, TK-10, TK-C) against tick infestations in livestock and pet animals (Patent file no. TEMP/E-1/59536/2020-DEL)

c) Technology developed:

- Developed anti-tick formulation and trial conducted as per the requirements of commercial house.

Project title: Study the effect of mesenchymal stem cell transplantation on ovarian function and fecundity in goats

Project Code	**:**	6016
Duration of the project	**:**	January 2017 – December 2019
PI Name	**:**	Dr. S. D. Kharche
CCPI Name	**:**	Dr. Monika Sachdev
Lead Centre	**:**	ICAR-CIRG, Makhdoom, Mathura
Cooperating centre	**:**	ICAR-CDRI, Lucknow

Objectives:

- To establish infertile rodent models by depleting their follicles and ovarian restoration through the transplantation of allo-genic or auto-genic MSCs.
- To standardize the isolation, enrichment, cryopreservation and characterization of goat MSCs.
- To study the effect of ovarian transplantation of MSC's in goats.
- To identify female fertility associated molecular markers.

Achievements:

a) Publications:

- Jena D, Kharche S D, Gururaj K, Singh S P, Rani Sonam and Pachoori A. (2020). Expression of heat shock proteins (HSPs) in caprine bone marrow derived mesenchymal stem cells. Indian Journal of Small Ruminants 26(1): 128-131.
- Pathak J, Kharche S D and Goel A. (2019). Development of caprine chimeric embryos reconstructed through ES-tetraploid complementation assay. Indian Journal of Animal Sciences 89(5): 519–521.
- Kharche S D, Jena D, Gangwar C, Khatti A and Balamurugan M. (2019). Role of certain growth factors and hormones in folliculogenesis. Indian Journal of Animal Sciences. 89(12):1303-1308.

Project title: Lactic acid bacteria based biorefineries for converting agro and food-based biomass into PLA and high-value-added products

Project Code	:	6017
Duration of the project	:	February 2017 - January 2020
PI Name	:	Dr. S.K. Khare
CCPI Names	:	Dr. H N Mishra
	:	Dr. Lata
Lead Centre	:	IIT, New Delhi
Cooperating centres	:	IIT, Kharagpur
	:	ICAR-IARI, New Delhi

Objectives:

- To utilize starch based and/or other carbohydrate rich biomass for Lactic acid bacteria (LAB) fermentation
- To develop solid state fermentation of selected agro wastes with LAB
- Downstream processing for product and co-product recovery by using the integration and intensification of downstream bioprocesses
- Development of Foods with improved organoleptic and nutraceutical properties by using polyols and Gama amino butyric acid in LAB fermentation.

Achievements:

a) Publications:

- Sharma A, Pranaw K, Singh S, Khare SK, Chandel AK, Singh Nain PK, Nain L (2020) Efficient two-step lactic acid production from cassava biomass using thermostable enzyme cocktail and lactic acid bacteria: insights from hydrolysis optimization and proteomics analysis. 3 Biotech 10, 409 (2020). https://doi.org/10.1007/s13205-020-02349-4.
- Kumar K, Yadav N, Nain L, Khare SK (2020) A simple downstream processing protocol for the recovery of lactic acid from the fermentation broth. Bioresource Technology. 318:124260.
- Grewal J, Khare SK (2018) One-pot bioprocess for lactic acid production from lignocellulosic agro-wastes by using ionic liquid stable Lactobacillus brevis. Bioresource Technology. 251:268-273.
- Grewal J, Khare SK (2017) 2-Pyrrolidone synthesis from γ-aminobutyric acid produced by Lactobacillus brevis under solid-state fermentation utilizing toxic deoiled cottonseed cake" Bioprocess and Biosystem Engineering. 40:145-152 https://doi.org/10.1007/s00449-016-1683-9.

b) Patent:

- Cereal based carbonated beverage/ mix and a process thereof.

c) Technology developed:

- Single step downstream solvent extraction process for recovery of lactic acid from fermentation medium

Project title: Elucidating the mechanism and assessing amelioration potential of Ocimum and Lucas in stress-induced impaired homeostasis on growth and reproduction in zebrafish

Project Code	**:**	6018
Duration of the project	**:**	March 2017 - February 2020
PI Name	**:**	Dr. Sudipta Maitra
CCPI Name	**:**	Dr. Satya Sundar Bhattacharya
Lead Centre	**:**	Visva Bharati Univ., Santiniketan
Cooperating centre	**:**	Tezpur University, Sonitpur

Objectives:

- To study influence of oxidative stress, environmental factors like oxygen, temperature, density, pH, polluting organic ambience and excess lipid diet on repressed growth of larva and fry, and reproduction in adult zebrafish.

- To study the molecular mechanism underlying the oxidative stress induced impaired metabolic homoeostasis and involvement of Fetuin A.

- To study the amelioration potential of compounds derived from *Ocimum sanctum, O. basilicum* and *Lucas aspera* on stress-induced impaired homeostasis.

Achievements:

a) Publications:

- Biswas S, Maitra, S (2021) Altered redox homeostasis in steroid-depleted follicles attenuates hCG regulation of follicular events: Cross-talk between endocrine and IGF axis in maturing oocytes. Free Radical Biology and Medicine, 172:675-687. https://doi.org/10.1016/j.freeradbiomed.2021.07.023.

- Biswas S, Ghosh S, Samanta A, Das S, Mukherjee U, Maitra S (2020) Bisphenol A impairs reproductive fitness in zebrafish ovary: Potential involvement of oxidative/nitrosative stress, inflammatory and apoptotic mediators. Environmental Pollution, 267:115692. DOI: 10.1016/j.envpol.2020.115692.

- Chowdhury S, Chatterjee SK, Bhattacharya S, Maitra S, Saikia SK (2020) Acidic ambiance induced post-oxidative stress affects AMPK-PGC1α-SIRT1 axis in the skeletal muscles of zebrafish Danio rerio Hamilton, 1822. Acta Biologica Szegediensis, 64(2). https://doi.org/10.14232/abs.2020.2.191-198.

