FARMERS' KNOWLEDGE OF WILD *MUSA* IN INDIA

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Uma Subbaraya
National Research Centre for Banana
Indian Council of Agricultural Reasearch
Thiruchippally, Tamil Nadu, India

Coordinated by
NeBambi Lutaladio and **Wilfried O. Baudoin**
Horticultural Crops Group
Crop and Grassland Service
FAO Plant Production and Protection Division

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Eric A. Kueneman
Chief
Crop and Grassland Service
FAO Plant Production and Protection Division

FOREWORD

India is a treasure chest of biodiversity that hosts a large variety of plants and animals. It has been one of the major centres of origin and distribution for both wild and cultivated bananas (*Musa* spp.), especially for *balbisiana*-derived hybrids.

Due to the antiquity of bananas in India, their great diversity and long history of domestication, bananas are interwoven with national heritage and culture and have great socio-economic significance. The rich genetic diversity is an irreplaceable resource, providing materials for introduction, domestication and improvement programmes as well as opportunities for the search and selection of *Musa* genotypes resistant to pests and diseases.

The broad genetic pool maintained by farmers can be used for future banana crop improvement as banana is essentially a clonally propagated crop with many sterile species, which makes progress through conventional breeding slow and difficult. Due to the limited number of landraces and commercial varieties available and their asexual reproduction, bananas have a narrow genetic pool that makes them vulnerable to pests and diseases. As a result, new breeding methods and tools, including biotechnology and mutation breeding, will be helpful to develop resistant bananas for cultivation without the threat of genetic drift.

The Food and Agriculture Organization of the United Nations (FAO) is committed to preserving agricultural biodiversity as a way of helping people develop a suitable livelihood base for their own resources. The Organization has long been concerned with conservation and sustainable use issues, which have been the focus of various Regular Programme work and field-based activities. With regard to bananas, FAO is concerned about the disappearance of wild bananas and how human presence and expansion affect their biology, especially in Southeast Asia. The Organization calls for greater use of genetic diversity for strengthening breeding programmes in developing countries and for promoting awareness of the inevitable consequences of a narrow genetic base in crops and the need for a broader genetic base, especially in the case of commercial bananas.

The present case study provides an insight into the indigenous technical knowledge regarding multiple uses of wild and cultivated bananas for the benefit and advantage of the local population in India. The study provides a picture of distribution of wild and cultivated *Musa* species of interest in the country; it sets out the vital role of local knowledge in conserving biodiversity and ecosystem function in the different agro-ecological zones of India where *Musa* species occur. The study also describes in detail the involvement of the tribal and farming communities in the conservation, maintenance, perpetuation and spread of banana genetic diversity.

This report synthesizes the available information and documents existing data from micro-sample surveys on the status and trends of the indigenous knowledge, innovations and practices of local communities embodying traditional lifestyles relevant to the conservation and sustainable use of biological diversity of wild and cultivated *Musa* species in India. It summarizes the implications of farmers' production systems on the ecosystem and contributes to a better understanding of some of the causes and effects directly related to the risk of loss of banana biodiversity in India. Strategies are recommended for expanding the use of wild *Musa* in breeding programmes beyond its traditional use for food, feed, herbal medicine and handicraft, as most of the desired resistant gene sources to biotic and abiotic stresses are harboured by the wild species. The report contains valuable information on wild *Musa* and identifies various issues to be addressed.

Researchers, banana scientists and policy-makers will find the material useful, and the study will contribute to the dissemination of indigenous knowledge, technical information and consolidated research results on the practices relevant to the customary management, conservation and sustainable use of biological diversity of wild *Musa* that may be at risk of disappearing. This will support sustainable agriculture development and *Musa* improvement initiatives as well as FAO's Special Programme for Food Security (SPFS).

Mahmoud B. Solh
Director
Plant Production and Protection Division
Agriculture Department

INTRODUCTION

In India, bananas are interwoven with national heritage and culture and have great socio-economic significance. Bananas have been accepted as the symbol of prosperity and fertility and has been nurtured within the sacred precincts. It has been rightly referred to as 'Kalpatharu' (a plant of all virtues) owing to its multifaceted uses by humans.

In India, bananas are known for its antiquity from its mention in the epic, Ramayana (2020 B.C.), Kautilya's Arthasastra (300-400 B.C.) and its presence in paintings and sculptures of Ajantha and Ellora (600 B.C.) caves of Maharashtra. Growing bananas and mention of dwarf stature bananas and a banana having reddish sap have been quoted in Tamil literature dating back to 120 B.C.

Banana is the name given to a group of commodities that includes dessert bananas, cooking bananas and beer bananas. It not only represents the sweet dessert fruits, but is also a staple food of 400 million people in the underdeveloped and developing economies.

Bananas are grown in more than 120 countries over an area of 10 million ha contributing to the production of 95 million tonnes (Anon., 2001). India has been the largest producer of bananas with an annual production of 16 million tonnes from an area of 0.4 million ha and accounts for nearly 15 percent of the global production (Singh, 2002).

Due to antiquity of bananas in India, their long history of domestication and the great diversity of dessert cultivars, a large number of banana clones are believed to have originated in India. One of the earlier collections, *Musa acuminate ssp. burmanniccoides* has contributed significantly to many breeding programmes across the globe for developing varieties resistant to sigatoka leaf spot disease.

With the increased realization that some wild species are being over-exploited, the relationship between *in situ* and *ex situ* conservation benefits and costs for wild species as well as the impact of farmers' practices on the ecosystem should help guide policies as to whether species conservation should take place in nature or the nursery, or both.

Apart from the conservation issue, the indigenous knowledge of wild species of *Musa*, for instance, is a treasure, but little information is available on this aspect and the methodology or protocol for its meaningful utility is still lacking.

In this report, the author provides an overview of general occurrence and ethnobotanical knowledge of *Musa* species in different geographical locations and agro-ecological zones in India, and then describes *Musa* genetic diversity and its conservation by ethnic groups and the implications of production practices on the ecosystem. The report provides an understanding of some of the causes and effects directly related to loss of *Musa* genetic diversity and makes recommendations on steps that should be taken to expand the use of wild *Musa* in breeding programmes.

SCOPE OF THE STUDY AND METHODS

The author's employment in the National Research Centre for Banana under the Indian Council of Agricultural Research (ICAR) has enabled her to travel far and wide across the Indian subcontinent and undertake exploration programmes. These explorations stretched over a period ranging from 25 to 30 days travelling across the targeted areas and camping among the local tribes.

Focus group discussions, group interviews, interactions with local heads and local doctors among the tribes, informal conversation with women folk gave an insight into the Indigenous Technical Knowledge (ITK) with regard to the use of wild and cultivated species for their advantage. Participatory transect walks in various landscapes with men and women also added information on *Musa* usage. Details on the exploration zones are given in Table 1.

Interaction with local headpersons gave a picture of distribution of wild *Musa* species of interest, both in their locality and among neighbourhood areas. During the interactions with village folk, much information on seasons of flowering, fruit type, usage of fruits, nature of stress under natural conditions, means of species perpetuation, human interventions in their perpetuation and spread, etc. were gathered. Emphasis was also given on gender diversity and involvement of tribal and farming folk in the conservation and maintenance of genetic diversity. Discussions with women helped in gathering information on the issues like gender involvement in genetic conservation of *Musa* species in their backyards or in the vicinity of villages or in protected areas within the forests. A general questionnaire (Table 2) was developed and used during the surveys and exploration process.

As a routine exercise during explorations, *Musa* Descriptor (Anon., 1996) was used in which information regarding passport data, crop management data, collection site environment and *in situ* plant descriptor, etc., were collected.

AGRO-ECOLOGIES IN THE AREAS OF EXISTING WILD *MUSA*

Wild *Musa* species are largely distributed in some tropical rain forests, wet evergreen forests to deciduous forests of low rainfall zones. The hilly tracts of these areas harbour a mosaic of tropical forests where *Musa* species may occur (Figure 1).

Tropical rain forests are found in the northeastern Indian Himalayas including Assam, Arunachal Pradesh, Meghalaya, parts of Nagaland to the southeast of India proper, and also in the Andaman and Nicobar Islands. Some tropical forests still exist in Manipur, Mizoram, Tripura of northeastern states, and in interior areas of western Ghats of Karnataka and Kerala (Rao, 1996; Rao, 1999). The few remaining forests are disturbed by the incursion of humans.

These ecological zones are characterized by wide climatic variation ranging from tropical, and subtropical, temperate to alpine zones. The temperature ranges from 8-15°C (mean minimum) to 30-35°C (mean maximum) and average annual temperature is between 18 and 22°C. March to April are the hottest months while November-January are the cold months. Rainfall is well distributed throughout the year except for February-April. Tropical rain forests receive rainfall in the range of 3 200-3 800 mm per year and Chirapunji of Meghalaya state receives one of the world's highest annual rainfalls.

