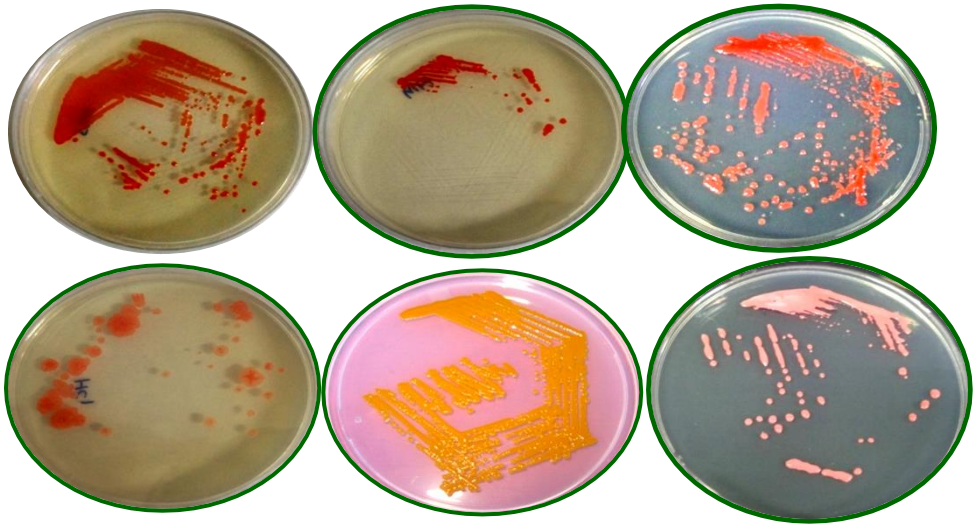
Strategies for Implementation of Delhi Declaration: a microbial perspective



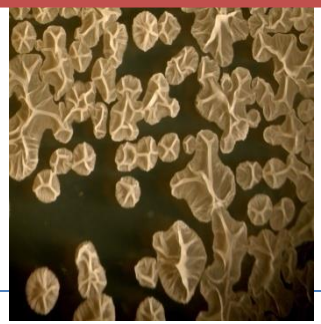
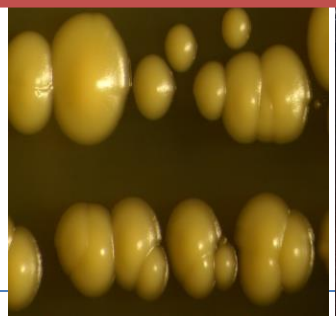
Anil K. Saxena

Director

ICAR-National Bureau of Agriculturally Important Microorganisms

Kushmaur, Maunath Bhanjan, Uttar Pradesh, INDIA

NAIMCC


Establishment of ICAR-NBAIM

Under Convention of Biological Diversity (CBD) and BD Act, ICAR established the ICAR-National Bureau of Agriculturally Important Microorganisms (ICAR-NBAIM) for collection, maintenance, conservation and supply of microorganisms all over the country.

- Established in 2001 at ICAR-NBPGR Building, Pusa Campus, New Delhi.
- On 1st June 2004 NBAIM shifted to Maunath Bhanjan of Uttar Pradesh State.

CERTIFICATE

Royalcert, certifies that the management system of the organization has been assessed and found to be in accordance with the requirements of the related standard

ISO 9001:2008

NATIONAL BUREAU OF AGRICULTURALLY IMPORTANT MICROORGANISMS
(Indian Council of Agricultural Research)
Village – Kushmaur, Post – NBAIM Campus, Mau (U.P.) 275101, India.

Scope

Provision of services to carry out Research & Development (R&D) Activities in terms of conducting basic and applied research on agriculturally important microorganisms including crops, horticulture animal husbandry and fisheries sciences.

Certification No : NAT090
Initial Certification Date : 28.03.2014
Issue Date : 28.03.2014
Expiration Date : 27.03.2017

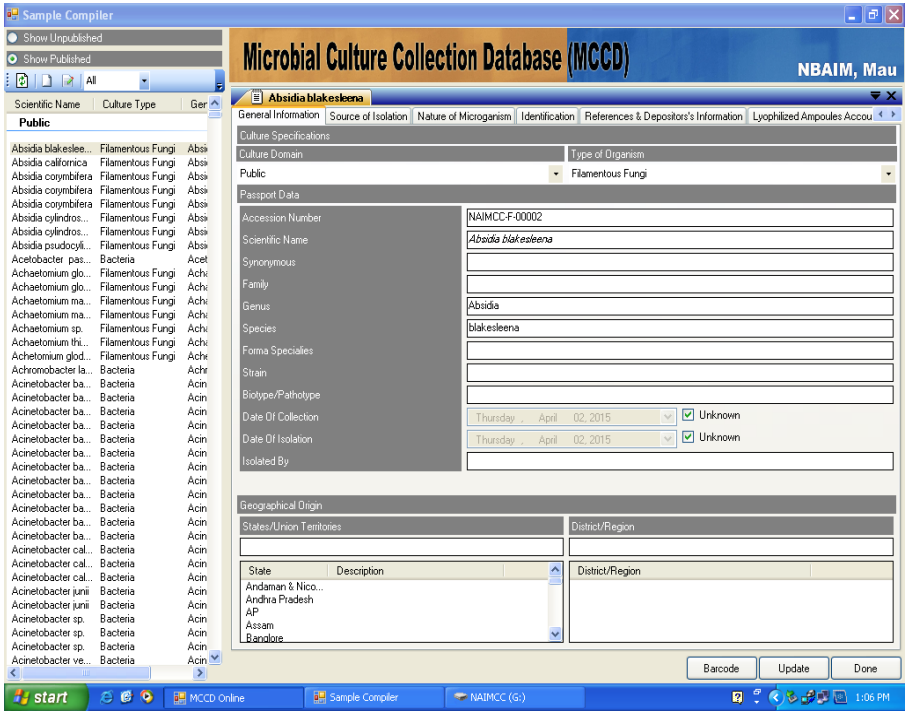
General Manager
Namik Sezgin

Mandate

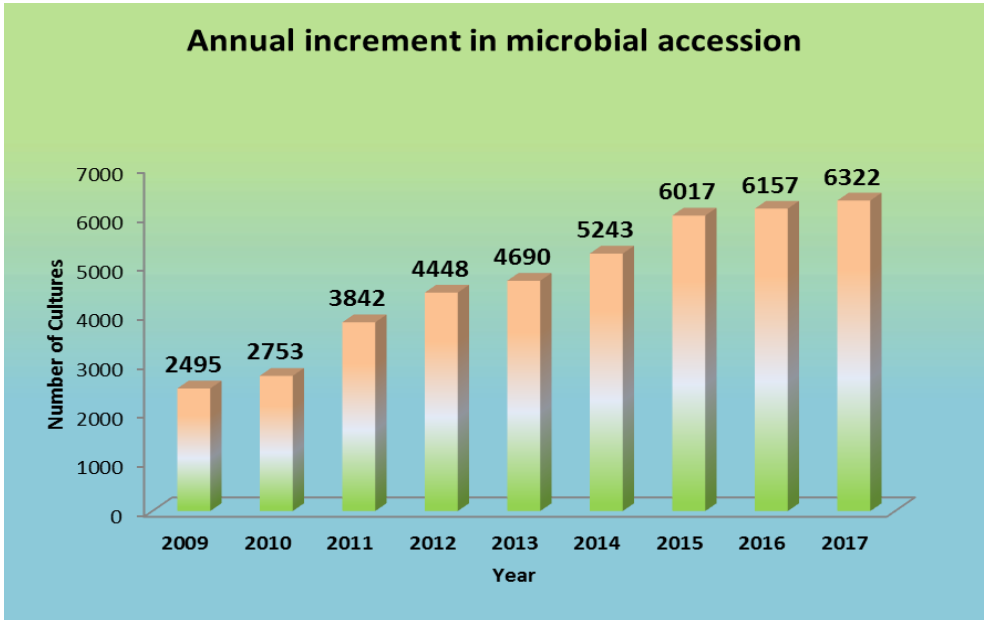
"To act as the nodal Institute at national level for acquisition and management of indigenous and exotic microbial genetic resources for food and agriculture, and to carry out related research and human resource development, for sustainable growth of agriculture".

