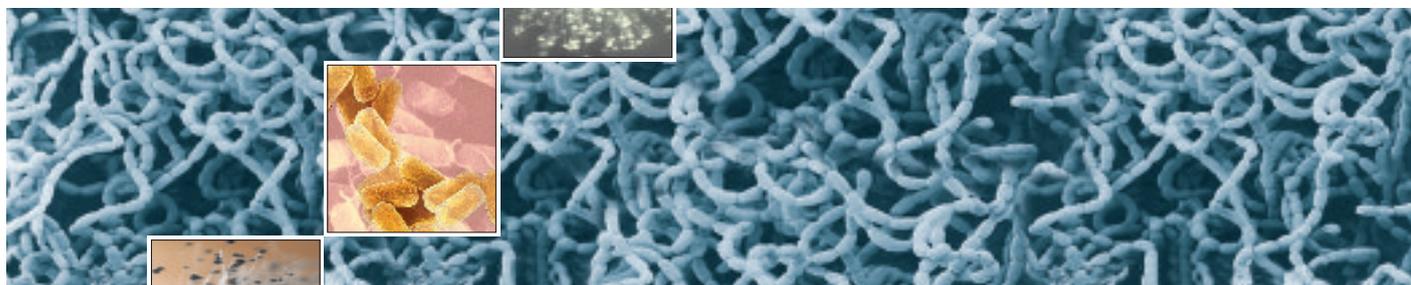


## NATIONAL BUREAU OF AGRICULTURALLY IMPORTANT MICROORGANISMS

### राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो

The Bureau is one of its kinds not only in India but whole in South East Asia as it focuses on the conservation and preservation of microbial diversity of Agriculturally Important Microorganisms



The unique genetic and biosynthetic capabilities of microorganisms has made them likely candidates for solving particularly difficult problems in the agriculture. For many years, soil microbiologists and microbial ecologists have tended to differentiate soil microorganisms as beneficial or harmful according to their functions and how they affect soil quality, plant growth and yield, and plant health. Despite the well-recognized importance of microorganisms, only less than 5% of the world's microorganisms are on record. In India, very limited and isolated efforts were made for tapping of microbial diversity of AIMS, their identification and preservation for different applications in agriculture and food sectors. The importance of microbial diversity in India was also realized, as a result of which, the Indian Council of Agricultural Research established National Bureau of Agriculturally Important Microorganisms (NBAIM) for exploration, evaluation and conservation of agriculturally important microorganisms (AIMs). The Bureau aims to excel in isolation and utilization of genes for conventional and unforeseen products of high economics and value in environment and agriculture. It is expected that NBAIM continues to fulfil its mandate to make Indian agriculture locally, regionally and globally competitive.

#### OBJECTIVES

- Exploration and Collection of Agriculturally Important Microorganisms (AIMs)
- Identification, characterization and documentation of AIMs
- Conservation, maintenance and utilization of AIMs
- Surveillance of indigenous/exotic AIMs
- Microbial diversity and systematics
- Human resource development

- ◆ The National Bureau of Agriculturally Important Microorganisms (NBAIM) was established in the IX Plan in the year 2001. The Bureau started functioning at Old NBPGR Building, New Delhi.
- ◆ The NBAIM shifted on June 1, 2004 to Kusmaur, Mau Nath Bhanjan, Uttar Pradesh.
- ◆ The Bureau draws the guidelines from the Crop Sciences Division of Indian Council of Agricultural Research (ICAR), Institute Management Committee (IMC), Research Advisory Committee (RAC), Germplasm Advisory Committee (GAC) and Institute Technical Committee (ITC).

#### INFRASTRUCTURE

The NBAIM has well-equipped research laboratories, Central instrumentation facility, separate Fungal and Bacterial labs, Molecular Biology lab, Genomics unit with ultramodern instrumentation, Lyophilization unit, Culture collection facility, including cyanobacterial culture unit, newly developed Microbial Genome Resource Repository (MGRR), administration block, scientists' lobby, library, Conference hall and miniconference rooms with state-of-the-art audio-visual equipments and Agricultural Research Information Service (ARIS) cell etc.

Looking at the prospects of the most modern research trends including microbial ecology, genomics, bioprospecting, gene-mining and bio-product development, the Bureau has taken a lead in research and development in these areas, and has acquired genome sequencing units, DNA fingerprinting unit, Shotgun Cloning Lab, Sequencing Laboratory and Genoinformatics centre, Confocal and SEM microscopy, HPLC and GC units and a separate unit for computerized and digital documentation. A Local Area Network and Website of NBAIM have been created, and all the units of the NBAIM are linked with various ICAR institutes and research organizations all over the country.