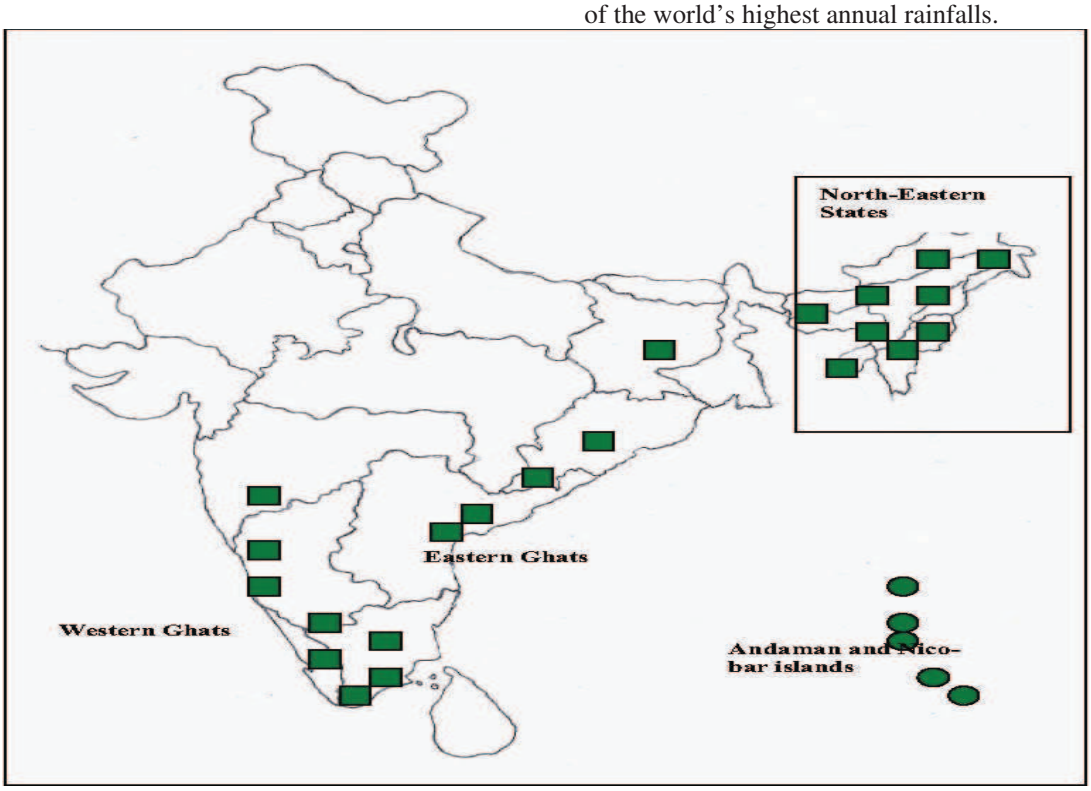

Figure 1. Areas of India where wild *Musa* occurs

Table 1. Details of exploration zones

States	Localities or locations	Number of villages or groups consulted (Approxi-mate)	Ethnic groups or tribes
Arunachal Pradesh	Tawang, West Kemeng, East Kemeng, Lower Subansiri, Lohit-	Villages > 50 Groups > 50	Nitshi, Apatani, Sherdukpens Adi Aka, Monpa, Mishmi
Meghalaya	Jowai, Nongpoh, Shillong	Villages > 15 Groups > 18	Garo, Khasi, and Jaintia
Assam	Kamrup, Kochbihar, Kokrajar, Nalbari< Dibrugarh, Tezpur, Kaziranga reserve forest	Villages > 32 Groups > 30	Koch, Bodo, Hajong, Aitunia, Karbi and Ahom
Tripura	Agartala, Ambassa, Udaipur, Dhrmanagar	Villages > 22 Groups > 20	Reangs, Chakmas, Meksha and Raichak
Mizoram	Aizawl, Kolasib, Ssairang, Seling	Villages > 20 Groups > 20	Luushai, Pawi, and Pang
Manipur	Imphal, Thamenglong, Noney, Ukhrul, Senapati	Villages > 30 Groups > 25	Manipuri, Kabui, Maram Meiteis, Thado and Ao
Nagaland	Dimapur, Kohima, Mao Song Sang	Villages > 25 Groups > 20	Naga, Sema, Angami, Ao, Mon, Lotha and Chakesang
Karnataka	Mysore, Coorg, Dharwar, Sirsi, Koraga, Kuruba, Sholiga	Villages > 35 Groups > 25	Jenu Kuruba, Bedar, Naika, Koraga, Kuruba, Sholiga
Tamil Nadu	Shevoroy hills, Pechipparai, Kanya kumari, Tirunelveli, Gudalur, Nilgiri Hills	Villages > 50 Groups > 28	Toda, Kattu Naikar, Ko rava,Malayali, Mudugar
Kerala	Silent Valley, Munar forest, KMTR reserve forest,	Villages > 25 Groups > 20	Irulas, Mylar, Malayalan, Mudugar
Andhra Pradesh	Arakku Valley, Tirumala Hills, Rajamundry, Vishakapatnam	Villages > 10 Groups > 10	Bhil, Chenchu, Gondu, Banjara
Andaman and Nicobar Islands	PortBlair, Chouldhari reserve forest, Rut Island, Bamboo Flat Island, Manglutan, Havelock Island, Ross Island	Villages > 30 Groups > 30	Andamanese, Bo, Shompen, Nicobarese, Sintelenese

Tropical moist forests receive an annual rainfall of 1 200-1 600m. Southwest monsoon accounts for the maximum rain in the northeastern states, western Ghats and Andaman and Nicobar Islands from April-August. Depressions during November-December and the southwest monsoon make up the annual rainfall in eastern Ghats and Andaman and Nicobar Islands. Relative humidity is usually high ranging between 82 and 85 percent.

Domesticated banana is basically a tropical crop but can grow in the warmer parts of subtropical regions. Of their progenitors, *Musa acuminata* is more tropical, but some subspecies of it can also be found at the edges of the subtropics or in tropical highlands. *Musa balbisiana* can be found farther north and in areas with strong dry seasons. In India, the remaining wild species occur at an altitude between 500-1 000 m above sea level in the sub-Himalayan mountains and western Ghats (Figure 2). In northeastern India in Khasi, Jaintia, Naga, Patkai and Garo hills, wild *Musa* species may occur also at both lower and higher altitudes. In the western Ghats, two centres of diversity, namely Agasthiarmalai and Silent Valley, are under moist tropical evergreen forests where evolution of *Musa* species has taken place separately from the northeastern zone.

Table 2. Types of questionnaires used during the surveys and exploration process

Type of questionnaire	Questionnaire A	Questionnaire B	Questionnaire C
Target group and topics of questionnaire	For individuals or individual families	For village communities – General Information	*For village community – on improved varieties*
Information requested	1. Name and family details 2. Land holding (backyard; community land or Jhum cultivation) 3. If backyard: types of fruit plants maintained 4. If bananas are grown: ▪ varieties grown; ▪ number of clumps maintained per variety; ▪ nature of cultivation (perennial or rationing); ▪ cultivation practices; ▪ disposal of bunches (consumed or sold to village market or sold to contractors); ▪ importance of bananas and plantains in their diet; ▪ other uses of the plant like flower buds, pseudostem core, etc., ▪ indigenous technical knowledge (ITK).	- Village holding and types of tribal communities - Distribution of tribal communities - Types of vegetation and prevailing farming systems - Composition of surrounding vegetation - Extent of spread of wild *Musa* - Types of wild *Musa* in their area - Distribution pattern of wild *Musa* - Intensity of spread of wild *Musa* species - Climatic conditions of the location (temperature, rain fall, length of winter period, number of rainy days) - Occurrence of natural calamities (drought, floods, frost and frequencies of occurrence) - Utility of wild species - Extent and mode of commercial exploitation, if any - Important traits noticed for the wild *Musa,* like better fibre content, sweet pulp, enhanced ash/dry matter content of plant parts - Distinct traits of wild species like rhizomaous roots or erect bunch or seedy fruits - Observation on the wild spp. About their adaptations to abiotic stresses like drought, high/low temperature - Natural conservation of wild species - Community efforts to conserve efforts wild *Musa* species, if any - ITK of wild species - Validity of proof, if any on ITK	- Number of domesticated *Musa* varieties - Time since they have been cultivated - If there is a new introduction, source and mode of introduction - Reasons for cultivating a new variety - Socio-economic reasons for introduction of new varieties - Marketing channels for commercial varieties - Method of multiplication of commercial varieties – suck bits or peppers, seeds - Mode of exchange of material - Mode of conservation, season and duration of conservation - Conventional value added products, if any

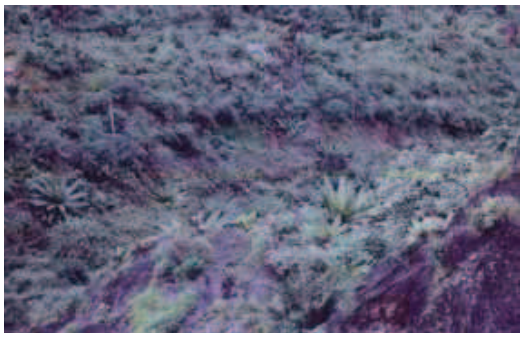

Figure 2. Natural habitats of wild *Ensete superbum* in western Ghats

The Andaman and Nicobar Islands (Figures 3 and 4), consisting of 350 islands and islets, lie in the Bay of Bengal (latitude $6^{o}14^{o}$N and longitude of 92-94^{o} E). Within a land area of 8 500 km^{2}, endemic flora has evolved over millions of years due to insular nature and physical isolation among islands and also from neighbouring continental land masses. The major islands are: North Andaman, Middle Andaman, South Andaman, Little Andaman, Car Nicobar, Teressa, Katchal, Kamorta, Noncowry, Little Nicobar and Great Nicobar.