- Mukherjee U, Samanta A, Biswas S, Das S, Ghosh S, Mandal DK, Maitra S (2020) Bisphenol A-induced oxidative stress, hepatotoxicity and altered estrogen receptor expression in *Labeo bata*: impact on metabolic homeostasis and inflammatory response. Ecotoxicology and Environmental Safety, 202:110944. https://doi.org/10.1016/j.ecoenv.2020.110944.

- Saha S, Das S, Das S, Samanta A, Maitra S, Sahoo P (2020) Prompt detection of endogenous hypochlorite (ClO−) in murine macrophages and zebrafish embryos facilitated by a distinctive chemodosimetric mode. Organic and Biomolecular Chemistry, 18(34):6716-6723.

- Biswas, S., Mukherjee U., & Maitra, S. (2020) Endocrine disruption and female reproductive health: Implications on cross-talk between endocrine and autocrine/paracrine axes in the ovary. Journal of Reproductive Health and Medicine, 1:2.

- Das S, Barman S, Teron R, Bhattacharya S S, Kim K-H (2020) Secondary metabolites and anti-microbial/anti-oxidant profiles in *Ocimum* spp.: Role of soil physico-chemical characteristics as eliciting factors. Environmental Research. 188:109749. https://doi.org/10.1016/j.envres.2020.109749.

- Nath P, Maitra S (2019) Physiological relevance of nitric oxide in ovarian functions: An overview. General and Comparative Endocrinology. 279: 35-44.

- Pal S, Nath P, Biswas S, Mukherjee U, Maitra S (2019) Nonylphenol attenuates SOCS3 expression and M1 polarization in lipopolysaccharide-treated rat splenic macrophages. Ecotoxicology and Environmental Safety 174:574-583. DOI: 10.1016/j.ecoenv.2019.03.012.

- Das S, Mukherjee U, Pal S, Maitra S, Sahoo P (2019) Selective Sensing of Al3+ Ion by Nitrophenyl Induced Coordination: Imaging in Zebrafish Brain Tissue. Organic and Biomolecular Chemistry 17(21):5230-5233.

- Nath P, Mukherjee U, Biswas S, Pal S, Das S, Ghosh S, Samanta A, Maitra S (2019) Expression of nitric oxide synthase (NOS) in *Anabas testudineus* ovary and participation of nitric oxide-cyclic GMP cascade in maintenance of meiotic arrest. Molecular and Cellular Endocrinology. 496: 110544.

- Nath P, Das D, Pal S, Maitra S (2018) Nitric oxide (NO) inhibition of meiotic G2-M1 transition in *Anabas testudineus* oocytes: Participation of cAMP-dependent protein kinase (PKA) in regulation of intra-oocyte signaling events. Molecular and Cellular Endocrinology. 460:162-169. DOI: 10.1016/j.mce.2017.07.019.

- Sarkar HS, Ghosh A, Das S, Maiti PK, Maitra S, Mandal S, Sahoo P (2018) Visualisation of DCP, a nerve agent mimic, in Catfish brain by a simple chemosensor Scientific Reports. 8(1):3402 DOI: 10.1038/s41598-018-21780-5.

- Biswas S, Maitra S (2017) Let's Talk and Grow Together: A Bidirectional Communication between Granulosa-and Oocyte-Derived Factors in the Ovary. Global Journal of Reproductive Medicine. 1(4): 555569. DOI: 10.19080/GJORM.2017.01.555569.

Project title: Energy efficient polyhouse and aeroponic system for mini tuber production of tissue cultured potato

Project Code	**:**	6019
Duration of the project	**:**	March 2017 - February 2020
PI Name	**:**	Dr. Jaywant Arakeri
CCPI Names	**:**	Dr. M. Udayakumar
	:	Dr. K.R. Sreenivas
	:	Dr. Murtaza Hasan
	:	Er. Sukhwinder Singh
Lead Centre	**:**	IISc, Bangalore
Cooperating centres	**:**	UAS, Bangalore
	:	JNCASR, Bangalore
	:	ICAR-IARI, New Delhi
	:	ICAR-CPRI, Jalandhar

Objectives:

- Design and development of aeroponic cultivation system for mini-tuber production with efficient misting and dynamic changes in temperature of container aeroponic system.
- Development of poly-house with passive climate control and monochromatic light sources, for optimizing the growth of tissue cultured potato plants aeroponically.
- To study the varying environmental conditions on mini-tuber production and their quality because of modifications in polyhouse, aeroponic system, fertigation protocols and by regulating the nitrogen nutrition and hormones.
- To compare the new aeroponic system with the existing CPRI-Aeroponic system under passively and fan-pad cooled polyhouse in tropical/subtropical climate conditions

Achievements:

a) Publications:

- Devi S, Singh S, Kaur RP, Shah MA and Singh RK (2019) Sprouting behaviour of aeroponic Minitubers of different varieties. Potato Journal. 46 (1): 67-72.
- Ramesh NT, Arakeri JH (2019) Actively and passively aspirated temperature sensors in a windless environment like greenhouses. Sādhanā. 44:1-7. doi.org/10.1007/s12046-019-1066-4.

Project title: identification of biomarkers for early diagnosis of mycobacterium avium subspecies paratuberculosis (MAP) infection and development of a test to differentiate between Johne's disease infected and vaccinated animals (DIVA)

Project Code	**:**	6020
Duration of the project	**:**	April 2017 - March 2020
PI Name	**:**	Dr. K. Gururaj
CCPI Names	**:**	Dr. Shalini Sharma
	:	Dr. Sangram Biswal
Lead Centre	**:**	ICAR-CIRG, Makhdoom
Cooperating centres	**:**	Lala Lajpat Rai University of Veterinary & Animal Sciences, Hisar
	:	OUAT Bhubaneswar

Objectives:

- To identify host cell markers for the early diagnosis of MAP infection
- To develop DIVA ELISA to differentiate between the MAP-infected and vaccinated animals

Achievements:

a) Publications:

- Biswal S, Sahoo N, Muduli S, Gururaj K (2020) Detection of *Mycobacterium avium* subsp. Paratuberculosis (MAP) from subclinical caprine Paratuberculosis cases of Odisha. Indian Journal of Animal Research. B-3691. doi:10.18805/ijar.
- Devi, S, Singh,S, Kaur, RP, Shah, MA and Singh, RK. (2019) Sprouting behavior of aeroponic Minitubers of different varieties. Potato Journal. 46 (1): 67-72.
- Sharma S, Singh S, Gautam AK, Mishra SR, Gupta S, Chaubey KK, Sangwan N (2019) "Assessment of lipid profile and acute phase proteins in MAP (*Mycobacterium avium* subspecies paratuberculosis) infected and healthy goats". Indian Journal of Animal Sciences. 89(12): 1313–1317.
- Biswal S, Pany SS, Singh SV, Sahoo N, Singh M, Gupta S, Chaubay KK. (2018). Bio-detection *Mycobacterium avium* subspecies paratuberculosis in the commercial milk and milk procucts sold in Bhubaneswar, Odhisa, India. International Journal of Current Microbiology and Applied Sciences, 7(1):753-761.
- Biswal S, Pany SS, Sahoo N, Singh M, Singh SV. (2018). Seroprevalence of *Mycobactirium avium* subspecies paratuberculosis (MAP) in goat population of Bhubaneswar, Odisha, India. International Journal of Current Microbiology and Applied Sciences, 7(1):1618-1623.

- Sharma S, Singh S, Sangwan N, Singh V, Chaubey K, Gupta S, Singh M (2017). Metabolic adjustments as signatures for pathogenesis and diagnosis of Johne's disease in goats. Haryana Veterinarian. 56 (2) 179-183.

b) Technology Developed:

- DIVA-ELISA for differentiation of JD infected animals from vaccinated animals: MAP Secretome protein-based DIVA-ELISA developed with very high specificity and sensitivity for differentiation of Johne's disease infected from vaccinated animals. Intra-plate and inter-plate variations have been minimised by fine-tuning of handling of reagents in the test assay. This test is under validation, with a very high sensitivity and specificity in differentiating Johne's disease-infected from vaccinated animals.

Project title: Understanding the molecular basis of peste-des-petits ruminants virus (PPRV) mediated host immune modulation for the development of next generation vaccine

Project Code	**:**	6021
Duration of the project	**:**	April 2017 - March 2020
PI Name	**:**	Dr. Rajeev Kaul
CCPI Names	**:**	Dr. S. Chandra Sekar
	:	Dr. Sharvan Sehrawat
	:	Dr. Prabhakar Temburne
Lead Centre	**:**	University of Delhi South Campus, Delhi
Cooperating centres	**:**	ICAR-IVRI, Mukteswar, Naini Tal, Uttrakhand
	:	Indian Institute of Science Education & Research (IISERM), Mohali
	:	Nagpur Veterinary College (NVC), Nagpur

Objectives:

- Modulation of host immune regulatory pathway by PPR Virus
- Development and evaluation of Non-Structural Protein (NSP) defective mutants of PPRV to understand the role of viral NSP in immune modulation of natural hosts
- Generating MHC class I tetramers for investigating PPRV-specific CD8 T cell responses employing a high throughput technology and deciphering immunosuppressive effects of PPRV in modulating host response.
- Role of miRNA in PPR Virus immunity & regulation

Achievements:

a) Patent:

- 'A novel Peste-des-petits-ruminants (PPR) viral vector based on the Indian vaccine strain Sungri/96

Project title: Aflatoxin-tolerant duck production through genetic and epigenetic approaches

Project Code	**:**	6022
Duration of the project	**:**	April 2017 - March 2020
PI Name	**:**	Dr. S. K. Mishra
CCPI Names	**:**	Dr. S. K. Panda
	:	Dr. Nikhil C. Nath
	:	Dr. Prasant K. Subudhi
Lead Centre	**:**	ICAR-CARI, Regional Centre, Bhubaneswar
Cooperating centres	**:**	College Of Veterinary Science, OUAT, Bhubaneswar
	:	College Of Veterinary Science, AAU, Guwahati
	:	College Of Veterinary Science, CAU, Aizawl

Objectives:

- To understand the epigenetic factors for the aflatoxin-tolerance in ducks using molecular tools.
- To investigate the adaptation of aflatoxin- tolerance in different breeds of ducks through selective breeding.
- To develop strategy for the alleviation of production-losses of ducks, caused due to dietary aflatoxin following integrated approaches.

Achievements:

a) Publications:

- Ali I, Panda S K, Pati S, Acharya A P, Mishra S K, Jena G R, Mohanty G P, Mohanty L, Das S, Kumar D (2019) Patho-morphological and genotoxic changes in induced aflatoxicosis in white pekin ducks (*Anas platyrynchus* domesticus). International Journal of Current Microbiology & Applied Sciences. 8(5): 1225-1233.
- Ali I, Panda S K, Pati S, Mishra S K, Mohanty G P, Jena G R, Acharya A P, Sahoo P R, Mohanty L, Mishra N, Kumar D, Sarkar A (2019) Growth performance and hemato-biochemical alterations in induced aflatoxicosis in white pekin ducks (*Anas platyrynchus* domesticus). Journal of Entomology & Zoology Studies. 7(3): 1291-1295.

Project title: Development of an electronic nose for the optimum harvesting time and fruit quality in apple and papaya

Project Code	**:**	6023
Duration of the project	**:**	June 2017 – February 2021
PI Name	**:**	Dr. Debabrata Sircar
CCPI Name	**:**	Dr. Javid Iqbal Mir
Lead Centre	**:**	IIT, Roorkee
Cooperating centre	**:**	ICAR-CITH, Srinagar, J&K

Objectives:

- Profiling of volatile metabolites at different pre-harvesting and post-harvesting time points during ripening of apple and papaya fruits to detect kinetic patterns of all ripening and fruit quality associated- metabolites.

- Co-relation analyses of volatile metabolite profiling with fruit physiology and nutritional quality under different pre-harvest and post-harvest conditions.

- Development and field-validation of an e-nose sensor prototype for the detection of appropriate ripening stage and fruit nutrition quality for harvesting.

