

Collection and characterisation of banana and plantains of northeastern India

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Introduction

A Memorandum of Understanding (MoU) for Scientific and Technical Cooperation in Plant Genetic Resources between Indian Council of Agricultural Research (ICAR), New Delhi and the International Network for Banana and Plantain (INIBAP), a programme of the IPGRI, was signed on July 19, 1999. This was to promote, develop and accelerate close collaborative efforts in the conservation and utilisation of plant genetic resources during the biennium 1997-1998 and was extended for another two years for a period up to December 2000. Under this bilateral programme, INIBAP has agreed to fund a project on "Collection, characterisation of banana and plantain in northeastern India". The project was initiated in the year September 1998 with the following objectives and work plan:

- Enhancement of banana genepool through prospection and collection in northeastern region.
- Characterisation of collected accessions and conservation.
- Documentation and development of database.

Banana is strongly believed to have originated from Southeast Asia, many of the species and clones have India as their homeland. Natural hybridization, mutation and polyploidy have contributed a lot for wide diversity among Indian bananas which have perpetuated through vegetative propagation over.

The northeastern states of India, namely Assam, Arunachal Pradesh, Meghalaya, Tripura, Mizoram and Manipur have been richest sources of natural diversity. Under this project, northeastern states were covered in phases and complete details on varietal situation wild germplasm, eco-compatibility and prevailing pests and diseases.

Preliminary survey

The preliminary exploration for *Musa* germplasm (available) in the Northeastern states was undertaken during January 1998, to prepare a base for the main survey from September to October. Initially, northern Brahmaputra areas were explored resulting in the identification of number of *balbisiana* clones growing wild, as well as in backyards, which include clones like Bhimkol, Athiakol, Borkal Baista and Kechulepa. Commercial orchards of Malbhog, Cheni Champa, Kachkel, Saapkal, etc. were observed for identification any variability. An accession similar to Kachkel but with ash coated fingers was found to have commercial significance around Guwahati in Assam state.

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Table 1. Areas explored and to be explored under this programme.

<i>Sl. No.</i>	<i>Survey</i>	<i>States covered</i>	<i>Areas covered</i>
1.	Preliminary survey	Assam	Khasi hills, northern Brahamaputra, Dhipu, Karbiogug, Guwahati, Jorhat, Bharabani
2.	Exploration phase I	Assam, Arunachal Pradesh, Meghalaya	Itanagar, Ziro, Potin, Lakhimpur, Dihrugarh, Namaai, Digboi, Jorhat, Guwahati, Kaziranga, Shillong
3.	Exploration phase II	Tripura, Mizoram, southern parts of Assam	Agartala, Ambassa, Bishal Nagar, Udaipur, Dharma Nagar, Aizawl, Seling, Varingtc, North and Central Mizoram
<i>Areas to be explored</i>			
4.	Exploration phase III	Nagaland, Manipur	-
5.	Exploration phase IV	Sikkim, Arunachal Pradesh	-
6.	Exploration phase V	selected areas	-

Exploration in Khasi hills of Meghalaya led to the identification of few wild *acuminata* diploids. They exhibited a unique characteristic of four ovules in each locule arranged in irregular rows. The suckers were collected for NRCB genebank for further characterization. In the same Khasi hill range of Kamrangia village (400 m. from m.s.l), few unique wild accessions were collected by name Rigitchi and Rissue with medicinal cultivars. Explorations were extended in the Khasi Hill ranges towards Dhipu and Karbiangurg, to add few more new accessions, Nuchan, Nuzzat, Numit, Lorrop, Luchin and Lonbing King Tongk. Survey also included visits to Horticultural Research Station (HRS), Assam Agricultural University Kahikuchi; A.A.U. Jorhat, ICAR complex Barapani and NBPGR regional station, Barapani. The preliminary exploration resulted to the collection of 20 new accessions to NRCB field gene bank.

Exploration phase 1

Northeastern states, being a hilly terrain poses a very tough route to the explorers, but with the valuable assistance from the State Forest Research Institute (SFRI), Itanagar, this exploration work was undertaken.