Figure 3. Natural habitats of wild *Musa* spp. in Andaman Islands

Eastern Ghat forests are located along the coastal line of the Bay of Bengal. Originally they extended from northern Orissa down to Andhra Pradesh. However, due to rapid deforestation in this zone, hardly any forests exist except for some pockets of northern Andhra Pradesh in Arakku Valley and southern Orissa where wild *Musa* species are known to occur. They are low hills with an altitude of 300-400 m above sea level, annual rainfall ranging from 900-1 300 mm and RH of 78-80 percent. The occurrence of *Musa* species in different geographical locations in India is illustrated in Annex 1 whilst the genetic diversity of wild bananas is shown in Figures 5 to 15.

Figure 4. Natural habitats of wild *Musa* spp. in Nicobar Islands

GENETIC DIVERSITY OF WILD BANANAS

Figure 5. *Musa sanguinea*

Figure 6. Musa balbisiana var. Andamanica

Figure 7. *Musa rosaceae*

Figure 8. *Musa balbisiana*

Figure 9. *Ensete glaucum*

Figure 10. *Musa itinerans*

Figure 11. *Musa rosaceae*

Figure 12. Buds of several wild and semi-wild species at different stages

Figure 13. Fruits and seeds of *Ensete* glaucum

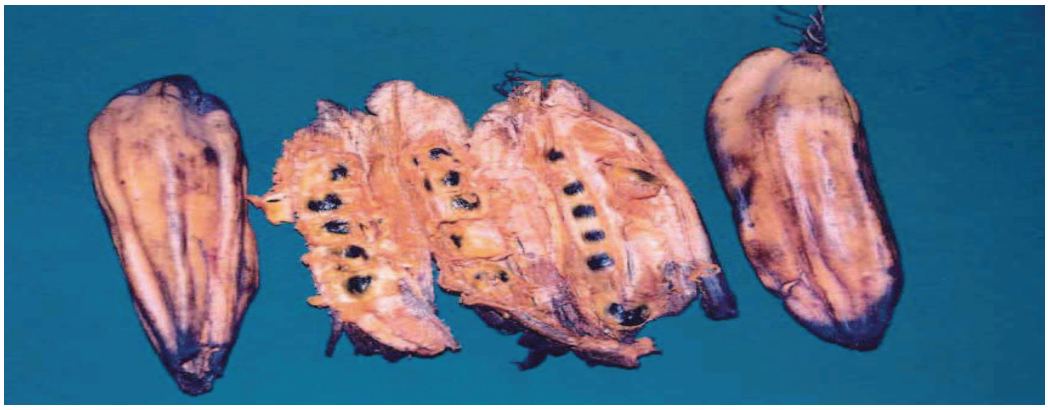

Figure 14. Fruits and seeds of *Ensete* spp.

Figure 15. Fruits and seeds of wild *Musa* spp.

MUSA AND ITS EVOLUTION

Bananas belong to the family *Musaceae*, in the order Zingiberales. The family *Musaceae* has two genera, *Musa* and *Ensete*, of which *Musa* encompasses wild and domesticated bananas and plantains. *Musa* has been subdivided into five sections, *Callimusa, Australimusa,* Eumusa*, Rhodochlamys* and Incertae sedis (Daniells, *et al*., 2001). The genus *Ensete* is present in Africa and Asia, and is considered an old and relict genus with few good species.

> [Editor's note: The reader is referred to Simmonds' classical book "The Evolution of the Bananas" published in 1962 for a succinct overview of banana evolution. Most of that treatment still stands, but three recent papers by Wong, *et al*. question the separateness of the sections. In these papers they combine *Musa* (Eumusa) with *Rhodochlamys* and *Callimusa* with *Australimusa.* It remains to be seen if these combinations will stand the test of more extensive research and time. In any case, the old section *Callimusa* contains small-statured ornamental bananas, *Rhodochlamys* also contains ornamental bananas, *Australimusa* contains the fibre bananas, *Musa textilis*, and the Pacific domesticates called 'Fe'i' bananas. The old section Eumusa contains the abundance of domesticated bananas and their progenitor wild species, as well as others.]

Domesticated bananas are parthenocarpic and generally seedless. Nearly all existing varieties were domesticated in prehistory by villagers of India through to New Guinea. Seeded *Musa acuminata* (Genome AA) became the progenitor of parthenocarpic AA diploid clones and of AAA triploids. The great bananas of international commerce (Cavendish) is an AAA triploid derived from pure *Musa acuminata*. The main area of domestication of pure *acuminata* types was probably Malaya and neighbouring islands and areas as far east as the Indo-Chinese peninsula.

The majority of domesticated alones, however, are of hybrid origin between *Musa acuminata* and the other major wild species in Eumusa, *Musa balbisiana* (Genome BB). They are either AB, AAB, or ABB in genomic terms.

The key mutation required to convert wild banana fruit into readily consumable fruit was parthenocarpy. This trait is governed by one or a few genes and it enables the fruit to fill with pulp even in the absence of pollination. This is different from seedlessness, which is governed by other genes, or induced by triploidization. Parthenocarpy must have occurred many times in *Musa acuminata* in Malaya and surrounding areas, enabling local people to pick up and grow different types which gradually became less seedy as other mutations occurred for seedlessness or as triploids occurred naturally.

> [Editor's note: For *Musa balbisiana*, the situation was different. Pure parthenocarpy either did not occur, or it was not picked up. Although Simmonds shows this species ranging from Sri Lanka and southeast India through to northeast India, Myanmar, South China to the Philippines and New Guinea, it is still not clear in how much of this area truly wild *Musa balbisiana* was and is native. In ancient times suckers of this species must have been carried far and wide as people migrated away from areas where it was native since it was and still is used today as a favourite leaf-banana. Its leaves are hardly affected by leaf spots and are favoured and sold for wrapping food and for plates. Thus, this other species was, in effect, domesticated, and, being highly male fertile, and at first, female fertile, hybridization occurred readily with the fruit-favoured parthenocarpic *acuminatas* in the villages. With time, these "domesticated" balbisianas were selected for soft-seeds and for fewer seeds and now these types are largely sterile, are given names and propagated by suckers. In this paper, the author treats

these as a wild species, whereas, in fact, they are domesticated, soft-seeded clones. In any case, it is not known how much of the hybrid A and B clones resulted from domesticated *acuminata*s being moved into areas where native wild *balbisiana* was present or how much was due to *balbisiana* clones being moved into *acuminata*-containing villages.]

India contains the largest number of hybrid AB clones of all types. It is reasonable to believe that most AABs and ABBs were from India and nearby areas such as Myanmar, Sri Lanka and Thailand. In India, it is well accepted that India is a major centre of domesticated banana origin and domestication (Singh and Suryanarayana, 1997; Jogiraju, 1931; Jacob, 1942a; Venkataramani, 1949; Chakravorti, 1948b; Chandraratna, 1951; Gandhi, 1952; Dutta, 1952; Nayar, 1952, 1958; Singh, *et al*., 1998; Uma and Selvarajan, 2001).

[Editor's note: It is believed by many that *Musa balbisiana* is truly wild in parts of the Philippines where there is some diversity and good seed viability and that this area was another site of hybrid AB domestication.]

WILD *MUSA* SPECIES IN INDIA

The major concentrations of wild species remaining in India is in the far northeastern states abutting China and Myanmar on the north and east and Bangladesh to the west.

In the southeastern and western Ghats there was formerly much forest, now mostly gone. With the disappearance of forest there is a disappearance of wild bananas. Sparse remnants remain at a few sites.

> [Editor's note: Much more field work and taxonomic work will be required to elucidate what species still exist in the wild in different parts of India.]

SECTION EUMUSA

Among the five major sections, Eumusa has at least 11 species and most of the edible bananas. *Musa acuminata* and *Musa balbisiana* in this section are the progenitors of most of the edible bananas.

Figure 16. *Musa nagensium* with elegant black pseudostem

Of the possibly 11-12 existing species of Eumusa, India has possibly seven: *Musa acuminata*, *Musa balbisiana*, *Musa itinerans*, *Musa nagensium*, *Musa aurantiaca*, and, possibly, *Musa sikkimensis* and *Musa cheesmani*. These last two were reported by Simmonds (1962) as well as an eighth species, *Musa flaviflora*, all from Assam.

Musa itinerans, a unique species with spreading rhizomatous roots, is distributed in Manipur (Simmonds, 1962), Mizoram and Arunachal Pradesh (Uma, *et al.*, 2003b). *Musa nagensium* (Figure 16) has been recorded in all northeastern states, Meghalaya, Manipur and Arunachal Pradesh, and it forms an exclusive underflora in the moist evergreen forests. In Arunachal Pradesh forests, *Musa nagensium* stretches over several hundreds of acres monotonously while *Musa aurantiaca* also occurs (Figure 17).

Figure 17. Natural clump of *Musa aurantiaca*

At least ten subspecies of *Musa acuminata* have been named and others probably exist. The Indonesian islands still having forests contain most subspecies and an abundance of wild plants. The remaining forests of Indochina, Malaysia and the Philippines and New Guinea also contain much *acuminata*.

In India, *Musa acuminata* has been identified in the natural habitats of Kaziranga forest

range of Assam, Khasi hill ranges of Meghalaya, southern and middle Andamans and in western Ghats of Karnataka. Surprisingly, Arunachal Pradesh with maximum diversity for other *Musa* species harbours less *Musa acuminata*. Morphotaxonomic and molecular characterization of these wild types revealed their identity to be *banksii, burmannica* and *burmannicoides*, suggesting that India has only three subspecies of *acuminata*.

