CALL II

Project title: The nature of impact of abiotic stresses on three diverse freshwater species of fishes

Project Code	**:**	2001
Duration of the project	**:**	January 2011- June 2014
PI Name	**:**	Prof. Rina Chakrabarti
CCPIs Names	**:**	Dr. B. P. Mohanty
	:	Dr. B. D. Banerjee
	:	Dr. Sasmita Mohanty
Lead Centre	**:**	Delhi University (DU), Delhi
Cooperating centres	**:**	ICAR-CIFRI, Barrackpore
	:	ICAR-CIFA, Bhubaneshwar
	:	KIIT University, Bhubaneswar

Objectives:

- To study the effect of abiotic stressors: temperature, light intensity and dissolved oxygen on the physiological responses of Indian major carps *Catla catla* (Family: Cyprinidae) and *Channa striatus* (Family: Channidae) and *catfish magur Clarias batrachus* (Family: Clariidae).
- To study the effect of abiotic stressors on the cellular responses of three species.
- To search for biomarkers for the physiological effect of high temperature and hypoxia in the three fish species.
- To study the role of selected amino acids, vitamins and aquatic flora in the remediation of abiotic stress in fish.

Achievements:

a) Publications:

- Basu M, Lenka SS, Paichha M, Patel B, Banerjee R, Das S, Jayasankar P, Samanta M (2016) B cell activating factor is induced by toll-like receptor and NOD-like receptor-ligands and plays critical role in IgM synthesis in *Labeo rohita*. Molecular Immunology. 78:9-26. Doi:10.1016/j.molimm.2016.08.010.
- Basu M, Lenka SS, Paichha M, Swain B, Patel B, Banerjee R, Jayasankar P, Das S, Samanta M (2016). Immunoglobulin (Ig) D in *Labeo rohita* is widely expressed and differentially modulated in viral, bacterial and parasitic antigenic challenges. Veterinary Immunology and Immunopathology. 179:77-84. Doi: 10.1016/j.vetimm.2016.08.008.
- Mahanty A, Purohit GK, Banerjee S, Karunakaran D, Mohanty S, Mohanty BP (2016) Proteomic changes in the liver of Channa striatus in response to high temperature stress. Electrophoresis. 37(12):1704-1717.
- Patel B, Banerjee R, Basu M, Lenka S, Samanta M, Das S (2016). Molecular cloning of IgZ heavy chain isotype in *Catla catla* and comparative expression profile of IgZ

and IgM following pathogenic infection. Microbiology and Immunology. 60:561-567. https://doi.org/10.1111/1348-0421.12399.

- Patel B, Kumar P, Banerjee R, Basu M, Pal A, Samanta M, Das S (2016*) Lactobacillus acidophilus* attenuates *Aeromonas hydrophila* induced cytotoxicity in catla thymus macrophages by modulating oxidative stress and inflammation. Molecular Immunology. 75:69-83. https://doi.org/10.1016/j.molimm.2016.05.012.

- Purohit GK, Mahanty A, Mohanty BP, Mohanty S (2016) Evaluation of housekeeping genes as references for quantitative real-time PCR analysis of gene expression in the murrel *Channa striatus* under high-temperature stress. Fish Physiol. Biochem. 42(1):125-35. doi: 10.1007/s10695-015-0123-0. Epub 2015 Sep 7.

- Basu M, Paichha M, Swain B, Lenka SS, Singh S, Chakrabarti R, Samanta M (2015) Modulation of TLR2, TLR4, TLR5, NOD1 and NOD2 receptor gene expressions and their downstream signaling molecules following thermal stress in the Indian major carp catla.5:1021–1030. 3 Biotech. doi 10.1007/s13205-015-0306-5.

- Basu M, Paichha M, Lenka SS, Chakrabarti R, Samanta M (2015) Hypoxic stress: impact on the modulation of TLR2, TLR4, NOD1and NOD2 receptor and their down-stream signalling genes expression in catla (*Catla catla*). Molecular Biology Reports. doi 10.1007/s11033-015-3932-4.

- Mohanty S, Mohanty A, Yadav RP, Purohit GK, Mohanty BN, Mohanty BP (2014) The Atri hot spring in Odisha - A natural ecosystem for global warming research. International Journal of Geology, Earth and Environmental Sciences. 4(1):85-90.

- Ahmad T, Singh SP, Khangembam BK, Sharma JG, Chakrabarti R (2014) Food consumption and digestive enzyme activity of *Clarias batrachus* exposed to various temperatures. Aquaculture Nutrition. 20(3): 265-272.doi.org/10.1111/anu.12072.

- Purohit GK, Mohanty A, Suar M, Sharma AP, Mohanty BP, Mohanty S (2014). Investigating hsp gene expression in liver of *Channa striatus* under heat stress for understanding the upper thermal acclimation. Biomed Research International. Article ID 381719, http://dx.doi.org/10.1155/2014/ 381719.

- Sharma JG, Singh SP, Mittal P, Chakrabarti R (2014) Impact of Temperature Gradient on the Indian Major Carp *Catla catla* Larvae. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences. DOI 10.1007/s40011-014-0419-3.

- Mohanty S, Mohanty BP (2013) The Atri hot spring in Odisha: An ideal ecosystem for climate change and global warming research. National Academy Science Letters. 32(5-6):149-156.

- Mohanty BP, Banerjee S, Bhattacharjee S, Mitra T, Purohit GK, Sharma A P, Karunakaran K, Mohanty S (2013) Muscle Proteomics of the Indian Major Carp Catla (*Catla catla*, Hamilton). Journal of Proteomics & Bioinformatics. 6: 252-263. doi:10.4172/jpb.1000288.

- Singh SP, Sharma JG, Ahmad T, Chakrabarti R (2013) Effect of Water Temperature on the Physiological Responses of Asian Catfish *Clarias batrachus* (Linnaeus 1758). Asian Fisheries Science 26:26-38.

Project title: Deciphering the mechanism of aberrant maternal recognition of pregnancy (MRP) events in sheep and buffalo under heat and nutritional stress

Project Code	**:**	2002
Duration of the project	**:**	January 2011 – December 2015
PI Name	**:**	Dr. Sukanta Mondal
CCPI Names	**:**	Dr. Davendra Kumar
	:	Dr. T.K. Datta
Lead Centre	**:**	ICAR-NIANP, Bangalore
Cooperating centres	**:**	ICAR-CSWRI, Avikanagar
	:	ICAR-NDRI, Karnal

Objectives:

- Studying the effect of heat and nutritional stresses on physiological responses, ovarian function and in vivo production of embryos and fertility in sheep
- Delineating the modulation of peripheral endocrine profiles as well as characterization and expression profiling of genes involved in MRP during heat and nutritional stress in sheep
- Studying the effect of heat and nutritional stresses on gene expression changes during late transition stages of embryonic development in sheep and buffalo

Achievements:

a) Publications:

- Mor A, Mondal S, Reddy IJ, Nandi S, Gupta PSP (2018) Molecular cloning and expression of FGF2 gene in pre-implantation developmental stages of *in vitro* produced sheep embryos. Reproduction in Domestic Animal. DOI: 10.1111/rda.13182.
- Mor A, Mondal S, Reddy IJ, Nandi S, Gupta PSP (2018) Expression profiling of Annexin II transcript during pre-implantation developmental stages of sheep embryo. International Journal of Biological Sciences 9 (1): 39 – 44.
- Mondal S, Mor A, Reddy IJ, Nandi S (2017) Impact of *in vitro* heat shock (42.50C) on prostaglandins, ionic and metabolic contents in sheep endometrial epithelial cells. Current Trends in Biomedical Engineering and Biosciences. 3(1):1-3. doi: 10.19080/CTBEB.2017.03.555604.
- Mondal S, Sardessai S, Varshney VP (2017) Application of radioimmunoassay for livestock fertility management. Biomedical Journal of Scientific and Technical Research DOI:10.26717/BJSTR.2017.01.000422.
- Mondal S, Mor A, Reddy IJ, Nandi S, Gupta PSP (2017) Heat stress induced alterations in prostaglandins, ionic and metabolic contents of sheep endometrial epithelial cells *in vitro*. Biomedical Journal of Scientific and Technical Research 1(4): BJSTR.MS.ID. 000384. DOI: 10.26717/BJSTR.2017.01.000384.

- Mor A, Mondal S, Reddy IJ (2017) Production of sheep embryos *in vitro*. Austin Endocrinology and Diabetes Case Reports 2(1): 1011.

- Indu S, Sejian V, Kumar D, Pareek A, Naqvi SMK (2015) Ideal proportion of roughage and concentrate for Malpura ewes to adapt and reproduce in a semi-arid tropical environment. Tropical Animal Health and Production 47(8):1487-95. DOI 10.1007/s11250-015-0889-1.

- Mishra SS, Markande AR, Keluskar RP, Indrani K, Nayak BB (2015) Simultaneous nitrification and denitrification by 1 novel heterotrophs in remediation of fish processing effluent. Journal of Basic Microbiology. 55(6):772-9. doi: 10.1002/jobm.201400783.

- Mondal S, Mor A, Reddy IJ, Nandi S (2015) Impact of exposure of elevated temperature (42.50C °C) on *in vitro* maturation, metabolic and ionic contents of sheep oocytes. Biomedicine 35(1): 65-71.

