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Studies on conservation and domestication of endangered and threatened medicinal plant species in India - A review

MEENAKSHI NEGI[1], KAVITA TYAGI[2], M S RAWAT[3] and SHAHID ULKHAIR[4]

National Medicinal Plants Board, Ministry of Health and Family Welfare, Government of India, AYUSH Bhawan, B Block, GPO Complex, INA, New Delhi 110 023

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ABSTRACT

The studies were undertaken under the aegis of the National Medicinal Plants Board (NMPB), New Delhi during 2002 - 2013, comprising *in-situ* and *ex-situ* conservation projects implemented through different State Forest Departments. Besides, R&D projects carried out by the ICAR, ICFRE, CSIR, DBT, SAUs have been taken. The contribution of NMPB in conservation and cultivation of endangered and threatened medicinal plant species in India is highlighted. There are several factors which are responsible for endangering these species in their natural habitat such as habitat loss due to diversion of forest land, biotic and abiotic interference in forest areas, unsustainable harvesting of medicinal and aromatic plants. The NMPB has supported several projects for conservation and cultivation of endangered and threatened medicinal plant species, viz.*Commiphora wightii* (A.) Bhandari,*Saraca asoca* (Roxb.) de Wilde*, Swertia chirayita* (Roxb. ex Fleming*), Aconitum heterophyllum* Wall. ex Royle*., Aquilaria malaccensis* Lamk*., Gloriosasuperba* L.*Nardostachys grandiflora* DC*., Picrorhizakurroa* Royle ex Benth*., Podophyllumhexandrum* Royle*, Pterocarpus marsupium* Roxb*., Pterocarpus santalinus* L. f., *Taxus wallichiana* Zucc*.,* Dashmool species *etc* in different states of the country. The NMPB has funded the establishment of 66 Medicinal Plant Conservation Areas (MPCAs) and 368 herbal gardens in different states. To encourage conservation, domestication and R&D activities, all the stakeholders need to be sensitized as to the cause of loss of species and the ways to address the problem. Make it more informative and attractive.

Key words: Conservation, Cultivation, Herbal garden, JFMCs, MPCAs, R&D, RET plants

India accounts for over 7-8% of the worlds' diversity though it covers only 2.4% of the earth's area (Anonymous 2014).It is also one of the biodiversity hotspots of the richest and highly endangered eco-regions of the world (Mayers *et al* 2000).There are around 17 000 species of higher plants, out of which around 8 000 are known for possessing various therapeutic properties (Anbarashan and Anbarashan 2010). About 960 species of medicinal plants are estimated to be in trade of which 178 species have annual consumption levels in excess of 100 metric tonnes (Ved and Goraya 2007). India has 15 Agroclimatic zones (Singh 2012) and medicinal plants are distributed across all bio-geographical regions, diverse habitats and landscapes. At present, medicinal plants are looked upon not only as a source of affordable health care, but also as a source of income (Tyagi 2006).With increasing interest in plant based traditional holistic systems of health the importance of medicinal plants has gained worldwide attention. Hence, the demand for medicinal plants has gone up significantly in both the developing and developed countries. The domestic trade of the AYUSH industry is for the order of ₹ 80 to 90 billion (1US$ = ₹ 50). The Indian medicinal plants and their products also account for exports in the range of ₹ 10 billion. There is global resurgence in traditional and alternative health care systems resulting in world herbal trade which stands at US$ 120 billion and is expected to reach US$ 7 trillion by 2050 (Marichamy *et al* 2014).

Plants are also being utilized for isolation of active ingredients for preparation and manufacture of modern drugs. About 2000 drugs being exclusively of plant origin of the 20 000 medicinal plants listed by the WHO globally (Dikshit 1999, Gupta and Chadha 1995), India's contribution is 15 - 20% (Singh 2000).Out of 8 000 medicinal plants available in India, about 10% (800 - 1 000 plant species) are threatened due to various reasons (Anonymous 2009), and hence an increasing number of species are now being substituted in herbal preparations. Unsustainable exploitation of several medicinal plant species and substantial loss of their habitats have resulted in the population decline of many high value medicinal plant species over the years (Planning commission 2000 and Kala and Sajwan 2007). Medicinal plants are now under great pressure due to their excessive collection or exploitation (Laloo *et al* 2000). The conservation and cultivation of rare and endangered

[1]Deputy CEO (e mail: meenakshinegi@hotmail.com), [2]Consultant (Agronomy) (e mail: kavitatyagii@gmail.com), [3]Research Officer (Botany) (e mail: msrawat03@rediffmail.com)

medicinal plants, therefore, should be given priority duly supported by relevant research and development activities. Rawat and Shankar (1998 and 2013) has also studied about conservation and cultivation aspects of threatened and high value medicinal plants of North East India.