[Editor's note: The mention of *Musa banksii* as present in India has to be in error as this subspecies is centred in New Guinea and not known west of Sulawesi. Also, whether *Musa burmannica* and *burmannicoides* are really different subspecies is questioned by such authorities as Shepherd.]

DIVERSITY OF *MUSA BALBISIANA*

The "B" genome from *Musa balbisiana* has been a rich genepool for many genes conferring resistance to various pests and diseases. Due to limited variability, this species has not been separated into subspecies. The wild accessions are simply mentioned as 'types' represented by the area or locality from where they were collected. *Musa balbisiana* is distributed in all the natural habitats of bananas, for example, Tamil Nadu, Kerala, Andhra Pradesh, Karnataka, Bihar, Orissa, West Bengal, northeastern states, and Andaman and Nicobar Islands. When wild forms of *Musa balbisiana* are discussed, it is very important to mention *Bhimkol* and *Elavazhai*, two wild types which have assumed the role of commercial varieties among the Assamese people and folks of western Ghats of Karnataka and Kerala, respectively.

[Editor's note: Whether *Musa balbisiana* is truly wild and indigenous in the states the author lists is probably not established. Since this species has been spread widely by humans in migrations, probably as suckers, it is now, indeed, present widely in villages. Where the clones are largely sterile and with distinctly different characteristics, they are really domesticated clones such as the ones described below. They are not "wild bananas". Feral *Musa balbisiana* could occur around villages, where introductions have been of fully fertile individuals.]

BHIMKOL

This is the most popular *Musa balbisiana* wild seeded type (BB) which has crept into large scale cultivation in northeastern India. Over years, *Bhimkol* (Figure 18) has been accepted as a household variety and is no more considered as wild. *Bhimkol* has its maximum distribution in Assam and to some extent in neighbouring states like West Bengal, Meghalaya, etc.

Bhimkol surprisingly has no localized cultivation on a stretch of land but each and every Assamese household has a minimum of four to five *Bhimkol* clumps in its backyard and its cultivation is approximately worked out to be on more than 8 000 ha. For a wild variety, this popularity is worth mentioning, which is attributed to several of its good traits mentioned under ethnobotany.

Figure 18. *Bhimkol*

Discussion with people and the available literature gave no specific mention of its era of commercial recognition. It is, however, evident that *Bhimkol* has been grown from time immemorial by Assamese tribes. Complete survey and study of diversity using morphological and molecular characterization has led to the understanding that the diversity among *Bhimkol* is almost nil. This owes to the fact that *Bhimkol* has strong pollination and fertilization barriers and the seed development is always incomplete. The ovules enlarge to become seeds but they are devoid of any endosperm and well developed embryo. Hence they are empty-seeded fruits. This trait of soft seededness makes it acceptable to eat as is pomegranate (*Punica granatum*).

ELAVAZHAI

It is a common seeded, diploid, wild type grown in all rural households of western Ghats of Karnataka. The main uses of *Elavazhai* (Figure 19) in daily life is the use of leaves as dining plates, as a part of their culture.

It is also used as a shade crop in areca palm plantations. Mixed cropping with this wild type is found to improve the microclimatic conditions favourable for arecanut. The leaves are also preferred for cooking special dishes over the leaves of other banana varieties, which are affected with foliar diseases.

Figure 19. ***Elavazhai***

CONSERVATION OF *MUSA* GENETIC DIVERSITY BY ETHNIC GROUPS

Indian people, irrespective of their geographic locations, consider bananas very close to their culture owing to their versatility and use by humans and animals. Conservation of useful and unique types is given more emphasis, while wild types, especially *Musa nagensium*, *Musa itinerans* and *Musa balbisiana*, exhibit persistent perpetuation in nature in some areas of the northeastern states (Figures 20 to 27).

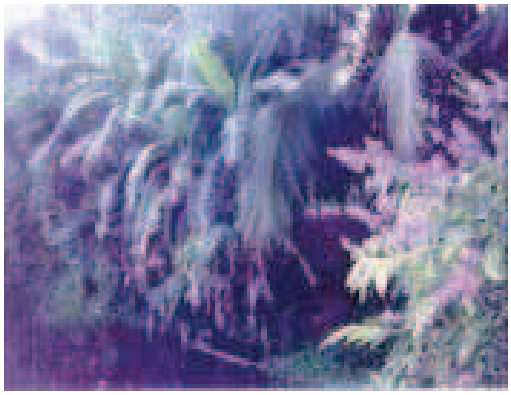

Figure 20. Conservation of wild *Musa* species around the family pond

By nature, *Bhimkol*, the most cultivated or domesticated wild type is hardy and perpetuates by its copious suckering habit. Every Assamese rural household has an area of not less than one acre with a house built in the centre, with a pond and garden. *Bhimkol* is grown along the boundaries to demarcate one's ownership. *Bhimkol* is planted and also maintained around the family pond to provide ducks and fishes a fine microclimate. Invariably *Bhimkol* gets perpetuated as a live hedge plant and folks maintain the best types discarding weak and poor-yielding offspring.

Musa itinerans, one of the truly wild species, exhibits large scale localized distribution in the West Siang district of Arunachal Pradesh around Hapoli, Potin and Sessa areas. Being stoloniferous in nature, they spread to a larger distance and occasionally become a nuisance in fields prepared for cultivation. In such cases, though they are cut and burnt, the local Adi tribes make sure that few clumps are left on the far side of the field or plant a few stoloniferous suckers in their backyard for their survival and maintenance.

Musa rosaceae (Syn. *Musa ornata*), one of the Rhodochlamys members is found in the plains of Lakhimpur in Assam, Subansiri, East Siang, Dirang districts of Arunachal Pradesh. It is distributed in clusters in wet humus mixed alluvial soils along the river courses. It is also abundant in central Mizoram. Nitshi and Adi tribes of Arunachal Pradesh and Mizo tribes of Mizoram harvest flowers for vegetable purpose and the rhizomes for cattle feed or for preparing medicine from its ash. While doing so, the complete destruction of a clump is avoided. Children are also taught to leave a couple of clumps for multiplication while collecting the flowers and rhizomes.

Figure 21. Conservation in a backyard garden

In villages, Gami near Daporijo (Arunachal Pradesh), where a unique hybrid of *Musa velutina* has been noticed, the Adi tribes are aware of its uniqueness and have multiplied the clumps along the water course in the outskirts of their villages. Surprisingly, even children, while collecting mature fruits for eating, spit the seeds and automatically cover the seed with soil with their foot. Spitting and seed covering are an integral part of eating wild banana fruits. This is a very unique way of conservation and perpetuation of wild *Musa* germplasm. Similar conservation practices have been adopted for *Musa aurantiaca* and *Musa sanguinea*, but in the case of *Musa velutina*, the situation is very different. It grows as a weed in Arunachal Pradesh (Bhalukpong area of West Kemeng district and Namsai forests of Lohit district) and villagers use the flower buds for vegetables. Whenever a large number of clumps of *Musa velutina* is removed as a weed, a few are planted along the bunds, backyard boundaries and on roadsides, by the women in the family. Whenever a tribe relocates from one place to another, the women become responsible for collecting a few suckers of each of the wild and cultivated species of bananas and establish them in their newly occupied land.

Figure 22. Conservation around sacred trees of the village

Ensete glaucum is well distributed on the Mizo hills of Mizoram and sparsely in Diphu hills of Assam. Being essentially non-suckering, seeds form the only way of propagation. Most households have a plant or two, in their backyard. As the plant grows, sheaths are ripped off and used as a vegetable. At least one plant, is left without being used and taken good care of by the female members of the family to make sure that it produces seeds and plants for the next year. Planting material is shared or sold only when the family is assured of sufficient material for its use.

Figure 23. Conservation around the village school complex

In Western Ghats, a clone of *Musa balbisiana* called *Elavazhai* is the only type with wide distribution. Ela means leaf, Vazhai means banana. This clone is the main source of everyday dining plates for each family. Each rural house is located in an area of 0.5-1.0 acres which harbours most of the plants required for daily needs. Bananas are an integral part of backyard gardens. Many families have family graves in a corner of their backyard considered sacred. Suckers of types like *Elavazhai* are usually planted in such vicinities where surroundings are kept clean. Ten to twenty clumps of *Elavazhai* are maintained in each household by the elderly women. Fertilization and irrigation, etc. are taken care of by them. A few suckers are carried along while visiting relatives, as a gift, together with banana fruits, flowers, betel leaves and sweets.

Among all the natural habitats, the situation of wild bananas in Andaman and Nicobar Islands was grave. Wild bananas have a restricted distribution and few people are aware of their existence. Only a few households had *Musa balbisiana* in their backyards, mostly the Bihari and Bengali communities migrated from the mainland. Exchange of suckers was witnessed in the same communities when better yields and soft seeded fruits are desired. *Musa acuminata* was seen occurring naturally along the watercourses. No human intervention for its conservation was noticed.

Figure 24. Wild *Musa* acuminate along watercourse

Forests of western Ghats of Kerala and Karnataka rarely harbour *Musa acuminata* in the Anaimalai hills of Kerala, KMTR forest ranges, Pechiparai areas, Shevroy hills of Yercaud, Nilgiris and Kodai hills of Tamil Nadu. In the Attappady valley of Agasthiar hills (Kerala state), Irulas and Mudugar tribes are the custodians of *Musa acuminata* subspecies *burmannica* and *En sete superbum* (Uma, *et al.,* 2002). Though not grown in their backyards, these tribes keep a watchful eye against destruction from wild elephants and wild boars in the forests where clumps are growing naturally. In such cases, a few suckers may be shifted to a safer place for their perpetuation.