- Mondal S, Mor A, Reddy IJ, Nandi S, Gupta PSP (2015) Effect of fibroblast growth factor 2 (FGF2) and insulin transferrin Selenium (ITS) on *in vitro* maturation, fertilization and embryo development in sheep. Brazilian Archives of Biology and Technology. 58(4):521-525. http://dx.doi.org/10.1590/S1516-8913201500059.

- Mondal S, Reddy IJ, Mor A (2015) Impact of nutritional stress on early embryonic survival. Functional Foods in Health and Disease. 5(9): 304-319. DOI: 10.31989/ffhd. v5i9.218.

- Mor A, Mondal S, Reddy IJ, Gupta PSP, Nandi S (2015) Influence of Season on Quality and In Vitro Maturation of Sheep Oocytes. International Journal on Environmental Sciences. 6 (2):162-166.

- Mor A, Mondal S, Reddy IJ, Soumya NP (2015) Genes Regulating Maternal Recognition of Pregnancy in Domestic Animals: an Update. Brazilian Archives of Biology and Technology. 58(6):854-863. https://doi.org/10.1590/S1516-89132015060284.

- Indu S, Sejian V, Naqvi SMK (2014) Effect of Short-Term Exposure to Different Environmental Temperature on Physiological Adaptability of *Malpura ewes* under Semi-Arid Tropical Environment. Journal of Veterinary Science and Medical Diagnosis. http://dx.doi.org/10.4172/2325-9590.1000141.

- Sejian V, Bahadur S, Naqvi SMK (2014) Effect of nutritional restriction on growth, adaptation physiology and estrous responses in *Malpura ewes*. Animal Biology. 64(2):189-20.

- Mondal S (2014) Climate Change and Early Embryo Loss. International Journal of Environmental Sciences. Vol. 5 (1):53-57.

- Mondal S (2013) Effect of change of climate on embryonic development. Indian Journal of Physiology and Allied Sciences. 67(4):34-38.

➢ Sejian V, Indu S, Naqvi SMK (2013) Impact of short-term exposure to different environmental temperature on the blood biochemical and endocrine responses of *Malpura ewes* under semi-arid tropical environment. Indian Journal of Animal Sciences. 83 (11):1155-1160.

Project title: Micro-encapsulation methods for bacteriocins for their controlled release

Project Code	**:**	2003
Duration of the project	**:**	January 2011 – March 2014
PI Name	**:**	Dr. K. Narsaiah
CCPI Name	**:**	Dr. R.K. Malik
Lead Centre	**:**	ICAR-CIPHET, Ludhiana
Cooperating centre	**:**	ICAR-NDRI, Karnal

Objectives:

- To study droplet formation using air, chilled air/nitrogen, ultrasonic nozzle, mechanical vibration and membrane emulsification for the production of microcapsules.
- Isolation, screening and characterisation (biochemical & molecular) of bacteriocin genic strains of lactic acid bacteria from different food products and encapsulation of bacteriocins.
- Release characteristics of bacteriocins in different classes of encapsulating material in dairy, meat and fruit-based food matrices

Achievements:

a) Publications:

- Narsaiah K, Wilson RA, Gokul K, Mandge, HM, Jha SN, Bhadwal Sheetal, Anurag RK, Malik RK, Vij S (2014) Effect of bacteriocin incorporated alginate coating on shelf life of minimally processed papaya (*Carica papaya* L.). Postharvest Biology and Technology. 100:212-218. 10.1016/j.postharvbio.2014.10.003.
- Narsaiah K, Jha SN, Mandge HM, Jha J, Manikanatan MR (2014) Optimisation of Microcapsule Production by Air Atomization Technique using Two Fluid Nozzle. Agriculture Research. 3(4):353-359. DOI: 10.1007/s40003-014-0123-9.
- Narsaiah K, Jha SN, Wilson RA, Mandge HM, Manikantan MR, Malik RK, Vij S (2013) Pediocin loaded nanoliposomes and hybrid alginate-nanoliposome delivery systems for slow release of pediocin. Bionanoscience. 3(1):37-42. https://doi.org/10.1007/s12668-012-0069-y.
- Wilson RA, Narsaiah K, Mandge HM (2013) Controlled release of functional ingredients in processed foods: Methods and applications of controlled release. Beverage and Food World. 40(5): 36-37.
- Narsaiah K, Jha SN, Wilson RA, Mandge HM, Manikantan MR (2012) Optimizing microencapsulation of nisin with sodium alginate and guar gum. Journal of Food Science and Technology. DOI: 10.1007/s13197-012-0886-6.

- Mandge HM, Narsaiah K, Wilson RA, Jha SN, Manikantan, M. R. (2012) Effect of process parameters and nozzle diameter on size of microcparticles prepared with two fluid glass nozzles. Crop improvement. (Special Issue):1183- 1184.

- Wilson RA, Narsaiah K, Mandge HM, Jha SN, Manikantan MR (2012) Controlled release of bactericin from hybrid hydrogel matrix. Crop improvement (Special Issue): 1293-1294.

b) Patent:

- An autoclavable microencapsulation system with multistage break up two fluid nozzle (Patent file no. 3014/DEL/2011)

Project title: Extraction and Micro-encapsulation of Nutraceutical for Effective Delivery into Different Food Matrices

Project Code	**:**	2004
Duration of the project	**:**	January 2011 – December 2015
PI Name	**:**	Dr. Abhjit Kar
CCPI Names	**:**	Dr. Manjoosha Srivastava
	:	Dr. Gargi Ghoshal
Lead Centre	**:**	ICAR-IARI, New Delhi
Cooperating centres	**:**	ICAR-NBRI, Lucknow
	:	Punjab University, Chandigarh

Objectives:

- Characterization of nutraceutical/functional materials of natural origin for their suitability as encapsulants
- Isolation and characterization of nutraceutical and functional compounds of fruits and vegetable origin to be used as the core
- Identification and formulation of appropriate encapsulants and encapsulating material combinations in single and multi/concentric cores
- Study of the release kinetics and interaction effects of the encapsulants/active ingredient under simulated gut conditions

Achievements:

a) Publications:

- Jain A, Sharma G, Kuswah V, Ghoshal G, Singh B, Jain S, Shivhare US, Katare OP (2017) Fabrication and functional attributes of lipidic nanoconstructs of lycopene: An innovative endeavour for enhanced cytotoxicity in MCF-7 breast cancer cells. Colloids and Surfaces B: Biointerfaces. 152, 482-491. DOI: 10.1016/j.colsurfb.2017.01.050.
- Jain A, Thakur D, Ghoshal G, Katare OP, Shivhare US (2015) Microencapsulation by Complex Coacervation Using Whey Protein Isolates and Gum Acacia: An Approach to Preserve the Functionality and Controlled Release of β-Carotene. Food Bioprocess Technology. 8:1635 -1644. https://doi.org/10.1007/s11947-015-1521-0.

Project title: Investigations on high pressure induced effect on quality characteristics of buffalo milk

Project Code	**:**	2005
Duration of the project	**:**	January 2011 – December 2012
PI Name	**:**	Dr. Ashish Kumar Singh
CCPI Name	**:**	Er. Rajesh Vishwakarma
Lead Centre	**:**	ICAR-NDRI, Karnal
Cooperating centre	**:**	ICAR-CIPHET, Ludhiana

Objectives:

- To elucidate the effect of high-pressure processing on chemical constituents and microbiological quality of buffalo milk
- To investigate the effect off HHP on functional properties of buffalo milk
- To study the quality characteristics of dairy products (Yoghurt & Khoa) manufactured by using HHP treated buffalo milk

Achievements:

a) Publications:

- Chawla R, Patil GR, Singh AK (2011) High Hydrostatic Technology in Dairy Processing: A review. Journal of Food Science & Technology. 48 (3):260-268.

Project title: Increasing the efficiency of microbial production of bioethanol from agricultural biomass

Project Code	:	2006
Duration of the project	:	January 2011 – December 2015
PI Name	:	Dr. Lata
CCPI Name	:	Dr. B.S. Chadha
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centre	:	GNDU, Amritsar

Objectives:

- Development of an efficient biological pre-treatment process for enhanced fermentability of lignocellulosic biomass
- Searching for an alternate set of microbes to the conventionally used ones, including plant pathogens, for a multifold increase in efficiency of delignification, saccharification and fermentation of pentoses /hexoses that has been obtained so far
- Saccharification of pre-treated lignocellulosic residue with efficient culturable/ non culturable microorganisms
- To develop robust microorganisms for the simultaneous fermentation of pentoses and hexoses.
- Optimisation of conditions for ethanol production from agricultural biomass.

Achievements:

a) Publications:

- Adak A, Tiwari R, Singh S, Sharma S, Nain L (2016) Laccase production by a novel white-rot fungus *Pseudolagarobasidium acaciicola* LA 1 through solid-state fermentation of Parthenium biomass and its application in dyes decolourization. Waste and Biomass Valorisation. Doi: 10.1007/s12649-016-9550-0.
- Mahajan C, Basotra N, Singh S, DiFalco M, Tsang A, Chadha, BS (2016) *Malbranchea cinnamomea*: A thermophilic fungal source of catalytically efficient lignocellulolytic glycosyl hydrolases and metal dependent enzymes. Bioresource Technology. 200:55–63. https://doi.org/10.1016/j.biortech.2015.09.113.
- Saritha M, Tiwari R, Singh S, Nain PKS, Rana S, Adak A, Arora A, Nain L (2016) Glycoside hydrolase production by *Aspergillus terreus* CM20 using mixture design approach for enhanced enzymatic saccharification of alkali pretreated paddy straw. Indian Journal of Experimental Biology 54(8):518-524. http://nopr.niscair.res.in/handle/123456789/35143.
- Sharma M, Mahajan C, Bhatti MS, Chadha BS (2016) Profiling and production of hemicellulases by thermophilic fungus *Malbranchea flava* and the role of xylanases in

improved bioconversion of pretreated lignocellulosics to ethanol.3 Biotech. 6(1):30. doi: 10.1007/s13205-015-0325-2.