Projects for setting up of MPCAs, *in-situ* conservation, artificial regeneration, *ex-situ* plantation, research and development on various aspects of medicinal plants, cultivation on farmer's lands etc were sought from across the country, through open advertisements in newspapers as well as through correspondence with the relevant organizations.

The projects thus received were put through a rigorous process of selection involving internal scrutiny and expert reviews in the first stage. Those projects which were positively recommended in the first stage were then placed before a Project Screening Committee (PSC) comprising experts drawn from across sectors, the projects which were recommended by the PSC were then placed before the Standing Finance Committee (SFC) for final approval. All such sanctioned projects were concurrently monitored and mentored during their life cycles. This process resulted in screening out over 70% of the proposals which were received, ensuring that only the very best projects were finally taken up.

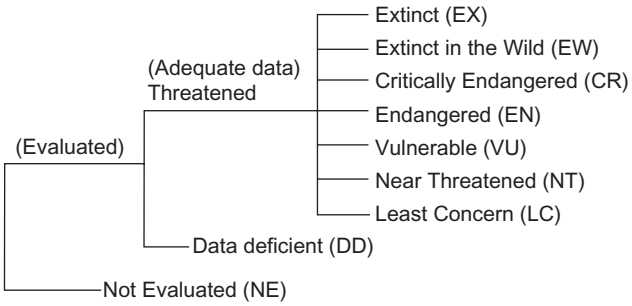
Potential of medicinal plants in India: India given its traditional knowledge in use of medicinal plants, coupled with its modern scientific capability and rich resource base is ideally placed to tap the global resurgence of interest in plant based therapies. The drugs used in ISM/traditional systems are primarily based on plant material and are considered to be safe, cost effective and with minimal or no side effects when genuine ingredients are used. Hence the effectiveness of these systems mainly depends upon the sustained availability of genuine raw material.

Main reasons for extinction

There are many potential causes of endangerment of medicinal plant species, such as deforestation and forest degradation which continues due to various factors (extension of cultivation, grazing, extraction of forest products, hydroelectric projects and commercial plantation Menon and Bawa 1997) habitat specificity, narrow range of distribution, introduction of exotics, climatic changes, population bottlenecks and genetic drift (Kala 2000 and 2005) (Weekley and Race 2001) and (Oostermeijer *et al* 2003). Only recently, scientists have become alarmed at the high rates of recent extinctions due to various anthropogenic activities. Some of these anthropogenic activities include intentional or accidental introduction of invasive alien species, over exploitation and unscientific collection of NTFP's including medicinal plants, unsustainable tourism, habitat destruction, encroachment etc.

Status of threatened medicinal plants species in India Red listed plants: Red data list of the International Union for Conservation of Nature (IUCN 2009) is the most comprehensive inventory of the conservation status of plants and animals in world. The aim of the Red list is to convey the urgency and scale of conservation problems to the public and policy makers and also motivate the global community to try to lessen the rate of extinction of such species. A series of Regional red lists are produced by countries or organizations, which assess the risk of extinction to species within a political management unit. The IUCN Red list is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies.