Distribution of wild *Musa* species is spread across the tropical, sub-tropical and to some extent into the pine forests. Most of the areas explored in northeastern India harbouring wild bananas, were the tropical semi evergreen forests and subtropical forests. These semi evergreen forests, due to their accessibility, are exposed to large scale exploitation and destruction as a result of shifting cultivation by the local tribes. In the semi evergreen forest ranges of east Kemeng, lower Subansiri, western Lohit and parts of east Siang districts, wild banana is cohabited with forest tree species like *Elaeocarpus*, *Pterospermum*, *Altingia excelsa*, *Terminalia*, *Myriocarpa* along with abundant bombax and *Dendrocalamus* (bamboo).

Like any other northeastern states, wild banana dominates the forest flora with elaborate clumps under different stages of growth. The Apatani and Nitshi tribes, the major tribal groups of Arunachal Pradesh co-habit the wilderness. These tribes are nomads adhering

to shifting cultivation, otherwise known as Jhum cultivation wherein a tribal group of 50-100 earmark and occupy a forest area of 10-25 ha and clear the jungle by cutting down all the trees. Fire is set to suppress any underground propagating material. Due to this, over a period of time, many natural *Musa* habitats have been wiped out. This accentuates the need to collect germplasm before its extinction from these areas of maximum diversity.

In Riverine Semi evergreen forests in the Renga river valley of lower Subansiri district and river valley in East Kemeng district, bananas were reported to grow along the river banks, riverine plains and swamps probably an edaphic modification to suit the locations. In these regions, most of the trees are deciduous and lack a dense, closed canopy. The trees are generally buttressed but due to more openness to sunshine, these were the first places to be cultivated by tribals through forest clearing. Bananas were earlier reported to be grown in swamps no longer exist due to human interference and settlement in these valleys.

The entry from Assam into Arunachal Pradesh was via Kimin towards Ziro. In Arunachal Pradesh, banana is a crop of wilderness and commercial cultivation is unknown. Occasionally, for the backyard gardens people have selected cultivars like Giant Governor, Malbhog, Champa, etc., for domestic utility. The route is a tough hilly track where wild bananas are grown luxuriantly on either side of the road. These are mostly the *balbisiana* clones and much diversity was noted for wild types in the Potin range. *Eumusa* and *Rhodochlamys* have co-habited a vast stretch with intermittent spread of clumps. A clear-cut eco-domination by *Eumusa* over slender, shy suckering but attractive *Rhodochlamys* members was noted.

Musa acuminata and *M. balbisiana* exhibited a well-balanced spatial distribution but occasionally both growing in a same locality. It was also noticed that *Rhodochlamys* group had better eco-compatibility with *acuminata* while in adjoining areas where *balbisiana* was dominant, no other *Musa* species were found growing. To be more specific, no other flora was noticed growing along with *M. balbisiana* except for occasional clumps of *Dendrocalamus* and trees like, *Mesua ferrea*, *Altingia excelsa*, *Clerodendrum wallichii*, etc.

In Assam state, banana is a part of agricultural landscape. Though banana cultivation is not on commercial scale, varieties like Jahaji (AAA), Cheeni Champa (AAB), Giant Governor (AAA), Lacatan (AAB), Malbhog (AAB) etc. are grown in small landholding ranging from 0.5 to 1 acres. The varieties like Bhimkol (BBB), Kechulepa (ABB), Kachkel (ABB) are grown in all homesteads along the household territory. Bananas are grown on bunds demarking ones own fields from the neighbour's fields. Bhimkol, a triploid, seeded, *balbisiana* clone is most widely grown backyard cultivar for its medicinal utilities. Though seeded, due to its soft seeded nature, pulp is consumed along with seeds. The other utilities of banana of northeastern folks is compiled and provided elsewhere in this report.

Meghalaya State is hillier compared to adjoining Assam located at an altitude of 800-1000 m. above msl. Garo, Khasi and Jaintia tribes thinly occupy the Garo, Khasi and Jaintia hills. During the present survey Khasi hill range of Meghalaya was partially explored for *Musa* variability. Commercialisation is slowly catching up owing to its vicinity to Shillong (the capital of Meghalaya) and changes have taken place in the field of horticulture. Shallow slopes of Khasi hills are put into cultivation by fruit crops like

banana and pineapple. The commercial cultivars of banana are the unique Kait Long (AAB) and Giant Governor (AAA) cultivated in a small scale. Borkal Baista (ABB) is another variety of homestead gardens. This is a triploid, non-seeded balbisiana clone with dual utilities of culinary and dessert purposes. In all the three states of Assam, Arunachal Pradesh and Meghalaya, an unusual utility of malebud as saled was documented. The immature male bud of wild banana even before the shooting is harvested and used for cooking special dishes.

