Chapter 2

REVIEW OF LITERATURE

2.1 TRENDS IN PRESERVATION OF MEDICINAL PLANTS

2.1.1. HISTORICAL PERSPECTIVE

The life stream carried in its currents its own supporting and protecting wisdom that became manifest at the beginning of each cycle of time. Man often guided by the instinct of lower animals, through accident, intuition, intelligent observation and inference, has accumulated knowledge about useful plants (as food and medicine) and harmful plants (poisons). There are theories about the evolution of plants, the nature of plant life and the position of plants in the whole realm of nature and human life as vegetation is the primary source of food and medicine for every form of life. Documented evidences about the understanding and use of plants as medicine in the pre-vedic period (Before 5,000 BC) are not available.

During Vedic period (5,000 — 2,500 BC), there has been a systematic use of plants as medicine in ancient India. The 'Oushadi Suktha' in Rigveda (10.97. 1-23) is the oldest document available on medicinal plants. It mentions 67 plants including...
Aswatha (*Ficus religiosa*), Khadira (*Acacia catechu*), Soma (identity controversial), Darbha (*Desmostachia bipinnata*), Sigru (*Moringa pterigosperma*) etc. The morphological characters of medicinal plants, their habitats, therapeutic classification and uses in curing various diseases are summarily described in it (Unnikrishnan 1997).

Yajurveda describes 81 plants including Apamarga (*Achyranthus aspera*), Arka (*Calotropis procera*), Arjuna (*Terminalia arjuna*), Vilwa (*Aegle marmelos*) etc. Atharvaveda, of which Ayurveda is considered to be the ‘Upaveda’, mentions as many as 289 plants including Kamala (*Nelumbo nucifera*), Kumuda (*Nymphaea alba*), Caturangula (*Cassia fistula*), Jeevanti (*Leptadenia reticulata*) etc. (Unnikrishnan 1997).

Many medicinal plants in the Vedic Period have contemporary recognition while a few of them have lost identity.

Though there has been extensive use of plants for medicinal purposes in the Vedic Period, the concept of conservation of plants had not emerged then, probably due to easy and plentiful availability and less of requirement.

Samhita period (2500 BC to 500 AD) otherwise known as the period of Secular Literature showed a systematic documentation of the understanding and knowledge of medicinal plants; the scientific practice of medicine in the name of Ayurveda was incepted then. Caraka Samhita (Agnivesha, 2500BC - 500 AD) mentions 12,850 medicinal plants to be used in different diseases. Susrutha Samhita (Susrutha 2500 BC — 500 AD) has 9650 and Astanga Samgraha (Vagbhata 500 AD) has mentioned 20,500 medicinal plants (Unnikrishnan 1997).

Analysis of the ancient literature on plant medicine during the period 2500 BC — 500 AD, gives the idea that, exhaustive descriptions are available on plants and their medicinal uses, nomenclature, biological properties and actions, habitats,
regional specifications, time and methods of collection, classification, combining and compounding of plant produces, contra-indications and so on. But, a definite concept or ideas on the concept of conservation of medicinal plants were not evolved. There are references on medicinal plants to be used as ‘abhavadravyas’ (substitutes) in the medical practice, giving a clue to the fact that certain plants were scarcely available or not available at all. The problem of non-availability of medicinal plants was successfully solved by resorting to substitutes rather than painstakingly preserving them.

During Mediaeval period (500 - 1500 AD), greater attention was paid exclusively on medical plants. *Nighantu* (Lexicons) exclusively dealing with medicinal plants based on different schools of classification. Identification of plants was done based on different schools of classification and was made specific by introducing synonyms. Notable works of this period are Dhanwantari Nighantu (250 — 1000 AD), Chakradatta (1075 AD), Nighantu Sesa (1200 AD), Sidha Mantra (1210 — 1247 AD), Madanapala Nighantu (1374 AD), Khayyadeva Nighantu (1450 AD). These works appear to be exhaustive compilations of medicinal plants and their uses. The idea of preservation/conservation of medicinal plants was not conceived in any of these works; the reason attributed being the same as existed in the Samhita Period.

In the Mediaeval period, greater works supplementing Surapala’s *Vrikshayurveda* were in vogue. Brihatsamhita by Varahamihira (505 AD) Lokopakaram by Chavudaraya (1025 AD) and Vrikshayurveda by Sarngadhara (1363 AD) can be recognised as popular works on the indigenous methods of plant protection (Chandrakanth 1995).

In the post-mediaeval period of 1500 to 1800 AD, many original works on medicinal plants were published. Bhavaprakasa (1550 AD), is the largest compilation...
on medicinal plants. An outstanding feature of this work is that it specifies soil types suitable for the growth of plants used for medicinal purposes. Nighanturatnakaram (1700 AD) and Raja Nighantu (1700 AD) also deal with the subject of medicinal plants purely based on Ayurvedic approach. Description of a large number of medicinal plants of Kerala can be seen in the original work of Van Rheede (1678 - 1703). References on the aspect of conservation of medicinal plants are not available in these works.

2.1.2. DEVELOPMENT OF MEDICINAL BOTANY IN 19TH CENTURY

The nomenclatural system of species identity in plants was introduced by Linnaeus (1707 - 1778) giving an impetus to the study of plants throughout the world. Following Linnaean classification, compilation works were carried out in our country to bring out the list of medicinal plants in the form of Materia Medica. The first Materia Medica was published by Ainslie. W in 1813, revised in 1826 describing more than 600 species. Based on observational and experimental studies, Bentley and Trimen in 1880 published four volumes of medicinal plants giving details of less than 500 species. Merion (1931) prepared a compilation of 734 medicinal plants of India. Bose (1932), Chopra (1956), Dymock and Hooper (1890), Kirtikar and Basu (1918), Nadkarni (1927), Mooss (1953), CSIR (1948) presented notable contributions, most of them appear to be exhaustive compilations. These works helped the researchers on plant medicine with sufficient informative data. The problem of the present study i.e. conservation and cultivation of medicinal plants was not an area of interest at that point of time.

Population being low, demand being less and extent of forests and waste lands being prolific, none attached importance to the aspects of cultivation and conservation
of medicinal plants.

2.1.3. **EVOLUTION OF THE CONCEPT OF PRESERVATION/CONSERVATION OF MEDICINAL PLANTS**

Industrialisation and consequent economic utilisation of forests, conversion of forest lands into agricultural fields to bring about green revolution, over-utilization of forest areas for meeting the local demands like timber, fuelwood, small timber, grazing etc., urbanisation, developmental activities like construction of irrigation and power projects, raising commercial plantations for providing employment opportunities etc. have resulted in the reduction of natural habitats, and this in turn depleted the natural medicinal plant resource. In the process, many plants have become rare, endangered and some have even extinct. Over harvesting and over-exploitation of medicinal plants added fuel to the fire. Due to unscientific utilisation, some medicinal plants are not properly and fully extracted and some are over-exploited resulting in a change in the species composition, density, regeneration, availability and above all, biodiversity. (Muraleedharan *et al* 1997) The alarming and unprecedented demand to meet the requirements of the ever increasing population and the continued decrease of forest and wasteland resulted in the evolution of the concept of preservation and sustainable use of this valuable natural resource.

The 10th General Assembly of IUCN (International Union for Conservation of Nature and Natural Resources) held at New Delhi in 1969 was a landmark in developing the idea of conservation. This focussed attention on the urgent need to preserve the endangered species of Indian flora and urged the Government to bring these endangered medicinal plants into effective cultivation. IUCN pointed out 4 plant species including *Rauvolfia serpentina* (Sarpagandhi) as threatened with extinction in their natural habitat. Therefore, it was proposed to set up a conservation
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unit to conserve the endemic and vanishing plant taxa in Indian Flora and to take up a base line study upon which future action plans can be prepared. Accordingly, *In-situ* and *Ex-situ* methods were separately considered to be implemented on long term as well as short term conservational strategies. During the last three decades, various efforts have been made in this direction. Programmes gained more popularity even in the absence of a concrete National Policy on the issue.

Scientific studies on various aspects of conservation became much popular in the beginning of 1970.

In 1976, a National Symposium was held in the RRL, Jammu on the “Cultivation and utilisation of Medicinal and Aromatic Plants”. After the symposium, a book was brought out in the year 1997 with added details along with the compilation of the papers presented (Atal and Kapur 1977). This compilation covered the multi-disciplinary aspects of the medicinal plants such as botany, agronomy, package of practices of their cultivation etc. This work envisaged the urgent need for conservation and sustainable use of medicinal plants and the need for cultivating the required species to reduce the pressure on the wild and other natural habitats.