Figure 25. *Musa velutina* hybrid conserved by the locals

In some regions, the local ethnic groups have a fair knowledge of wild banana varieties and their uses. Hence, over years, their cultivation and maintenance have become part of every village household. The eldest women folk are generally involved with kitchen gardens including bananas and become the custodian of genetic material. They decide whether the number of clumps available in their gardens is sufficient to produce fruits or sufficient to get burnt ash, etc. throughout the year for the family in regular succession. If not, new planting is undertaken.

[Editor's note: It is not clear if the author is referring to more than domesticated clones of *Musa balbisiana*.]

Figure 26. *Ensete glaucum* conserved and pampered as a garden

For new planting, healthy-looking suckers from the existing clump or from neighbouring villages are used. Exchange of healthy and robust plant suckers among relatives during their visits is a common feature and thus perpetuation of elite clones is maintained among the tribes.

Figure 27. Assam women providing ethnobotanical information on *Musa*

ETHNOBOTANICAL KNOWLEDGE OF *MUSA* SPECIES

Figure 28. Cut pseudostem of *Ensete glaucum* for sap collection

In forested areas, where people are still food gatherers, a knowledge of biodiversity is inextricably interwoven into the social culture and is the main source of providing livelihood. Humans living in a natural environment comprising land, water, plants, animals, etc. have confronted problems for their existence and found solutions managing the elements of nature. This knowledge consists of much useful information, which is passed on from generation to generation. People exclusively depend on the local resources and on indigenous knowledge for their existence in a fragile ecosystem.

Figure 29. Sap of *Ensete* glaucum collected for its medicinal properties

Figure 30. Yet to open flower buds of wild bananas sold in the market as vegetable

Figure 31. Packed leaves of *Musa balbisiana* sold as dining plates

Musa species have been an inseparable element to the people who live in forests away from the modern world. The tribes and ethnic groups exploit them for their basic necessities like food, fodder, fibre, shelter and medicine, etc. (Figures 28 to 33). It is wise to acknowledge the importance of farmers' indigenous knowledge. This will form the basis for the future management of genetic resources if sustainable agriculture is to be achieved and farmers' livelihoods ensured (Almekinders, *et al.*, 2000). Interaction with farmers and tribes has depicted a wide spectrum of ethnobotanical uses of *Musa*, but some beliefs are difficult to validate (Annex 2).

FARMERS' PRODUCTION PRACTICES ON THE ECOSYSTEM

Figure 32. Mature flower buds of wild bananas sold as vegetable

Wild bananas occur in the humid and evergreen forests of northeastern India, western Ghats, eastern Ghats, and Andaman and Nicobar Islands. A wide array of tribes cohabiting the forests with wild bananas has diverse ethnic and sociocultural backgrounds. They have a way of farming and modes of agricultural production different from the garden and wetland production in the plains. Irrespective of the tribe, people are generally referred to as **Jhumiyas**, based on their agricultural practices. They follow Jhum cultivation, also known as Slash and Burn cultivation (Figures 34 and 35).

Figure 33. Inner core of the pseudostem of wild bananas sold for salad

JHUM CULTIVATION

Jhum is a special kind of agricultural practice among the indigenous people of the northeastern states, Andaman and Nicobar Islands and western Ghats. This method is also known as '**Slash and Burn**' cultivation. Jhuming involves clearing a forest area by cutting and burning of trees and then taking up cultivation. The livelihood and culture of the tribal people in forested areas depend on Jhum cultivation to a great extent. Choice of land for Jhum cultivation depends on certain criteria that include slope, water source in the vicinity and fertility of the soil, etc. 'Moinosh' soil that is both sandy and rocky is preferred by the cultivators. Abundance of earthworms in soil is seen as an essential pre-requisite for Jhum cultivation. Land is processed or prepared from January to March by clearing off the trees and bushes for Jhum cultivation. Sowing or planting is taken up in the whole month of March and crops are ready for harvesting by August and the land is left fallow after. Usually, the land is left

fallow for 10-15 years to let it regain its fertility.

Figure 34. Forest clearing – Jhum cultivation

IMPLICATIONS OF JHUM CULTIVATION

Jhuming still remains the main cropping system among the tribal people. It is a way of life that encompasses their social and cultural values and goes beyond the narrow mores of economic values. The entire process of Jhum cultivation and harvesting is based on the concepts of common land ownership, exchange and sharing. The system was practiced by the hill tribes for centuries and was in harmony with their ecology (Hasan, 2003).

Figure 35. Forest burning – Jhum cultivation

Several interactions held with the local people in exploration sites revealed that irrespective of geographical location, type of tribe and their socio-economic status, all had a common opinion that centuries ago, hill farming models were sustainable but only lacked a steady cash flow. Each family had enough fertile land demarcated for year round cultivation of cereals and pulses, etc. This was supported by a larger common area, village forest or community forest. However, with the present situation, hill tribes are no longer able to sustain themselves for the whole year. Some of the reasons attributed to the decline are:

a. Earlier, under Jhum cultivation, the land was left fallow for 15-20 years, which allowed the forest to regenerate and the soil to stabilize. Due to increases in population and shrinking area under forest cover, however, people are forced to cultivate the same land more frequently. The frequency of leaving the land fallow has been reduced from 15 years to three to five years during which the forests have become permanent settlements and have turned into wasteland in no time.

b. Due to large numbers and frequent grazing of animals owned by the tribes, regeneration of forest seedlings is severely hampered and young shoots are trampled. Barren lands have made the soil more vulnerable to erosion.

c. Uncontrolled grazing, along with forest fires and encroachments have also contributed to faster depletion of fertile soil cover.

d. The forests are also being cleared due to exclusive dependence on tribes for the supply of fuel wood (Figure 36).

e. Development, in terms of construction of roads, dams and bridges in the forest zone, has brought in accelerated depletion of the natural biosphere (Figure 37).

Figure 36. Forest being cleared inhabited with wild bananas in Andaman and Nicobar islands

The tribal home gardens or backyard gardens are the well accepted 'Micro Diversity Areas' and have been the treasure spots for preserving and utilizing a great diversity of crop species like *Musa*, citrus, cereals, pulses, and even cultivation techniques. The women have been the custodians of these gardens giving variety to the daily menu, enriching the diet and often providing supplementary income. *Ensete* glaucum, with various names such as Chang Pawl and Sai Su, is used for fibre and vegetable. Other named varieties with uncertain status that are used for fibre extraction by poor tribal families over generations are Lairawk, Chang Their, Bantaw and Chang Wandawt.

With the present scenario in Jhum cultivation practices, tribes are quite aware of the fact that there is a fast erosion of valuable plant species. Village doctors spend long hours, searching with great difficulty for *Musa* or other medicinal herbs in the forest to prepare native medicines.

Figure 37. Developmental activities like roads and bridges enable destructive human incursion

Many other species like *Musa* sikkimensis and *Musa nepalensis*, etc. were described to be widely distributed in northeast Indian forests (Simmonds, 1962), but now have a very localized distribution, or are gone altogether.

The most important example of the extinction of wild *Musa* is that of *Musa acuminata* spp. *Burmannicoides*. There is a single clone remaining, taken from the Indian Botanic Garden in Calcutta, named Calcutta-4. As the name suggests, it traces its origin in northeast India/Myanmar. It has been the only gene source conferring resistance to dreaded black Sigatoka leaf spot disease caused by *Mycosphaerella fijiensis*. None of the recent explorations conducted by various Indian organizations could locate this species in its natural habitat and there is every chance that it has been completely wiped out by human incursions. This wild species is available only as a single accession, Calcutta-4, at the International Transit Centre (ITC), Belgium, which supplied it to banana breeding programmes. This has been an eye-opening tragedy witnessed by *Musa* scientists in the last four to five decades.

This awareness of genetic erosion has slowly crept into the minds of farmers and local

tribes (Figures 38 to 43) and therefore a steady thrust on conservation of genetic resources is being emphasized. Government, environmentalists, farmers' organizations and local tribes have given momentum to this movement. *Musa* is one among the several prized crop species having importance in terms of conservation.

Owing to its multifaceted uses (Figures 44 to 46) as food, fodder, fibre, shelter and medicine for existence of tribes against forest hardships, a number of projects aimed at rebuilding and conserving natural resources, including *Musa* species, are being operated in the context of their vulnerability to genetic erosion.

For example, '**Hahn Chhantu**' is a non-governmental organization operating in Mizoram State involved indirectly with the conservation of *Musa* germplasm. '**Hahn Chhantu**' meaning the rescuer of ethnicity or community was established in 1994. This was started with an aim to achieve self support or self-sufficiency for local tribes from locally available natural resources. The organization is encouraging the tribes in the cultivation of wild *Musa* species.