Achievements:

a) Publications:

- Teotia D, Gaid M, Saini SS, Verma A, Yennamalli RM, Khare SP, Ambatipudi K, Mir JI, Beuerle T, Hänsch R, Roy P, Agrawal PK, Beerhues L, Sircar D (2019) Cinnamate: CoA-ligase is involved in benzoate-derived biphenyl phytoalexin biosynthesis in *Malus domestica* 'Golden Delicious'. Plant Journal. 100:1176-1192 doi:org/10.1111/tpj.14506.

- Sarkate A, Saini SS, Teotia D, Gaid M, Mir JI, Roy P, Agrawal PK, Sircar D (2018) Comparative metabolomics of scab-resistant and susceptible apple cell cultures in response to scab fungus elicitor treatment. Scientific Reports (8) 17844. doi:10.1038/s41598-018-36237-y.

b) Technology Developed:

- Electronic nose sensor prototype is ready to field validate

Project title: Detection and control of bacterial pathogens in poultry by developing chemical genomic strategies to combat multiple antibiotic resistance

Project Code	**:**	6024
Duration of the project	**:**	June 2017 - May 2020
PI Name	**:**	Dr Naveen K Navani
CCPI Name	**:**	Dr Ajit Singh Yadav
Lead Centre	**:**	IIT, Roorkee
Cooperating centre	**:**	ICAR-CARI, Izatnagar

Objectives:

- To develop detection system using aptamers against multiple antibiotic resistant strains of *Salmonella enterica* sero var enteritidis and *Campylobacter jejuni* isolated from poultry.
- To determine the antibacterial combinations of essential oils with representative antibiotics from five major categories against Gram-negative and Gram-positive bacterial pathogens (including MDR *S enteritidis* and *C. jejuni*).
- To ascertain mode of action of synergy combinations.
- To evaluate lead combinations of essential oils on poultry birds (In collaboration with CARI

Achievements:

a) Publications:

- Geeta, Yadav AS, Pradhan S, Rajoria R, Kumar A, Gopi M, Navani NK, Pathania R (2021) Probiotic Attributes of Lactobacillus fermentum NKN51 Isolated from Yak Cottage Cheese and the Impact of Its Feeding on Growth, Immunity, Caecal Microbiology and Jejunal Histology in the Starter Phase of Broiler Birds. Indian Journal of Animal Research, 55(4):451-456.
- Ghosh T, Srivastava SK, Gaurav A, Kumar A, Kumar P, Yadav AS, Navani NK (2019) A Combination of Linalool, Vitamin C, and Copper Synergistically Triggers Reactive Oxygen Species and DNA Damage and Inhibits *Salmonella enterica* subsp. enterica *Serovar Typhi* and *Vibrio fluvialis*. Applied and Environmental Microbiology. 85(4): e02487-18. DOI: 10.1128/AEM.02487-18.
- Ghosh T, Beniwal A, Semwal A, Navani NK (2019) Mechanistic Insights into probiotic properties of lactic acid bacteria associated with ethnic fermented dairy products. Frontiers in Microbiology. 10:502. https://doi.org/10.3389/fmicb.2019.00502.
- Ghosh T, Srivastava SK, Gaurav A, Kumar A, Kumar P, Yadav AS, Navani NK (2019) A combination of linalool, vitamin C, and copper synergistically triggers reactive oxygen species and DNA damage and inhibits *Salmonella enterica* subsp.

Enterica serovar typhi and *Vibrio fluvialis*. Applied and Environmental Microbiology. 85(4), e02487-18. DOI: 10.1128/AEM.02487-18.

- Sharma, R., Kumar, P., Kaushal, V., Das, R., & Navani, N. K. (2018) A novel protein tyrosine phosphatase-like phytase from *Lactobacillus fermentum* NKN51: Cloning, characterization and application in mineral release for food technology applications. Bioresource Technology. 249:1000-1008. DOI: 10.1016/j.biortech.2017.10.106.

b) Technology developed:

- Level of *Lactobacillus fermentum* in feed of broiler chickens was standardized.

- Role of prebiotic and acidifier was elucidated with use of *L. fermentum* and lead combination of antimicrobials.

Project title: Synthesis, characterization and effect of graded levels of nano selenium supplementation on the performance of broiler chicken

Project Code	**:**	6025
Duration of the project	**:**	June 2017 - May 2020
PI Name	**:**	Dr. Niranjan Panda
CCPI Name	**:**	Dr. Ashok Kumar Mohanty
Lead Centre	**:**	OUAT, Bhubaneswar
Cooperating centre	**:**	ICAR-NDRI, Karnal

Objectives:

- To assess the effects of dietary Nano-Se supplementation on the growth performance of broilers.
- To evaluate the toxicological effect and safety of Nano-Se feeding in broiler chicken.
- To investigate the effects of dietary Nano-Se on expression of different genes and proteins associated with stress response, immunity and growth.
- Development of nano-Se fortified pelleted feed for enhanced production of broiler chicken.

Achievements:

a) Publications

- Debata A, Kamdev S, Swain RK, Jena D, Pati S (2019). Green Synthesis, Characterization and Antimicrobial Evaluation of Nano Silver on Mastitis Causing Microorganisms, International Journal of Current Microbiology and Applied Sciences, 8(10): 1891-1895.

Project title: Genetic variability of milk protein and its characterization by proteomic approach in Indian goats

Project Code	**:**	6026
Duration of the project	**:**	June 2017 - November 2020
PI Name	**:**	Dr. Pramod Kumar Rout
CCPI Name	**:**	Dr. S N De
Lead Centre	**:**	ICAR-CIRG, Makhdoom
Cooperating centre	**:**	ICAR-NDRI, Karnal

Objectives:

- Analysing the milk protein variability at DNA and protein levels in different goat breeds and their association with production and milk quality traits
- Identification and characterisation of bioactive peptides in relation to different genotypes and production status

Achievements:

a) Publications:

- Verma M, Dige MS, Kaushik R., Gautam D, De S, Rout PK (2020) Milk composition traits in Jamunapari goats: genetic parameter estimation and effect of allelic variation in CSN1S1 gene. International Journal of Dairy Technology 73(1). doi: 10.1111/1471-0307.12651.
- Verma M, Dige MS, Gautam D, De S, Rout PK (2020) Functional milk proteome analysis of genetically diverse goats from different agroclimatic regions. Journal of Proteomics 227:103916. https://doi.org/10.1016/j.jprot.2020.103916
- Gautam D, Vats A, Verma M, Rout PK, Meena AS, Ali M, Deepika S, De S (2019) Genetic variation in CSN3 exon IV region of Indian goats and a new nomenclature of CSN3 variants. Animal Genetics 50(2): 191-192. https://doi.org/10.1111/age.12767.