### National Agriculturally Important Microbial Culture Collection (NAIMCC)

- Biodiversity Authority of India recognizes the NBAIM culture collection as the National Repository. The bureau follows strict quality control and biosafety standards in the culture collection as well as in laboratories. Various types of microorganism including filamentous fungi, bacteria, actinomycetes and yeasts are maintained under the long-term preservation. Each culture is preserved by two methods according to the type of microorganism. Fungi are preserved under mineral oil and by freeze-drying/ lyophilization. The bacteria, actinomycetes and yeast are preserved by freeze-drying/ lyophilization and in glycerol at  $-80^{\circ}\text{C}$ . For short-term storage, the cultures are maintained on the slants in appropriate medium at  $4^{\circ}\text{C}$ .
- The culture collection unit preserves and conserves microbial diversity of the country. The collection has wide diversity of fungi, including more than 700 species belonging to 250 genera. Likewise the bacterial collection has more than 100 species belonging to 35 genera.
- The NAIMCC has developed state-of-the art short-term conservation of AIMS based on culture and mineral oil techniques. Using these

A software developed by the bureau lists out characteristics of AIMS in terms of origin, ecology, morphology, physiology and biochemical parameters, pathogenic/nonpathogenic nature, detailed available information about specific properties and molecular tools used for the characterization of AIMS.

techniques, AIMS can be conserved for 5-10 years.

- The NAIMCC has high capacity lyophilizers for long term preservation of AIMS (20-25 years) under vacuum at  $-60^{\circ}\text{C}$ .
- The NAIMCC exchanges cultures on MOU basis with different National Institutes/ Organizations.
- The NAIMCC has conserved bacterial isolates reported from extreme environments for the first time in India such as *Bacillus humi*, *B. drentensis*, *B. asahii*, *B. cohnii*, *B. pumilus*, *B. niacini*, *B. djibelorensis*, *B. fumarioli*, *B. senequalensis*, *B. oleronius* and *B. sporothermodurans*, *Halomonas sp.*, *Marinobacter alkaliphilus*, *M. hydrocarbonoelasticus*, *Halomonas variabilis*, *Alteromonadales bacterium*, *Nitrincola lacisaponensis*, *Bacillus thuringiensis*, *Chromohalobacter salexigens*, *Marinobacter aquaeolei*.

### DNA Fingerprinting Unit

The NBAIM has fully operational DNA fingerprinting unit; well equipped with highly advanced instruments routinely used for DNA profiling and fingerprinting. Unit contains rooms for Electrophoresis, Gel Documentation, PCR (Amplicon room), and DNA sequencing section. It contains Pyro DNA Sequencer (454 Life Sciences), DNA sequencer (ABI 3130 XL) and Real Time PCR. The bureau is also using metabolic genes and toxin genes to develop diagnostic DNA probes for some AIMS.

### SIGNIFICANT ACHIEVEMENTS

The NBAIM has collected thousands of Agriculturally Important Microorganisms (AIMs) (pathogenic and saprophytic) from local crop plants/survey of Indo-Gangetic plains/extreme environments. Surveys at following sites have been completed so far: Western Himalayas, warm subhumid and cold arideco- region; Western plains-Kachchh and part of Kathiawar peninsula, hot arid eco-region; Karnataka plateau (Rayalaseema), hot arid region with deep loamy and clayey mixed red and black soils (low to medium awc and lgp);



Northern plains (and central highlands) including Aravallis, hot semi-arid ecoregion; Central highlands (Malwa, Bundelkhand), Gujarat plain and Kathiawar peninsula, semi-arid eco-region; Deccan plateau, Eastern Ghats with hot semi-arid eco-region; Tamil Nadu uplands- hot semiarid eco-region; Northern plain- hot sub-humid (dry) eco-region; Moderately to gently sloping Chhattisgarh/Mahanadi basin, hot moist/dry subhumid transitional with deep loamy to clayey red and yellow soils (medium awc lgp); Eastern plateau (Chhottanagpur) and Eastern plain, hot subhumid (moist) eco-region; Assam and Bengal plain, hot subhumid to humid (inclusion of perhumid) ecoregion; Eastern coastal plains- hot subhumid to semiarid eco-region; Western coastal plains- hot humid eco-region Islands of Andaman-Nicobar and Lakshadweep, hot humid to per humid island ecoregion.

The bureau has developed several protocols based on morphological/physiological and molecular tools for identification and characterization of *Trichoderma*, *Fusarium*, *Bacillus*, *Pseudomonas*, *Azotobacter*, *Azospirillum*, *Streptomyces*, *Alternaria* and *Macrophomina*.