The Horticultural Division of the Union Ministry of Agriculture and Co-operation has then established 16 herbal gardens in the different Agricultural Universities and National Research Laboratories in India with the objective of collecting the varieties occurring in the wild population in respect of 100 medicinal plant species and 35 endangered species and raise them in the herbal gardens to be set up as *ex-situ* conservation centres. (Gupta and Chadha, 1995).

Since 1971, CCRAS has set up 17 survey units in 16 stations of the country at different climatic and altitudinal levels. Identification of herbal drugs in Ayurveda, Sidha and also folklore drugs was carried out. These units explored 146 forest divisions/areas in different States, collected about 1 lakh plant specimens representing...
different families, genera and species. A total number of 90,000 herbarium sheets were incorporated in different institutions, and about 2936 drug samples was also collected and preserved (CCRAS, 1983-84).

The last three decades showed a quantum leap in terms of conservation of medicinal plants at National and International levels. Conceiving the idea of preservation, various agencies contributed to the cause. Entrepreneurs, Research Institutes, Agricultural Universities, Ayurvedic Pharmaceuticals, Forest Departments, Non-Governmental Organisations etc. participated in various sporadic and coordinated programmes of conservation of medicinal plants. The advancement in the conceptual, technical and operational levels of conservation of medicinal plants could be appreciated through the establishment of Gene Banks in the country for medium and long term storage of seeds and propagules. The G 15 summit at Caracas in 1991 had made the proposal for establishing Gene Banks and the Department of Biotechnology, Government of India has set up three National Gene Banks each at Tropical Botanical Garden and Research Institute, Palode—Thiruvananthapuram, National Bureau of Plant Genetic Resource, New Delhi and Central Institute of Medicinal and Aromatic plants, Lucknow during 1992-1993 (GEBMAP 1995).

Researchers also have made notable contributions. In this context medicinal plants were also identified as important entities of endangered taxa (Qureshi and Kaul, 1970). Maheswari (1977) recognised five status categories of rare plants as per IUCN guidelines.

A comprehensive collection of the threatened plants of India was carried out by Jain and Sasthri (1980). Batisse (1982) viewed the biosphere reserve, as the tool for environmental conservation putting plants on top priority. Arora (1983) made an assessment of the threatened plants of India and the depleting genetic resource of the Nation, under the aegis of Botanical Survey of India. Nambiar et. al. (1985) and
Nair and Daniel (1986) published the list of medicinal plants found in the forests of Kerala (Appendix VI) Basha (1990) stressed the urgent need for conservation and sustainable management of medicinal plants in the forests of Kerala.

**In situ** conservation was studied in the Kerala context by Sasidharan (1991) under the rare, endangered and endemic categories and listed out 10 species of medicinal plants of restricted distribution. These are Salacia **oblonga**, *Nervilia aragona*, *Coscinium fenestratum*, *Aphanamyxis polystachya*, *Symplocos cochinchinensis*, *Drocera peltata*, *Trichosanthes curcumerina*, *Rubia cordifolia*, *Trichosantes curcumerina*, *Rubia cordifolia*, *Malaxis rheedi*, *Iphigenia indica*. It put the early concepts on **in situ** conservation in the right perspective. The study listed out 33 medicinal plants required in large quantities, for the manufacture of various indigenous medicines. It made a special case of *Coscinium fenestratum* as threatened in the wild. Singh and Subramanian (1991) studied the endemic plants of Kerala and emphasized the need for their conservation.

Gupta and Chadha (1995) described the different forest types of India and their medicinal plant components. The Western Himalayas, Eastern Himalayas, Assam and North East India, Semi Arid regions including Thar desert, Gangetic plains, Western Ghats and Malabar region, Deccan peninsula, Andaman and Nicobar islands were studied separately and a list of 35 endangered medicinal and aromatic plants were identified.

Basha (1990) while describing the importance of Forests of Kerala classified the forest types and listed out number of medicinal plants found in each type.

1. West Coast Tropical evergreen forests 176 species
2. West Coast Tropical semi evergreen forests 37 species
3. South Indian moist deciduous forests 297 species
4. Southern sub-tropical broad leaved hill forests 4 species
5. Southern Montane wet temperate forests 30 species
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6 Southern Tropical dry deciduous forests 115 species
7 Grasslands 20 species

Amalraj et. al (1991) enlisted 4 endangered and 8 threatened medicinal plants in the Western Ghats of Kerala as follows.

**Endangered**
- Coscinium fenestratnum
- Kaempferia galanga
- Rauvolfia serpentina
- Saraca asoca

**Threatened**
- Acorus calamus
- Adathoda beddomei
- Alpinia galanga
- Curcuma zedoria
- Drosera peltata
- Gloriosa superba
- Hemidesmus indicus
- Plectranthus barbatus

Dan.M and Shanawaz Khan (1991) compiled 6 rare medicinal plants in the Western Ghats of Kerala. These are
- Conscinium fenestratum
- Embelia ribes
- Helminthostachys zeylanica
- Heracleum candollaenum
- Holostemma adakodien
- Rauvolfia serpentina

Muraleedharan et al (1997) conducted an exhaustive study of the sustainable use of non-wood forest products in the three areas of the Western Ghats, Kerala and recorded 229 species of which 202 species being extracted for medicinal purposes. The study concluded that illegal, unscientific and frequent harvest as well as high rate of ‘legitimate’ extraction by tribals resulted in poor density sparse distribution and depletion of the medicinal plant resource. Another study on the nonwood forest produce including the medicinal plants was carried out by Nair (1996) and highlighted the necessity for their conservation and sustainable utilization.

While studying the status sacred groves in Kerala Basha (1997) listed out 459 species having medicinal properties occurring widely distributed and stressed the
need to conserve the sacred groves through participation of local communities (Appendix V).

Chandrasekhara and Sankar (1998), Desmukh et. al (1998), Godbole et. al (1998), Pushpangadan et. al (1998) and Ramakrishnan (1998) stressed the needs for the conservation of the Sacred groves as refugia for the important plants which include large number of medicinal species. Bhagwat (1998) studied on sacred groves as a traditional network of nature reserves, being instrumental in protecting certain habitats and species that are otherwise excluded from protected area network. It is well known that Sacred groves play a major role in the conservation of various plants including rare medicinal plants and also the biodiversity.

The new concept of ‘simulated’ in situ gene bank is being introduced as a novel approach for conservation of medicinal and aromatic plants at the Tropical Botanical Garden and Research Institute (TBGRI), Palode, Thiruvananthapuram. This is a pioneering field of conservation linking in situ and ex situ attempts. In this exercise, the Institute developed a number of so called in situ field gene bank plots accommodating nearly 5000 accessions including about 100 endemic/rare, endangered and threatened medicinal and aromatic plants from the peninsular India. (Jabbar et al 1998).

Ex-situ conservation and the importance of domestication of wild medicinal plants have long been recognised by various researchers. Nayar (1992) stressed ex-situ conservation as the simplest yet feasible method and the importance of increased social concern for this method was highlighted.

In vitro growth studies of selected medicinal plants from the Western Ghats were conducted at TGBRI, Palode, Thiruvananthapuram by De Cruz et. al (1998) as part of the ex situ conservation programme Piper barberi, Piper longum and
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*Baliospermum montanum* were raised in appropriate media using shoot tip/axillary bud explants. The study demonstrated varied requirements of different species for short-to-medium term storage and proved to be a working model, though the procedure is expensive.

Seed bank and cryobank are the means of long term *in vitro* models that serve *ex-situ* conservation. The programmes are fully funded by DBT, Government of India at 3 centres (GEBMAP 1995).

Non-Governmental agencies in collaboration with ethnic groups have done commendable jobs in the conservation of medicinal plants. The Foundation for Revitalisation of Local Health Traditions (FRLHT) founded in 1991 with Head Quarters in Bangalore was the pioneering NGO to take up the case of India’s medicinal plant heritage. The foundation’s thrust areas are, traditional medicine and health care, *in situ* and *ex situ* conservation of medicinal plants, preparation of computerised multi-disciplinary databases on medical plants; primary focus being on medicinal plants conservation efforts and dissemination of related information. (FRLHT 1998)

LSPSS, Coimbatore; CIMH, Coimbatore; PDS, Peerumedu; MSSRF, Chennai;; SAMBANDH, Cuttack; ZOO and KRA Bangalore are the notable NGOs who have contributed sufficiently in the field of conservation of medicinal plants.