Project title: Potential gene mining from salt tolerant grasses for improvement of salt tolerance in crops

Project Code	**:**	6027
Duration of the project	**:**	June 2017-November 2020
PI Name	**:**	Dr. Anita Mann
CCPI Names	**:**	Dr. Monendra Grover
	:	Dr. Parameswaran C
Lead Centre	**:**	CSSRI, Karnal
Cooperating centres	**:**	ICAR-IASRI, New Delhi
	:	ICAR-NRRI, Cuttack

Objectives:

- Generation of transcriptomic profile of halophytes *U. setulosa, D. annuatum* and salt tolerant CSR-10 to identify differentially expressed genes under salinity stress
- Identification of differentially expressed relevant genes that regulate specific salinity responsive pathways and studying their expression in different stages of plant growth
- Studying functional validation of a few identified genes in model systems and subsequently most prominent ones in rice

Achievements:

a) Publications:

- Mann A, Kumar N, Lata C, Kumar A, Kumar A, Meena BL (2019) Functional annotation of differentially expressed genes under salt stress in *Dichanthium annulatum*. Plant Physiology Reports. 24:104-111.

Project title: Resveratrol and catechins-loaded niosomes and nanoparticles as delivery vehicles for fortification of milk and milk products

Project Code	**:**	6028
Duration of the project	**:**	June 2017 - September 2020
PI Name	**:**	Dr. P. Heartwin Amaldas
CCPI Name	**:**	Dr. N. Subramanian
Lead Centre	**:**	ICAR-NDRI, SRS, Bengaluru
Cooperating centre	**:**	Anna University, Tiruchirappalli

Objectives:

- Process optimization for preparation of proniosomes and niosomes by thin film hydration technique and their characterization
- Preparation of nanoencapsulated bioactives by electrospinning and their characterization
- Development of delivery systems such as milk and dahi with nanoenapsulated bioactives, and evaluation of their physico-chemical, microstructural, textural, sensorial and functional properties
- Determination of safety and toxicological effects of nanoencapsulates by in vitro and in *vivo* techniques
- Organize national workshop and training programmes on bioactives to various stakeholders.

Achievements:

a) Publications:

- Shruthi P, Heartwin AP, Emerald FME, Naik SB, Laxmana NN (2020) Resveratrol-loaded proniosomes: Formulation, characterisation and fortification. LWT-Food Science and Technology. 134:110127. https://doi.org/10.1016/j.lwt.2020.110127.
- Shruthi PA, Pushpadass HA, Emerald FME, Battula SN, Naik NL (2020) Resveratrol-loaded proniosomes: Formulation, characterisation and fortification. LWT-Food Science and Technology. 134. https://doi.org/10.1016/j.lwt.2020.110127.
- Shruthi PA, Pushpadass HA, Emerald FME, Battula SN, Naik NL (2020) Formulation and characterisation of catechin-loaded proniosomes for food fortification. Journal of the Science of Food and Agriculture. DOI 10.1002/jsfa.10868.
- Seethu BG, Pushpadass HA, Emerald FME, Nath BS, Naik NL, Subramaniam KS (2019) Electrohydrodynamic encapsulation of resveratrol using food-grade nanofibres: process optimization, characterization and fortification. Food and Bioprocess Technology. 13:341–354 doi: 10.1007/s11947-019-02399-4.

- Vankayala JS, Battula SN, Kandasamy R, Mariya GA, Franklin M, Pushpadass HA, Naik L (2018) Surfactants and fatty alcohol based novel nanovesicles for resveratrol: Process optimization, characterization and evaluation of functional properties in RAW 264.7 macrophage cells. Journal of Molecular Liquids 261(1):387-396.

Project title: Development of an automated soil nutrient sensing system

Project Code	**:**	6029
Duration of the project	**:**	June 2017 – December 2020
PI Name	**:**	Dr. P. S. Tiwari
CCPI Names	**:**	Dr. Sanjay Srivastava
	:	Dr. Babankumar Bansod
Lead Centre	**:**	ICAR-CIAE, Bhopal
Cooperating centres	**:**	ICAR-IISS, Bhopal
	:	CSIO, Chandigarh

Objectives:

- Development of an automated soil sampling system.
- Assessment of methodologies for fast and non-destructive estimation of soil organic matter, soil nutrients (N, P, K and Zn), soil physical and chemical attributes by analysis of reflectance spectroscopy, ion selective electrodes and electro-chemical sensors.
- To develop the multi-parametric sensing head for mobile-soil-sensing and development of associated field-scale embedded system.

Achievements:

a) Publications:

- Sahni RK, Kumar D, Tiwari PS, Kumar V, Kumar SP, Chandel NS (2018) A DGPS Based on-the-go Soil Nutrient Mapping System: A Review, The Andhra Agricultural Journal. J 65 (spl). 1-6

b) Technology developed:

- Automated soil sampler is developed and needs to be integrated with the soil nutrient sensing system.
- DGPS has been received and installed at ICAR-CIAE, Bhopal.

Project title: Bioremediation of chemical contaminants and their complexes present in drainage wastewater with high dynamic flux used for irrigation in urban and periurban agriculture

Project Code	:	6030
Duration of the project	:	February 2018 - April 2021
PI Name	:	Dr. Dileep Kumar Singh
CCPI Names	:	Dr. Rosin K.G.
	:	Dr. Jaya N. Surya
Lead Centre	:	University of Delhi, Delhi
Cooperating centres	:	ICAR-IARI, New Delhi
	:	NBSS&LUP, RC, New Delhi

Objectives:

- Estimation of chemical contaminants (antibiotics and chemical complex) in wastewater with high dynamic flux in and around Delhi.
- Development of viable techniques for bioremediation of antibiotics and chemical complexes in wastewater.
- Development of processes for easy and long-term storage of microbes, microbial products and their easy delivery to contaminated site.
- Development of a pilot scale up-scalable bioreactor based on identified microbes, microbial bioprocesses and biofilm for decontamination of wastewater for agricultural usage.