Greenhouse trials for some PGPR and biocontrol agents such as *Pseudomonas fluorescens* and *Trichoderma harzianum* are being performed.

#### MANDATE

To act as the nodal centre at the national level for acquisition and management of indigenous and exotic microbial genetic resources for food and agriculture, and to carry out related research and human resource development for sustainable growth of agriculture

#### VISION

◆ In a near future, the NBAIM will be one of the India's largest holders of microbial germplasm and a readily available source of AIMS for the researchers and industry. The "National Gene Bank" facility could also be offered on regional scale to store germplasm of AIMS of South Asian countries. Integration of new tools of biotechnology with microbial germplasm resource management may be further strengthened to enhance effectiveness of management and utilization strategies. Molecular characterization may be used for identification of the AIMS and enable rapid assessment of diversity. Using molecular markers, screening of large collections for specific traits may be done. NBAIM would assume leadership to train the specialized manpower in the area of R&D activities at regional, national and international levels. NBAIM will act as "Nodal Centre" for the registration of AIMS.



## Application of Microorganisms in Agriculture and Allied Sectors (AMAAS)

(No. of Projects - 81)

### Objectives

- Deciphering the structural and functional diversity of agriculturally important microorganisms and to develop microbial map of the country.
- Improving nutrient use efficiency through microbial interventions for sustainable crop production and maintenance of soil health.
- Characterization of plant growth promoting rhizobacteria and to develop bioconsortium for enhanced growth and yield of important crop plants.
- Formulation of microbe or microbe-based preparations for biocontrol of phytopathogens, insect pests and weeds.
- Development of microbe-based technologies for agrowaste management and biodegradation for sustainable crop production.
- Harnessing microbial activities for bioremediation of organic and inorganic environmental pollutants.
- Management of abiotic stresses using microorganisms.
- Development of microbe mediated processes for product development and value addition in agriculture.
- Unraveling microbial genomics for its utilization in agriculture and industry.
- Development of technologies for rapid microbial diagnostics.
- Human resource development in microbial conservation and utilization.

This project has 7 components: (i) Microbial diversity and identification; (ii) Nutrient management, PGPR and Biocontrol; (iii) Microbial management of agrowaste, bioremediation and microbes in post-harvest and processing (iv) Microbial management of abiotic stress; (v) Microbial genomics; (vi) Microbial Genomic Resource Repository; (vii) Human resource development



## Useful AIMS

The Bureau has a good collection of very useful microbes with fascinating properties of agricultural and industrial importance. Among these species of *Trichoderma*, *Arthrotrichum*, *Dactylaria*, *Rhizoctonia*, *Fusarium*, *Helminthosporium*, *Phytophthora*, *Cercospora*, *Colletotrichum*, *Pythium*, *Penicillium*, *Pestalotia*, *Phomopsis*, *Cryptococcus*, *Saccharomyces*, *Candida*, *Macrophomina*, *Peronospora*, *Aspergillus*, *Erysiphe*, *Sclerotium*, *Venturia*, *Curvularia*, Mycorrhizal fungi (*Glomus*), *Agaricus*, *Alternaria*, *Gliocladium*, *Verticillium*, *Claviceps*, *Uromyces*, *Melampsora*, *Albugo*, *Rhizobium*, *Azotobacter*, *Pseudomonas*; phosphate-solubilizing bacteria and fungi- *Catenaria anguillulae*, *Arthrotrichum oligospora*, *Rhizoctonia solani*, *Bacillus* spp.; cellulose-degrading bacteria- *Fibrobacteria succinogenes*, *Ruminococcus flavifaciens*, *R. albus*, *Clostridium lochheadii*, *Eubacteria cellulosa*; hemicellulose-degrading bacteria-*E. xylanophilum*, *Coprococcus eutactus*, *Treponema bryantii*; starch-degrading bacteria-*Streptococcus bovis*, *Ruminobacteria amylophilus*, *R. ruminicola*, *Succinimonas amylolytica*; sugar-utilizing bacteria- *Lactobacillus ruminis*, *L. vitulinus*; acid-utilizing bacteria-*Megasphaera elsedenii* (lactate), *Veillonella parvulata* (lactate), *Oxalobacter formigenes* (oxalate); protein-degrading bacteria -*Bacteroides amylophilus*, *Butyrivibrio fibrisolvens*, *Streptococcus bovis*; urea-degrading bacteria-*Bacteroides*, *Ruminococcus*, *Micrococcus*, *Streptococcus*, *Butyrivibrio*; nitrogen-fixing bacteria-*Clostridium pasteurianum*, *Bacillus macerans*, *Citrobacter freundii*; lipid-degrading bacteria-*Anaerovibro lipolytica*; methanogenic bacteria-*Methanobrevibacter ruminantium*, *Methanosarcina barkeri*; tannin-degrading bacteria-*S. caprinus* etc. are of paramount importance, and are being conserved and preserved

### Microbial genomics

The NBAIM is a Nodal Centre for complete genome sequencing of an agriculturally important bacterium *Mesorhizobium ciceri* Ca181.