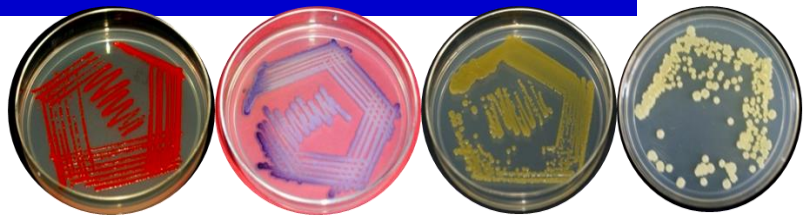
Repositories

- National Agriculturally Important Microorganisms Culture Collection (NAIMCC)
- Microbial Genetic Resource Repository (MGRR)

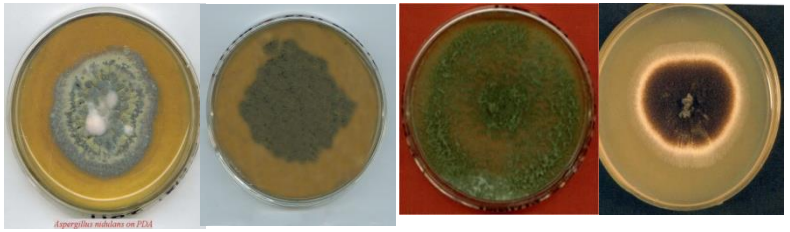


National Agriculturally Important Microbial Culture Collection (Working under quality-driven management processes according to OECD guidelines)

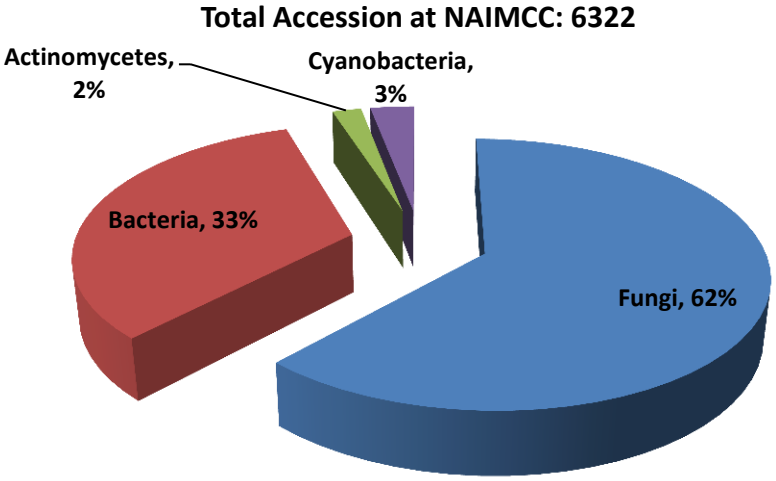




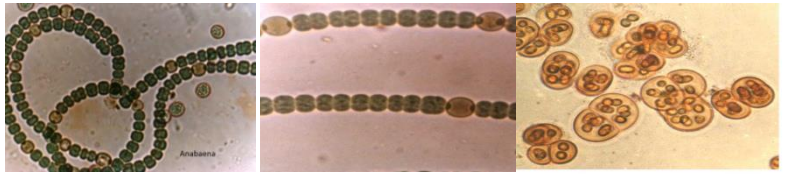
Bacterial holding (2293)



Fungal holding (3801)



Actinomycetes



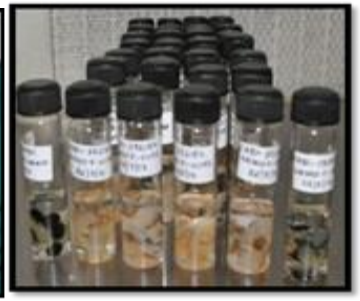
Cyanobacterial holding (228)

Preservation Methods

Conservation of AIMs

- **Short Term**
  - **Sub-culturing**
  - **Glycerol Stocks**
  - **Mineral Oil- storage**
- **Long Term**
  - **Lyophilization**
  - **Cryopreservation**