The Forest Department has proper guidelines for effective management of MFP (Minor Forest Produce) including medicinal plants; based on the Report of National Commission on Agriculture 1976—Part IX—Forestry (NCA, 1976). Both Central and State Governments have multidimensional programmes on medicinal plant conservation with financial supports. A list of 119 NWFPs, of which 117 medicinal plants collected from the forests of Kerala has been prepared by the Forest Department.
for effective regulation of their wild collection. (Appendix VII). Bash and Nair (1993) studied the problems and prospects of NWFPs in the forests of Kerala making special case of medicinal plants

BHU, Varanasi; GAU, Jamnagar AVS, Kottakkal; AVP, Coimbatore; Dabur, NewDelhi are the outstanding institutions which carry out conservation of medicinal plants in the autonomous/corporate sector.

Though an independent Ministry of Environment and Forests (MoEF) was set up, a National Policy on the conservation and cultivation of medicinal plants programmes is yet to be chalked out and implemented.

MoEF, Government of India sponsored a national consultation on medicinal plants, organised jointly by FRLHT and MSSRF at Chennai on January 10—11, 1997. It made solid recommendations for drafting the framework of a National Policy. It also suggested goals of National policy and putforth specific guidelines for the same (MoEF 1997).

The International Conference on Medicinal plants held at Bangalore in February 1998 was attended by major stakeholders from 35 countries. It made a Declaration to the spirit and action on the cause of conservation of medicinal plants. It also made specific recommendations to be followed and implemented by the Government, Non-Governmental organisations, trade and enterprise, and also suggested recommendations on traditional resource rights (BGCN.1998). (Appendix XV)

2.1.4. PRESENT TRENDS IN PRESERVATION OF MEDICINAL PLANTS

2.1.4.1. IN SITU CONSERVATION

It is only in nature, that plant diversity at genetic, species and ecosystem level can be preserved on a long term basis. It is proved that unless medicinal plant
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species are conserved in the wild (natural habitats) in viable breeding population, they run the risk of extinction. Sasidharan (1991) suggested that the most effective way to conserve plants is to conserve them in their natural habitat providing ecological conditions for regeneration. An algorithm for the in-situ conservation strategy was put forth in the symposium on Rare, Endangered and Endemic plants (of the Western Ghats) during August 1991 held at Thiruvananthapuram (APPENDIX VIII). The necessity for the endemic angiosperms of the forest areas was stressed by Basha and Nair (1991) in that symposium.

The concepts of plant succession, plant adaptation, phytogeography, principles of restoration and enhancement, conservation of desired species, checking deforestation, availability of quality medicinal plants, sustainable management of ecosystem, and biodiversity conservation are the essential criteria which require much attention in deciding in-situ conservation of medicinal plants.

The forestry sector can play the most effective role in ensuring the long term in situ conservation and sustainable availability of medicinal plants. The forests of India are estimated to harbour 90% of India's medicinal plants diversity in the wide range of forest types that occur across the country. Only 10% of the known medicinal plants of India occur in non-forest habitats [Agricultural fields, swampy and marshy lands, water courses, grasslands etc.] (Rai et. al 1999).

The State Forest Department being the custodian of the forests has, therefore, a very crucial role to play in the context of in situ conservation.

Discontinuous species, or the medicinal plants having disjunct areas of distribution need more intensive practice of in-situ conservation. Conservation of these dispersed and widely separated populations is possible only through setting up of a network of representative medicinal plant conservation reserves; with a broadly common
management framework. Endemic species as well as cosmopolitan species (wides) can also be conserved in this fashion, since their survival is guaranteed in most other agro-climatic zones. The flow chart for conservation of endemic flora is given in Appendix X.

For long term conservation and management of medicinal plants, an *in-situ* network would need to be integrated into regular forestry and wildlife management in the country. Prioritization in the forest management, intensive training to forest officers at various levels as well as training of native community leaders are necessary for this. (Muraleedharan 1997)

Since 1993, in 3 states of South India namely Kerala, Karnataka and Tamil Nadu and more recently in Maharashtra, the Forest Departments in collaboration with FRLHT, Bangalore have established a network of 33 ‘Medicinal Plant Conservation Areas’ (MPCAs) across the entire altitudinal range of South India from 15 mts above MSL at Kodikkarai which is one of the last few pockets of dry evergreen forest types of India, to 2000 mts above MSL at Eravikulain covering all the different vegetation types. Each of these reserves is around 200 hectares in size. The objective of the project was to establish a system of medicinal plants conservation network in the project states. (Network map — Annexure XI)

This network is conserving the germ plasm of the wild medicinal plants of South India. Detailed botanical and ecological studies are being carried out in each of these reserves to document the medicinal plants that are present in them and to study their populations in the natural conditions, their occurrence, distribution pattern and the soil, rainfall, associations, altitude, aspect etc. in which the plants grow. The analysis of this documentation will provide general guidelines for *in-situ* conservation of medicinal plants in different forest habitats. It will also help to identify breeding
populations of Red-Listed plants in the MPCAs. The data can assist also, in the 
assessment of species under threat for which MPCAs can serve as research sites to 
plan re-introductions (Tandon 1997). Botanical studies in the MPCAs or Kerala were 
conducted by Sasidharan et. al (1996).

This project funded by DANIDA which ensures participation of local people, 
individual researchers and environmental groups like NGOs of South India. A 
relative development related to this project is the establishment of an extensive 
herbarium which is in steady progress and this is an integral part of ex-situ 
conservation.

There are proposals for sub-strategies to be worked out in combination with 
conventional in situ practices like re-introduction, introduction, reinforcement and 
regulation of wild collection.

(A) RE-INTRODUCTION

The release and management of a plant into an area in which it formerly occurred, 
but in which it is now extinct or believed to be extinct is termed as re-introduction. 
This is also called re-instatement and aims at habitat restoration. This new science 
has been reviewed as long term, time consuming and expensive, and if their 
application is to be considered as a valid conservation exercise, they require rigorous 
control, with the establishment of strict guidelines and appropriate National 
Legislation. (BGCI 1995). The IUCN Species Survival Commission has produced 
guidelines for worldwide plant re-introductions (Ibid).

(B) INTRODUCTION

Introduction means establishment of a plant in an area in which it has never been
known to occur. The essential prerequisites for this strategy involve detailed research on the taxonomy, genetics, reproduction, distribution and ecology of the species and practical aspects of propagation and aftercare of the plants \textit{in situ}. (BGCI 1995).

(C) RE-INFORCEMENT

This is proposed as a measure to increase population size or diversity by adding individuals to an existing population, also called supplementation or restocking. All the population of species of the medicinal plants identified as rare/endangered/threatened could be augmented by this procedure (BCGI 1995) Specific forest areas should be earmarked for this purpose and collection of MFPs should be strictly prohibited for a time frame. This is reviewed as less expensive compared to the former two procedures and can enrich the wild medicinal plant resource in a predictable manner.

Preliminary trials on enrichment/supplement planting in 3 areas of tropical moist forests of Kerala revealed that cost effective and simple methods of propagation could be developed for certain species of NWFPs including medicinal plants (Muraleedharan 1997). The procedures undertaken in the study areas indicated the potential for reinforcement of medicinal plants.

(D) REGULATION OF WILD COLLECTION

The essential component for conservation and management of medicinal plants is regulating the harvest of medicinal plants from the wild for commercial purposes, particularly those species whose harvest inevitably involves destructive collection. For sustainable resource use, one needs to consider the regeneration rate of the
resource also. Post-harvest regeneration capacity varies among different species of medicinal plants. Muraleedharan (1997) demonstrated that 35-50 percent harvest is in the sustainable limit in case of plants regenerated through seeds. Vegetatively propagating species recorded a 100 percent regeneration index, even when the harvest is as high as 95 percent (Ibid).

Hence, the present management system of NTFP/NWFP collection as well as its utilisation needs to be critically examined and re-designed so that local communities can develop a stake in sustainably harvesting medicinal plants from the forest.

Field level staff in the State Forest Departments should be oriented, trained and informed about the sustainable methods of collection and trade of medicinal plants and the restrictions thereof notified by the Central Government under CITES. The list of Negative Export of the medicinal plant species published by the Ministry of Commerce should be made available to all the forest divisions so that the field level staff can come to know of the same.