Achievements:

a) Publications:

- Sodhi KK, Kumar M, Singh DK (2021) Insight into the amoxicillin resistance, ecotoxicity, and remediation strategies. Journal of water process engineering. 39:101858. https://doi.org/10.1016/j.jwpe.2020.101858.
- Sodhi KK, Kumar M, Dhaulaniya AS, Balan B, Singh DK (2021) Enhanced ciprofloxacin removal by plant growth-promoting *Microbacterium* sp. WHC1 in presence of Eichhornia crassipes root exudates. Environmental Sustainability. 4 (1), 143-153.
- Balan B, Dhaulaniya AS, Varma DA, Sodhi KK, Kumar M, Tiwari M, Singh DK (2021) Microbial biofilm ecology, in silico study of quorum sensing receptor-ligand interactions and biofilm mediated bioremediation Archives of microbiology 203: 13-30. (DOI: 10.1007/s00203-020-02012-9) 1432072X, 03028933.
- Kumari S, Amit, Jamwal R, Mishra N, Singh DK (2020) Recent Developments in Environmental Mercury Bioremediation and its Toxicity: A Review Environmental

Nanotechnology, Monitoring & Management, 13: 100283. https://doi.org/10.1016/j.enmm.2020.100283.

- Sodhi KK, Kumar K, Singh DK (2020) Assessing the bacterial diversity and functional profiles of the River Yamuna using Illumina MiSeq sequencing Archives of microbiology 203: 367. 375.https://doi.org/10.1007/s00203-020-02045-0.

- Sodhi KK, Kumar M, Singh DK (2020) Multi-metal resistance and potential of Alcaligenes sp. MMA for the removal of heavy metals. SN Applied Sciences. doi: 10.1007/s42452-020-03583-4.

- Sodhi KK, Kumar M, Singh DK (2020) Potential application in amoxicillin removal of Alcaligenes sp. MMA and enzymatic studies through molecular docking, Archives of microbiology 202: 1489–1495. https://doi.org/10.1007/s00203-020-01868-1.

- Sharma N, Sodhi KK, Kumar M, Singh DK (2020) Heavy Metals eco-toxicity with major concern to Chromium and recent advancement in remediation technologies. Environmental Nanotechnology, Monitoring & Management: 15 (2) 100388. https://doi.org/10.1016/j.enmm.2020.100388.

- Dhaulaniya AS, Balan B, Agrawal PK, Singh DK (2019) Cold survival strategies for bacteria, recent advancement and potential industrial applications. Archives of microbiology 201 (1), 1-16. https://doi.org/10.1007/s00203-018-1602-3.

- Singh T, Singh DK ((2019) Rhizospheric *Microbacterium sp.* P27 Showing Potential of Lindane Degradation and Plant Growth Promoting Traits. Current Microbiology 76:888-895 https://doi.org/10.1007/s00284-019-01703-x.

- Singh NS, Sharma R, Singh DK (2019) Identification of enzyme(s) capable of degrading Endosulfan and Endosulfan sulfate using in silico techniques. Enzyme and Microbial Technology 124:32-40. DOI: 10.1016/j.enzmictec.2019.01.003

- Kumar M, Jaiswal S, Sodhi KK, Shree P, Singh DK, Agrawal PK, Shukla P (2019) Antibiotics bioremediation: Perspectives on its ecotoxicity and resistance. Environment International Elsevier. 124: 448-461 https://doi.org/10.1016/j.envint.2018.12.065.

- Singh T, Singh DK (2019) Lindane degradation by root epiphytic bacterium *Achromobacter s*p. strain A3 from Acorus calamus and characterization of associated proteins. International Journal of Phytoremediation 21(5): 419-424.

- Kumar M, Sodhi KK, Singh P, Agrawal PK, Singh DK (2019) Synthesis and characterization of antibiotic-metal complexes [FeCl3 (L2) 2H2O and Ni (NO3) 2 (L1) 2H2O] and enhanced antibacterial activity. Environmental Nanotechnology, Monitoring & Management. doi.org/10.1016/j.enmm.2019.100209 Elsevier.

- Kumar M, Jaiswal S, Sodhi KK, Shree P, Singh DK, Agrawal PK, Shukla P (2019) Antibiotics bioremediation: Perspectives on its ecotoxicity and resistance. Environment International. 124:448-461 doi.org/10.1016/j.envint.2018.12.065.

- Kumar M, Sodhi KK, Singh DK (2019) Bioremediation of Penicillin G by Serratia sp. R1, and enzymatic study through molecular docking. Environmental Nanotechnology, Monitoring & Management. doi.org/10.1016/j.enmm.2019.100246.

- Sodhi KK, Kumar M, Balan B, Dhaulaniya AS, Singh DK (2019) Isolation and characterisation of amoxicillin-resistant bacteria and amoxicillin-induced alteration in its protein profiling and RNA yield. Archives of Microbiology. 202:225 232. doi.org/10.1007/s00203-019-01737-6.

- Sodhi KK, Kumar M, Agrawal PK, Singh DK (2019) Perspectives on arsenic toxicity, carcinogenicity and its systemic remediation strategies. Environmental Technology & Innovation. doi.org/10.1016/j.eti.2019.100462.

- Singh NS, Sharma R, Singh DK (2019) Identification of enzyme (s) capable of degrading endosulfan and endosulfan sulfate using in silico techniques. Enzyme and Microbial Technology. 124:32-40. doi.org/10.1016/j.enzmictec.2019.01.003.

- Singh T, Singh DK (2018) Isolation and Protein Characterisation of Lindane Degrading Root Epiphytic Bacterium Arthrobacter sp. T16 from Typha latifolia. Notulae Scientia Biological, 10(4):559-566. DOI: 10.25835/nsb10410318.

