

Conservation of medicinal and aromatic plants in India: Current status and future prospects

Biodiversity encompasses all the organisms, species, populations, genetic variation and assemblages of communities and ecosystems among these organisms. The variety and variations in biodiversity occurring in nature, has sustained the harmonious existence of life on earth wherein Medicinal and Aromatic Plants (MAPs) are being used in traditional and modern medicine worldwide. India poses a rich diversity of MAPs but the climate change is a real threat to this rich diversity. Also, the indiscriminate use of medicinal plants from wild, to cater the growing demand is leading to the loss of MAPs diversity. Therefore, an integrated approach towards conservation of the rich MAPs diversity should be followed globally which includes *in situ* and *ex situ* conservation strategies along with sustainable utilization of the biodiversity.

BIODIVERSITY contributes significantly towards human livelihood and development, and thus plays a predominant role in the well-being of the global population. According to WHO, more than 80% of drugs used today across the world are derived from medicinal plants and more than 85% of population of the world use medicinal plants for their healthcare. Natural substances have long served as sources of therapeutic drugs, where drugs including digitalis (from Foxglove), ergotamine (from *Claviceps* infected rye), quinine (from *Cinchona*), salicylates (Willow bark), vinblastine & vincristine (Periwinkle) and Artemisinin (*Artemisia*) can be cited as some classical examples. India is a rich reservoir of valuable genetic resources of Medicinal and Aromatic Plants (MAPs) as it is gifted with diverse geographic and agro-climatic zones and a rich culture of folklore and traditional knowledge. The use of this knowhow in the healthcare has resulted in the application of MAPs in large numbers in our traditional systems of medicines called as “Indian systems of medicine (ISM)” which consists of Ayurveda, Siddha, Unani and Homoeopathy, and therapies such as Yoga and Naturopathy. It is estimated that more than 6,000 higher plant species forming about 40% of the higher plant diversity of the country are used in its folk healthcare. Out of these species, 960 medicinal plant species are under trade, in which 178 species are very high in demand (>100 MT per annum). These species accounted for almost 80% of the total industrial demand of all botanicals in the country. But out of 178 medicinal plants species in high trade, only 36 species are sourced largely from cultivation and rest from the wild. This indiscriminate use of medicinal plants from wild to cater the growing demand, has led to steady erosion and loss of medicinal plants biodiversity from the natural habitat.

Therefore, it is necessary to pay attention towards plant genetic resource management of these MAPs. In this article, we have discussed in brief about the status, trends and threat to diversity, strategies of conservation along with present status and future prospects.

Biodiversity of MAPs in India

State and trends of biodiversity: The term Biodiversity is defined as “the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (Source: World Conservation Union). India is one of the 17 mega bio-diversity rich countries and has 7% of the world’s bio-diversity. There are 15 agro-climatic regions, 45,000 different plant species out of which 15,000 are medicinal plants. About 8,000 plants are used in Indian Systems of Medicine and folk medicines. An analysis of distribution of MAPs in natural

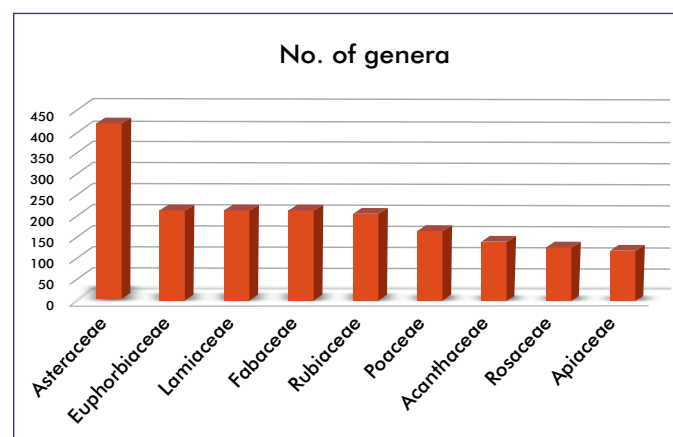


Fig. 1. Family-wise distribution of MAPs genera

habitat showed that about 70% of India's MAPs are found in tropical forests of Western and Eastern ghats, the Vindhya's, Chhota Nagpur plateau, Aravalli's and the Himalayas. Studies also showed that a large percentage of known MAPs occur in the dry and moist deciduous vegetation area compared to evergreen and temperate regions. Habit-wise classification showed that 33% are trees, 32% herbs, 20% shrubs, 12% creepers and 3% others (Fig.2). An analysis of 386 families and 2200 genera in which MAPs were recorded showed that Asteraceae family possess highest number of species (Fig.1).