These exploration expeditions conducted in the three northeastern states of Assam, Arunachal Pradesh and Meghalaya led to the collection of accessions including both wild and cultivated varieties. Though there are earlier reports about variability with respect to section *Rhodochlamys* apart from *Eumusa*. Present explorations confirmed the occurrence of *Rhodochlamys* in the forests of Arunachal Pradesh and Assam. Four unique types were identified and collected for planting in NRCB genebank whose subspecies level required further confirmation. *Musa velutina*, a *Rhodochlamys* member with pink coloured dehiscent fruits, was also found in Assam and Arunachal Pradesh.

Table 2. Details of new accessions collected during the exploration, 1998-99.

Section Eumusa - wild	8
<i>Musa acuminata</i> - 3 subspecies	3
<i>Musa balbisiana</i> - 4 clones	4
Section Eumusa - Genus <i>Musa</i> - cultivated	20
Acuminata - balbisiana hybrids - AAB and ABB types	
Balbisiana - diploid and triploid clones	
Section Eumusa - Genus <i>Ensete</i>	1
Section <i>Rhodochlamys</i> - wild	3
Species not identified - 3 clones	

During explorations in Diphu hills of Assam, *Ensete glaucum* (small) was noticed growing wild in the forest. The other members of *Eumusa* collected during exploration included two acuminata diploids and four wild balbisiana clones apart from AAA, AAB and ABB members.

Exploration phase II

Three northeastern states, namely Tripura, Mizoram and Southern Assam were explored during May 2000 for variability in banana and plantain. These are areas where natural introgression has occurred between *Musa balbisiana* of the Indian subcontinent with *Musa acuminata* from southeastern Asia.

Banana varietal situation in Tripura

Banana is one among the major fruits in Tripura after jackfruit, mango and litchi. Very few growers within the city limits are following annual planting system in some

commercial varieties like Silk and Monthan. Under Jhum cultivation system, banana is used as a shade crop and also raised all along the contour bunds for which hardy varieties like Cheeni Champa and cooking types like Somai and Kanchkola are used. Commercial clones of Tripura are Cheeni Champa (Mysore, AAB), Silk (AAB), Kanchkola (ABB), Somai (Pisang Awak, ABB) and other ethnic varieties.

Status of banana diseases in Tripura

Fusarium wilt is the main problem in almost all banana-growing regions. Susceptible cultivars in order of severity are Sabri (Silk) followed by Somai and Kanchkola. Among the viral diseases banana bunchy top is very rampant throughout the state with maximum occurrence on Cheeni Champa (Mysore, AAB). Occurrence was also noticed on Jahaji (Cavendish, AAA), Dwarf Cavendish and on Aittakola. Occasional occurrence on wild bananas was also noticed along the Teliamera and Attaramora forest ranges. Banana streak virus was seldom observed in all three states of Tripura, southern Assam and Mizoram. But in southern Assam, occasional occurrence was noticed in outskirts of Silchar town. Champa (Mysore, AAB) suckers obtained from south-central Mizoram expressed BSV symptoms.

Varietal situation in Mizoram

Amrit Sagar, a unique AAA cultivar, is popular among smallscale and backyard growers. This variety is popularly known as Vai Bahl-al or Cavendish. Banana is referred as Bal-hla in Mizo language like Kola, Kela or Vazhai. In the northern provinces, Cheeni Champa is commercially grown in areas of Bhaga Bazar, Vairengte, Bilkhaw Thlir, Kolasib, etc. This cultivation is influenced by popular cultivation of cv. Mysore in Assam district. Apart from the commercial cultivars, many wild types are abundantly grown. These are preferred for their male flower buds to be used as vegetables.