- Shweta S, Tiwari R, Rana S, Saritha M, Singh S, Arora A, Nain L (2016) Saccharification of biopretreated paddy straw with indigenous holocellulase and fermentation with *Saccharomyces cerevisiae* LN1 under optimized conditions. Energy, Ecology and Environment. 1:419–429. Doi: 10.1007/s40974-016-0021-z.

- Rana S, Anurup A, Tiwari R, Sharma A, Saritha M, Singh S, Nain L (2015) Pretreatment and Designing Energy Crops: Technological Innovations and Prospects. Research Journal of Microbiology. 10 (12):557-570. DOI: 10.3923/jm.2015.557.570.

- Rani V, Dash S, Nain L, Arora A (2015) Expression of novel glucose tolerant β-glucosidase on cell surface by *Rhodotorula glutinis* isolate. Biocatalysis and Agricultural Biotechnology. 4(3):380-7. DOI:10.1016/J.BCAB.2015.06.004.

- Singh S, Tiwari R, Renuse S, Pranaw K, Nain L (2015) Proteomic analysis of Streptomyces sp. ssr-198 grown on paddy straw. Journal of Basic Microbiology. 2014. DOI: 10.1002/jobm.201400639.

- Tiwari R, Nain PK, Singh S, Adak A, Saritha M, Rana S, Sharma A, Nain L (2015) Cold active holocellulase cocktail from *Aspergillus niger* SH3: process optimization for production and biomass hydrolysis. Journal of the Taiwan Institute of Chemical Engineers 56:57-66.

- Tiwari R, Pranaw K, Singh S, Nain PKS, Shukla P, Lata (2015) Two step statistical optimization for cold active β-glucosidase production from *Pseudomonas lutea* BG8 and its application for improving saccharification of paddy straw. Biotechnology and Applied Biochemistry. doi: 10.1002/bab.1415.

- Mahajan C, Chadha, BS, Nain L, Kaur A (2014) Evaluation of glycosyl hydrolases from thermophilic fungi for their potential in bioconversion of alkali and biologically treated *Parthenium hysterophorus* weed and rice straw into ethanol. Bioresource Technology. 163:300-307. 10.1016/j.biortech.2014.04.057.

- Pandey S, Kushwah J, Tiwari R, Kumar R, Somvanshi VS, Nain L, Saxena AK (2014) Cloning and expression of β-1, 4-endoglucanase gene from *Bacillus subtilis* isolated from soil long term irrigated with effluents of paper and pulp mill. Microbiological Research. 169(9/10):693-8. https://doi.org/10.1016/j.micres.2014.02.006.

- Pandey S, Singh S, Yadav AN, Nain L, Saxena AK (2014) Phylogenetic diversity and characterisation of novel and efficient cellulase-producing bacterial isolates from various extreme environments. Bioscience, Biotechnology, and Biochemistry. 77(7):1474-80. DOI: http://dx.doi.org/10.1271/ bbb.130121.

- Pandey S, Tiwari R, Singh S, Nain L, Saxena AK (2014) Evaluation of β-1, 4-endoglucanases produced by bacilli isolated from paper and pulp mill effluents irrigated soil. Journal of Microbiology and Biotechnology. 24(8):1073–1080. DOI: 10.4014/jmb.1311.11051.

- Pandiyan K, Tiwari R, Rana S, Arora A, Singh S, Saxena AK, Nain L (2014) Comparative efficiency of different pretreatment methods on enzymatic digestibility of Parthenium sp. World Journal of Microbiology and Biotechnology. 30(1):55-64. DOI: 10.1007/s11274-013-1422-1.

- Pandiyan K, Tiwari R, Singh S, Nain PK, Rana S, Arora A, Singh SB, Nain L (2014) Optimization of enzymatic saccharification of alkali pretreated Parthenium sp. using response surface methodology. Enzyme Research. 2014:764898. doi: 10.1155/2014/764898.

- Singh S, Pranaw K, Singh B, Tiwari R, and Nain L (2014) Production, optimization and evaluation of multicomponent holocellulase produced by Streptomyces sp. ssr-198. Journal of Taiwan Institute of Chemical Engineering. 45:2379-86.

- Tiwari R, Shukla P, Singh S, Nain L (2014) Novel cold active β-glucosidase from *Pseudomonas lutea* BG8 suitable for simultaneous saccharification and fermentation. RSC Advances. 4:58108-58115.

- Tiwari R, Singh S, Singh N, Adak A, Rana S, Sharma A, Arora A, Nain L (2014) Unwrapping the hydrolytic system of the phytopathogenic fungus *Phoma exigua* by secretome analysis. Process Biochemistry. 49:1630-1636. https://doi.org/10.1016/j.procbio.2014.06.023.

- Amat D, Arora A, Nain L, Saxena AK (2014) Biomass hydrolyzing enzymes from plant pathogen *Xanthomonas axonopodis* pv. punicae: optimizing production and characterization. Annals of Microbiology. 64(1):267-74. https://doi.org/10.1007/s13213-013-0659-0.

- Rana S, Tiwari R, Arora A, Singh S, Kaushik R, Saxena AK, Datta SC, Nain L (2013) Prospecting Parthenium sp. pretreated with *Trametes hirsuta*, as a potential bioethanol feedstock. Biocatalysis and Agricultural Biotechnology. 2(2):152-158.

- Saritha M, Amat D, Choudhary J, Arora A, Nain L (2013) Novel perspectives for evolving enzyme cocktails for lignocellulose hydrolysis in biorefineries. Sustainable Chemical Processes. 1:15. DOI: 10.1186/2043-7129-1-15.

- Tiwari R, Rana S, Singh S, Arora A, Kaushik R, Agrawal VV, Saxena AK, Nain L (2013) Biological delignification of paddy straw and Parthenium sp. using a novel micromycete *Myrothecium roridum* LG7 for enhanced saccharification. Bioresource Technology. 135:7-11. DOI: 10.1016/j.biortech.2012.12.079.

- Tiwari R, Singh S, Nain PKS, Rana S, Sharma A, Pranaw K, Nain L (2013) Harnessing the hydrolytic potential of phytopathogenic fungus *Phoma exigua* ITCC 2049 for saccharification of lignocellulosic biomass. Bioresource Technology. 50:228-234. https://doi.org/10.1016/j.biortech.2013.10.007.

- Saritha M, Arora A, Nain L (2012) Biological pretreatment of lignocellulosic substrates for enhanced delignification and enzymatic digestibility. Indian Journal of Microbiology. 52 (2):122–130. doi: 10.1007/s12088-011-0199-x.

- Saritha M, Arora A, Nain L (2012) Pretreatment of paddy straw with *Trametes hirsuta* for improved enzymatic saccharification. Bioresource Technology. 104:459–465. DOI: 10.1016/j.biortech.2011.10.043.

- Saritha M, Arora A, Singh S, Nain L (2012) *Streptomyces griseorubens* mediated delignification of paddy straw for improved enzymatic saccharification yields. Bioresource Technology. 135:12-17. DOI: 10.1016/j.biortech.2012.11.040

Project title: Studies on microalgal triacylglycerols (TAGs) as a Source of Biodiesel

Project Code	**:**	2007
Duration of the project	**:**	January 2011 – March 2016
PI Name	**:**	Dr. Nirupama Mallick
Lead Centre	**:**	IIT, Kharagpur

Objectives:

- To study and standardise the parameters for efficient cultivation and lipid accumulation in the selected TAG-producing microalgae.
- To establish the downstream processes for microalgal biodiesel production.
- To explore an integrated sequential processing approach for an algal biorefinery.