The IUCN categorizes a plant as Extinct (EX), Extinct in the wild (EW), Critically endangered (CR), Endangered (EN), Vulnerable (VU), Near threatened (NT), Least concern (LC), Data deficient (DD), Lower risk (LR) and Not evaluated (NE) on the basis of criteria like reduction in population size, geographical range (extent of occurrence and area of occupancy), population size of estimated mature individuals and quantitative analysis showing the probability of extinction in the wild. As per the latest classification of the IUCN, various plant species can be placed into one of the following categories:



Source: IUCN Red list Version, 2009

Endangered and threatened plants in India: According to the data available from BSI 70 species of medicinal plants are Endangered and Threatened, viz. *Aconitum balfourii* Stapf, *A. chasmanthum* Stapf ex Holmes, *A. deinorrhizum* Stapf, *A. falconeri* var. *latilobum* Stapf, *A. ferox* Wall. ex Ser., *A. heterophyllum* Wall. ex Royle, *Acorus gramineus* Sol. Aiton, *Allium stracheyi* Baker, *Amyris balsamifera* L., *Angelica glauca* Edgeworth, *Anogeissussericea* var. *nummularia* King ex Duthie, *Aquilariamalaccensis* Lamk., *Aquilariakhasiana* Hallier f. *Aristolochiabracteolata* Lam., *A. indica* Linn., *Arnebia benthami* Wall. ex G. Don, *Atropa acuminata* Royle, *Berberi saffinis* G.Don, *B. apiculata* Ahrendt, *B. aristata* DC, *Bergeniastracheyi* Hook.f. &Thorns, *Boronia megastigma* Bartl., *Capparis pachyphylla* Jacobs., *Carumvillosum* Haines, *Cedrusdeodara* Roxb, *Colchicum luteum* Baker, *Coptisteeta* Wall., *Coscinium fenestratum* Gaertn., *Dactylorhiza hatagirea* D. Don, *Dioscorea deltoidea* Wall. ex Kunth, *Elaeocarpus prunifolius* Wall., *Ephedra gerardiana* Wallich ex Stapf, *Ferula gummosa* boiss., *Gaultheria fragrantissima* Wall., *Gentiana kurroa* Royle,*Gloriosa superba* L., *Hedychiumcoronarium* Koenig, *Hedychium acuminatum* Buch.-Ham., *Hyoscyamus niger* L., *Hydnocarpus-macrocarpa* (Bedd.) Warp., *Inula*

racemosa Hook. f., *Iphigenia indica* (L.) Kunth*, I. pallida* Baker, *I. stellata* Blatt., *Jurinea dolomiaea* Boiss., *Kalanchoe roseus* Clarke, *Madhuca insignis* (Radlk.) H.J.Lam*, Myristicafragrans* Houtt., *Myroxylon balsamum* (Linn.) *var. pereirae, Nardostachys grandiflora* DC., *Origanum vulgare* (Linn.), *Panax pseudoginseng* Wallich, *Picrorrhizakurroa* Royle ex Benth., *Podophyllum hexandrum* Royle*, Pogostemon cablin* Blanco*, Pterocarpus santalinus* Linn. f., *Rauvolfia serpentina* (L.) Benth., ex Kurz, *Rheum australe* Wall. ex Meissn*, Santalum album* L., *Satureja hortensis* L. *Saussurea bracteata* Decne., *S. costus* (Falc.) Lipsch. *S. gnaphaloides* (Royle ex DC.) Sch.Bip., *Swertia chirayita* (Roxb. ex Fleming*), Taxus wallichiana* Zucc*., Toxocarpu-skurzii* Hook. f.,*Urginea indica* Kunth., *Urginea maritima* (L) Bak., *Vitex peduncularis* Wall. ex Schauer *etc.*

Legal status

The medicinal plants in India are protected under the Indian Forest Act 1927, Biological Diversity Act 2002 and Wild Life Protection Act 1972.

Indian Forest Act 1927: Medicinal plants are included under Non Timber Forest Produce and regulated under the IFA.

Wildlife (Protection) Act, 1972: The term "wildlife", as per Section 2 (37) of the Act, includes any animal, aquatic or land vegetation, which forms part of any habitat.

Section 17A: prohibits picking, uprooting, damaging, destroying, acquiring or collecting specified plants from any forest land and area specified. It also prohibits possession, sale, offer for sale, transfer by way of gift or otherwise or transport of specified plants and their derivatives.

Biological Diversity Act - Under Section 38 of the Biological Diversity Act, 2002 the Central Government, in consultation with the concerned State Governments, may from time to time, notify any species which is on the verge of extinction or likely to become extinct in the near future as a threatened species, and prohibit or regulate their collection and also to take appropriate steps to rehabilitate and preserve such species.