**ASSESSMENT OF CONSERVATION STATUS**

Threat status of the prioritized medicinal plants has to be assessed and assigned from time to time so as to incorporate newer strategies and methods. Conservation Assessment and Management Plan (CAMP) is a unique and pioneering initiative by FRLHT and 142 species of medicinal plants have undergone assessment for assignment into the IUCN Red-Listing categories. (MoEF 1997)

**2.1.4.2. EX-SITU CONSERVATION**

Ex situ comprises the widely practised methods and procedures of conservation
of medicinal plants by creating, raising and maintaining medicinal plant gardens. Though the concept of preservation is partially fulfilled by this method, various new modalities are being tried to make it more comprehensive and reliable.

Collection and growing of all the medicinal plants known to the various ethnic communities in different parts of the country as well as those plants registered in the texts of codified medical systems is the objective of *ex-situ* conservation. Such a chain of *ex situ* centres will act as regional repositories of our cultural, traditional and ethnomedical heritage and act as the living repositories of our society's knowledge on medicinal plants.

Under *ex situ* method, preservation strategies include live plants in Herbal gardens, Medicinal Plants Conservation Parks (MPCPs), Ethno-Medicinal Forests (EMFs), Gene Banks, 'Simulated' *in situ* gene banks and Herbarium collections.

Bio technology laboratories offer *in vitro* pollen, embryo and seed cultures of medicinal plants, for which conventional methods of storage are unsuccessful or inadequate. These methods need more critical analysis, since it involves treatment of the genetic material by chemicals.

Collection and establishment of herbarium, though a less viable method is considered at times as a supporting strategy for *ex-situ* conservation.

The algorithm of decisions tree for *ex-situ* conservation is presented in the Appendix IX.

### 2.1.4.2.(A) HERBAL GARDENS

Setting up of herbal gardens is one of the commonest and successful conservational
strategy. These gardens reflect the conventional thinking and practice of conservation. Sporadic as well as network functioning are followed by different agencies.

A well-developed land area, with all facilities to promote and protect plant growth is the essential requirement of a herbal garden. Activities include collection of medicinal plants from different and often distant natural habitats and raising them in the proposed area by providing maximum natural agro-climatic conditions for individual species with provisions of nursing, manuring, watering, treatment of diseases and so on.

Objectives of herbal gardens are four fold

i) conservation

ii) utilisation

iii) education, research and development.

iv) extension

Conservation is possible in case of all medicinal plants including those in the RET (Rare, Endangered, Threatened) category, since there is safety from over exploitation.

The present information on distribution of the herbal gardens distribution in India is scanty. The data on herbal gardens in India showed roughly about 75 numbers during 1991 — 1992 (Table 2.1). More recently, a network of 15 gardens have been set up in South India with the initiative of FRLHT; including the one located at TBGRI, Palode and the other under Peermedu Development Society at Peermedu, Kerala.
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<table>
<thead>
<tr>
<th>State</th>
<th>Number of Herbal Gardens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assam</td>
<td>1</td>
</tr>
<tr>
<td>Bihar</td>
<td>1</td>
</tr>
<tr>
<td>Gujarat</td>
<td>12</td>
</tr>
<tr>
<td>Karnataka</td>
<td>11</td>
</tr>
<tr>
<td>Kerala</td>
<td>12</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
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</tr>
<tr>
<td>Maharashtra</td>
<td>11</td>
</tr>
<tr>
<td>Orissa</td>
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<td>1</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>15</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>5</td>
</tr>
<tr>
<td>W. Bengal</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
</tr>
</tbody>
</table>


Table 2.1. List of herbal gardens — Statewise

Two of South India’s leading Ayurvedic manufacturing companies namely Arya Vaidya Sala, Kottakkal and Arya Vaidya Pharmacy (Cbe), Kanjikode have established their own herbal gardens with exhaustive collections. Other Ayurvedic Companies like Kerala Ayurveda Pharmacy Ltd., Aluva; Nagarjuna Herbal Concentrates, Thodupuzha etc. have also entered into this field. Herbal gardens are also set up by several Agricultural Universities, State Forest Departments, Directorate of ISM and Ayurveda Colleges in several States of the Country.

Types of Herbal Garden

Based on the purpose, the herbal gardens can be categorised as:

i. Primary Health Care/Backyard herbal garden: Garden around a house, useful for the family to take care of its primary health needs.

ii. Community herbal garden: A co-operative effort on growing medicinal plants around a community dwelling, benefitting all, and protected by all.

iii. Botanical herbal garden: Aims at true conservation of medicinal plants.
iv. Therapeutic herbal garden: Gardens maintained by people of different systems of medicine growing their medicinal plants useful in respective systems.

v. Institutional herbal garden: Gardens attached to educational, Government and Public enterprises, aiming at creating public awareness on medicinal plants.

iv. Sacred herbal garden: Gardens maintained to keep up and perpetuate the cultural and religious beliefs.

vii. Commercial herbal garden: Gardens housing commercially traded medicinal plants helping in Research and to meet crude drug requirements.

2.1.4.2.(b). Medicinal Plants Conservation Parks (MPCPs)

These form an integral part of Medicinal Plants Conservation Network (MPCN) implemented in 1993 and co-ordinated by FRLHT, at different locations of Southern States of India (Appendix XI)

An MPCP is a conservation centre on a patch of land (varying between 2 and 10 hectares) dedicated on a long term basis for the *ex-situ* conservation of the local, indigenous medicinal plant diversity; which is community oriented in nature. A network of carefully surveyed accessions of wild germ plasm, a nursery and live collection of Red-Listed species of medicinal plants are the essential components of these MPCPs. (Tandon 1997). Therefore, this network of MPCPs can potentially grow all the medicinal species under more or less natural conditions.

There are 15 such parks in South India (Karnataka 4, Kerala 4, TamilNadu 7) set up by FRLHT, under the DANIDA funded project “Strengthening of the medicinal plants resource base in India in the context of Primary Health Care”.

The associated departments of an MPCP are, (i). The Outreach nursery (ii)
2.1.4.2.(C). ETHNO-MEDICINAL FORESTS (EMFs)

This model is an extension of MPCP. It is essentially a living collection of the entire plant diversity known to the local people and used by them for medicinal purposes. It mimics as far as possible, the real forest type and attempts to incorporate possible genetic variation within the collection. The EMF is modelled after forest ecosystem which is representative of a particular bio-climatic region where the ex-situ conservation site is located.

The entire area would be divided into blocks, in which a multicultural planting pattern of growing trees, shrubs, climbers, herbs etc will be followed (Pushpangadan 1998).

The model appears to serve the highest level of ex-situ conservation in terms of bio-diversity conservation and is projected to be more practical, utilitarian, unifying and feasible (Tandon 1998)

2.1.4.2.(D). GENE BANKS

The concept of gene bank (Germ plasm bank) has primarily taken up the challenge of conserving gene pool of medicinally important plant species by making use of the tools developed by biotechnology. For conserving genetic materials, seeds, pollen grains, vegetatively propagating parts, plant tissues or genome of the plant cells are collected. Seeds being compact and easy to handle, their collection and preservation are commonly adopted. These are stored in hermetically sealed containers, dried to a desired moisture level and maintained at desired low temperature, a process called
Chapter 3

cryopreservation.

Cryopreservation has many advantages such as easy to handle, requiring less space, longevity, cheap maintenance, high propagation potential, maintenance of pathogen free stock and has least problems of genetic erosion of stock.

During 1991-1993 the department of biotechnology, Government of India, has taken the initiative to establish 3 gene banks in the country (MoEF draft 1997). One is with ICAR at NBGR, New Delhi, the second with CIMAP, Lucknow and third with TBGRI, Thiruvananthapuram. The gene-banks are expected to serve medium to long term storage and preservation of medicinal plants.

A Field Gene Bank is a land area of *ex-situ* conservation for medicinal plants in the Threatened/Rare/Endangered category and species of economic value with a wide spectrum of intraspecific variants.

**‘SIMULATED’ IN SITU GENE BANKS**

This is a novel field conservation method for medicinal and aromatic plants by linking *in situ* and *ex-situ* methods. A protected, degraded but densely regenerated forest plot with natural populations of several species is selected, where recreation of the forest ecosystem in the original form by introducing missing plants is being tried. Introduction will be done after careful consideration of various factors peculiar to their natural habitats so that symbiotic balance is achieved in the community of plants. All possible samples including a broad spectrum of genetic variants - cytotypes, ecotypes, morphotypes and chemotypes - of selected species will be introduced and maintained in the gene bank. (Jabbar et. al 1998)

This is an exceptional method of *ex-situ* conservation capable of conserving
maximum possible intraspecific variability among medicinal plants. More recently, related species of medicinal plants are also being considered for introduction in this method (Mohandas 1999).