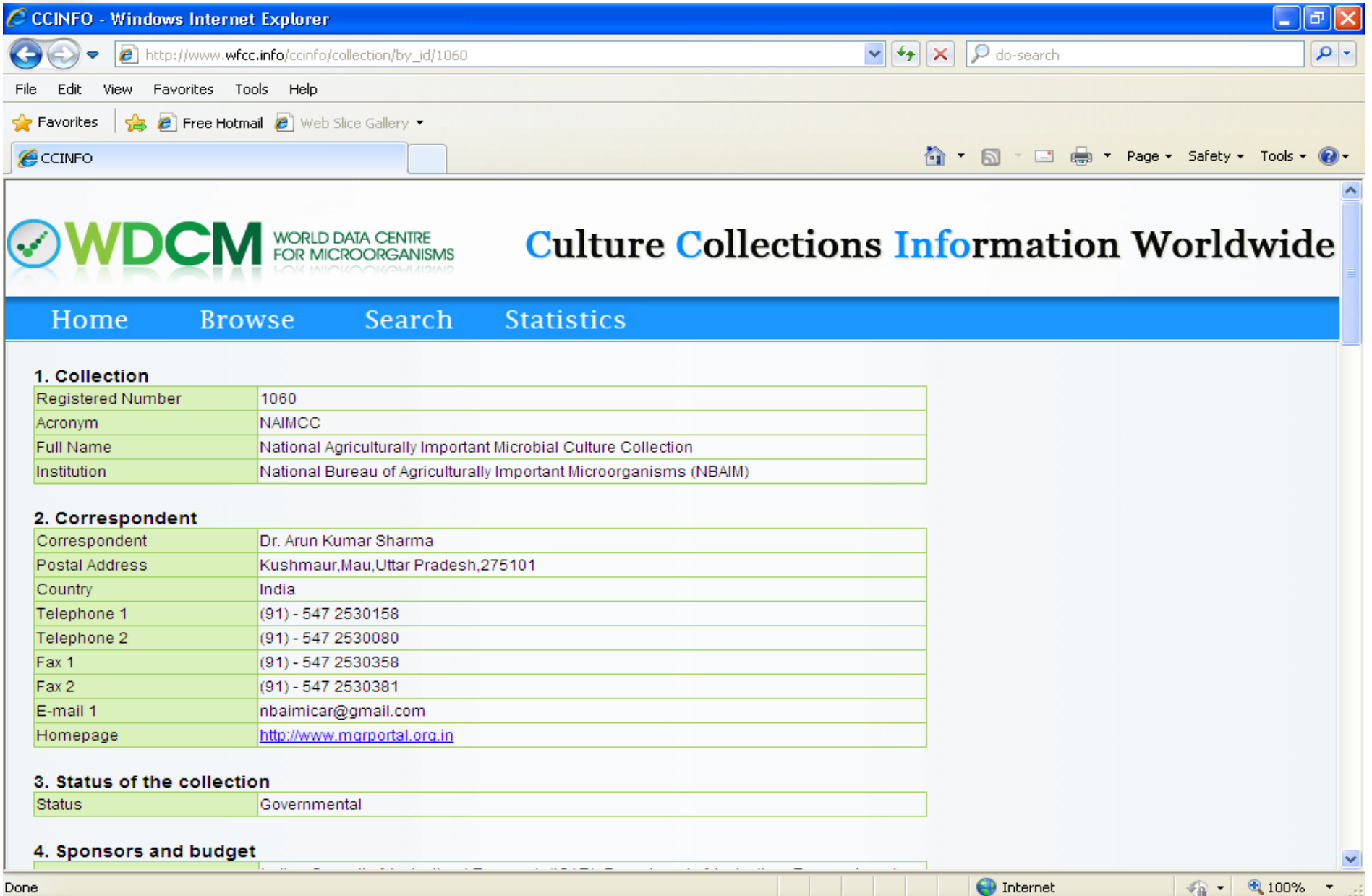




Genetic materials deposited in Microbial Genetic Resource Repository

Material	Description	Quantity (No. of glycerol stocks)
Host	*E. coli* DH5á	20
	E. coli JM 107	20
	E. coli BL21	10
Competent cells	*E. coli* DH5á	150
	E. coli BL21	60
Plasmid & Vectors	pUC19	60
	pBR322	100
	pET29 (a)	10
Clones	*phy gene*	30
	csp gene (*Pseudomonas koreensis*-P2)	300
	Chitinase (*B. licheniformis* CV22)	500
	Xylanase (*B. licheniformis* CV22)	500
	Chitinase (*B. licheniformis* CM28)	500
	Xylanase (*B. licheniformis* CM28)	500
	Xylanase (*B. subtilis* CG13)	500
	Xylanase (*B. subtilis* CG21)	500
	nod D (*Rhizobium* sp.)	500
	rpo B (*Rhizobium* sp.)	200
	pltc gene(*Pseudomonas* sp.)	500
	16S rRNA gene (*P.fluorescens*)	550
	16S rRNA gene (*Cellulosimicrobium funkei*)	500
	16s rRNA gene (*Exiguobacterium* sp.)	500
	ITS (*Penicilliopsis* sp.)	500
	ITS (*Trichoderma* sp.)	550
	ITS (*Beauveria bassiana*)	2580
	16S rRNA gene from Metagenomic of Goa Mangrove	2500
	Total clones	**12210**

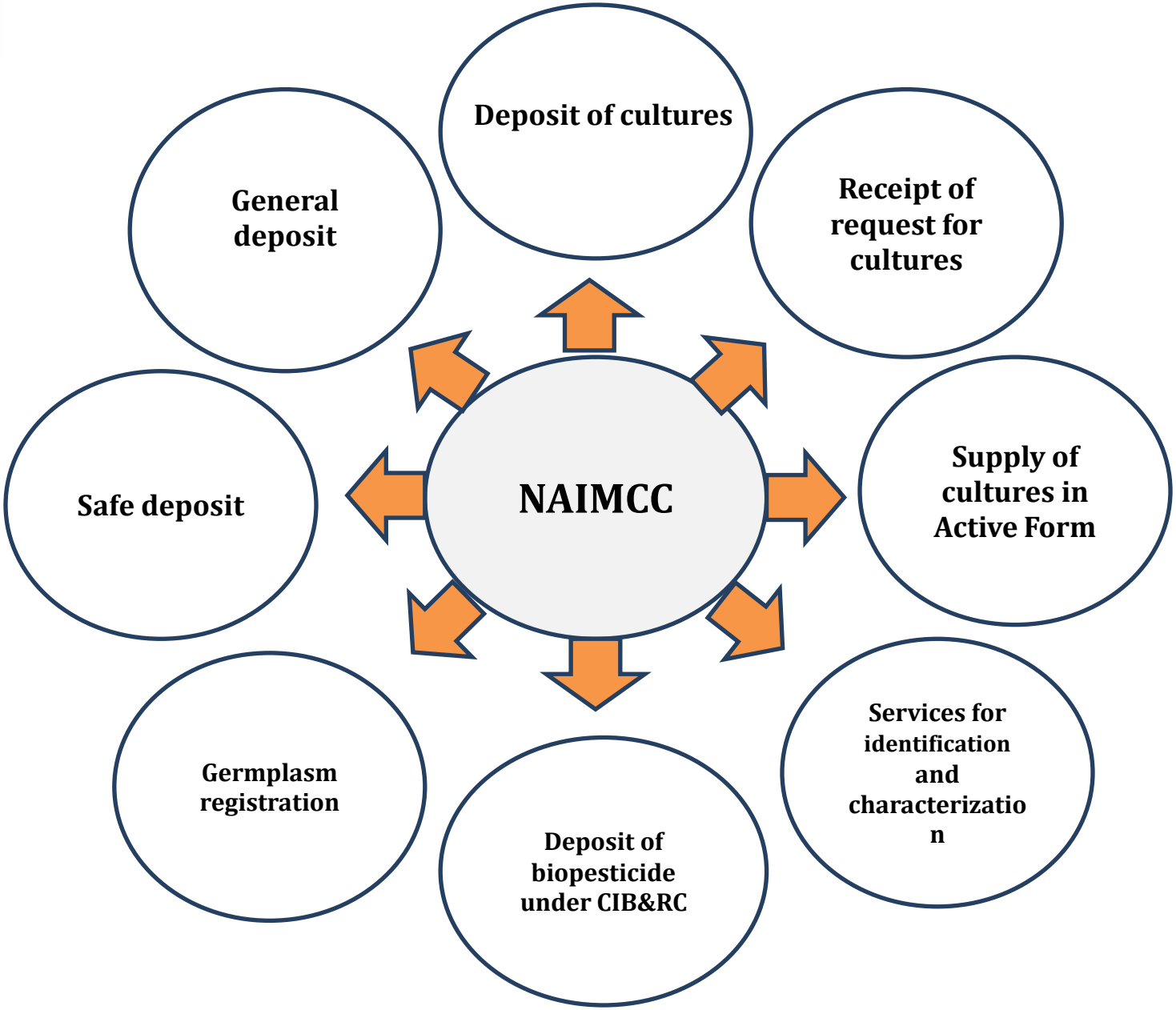
An Affiliate member of World Federation of Culture Collections (WFCC)



Microbial Genetic Resource Portal (www.mgrportal.org.in)