Achievements:

a) Publications:

- Bagchi SK, Rao PS, Mallick N (2015) Development of an oven drying protocol to improve biodiesel production for an indigenous chlorophycean microalga Scenedesmus sp. Bioresource Technology. 180:201-213. doi: 10.1016/j.biortech.2014.12.092.
- Patnaik R, Mallick, N (2015) Utilization of Scenedesmus obliquus biomass as feedstock for biodiesel and other industrially important co-products: an integrated paradigm for microalgal biorefinery. Algal Research. 12: 328-336. https://dx.doi.org/10.1016/j.algal.2015.09.009.
- Singh DK, Mallick N (2014) Accumulation potential of lipids and analysis of fatty acid profile of few microalgal species for biodiesel feedstock. Journal of Microbiology and Biotechnology Research. 4:37-44.
- Gorain PC, Bagchi SK, Mallick N (2013) Effects of calcium, magnesium and sodium chloride in enhancing lipid accumulation in two green microalgae. Environmental Technology. 34(13-16):1887-94. doi: 10.1080/09593330.2013.812668.
- Mandal S, Patnaik R, Singh AK, Mallick N (2013) Comparative assessment of various lipid extraction protocols and optimization of transesterification process for microalgal biodiesel production. Environmental Technology. 34:2009-2018. https://doi.org/10.1080/09593330.2013.827730.
- Mandal S, Mallick N (2012) Biodiesel production by the green microalga *Scenedesmus obliquus* in a recirculatory aquaculture system. Applied and Environmental Microbiology. 78:5929-5933. doi: 10.1128/AEM.00610-12.
- Mallick N, Mandal S, Singh AK, Bishai M, Dash A (2011) Green microalga *Chlorella vulgaris* as a potential feedstock for biodiesel. Journal of Chemical Technology & Biotechnology. 87:135-145. https://doi.org/10.1002/jctb.2694

Project title: Studies on sucrose accumulation for efficient ethanol production from sweet sorghum

Project Code	**:**	2008
Duration of the project	**:**	January 2011 – March 2016
PI Name	**:**	Dr. C.V. Ratnavathi
CCPI Name	**:**	Dr. S.R. Gadakh
Lead Centre	**:**	ICAR-DSR, Hyderabad
Cooperating centre	**:**	MPKV, Rahuri

Objectives:

- Characterisation of changes in sucrose accumulation and specific sugar profile during the key crop growth stages in leaves, stem and stem juice.
- Response of key enzymes of sucrose synthesis /degradation metabolism during crop growth period.
- Studying the limiting factors for the accumulation and stability of sucrose in stem in comparison to sugarcane.
- Identification of potential genotypes for high ethanol recovery.
- To extract lignin from biomass and explore the possibility of high-density energy production

Achievements:

a) Publications:

- Borade RM, Dalvi US, Lokhande PK, Naik RM, Shinde MS (2015) Influence of stage of harvesting on composition of sweet sorghum. Bioinfolet. 12 (1B):219-223.
- Shinde MS, Gaikwad AR, Repe SS, Dalvi US, Gadakh SR (2013) Physio-biochemical assessment of sweet sorghum genotypes during post-rainy season. Journal of Academia and Industrial Research. 1(8):501-507.
- Shinde MS, Mutkale BR, Gaikwad AR, Dalvi US, Gadak SR (2013) Photoperiod sensitivity studies in sweet sorghum. Journal of Academia and Industrial Research. 1(11):696-699.
- Dalvi US, Chavan UD, Shinde MS, Gaikwad AR, Gadakh SR (2013) Seasonal impact on biomass, juice quality and sugar attributes of sweet sorghum. Journal of Academia and Industrial Research 1 (8):431-434.
- Dalvi US, Chavan UD, Shinde MS, Gadakh SR (2012) Effect of staggered planting on stalk yield, sugar content and ethanol yield of sweet sorghum for increasing harvest window. Sugar tech. 14(2):144-147. DOI: 10.1007/s12355-011-0126-9.

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- Ratnavathi CV, Ravikumar S, Vijaykumar BS, Gopalakrishna D, Patil JV (2012) Effect of Time of Planting on Cane Yield and Quality Characters in Sweet Sorghum. Journal of Sustainable Bioenergy Systems. (2):1-9. http://dx.doi.org/10.4236/jsbs.2012.21001.

- Dalvi US, Chavan UD, Shinde MS, Gadakh SR (2011) Assesment of sweet sorghum cultivars for efficient ethanol production. Sugar tech 13(3): 186-190.

- Ratnavathi CV, Chakravarthy SK, Komala VV, Chavan UD, Patil JV (2011) Sweet Sorghum as Feedstock for Biofuel Production: A Review. Sugar Tech. 13(4):399–407.

Project title: Isolation of Clostridium strains and a two-phase digestion system for efficient butanol production

Project Code	**:**	2009
Duration of the project	**:**	January 2011 – March 2016
PI Name	**:**	Dr. Geeta G. Shirnalli
CCPI Name	**:**	Dr. S. Karthikeyan
Lead Centre	**:**	UAS, Dharwad
Cooperating centre	**:**	TNAU, Coimbatore

Objectives:

- To isolate the Clostridium species from natural anaerobic habitats for obtaining Clostridium isolates and comparing of already identified Clostridium strains for high butanol tolerance, utilisation of pentose sugars and mesophilic strains.
- To evaluate the feasibility of two-phase digestion: Aerobic phase for production of CO, CO2, N and H2 and anaerobic phase with Clostridium spp for production of butanol.
- Evaluation of efficiency of the identified Clostridium isolates along with the already identified strains in anaerobic fermentation of various types of biomass substrates.
- To perform comparative analysis of the energy balance sheet through methane, ethyl alcohol and butanol production in bioenergy production.

Achievements:

a) Publications:

- Geeta GS, Marihal AK, Babar SR (2014) Exploration of Acidogenic and Solventogenic *Clostridum* sp. from Habitat of Different Ecosystems. Journal of Pure and Applied Microbiology. 8 (5):3755-3763

Project title: Development of pod borer resistant transgenic pigeonpea and chickpea

Project Code	:	2010
Duration of the project	:	January 2011 – March 2017
PI Name	:	Dr N. P.Singh
CCPI Names	:	Dr. Rohini Sreevathsa
	:	Dr. Sumangala Bhatt
	:	Dr. Bidyut K. Sarmah
	:	Dr. Sudip K.Ghosh
	:	Dr. S. Das
	:	Dr. W. Tyagi
	:	Dr. D. Chakraborty
Lead Centre	:	ICAR-IIPR, Kanpur
Cooperating centres	:	ICAR-NRCPB, New Delhi
	:	UAS, Dharwad
	:	AAU, Jorhat
	:	IIT, Kharagpur
	:	Bose Institute, Kolkata
	:	CAU, Shillong
	:	St. Xavier College, Kolkata

Objectives:

- To establish efficient insecticidal protein gene transfer protocols for generating a large number of independent transgenic events in pigeonpea and chickpea.
- To develop marker-free transgenic plant lines of pigeonpea and chickpea resistant to pod borers containing one or more insecticidal transgene(s).
- To make attempts to prevent expression of the insecticidal gene(s) in seed
- Characterization of selected transgenic events and confined field trials

Achievements:

a) Publications:

- Tirthkar MB, Bhat S (2018) Development and molecular characterisation of transgenic pigeonpea carrying cry2Aa for podborer resistance. Journal of Pharmacognosy and Photochemistry. 7(3): 1581-1585.
- Ghosh G, Ganguly S, Purohit A, Kundu RC, Das S, Chakraborti D (2017) Transgenic pigeon pea events expressing Cry1Ac and Cry2Aa exhibit resistance to *Helicoverpa armigera*. Plant Cell Reports 36:1037-105. DOI 10.1007/s00299-017-2133-0.
- Chakraborty J, Sen S, Ghosh P, Sengupta AD, Das S (2016) Homologous promoter derived constitutive and chloroplast-targeted expression of synthetic cry1Ac in

transgenic chickpea confers resistance against *Helicoverpa armigera*. Plant Cell Tissue and Organ Culture. https://doi.org/10.1007/s11240-016-0968-7.

- Ghosh G, Purohit A, Chaudhuri RK, Chakraborti D (2014) Advances in genetic transformation of important pulse crop pigeonpea. OA Biotechnology. 12:3(1):5.

- Ghosh G, Purohit A, Ganguly S, Chaudhuri RK, Chakraborti D (2014) *In vitro* shoot grafting on rootstock: An effective tool for Agrobacterium-mediated transformation of pigeonpea (*Cajanus cajan* L. Millsp). Plant Biotechnology 31:301-308. https://doi.org/10.5511/plantbiotechnology.14.0805a.

- Mahale BM, Fakrudin B, Neha SM, Patil V, Bhat S, Krishnaraj PU (2014) Effect of cytokines and their concentration regimes on multiple shoot induction using cotyledonary node with cotyledon and embryo disc with half cotyledon explants in pigeon pea (*Cajanus cajan* L. Millsp.). Indian J. Genet. 74 (3):335-343. DOI: 10.5958/0975-6906.2014.00851.7.

- Sengupta A, Sarkar A, Prerna P, Ghosh SD, Das S (2013) New Insight to Structure-Function Relationship of GalNAc Mediated Primary Interaction between Insecticidal Cry1Ac Toxin and HaALP Receptor of *Helicoverpa armigera*, PLoS ONE. 8(10): e78249. https://doi.org/10.1371/journal.pone.0078249.

- Srivastava J, Das A, Soren KR, Chaturvedi SK, Nadarajan N, Datta S (2012) Ontogeny of *in vitro* shoot organogenesis from axillary meristem explants in chickpea (*Cicer arietinum* L.). Journal of Crop Science and Biotechnology. 15(3):53-57. DOI:10.1007/s12892-012-0032-z.