2.1.4.2.(E). HERBARIUM COLLECTIONS

The role of herbarium in authenticating identity of plants is well-known; which also does an ancillary job in promoting the concept of ex-situ conservation. Botanical surveys and survey units set up by different councils for research on medicinal plants have contributed much in this direction. Forest departments in various states and Forest Research Institutes have extensive herbarium collections. The major shortcoming of the method is that the specimens are not alive and cannot be used for regeneration process, unlike the other means of conservation.

An estimated 90000 herbarium sheets are said to be incorporated in different institutes under the aegis of CCRAS (CCRAS 1983—84). The FRLHT herbarium houses 11230 specimens of about 2250 species of medicinal plants (Tandon 1997)

2.2. TRENDS IN CULTIVATION OF MEDICINAL PLANTS

2.2.1 HISTORICAL PERSPECTIVE

The history of medicinal plants in its entirety would carry us back to the remotest antiquity where the pre-historic man lived as a part and parcel of his immediate environment being dependent on useful plants as food and medicine. It is postulated that the struggle of man for existence was a continuous saga in which he identified the basic requirements and discovered various options through accidents, observations and generalizations. Sufficient data is not available to confirm as to
what was the modality of treatment for various ailments at the dawn of various civilizations. Since disease is considered to be as old as mankind, chances are more in favour of plants that might have helped him to combat diseases or maladies resulted out of natural calamities; necessitating the knowledge of medicinal plants to the pre-historic man. There can be no chance left for the nomad to cultivate plants either for food or for medicine since he moved from place to place.

The Vedic Period (5,000-2,500 BC) has documented evidences on the use of medicinal plants. As the population remained settled, they started the technique of cultivation. The medicinal flora available in the vedic literature speak the depth of the ancient knowledge about their medicinal values. There is mention of 67 medicinal plants by name in Rigveda, 81 in Yajurveda and 289 in Atharvaveda (LSPSS, 1996). No specific references are available regarding the cultivational practices during this period.

References are available regarding the concept and practice of planting trees during the post-Vedic Period (2500BC - 500AD). 'Matsya Purana' mentions the importance of planting trees to attain moksha (Apte 1907). Agni Purana and Padma Purana also share the same-view (LSPSS, 1996). To quote from Vrikshayurveda, “we read in Sastras that excavation of a pond is equivalent (in virtues) to sinking of ten wells, a lake is equivalent to ten ponds, a son is equivalent to ten such lakes and a plant (tree) is good as ten sons” (Ramachandra Rao 1993).

The importance of plantation as a practice can be appreciated from the following. “He who plants the Amalaka (Emblica officinalis) tree, reaps the fruits of constant asceticism, the giving of earth and many sacrifices (Yagnas)”. A similar quotation

1. 'Dasakoopasamo vapi dasavapisamo hrdah

dasahrdasamo putra dasaputrastrasamo drumah' Vrikshayurveda 2:5

can again be read as “there can be no doubt of the fact that the man who plants four
Plaksha (*Ficus glomerata*) trees enjoys the fruits of ‘Rajasuya’ Sacrifice (2).

The foregoing references hold the view that planting and conserving plants were
considered vital for ensuring mutual benefit to man and nature.

It was in the post Vedic period (2500BC-500AD) that Ayurveda emerged as a
scientific medical system with treatises like Caraka Samhita, Sushruta Samhita
and Ashtanga Samgraha.

A close review of these classics would give the idea that medicinal plants were
freely available in the wild and cultivation was not a concern at all during this period.
Caraka Samhita says that “the shepherds and forest dwellers know plants by name”
(3). He further comments that “the knowledge of (medicinal) plants can be had from
the cowherds, hermits, hunters and other forest dwellers”. (4)

Dhanwantari Nighantu (500AD) also appreciates the in depth knowledge of ethnic
groups for identifying various medicinal plants in the wild based on specific features.
“ The forest dwellers have clear ideas about the measurements (*pramana*), colour
(*varna*), morphology (*akruti*) and specific reproductive characteristics (*jatilinga*) of
each medicinal plant” (5).

Susrutha Samhita contains a pictorial description on the localities for
for collecting medicinal plants. “ One should search for medicinal plants on river

---

2. *Chaturnam Plaksha vrukshanam ropanannatra samsayah
rajasuyasya yajuasya phalum prapnoti manavah. Vrikshayurveda 2:14
3. ‘Oushadhir Namaroopabhyyam janate hyajapa vane’ C.S.Su 1/19
5. “Kiratagopalaka tapasadya vanecarastatkushala
tathanye vidanti nanavidhu beshajam
pramana varnakruti namajoti” DN 1,6
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beds, mountains, in the vicinity of big lakes, in forests famous for vegetation and near the ashrams of Rishis” (6).

There was no apparent/absolute scarcity for medicinal plants during this period. This is a fact that can again be clearly understood from the following. “The medicinal plants collected from the immediate surroundings (of the people) are best appreciated for therapeutic purposes” (7).

The period from 500AD-1900AD recorded extensive use of medicinal plants, and the practice of medicine was flourished. A better understanding and documentation of the existing flora used in medicine was recorded in this period. Lot of works in the form of lexicons were published during this period (Appendix XII). There were additions of even exotic medicinal plants into the pharmacopeae.

From the foregoing references, it can be assumed that either the principle or the practice of cultivation of medicinal plants was not in existence anywhere in India during the above periods and this trend is believed to have continued till twentieth century.

In the meantime the remarkable awareness and knowledge of ancient Indians about plants resulted in the slow emergence of a different school of thought devoted exclusively to plants and their survival, popularly known as Vriksayurveda. It dealt with the topics on plant science such as collection, selection and storage of seeds, germination, sowing, techniques of plant propagation, grafting, nursing, irrigation, testing and selection of soil for cultivation, manuring, pest and disease management and various botanical novelties (Vijayalakshmi et. al 1997).

7. Yasmin dese tu yo jata tasya tajjoushadham hitam C.S. Su. 4/20
Indian Plant Science (*Vrikshayurveda*) made remarkable contributions during this period in the field of cultivational practices of different plants. Upavana Vinoda (13th Century AD), Krishiparasara (950-1100AD), Raja Nighantu (11th Century AD), Krishi Sukthi (8—9th Century), Sarngdhara Padhati (1300AD) are notable works dealing with different aspects of cultivation.

### 2.2.1.2. SALIENT FEATURES OF VRIKSHAYURVEDA IN THE CULTIVATION OF PLANTS

*Plant propagation* by seeds (*bijaruha*), roots (*mulaj'a*), cuttings (*skandaja*), apical portions (*agrabija*) and leaves (*pranayoni*) are mentioned as the basic methods of plant propagation (LSPSS, 1996). Amongst them, propagation by seeds is the commonest method. The table 2.2. shows the means of propagation with examples of relevant medicinal plants.

<table>
<thead>
<tr>
<th>Beeja(Seeds)</th>
<th>Kaanda(cutting)</th>
<th>Beeja &amp; Kaanda</th>
<th>Kanda (Bulb+under ground stems)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jambu</td>
<td>Tambuli</td>
<td>Patala</td>
<td>Kumkuma</td>
</tr>
<tr>
<td>Champaka</td>
<td>Sinduvara</td>
<td>Dadima</td>
<td>Ardra</td>
</tr>
<tr>
<td>Punnaga</td>
<td>Tagara</td>
<td>Plakhsa</td>
<td>Rasna</td>
</tr>
<tr>
<td>Nagakesara</td>
<td></td>
<td>Karavira</td>
<td>Aluka</td>
</tr>
<tr>
<td>Badari</td>
<td></td>
<td>Udumbara</td>
<td></td>
</tr>
<tr>
<td>Panasa</td>
<td></td>
<td>Vata</td>
<td></td>
</tr>
<tr>
<td>Madhuka</td>
<td></td>
<td>Mallika</td>
<td></td>
</tr>
</tbody>
</table>

*Source. Sarngdhara Padhati 3:46-49 (Ramachandra Rao 1993).*

**Table 2.2. Means of propagation of plants mentioned in ancient literature**

*Seed collection* is recommended to be done in the month of ‘*Magha*’ or in ‘*Phalguna*’ (January-March) and are dried thoroughly in the sun without keeping it...
directly on the floor (Ramachandra Rao 1993). Other precautions while storing seeds are also mentioned in detail.

*Seed Treatment* is indicated to prevent fungoid growth and to protect the seeds from deterioration in quality. Vaca (*Acorus calamus*) and Vidanga (*Embelia ribes*) are suggested as fungicides, the powder of which is to be rubbed over the seeds. (Vijayalakshmi et al. 1997).