Role of National Medicinal Plants Board: The National Medicinal Plants Board (NMPB) was set up on 24 November 2000 under a Government Resolution with the overarching responsibility of coordinating all matters related to medicinal plants. NMPB promotes *ex-situ/in-situ* conservation of medicinal plants under the Central Sector Scheme for Conservation, Development and Sustainable Management of Medicinal Plants, along with R&D, Survey & Inventorisation, Production of Quality Planting Material, Extension activities, Value addition and IEC activities. Under the Centrally Sponsored Scheme of National Mission on Medicinal Plants, cultivation of medicinal plants on private land with backward linkages for establishment of nurseries, for supply of quality planting material and forward linkages for post-harvest management, marketing infrastructure, certification and crop-insurance are taken up. This is being achieved by cultivation of medicinal plants in identified zones/clusters within selected districts of States having potential for cultivation of such plants following good agricultural practices through Farmers/Cultivators/Growers, Associations, Federations, Self Help Groups. Cultivation of medicinal plant species is a complementary activity to conserving the genetic diversity of prioritized medicinal plant species. It is especially desirable in case of species,

Table 1 RET plant species being supported for cultivation on private lands under the Centrally Sponsored Scheme of National Mission on Medicinal Plants during 2008-09, 2009-10, 2010-11, 2011-12 and 2012-13

Medicinal plants species	Common name	Area ha.				
		2008-09	2009-10	2010-11	2011-12	2012-13
Aconitum heterophyllum Wall. exRoyle.	Atis	0	50.0	5.0	0	55.0
*Aquilaria malaccensis*Lamk .	Agar	165.0	618.0	25.0	0	0
Commiphora wightii (A.) Bhandari	Guggal	0	0.0	8.0	169.6	0
Gloriosa superba Linn.	Kalihari	558.8	783.6	961.7	1026.8	616.2
Hedychium spicatum Buch.- Ham.	Kapoor Kachari	0	0	50	0	0
Nardostachys grandiflora DC.	Jatamanasi	0	50.0	2.0	1.7	80.0
Picrorhiza kurroa Royle Ex Benth.	kutki	0	0.0	14.0	2.4	5.0
Plumbagozeylanica Linn.	Chitrak	0	2.9	0.0	0	0
Podophyllum hexandrum Royle	Bankakari	0	5.0	0.0	2.7	0
Pterocarpus marsupium Roxb.	Beejasar	0	79.9	32.8	0	0
Pterocarpus santalinus L.F.	Rakthachandan	0	88.9	32.0	0	0
Rauvolfias erpentina (Linn.) Benth., ex Kurz	Sarpagandha	44.0	371.0	323.5	219.7	203.7
Santalum album Linn.	Chandan	321.1	246.5	149.0	0	0
Saraca asoca (Roxb.) De Wild	Ashok	69.0	132.9	56.9	449.0	714.0
Swertia chirayita (Roxb. ex Fleming) H.Karst.	Chirata	0	324.5	180.0	81.8	152.0
Saussurea costus (Falc.) Lipsch.	Kuth	0	10.0	28.4	5.9	0
Valeriana wallichii DC.	Tagar	0	0	0	200	326.5
Total		1157.9	2763.2	1868.3	2159.3	2152.4

where wild populations have dwindled to critical levels and viable populations for some of these species are not available for initiating *in situ* conservation action.

Endangered and threatened medicinal plants supported under the schemes of NMPB. The NMPB has drawn up a list of 140 medicinal plants which have been prioritized for cultivation. Some RET plant species which are medicinally important have been supported under different Schemes of National Medicinal Plants Board for their cultivation (Table 1) and conservation (Table 2).Enumeration of some of the important R&D projects on endangered and threatened Medicinal Plant species are also specified below:

Salient achievements of NMPB

i. In due appreciation of the need for conservation of medicinal plants, initiatives have been taken for establishing 66 Medicinal Plants Conservation Areas (MPCAs) covering an area of 11 427 ha in States like Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Nagaland, Sikkim, Mizoram, Rajasthan, Tamil Nadu and West Bengal (Table 3).

