MEDICINAL PLANTS CONSERVATION AND SUSTAINABLE USE THROUGH FOREST GENE BANKS

T.S. SRINIVASAMURTHY*, MOHAN KARNAT**, V. PRABHAKARAN**, S.N. JADHAV*
SATISH ELKUNCHWAR**, K. RAVIKUMAR AND UTKARSH GHATE

Foundation for Revitalisation of Local Health Traditions (FRLHT), Bangalore (Karnataka).

Introduction

India is privileged in hosting 2 of the 25 Global Biodiversity Hotspots, and an astonishing medicinal plants diversity comprising about 7,500 species, amongst nearly 17,000 flowering plant species it harbours (Ved *et al.*, 2001). Thus, every alternate flowering plant in India is used in one or more its medicinal systems-Ayurveda, Siddha, Unani, Tibetian, Modern and Folk, encompassing 4,500 communities. About 800 medicinal plant species are traded; valuing Rs. 120 crores as raw drugs at source annually across the country (Shankar, 2002). After value addition, these annually generate Rs. 4,000 crores for the Indian Herbal Industry of which exports constitute just 13% i.e. Rs. 450 crores (i.e. US$90 million). Over 80% of the traded medicinal plants are often collected destructively and unsustainably, in unregulated fashion from forest areas as raw drugs, endangering several species (Ved *et al*, 1998). Indian herbal trade can grow manifold soon as estimated by the Planning Commission, Government of India (Anon., 2000). Depleted wild stock cannot fuel herbal industry growth, which must rely on commercial cultivation, today annually accounting just Rs. 12 crores nationally. Growth in commercial cultivation would require "authenticated quality planting material", needed in the emerging global herbal industry. Besides harvests from the wild need to be certified as "eco-friendly" or "good sourcing practice" i.e. sustainable (Laird, 1999)

Excessive harvest of herbal materials from forest areas over the last century has eroded these resources severely. The Botanical Survey of India (BSI) had assessed threat status of 620 Indian plants, using herbarium information and the 1972 criteria for 'red listing' (Nayar and Sastry, 1987-90). Red listing requires updating with latest criteria of International Union for Conservation of Nature and Natural Resources (IUCN) and ground information. To update the Red list of medicinal plant species of peninsular Indian states (Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu); Foundation for Revitalisation of Local Health Traditions (FRLHT) used rapid and participatory methodology termed as Conservation Assessment and Management Plan (CAMP) workshops, guided by Conservation Breeding Specialist Group (CBSG)-India at the Zoo Outreach Organisation (ZOO), Coimbatore

* Conservator of Forests
** Dy. Conservator of Forests

(Ravikumar and Ved, 2000). Six such CAMP workshops organised at Bangalore (4), Pune (1) and Hyderabad (1) during 1995 to 2001, using 1994 red listing criteria at Bangalore for Karnataka, Kerala and Tamil Nadu and 2000 criteria at Pune and Hyderabad for Maharashtra and Andhra Pradesh respectively. CAMP synthesised field perceptions of about 200 field botanists including BSI, forest officials, industry staff etc. regarding 164 species, assessed for being extensively traded and/ or endemic and/or harvested essentially destructive (e.g. root, bark etc). Of these, 134 species were red listed in one or more states (Table 1).

Cultivation from Conservation

Cultivation cannot substitute conservation of natural populations i.e. *in-situ*. Cultivation of desired strains of some of these species can help only in meeting the industrial demand and reduce the harvest pressure on the wild. But cultivation cannot conserve their entire natural variations spread across bio-geographic zones and habitat types along with their natural pollinating or dispersing animals or factors. Further, cultivation prospects for many of these threatened species are rather bleak. Though propagation techniques are known for half of the threatened species (Omman *et al*, 2000), hardly 5-10% species are cultivated commercially such as *Gloriosa superba* L., as industry prefers cheap harvests from the wild than the costly production from cultivation. Farmers are not ready to risk cultivation of medicinal plants including the highly demanded threatened species, due to absence of agro-technology

Table 1

Coverage of medicinal plant diversity including threatened species by the Medicinal Plant Conservation Area (MPCA) network across Peninsular Indian forests