*Preparation of seed bed.* “First of all, one should sow the seeds in the seed bed prepared with grass spread over it and sprinkle milk and water, and when seed germinate, remove the grass, dry the earth a little under sunlight and transplant these sprouts together with their roots and the earth attached thereto” (8)

*Sowing time* is suggested as the months of Ashada and Sravana (Mid June -mid August) which is the season of early rains. This is best for planting trees. If the seedlings are not too tender, these can be planted in any season except *Greeshma* (hot summer) season (9).

Several recipes, suggestions and recommendations for sowing seeds of different species of plants are available in detail, in the texts and manuscripts of *Vrikshayurveda*.

*The process of planting* has been described as follows:-

“When a sprout planted after being sprinkled with milk grows one cubit in length, dig it out together with the attached earth, apply roots of Vidanga (*Embelia ribes*), Useera (*Veteveria zizanoides*) and ghee pasted together and then replant it in a pit

---

8. ‘Beejadhaneem trinastheernamkrtva sincet payombuna jatamkuramca salillainistrinam soshamanayet’ (Sarngdharâ Padhati 56:5)
together with cowdung. (10)

In a garden, **spacing** should be 10 cubits (1 cubits = 0.3 meters) in their lower level, 20 cubits in their higher level and 16 cubits in the middle levels of the garden. In case the garden or cultivating area is plain, grass like plants should be spaced out at an interval of 2 cubits, trees at 4 cubits and gulmas (shrubs) 3 cubits apart.

**Watering** the newly planted trees as well as plantation is also discussed. Newly planted trees should be watered both in the morning and the evening. During summer twice a day is preferred. Daily watering in spring and alternate watering in Autumn and winter will suffice. (11)

**Plant nutrition** was referred to as ‘**dohada**’ meaning special treatment, manure and fertilizer. It is said that trees do not produce flowers and fruits and be healthy merely because they are planted. Hence nourishment of plants is of greater importance. The importance of green manure prepared from straw of barley (*yava*) and sesame (*tila*) and natural manure of animals like cowdung were recognized by our ancestors as increasing the productivity of the crops (LSPSS, 1996).

The cultivators not only knew the use of manure in agriculture, but also possessed a fair knowledge of manufacturing it. A cowdung pit called ‘**Uvadhya-goha**’ was specially dug for decomposing the cowdung. Thus it can be seen that livestock farming was an integral part maintained by plant cultivators and agriculturists of those times (Majumdar and Banerjee 1960).

A popular form of artificial liquid manure called ‘**kunapajala**’ was extensively

---

10. Hasta pramanan payasa sutiktan
Samkramayet moolavaha samrutkan
Sapirmadhooseera vidangu lipta
nimbe nidadyacha karishayukte lihid—59.7

11. Hemante Sisire deyamjalam caikantare dine
Vasante pratyahe greeshme Sayam Pratar nivhechanam (Vrikshayurveda: 71:7)
used in the plantations to increase the fertility and productivity of the land (Ramachandra Rao 1993, Majumdar 1935)

References on Pest and Disease management is available in ‘Brihat Samhita’ and also in ‘Agnipurana’. To quote famous scientist Gunaratna, “Just as human body is subject to jaundice, dropsy, emaciation, defects of finger, nose etc, plants too suffer from similar diseases such as displacement and dislocation of flowers/fruits/leaves, bark and by applying appropriate remedies prescribed in Vrikshayurveda, unnatural growth, deterioration, wounds, fractures etc can be cured in plants (Gunaratna 1905).

Various diseases of plants and their respective treatments are exhaustively dealt with in the texts of Vriskhayurveda based on the classical school of Ayurveda (LSPSS, 1996).

Pest control practices can be categorised as botanical, mechanical, agronomical, biological and other methods, and was supplemented by practices of religious ceremonies and rituals. These methods are simple, cost-effective, eco-friendly and easily adaptable (Vijayalakshmi et al. 1997).

Evaluation of ancient techniques was attempted by some researchers during the last two decades. Enhancement of growth and flowering in Balsam (Impatients sultana) was studied after applying a decoction mentioned in Vrikshayurveda. The results showed that the response to the decoction was found favourable in all three stages of application i.e. germinative, vegetative and flowering stages (Vijayalakshmi et. al. 1997).

There are also botanical marvels referred to, in the texts such as measures to increase the fragrance of flowers, change the colour of flowers, to colour the fibres of cotton, make flowers out of season, produce fruits without flowers, increase yield
of fruits etc. (Ramachandra Rao 1993).

2.2.1.3. CULTIVATION OF MEDICINAL PLANTS: DEVELOPMENT OF THE SCIENTIFIC SCHOOL OF THOUGHTS

Medicinal plants are the Chief resource of drugs in Ayurveda and other Indian Systems of Medicine: Pharmaceutical, cosmetics and flavour industries also use medicinal and aromatic plants in large quantities. The increasing demand for different medicinal plants from various user groups enhance pressure on the wild ultimately leading to many species becoming Rare/Endangered/Threatened and even Extinct.

There were sporadic attempts of cultivation of the species in demand. Due to the lack of concrete guidelines and/or package of practices, most of the programmes were eventually wound up. The first half of 20th century could not contribute much to the concept of cultivation of medicinal plants.

In the post-independence era, Government of India had set up research programmes at various levels under different departments to promote the cultivation of medicinal plants. The various departments are the Ministry of Health and Family Welfare operating through Central Council of Research in Ayurveda and Sidha (CCRAS), the Ministry of Environment and Forests through its constituent research set up viz. Indian Council for Forestry Research and Education (ICFRE) the Council of Scientific and Industrial Research (CSIR) through its chain of research institutes in different parts of the country.

More intensively, Ministry of Agriculture, under the Department of Agricultural Research and Education (DARE) Co-ordinates cultivational works and research activities under the aegis of Indian Council of Agricultural Research (ICAR) which has a network of National Research Institutes and State Agricultural Universities.
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There are also several other organisations under the State Governments, corporate sector/private sector in the country which conduct researches on some of these crops and their cultivational aspects. If taken together the research infrastructure is fairly large, but because of large and diverse number of species involved and poor intra-institutional linkages on the one hand, and the nature of priorities assigned in mandate of these organisations on the other, the impact occasionally get diffused at operational level (Gupta and Chadha, 1995).

Besides funding for research activities on medicinal plants and their cultivation, most institutions have brought out books, monographs, bulletins, extension leaflets and seminar proceedings on many crops. The time-bound research schemes served a useful purpose in the assembly of germplasm, their field and laboratory evaluation, selection, initial development of cultural practices, primary processing and development of standard analytical methods for quality evaluation (Ibid).

To generate scientific and technical manpower in the field of Medicinal and Aromatic Plants, teaching courses in Economic Botany have been introduced in the Universities. After careful evaluation of these programmes, it was found that these basic courses are totally inadequate to build up scientific manpower in this sector. In a further step, medicinal and aromatic crops were included in the curriculum of the graduate students in the University of Agricultural Sciences, Bangalore as early as 1973, which was later followed by all Agricultural Universities. The table 2.3. shows the track record of various institutions, involved in research projects of medicinal and aromatic plants with details of crops.
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#### Location of the Centre and Year of Start

<table>
<thead>
<tr>
<th></th>
<th>Mandatory crops</th>
<th>Introductory crops</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. ICAR Institutes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. IIHR, Bangalore, Karnataka</td>
<td>*Dioscorea, Periwinkle, Khasi-kateri, Geranium, Patchouli, Jasmine</td>
<td></td>
</tr>
<tr>
<td><strong>B. Agricultural Universities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. JNKVV, Mandsaur (M. P.) 1980</td>
<td>Opium Poppy, Asgand</td>
<td>Liquorice (transferred from Indore), Safed Musli</td>
</tr>
<tr>
<td>7. RAU, Udaipur (Rajasthan) 1980</td>
<td>Opium Poppy</td>
<td>Safed Musli</td>
</tr>
<tr>
<td>8. ANDAU &amp; T, Faizabad, (U. P.), 1980</td>
<td>Opium Poppy, Palmarosa, Vetiver</td>
<td>Lemongrass, Psoralea</td>
</tr>
<tr>
<td>10. HAU, Hissar, (Haryana) 1992</td>
<td>Isabgol, Liquorice, Palmarosa, Vetiver</td>
<td>Basil</td>
</tr>
<tr>
<td>11. PKV, Akola (Maharashtra) 1992</td>
<td>Palmarosa, Vetiver</td>
<td>Basil, Cropping systems research based on Med. &amp; Aro. Plants in and around regions with low irrigation potential</td>
</tr>
</tbody>
</table>

Note: * represents work now completed and closed  
# Located initially at Pilwai (Mehsana distt.) and Ootacamund (Nilgirie District) and shifted to present locations in 1975, respectively.