ii. Network project on RET Plants: A Network Project on "RET Medicinal Plants Conservation and Utilization in South and North East India" was implemented in collaboration with the Indian Institute of Horticulture Research, Bangalore; UAS Dharwad; M/s Avestha Genegraine Technologies Pvt. Ltd. Bangalore; Centre For Medicinal Plants Research (CMPR), Kottakkal, Kerala; MS Swaminathan Research Foundation, Kerala; Tropical Botanical Garden Research Institute, Thiruvananthapuram, Kerala; St Joseph's College, Tiruchirapalli, Tamil Nadu; Manonmaniam Sundaranar University, Annamalai University, Tamil Nadu and NEDFI, Asom with the following objectives:-

(a) Establishment of *ex-situ* collections at IIHR and

Table 2 Some RET Species covered under Resource Augmentation in forest area

Medicinal plants species	Family	Common name	Part used	Threat status
**Aconitum heterophyllum* Wall. ex Royle.	Ranunculaceae	Atis	Root (Rhizome)	Critically endangered/North West
Aquilariamalaccensis Lam.	Thymelaeaceae	Agar	Bark/Heartwood	Vulnerable
**Berberisaristata* DC.	Berberidaceae	Daruhaldi	Root, bark	Critically endangered / North East
Commiphorawightii (A.) Bhandari	Burseraceae	Guggal	Gum resin	Data deficient
Curculigoorchioides Gaertn.	Hypoxidaceae	Kali Musii	Root	Vulnerable / Regional (C. India)
**Curcuma caesia* Roxb.	Zingiberaceae	Kali Haldi	Root (Rhizome)	Critically endangered / C. India
Dactylorhiza hatagirea (Don.) Soo	Orchidaceae	Hathajari	Root	Critically endangered / North West
Embeliaribes Burm.F.	Myrsinaceae	VaiVadang	Fruit	Low risk-Near threatened / Regional
**Gloriosa superba* Linn.	Liliaceae	Kalihari	Seed/ Root	Low risk-Near threatened / Regional
Hedychium coronarium Koenig	Zingiberaceae	Gulabakawali	Flower	Low risk-Near threatened / Regional
**Nardostachys grandiflora* DC.	Valerianaceae	Jatamanasi	dried rhizomes (roots)	Critically endangered / Kumaonregio
Panax pseudoginseng Wall.	Araliaceae	Ginseng	Root	Endangered / North East
**Picrorhizakurrooa* Royle Ex Benth.	Scrophulariaceae	kutki	Root	Endangered
Plumbago zeylenica Linn.	Plumbaginaceae	Chitrak	Root	Naturalized exotics not assessed for National Red List.
**Podophyllum hexandrum* Royle.	Berberidaceae	Bankakari	Fruit/ Root	Endangered
Pterocarpus santalinus L.F.	Fabaceae	Rakthachandan	Heartwood	Endangered / Global
Pterocarpus marsupium Roxb.	Fabaceae	Beejasar	Heartwood, Bark(Stem) Resin, Fruit (Seed)	Vulnerable / East Indian/ Malabar Kino
**Rauvolfia serpentina* (L.) Benth. Ex Kurz	Apocynaceae	Sarpagandha	Root	Endangered / Regional
**Rheum australe* D.Don syn. *R. emodi* Wall.	Polygonaceae	Revandchini	Root (Rhizome)	Vulnerable / North West
Santalum album L.	Santalaceae	Chandan	Wood (heartwood)	Endangered / regional (Vulnerable)
Saraca asoca (Roxb.) de Wilde	Caesalpiniaceae	Ashok	Bark (Stem)	Endangered / Regional(Vulnerable)
**Swertia chirayita* Roxb. Ex (Fleming) Karst.	Gentianaceae	Chirata	Whole Plant	Vulnerable in Darjeeling Himalaya
**Saussurea costus* (Falc.) Lipsch.	Asteraceae	Kuth	Root/Stem	Critically endangered / North West
Taxus wallichiana Zucc.	Taxaceae	Talispatra	Leaf	Endangered / North East
Strychnosnux-vomica L.	Loganiaceae	Kuchla	Fruit (Seed)/ Stem	—
Valeriana jatamansi Jones.	Valerianaceae	Tagar	Root/ Whole Plant	Critically endangered / North East