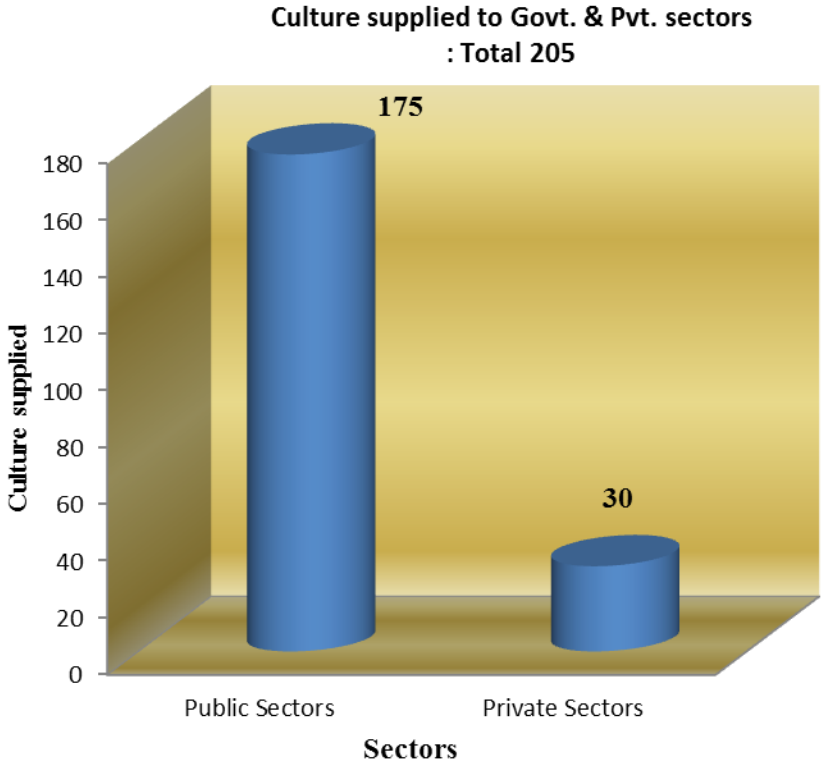
Microbial Genetic Resource Portal contains information on :

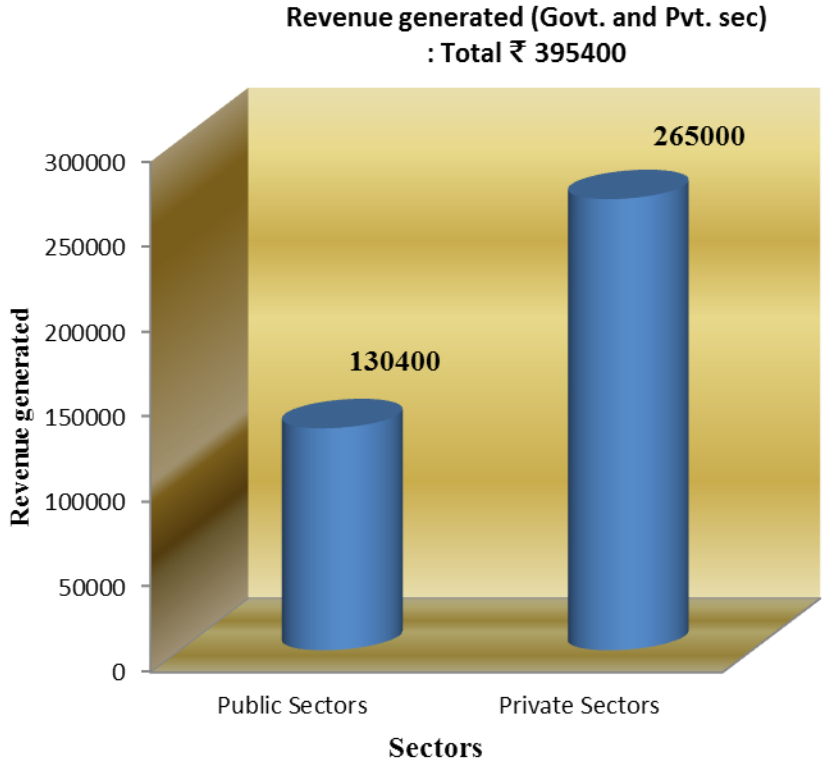
- NAIMCC - National Agriculturally Important Microbial Culture Collection
- MGRR - Microbial Genomic Resource Repository
- Designated Culture Collections of India by NBA
- Information on AMAAS (Application of Microbes in Agriculture and Allied Sectors)
- Services offered by NAIMCC/NBAIM
- Guidelines for Registration of Elite Microbial Germplasm
- Accessibility of culture collection catalogues
- Passport Data Form for Microbial Deposition



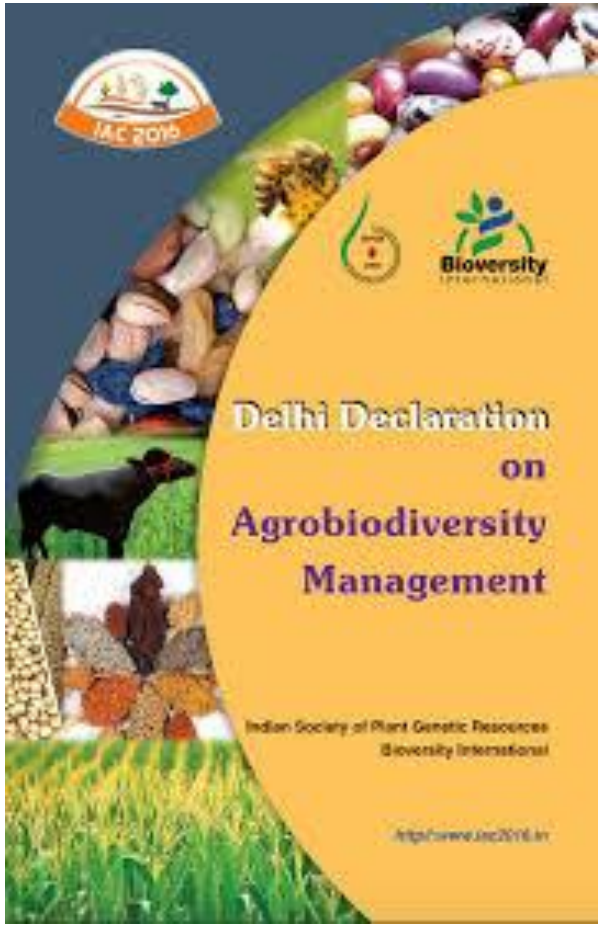
Overview of Services in NAIMCC

Revenue generated through supply of cultures (2016-17)





Delhi Declaration



- **The declaration will help to achieve the National Biodiversity Targets (NBTs) in line with the Aichi targets**

- **The declaration emphasizes conservation of agro-biodiversity for which the utmost requirement is identification and cataloguing of biodiversity using cutting edge science and technology**

- **Concerted efforts should be taken to strengthen and build capacity for taxonomy and biosystematics which was also highlighted in NBAP 2008**

- **Policy changes are required for exchange of germplasm in line with Aichi Targets, Nagoya Protocol and Delhi Declaration**