State of biodiversity use: In case of MAPs, India has rich biodiversity spread over different agro-ecological zones. Among the various species of MAPs, as per NMPB study, about 960 MAPs are under trade where 178 species are consumed in volumes exceeding 100 MT per year, with their consolidated consumption accounting for about 80% of the total industrial demand of all botanicals in the country. Analysis of these 178 species by their major sources of supply reveals that 21 species (12%) are obtained from temperate forests, 70 species (40%) are obtained from tropical forests, 36 species (20%) are obtained largely or wholly from cultivations/plantations, 46 species (25%) are obtained largely from roadsides and other degraded land use elements and the remaining 5 species (3%) are imported from other countries.

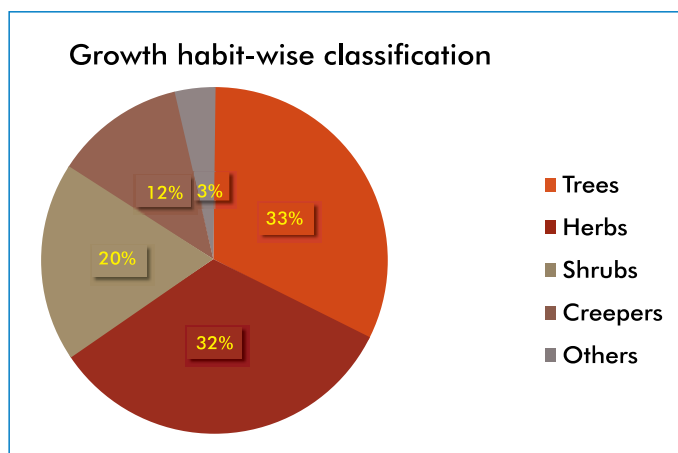


Fig. 2. Growth habit-wise classification of MAPs

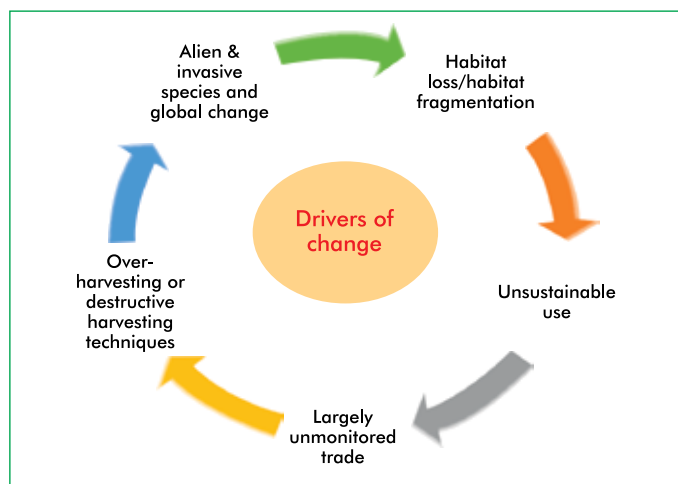


Fig. 3. Schematic description of different threats to biodiversity

Drivers of change: The main threats to the biodiversity of MAPs are those which negatively affect the biodiversity of flora and fauna that is used by humans (Fig. 3). Therefore, to preserve the available biodiversity for the posterity, the holistic strategies for conservation of biodiversity are being followed at national and international level.

Interventions on conservation of MAPs

The aim of conservation is to support sustainable development by protecting and using biological resources in such a way that do not diminish the diversity available or destroy important habitats and ecosystems. Biodiversity conservation can be achieved either *in situ* or *ex situ* conservation (Fig. 4).