Project title: Use of RNAi technology in developing low phytate soybean and rice

Project Code	:	2011
Duration of the project	:	June 2011 – May 2015
PI Name	:	Dr. Archana Sachdev
CCPI Names	:	Dr. Karabi Datta
	:	Dr. Anita Rani
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centres	:	CU, Kolkata
	:	ICAR-DOSR, Indore

Objectives:

- Development of transgenic soybean and rice with reduced levels of phytate content in seeds
- Biochemical analysis and study of iron bioavailability with the transgenic seeds

Achievements:

a) Publications:

- Kumar A, Kumar V, Krishnan V, Hada A, Marathe A, Parameswaran C, Jolly M, Sachdev A (2019) Seed targeted RNAi-mediated silencing of GmMIPS1 limits phytate accumulation and improves mineral bioavailability in soybean. Scientific Reports. 9(1):7744 https://doi.org/10.1038/s41598-019-44255-7.
- Punjabi M, Bharadvaja N, Jolly M, Dahuja A, Sachdev A (2018) Development and Evaluation of Low Phytic Acid Soybean by siRNA Triggered Seed Specific Silencing of Inositol Polyphosphate 6-/3-/5-Kinase Gene. Frontiers in Plant Science. 9:804.
- Kumari S, Krishnan V, Jolly M, Sachdev A (2015) Phytate reduction and HCl extractability of essential minerals during soaking and generation in soybean (*Glycine max*. L). Indian Journal of Plant Physiology. 20(1):44-49 https://doi.org/10.1007/s40502-014-0132-5.
- Kumari S, Krishnan V and Sachdev A (2015) Impact of soaking and germination durations on antioxidants and anti-nutrients of black and yellow soybean (*Glycine max* L) varieties. Journal of Plant Biochemistry & Biotechnology. 24(3):355–358 (doi.org/10.1007/s13562-014-0282-6).
- Krishnan V, Singh A, Vinutha T, Singh B, Dahuja A, Rai RD, Sachdev A (2015) Low gamma irradiation effects on protein profile, solubility, oxidation, scavenger ability and bioavailability of essential minerals in black and yellow Indian soybean (*Glycine max* L) varieties. Journal of Radioanalytical and Nuclear Chemistry. 307(1): 49–57 (doi: 10.1007/s10967-015-4193-3).

- Krishnan V, Jain V, Vinutha T, Hada A, Manickavasagam M, Ganapathi A, Rai RD, Sachdev A (2015) Molecular modeling and in-silico characterization of glycine max, Inositol (1, 3, 4) tris 5/6 kinase: A potential candidate gene for developing low phytate transgenics. Plant Omics Journal. 8: 381-391.

- Hada A, Gupta AK, Theboral J, Manickavasagam M, Ganapathi A, Jolly M, Sachdev A (2014) Developing rapid and reliable regeneration system using cotyledonary–node method in Indian soybean genotypes (*Glycine max* L.). International Journal of Innovative Research in Science, Engineering and Technology. 3(5):12678-12686.

- Kumar AK, Lal V, Jolly SK, Monica, Sachdev A (2014) Influence of gamma rays and ethyl methane sulphonate (EMS) on the levels of phytic acid, raffinose family oligosaccharides and antioxidants in soybean seeds of different genotypes, Journal of Plant Biochemistry & Biotechnology. DOI:10.1007/s13562 -014-0282-6.

- Kumari S, Krishnan V and Sachdev A (2014) *In vivo* bioavailability of essential minerals and phytase activity during soaking and germination in soybean (*Glycine max* L.). Australian Journal of Crop Science 8(8):1168-1174.

- Kumari S, Lal SK, Sachdev A (2014) Identification of putative low phytic acid mutants and assessment of the total P, phytate P, protein and divalent cations in mutant populations of soybean. Australian Journal of Crop Sciences. 8 (3):435- 441.

- Singh P, Jolly M, Punjabi M, Rai RD, Sachdev A (2013) Characterization and expression of codon optimized soybean phytase gene in E. Coli. Indian Journal of Biochemistry & Biophysics. 50:537-547.

- Ali N, Paul S, Gayen D, Sarkar SN, Datta SK, Datta K (2013) Development of low phytate indica rice by RNAi mediated seed-specific silencing of inositol 1, 3, 4, 5, 6-pentakisphosphate 2-kinase (IPK1) gene. PLOS ONE 8(7): e68161 Doi: 10.1371/journal.pone. 0068161.

- Ali N, Paul S, Gayen D, Sarkar SN, Datta, SK, Datta K (2013) RNAi mediated down regulation of myo inositol 3 phosphte synthase to generate low phytate rice. Rice. 6:12. https://doi.org/10.1186/1939-8433-6-12.

- Kumari S, Sachdev A (2013) Molecular cloning, characterization and bacterial overexpression of D-myo-inositol 3-phosphate synthase (MIPS) gene from soybean (*Glycine max* [L.] Merr.). Australian Journal of Crop Sciences. 7:1884-1892.

- Kumar A, Kumari S, Jolly M, Rai RD, Sachdev A (2012) Cloning and characterization of myo- inositol-1-phosphate synthase (mips1) gene in developing seeds of *Glycine max*. Indian Journal of Plant Physiology. 17(2):121-127.

- Kumari S, Jolly M, Krishnan V, Dahuja A, Sachdev A (2012) Spatial and temporal expression analysis of D-myo-inositol 3-phosphate synthase (MIPS) gene family in *Glycine max* L. African Journal of Biotechnology. 11:16443-16454. DOI: 10.5897/AJB12.2811.

Project title: Identification of nucleopolyhedrovirus (NPV) encoded proteins and small RNAs and feasibility of their expression in plant to control predation by *Helicoverpa armigera*

Project Code	**:**	2012
Duration of the project	**:**	January 2011 – March 2016
PI Name	**:**	Dr. Raj K. Bhatnagar
CCPI Name	**:**	Dr. S.K. Jalali
Lead Centre	**:**	ICGEB, New Delhi
Cooperating centre	**:**	ICAR-NBAII, Bangalore

Objectives:

- To understand the diversity and specificity of NPV that infect *Helicoverpa armigera* present in diverse locations and feed on different crops by sequencing and analysing genome of NPV.
- Identification and characterisation of viral genome encoded RNAi suppressors.
- MicroRNA Prediction of microRNAs encoded by the viral genome.
- Evaluation of proteins encoded by viral genome as insecticidal proteins by expressing them in tobacco.

Achievements:

a) Publications:

- Jose J, Jalali SK, Shivalingaswamy TM, Krishnakumar NK, Bhatnagar R, Bandyopadhyay A (2013) Molecular characterization of nucleopolyhedroviral of three lepidopteran pests using late expression factor-8 gene. Indian Journal of Virology. 24:59-65.
- Jalali SK, Shivalingaswamy TM, Jose J, Bhatnagar R (2012) Virus research Newsletter. Diagnosis of baculoviral isolates in India and synthetic miRNA for larvicidal activity. Virus Research News. 1(1):4-5.

Project title: Regulation of fatty acid synthesis by RNA interference in pig

Project Code	**:**	2013
Duration of the project	**:**	January 2011 – March 2016
PI Name	**:**	Dr. Sujoy Kumar Dhara
CCPI Name	**:**	Dr. Soumen Naskar
Lead Centre	**:**	ICAR-IVRI, Izatnagar
Cooperating centre	**:**	ICAR-NRCP, Rani, Guwahati

Objectives:

- To express and screen RNAi constructs against *ELOVL6* and *SCD1* genes in cell lines
- To establish induced pluripotency stem (iPS) cells from Pig fibroblasts/ mesenchymal stem cells and overexpress RNAi constructs in pig iPS cells
- To produce Chimeric pig and evaluate of efficiency of RNAi approach

Achievements:

a) Publications:

- Santra L, Gupta S, Kannan S, Singh AK, Gandham RK, Naskar S, Ghosh J, Dhara SK (2017) Long bones, a slaughterhouse by-product, may serve as an excellent source for mesenchymal stem cells. Indian Journal of Animal Sciences 87 (1): 53 –58.
- Singh AK, Naskar S, Saikia B, Vashi Y, Gupta S, Banik S, Tamuli MK, Pande V, Sarma DK, Dhara SK (2017) Effect of testicular tissue lysate on developmental competence of porcine oocytes matured and fertilized *in vitro*. Reproduction in Domestic Animals. 52(2): 183-188, https://doi.org/10.1111/rda.12875.
- Santra L, Gupta S, Singh AK, Mahawar M, Gandham RK, Dhara SK (2017) RNAi Mediated Transgenesis for Improving Animal Produce. Asian Journal of Animal and Veterinary Advances. 12: 123-131. DOI: 10.3923/ajava.2017.123.13.
- Naskar S, Borah S, Vashi Y, Thomas R, Sarma DK, Goswami J, Dhara SK (2016) Steroid and metabolic hormonal profile of porcine serum vis-à-vis ovarian follicular fluid. Veterinary World. 9(11):1320-1323. doi: 10.14202/vetworld.2016.1320-1323.
- Naskar S, Borah S, Vashi Y, Thomas R, Dhara SK, Banik S (2015) Evaluation of Pig Rearing Farmers of North East India as Prospective Breeder: A Retrospective Analysis. Indian Journal of Animal Research. 49 (1):118-121. DOI: 10.5958/0976-0555.2015.00025.4.
- Santra L, Gupta S, Singh AK, Sahu AR, Gandham RK, Naskar S, Maity SK, Ghosh J, Dhara SK (2015) A Comparative Analysis of Invasive and Non-Invasive Method of Bone Marrow Stromal Cell Isolation. Asian Journal of Animal and Veterinary Advances. 10 (10):549-555.

- Naskar S, Mandal GP, Borah S, Vashi Y, Thomas R, Dhara SK (2014) Evaluation of fatty acid profile in subcutaneous adipose tissue of indigenous and crossbred pigs. Indian Journal of Animal Science. 84 (1): 88–90.