It will be the first microorganism to be sequenced in the country. *Mesorhizobium ciceri* is highly specific and promising bacterial strain for chickpea with multiple plant growth promoting activities.

Genomic DNA library of *Mesorhizobium ciceri* has been prepared in pUC 19. A total of 2,000 clones have been sequenced and blast searched. Several genes



have been identified that can be further used in different studies.

### Microbial Genomic Resource Repository

This resource repository is in the process of establishment at the NBAIM, and it would carry out following:

- Collection of DNA materials from microorganisms and other relevant organisms, which result from various molecular genetics and genomics research programmes
- Acquisition of gene constructs from various sources
- Value-addition to genomic resources
- NBAIM is a consortium leader of the NAIP Project on "Diversity analysis of Bacillus and other predominant genera in extreme environments and their utilization in agriculture".
- The NBAIM is a consortium partner in the NAIP Mega Project on "Bioprospecting of genes and allele mining for abiotic stress tolerance".
- Consortium partner in the NAIP Mega Project on "Georeferenced Soil Information System for Land use Planning and Monitoring Soil and Land Quality for Agriculture"
- Characterization, validation and conservation of microbial genomic resources
- Production/multiplication and quality control for distribution
- Exchange of genomic resources under a material transfer agreement (MTA)
- Development of a user friendly web-based information system for microbial genomic resources

### INTERNATIONAL LINKAGES

The NBAIM is an affiliated member of the World Federation of the Culture Collection (WFCC).

The Bureau has linkages with International microbial resource centres covered under the umbrella of the WFCC and OCDE.

Under the World Bank-aided National Agricultural Technology Project, ICAR approved projects under the Bioscience Component with the ICAR-CABI Bioscience, UK.



## THRUST AREAS OF XI PLAN

- Characterization of AIMs and development of molecular diagnostic tools.
- Database of the collection on electronic format and short and long term conservation of AIMs
- Identification of AIMs for utilization as bio-fertilizers, bio-pesticides, growth promoting microorganisms, bio-indicators and for biodegradation, bioremediation, bio-composting.
- To conserve and characterize variable AIMs for their optimum utilization by the future generations. A better understanding of microbial diversity promises to provide array of new products and processes as well as a better awareness of microbial biosphere; the earth's life support system.
- Biosystematics of microbial isolates of Indian origin is urgently needed. The NBAIM is the only National body which can take lead in this matter and scientists and researchers from all over the country could get "identification and diagnostics" of AIMs.
- Development of The National Culture Collection Centre as per Budapest Treaty with the state-of-the-art facilities for identification and taxonomic studies of agriculturally important microorganisms. The NBAIM may act as a nodal centre for developing a "National Facility for the Identification of AIMs".
- The NBAIM will act as a nodal agency responsible for taking appropriate measures for the system-wide management of AIMs.
- Enhancing productivity of crop plants
- Deciphering functional diversity of bacteria with respect to abiotic stresses (soil salinity, drought, temperature) for use in agriculture.

### Trainings Organised by NBAIM

- Joint NBAIM – CABI (U.K) workshop on "Isolation, preservation and Conservation of AIMs and use of potential molecular tools for their identification" March 16–17, 2004.
- First in-house training on Isolation, Maintenance and Cryopreservation of AIMs by U.K.- CABI. September 4–9, 2004.
- Biochemical and Molecular Characterization of Agriculturally Important Microorganisms" April 22-29, 2005
- National training programme on "Microbial Diversity Analysis of Agriculturally Important Microorganisms" January 3-25, 2006.
- NBAIM-NCL, Pune Joint training programme on



"Bioinformatics in conservation of microorganisms" May1-8, 2006.