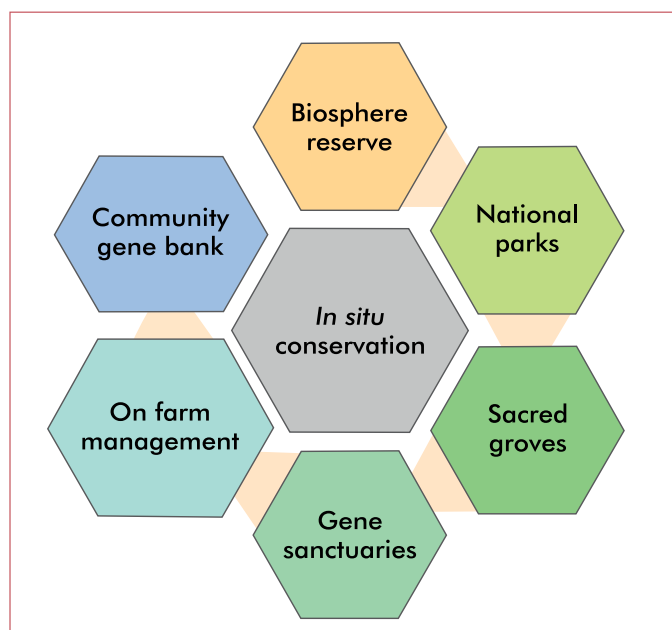


Fig. 4. *In situ* conservation strategies

In situ conservation

In situ conservation is on-site conservation or the conservation of genetic resources in natural populations or in the area where it grows naturally. It includes establishment of national park, biosphere reserve or gene sanctuary. In India, government has established 18 biosphere reserves for conservation of flora and fauna under Ministry of Environment, Forest and Climate

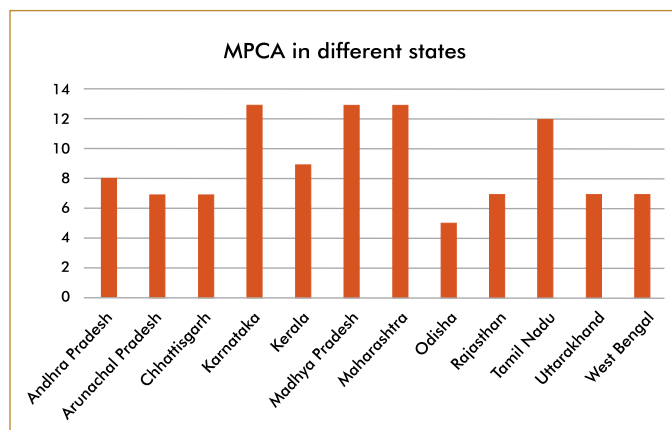


Fig. 5. Distribution of MPCAs across the country

change based on the UNESCO Man and the Biosphere (MAB) Programme. Moreover, since 1993, FRLHT has pioneered the *in situ* conservation of India's medicinal plant diversity. A Medicinal Plant Conservation Area (MPCA), a network of approximately 10 conservation sites of 200 to 300 hectares is officially designated by FRLHT in the states of Karnataka, Tamil Nadu, Kerala, Andhra Pradesh and Maharashtra. Presently, 108 MPCA sites represent models for other communities worldwide to implement for maintaining their own indigenous health traditions along with biological and cultural diversity (Fig. 5).

Sacred groves: Sacred groves are the patches of forests which are preserved by the inhabitants for their spiritual and religious significance. The sacred grove culture in India predates to *Vedic era*. These were the sections of forests where ordinary activities like gathering of wood/leaves/plants, tree felling, hunting, fishing, grazing, building dwellings were prohibited. In India, sacred groves are distributed across the country (Fig. 6).

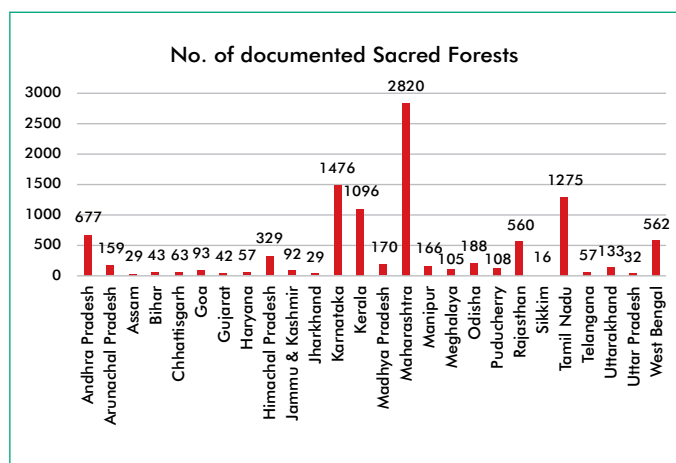


Fig. 6. Distribution of Sacred groves across the country

Farmer's role in conservation: Farmers are also playing an important role in conserving the biodiversity by "cultivating a diverse set of crops in the agro-ecosystems where either the crops have originated or are secondary center of diversity", this is known as "On-farm conservation" which is a part of *in situ* conservation strategies. On-farm conservation requires a multidisciplinary approach, i.e. (I) socio-economic research to understand and analyse farmers' knowledge; (II) population and conservation biology; (III) studies on the dynamics of the local landraces and farmer's varieties to understand population differences, gene flow, degree of inbreeding, selection pressure etc.; (IV) crop improvement research in mass selection and simple breeding methods and (V) extension studies for lesser-known crops and varieties for their seed production, marketing and distribution.