* These species are also in cultivation

Table 3 MPCAs supported by NMPB

State	No. of MPCAs	Area (in ha)
Gujarat	11	2 000
Haryana	2	500
Himachal Pradesh	5	875
Jammu and Kashmir	3	450
Karnataka	11	1 602
Maharashtra	8	1 600
Rajasthan	2	200
Madhya Pradesh	1	200
Nagaland	2	400
Sikkim	4	800
Mizoram	2	400
Tamilnadu	8	1 000
West Bengal	7	1 400
	66	11 427

Table 4 NMPB Support to Joint Forest Management Committees (JFMCs) in different states. This activity is focused on income augmentation of forest dependent communities through capacity building of members of JFMCs for value addition like drying, storage, primary processing of the produce collected from the wild

State	No. of JFMCs						
	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
Kerala	10						10
Sikkim	21						21
Nagaland		50			5		55
Tripura	3		5				8
Madhya Pradesh						435	435
Andhra Pradesh				6			6
Arunachal Pradesh				5			5
Gujarat				13		28	41
Karnataka				14			14
Maharashtra					10		10
Odisha						23	23
Tamil Nadu						5	5
Total	34	50	5	38	15	491	633

other Centres as field gene bank.

(b) Establishment of the collections *in-vitro* and optimal generation of *in-vitro* plants.

(c) Morphological, chemical and molecular characterization of the collected accessions.

(d) *In-vitro* conservation and establishment of in-vitro active gene bank-IVAG (*In-vitro* active gene bank) for RET species.

(e) Scientific dossier preparation, phytochemical analysis and database compilation.

In-vitro mass propagation techniques in two sps. of *Salacia* and *ex-situ* conservation of *Garcinia indica* have been successfully studied.

iii. NMPB supported resource augmentation of medicinal plants in native habitats by taking up plantations in forest areas through State Forest Department over 19 482 ha. Some of the important species covered under this area.

(a) Guggal *(Commiphora wightii)*: *Commiphora wightii* is an important plant in Ayurvedic system of medicine. Plant contains anti-inflammatory and diuretic activities. In the last few decades there has been a sharp decline in natural population of this species resulting in its inclusion in the IUCN list of endangered species. It is endemic in the dry western states of India. Gum resin of the plant, used in more than 100 Ayurvedic preparations, has an estimated demand of more than 900 MT out of which 90% is still imported. Therefore, projects were sanctioned on conservation and plantation to State Forest Departments of Gujarat, Haryana and Rajasthan, which are the natural habitats of this endangered species. Results are very encouraging. In Gujarat 11 MPCAs covering 2 000 ha, Haryana 2 MPCAs covering 500 ha and Rajasthan 2 MPCAs covering 200 ha have been supported by NMPB. Under resource augmentation 3200 ha in Gujarat and 1 700 hectares in Rajasthan have been covered by the respective State Forest Departments.

Network project on guggal: NMPB has also supported an R&D project on Network Research on Guggal involving three Institutions namely AFRI&CAZRI, Jodhpur and CIMAP, Lucknow under the supervision of Director, DMAPR, Anand. The targets achieved by the Institutions are:-

- Surveys were conducted in the guggal tapping areas of Gujarat and indigenous knowledge associated with gum tapping was documented. A bacterium was isolated from the gum oozing bark of guggal and is under study for its inductions of oleo-gum-resine oozing.
- RAPD markers were analysed in 49 guggal accessions of Gujarat and 24 of Rajasthan. Characterization of ISSR markers are under study (including CAZRI samples).
- HPLC/HPTLC analysis for chemical evaluation of guggulsteronein the 39 accessions of Gujarat samples was done.
- A total of 73 accessions have been maintained in the field gene bank and are under study for various traits and identification of quality planting material for higher yield and gum quality. Two accessions Guj-11(H) and Bhuj 17(M) showed >80% rooting while black seeds showed 66% germination. Ethephon treatment increased gum yield and decreased mortality
- *Ex-situ* conservation of accessions using cutting/ seed etc.

b. Ashok (*Saraca asoca*): The bark of the tree is the main ingredient of "Ashokarishta" which is useful in gynecological disorders. The tree is endangered in its natural habitat and its bark is widely substituted by adulterants from other allied species. The domestic demand of more than 2 000 MT cannot be met form wild sources. Conservation and resource augmentation of this species is the only way to meet the demand.More than 1 048 ha area has been planted by forest departments of Karnataka, Orissa, Gujarat, Madhya Pradesh and Andhra Pradesh.