Category/ State	Karnataka	Kerala	T.N.	A.P.	Maharashtra
No. of MPCAs	13	8	12	8	13
MPCA Network Area (ha)	2,800	1,500	2,000	2,000	3,000
Flowering plant species of state	3,000	4,000	4,000	2,800	3,000
Species listed from MPCAs	1,400	1,900	1,800	1,800	850
Medicinal plant species of state	2,000	1,300	2,000	1,800	2,100
Medicinal plant species in MPCAs	950	550	900	650	500
MPCA hosted % of state medicinal plants	46	43	44	35	25
Threatened species	67	74	72	39	26
Threatened species in MPCAs	42	39	22	21	10
Globally threatened (endemic) species	34	47	47	11	5
Globally threatened species in MPCAs	21	23	9	7	0

packages, authentic and quality planting materials, buy back guarantee, venture capital fund or incubation grants, subsidies, concessions etc. The National Medicinal Plants Board established subsequently by the government to promote cultivation as recommended in the aforesaid Planning Commission report has initiated such steps. Full-scale commercial cultivation would develop only after decades. So, industry must cope with shortfall in supply through substitutes mentioned in pharmacopoeia and sustainable harvest from the wild.

Selection of *in-situ* gene bank sites

State Forest Departments (SFDs) of Peninsular Indian States have been developing a pioneering model termed Medicinal Plant Conservation Area (MPCA), for *in-situ* conservation involving local people in conservation efforts (Goraya and Tandon, 1996). Local community benefits from training to usage of locally available medicinal plants for their primary health care needs, and making available planting material for users, both non-commercial and commercial. Criteria for selecting an MPCA site, include singly or in combination :

(a) Reputed biodiversity hotspot e.g. Agastyamalai, Kerala.
(b) Traditionally source of reputed medicinal plant e.g. Kutralam, Tamil Nadu.
(c) Sites which do not to affect local livelihoods, as at most sites.
(d) Easily accessible for management e.g. Mundanthurai, Tamil Nadu.
(e) Sufficiently large (200-500 ha) for adequate management attention of Forest Department, as at most sites.
(f) Representative of forest type/ ecological conditions not reflected by other MPCAs so that about 10-15 MPCAs per state reflect all the forest types/ecological zones.
(g) Capturing significant numbers or populations of red listed species e.g. *Saraca asoca* in Kollur in Karnataka.
(h) Traditional conservation site e.g. Gadmauli sacred forest grove in Maharashtra.

During 1993 to 2000, State Forest Departments of Karnataka, Kerala and Tamil Nadu established a network of 32 MPCAs with an average size of 200 ha i.e. 2 km^2 in co-ordination with FRLHT. Each MPCA covers 1- 2 forest types and varying human interference. MPCA network together covers all the forest types and ecological zones in each state. Some MPCAs are inside Protected Areas (PAs) i.e. such as Wildlife Sanctuaries (WLS) and National Parks (NPs), for added medicinal plants focus, while some are easily accessible. Management in MPCAs focuses on greater protection from fire, grazing and harvests than surrounding forests. Community outreach activities include raising nursery of local medicinal plants, besides collaborative botanical survey and monitoring involving local knowledgeable people.

This Southern Indian MPCA network was steered by Ministry of Environment and Forests (MoEF), Govt. of India (GoI); with the support of Danish International Development Assistance (DANIDA) and facilitated by FRLHT. Its success motivated United Nations Development Programme (UNDP) to sponsor its extension to 13 and 8 sites in Maharashtra and Andhra Pradesh (AP) states respectively during 2000. This is co-

ordinated with concerned SFDs respectively by Rural Communes, Mumbai, and Environmental Protection Training and Research Institute (EPTRI), Hyderabad; in consultation with FRLHT.