- Brainstorming session on "Application of Microorganisms in Agriculture and Allied Sectors" April 17, 2006.
- Kisan Gosthi May 15, 2006.
- NBAIM-NRC Mushroom joint training programme July 22, 2006.
- Kisan Mela November 18, 2006.
- National Training on 'Microbial diversity Analysis of Extremophiles' November 26-30, 2006.
- Training on 'Microbial Community Analysis through Metagenomics' February 3 - 7, 2007.
- National Training on "DNA Sequencing and Microbial Identification Module of Agriculturally Important Microorganisms" September 17-21, 2007.
- National Training on "Microbial Identification Modules for Some Agriculturally Important Microorganisms" September 26 - October 16, 2007.
- Second NBAIM-NRC Mushroom joint training programme September 29 - 30, 2007
- Kisan Gosthi October 31, 2007.
- Molecular and serological detection of plant viruses from February 24 – March 1, 2008.
- DNA Sequencing and microbial identification from September 1-7, 2008
- Microbial Chemical Taxonomy: Polyphasic Approach from September 19 - 29, 2008.
- National Training Programme on "Novel and innovative biochemical and molecular tools for characterization of Agriculturally Important Microorganism" from January 5 - 23, 2009.
- National Training on The evolutionary diversification of cyanobacteria : Biochemical, Molecular and Phylogenetic Approaches from July, 14 - 19, 2009.
- Summer School on "Recent Advances in Molecular Identification and Characterization of Agriculturally Important Microorganisms" from September 1 - 21, 2009.
- National training programme on Molecular Approaches for Identification and Characterization of Actinomycetes from December 01 - 10, 2009.



### Scientific Staff

Prof. Dilip K. Arora	Director
Dr. A. B. Dash	Senior Scientist
Dr. Rajeev Kaushik	Senior Scientist
Dr. Alok K. Srivastava	Senior Scientist
Dr. Sudheer Kumar	Senior Scientist
Dr. D. P. Singh	Senior Scientist
Mr. Anurag Chaurasia	Scientist
Dr. Mahesh Yandigeri	Scientist
Dr. Kamlesh Kumar Meena	Scientist
Mr. Uday Bhan Singh	Scientist

### Research Associate/ Senior

#### Research Fellow:

Sudhanshu Kashyap  
Rakesh Kumar  
Ram Nageena Singh  
Sukumar Mesapogu  
Manoj Kumar Singh  
B. Bharath Kumar  
Anjaney Sharma  
Harmesh Sahay  
Arvind Yadav  
Shachi Vardhan  
Anupama P.D.  
Rajesh Kumar Singh  
Shweta Tiwari  
Hemant Patil  
Manoj Kumar Solanki  
Nidhi Singh  
Subhash Yadav  
Binu Mani Tripathi

Rameshwar Tiwari  
Nityanand Malviya  
Anamika Srivastva  
Pratibha Singh  
Anu Sharma  
Preeti Sahi  
Manish Kumar Srivastava  
Alok Ramkesh Rai  
Ashutosh Kumar  
Achala Bakshi  
Neha Srivastava  
Shivani Yadav  
Madhusudan Panchal  
Manish Roy  
Divya Singh  
Anuradha Rai  
Sucheta Singh  
Sumi Srivastava  
Shradha Gupta  
Shikha Gangwar  
Supriya Srivastava  
Raghendra Pratap Singh  
Priyanka Kumari  
Pratiksha Singh  
Deepak Maurya  
Jyoti Yadav  
Ruchi Singh  
Bhavana Gangwar  
Dev Vrat Tripathi  
Sumit Singh  
Sri Krishna

### Administrative Staff:

S. N. Yadav  
Shyamji Shukla  
Manish Kr. Jain  
Ashok Kumar  
Sudesh Kumar  
Satish Pal  
Mahesh Yadav  
Pilloo Meena  
Rajkumar Meena

### Technical Staff:

Anchal Kr. Srivastava  
Amit Rai  
Alok Upadhyay  
S. S. Reddy

### Supporting Staff:

Amarnath Singh Patel  
Manoj Kumar  
Bali Ram  
Chetan Singh  
Ram Gopal  
Rekha Gupta  
Ram Avadh Singh  
Chandra Kishore Gaud  
Anil Kumar Rana  
Asheesh Kumar Singh  
Pratap Singh  
Ajay Vishwakarma



Corresponding Address

**Prof. Dilip K. Arora**, Director

**NATIONAL BUREAU OF AGRICULTURALLY IMPORTANT MICROORGANISMS**

Kusmaur, P. Box No. 6, P.O. : Kaithauli, Mau Nath Bhanjan - 275 101 (U.P.)

Phone: 0547-2530080 Fax : 0547-2530358

E.mail : nbaimicar@gmail.com

Visit us at: [www.nbaim.org](http://www.nbaim.org)

Published by : Prof. Dilip K. Arora, Director, NBAIM, Mau