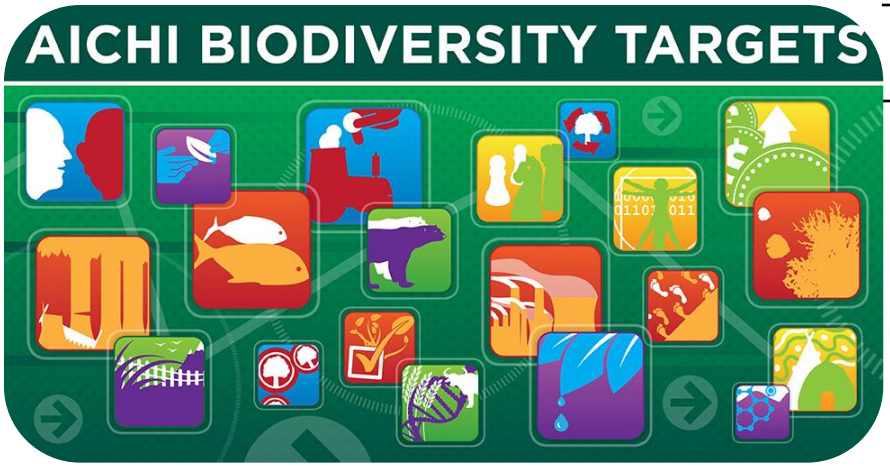
- **Inter-departmental or Inter-ministerial collaboration /cooperation should be encouraged more**

Sustainable Development Goals (SDGs)

- Goal 1: Sustainable use, Goal 2: Conservation, Goal 3: Access benefit sharing, Goal 4: Participation

Aichi Biodiversity Targets (20 Targets)

Strategic Goal A	Addressing the underlying cause of biodiversity loss by mainstreaming biodiversity across government and society
Strategic Goal B	Reduce the direct pressure on biodiversity and promote sustainable use
Strategic Goal C	To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity
Strategic Goal D	Enhance the benefits to all from biodiversity and ecosystem services
Strategic Goal E	Enhance implementation through participatory planning, knowledge management and capacity building



National Biodiversity Target pertinent to microbial diversity and conservation

By 2020 a significant proportion of the country's population, especially the youth is aware of the values of biodiversity and steps they can take to conserve and use it

Strategies for reducing rate of degradation, fragmentation and loss of all natural habitats are finalized and actions put in place by 2020 for environmental amelioration and human well-being.

By 2020, measures are adopted for sustainable management of agriculture, forestry and fisheries.

By 2020, genetic diversity of cultivated plants, farm livestock, and their wild relatives, including other socioeconomically as well as Culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and Safeguarding their genetic diversity.

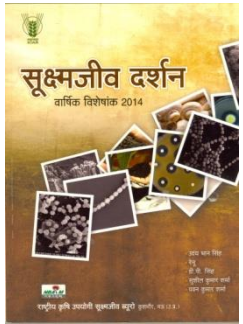
By 2020, ecosystem services, especially those relating to water, human health, livelihoods and well-being, are enumerated and measures to safeguard them are identified, taking into account the needs of women and local communities, particularly the poor and vulnerable sections.

By 2015, Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization as per the Nagoya Protocol are operational, consistent with national legislations.

By 2020, opportunities to increase the availability of financial, human and technical resources to facilitate effective implementation of the Strategic Plan for Biodiversity 2011-2020 and the national targets are identified and the Strategy for Resource Mobilization is adopted.

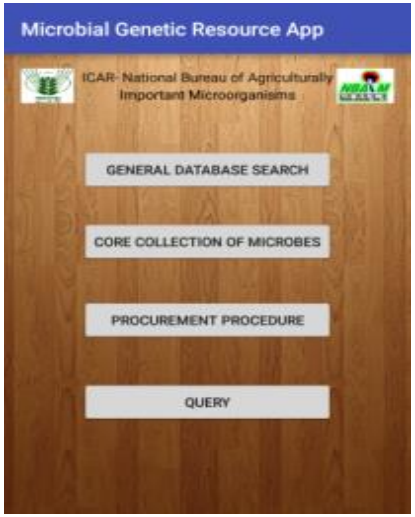
National Biodiversity Target	Initiatives and actions taken for management of microbial diversity
NBT1	By 2020 a significant proportion of the country's population, especially the youth is aware of the values of biodiversity and steps they can take to conserve and use it

- *Creating awareness about agro-microbial wealth of India among school going children.*
- *Printing booklet/pamphlet on microbial wealth and their usefulness in Hindi and English for general public.*
- *Spreading awareness among people regarding microbial diversity conservation and maintenance at various fora like Kisan Goshtis, Mera Gaon Mera Gaurav, Swacch Bharat Campaign and training programs at the Bureau.*
- *Popularizing community composting program at the village or block level.*

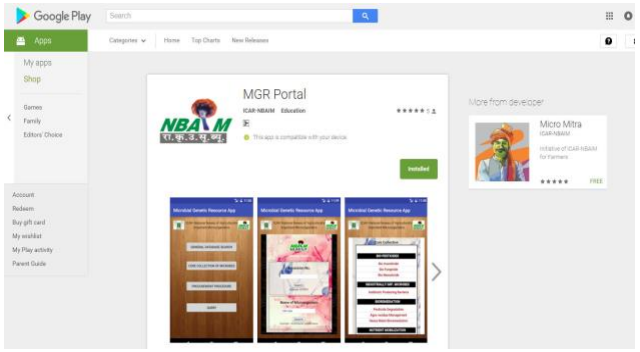


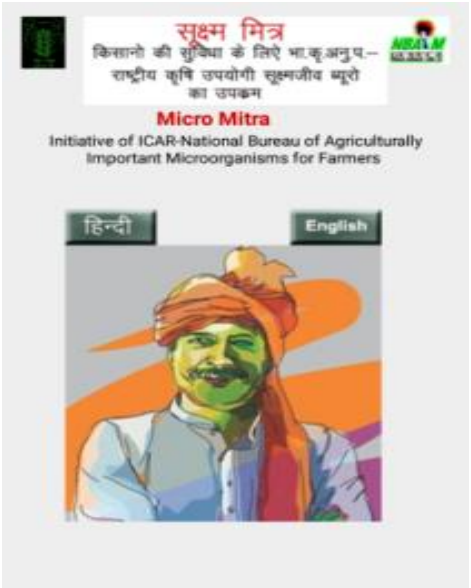
Mobile Apps for digital outreach

Mobile apps developed by ICAR-NBAIM and launched by Hon'ble Minister of Agriculture & Farmer's Welfare, Sh. Radha Mohan Singh Ji on 15.03.17 in Krishi Unnati Mela

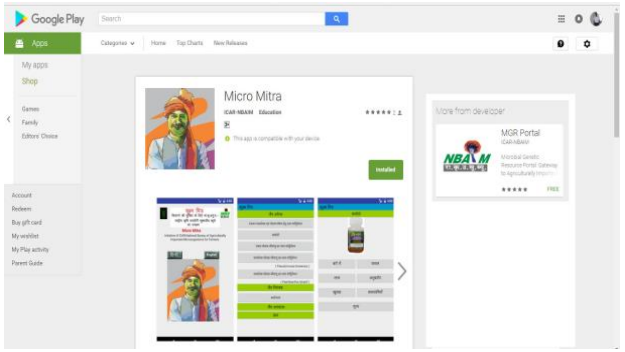


MGRportal App: An android based mobile app of MGRportal for general search of microbial accessions by accession number or by name in NAIMCC database.