Species Coverage

MPCA network remarkably represents nearly half (45%) the medicinal plant diversity in each State while covering just 0.1% of their forest area (Table 1) due to careful distribution of MPCAs across different forest types, climatic and soil-water regimes (Ved *et al.*, 2001). Each MPCA hosts 100-200 medicinal plant species, including 5-25 Red Listed species. The 54 MPCA network harbours 93 (i.e. 70%) of the 134 peninsular red listed medicinal plant species, though MPCAs were selected before red listing, on other criteria such as forest type representativeness, socio-cultural value etc. Mere record of the presence of a species in an MPCA may not guarantee its long-term conservation, which requires at least 200 breeding individuals per species for continued evolution in contiguous habitats, to survive any bio-climatic disasters (Soule, 1980). For, though MVP is known to be 500 for long-term evolution and in isolated habitat conditions, the famous 50:500 thumb rule of Conservation Biology advocates "effective population" size (N_e) to be 50, as minimum viable population (MVP) for short-term conservation in contiguous habitat, as is the case with most MPCAs. Only 25% of the adult i.e. breeding individuals constitute effective population of any species, as the probability of random mating between individuals belonging to different genetic lineage is 25%, required to maintain genetic variation. MPCAs and neighbouring forests may harbour MVP (>200) of several red listed species, as enumeration covering 1% of MPCA area has recorded 3-20 red listed species per MPCA exceeding 2 individuals along transect.

MPCA Activities

(a) *Botanical Research* : Botanical survey by FRLHT has been a valuable contribution to plant taxonomic research in Southern India, generating over 30,000 specimens representing over 3,000 flowering plant species (Ved *et al.*, 2001). This includes about 2000 medicinal plants (i.e. 60% of all medicinal plants of peninsular India) and all the red listed (RL) species assessed. This has also yielded 4,000 images of most of these species and 10,000 raw drug samples belonging to 417 species. FRLHT herbarium and museum has been recently recognised with the international citation code FRLH; besides as "Centre of Excellence in Medicinal Plants and Traditional Knowledge" recognition by the MoEF. Remarkable findings include rediscovery of unique RL species such as *Utleria salicifolia* Bedd. (Prabakaran *et al.*, 2001). These first hand field data have greatly enriched the eco-distribution maps of the RL species that FRLHT compiled for MoEF, which could be useful information to decide on cultivation requirements of species in terms of climate, soil, and water regimes.

(b) *Ecological Research* : To assess population structure and potential of medicinal plants species, about 20 transects measuring 250 x 4 m (i.e. 1,000 m^2 i.e. 0.1 ha) each, were enumerated in each MPCA. Together, these cover about 1 to 2 ha i.e. up to 1% of the MPCA area. Trees and lianas (Girth at Breast Height i.e. GBH > 30 cm) were sampled throughout while shrubs/saplings/climbers (3 cm

<GBH < 30 cm) were sampled across 20% of transect area while herbs/ seedling (GBH < 3 cm) were counted across strips measuring 4%.

MPCA transects have sampled about 2,000 individuals belonging to 300 flowering plant species on an average per MPCA, half of these being medicinal. About 60% of the species are estimated to possess MVP (>200 adult individuals) inside MPCA, with 2 or more individuals being counted in the 1 % sampling. About 15-20 % of the species possess even the upper limit of MVP (2,000 adults). Most species in MPCA may possess MVP upper limit if forests adjoining the MPCA are also well protected. By protecting an area equal to the MPCA area in its neighbourhood, additional 50-60% species could be covered. However, doubling the number of MPCAs sites would hardly add 15-20% additional species, as MPCA network represents forest type diversity very well, as indicated by the species-area curve extrapolations.

(c) *Threatened species recovery research* : To understand reproductive biology, extrinsic and intrinsic threats and to outline possible management strategies for threatened species, FRLHT has initiated collaborative field research programme (Mali *et al.*, 2001) involving reputed research institutes Ashoka Trust for Research in Ecology and Environment (ATREE), Bangalore (Karnataka); Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore (Tamil Nadu) and Tropical Botanical Garden and Research Institute (TBGRI), Palode (Kerala). These institutions are conducting recovery research in 2-3 MPCAs each, in co-ordination with local forest officials and people, altogether covering 7 MPCAs since 2000. This programme has begun to throw light on conservation problems and prospects of species that may be suffering from pollination or dispersal problems, poor fruit set or regeneration, scarcity of saplings. Novel propagation techniques have been innovated for 15 red listed species including *Trichopus zeylanicus* Gaertn. subsp. *travancoricus* Burkill ex Narayanan. Probable management techniques emanating from this programme include hand pollination or dispersal, foliar sprays or vegetatively reproduced (using air layering or tissue culture) saplings for replanting in degraded forests etc. The research has also generated in population distribution maps of each RL species in each MPCA, incorporated into Geographic Information System (GIS). This provides a benchmark for future monitoring.