**Source:** GUPTA AND CHADHA 1995

**Table 2.3. All India Co-ordinated Research Project on Medicinal & Aromatic Plants Centres and Crops under Investigation**

CCRAS has taken up cultivation of medicinal plants on experimental scale. The aim of the project was to study the adaptability, growth, flowering, fruiting and also to assess the yield at different altitudinal levels and other ecological conditions. The plantations included tropical, sub-tropical and temperate, besides exotic zones.
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Suitable agro-techniques for successful growth of scarcely distributed/threatened plants were found out. Propagation of saffron at ‘Tarikhet in the year 1960’ and cultivation of Guggulu in ‘Mangliawas in 1964’ etc. provided adequate impetus on mass cultivation of medicinal plants (CCRAs 1983-84).

Standard cultivating techniques and package of practices are now available for different medicinal plant species. (Table 2.4). The text by Atal and Kapur was revised in 1982 in two volumes on medicinal and aromatic plants separately—Taxonomical identity, methods of genetic improvement, sites of cultivation, raising of nursery, preparation of land, manuring, harvesting etc. are dealt with in detail, in the publication.

Table 2.4. List of medicinal and aromatic plants having standard package of practices.

| 1. Dioscorea floribunda | 11. Gloriosa superba |
| 2. Dioscorea composita | 12. Catharanthus roseus |
| 5. Papaver somniferum | 15. Acacia catechu |
| 7. Atropa belladona | 17. Aloe vera |
| 8. Datura innoxia | 18. Cassia angustifolia |
| 9. Datura metel | 19. Plantago ovata |


The above list of medicinal plants throws light to the fact that only economically beneficial plants are being studied and standardised in cultivanional practices. Herbs and plants used extensively in Ayurveda and other indigenous systems of medicine which are rare, endangered or threatened in status are not given due importance.
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Many research works on the cultivation of medicinal plants were also conducted in the past two decades.

Karnick (1977) undertook ethnobotanical, pharmacognostical and cultivation studies of *Hemidesmus indicus* and highlighted the quality of cultivated plants on par with natural species.

Rajagopal (1983) standardised the propagation method, time of planting, time of harvest of *Kaempferia galanga* and phyto-chemical analysis was attempted to screen the pharmacological efficacy of the species.

Pushpangadan and Rajasekharan (1987) have developed a scientific approach and methodology for domestication and commercial cultivation of medicinal plants.

The Kerala Forest Department started Tribal Medicinal Plant Gardens in the forest areas in Wyanad District involving the local tribals. In cultivation, the traditional methods were followed and the attempt was much successful (Basha 1989). The species cultivated are listed in Table 2.5.

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Local Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pletranthus vettiveroides</em></td>
<td>Iruveli</td>
</tr>
<tr>
<td><em>Alpinia galanga</em></td>
<td>Aratha</td>
</tr>
<tr>
<td><em>Kaempferia rotunda</em></td>
<td>Changazhiu neerkoova</td>
</tr>
<tr>
<td><em>Maranta arundinacea</em></td>
<td>Koova</td>
</tr>
<tr>
<td><em>Curcuma longa</em></td>
<td>Manjal</td>
</tr>
<tr>
<td><em>Narveilia aragoara</em></td>
<td>Orilathamara</td>
</tr>
<tr>
<td><em>Kaempferia galanga</em></td>
<td>Kacholam</td>
</tr>
<tr>
<td><em>Plumbago rosea</em></td>
<td>Koduveli</td>
</tr>
<tr>
<td><em>Rubia cordifolia</em></td>
<td>Manjatti</td>
</tr>
<tr>
<td><em>Adathoda beddomei</em></td>
<td>Adalodakam</td>
</tr>
<tr>
<td><em>Solanum xanthocarpum</em></td>
<td>Cheruvazhuthina</td>
</tr>
<tr>
<td><em>Solanum anguivi</em></td>
<td>Putharichunda</td>
</tr>
</tbody>
</table>
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Desmodium gangeticum  Orila
Pseudarthria viscidia  Moovila
Punica granatum  Mathalam
Emblica officinalis  Nelli
Oroxylum indicum  Palakappayyani
Muraya koenigi  Kariveppila
Eclipta alba  Kayyonni
Holostemma adakodien  Adapathiyan
Indigofera tinctoria  Neelamari

Source: Inspection report. SFD, Kerala 1989

Table 2.5. List of important medicinal plants cultivated in the Tribal Medicinal plant Gardens at Wyanad, Kerala

Banerjee and Datta (1991) considered various aspects and effects of seasons, age, phase and hormones on the medicinal compound accumulation in plants. Nair *et al.* (1991) put forth the concept of introducing medicinal and aromatic plants as intercrops in other plantations and projected it as promising method of cultivating medicinal plants.


Swarupanandan and Sasidharan (1992) conducted studies on the causes for paucity for regeneration in some of the important trees in a natural ecosystem. The findings throw light on the concept of setting up of medicinal plant development areas within the degraded forests for cultivation of medicinal plants.

Nair *et. al.* (1992) suggested that depending upon natural habitats of the plant, various zones at different altitudes should be selected for cultivation.
The aspect of whether the medicinal plants are required to be cultivated in the wild or domesticated in other environments in cultivational practices was analysed by many researchers. Nayur (1992), Samuel et. al (1993) have studied various considerations on domestication of wild medicinal plants of Ayurvedic importance so that future strategies of commercial cultivation can be worked out. Pushpangadan (1992) also studied on domestication and commercial cultivation of wild medicinal and aromatic plants with emphasis on conservation biology aspects.

Established in 1993, the Medicinal Plants (India) Project is being implemented by the Arya Vaidya Sala Herbal Garden sponsored by IDRC, Canada. The principal objectives include, evolving techniques for propagation and develop models for on farm cultivation. Under the project, ten medicinal plant species thoroughly studied by Nambiar, (1999)

1. Baliospermum montanum
2. Celastrus paniculatus
3. Coscinium fenestratum
4. Crateva magna
5. Embelia ribes
6. Hemidesmus indicus
7. Holostemma adakodien
8. Rubia cordifolia
9. Saraca asoca
10. Trichosanthes lobata

In addition, the project now develops strategies for sustainable supplies of the following ten species (Nambiar, 1999).

1. Aegle marmelos
2. Asparagus recemosus
3. Bacopa moninieri
4. Holarrhena pubescens
5. Kaempferia rotunda
6. Limonia acidissima
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7 Nervilia aragoana
8 Oroxyllum indicum
9 Plumbago indica
10 Rotula aquatica

Miniraj (1997), after analysing the growth pattern (viz. plant height, branching, flowering, root shoot ratio) and regeneration pattern, both in wild and domestic environment for selected species came to the conclusion that biological and economic yield showed marginal variation in most instances. Parameters of the study included presence of alkaloids, total soluble sugar, starch and free amino acids. Confirmation by TLC was also employed. The final results of the domestic environment and biochemical analysis indicated the possibility of cultivating the medicinal plant species by providing conditions similar to that of natural habitats to ensure the quality.

Gangaprasad (1998) described the in vitro-propagation and restoration of Janakia arayalpatra, a rare ethnomedicinal plant. The result is encouraging as it was found that a single juvenile nodal emplant can produce more than 36 shoots within 2 months. Six months old community potted plants showed no morphological and growth abnormalities.

Rapid micropropagation of Phyllanthus kozhikodianus was attempted by Asha (1998) and the technique was standardised to obtain true to type plants of best cultivars.

Ayurvedic System of medicine holds good the theory of collecting medicinal plants from their natural habitats for maximum potency and efficacy in the treatment of diseases (Vaghbata). Notwithstanding anymore resource in the wild, on the face of decreasing natural forest cover and natural habitats, effective measures should be chalked out for sustainable use as well as management of the medicinal plant resource. In this context, conservation of the medicinal plants from extinction and cultivation
Chapter 2

of required species to meet the demand by various user groups appear to be the only plausible strategies.

2.2.2. CURRENT TRENDS IN CULTIVATION OF MEDICINAL PLANTS

Cultivation is the inveterate natural corollary of agriculture. It implies growing or raising of annual crops, generally as monoculture in the field. Medicinal plant cultivation in this sense, is possible where the technology and agronomic practices for a species have been worked out and tested. Roughly one third of medicinal plants are trees and cannot be cultivated in the conventional meaning (Tandon and Iyer 1997).