The Changel group of bananas, otherwise the wild species, are usually used for fibre extraction purposes and the use of commercial varieties for fibre extraction is seldom seen. Local tribes, the Mizos, Lushais, Lakhers, etc. are educated in the use of wild bananas for fibre extraction, which is a sustainable source of income to the poor families. Local tribes collect the whole plant of wild varieties at the time of shooting. A local technology has been developed by the NGO for extraction of fibre from banana pseudostems. The tribal folks are given training for 15-20 days to extract banana fibre to make banana fibre crafts. The organization supports the tribes to extract fibre in their households or in community areas of villages. Orphans and destitutes are employed by the organization for making handicrafts using fibre bought from local tribes. Slowly, the organization is extending its activity to jails, remand homes and dead-diction centres and helps them to earn money and conserve the wild species.

ETHNIC GROUPS OF NORTHEAST INDIAN STATES

Figure 38. Discussion with Naga tribes

Figure 39. Akka tribe of West Kemeng

Figure 40. Adi tribe of Siang

Figure 41. Apathani tribe of Subansiri

Figure 42. Nitshi tribe of Kemeng district

Figure 43. Monpa of Tavang district

CHARACTERIZATION OF WILD *MUSA* GERMPLASM

Taxonomic characters of the wild bananas known and accepted as of 1962 are given numerical values by Simmonds in his little book on evolution of bananas. Twenty-five morphological characters are used and these are given for 13 species in Eumusa, four species in *Rhodochlamys*, five in *Australimusa*, and four in *Callimusa*.

Figure 44. Wild species collected for fibre extraction by northeast tribal women

For domesticated cultivars, a similar notation was provided by Simmonds and Shepherd (1955). This was modified by Singh and Uma (2000). Use of this system for cultivars enables determination of ploidy and the genome dosage from each of the wild parental species, *acuminata* and *balbisiana.* Thus, cultivars are determined as AA, AAA, AAB, ABB, BB and BBB. Using this characterization method, the author has analysed 70 wild and cultivar accessions.

Although isozymes were used earlier to characterize germplasm, these have been replaced by RAPDs (Random Amplification of Polymorphic DNA) of which the author characterized 16 accessions of *Musa balbisiana*, which included soft-seeded cultivars as well as hard-seeded wilds. They grouped into three clusters. By morphological classification they grouped into seven clusters. The average polymorphism amongst accessions was 74.6 percent. The results obtained from RAPD and morphological characterization exhibited almost 92 percent similarity. The geographic distribution of the test clones had an effect on clustering. The wild types from Assam forests grouped together (Uma, *et al.*, communicated).

Wild *acuminata* from Andaman were grouped into two clusters by the use of RAPDs. These differed from the *acuminata*s from mainland India. From Andaman there were similarities with accessions from Sumatran islands, and those from northeast states were similar to accessions from Malaysia, Myanmar, the Philippines and Thailand.

Figure 45. Handicrafts made from wild banana fibre

Overall, morphological and molecular characterization of wild *Musa* species has highlighted the localized evolution and diversification at various geographical locations in the Indian subcontinent.

POTENTIAL AND CONSTRAINTS OF USING WILD *MUSA*

Bananas (*Musa* spp.) have a number of pests and diseases co-evolved owing to long periods of evolution. Among the insect pests, banana rhizome weevil (*Cosmopolites sordidus*) and pseudostem borer (*Odoiporus longicollis*) and nematodes (*Radopholus similis, Pratylenchus coffeae, Meloidogyne incognita, Helicotylenchus multicinctus*) are causes of concern. Among the diseases, Fusarium wilt (*Fusarium oxysporum f.sp cubense*), Sigatoka leaf spot (*Mycosphaerella musicola, Musa fijiensis*) are the major constraints. Recently, a new leaf spot disease has been identified in India, *Mycosphaerella eumusa,* that causes considerable damage to many commercial clones in India. Among viral diseases, Banana Bunchy Top Virus (BBTV), Banana Streak Virus (BSV), Banana Bract Mosaic Virus (BBMV) and Cucumber Mosaic Virus (CMV) are devastating in many regions. BSV has become more important since it integrates with the host genome and limits the way of developing new varieties through conventional breeding.

Figure 46. Raw banana fibre dyed different colours

Banana is a recalcitrant crop for improvement owing to its parthenocarpy, non-seeded nature, and male and/or female sterility. Also, the triploid nature of the best clones severely limits their use as parents. For any crop improvement programme, availability of desired gene sources in cultivated or wild forms is the prerequisite. In bananas, most of the desired resistant gene sources are harboured by the wild species, especially *Musa acuminata* subspecies and *Musa balbisiana*.

Figure 47. Primitive cultivar with breeding potential

One of the subspecies, *Musa acuminata* spp. *burmannicoides* (wild) that originated from India is the major gene source conferring resistance to Sigatoka leaf spot diseases. This is the only wild type extensively used in all breeding programmes and it is under the shadow of threat of breakdown of resistance. A vigorous search for alternate sources for Sigatoka resistance is necessary and much attention is being paid to Indian collections. *Musa acuminata* spp. *burmannica*, originating from western Ghats of Karnataka and Kerala is also a potential source exhibiting resistance to leaf spot diseases. Among primitive diploid clones, Kalmatti and Sembatti, ecotypes of cv. Matti (AA)

have proven to be the better resistance source in breeding programmes. Other primitive varieties like Hatidat, Kanaibansi, and Anaikomban have exhibited partial resistance to leaf spot incidence fertility when pollinated, enabling them to set seeds under controlled pollination and yet they remain parthenocarpic under unpollinated conditions. Sannachenkadali (AA) is another diploid *acuminata* cultivar, found in the southern tips of Tamil Nadu and Kerala, that has been an excellent source of resistant genes against Sigatoka leaf spot, Fusarium wilt and nematodes. Being a diploid red cultivar, it has good potential for improving the commercial Red Bananas (AAA) against Fusarium wilt and Sigatoka leaf spot diseases.

Figure 48. Unknown leaf spot disease on wild *Musa* spp. in their natural habitat

Wild *Musa balbisiana*, a collective group of many 'wild types' with no specific subspecies status, has proven to be an excellent source of resistance to various biotic and abiotic stresses. *Musa balbisiana* types are immune to Fusarium wilt, leaf spot diseases like Sigatoka (*Mycosphaerella musicola, Musa fijiensis, Musa eumusae*), Cordana and Septoria leaf spot, rust and bacterial diseases like head rot (*Erwinia* spp.). They are also very tolerant to pseudostem weevil (*Odoiporus longicollis*) and rhizome weevil (*Cosmopolites sordidus Germar*). Apart from having resistance to biotic stresses, *Musa balbisiana* is highly tolerant to severe drought, cold and poor soil conditions.

Outweighing these advantages of *Musa balbisiana* is the problem of BSV which has integrated with the host B-genome. The limited number of *balbisiana* accessions maintained in most genebanks and all tested B-derived hybrids, i.e. *acuminata-balbisiana*, natural hybrids, have their genome contaminated with integrated BSV. Some of the human-induced hybrids developed in breeding programmes have expressed symptoms of BSV. This situation has forced some of the banana breeding programmes like that of CIRAD, France to temporarily halt using *Musa balbisiana* as a parent.

It is hoped that the search for more *Musa balbisiana* types in the areas of its origin and natural diversity might reveal individuals free of integrated BSV.

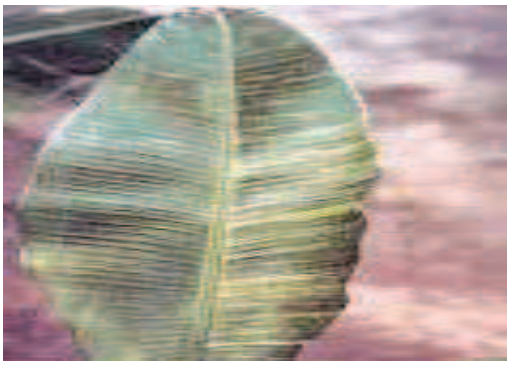

Figure 49. Banana Streak Virus (BSV)

Asia offers many unexplored areas where a search might reveal truly wild *balbisiana.* More systematic research on the B-genome and on accessions with B-containing genomes (AB, AAB, ABB, ABB) is needed. India, which is the major centre of origin and diversity of these natural hybrids, has much to offer the international community with its diversity in pure *balbisiana* and bispecific clones (Figures 47 to 49). Indian banana scientists are optimistic about locating and revitalizing banana breeding programmes with the inclusion of BSV-free *Musa balbisiana.*

CONCLUSIONS AND RECOMMENDATIONS

Bananas have been an important and integral part of Indian floral heritage with their great diversity and long periods of domestication. As the major centre of origin of interspecific AB hybrids, the Indian subcontinent has contributed enormously to the global wide genetic base of *Musa*.

In northeastern India, western Ghats, eastern Ghats and in Andaman and Nicobar Islands, some wild *Musa* species still exist. Some species, however, are already extinct, and they have been extirpated from most of India that was once in forest.

Apart from *Musa acuminata* and *Musa balbisiana*, the progenitors of present day bananas, a number of peripheral species, which have contributed to the total diversity are also known to occur. Though explorations and reports have revealed the occurrence of many more new species, natural hybrids and mutants, the geographical locations, unfavourable terrains, delicate political situations, insurgency problems, poor transportation facilities and wild animals, have made natural *Musa* habitats highly inaccessible. A systematic exploration, and developing good *ex situ* collections is the priority together with their conservation. The prevailing agricultural production system, Jhum cultivation, has depleted the fauna and floral treasury through incessant ecosystem destruction and subsequent genetic erosion. *Musa acuminata* spp. *burmannicoides* has been lost, but it is probable that many more valuable gene sources have been lost. The Government, Indian Council of Agricultural Research (ICAR) and other NGOs are supporting various *in situ* and *ex situ* conservation programmes. However, for a crop like banana, *ex situ* conservation in specific locations is not easy and needs more commitment.