(d) *User Orientation* : Nurseries of medicinal plants from propagules of species in the MPCA have been raised at 18 Southern Indian MPCAs, raising about 2 million saplings of 106 species, including 30 RL species. These are primarily sold at cost basis to non-commercial users like local people to raise Kitchen Herbal Gardens (KHG) for affordable domestic healthcare. Commercial users such as industries and farmers are charged higher. MPCA propagules have been also used to develop Ethno Medicinal Forests/ Gardens (EMF/G). Some MPCAs feed into to seed centres of the forest department, to supply of quality planting material of highly traded and/or threatened species; as begun with the Tamil Nadu Forest Department. Protocols for germplasm collection, tagging, storage and seed-testing are being developed for highly traded or threatened species. Germplasm supplied by seed centre can be effectively used by plant breeders and by

forest managers for cultivation and conservation.

Nature trails have been created in the periphery of the MPCA to familiarise the tourists with the local medicinal flora by fixing name plates to important plants along the trails and with the help of the local persons serving as eco-guides. Nature camps for school/college students have been conducted to sensitise them about MPCAs such as at Sandur in Karnataka. *Interpretation centres such as at Top Slip* (Annamalai) in Tamil Nadu host a repository of local ethno-medicinal wealth for the tourists and students.

Barefoot botanists (BFB) training programmes have been conducted at Savandurga, Sandur, Devrayandurga, Talcauvery, B.R. Hills and Agumbe MPCA in Karnataka and extensively in Maharashtra, besides Andhra Pradesh with Forest Department support. These village botanists (VB) can help in ethno-medicinal inventory and monitor populations of RL species, besides collecting germplasm of distinct target populations of priority traded species for ascertaining quality, including for nursery propagation. Herbal industry increasingly requires such genetic fingerprints to accompany the raw drug supply, besides authentic identity and chemical profile, even for the planting material.

While MPCA model with high conservation value represents good forests, SFDs have also initiated Medicinal Plant Development Area (MPDA) models at 12 sites in 3 states as a demonstration project with extension value. MPDAs aim to restore degraded forest lands using the guidelines of Joint Forest Management (JFM) framework. MPDAs have been successfully internalised by the Tamil Nadu Forest Department under Tamilnadu Afforestation Programme (TAP).

Institutional Sustainability

To cater to the MPCA, SFDs have established the Local Management Committees (LMCs) comprising of local people, panchayat members, forest officials, Nati-vaidyas i.e. folk healers, school teachers etc. LMCs have also been registered under Societies Act as in Karnataka and Maharashtra for financial stability. SFDs are also internalising MPCAs in the departmental Working Plans as in Kerala, as with the MPDA and TAP. Maharashtra, Karnataka and Tamil Nadu SFD have conducted orientation of Working plan officers, to be followed by other SFDs soon. Over 100 training programmes conducted by FRLHT for forest officers at all levels as well as for Local Management Committee (LMC) and Self Help Group (SHG) members have strengthened local capacity significantly. Thus, state stewardship and user support would ensure the long-term socio-economic sustainability of MPCAs, besides possible support from agencies such as UNDP.

Implications and follow up

MPCA model is not an end in itself given its limited coverage of medicinal species or Red listed species. It is a flagship programme to involve local people and users meaningfully; resembling the Joint Protected Area Management (JPAM) concept, endorsed by the National Biodiversity Strategy and Action Plan (NBSAP). It may be gradually recognised and used as attempted in Maharashtra State Agricultural Policy 2003-2027 to recognise MPCA as source of

authenticated, quality planting material (M.S. Swaminathan, *pers. comm.*). Global Environment Facility (GEF), United Nations Environment Programme (UNEP) has involved FRLHT in developing similar programmes for Northern Indian states of Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Chattisgarh, Sikkim, Meghalaya and Arunachal Pradesh soon. This may help to implement aforesaid Planning Commission recommendations to establish 200 MPCAs and 200 MPDAs country-wide.