Micromitra App: Another bilingual mobile app for farmers. It enlists various microbe based technologies developed at ICAR-NBAIM, Mau, U.P. and gives details about crops benefited, advantages, application, dosage, precautions and cost of each technology.



Both the apps can be downloaded from www.mgrportal.org.in site as well as play store.

National Biodiversity Target	Initiatives and actions taken for management of microbial diversity
NBT3 NBT5 NBT8	**Poverty alleviation, food, nutritional and health security, gender equity and global partnership.** ➢ Since its inception the Bureau is constantly engaged in finding and validating microbial technologies helpful for maintaining soil health and soil biological diversity through reduction in chemical inputs. ➢ The Bureau has developed and popularized biofertilizers and biocontrol agents useful for diverse crops. ➢ Several microbe based agro-inputs have been developed and has been successfully validated like biofertilizers *viz;* Bio NPK, BioPhos, Biophos^{+}, BioZinc, BioPotash etc. ➢ These biofertilizers can reduce the consumption of chemical fertilizers to the tune of 25-30% without compromising with yield.

Microbial consortium for alleviation of salinity and drought stress

Improving nutrient use efficiency through microbial interventions for sustainable crop production and maintenance of soil health.

- ***Arthrobacter sulfonivorans*** **and DS-68** ***Enterococcus hirae*** **DS-163 increased the iron concentration in grains from 30 to 49 mg kg^{-1}**

- ***Bacillus subtilis*** **DS-178 and** ***Arthrobacter*** **sp. DS-179 increased the Zn concentration from 28 to 42 mg kg^{-1}**

Exploration and conservation of microbes isolated from different niches of the country

Sea beach near
Diu Fort

Ice sample collection, Leh

Jhoom cultivation site

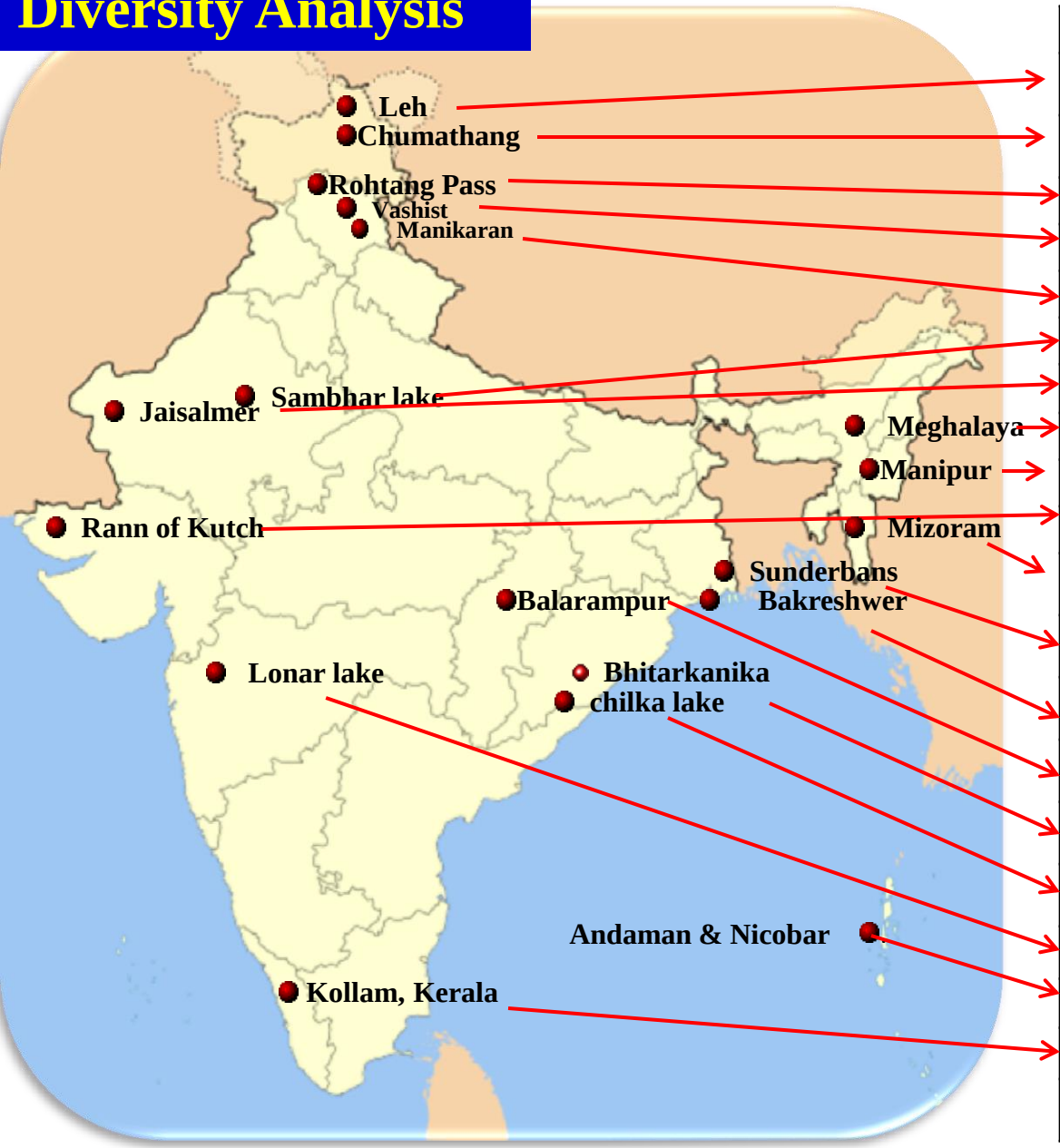
Manipur

Vegetation in marshy area of Diu Islands

Bhayender salt pans
Mumbai

Umsaw Reserve Forest
Meghalaya

Diversity Analysis

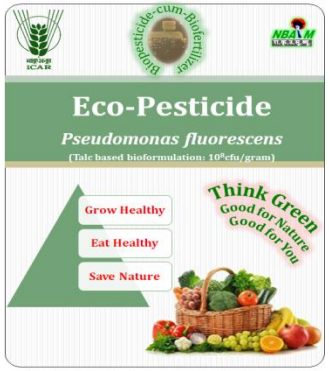


S.N	Location/Sites	Total	*Bacilli*
1	Leh	171	59
2	Chumathang	24	24
3	Rohtang Pass	157	48
4	Vashist	11	8
5	Manikaran	146	58
6	Sambhar lake	117	30
7	Jaisalmer	89	29
8	Meghalaya	37	14
9	Manipur	45	16
10	Rann's Kutch	131	45
11	Mizoram	35	15
12	Sunderbans	108	22
13	Bakreshwar	21	17
14	Balarampur	31	22
15	Bhitarkanika	106	54
16	Chilka lake	166	45
17	Lonar lake	72	37
18	Andaman & Nicobar	27	27
19	Kerala	47	12
	Total	1541	582

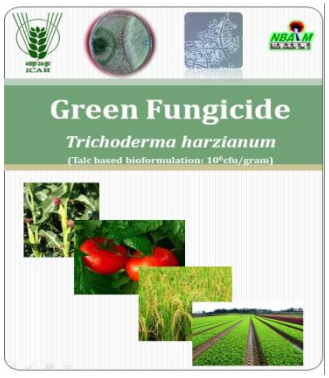
First attempt was made to develop the base line information on predominant genera in different extreme environments of the country.