- Naskar S, Vashi Y, Dhara SK, Banik S, Borah S (2014) Genetic variation at alpha-1-fucosyltransferase (FUT1) and leptin (LEP) gene in indigenous pigs and their association with economic traits. Indian Veterinary Journal 91(7):14-17.

Project title: RNAi mediated comparative functional analysis of immune response genes in ruminants and fish against *Mycobacterium avium ssp. paratuberculosis* and *M. Fortuitum*

Project Code	:	2014
Duration of the project	:	January 2011– March 2015
PI Name	:	Dr. Abhijit Mitra
CCPI Names	:	Dr. Shibnath Mazumdar
	:	Dr. Dhirendra Singh
Lead Centre	:	ICAR-IVRI, Izatnagar
Cooperating centres	:	Delhi University (DU), Delhi
	:	ICAR-CSWRI, Avikanagar

Objectives:

- To develop experimental models for studying the comparative innate immune response against *Mycobacterium fortuitum* and *M. a. paratuberculosis* in ruminants and fish
- To identify important immune-response genes associated with tolerance and susceptibility to *Mycobacterium fortuitum* and *M. a. paratuberculosis* and study their comparative functional analysis through RNAi silencing in ruminants and fish.

Achievements:

a) Publications:

- Sharma D, Golla N, Singh D, Onteru SK (2018). A highly efficient method for extracting next-generation sequencing quality RNA from adipose tissue of recalcitrant animal species. Journal of Cellular Physiology. 233(3):1971-1974. https://doi.org/10.1002/jcp.25951.

Project title: Phenomics of moisture deficit and low temperature stress tolerance in rice

Project Code	:	2015
Duration of the project	:	February 2011 – March 2016
PI Name	:	Dr. Viswanathan Chinnusamy
CCPI Names	:	Dr. P.K. Mondal
	:	Dr. S. Chaudhury
	:	Dr. J. P. Khurana
	:	Dr. S.K.Dash
	:	Dr. G. Chandel
	:	Dr. Wricha Tyagi
	:	Dr. A. Pattanaik
	:	Dr. Sudeep Marwaha
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centres	:	ICAR-NRCPB, New Delhi
	:	IIT, Delhi
	:	University of Delhi (DU), Delhi
	:	ICAR-CRRI, Cuttack
	:	ICAR-IGKV, Raipur
	:	CAU, Imphal
	:	ICAR-NEHR, Barapani
	:	ICAR-IASRI, New Delhi

Objectives:

- Establishment of a medium capacity high precision Plant Phenomics Facility and standardization of operation.
- Precision phenotyping of a contrasting set of rice germplasm for soil moisture deficit and low temperature stress tolerance and creation of phenome database.
- Identification of the role of candidate genes in moisture deficit and low temperature stress tolerance
- Human resource development in the area of Plant Phenomics
- A set of functionally validated genes for use in development of moisture deficit and low temperature stress tolerant crops. 5. Trained human resource able to use and research in to non-destructive high-throughput precision phenotyping of plants for stress tolerance.

Achievements:

a) Publications:

- Chandel G, Dubey M, Meena R (2013) Differential expression of heat shock proteins and heat stress transcription factor genes in rice exposed to different levels of heat stress. Journal of Plant Biochemistry and Biotechnology 22:277-285. https://doi.org/10.1007/s13562-012-0156-8

Project title: Unravelling biochemical and molecular basis of bacterial and fungal endo-symbiosis for management of abiotic stresses in plants

Project Code	**:**	2016
Duration of the project	**:**	June 2011 – May 2016
PI Name	**:**	Dr. K. K. Pal
CCPI Names	**:**	Dr. Ajit Varma
	:	Dr. Devidayal
Lead Centre	**:**	ICAR-DGR, Junagarh
Cooperating centres	**:**	Amity University, Noida
	:	ICAR-CAZRI, Jodhpur

Objectives:

- To identify the role of endosymbionts in imparting moisture, salinity and high temperature tolerance to groundnut and pearl millet in arid and semi-arid areas
- To understand the physiological, biochemical and molecular bases of imparting tolerance to abiotic stresses by endosymbiotic associations
- To validate the role of endosymbiotic associations in alleviating abiotic stresses in groundnut and pearl millet under field conditions

Achievements:

a) Publications:

- Mishra M, Prasad R, Varma A (2015) Endophytic Fungi: Biodiversity and Functions. International Journal of Pharma and Bio Sciences. 6(1):18–36.
- Chadha N, Mishra M, Bandyopadhyay P, Agarwal A, Prasad R, Varma A (2014) Root endophytic fungi: Research update. Journal of Biology and Life Science. 5(2):2157-6076.
- Chadha N, Mishra M, Prasad R, Varma A (2014) Protocol for production of the beneficial fungus *Piriformospora indica* for field applications. Journal of Endocytobiosis and Cell Research. 25:42-46.
- Mishra M, Chadha N, Kumar V, Prasad R, Varma A (2014) Root endophytic fungi from two extreme geographical regions of India. Journal of Endocytobiosis and Cell Research. 25:20-26.
- Mishra M, Prasad R, Varma A (2014) Rootonic with Bio-zinc to accelerate *Pennisetum glaucum* seed germination and plant growth. International Journal of Plant Animal and Environmental Sciences 4(3):2014.

Project title: Improvement in Cotton Fabric Quality by Plasma Nano-technology: An Eco-Friendly Approach

Project Code	**:**	2017
Duration of the project	**:**	June 2011 – May 2014
PI Name	**:**	Dr. Kartick Kumar Samanta
CCPI Name	**:**	Dr. Amish G Joshi
Lead Centre	**:**	ICAR-CIRCOT, Mumbai
Cooperating centre	**:**	NPL, New Delhi

Objectives:

- Design, fabrication and development of atmospheric pressure glow cold plasma reactor
- Investigate the effect of different plasma parameters on generation and stabilization of atmospheric pressure glow plasma
- Investigate the effect of plasma treatment in the improvement of colour value of cotton and cotton-polyester blended textiles
- Study the generation of plasma in the presence of hydrocarbon/fluorocarbon precursor and plasma polymerization to impart hydrophobic to super-hydrophobic functionality in textile
- Investigate the effect of plasma treatment in improving of interfacial strength of the natural fibre composite

Achievements:

a) Publications:

- Samanta KK, Gayatri TN, Saxena S, Basak S, Chattopadhyay SK, Arputharaj A, Prasad V (2016) Hydrophobic Functionalization of Cellulosic Substrates using Atmospheric Pressure Plasma, Cellulose Chemistry and Technology 50 (7-8):745-754.
- Samanta KK, Patil PG, Saxena S, Arputharaj A, Basak S Gayatri TN (2015) Value Added Nano-finishing of Cotton Textile using Water-free Plasma Technology. Cotton Research Journal. 7 (1): 83-92.
- Samanta KK, Gayatri TN, Saxena S, Basak S, Chattopadhyay SK, Arputharaj A (2014) Effect of Plasma Treatment on Physico-chemical Properties of Cotton. International Journal of Engineering Research & Technology 3 (03):2467-2477.
- Teli MD, Samanta KK, Pandit P, Basak S, Chattopadhyay SK (2014) Low Temperature Dyeing of Silk using Atmospheric Plasma Treatment. Indian Journal of Natural Fibres 1(1):1-7.
- Samanta KK, Gayatri TN, Shaikh AH, Saxena S, Arputharaj A, Basak S, Chattopadhyay SK (2013) Effect of Helium-Oxygen Plasma Treatment on Physical and Chemical Properties of Cotton Textile. International Journal of Bioresource Science. 1(1):57-63.

Project title: Genomics for augmenting fibre quality improvement in jute

Project Code	**:**	2018
Duration of the project	**:**	June 2011- May 2016
PI Name	**:**	Dr. D. Sarkar
CCPI Name	**:**	Dr. N.K. Singh
Lead Centre	**:**	ICAR-CRIJAF, Barrackpore
Cooperating centre	**:**	ICAR-NRCPB, New Delhi

Objectives:

- To develop a classical genetic linkage map of the tossa jute (*Corchorus olitorius* L.)
- To construct ultra-high density (UHD) molecular maps of the tossa jute (*Corchorus olitorius* L.)
- To dissect the complex gene effects underlying bast-fibre quality traits in the tossa (*C. olitorius* L.) jute by SNP-based genome-wide association (LD) mapping
- Capability to dissect the genetic architecture of the complex bast fibre quality traits in allied fibre crop species, such as HC mesta (kenaf), HS mesta (roselle), flax, sunhemp, etc. by identifying the synteny (mapping).
- Identification of genes underlying fibre quality traits in mesta (kenaf and roselle) by identifying the orthologous regions in the dark jute genome.