Under R&D projects identification of elite germplasm, QPM and authentication through pharmacognostical studies of Ashoka were also carried out.

c. Dashmool: Dashmools are a group of ten plants whose roots are used in several preparations of Ayurvedic Medicines, like Dashmoolarista, Dashmoolkwath, Dashmool oil and Dashmool Haritaki. Out of these ten species five are tree species and comprise the Brihatmool. These are *Aegle marmelos* Correa. (Bael), *Gmelinaarborea* Rox. burg (Gambhari), *Oroxylumindicum* Vent. (Syonaka), *Streospermumchelenoides* L.f. (D.C.) (Padala), *Premnaintegrifolia* L. (Agnimanth). The other five species of Dashmoolaare herbs and shrubs and are collectively called Laghumool. These are *Urariapicta* Desv. (Prishmnparni), *Solanum surattense* Brum.f. (Choti Knatakari), *Solanumindicum* L. (Brihati), *Tribulusterrestris* Linn. (Gokharu), *Desmodiumgangeticum*(L.) DC. (Salparni). Brihatmool and Laghumool together comprise Dashmool. A project on cultivation of these species is being implemented by Forest Department Gujarat, Maharashtra and Orissa, covering 1 863 ha of land. Under R&D projects agro technique to procure raw material from root of tree species have been carried out.

iv. *Ex-situ* conservation measure

Establishment of herbal gardens in different states: NMPB has funded 250 projects for establishment of 368 herbal gardens in different states. These projects were sanctioned to government organizations, non government organizations and forest departments. A major project was sanctioned to Directorate of Medicinal and Aromatic Plants Research (DMAPR) for networking of herbal gardens for supply of quality planting material in India. More than 140 herbal gardens are registered on the website, i.e. www.herbalgardenindia.org. This website was launched on the occasion of International Symposium on afforestation of medicinal trees at 3rd World Ayurveda Congress and Arogya, 2008 at Jaipur on 20 December 2008 and contains information on more than 500 plants. 13 297 Home Herbal Gardens were supported by NMPB through NGOs and SMPBs. 2 257 School Herbal Gardens were established by SMPBs and NGOs supported by NMPB.

As discussed above there is a need to focus on conservation of threatened medicinal plants species. Conservation of medicinal plants is one of the challenges facing the world today. Given the rate at which species are facing extinction due to factors like biotic and abiotic pressures on forests, diversion of forest land for non-forestry purposes and climate change, it is extremely important to take corrective steps to ensure sustained availability of resources. The NMPB has been striving to shift sourcing of medicinal plants from wild areas to cultivated sources. Under the Centrally Sponsored Scheme of National Mission on Medicinal Plants subsidy is provided to farmers for cultivation of certain prioritized species on their lands with backward and forward linkages. The scheme has been under implementation since 2008-09 and so far about 1.5 lakh hectares of farmers' lands have been covered. Apart from this under the Central Sector Scheme for Conservation and Sustainable Development of Medicinal Plants, thrust is provided to *in-situ* and *ex-situ* conservation of medicinal plants. This is mainly done through State Forest Departments. So far about 62 000 ha have been brought under conservation efforts including improvement in planting. Medicinal Plants sector is both an ancient as well as a sunrise sector. While it provides diverse opportunities to the country it is also faced with cross-cutting issues which are dealt with different Departments. A lot of synergy is already taking effect among various agencies both in and outside the government sector, however a lot more still needs to be done. Rawat and Shankar (1998 and 2013) have also been studied about the conservation and cultivation aspects of threatened and endangered medicinal plant species in North East region.

CONCLUSION

Given the importance of medicinal plants as a resource for the Indian systems of medicine, it is imperative that an increased focus on their conservation, cultivation and sustainable use should be given. It is important that all stakeholders, like policy makers, resource managers, manufacturers and consumers are sensitized to the need for augmentation of this resource.

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