- James A, Singh DK, Khankhane PJ (2018) Enhanced atrazine removal by hydrophyte-bacterium associations and *in vitro* screening of the isolates for their plant growth-promoting potential. International Journal of Phytoremediation 20(2):89-97. https://doi.org/10.1080/15226514.2017.1337068.

- Singh T, Singh DK (2018) Assessing the bacterial community structure in the rhizoplane of wetland plants", Bulletin of Environmental Contamination and Toxicology. 101:521 526.

- James A, Singh DK (2018) Assessment of atrazine decontamination by epiphytic root bacteria isolated from emergent hydrophytes. Annals of Microbiology. DOI: 10.1007/s13213-018-1404-5.

- Singh T, Singh DK (2017) Phytoremediation of organochlorine pesticides: Concept, method, and recent developments. International Journal of Phytoremediation. 19(9): 834-843. https://doi.org/10.1080/15226514.2017.1290579.

- Bajaj S, Khare S and Singh DK (2017). Biodegradation of γ-hexachlorocyclohexane (lindane) by halophilic bacterium *Chromohalobacter* sp. LD2 isolated from HCH dumpsite. International Biodeterioration & Biodegradation. 122:23-28. https://doi.org/10.1016/j.ibiod.2017.04.014.

b) Technology Developed:

- Bioremediation technology for heavy metals present in drain water has been developed

Project Title: Development of biological filter for safe wastewater irrigation exploiting microbial bioremediation trait

Project Code	**:**	6031
Duration of the project	**:**	February 2018 - November 2021
PI Name	**:**	Dr. Sachidulal Raychaudhuri
CCPI Name	**:**	Dr. Asheesh Kumar Yadav
Lead Centre	**:**	ICAR-IIWM, Bhubaneswar
Cooperating centre	**:**	ICAR-IMMT, Bhubaneswar

Objectives:

- Development of suitable microbial consortia for bioremediation of urban wastewater to reduce heavy metals and organics (including pharmaceuticals)
- Design and development of a biofilter

Achievements:

- Six novel bacterial isolates were identified, sequenced, and used to develop a unique immobilized microbial hydrogel bead consortium for biofiltration applications.
- Four innovative biofilters were designed, with graphite-packed systems showing robust biofilm formation and effective metal removal, driven primarily by microbial activity rather than physical adsorption, making them suitable for safe discharge and irrigation.

Project title: Enhancing decomposition rate and quality of bio-waste through microbial consortia for improving soil health

Project Code	:	6032
Duration of the project	:	February 2018 - March 2021
PI Name	:	Dr. A. B. Singh
CCPI Names	:	Dr. Dipak Ranjan Biswas
	:	Dr. G. Selvakumar
Lead Centre	:	ICAR-IISS, Bhopal
Cooperating centres	:	ICAR-IARI, New Delhi
	:	ICAR-IIHR, Bengaluru

Objectives:

- To study the kinetic response of thermophilic bio-inoculum for improving decomposition rate of bio-waste.
- To study the bioaccumulation mechanisms of microbes for minimising the heavy metal loads using a bio-filter and reduce pathogens to improve the quality of compost.
- To evaluate nutrient-enriched compost using various indigenous nutrient sources for improving nutrient use efficiency and soil health.

Achievements:

a) Publications:

- Sahu A, Manna MC, Bhattacharjya S, Thakur JK, Mandal A, Rahman MM, Singh UB, Bhargav VK, Srivastava S, Patra AK, Chaudhari SK, Khanna SS (2019) Thermophilic ligno-cellulolytic fungi: The future of efficient and rapid bio-waste management. Journal of Environmental Management. 244:144-153. https://doi.org/10.1016/j.jenvman.2019.04.015.
- Bhattacharjya S, Sahu A, Manna MC, Patra AK (2019) Potential of surplus crop residues, horticultural waste and animal excreta as a nutrient source in the central and western regions of India. Current Science. 116(8):1314.
- Manna MC, Rahman MM, Naidu R, Sahu A, Hattacharjya S, Wanjari RH, Patra AK, Chaudhari SK, Majumdar K, Khanna SS (2018) Bio-Waste Management in Subtropical Soils of India: Future Challenges and Opportunities in Agriculture. Advances in Agronomy. 152:89-148.
- Manna MC, Patra AK, Chaudhari SK (2018) Recent advances in composting technologies for efficient utilization of biowaste in agriculture. India Journal of fertilizers. 14:84-92.

b) Technology Developed:

- Development of rapid decomposition of agro and domestic wastes.
- Customised drum-type composting unit for enhance the decomposition of organic residues.

- Isolation of potential lignocellulosic microbial consortia (bacteria and fungi) for accelerating decomposition.

- Developed a bio-filter to remove heavy metals from compost and improve the quality of compost.

- Developed microbial consortia (including bacteria, fungi, actinomycetes, yeast) for rapid composting.

Project title: Development of Electronic Sensing System for Safe Management of Potato, Onion, and Tomato in Storage

Project Code	**:**	6033
Duration of the project	**:**	August 2018 - January 2022
PI Name	**:**	Dr. Debabandya Mohapatra
CCPI Names	**:**	Dr. Alokesh Ghosh
	:	Dr. Bharat Modhera
Lead Centre	**:**	ICAR-CIAE, Bhopal
Cooperating centres	**:**	C-DAC, Kolkata
	:	MANIT, Bhopal

Objectives:

- Identification and quantification of VOCs generated by pathogens involved in the spoilage of potato onion and tomato during storage
- Selection of suitable sensors and development of sensing system for obtaining adequate information on potato onion and tomato health

Achievements:

a) Publications:

- Tiwari S, Kate A, Mohapatra D, Tripathi MK, Ray H, Akuli A, Ghosh A, Modhera B (2020) Volatile organic compounds (VOCs): Biomarkers for quality management of horticultural commodities during storage through e-sensing. Trends in Food Science & Technology, 106, 417-433. https://doi.org/10.1016/j.tifs.2020.10.039.