Indian Biological Diversity Act, 2002 seeking to regulate Access and Benefit Sharing (ABS); recommends establishment of Biodiversity Management Committees (BMC) for conservation and sustainable use of biodiversity, including its chronicling, regulating commercial use and rehabilitation of threatened species. CAMP, LMC, VB, Nurseries and Recovery Research programmes of MPCA provide rich experience to operationalise the provisions of the Act and NBSAP.

Acknowledgements

The programme owes its success to State Forest Departments of Karnataka, Kerala, Tamil Nadu, Maharashtra and Andhra Pradesh including MPCA officers and field staff, besides DANIDA. Numerous past and present FRLHT colleagues including Director Mr. Darshan Shankar, Deputy Director Mr. D.K. Ved, IFS, and staff Dr. P.S. Udayan, Mr. R. Vijaya Sankar, Mr. B.S. Somashekhar, Dr. Subhash Mali, Mr. Narsimha Reddy, Mr. Sudhakar Reddy, Mr. Raghu Velankar, Mr. Suresh Jagtap and Ms. Anagha Ranade, besides several NGO colleagues. We are obliged to them all.

SUMMARY

State Forest Departments (SFDs) of Andhra Pradesh, Karnataka, Kerala,Tamil Nadu and Maharashtra, in consultation with FRLHT and the support of DANIDA and UNDP have established 54 forest gene banks sites termed 'Medicinal Plant Conservation Areas (MPCA)'. The network of 54 MPCAs measuring 200 ha to 500 ha each established gradually since 1993 represents all forest types and large bio-climatic and soil regime variation. These gene banks harbour recorded populations of 45% of flowering and medicinal plants of Peninsular India, including 70% of the red listed. The intra-specific diversity i.e. germplasm conserved in the MPCA network can be used to provide authenticated quality planting material for commercial cultivation to meet rising demands of the herbal industry. MPCAs also constitute 'study sites' for threatened species recovery research. MPCAs have proved crucial in capacity building of forestry staff, local communities and researchers in the conservation of Medicinal Plants for sustainable use and equitable benefit sharing. This experience can help in implementing plans and programmes under the Biological Diversity Act 2002, National Biodiversity Strategy and Action Plan (NBSAP) and Medicinal Plants Board.

वन जीन बैंकों द्वारा औषध पौधों का संरक्षण और दीर्घकालिक उपयोग

टी०एस० श्रीनिवासामूर्ति, एम० करनट, वी० प्रभाकरन, एस०एन० जाधव, सतीश एलकुंचवार,
के० रविकुमार व उत्कर्ष घाटे

सारांश

आंध्रप्रदेश, कर्णाटक, केरल, तमिलनाडु और महाराष्ट्र के राज्य वन विभागों ने स्थानीय स्वास्थ्य परम्परा पुनरूज्जीवन प्रतिष्ठान (एफ आर एल एच टी) के परामर्श और डैनिडा और उण्डप की सहायता से औषध पादप संरक्षण क्षेत्र MPCA नामक 54 वन जीन बैंक स्थल स्थापित किए हैं । संरक्षण क्षेत्रों का यह जालकर्म जिसमें प्रत्येक क्षेत्र का क्षेत्रफल 200