Wild bananas of Mizoram are (Chang-el):

- | | |
|---------------|---|
| 1. Changthir | 5. Chang Vandawt (<i>Musa ornata</i>) |
| 2. Changpui | 6. Sai Su |
| 3. Changpawal | 7. Lai Roop |
| 4. Lairawk | |

Local cultivars are (Bahl-al):

- | | |
|---------------------|-----------------------------------|
| 1. Banria (P. Awak) | 2. Vai Bah-Vaa Kual (Amrit Sagar) |
| 3. Ban Pawl | 4. Lang Bahlal |
| 5. Kawrmuat | 6. Balbattla Thir (Mysore) |

Changthir is the predominant *M. balbisiana* cultivar found grown through out Mizoram. Of all these wild types, Sai Su (*Ensete glaucum*) is the most unique wild type. Unlike other cultivars, Sai Su does not put forth any side suckers and seeds form the only source of propagation. Flower bud is unusually large, bracts are loosely packed and bracts are pale green in colour. Bracts are persistent in nature giving the flower bud the look of an inverted green lotus flower. The plant sap is unusually orange in colour. The succulent leaf sheaths is a popular vegetable sold in market in pieces of 1 to 1.5 ft. Fibre from the leaf sheath is used for making fancy articles. This wild variety is mostly seen in dry, sandy or rocky places.

Table 3. Details of *Musa* accessions collected during exploration.

Genus	Section	Site of collection	Species	No. of accessions	Economic utility
<i>Ensete</i>	-	Assam, Tripura, Mizoram	<i>Ensete glaucum</i>	1	fibre, vegetable, ornamental
<i>Musa</i>	Australimusa	-	-	-	-
	Calimusa	-	-	-	-
	Eumusa	Assam, Tripura, Mizoram	<i>M. acuminata</i>	9	fruit, vegetable
			<i>M. balbisiana</i>	1	
		Tripura	Cavendish (AAA)	2	fruit, vegetables
		Tripura	Red (AAA)	1	
		Tripura, Mizoram	Silk (AAB)	3	
		Tripura, Mizoram	Mysore (AAB)	1	
		Tripura, Mizoram	Pisang Awak (ABB)	3	
		Tripura	Unique	1	
	Rhodochlamys	Assam, Mizoram	<i>M. ornata</i>	1	ornamental
Assam, Tripura, Mizoram		Unidentified	5	-	

Constraints

These accessions from northeast have been collected from areas where temperature range is between 30-32°C (max), 4-6°C (min), 60-80% RH and an annual rainfall of 1600 mm. These accessions find it difficult to acclimatise and establish to the climatic conditions prevailing in Trichy, where maximum temperature ranges from 38-40°C with a minimum of 20-22°C and a relative humidity of 40-80% and an annual rainfall of 600 mm. Quite a few of these accessions which were brought from these exploration have been lost. Efforts are made to recollect them through resource persons from the respective states. Other alternatives of identifying one of the Northeast Agricultural University or State Horticultural Department to take care of one set of duplicate accessions is being explored by ICAR and NRCB jointly.

Characterisation

The accessions collected during the preliminary exploration to northeastern India were planted in the NRCB genebank for evaluation and characterization. The 15 character score card developed by Simmonds and Shepherd was used to give the initial genomic status. But the ambiguity posed by this score card in providing genomic states to various collections led us to develop a new score card, which is provided. The trend of scoring in most of the accessions for a particular genome was used as the score range. Though a modified scoring system was suggested, providing a distinct cut off scores for different

genomes was not easy. Many overlapping scores were noticed between the genomes like AAB and AB; ABB and ABBB, which need to be characterised using molecular markers.

Table 4. Modified score card for assigning tentative genomic groups.

<i>Genomes</i>	<i>Score card of</i>		
	<i>Simmonds & Shepherd (1982)</i>	<i>Silayoi & Chomchalow (1987)</i>	<i>Singh & Uma (1996)</i>
AA/AAA	15-23	15-25	15-25
AAB	24-46	26-46	26-45
AB	49	-	46-49
ABB	59-63	59-63	59-65
ABBB	67	-	66-69
BB/BBB	-	70-75	70-75

Evaluation and documentation

The explored accessions have been planted in NRCB field genebank and are being evaluated for their growth, yield parameters along with their reaction to biotic and abiotic stresses.

Musa germplasm information system (MGIS)

MGIS facilitates germplasm curator with a management tool for their collections and assembles the information available in these collections. This forms an international database for use by the researchers working on *Musa* conservation and improvement programmes. International Network for Improvement in Banana and Plantain (INIBAP), France, centralises the information from all the genebanks at global level after verifying its validity and coordinates all the activities of the system. As a first level programme, it organised training programme for the genebank curators in which a scientist from NRCB was trained. The Institute is provided with software to document the data on germplasm and to develop a database. This has been successfully installed at the centre and a database has been created with full details of characterisation and evaluation data for 50 accessions comprising of wild and cultivated accessions. The passport data has also been provided for 809 accessions collected by the centre.