Ex situ conservation

Conservation of plant genetic resources outside their natural habitat is known as *ex situ* conservation. It facilitates conservation in controlled conditions and makes possible

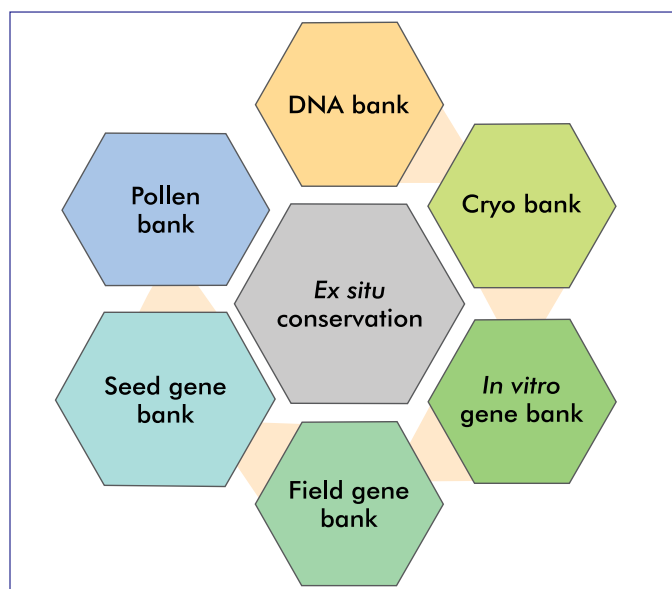


Fig. 7. Ex situ conservation strategies

reintroduction of species into wild. It can be achieved through (1) Seed gene banks, (2) Botanical Garden/field gene banks, (3) *in vitro* banks, (4) Cryopreservation banks, and (5) DNA banks (Fig. 7 & 8).

Seed gene banks: Seed banks are the easy, most effective and efficient way of conservation of species that produce orthodox seeds. Seed can be stored for 5-25 years in medium term storage (0-5°C and 35% RH) whereas it can be up to hundred years in long term storage (-10°C to -20°C). A total of about 9,361 accessions of MAPs species are conserved as base collections at National Seed Gene Bank, NBPGR, New Delhi (source: www.nbpgr.ernet.in).

Botanical garden/field gene banks: Botanical garden/field gene bank are used to conserve those species which lose their viability during seed gene bank storage. There are many field gene banks/botanical gardens maintained by government and non-governmental organizations in India. National biodiversity authority (NBA), an autonomous and statutory body of the Ministry of Environment and Forests, Government of India listed existence of 109 botanical gardens across 18 states in

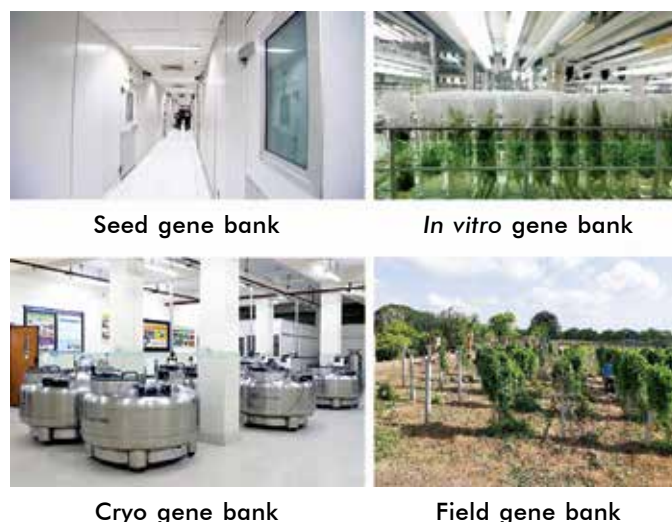


Fig. 8. Representative pics of ex situ conservation strategies

India (source: <http://nbaindia.org/link/241/34/1/SBBs.html>). Ministry of Agriculture under horticultural division has established 16 herbal gardens all over India which are maintaining about 150 medicinal plants. Botanical garden at ICAR-DMAPR, Anand in an area of about 10 ha maintains 140 tree species, 65 shrubs, 40 creepers and 250 herbs and at field gene bank 2313 accessions of 20 medicinal plant species including 9 mandated crops are (Source: Annual Report 2022, DMAPR). In addition, a web based “Herbal Gardens of India” system developed by the Directorate with the financial support of NMPB is hosted at <http://www.herbalgardenindia.org> and provides online information about the herbal gardens and facilitates the exchange of medicinal species among the member herbal gardens within the country.