हैक्टै0 से लगाकर 500 हेक्टे0 तक का है, धीरे-धीरे 1993 से स्थापित किया गया है और ये क्षेत्र सभी तरह के वन प्ररूपों तथा बड़े-बड़े जैव जलवायु और मृदा क्षेत्रों के भेदों का प्रतिनिधित्व करते हैं । इन जीन बैंकों में पठारीय भारत में पुष्पित होने वाले और औषधीय पादपों के 45% पादपों को लिया हुआ है और उनमें लाल सूची में दर्ज हुए 70% पादप भी सम्मिलित हैं । जाति के अन्दर की विविधता अर्थात् औषध पादप संरक्षण क्षेत्र में संरक्षित बीजप्ररस का औषध-शाक उद्योग की बढ़ती हुई औद्योगिक मांग पूरी करने को व्यापारिक खेती करने के लिए प्रमाणित उत्तम गुणवत्ता वाली रोपण सामग्री देने हेतु भी उपयोग किया जा सकता है । ये 'संरक्षण क्षेत्र' पुर्नप्राप्ति अनुसन्धान के लिए 'अध्ययन केन्द्र' भी हैं तथा दीर्घकालिक उपयोग और साम्यतापरक लाभ विभाजन के लिए औषधीय पादपों के संरक्षण में अनुसन्धान करने वालों, स्थानीय समुदायों और वानिकी कर्मचारियों की क्षमताएं बढ़ाने में इन्होंने महत्वपूर्ण योग दिया है । यह अनुभव जैविकीय विविधता अधिनियम (बायोलाजिकल डायवर्सिटी ऐक्ट), 2002 तथा राष्ट्रीय जैवविविधता समरनीति व कार्य योजना (एन.बी.एस.ए.पी.) तथा औषधीय पादप मण्डल की योजनाओं और कार्यक्रमों के क्रियान्वयन में भी सहायता दे सकता है ।

References

Anon. (2000) Report of the Task Force on Conservation and Sustainable Use of Medicinal Plants. Planning Commission, Government of India, New Delhi.

Goraya G.S. and V. Tandon (1996). *In-situ* Conservation of Medicinal Plant Diversity in Tropical Forests of Southern India. *MyForest*, **32**(4): 247-257.

Laird, S.A. (1999) The botanical medicine industry. *The Commercial Use of biodiversity: access to Genetic Resources & Benefit Sharing* (K. Ten Cate and S.A. Laird, eds). Earthscan, London. pp. 78-116.

Mali, S., D.K. Ved and T.S. Srinivasmurthy (2001). An approach to conservation of threatened plant species through species recovery. Tropical Ecosystems: Structure, Diversity and Human Welfare (Ganeshaiah, K.N., R. Uma Shanker and K.S. Bawa, eds.). Oxford and IBH, New Delhi. pp. 670-673.

Nayar, M.P. and A.R.K. Sastry (1987-1990). *Red Data Book of Indian Plants.* Vols. I-III, Botanical Survey of India, Calcutta.

Omman, Sumy, D.K. Ved and R. Krishnan (2000). *Tropical Indian Medicinal Plants: Propagation Methods.* FRLHT, Bangalore.

Prabahkaran, V., K. Ravikumar and R. Vijay Shankar (2001). Rediscovery of the millennium-*Ulteria salicifolia*. *Amruth,* 5 (2): 21-27.

Ravikumar, K. and D.K. Ved (2000). *Illustrated fieldguide to 100 red-listed medicinal plants of conservation concern in Southern India*. FRLHT, Bangalore.

Shankar, Darshan (2002). A Holistic Perspective for Management of Indian Medicinal Plants. *Jr. Agri. Fin.,* **34** (3) (Spl. Issue on Med. Pl.) : 22-24.

Soule, M.E. (1980). Thresholds for survival: Maintaining fitness and evolutionary potential. *Conservation biology: An evolutionary-ecological perspective* M.E. Soule and B.A. Wilcox, eds.). Sinauer Assoc., Sunderland, MA. pp. 151-169.

Ved, D.K., Anjana Mudappa and Darshan Shankar (1998). Regulating export of endangered medicinal plant species: Need for scientific rigour. *Current Science* **75** (4): 341-344.

Ved D.K., C.L. Prathima, Nancy Morton and Darshan Shankar (2001). Conservation of India's medicinal plant diversity through a novel approach of establishing a network of *in-situ* gene banks. *Forest Genetic Resources: Status, Threats and Conservation Strategies* (Uma Shaanker, R., Geneshaiah, K. N. and Bawa, K.S., eds.). Oxford and IBH, New Delhi. pp. 183-194.