Microbial genetic resource management for combating biotic stress in the changing climate scenario

Eco-Green Fungicide: Vermi-based bioformulation of *Trichoderma viride*.



Eco-Pesticide: Talc based bioformulation of *Pseudomonas fluorescens*



Green Fungicide: Talc based bioformulation of *Trichoderma harzianum*.

Bio Pulse: A fly ash based formulation for biocontrol of *Fusarium* wilt in pulses

- **A bioformulation of *Trichoderma harzianum* and *Bacillus amyloliquefaciens* for control of *Fusarium* wilt in chickpea.**
- **Treatment with formulation could suppress wilt disease by 40% and increased the grain yield by 15% in chickpea on farmers' field.**

Bioformulation Control plot Treated plot

Proposed Action plan

- **Promoting utilization of the low cost microbe based formulation by farmers for enhancing crop productivity as well as soil health for maintaining long term sustainability.**
- **Improving nutrient use efficiency through microbial interventions for sustainable crop production and maintenance of soil health.**
- **Microbial genetic resource management for combating abiotic and biotic stress in the changing climate scenario**
- **Reclamation of problem and degraded soils by utilization of microorganism**
- **Screening of microalgae for nutritional quality, food grade pigments and bio-energy production (Project mode).**

Initiate, strengthen and promote complementary strategies to conserve agrobiodiversity

- ***ICAR-NBAIM is in the process of optimization of methods of preservation of lyo-recalcitrant microbes (archaea, strict anaerobes; non- sporulating fungi)(Project mode)***

- **Developed technology for long term storage of Cyanobacterial Cultures**

Culture storage on sterilized and dried Whatman filter paper strips

Culture was viable for 12 months as evident from chlorophyll content used as a measure of growth

Culture storage on sterilized silica gel (mesh size 60-120)

Culture retained its viability even after 18 months.

Proposed Action Plan

- ***ICAR-NBAIM in collaboration with MoEF&CC develop strategies for unique microbes by conserving their unique habitats (place, endangered animal/plant etc) to save such rare microbes which are metabolically active and having compounds of different nature that could be utilized in industry and agriculture.***
- ***Deciphering the microbiome of wild relatives of important crop plants and its ex situ conservation***
- ***Development of fail- safe deposit of core collection of agriculturally important microorganisms in perma frost regions***

Employ modern technologies

❖ Bacillus

Antonie van Leeuwenhoek (2011) 99:283–296
DOI 10.1007/s10482-010-9487-4

ORIGINAL PAPER

Restriction analysis and partial sequencing of the 16S rRNA gene as index for rapid identification of *Bacillus* species

S. Vardhan · R. Kaushik · A. K. Saxena · D. K. Arora

❖ Macrophomina phaseolina

Mycologia, 99(6), 2007, pp. 797–803.

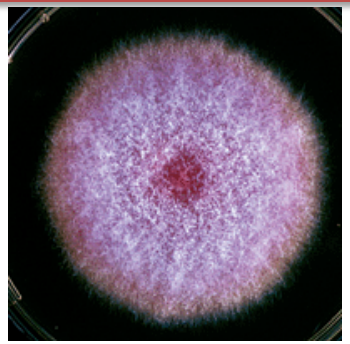
Issued 6 February 2008

Identification and detection of *Macrophomina phaseolina* by using species-specific oligonucleotide primers and probe

Bandamaravuri Kishore Babu
Anil K. Saxena[1]

that showed some degree of variation among the
Sequence variation in the rRNA genes allows the use

❖ Fusarium udum



Mycopathologia
DOI 10.1007/s11046-010-9382-6

Real-time PCR Assay Based on Topoisomerase-II Gene for Detection of *Fusarium udum*

Mukesh Kumar Yadav · Bandavari Kishore Babu · Anil Kumar Saxena · Bhim Pratap Singh · Kiran Singh · Dilip Kumar Arora

Draft genomes sequenced

Ten genomes have been sequenced

- ***Pseudomonas koreensis* P2**
- ***Brevibacillus borstelensis* LCHU R05,**
- ***Exiguobacterium profundum* PHM11**
- ***Staphylococcus xylosus* LSR_02N**
- ***Bacillus subtilis* RC25**
- ***Fusarium udum* F02845**
- ***Chromohalobacter selaxigenes***
- ***Pseudomonas azotoformans***
- ***Pseudomonas aeruginosa* PF1**
- ***Pseudomonas aeruginosa* PF3**
- ***Pseudomonas plecoglossicida* PF2**
- ***Pseudomonas plecoglossicida* PF4**

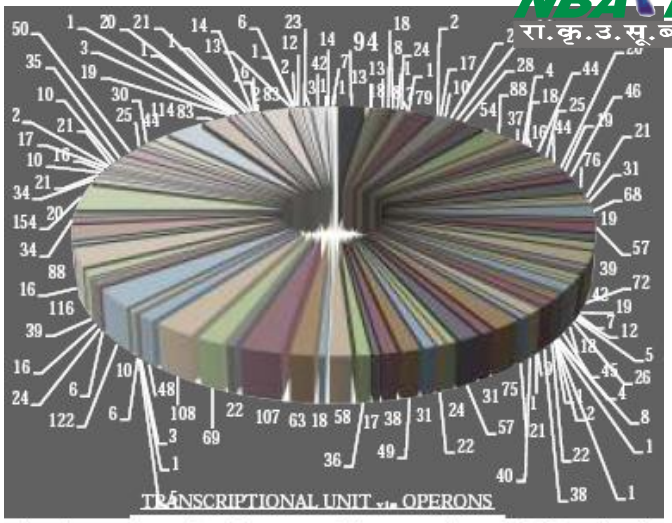
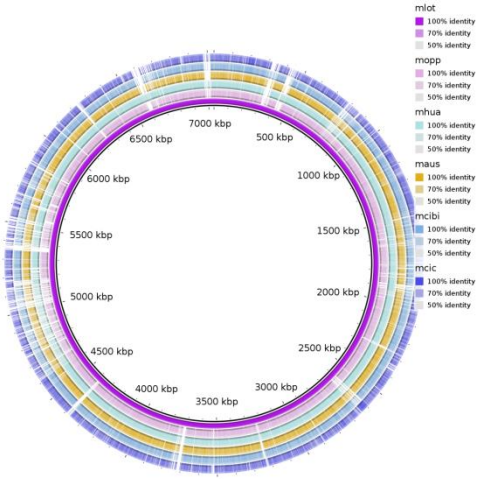


Fig. 1b: Operons having more than one transcriptional units

- **Comparative genomic analysis of six species of the genus *Mesorhizobium* (***Mesorhizobium ciceri*** ca181, *M. ciceri* biovar *biserrulae* WSM1271, *M. loti* MAFF303099, *M. australicum* WSM2073, *M. huakuii* 7653R and *M. opportunistum* WSM2075) **provided insight into bacterial evolution and nif gene analysis.**



Genome wide blast comparison of *M.ciceri* ca181 with related *Mesorhizobium* species. Higher color intensity represents higher percentage identity

- A total of 7003 orthologous clusters were identified of which 40% comprise the core genome of these *Mesorhizobium* strains. The motifs distribution highlights that the nif genes are supposed to be conserved during evolution.