***In vitro* and cryopreservation repository:** *In vitro* repository is an important strategy for conserving flora with vegetative propagation, recalcitrant seed or in plants where seed formation is very poor. There are four methods of *in vitro* preservation, viz. cryopreservation (storage of tissue and cell culture at low temperatures, in some cases as low as -196°C), slow growth shoot culture, normal growth culture and regenerative excised root culture. In order to strengthen the efforts of *in vitro* conservation of MAPs, a tissue culture repository has been established at NBPGR, New Delhi. At present, -211 accessions MAPs (e.g. *Coleus*, *Rauvolfia*, *Tylophora*, *Valeriana*, etc.) are *in vitro* conserved and -975 accessions of various MAPs are cryo-preserved at NBPGR, New Delhi (Source: www.nbpgr.ernet.in).

Sustainable utilization

Sustainable utilization of medicinal and aromatic plants (MAPs) involves the responsible and ethical use of these valuable resources to meet present and future needs. There are some key considerations for achieving sustainable utilization in MAPs:

Conservation and biodiversity: Protecting and conserving the natural habitats and biodiversity where MAPs grow is crucial. This includes implementing measures such as establishing protected areas, promoting sustainable harvesting practices, and preventing the overexploitation of species.

Cultivation and agroforestry: Promoting the cultivation of MAPs through sustainable farming practices, i.e. GACP (Good Agricultural Cultivation Practices) can help in reducing pressure on wild populations. Agroforestry techniques, such as intercropping with other crops, can enhance biodiversity and support ecosystem health.

Harvesting and collection: Harvesting practices should be carefully managed to avoid damage to the plants and their surroundings. Implementing selective harvesting methods, such as selective pruning or tapping, can allow plants to regenerate and maintain their populations.

Value chain and fair trade: Promoting fair trade practices ensures that local communities and indigenous peoples involved in the MAPs value chain receive fair compensation for their knowledge and resources. Fair trade certification and partnerships can help create market

incentives for sustainable production.

Research and development: Encouraging scientific research and development on MAPs can lead to the identification of sustainable cultivation techniques, efficient extraction methods, and innovative uses for these plants. This can contribute to the development of sustainable products and practices.

Legal frameworks and regulation: Governments and regulatory bodies play a crucial role in enacting and enforcing laws and regulations that protect MAPs. These frameworks can include measures to control access to certain species, define sustainable harvesting quotas, and ensure compliance with sustainable practices.

Education and awareness: Raising awareness among stakeholders, including local communities, practitioners, and consumers, about the importance of sustainable utilization is essential. Education programs can promote responsible harvesting, cultivation, and consumption of MAPs.

Certification and labelling: Establishing certification schemes and labelling systems can help consumers make informed choices and support sustainable products. Labels such as organic, fair trade, or sustainably sourced can provide assurance regarding the ethical and sustainable practices used in the production of MAPs.

Collaboration and partnerships: Collaboration among governments, NGOs, local communities, and industry stakeholders is crucial for implementing sustainable practices. Public-private partnerships can facilitate knowledge sharing, capacity building, and the development of sustainable supply chains.

Future prospects

Conservation and sustainable use of biodiversity in Medicinal and Aromatic Plants in India is a very important component towards overall growth. The following steps are important to take this work forward:

- Use of GIS will help in Geo-referencing/gap analysis and prediction and distribution of species using environmental variables to plan future explorations besides mapping of trait-specific germplasms with respect to bioactive compounds.
- Use of biotechnological tools like *in vitro* storage/ cryopreservation including pollen preservation to strengthen the conservation of MAPs.
- Use of molecular marker tools like SSR/SNP/GWAS to improve the understanding of extent, nature and distribution of diversity in MAPs; and develop the varieties with high yield and quality for sustainable production.

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