Achievements:

a) Publications:

- Sarkar D, Kundu A, Das D, Chakraborty A, Mandal NA, Satya P, Karmakar PG, Kar CS, Mitra J, Singh NK (2019) Resolving population structure and genetic differentiation associated with RAD-SNP loci under selection in tossa jute (*Corchorus olitorius* L.). Molecular Genetics and Genomics. 294(2):479-492. https://doi.org/10.1007/s00438-018-1526-2.
- Chakraborty A, Sarkar D, Satya P, Karmakar PG, Singh NK (2015) Pathways associated with lignin biosynthesis in lignomaniac jute fibres. Molecular Genetics and Genomics. 290:1523-1542. https://doi.org/10.1007/s00438-015-1013-y.
- Kundu A, Chakraborty A, Mandal NA, Das D, Karmakar PG, Singh NK, Sarkar D (2015) A restriction-site-associated DNA (RAD) linkage map, comparative genomics and identification of QTL for histological fibre content coincident with those for retted bast fibre yield and its major components in jute (*Corchorus olitorius* L., Malvaceae s.l.). Molecular Breeding. 35:19. doi:10.1007/s11032-015-0249-x.
- Kundu A, Sarkar D, Mandal NA, Sinha MK, Mahapatra BS (2012) A secondary phloic (bast) fibre-shy (bfs) mutant of dark jute (*Corchorus olitorius* L.) develops lignified fibre cells but is defective in cambial activity. Plant Growth Regulation. 67:45-55. doi:10.1007/s10725-012-9660-z

Project title: Genetic manipulation-based enhancement of microbial phosphate and nitrate remediation for waste water treatment

Project Code	:	2019
Duration of the project	:	June 2011 – May 2014
PI Name	:	Dr. Shaon Ray Chaudhuri
CCPI Names	:	Dr. Arunava Goswami
	:	Dr. Krishna Ray
Lead Centre	:	WBUT, Kolkata
Cooperating centres	:	ISI, Kolkata
	:	WBSUB, West Bengal

Objectives:

- Identification as well as characterization of efficient nitrate and phosphate accumulating microbes for scavenging nitrogenous and phosphatic contaminants from urban waste water and optimization of the efficiency in packed bed reactors
- Nanoparticle mediated gene transfer for enhancing the efficiency of nitrate and phosphate accumulation of the microbes
- Utilizing the bacteria with accumulated phosphate and nitrate as biofertilizer for plant growth promotion for agriculture

Achievements:

a) Publications:

- Chandra S, Patra P, Pathan S, Roy S, Mitra S, Layek A, Bhar R, Pramanik P, Goswami A (2013) Luminescent S-doped carbon dots: An emergent architecture for multimodal applications, Journal of Materials Chemistry1: 2375-2382. doi: 10.1039/C3TB00583F.
- Debroy S, Bhattacharjee A, Thakur AR, Raychaudhuri S (2013) Draft Genome of a nitrate and phosphate accumulating Bacillus sp MCC0008. Genome Announcement. 1(1): 189-12. doi: 10.1128/genomeA.00189-12.
- Ray K, Mukherjee C, Ghosh AN (2013) A Way to Curb Phosphorus Toxicity in the Environment: Use of Polyphosphate Reservoir of Cyanobacteria and Microalga as a Safe Alternative Phosphorus Biofertilizer for Indian Agriculture. Environmental Science & Technolog. 47(20):11378−11379. https://doi.org/10.1021/es403057c.
- Debroy S, Das S, Ghosh S, Banerjee S, Chatterjee D, Bhattacharjee A, Mukherjee I, Raychaudhuri S (2012) Isolation of Nitrate and Phosphate Removing Bacteria from Various Environmental Sites. Journal of Biological Sciences. 12(2):62-71. DOI: 10.3844/ojbsci.2012.62.71.
- Mitra S, Chandra S, Patra P, Pramanik P, Goswami A (2011) Novel fluorescent matrix embedded carbon quantum dots for the production of stable gold and silver hydrosols. Journal of Materials Chemistry. 21:17638-17641. doi: 10.1039/ c1jm13858h.

- Chandra S, Mitra S, Laha D, Bag S, Das P, Goswami A, Pramanik P (2011) Fabrication of multi structure nanocarbons from carbon xerogel: a unique scaffold towards bioimaging. Chemical Communications. 47: 8587-8589. doi: 10.1039/C1CC11848J.

b) Patent:

- Microbial Consortium for nitrate and phosphate sequestration for environmental sustenance (Patent file no. 1179/KOL/2013).

- Method of Improving Elemental and Nutritional Content of Plant Seeds Using Bacillus Strain MCC0008 as a Biofertilizer (Patent file no. 1328/KOL/2013).

Project title: Molecular characterization and validation of fiber strength genes with fiber specific promoter for improvement in cotton

Project Code	**:**	2020
Duration of the project	**:**	August 2011– July 2016
PI Name	**:**	Dr. Balasubramani
CCPI Name	**:**	1
Lead Centre	**:**	ICAR-CICR, Nagpur
Cooperating centre	**:**	UAS, Dharwad

Objectives:

- To characterize the cotton fibre developmental major genes that are responsible for high strength by taking advantage initially from already known information and then building the standard strategy for plant molecular biological characterization of the molecular details of its function

- To identify and functionally characterize the promoter elements that are of fibre-specific expression genes that function during secondary wall synthesis

Achievements:

a) Publications:

- Balasubramani G, Raghavendra KP, Amudha J, Patil BR, Waghmare VN (2020) Expression analysis of genes associated with secondary cell wall biosynthesis in cotton (*Gossypium hirsutum* L.) Plant cell biotechnology and molecular biology, 21: 103.

- Joshi V, Patil BR (2018) Genetic variability and heritability study in f2 population for Yield, yield attributes and fibre quality traits in cotton (*Gossypium hirsutum* L.), Journal of Pharmacognosy and phytochemistry 7(4): 2816-2818

- Lokeshkumar BM, Patil BR (2018). Estimation of genetic variability parameters in f2 population of gossypium hirsutum l. For yield, yield attributes and fibre quality trait, Int. J. Curr. Microbiol.App.Sci 7(9): 360-367.

Project title: Mitigating abiotic stresses and enhancing resource-use efficiency in pulses in rice fallows through innovative resource conservation practices

Project Code	**:**	2021
Duration of the project	**:**	June 2011– May 2016
PI Name	**:**	Dr. S.S. Singh
CCPI Names	**:**	Dr. R.N.Singh
	:	Dr. P.K. Bandyopadhyay
	:	Dr. P. Parasuraman
	:	Dr. Anup Das
Lead Centre	**:**	ICAR-IIPR, Kanpur
Cooperating centres	**:**	ICAR-IGKV, Raipur
	:	BCKV, Nadia
	:	TRRI, Adhuturai
	:	ICAR-RC-NEH, Meghalaya

Objectives:

- To understand the rice-pulse relay cropping as a conservation agriculture system and mitigate moisture stress faced by the pulse crop in the system.
- To evaluate the role of use of rice stubbles and zero-tillage in the rice fallow-pulse system for conserving soil moisture and enhance soil physico-chemical characteristics.

Achievements:

- Achieved efficient soil moisture conservation and residue management, leading to drought mitigation and improved soil health, while also enhancing pulse productivity, sustainability, and farm income through rice relay cropping and expanded cultivation area.

Project title: Capture and removal of ammonia from fish processing waste water using Archaea

Project Code	**:**	2022
Duration of the project	**:**	June 2011 – May 2016
PI Name	**:**	Dr. B.B. Nayak
CCPI Name	**:**	Dr. S.K. Girisha
Lead Centre	**:**	ICAR-CIFE, Mumbai
Cooperating centre	**:**	CoF, Mangalore

Objectives:

- To identify archaebacterial members in the toxic, suboxic and anoxic stages of seafood processing effluent treatment plant
- To study optimal physiological parameters for mass production of the identified archaeal strains
- To enrich archaeal strains and apply them for efficient effluent treatment
- To harvest of the archaeal biomass after effluent treatment for use as biofertiliser

Achievements:

a) Publications:

- Markande AR, Kapagunta C, Patil PS, Nayak BB (2016) Effective remediation of fish processing waste using mixed culture biofilms capable of simultaneous nitrification and denitrification. Journal of Basic Microbiology. 56:1 5. https://doi.org/10.1002/jobm.201500723.
- Reddy AD, Subrahmanyam G, Rajeswari V, Nayak BB, Karunasagar I (2014) Ammonia oxidizing microbes and physiochemical parameters of effluent treatment plants of fish processing industries. Frontier Journal of Veterinary and Animal Sciences. 3(2): 188-193.
- Reddy D, Subrahmanyam G, Kallappa GS, Karunasagar I, Indrani K (2014) Detection of ammonia-oxidising archaea in fish processing effluent treatment plants. Indian J. Microbiol. 54(4):434–438, DOI 10.1007/s12088-014-0484-6.

Project title: Bioremediation of agrochemicals and heavy metals present in Yamuna and drainage water used for irrigation in urban and peri-urban agricultural areas

Project Code	**:**	2023
Duration of the project	**:**	June 2012 – May 2016
PI Name	**:**	Dr. Dileep Kumar Singh
CCPI Names	**:**	Dr. Anushree Malik
	:	Dr. (Ms.) Neelam Patel
Lead Centre	**:**	University of Delhi (DU), New Delhi
Cooperating centres	**:**	IIT, Delhi
	:	ICAR-IARI, New Delhi

Objectives:

- Estimation of toxic heavy metals (Cu, Cd, Ni, Zn, Pb and Cr) and organochlorine pesticides (DDT, γ- lindane, endosulfan and methoxychlor) in water with high dynamic flux of contaminants, soil and crops in urban and peri-urban agricultural areas in and around Delhi

- Development of techniques for bioremediation of water and soil using non-pathogenic microbes and microbial bioprocesses, and safe disposal of remedial biomass

- Development of processes for easy and long-term storage of microbes and their easy delivery to contaminated sites (s)

- Development of a pilot scale up-scalable bioreactor based on identified microbes and microbial bioprocesses for decontamination of water for agricultural usage and test the effectiveness of decontaminated water in reducing the toxicity to crops in small experimental plots

Achievements:

a) Publications:

- Bhattacharjee A, Khurana JP, Jain M (2016) Characterisation of rice homeobox genes, OsHOX22 and OsHOX24, and over-expression of OsHOX24 in transgenic Arabidopsis suggest their role in abiotic stress response. Frontiers in Plant Science. 7:627 doi: 10.3389/fpls.2016.00627.