Proposed Action Plan

- **Studying the community shift of the microbiome in different agro-climatic zones of India using 'Omics' approaches, with reference to various agricultural practices prevalent in the zone.**

- **Functional metagenomics for next generation enzymes, antibiotics and anti microbials.**

- **Development of indicator microorganisms for soil fertility, degraded soils and pesticide residue (Project in operation)**

Necessity of global exchange of plant, animal, aquatic, microbial and insect genetic resources to diversify agriculture as well as our food basket

- **ICAR-NBAIM will promote microbes of global interest for their exchange under the ambit of BD Act 2003 through regulatory mechanisms developed by National Biodiversity Authority (NBA). As repository of agriculturally important microorganisms, ICAR-NBAIM will request NBA to develop mechanisms for trans-boundary exchange of such useful material for various purposes including for taxonomic study while ensuring equitable benefit sharing with country of origin.**

- **NBAIM emphasize the exchange of microbial commons for global benefit which should be free from any levies and duties.**

Harmonise existing biosecurity systems, including phytosanitary and quarantine, and enhance their capacities to facilitate safe trans-boundary movement of germplasm.

- **ICAR-NBAIM is supporting DPPSQ in import of microbes from abroad.**
- **Capacity building for development of diagnostics for microbial pests**

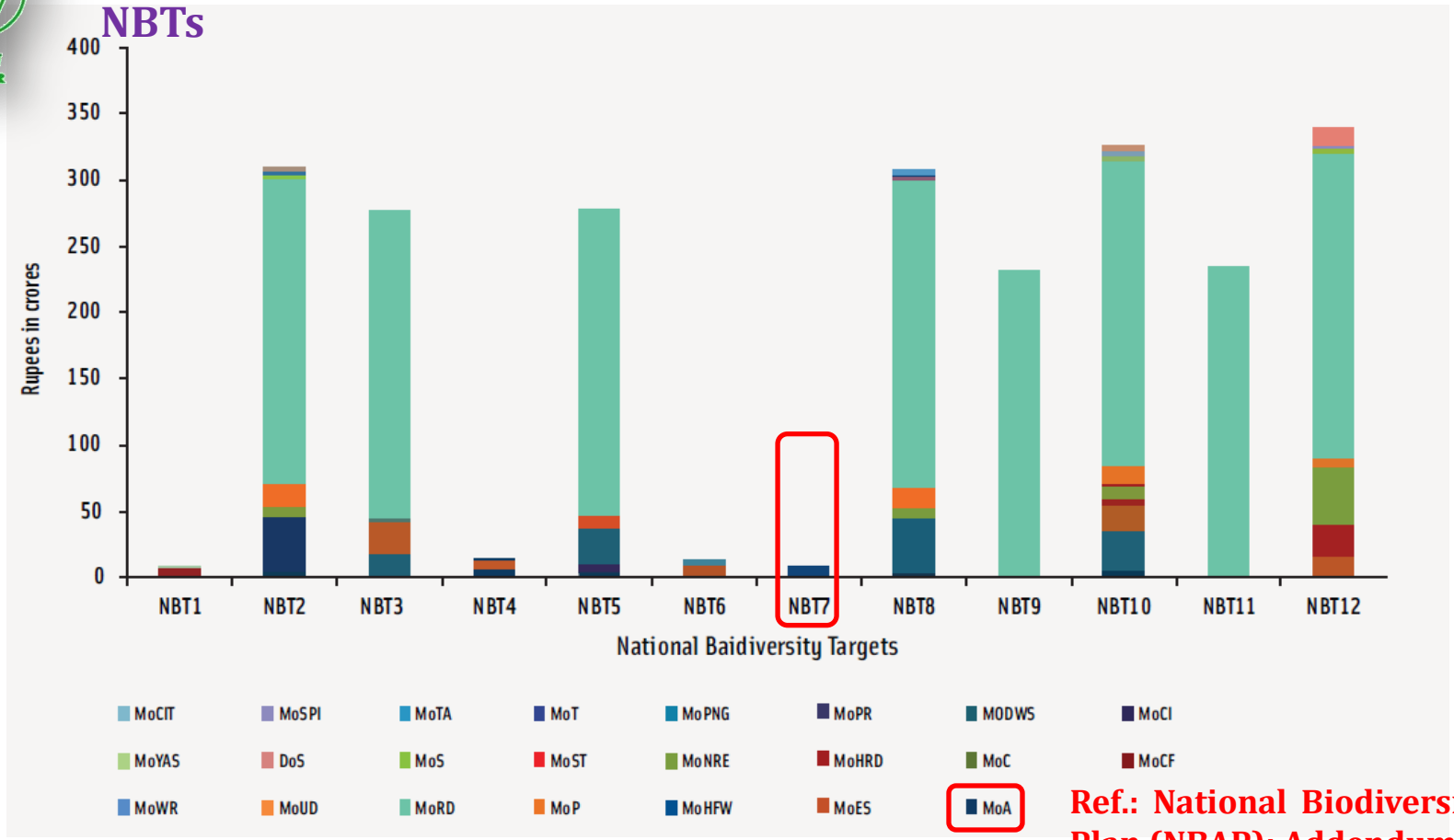
Development and implementation of an Agrobiodiversity Index to help monitor on-going genetic resource conservation and management efforts

Proposed Action Plan

- **Deciphering the structural and functional diversity of agriculturally important microorganisms and to develop "microbial map" and diversity indices for microbes in certain benchmark sites of the country.**

- **Developing a digitized database of the species and genetic diversity of fungi, bacteria, actinomycetes and archaea through making the existing ones comprehensive and sustainable.**

Budget allocation by different ministries during 2013-14 to attain NBTs



Ref.: National Biodiversity Action Plan (NBAP): Addendum 2014

- **Ministry of Agriculture & Farmer Welfare should allocate more budget at least for characterization and conservation of agro-biodiversity**
- **If required a joint funding system should developed with MoEF , MoES for conservation of biodiversity**
- ***ICAR-NBAIM would emphasize creation of separate funds for conservation of microbial resources under the ambit of International Agrobiodiversity Fund and India would be one the partners in funding such international body to avoid loss of such useful genetic resources.***

Propose Development of Network of Indian Agricultural Microbial Genetic Resource Collections for Developing Core Collection of Microbes for Use in Agriculture

Form C

Under International Bacteriological Code of Nomenclature under Rule 27 & 30, mandatory deposition of microbial species in two internationally recognized culture collections, one in country of origin and other foreign one.

Form C: 'Prior intimation' for deposit of microbe in foreign repository

Any non-Indian person accessing the deposited microorganisms of Indian origin from foreign repository should take 'Prior Approval' of NBA as per section 3 of BD Act 2002

Problem Associated with Deposition of Culture to International Repositories

1. Type strains deposited in Indian cultures are not recognised as valid deposit for publication since they are not available to researchers abroad.
2. Foreign mBRC refuse to accept microbial cultures of Indian origin saying that India is not following in Nagoya Protocol

Thank You