Some *Musa* genetic resources are conserved in field gene banks at several sites in India. Most collections have serious virus problems. Conservation efforts or national parks should be established where wild *Musa* still occurs. Evaluation of the wild species for their suitability for direct uses like fibre source, food source and medicinal application, etc. and indirect uses like resistant gene sources for biotic and abiotic traits in the breeding programmes would be useful; however, exploitation for fibre, etc. should be evaluated against the potential of perpetuation of the wild species.

The indigenous knowledge of wild *Musa* is a treasure, but little information is available on this aspect. Though efforts are underway to collect and collate the information, the methodology or exact procedure for its meaningful utility is still lacking. A lot of medicinal uses were mentioned in earlier Indian medical epics and other documents, but there is a void on their protocols. Involvement of local NGOs, local doctors and tribal doctors in collating the information on indigenous technical knowledge forms the basis for the understanding of some of the courses and effects directly related to the loss of genetic diversity in Musa and other species, for the future management of genetic resources for achieving sustainable agriculture and assuring tribal livelihoods (Annex 3).

The tribes are aware of the ruinous effects of Jhum cultivation. Jhumming, being their way of living, needs a paradigm shift and this subject needs sensitive handling. ICAR has evolved a three-tier hill-farming package combining forestry, horticulture, tree farming, and terraced cultivation. Jhum farming needs to be refined and reduced to ensure better land management. The thrust

should be on educating the Jhum farmers on alternate methods of cultivation.

Selected *Musa* wild species have been exploited for specific purposes like roofing, medicines, fibre extraction, handcraft preparation and medicinal applications, etc. The suitability of different varieties for a wide array of uses needs to be balanced with germplasm survival and alternative methods of livelihood. Developing wild *Musa* for their direct uses is expected to add to the holistic process of bringing in ecostability. From the breeders point of view, however, *Musa* species offer ample scope for their utilization in banana improvement programmes.

The only constraint in using *Musa balbisiana* is the integration of BSV in its genome. The search for wild types free from BSV, development of protocols to eliminate BSV at genomic level and exploiting the possibilities of using wild types carrying only dead sequences of BSV are expected to bring an improvement in *Musa* breeding strategies.

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ACRONYMS

AGPC – FAO	The FAO Crop and Grassland Service (AGPC)
AGPP–FAO	The FAO Plant Protection Service (AGPP)
CIRAD	Centre de cooperation international en recherché agronomique pour le développement
FNPP	FAO/Netherlands Partnership Programme
ICAR	Indian Council of Agricultural Research
INIBAP	International Network for the Improvement of Bananas and Plantains
ITC	International Transit Centre
ITK	Indigenous Technical Knowledge
KMTR	Kalakad-Mundanthurai Tiger Reserve in Tamil Nadu
NRCB000	Trichy National Research Centre for Banana
RAPD	Random Amplification of Polymorphic DNA

ANNEX 1

Occurrence of *Musa* species in different geographical locations in India

States	Diversity collected			
	Genus	**Species**	**Subspecies/type***	**Section**
Tamil Nadu	*Musa*	*acuminata*	*ssp burmannica*	Eumusa
		balbisiana	type *Elavazhai*	
Kerala	*Musa*	*acuminata*	*ssp*. burmannica	
		balbisiana	type *Elavazhai*	
		laterita		Rhodochlamys
	Ensete	*superbum*		
Karnataka	*Musa*	*acuminata*	*ssp*. burmannica	Eumusa
		balbisiana	type *Elavazhai*	
	Ensete	*superbum*		
Andhra Pradesh	*Musa*	*balbisiana*	type Arakku	Eumusa
		ornata		Rhodochlam
Orissa	*Musa*	*balbisiana*		Eumusa
		ornata		Rhodochlamys
Bihar	*Musa*	*balbisiana*	type Bhimkol	Eumusa
			type Athiakol	
West Bengal	*Musa*	*balbisiana*	type Bhimkol	Eumusa
	Ensete	*superbum*	type Athiakol	
Assam	*Musa*	*acuminata*	*ssp*. burmannica	Eumusa
			type Kaziranga	
		balbisiana	type Bhimkol	
			type Athiakol	
			type Rissue	
	Ensete	*glaucum*	type Small	
Arunachal Prad	*Musa*	*acuminata*	type Khaziranga	
		balbisiana	type Sessa-I	
			type Sessa-II	
			type Sessa-III	
			type Seppa-I	
		itinerans	-	
		aurantiaca	type Ziro-I	Rhodochlamys
			type Ziro-II	
		rosacea		Rhodochlamys
		ornata		
		velutina	Normal type	
			Red fruited type	
			Hybrid	

States	Diversity collected			
Meghalaya	*Musa*	*acuminata*	*ssp.*. burmannica	Eumusa
			type Kaziranga	
		balbisiana	type Bhimkol	
			type Athiakol	
			type Rissue	
Manipur	*Musa*	nagensium		Eumusa
		acuminate		
		balbisiana	type Themenglong	
			type Athiakol	
			type Bhimkol	
Mizoram	*Musa*	*acuminata*	type Kaziranga	Eumusa
		balbisiana	type Bhimkol	
			type Athiakol	
		nagensium		
		glaucum		
		Rosacea**		Rhodochlamys
		rubra		
Tripura	*Musa*	*acuminata*	type Rigitchi	Eumusa
		balbisiana	type Bhimkol	
			type Athiakol	
Nagaland	*Musa*	*acuminata*	type Rigitchi	Eumusa
			type burmannica	
		balbisiana	type Pagalapahad	
			type Themenglong	
			type Phirima	
Andaman Nicobar Island	*Musa*	*acuminata*	type Jirkatang type Chouldhari	Eumusa
		balbisiana	type Nicobar	
		balbisiana	type Mayabander	
			type My My	
			type Baratang	

Editor's note: Where a type name is given, it probably represents a domesticated clone.

ANNEX 2

Ethnobotany of Bananas and Plantains

Sl. No.	Tribe	Location	Clone or type used	Plant part used	Methodology	Form used	Properties
1	Tagins and Nitshi	Subansiri district of Arunachal Pradesh	*M. balbisiana* (w) *M.nagensium* (w) and other domestic clones	Pseudostem sap	Collected from the wedge shaped cut on the pseudostem	Used for drink-called 'khar'	Good for diabetes and stomach ailments
2	Ahoms, Bodo Hajong, Garo Mikir	Assam	Bhimkol Athiakol	Inner core of pseudostem and fruit peel	Cut into small pieces, sun dried and burnt to obtain ash.	Drink Additive to meat	Drink as ant acid, colic and for heart burn For meat softening
3	Ahoms, Garo, Karbi, Bodo, Koch tribes Khasi	Assam, West Bengal, Meghalaya	Bhimkol Athiakol	Pseudostem	Juice extracts by crushing pseudostem is filtered and consumed orally	Drink	To dissolve kidney stones, reduce stomach ulcers and for better bowel movement
4	Kuki	Themenglong, Imphal, Noney, Irang areas of of Manipur	*M. balbisiana, M. acuminata*	Shoots	Fibreless inner shoots of young suckers	Salad and vegetables	-
5	Common people	Tamil Nadu, Kerala, Karna-taka	Mysore (AAB), Pisang Awak (ABB)	Inner core of pseudostem	Cooked with pulses	Vegetable	To induce excess urination and dissolve kidney stones. To alleviate anaemia
6	Village folks	Tamil Nadu	Mysore (AAB), Pisang Awak (ABB)	Young growing meristem of 5 cm^3	Cooked with spices	Vegetable	To induce excess urination and dissolve kidney stones. To alleviate anaemia
7	Mizo tribes Diphu tribes	Mizoram Assam	*Ensete glaucum*	Leaf sheath	Cut into small pieces	Salad or vegetable	Source of fibre in daily diet
8	All tribes of Tirap, Lohit districts	Arunachal Pradesh	*M. balbisiana* and edible clones	Young meristem of suckers	Chopped into pieces and added into curry	Vegetable	To remove inadvertent addition of excess salt while cooking
9	All tribes	Northeastern region	*M. balbisiana*	One foot long bits of leaf sheath on the pseudostem	-	Coolant	For wrapping betel leaves and long distance transportation
10	All tribes	Northeastern region	*M. balbisiana*	One foot of long bits of leaf sheath on the pseudostem	-	-	Sunshade for young transplants and seedlings