Project title: ICT based extension strategies for nutrition sensitive agriculture in the states of UP and Odisha

Project Code	**:**	6034
Duration of the project	**:**	November 2018 – October 2021
PI Name	**:**	Dr. Satyapriya
CCPI Names	**:**	Dr. K.N. Singh
	:	Dr. Shantanu Dubey
	:	Dr. P. J. Mishra
Lead Centre	**:**	ICAR-IARI, New Delhi
Cooperating centres	**:**	ICAR-IASRI, New Delhi
	:	ICAR-ATARI, Kanpur
	:	OUAT, Bhubaneswar

Objectives:

- To understand the relevance and efficacy of the existing agricultural extension approaches and practices
- To develop and validate ICT mediated agriculture extension model in and disadvantaged areas of UP and Orissa
- To create a comprehensive framework for ICT driven Extension Advisory services in disadvantaged areas of UP and Orissa

Achievements:

a) Publications:

- Satyapriya, Bishnoi S, Singh KN, Ray M, Dahiya S, Dubey SK, Singh A, Mishra P, Pattanaik B, Shankar R, Rubeka, Yadav M, Pandey J, Rai V, Singh SP, Mahapatra SK, Singh P (2021) Development and Standardization of Perception Scales for Farmers and Extensionists Regarding Impact of Climate Change on Nutrition. Journal of Community Mobilization and Sustainable Development. 16(1):234-244.
- Satyapriya, Bishnoi S, Singh S, Singh KN, Ray M, Dahiya S, Dubey SK, Singh A, Mishra P, Pattanaik B, Yadav M, Rubeka, Shankar R, Singh S, Pandey J, Rai V, Singh SP, Mahapatra SK, Singh P (2020) A Knowledge Test for Agricultural Extension Personnel on Agri- Nutrition. Journal of Community Mobilization and Sustainable Development, Vol. 15(3):649-652.
- Satyapriya, Bishnoi S, Singh S, Singh KN, Ray M, Dahiya S, Dubey SK, Singh A, Mishra P, Rubeka, Shankar R, Yadav M, Pandey J, Rai V, Singh SP, Mahapatra SK, Singh P (2020) Nutritional Health Belief Model for Understanding Motivational Health Behaviour of Farmers. Indian Journal of Extension Education. 20 (4):48-54.
- Satyapriya, Bishnoi S, Singh KN, Ray M, Dahiya S, Dubey SK, Singh A, Mishra P, Singh S, Pattanaik B, Yadav M, Rubeka, Shankar R, Pandey J, Rai V, Singh SP, Mahapatra SK, Singh P (2020) Competencies and Gap Analysis of the Krishi Vigyan Kendra Extensionists and Barriers in Acquiring ICT Based Competencies. Indian Journal of Extension Education. 56(2):65-71

Project title: Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean

Project Code	**:**	6035
Duration of the project	**:**	December 2018- November 2021
PI Name	**:**	Dr. Milind B. Ratnaparkhe
CCPI Names	**:**	Dr. Ajay Kumar Singh
	:	Ms. Annapurna Chitikineni
Lead Centre	**:**	ICAR-IISR, Indore
Cooperating centres	**:**	ICAR-NIASM, Malegaon, Baramati
	:	ICRISAT, Hyderabad

Objectives:

- Genome wide association studies in soybean for drought adoptive traits, water stagnation stress condition and seed composition traits.
- Identification of key genes and pathways associated with drought stress, water stagnation stress, seed composition and seed yield related attributes using gene expression profiling and bioinformatics analysis.
- Functional characterization of candidate genes related to drought, water stagnation stress tolerance and seed composition traits through RNAi approach

Achievements:

a) Publications:

- Rane J, Singh AK, Tiwari M, Vara Prasad PV, Jagadish K (2022). Effective use of water in crop plants in dryland agriculture: Implications of reactive oxygen species and antioxidative system. Front. Plant Sci. 12:778270.
- Rane J, Singh AK, Kumar M, Boraiah KM, Meena KK, Pradhan A, Prasad PVV (2021). The adaptation and tolerance of major cereals and legumes to important abiotic stresses. Int. J. Mol. Sci. 22:12970.

Project title: Studies on thermal degradation of crop residues for kinetics, bio-polymeric transitions and value-added products

Project Code	:	6036
Duration of the project	:	April 2019 to March 2022
PI Name	:	Dr. Sandip Gangil
CCPI Names	:	Dr. Dinesh C. Pant
	:	Dr. P. Subramanian
Lead Centre	:	ICAR-CIAE, Bhopal
Cooperating centres	:	TERI, New Delhi
	:	TNAU, Coimbatore

Objectives:

- To study the thermal degradation kinetics of selected biomaterials during torrefaction, slow pyrolysis, low temperature gasification and fast pyrolysis.

- To analyze, model, and validate at laboratory scale the time dependent thermal degradation processes in terms of temperature, biomaterial parameters, and the process output.

Achievements:

a) Publications

- Durga LM, Gangil S, Bhargav VK (2022) Conversion of agricultural waste to valuable carbonaceous material: Brief review, Materials Today: Proceedings 56(3):1290-1297.

- Sahu P, Gangil S, Bhargav VK (2022) Pyrolytic thermal degradation kinetics of pigeon pea stalk (*Cajanus Cajan*): Determination of kinetic and thermodynamic parameters, Materials Today: Proceedings 56 (3): 1542-1550.

- Nithiya K, Subramanian P, Ramesh D, Uma D, Surendrakumar A (2022) Bio-oil production from groundnut shell fast pyrolysis in spouted bed reactor. Poll Res. 41(1): 320 – 324.

- Nithiya K, Subramanian P, Ramesh D, Uma D, Surendrakumar A (2022) Pyrolytic kinetic Study of Sugarcane Bagasse using Thermogravimetric Analysis. Chem Sci Rev Lett. 11 (41): 19-23.

- Agrawal A, Sood D (2021) Development and Performance Analysis of Pine Needle Based Downdraft Gasifier System. In: Baredar PV, Tangellapalli S, Solanki CS (eds) Advances in Clean Energy Technologies. Springer Proceedings in Energy. Springer, Singapore. https://doi.org/10.1007/978-981-16-0235-1_13. pp 163–170.