- Bhattacharya A, Dey P, Gola D, Mishra A, Malik A, Patel N (2015) Assessment of Yamuna and associated drains used for irrigation in rural and peri-urban settings of Delhi NCR. Environmental monitoring and assessment. 187(1): 1-13. doi: 10.1007/s10661-014-4146-2.

- Pal S, Patel N, Malik A, Singh DK (2015) Heavy metal health risk assessment and microbial menaces via dietary intake of vegetables collected from Delhi and national capital regions peri urban area, India. Journal of Food, Agriculture & Environment 13 (2):82-88.

- Kaushik P, Mishra A, Malik A, Sharma S (2015) Production and shelf-life evaluation of storable myco-granules for multiple environmental applications. International

Biodeterioration & Biodegradation. 100:70-78. https://doi.org/10.1016/j.ibiod.2015.02.011.

- Madhu, Singh DK (2014) Biodegradation of Endosulfan in broth medium and soil microcosm by Klebsiella sp. Bull. Of Environ. Contam. Toxicol. 92:237–242 DOI: 10.1007/s00128-013-1168-3.

- Singh M, Singh DK (2014) Endosulfan induced alteration in bacterial protein profile and RNA yield of Klebsiella sp. M3, *Achromobacter* sp. M6, and *Rhodococcus* sp. M2. Journal of Hazardous Materials. 265: 233-241. https://doi.org/10.1016/j.jhazmat.2013.11.061.

- Mishra A, Malik A (2014) Metal and dye removal using fungal consortium from mixed waste stream: Optimisation and validation. Ecological Engineering. 69:226-231. https://doi.org/10.1016/j.ecoleng.2014.04.007.

- Mishra A, Malik A (2014) Novel fungal consortium for bioremediation of metals and dyes from mixed waste stream. Bioresource Technology. 171:217-226. DOI: 10.1016/j.biortech.2014.08.047.

- Mishra A, Malik A (2013) Recent advances in microbial metal bioaccumulation. Critical Reviews in Environmental Science and Technology. 43:1162-1222. https://doi.org/10.1080/10934529.2011.627044.

- Mishra A, Malik A. (2012) Simultaneous bioaccumulation of multiple metals from electroplating effluent using *Aspergillus lentulus*. Water Research. 46(16):4991-4998. doi: 10.1016/j.watres.2012.06.035.

Project title: Crop Simulation Studies to Understand the Effect of Moisture and Temperature Stress on Growth and Yield of Wheat

Project Code	:	2024
Duration of the project	:	June 2012- May 2015
PI Name	:	Dr. P. Krishnan
CCPI Names	:	Dr. R.K. Sharma
	:	Dr. Jagdev Sharma
	:	Dr. Sanjay Borkar
	:	Dr. (Mrs.) Prachi Misra Sahoo
Lead Centre	:	ICAR-IARI, New Delhi
Cooperating centres	:	ICAR-IIWBR, Karnal
	:	ICAR-NCRG,Pune
	:	Shivrai Technologies Pvt. Ltd. Pune
	:	ICAR-ISARI, New Delhi

Objectives:

- To characterise the effect of nature and duration of stress due to moisture deficit and high temperature stress at various stages on the growth and yield of the wheat crop
- To compare the efficiency of the models-INFOCROP-Wheat, DSSAT-Wheat and APSIM-Wheat in simulating the effect of moisture deficit and high temperature stress
- To identify the limitations of each model and adapt the best crop simulation model to describe the stress effect on wheat crop growth and yield

Achievements:

a) Publications:

- Tyagi SK, Singh R, Krishnan P, Verma R (2014) Variations in Meteorological Condition resulted decline in wheat yield in North-West Indo-Gangetic Plains. Journal of Agricultural Physics. 13(2):175-181.
- Varshney RK, Mohan SM, Gaur PM, Gangarao NVPR, Pandey MK, Bohra A, Sawargaonkar S, Kimurto PK, Janila P, Saxena KB, Fikre A, Sharma M, Pratap A, Tripathi S, Datta SK, Chaturvedi G, Anuradha A, Babbar RG, Chaudhary MB, Mhase CH, Bharadwaj S, Mannur DM, Harer PN, Guo B, Liang X, Nadarajan N, Gowda CLL (2013). Achievements and prospects of genomics-assisted breeding in three legume crops of the semi-arid tropics. Biotechnology Advances. 31:1120–1134. DOI: 10.1016/j.biotechadv.2013.01.001
- Varshney RK, Bertioli DJ, Moretzsohn MC, Vadez V, Krishnamurty L, Aruna R, Nigam SN, Ravi K, He G, Knapp SJ, Hoisington, DA (2009) The first SSR based genetic linkage map for cultivated groundnut (*Arachis hypogaea* L.). Theoretical and Applied Genetics. 118(4):729–739. DOI: 10.1007/s00122-008-0933-x
- Varshney RK, Close TJ, Singh NK, Hoisington DA, Cook DR (2009) Orphan legume crops enter the genomics era! Current Opinion in Plant Biology. 12(2):202-210. DOI: 10.1016/j.pbi.2008.12.004 .

- Varshney RK, Hiremath PJ, Lekha P, Kashiwagi U, Balaji J, Deokar AA, Vadez V, Xiao Y, Srinivasan R, Gaur PM, Siddique KHM, Town CD, Hoisington DA (2009) A Comprehensive resource of drought and salinity responsive ESTs for gene discovery and marker development in chickpea (*Cicer arietinum* L.). B M C Genomics. 10:523.

- Varshney RK, Mahendar T, Aruna R, Nigam SN, Vadez V, Hoisington DA (2009) High level of natural variation in a groundnut (*Arachis hypogaea* L.) germplasm collection assayed by selected informative SSR markers. Plant Breed. 128(5):486–494. https://doi.org/10.1111/j.1439-0523.2009.01638.x

Project title: Decision Support System for Enhancing Water Productivity of Irrigated Rice-Wheat Cropping System

Project Code	**:**	2025
Duration of the project	**:**	June 2012- May 2016
PI Name	**:**	Dr. A. Sarangi
CCPI Name	**:**	Dr. Ranu Rani Sethi
Lead Centre	**:**	ICAR-IARI, New Delhi
Cooperating centre	**:**	ICAR-IIWM, Bhubaneshwar

Objectives:

- Acquisition, generation and synthesis of data pertaining to soil-water-plant interactions and carbon economy in both the conventional and conservation agriculture for the rice-wheat cropping system under irrigated conditions.

- Development of crop water productivity functions and estimation of carbon economy under different land, crop and water management situations in rice-wheat cropping systems.

- Calibration and validation of crop models to generate water productivity and carbon economy under variable input use scenarios in present and simulated future climatic variables and development of data integration protocols of the Decision Support System (DSS).

- Development and validation of a Sustainable Water Productivity Decision Support System (SWAPDSS-RW) for enhancing water productivity in Rice-Wheat cropping system under irrigated environment.

Achievements:

a) Publications:

- Sethi RR, Mandal KG, Sarangi A, Behera A, Aggarwal R, Brar AS, Sahu AS, Bandyopadhyay KK, Ambast SK (2016) Simulating paddy crop response to irrigation using FAO Aqua Crop model: a case study. Journal of Food, Agriculture & Environment 14 (2): 99–103.

- Sethi RR, Sahu AS, Kaledhonkar MJ, Sarangi A, Rani P, Kumar A, Mandal KG (2014) Quantitative determination of rice cultivated areas using geospatial techniques. IOSR Journal of Environmental Science, Toxicology and Food Technology. 8(4):76-81.

- Kumar D, Sarangi A, Bandyopadhyaya, Singh DK, Kumar L, Singh N (2013) Performance evaluation of rice cultivation methods under different varieties and irrigation regimes on water productivity. International Journal of Agriculture and Food Science Technology. 4(7):659-660.

Project title: Decision Support System for enhancing productivity of grapes under moisture and temperature stress conditions

Project Code	**:**	2026
Duration of the project	**:**	June 2012- May 2016
PI Name	**:**	Dr. A.K. Upadhyay
CCPI Names	**:**	Dr. S. Naresh Kumar
	:	Dr. Sanjay Borkar
Lead Centre	**:**	ICAR-NRC for Grapes, Pune
Cooperating centres	**:**	ICAR-IARI, New Delhi
	:	Shivrai Technologies Pvt. Ltd. (STPL), Pune

Objectives:

- To study the effect of moisture and temperature stress on growth and yield of grapes to generate data library required for crop growth model and decision support system (DSS).
- To initiate model development for grape.
- To develop decision support system for improving crop productivity under moisture and temperature stress conditions

Achievements:

- Developed an agro-informatics database, crop simulation model, and a web/mobile-based Decision Support System to enhance grape productivity under moisture and heat stress.