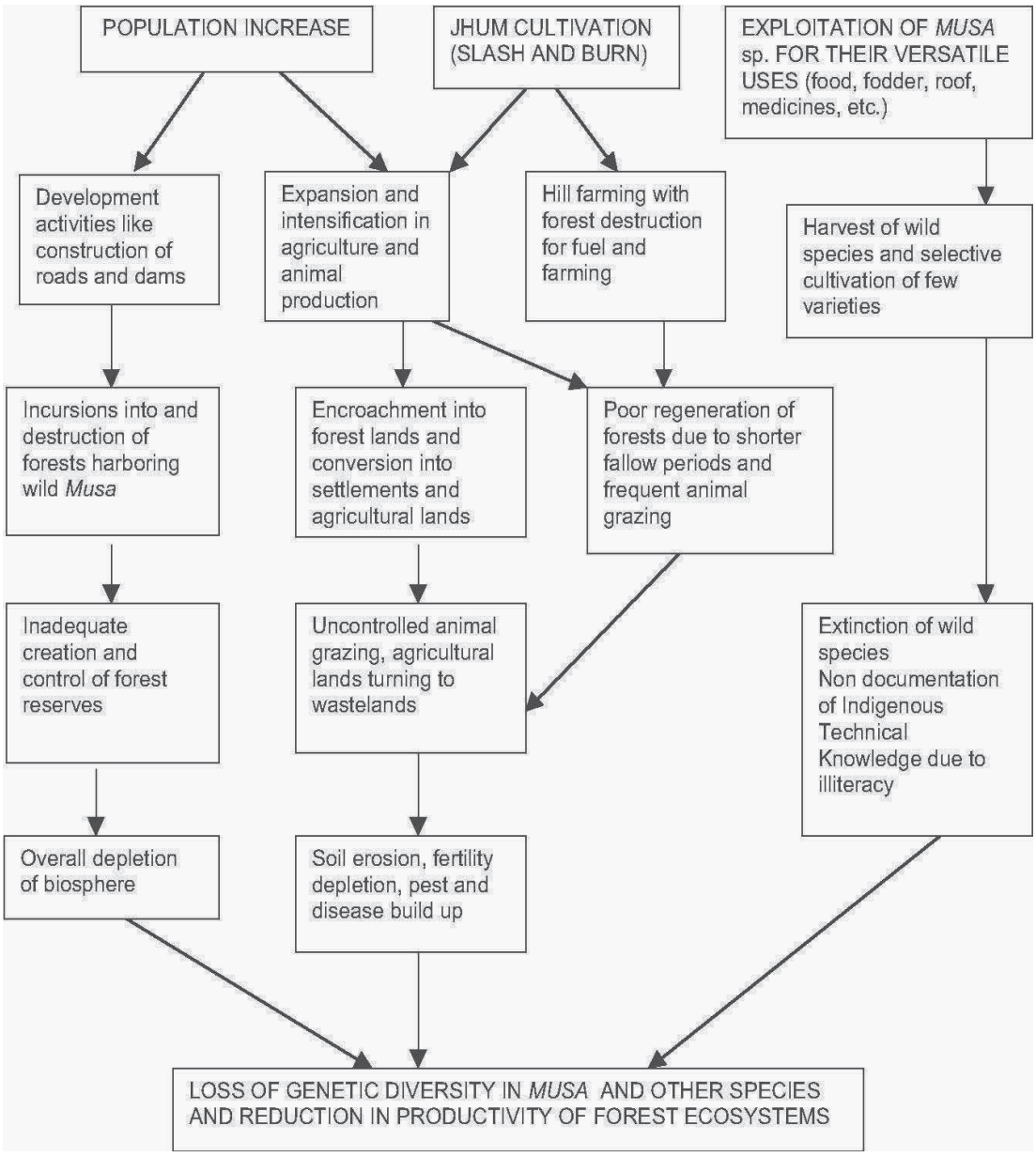
Sl. No.	Tribe	Location	*Clone or type used*	Plant part used	Methodology	Form used	Properties
11	Village folks	Assam	*Bhimkol*	Pseudostem	4-5 stems are tied parallely	As a raft to cross rivers and a mode of transportation during floods	-
12	Mizo tribes	Mizoram	*Changtheir Changpui Chang Pawal Chang Vand-wat Lairoop Ensete glaucum*	Mature pseu-dostem	Fibre is hand extracted	For making handicrafts (with export potential)	Sustained income source
13	Apatani, Adi, Nitshi	Subansiri & Siang districts of Arunachal Pradesh	*M. balbisiana M. nagensium, Bhimkol, M. ornata, M. rosaceae, M. aurantiaca*	Young leaves	Fibreless young and unopened leaves are ground to paste	Poultice against burns	Cooling and early healing effect
14	Mizo Manipuri	Mizoram Manipur	*M. balbisiana M. acuminata M. nagensium*	Tender leaves	Oil smeared leaves	For dressing wounds and blistered skin surfaces	Coolant
15	Irulas	Kerala	*M. acuminata Ensete glaucum*	Leaves	Ash obtained by burning leaves	Inhaled by asthma patients	For relief from wheezing
16	Tangam, Sherdukpens, Mishmi Bodo, Lalung, Garo of Assam.	Dirang, West Siang, Upper Siang districts of Arunachal Pradesh. Assam	*M. nagensium M. balbisiana Bhimkol M. ornata M. rosaceae M. aurantiaca*	Leaves	Water proof banana leaves after scorching are used as inner lining for the wooden barrel used for making rice beer	Lining for the wooden barrels	Adds flavour to the beer
17	All tribes	Arunachal Pradesh, Meghalaya, Tripura, Manipur	*Bhimkol, Athi-akol, M. nagensium*	Mature leaves	Dried leaves	As roofing material for preparing temporary sheds and animal sheds	Cheap source of roofing material
18	Common man	Tamil Nadu, Kerala, Karna-taka, Assam, Tripura, Meghalaya	*Mysore (AAB) Pisang Awak (ABB)*	Flower buds	Cooked with pulses or with coconut	Vegetable	Good for heart and kidney stones. Anti dysmeno rrhoeic
19	All tribes	Assam, Arun-achal Pradesh, Meghalaya, Manipur and Tripura	*M. acuminata M. balbisiana M. ornata M. rosacea M. velutina*	Flower buds	Cooked with pulses and cereals	Vegetable	As an alternate vegetable source during dry periods.
20	All tribes of Lohit and Tirap district	Arunachal Pradesh	*M. balbisiana, M. acuminata, M. nagensium*	Yet to emerge immature inflorescence	Cooked with pulses	Vegetable	Alternate source of vegetable during periods of dry season and hunger

Sl. No.	Tribe	Location	*Clone or type used*	Plant part used	Methodology	Form used	Properties
21	Adi, Mishmi, Sherdukpens etc.	Arunachal Pradesh	*M. acuminata M. balbisiana and others*	Flowers	Boiled	Eaten with salt and oil	For relief from joint pains and for better blood circulation
22	Ahoms, Garo, Karbi, Bodo, Koch tribes Khasi,	Assam, West Bengal, Meghalaya	*M. acuminata, M. balbisiana, M. nagensium and M. ornata, M. aurantiaca, M. laterita*	Root	Not revealed	In ayurvedic preparations for herbal medicines	Anthelmentic and tonic
23	All tribes	Northeastern India	*All wild types of M. acuminata, M. balbisiana, M. nagensium and M. ornata, M. aurantiaca, M. laterita*	Rhizome	Chopped and cooked with pulses	Cattle and pig feed	Cheap source of animal feed
24	All tribes of	Assam, Meghalaya and Lower Arunachal Pradesh	*Bhimkol Athiakol*	Underground rhizomes	Cut into small pieces, sun dried and burnt to obtain ash	Detergent	For washing clothes
25	Adi, Nitshi, Sherdukpen, Apatani and others	Arunachal Pradesh	*Any fruit of Eumusa (*wild *Musa* spp.*)*	Ripe fruit pulp	Pulp is mashed with water and sieved to remove seeds and mucilagenous pulp is collected	Additive to cereal beer made of rice, sorghum, etc.	For better fermenting of beer with fruity flavour
26	Ahoms, Garo, Khasi, Karbi, Bodo, Koch tribes	Assam	*Bhimkol*	Ripe fruit pulp	Pulp is mashed with water and sieved to remove seeds and mucilagenous pulp is collected	Additive to cereal beer made of rice, sorghum, etc	For better fermenting of beer with fruity flavour
27	Ahoms, Garo, Karbi, Bodo, Koch tribes Khasi	Assam, West Bengal, Meghalaya	*Bhimkol, Athiakol*	Mucilagenous pulp of fruits	Pulp is mashed with water and sieved to remove seeds. Pulp is collected, dried as flakes and powdered	Baby food with rice or milk	Easily digestible for infants
28	Local tribes of Subanisiri, Dibang, Tirap districts	Arunachal Pradesh	*M. nagensium*	Ripe and unripe fruits	Cooked with sorghum and other cereals	Pig feed	For better health of piglets

Sl. No.	Tribe	Location	*Clone or type used*	Plant part used	Methodology	Form used	Properties
29	Ahoms, Garo, Karbi, Bodo, Koch tribes Khasi,	Assam, West Bengal, Meghalaya	*M. acuminata, M. balbisiana, M. nagensium and M. ornata, M. aurantiaca, M. laterita*	Whole plant	Finely chopped and mixed with soil. Allowed to feed on plant waste and its excreta is collected for manuring	Vermicom-posting	Vermicompost used as a biological manure for growth of crop plants

ANNEX 3

Drivers – effects framework showing a synthesis of causes and effects of biodiversity loss revealed by the case study on "Farmers' Knowledge of Wild *Musa* in India"



FARMERS' KNOWLEDGE OF WILD *MUSA* IN INDIA

This publication provides an overview of general occurrence of *Musa* species in different geographical locations and agro-ecological zones in India, and describes *Musa* genetic diversity and its conservation by ethnic groups. It provides an insight into the indigenous knowledge regarding multiple uses of wild and cultivated bananas for the benefit and advantage of the local communities. It summarizes the implications of farmers' production systems on the ecosystem and contributes to a better understanding of some of the causes and effects directly related to the risk of loss of banana biodiversity in India and makes recommendations on steps that should be taken to expand the use of wild *Musa* in breeding programmes.

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