Thus the practices of traditional agriculture, has to be critically studied against each medicinal plant species. Simultaneously agro-technologies developed for cash crops and plantation crops (eg. cashew, rubber) have to be integrated. Thus an integrated approach in the cultivation can only fulfil the market demand of medicinal plants in the pharmaceutical, cosmetics and flavour industries (Tandon and Iyer 1997).

Medicinal plants can be cultivated either in/near the natural habitats where species are distributed in the wild. Domestication and cultivation is the alternate strategy. It is established beyond doubt that plants grown in their natural homes possess greater medicinal value (Miniraj 1997). As this method poses many problems cultivation of domesticated species are more acceptable and is being followed vis-a-vis agriculture.

Agro-climatic situations of the different parts (Appendix XIII) of Kerala have to be considered in planning the cultivaltional practices because site specific technologies only will give the optimum results.
BASIC CONSIDERATIONS ON CULTIVATIONAL PRACTICES

The following are considered by Doraiswamy and Venkitesan (1982) as the basic considerations for the cultivational practices of medicinal plants.

i. Agro-climatic conditions.
ii. Soil type, depth, capacity to retain moisture.
iii. Response to manuring and uptake
iv. Availability of potential species as planting material.
v. Appropriate propagation methods.
vi. Package of practices and economics for each crop.
vii. Crop-rotation and inter cropping
viii. Pest/disease management during nursery stage/field stage
ix. Possibilities of animal damage.
x. Processing of raw material, manpower, mechanisation
xi. Marketing.

Cultivational trends can be studied under 4 major heads

1. Nursery practice
2. Field cultivation (monoculture)
   a. Small scale
   b. Large scale
3. Intercropping
4. Medicinal Plants Development Areas (MPDAs)

2.2.2.1 NURSERY PRACTICES

Nursery is the place where plants are reared for the purpose of transplanting into cultivating/growing areas. Successful commercial cultivation of crops primarily depends on raising seedlings in nurseries in the proper time. Seed germination, vegetative multiplication by cuttings (Atal and Kapur 1982), micropropagation for
mass multiplication (Gupta and Chadha 1995) etc. are employed as primary procedures. Proper control measures to prevent environmental stress and pest/disease should also be ensured throughout.

The primary step to ensure immediate availability of medicinal plants and planting materials to various user groups is to promote a network of medicinal plant nurseries which will help to multiply all the regional plants that are used in the traditional medicine and in the industry. These nurseries can act as the primary source of supply of medicinal plants and seed material that can be subsequently multiplied by various user groups for cultivation.

Various agencies involved in the conservation of medicinal plants can set up nurseries attached to their fields of operation. Agencies actively operating in the field of cultivation should have their own nursery for self-reliance in order to ensure quality and timely planting material.

Co-ordinated work of different nursery setups is essentially required to avoid ambiguity of priorities and unhealthy practices. National level co-ordination in the medicinal plant nurseries can help to prioritize the best crops considering the economics of the species in order to make available medicinal plants to growers as well as users.

The Forest Departments, Agricultural extension agencies, Gramapanchayats, NGOs and Private agencies are to be encouraged to establish nurseries to grow medicinal plants. The Government can support this by declaring subsidies for infrastructure setting and by providing low interest long-term loans to the entrepreneurs (FRLHT 1998). The updated list of planting materials of different species should be made available to the user groups from time to time.
Biotechnology has new tools for mass multiplication of plantlets where true seed is not produced. The technologies available now offer cost-effective and time-intensive production of crops, irrespective of biological and environmental stress (Dubey 1995). Explant culture, root culture, shoot culture, production of stress/disease resistant plants and micropropagation are the emerging trends in biotechnology that would add in the cultivation of medicinal plants, as it is being utilised in Agriculture/Horticulture.

In the National Scenario, ICAR and CSIR (CIMAP) network have set up nurseries to meet the requirements of planting material of medicinal plants (MoEF 1997). In South India, FRLHT has recently set up a network of 55 supply nurseries that are mandated to raise four basic packages (Arun Subbiah, 1996) viz.

i. Plants for primary healthcare

ii. A package of economic plants needed by the industry.

iii. RET plants for possible re-introduction into their natural habitats.

iv. An institutional garden package.

In Kerala, Ayurvedic medicine manufacturing companies like Kerala Ayurveda Pharmacy Ltd. (KAPL), Aluva; Nagarjuna Herbal Concentrates, Thodupuzha; Arya Vaidya Sala, Kottakkal and also Institutions like KAU and KFRI have taken up initiative to raise nurseries and setting up extension/supply centres and mobile units for supplying planting materials of medicinal plants. Extensive media coverage is given to these programmes to motivate individuals as well as institutions to take up cultivation of medicinally important species.
Chapter 2

2.2.2.2. FIELD CULTIVATION

Swaminathan (1982) opined that the trade in the raw material from medicinal plants is largely unorganised and uncertain both in demand and price. Today, the large scale cultivation of medicinal plants is inversely linked to prevalence of easy and cheap collection from the wild, lack of regulations in the trade, insufficient information on the profit from the wild collection by the network of middlemen and traders and absence of industry’s interest in providing buy-back guarantees to growers. Policy measures are thus vital, to promote cultivation of medicinal plants along with farm management practices.

Cultivation of medicinal plants is also difficult due to lack of standardised agronomic practices for most species. Agrotechnology for nearly 40 species has been developed by ICAR, Agricultural Universities and CSIR. But, most of these are for aromatic plants or plants used by modern pharmaceutical industry.

Out of 400 odd species (excluding spices) that are used by Ayurvedic, Unani and Siddha systems of medicine, less than 20 species are under commercial cultivation (MoEF 1997).

Pushpangadan (1991) compiled the agrotechnologies for ten species of medicinal plants that can be cultivated in Kerala. The plants enlisted are:

1. Holostemma adakodien
2. Desmodium gangeticum
3. Kaempferia galanga
4. Strobilanthes nilgrian\is
5. Alpinia calcarata
6. Adathoda beddomie
7. Plumbago indica
8. Indigofera tinctoria
9. Pseudarthria viscida
Baby Joseph (1994) suggested 10 species of medicinal plants which can be cultivated in pots as ornamental medicinal plants and another 10 species which can be cultivated in the courtyard/backyard garden of the houses.

### Ornamental Medicinal Plants

<table>
<thead>
<tr>
<th>No.</th>
<th>Plant Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plumbago rosea</td>
</tr>
<tr>
<td>2</td>
<td>Alpinia galanga</td>
</tr>
<tr>
<td>3</td>
<td>Piper longum</td>
</tr>
<tr>
<td>4</td>
<td>Kaempferia galanga</td>
</tr>
<tr>
<td>5</td>
<td>Oxalis corniculata</td>
</tr>
<tr>
<td>6</td>
<td>Bacopa monieri</td>
</tr>
<tr>
<td>7</td>
<td>Acorus calamus</td>
</tr>
<tr>
<td>8</td>
<td>Asparagus recemosus</td>
</tr>
<tr>
<td>9</td>
<td>Ocimum kilimanjcharicum</td>
</tr>
<tr>
<td>10</td>
<td>Strobilanthes ciliatus</td>
</tr>
</tbody>
</table>

### Others

<table>
<thead>
<tr>
<th>No.</th>
<th>Plant Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adathoda beddomei</td>
</tr>
<tr>
<td>2</td>
<td>Andrographis paniculata</td>
</tr>
<tr>
<td>3</td>
<td>Oxalis corniculata</td>
</tr>
<tr>
<td>4</td>
<td>Piper longum</td>
</tr>
<tr>
<td>5</td>
<td>Bacopa monieri</td>
</tr>
<tr>
<td>6</td>
<td>Indigofera tinctoria</td>
</tr>
<tr>
<td>7</td>
<td>Coleus aromaticus</td>
</tr>
<tr>
<td>8</td>
<td>Azadirachta indica</td>
</tr>
<tr>
<td>9</td>
<td>Aegle marmelos</td>
</tr>
<tr>
<td>10</td>
<td>Ocimum sanctum</td>
</tr>
</tbody>
</table>

Arun Subbiah (1996) compiled agrotechnologies of 17 selected medicinal plant species for small scale and large scale cultivations. The plants are:

<table>
<thead>
<tr>
<th>No.</th>
<th>Plant Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Azadirachta indica</td>
</tr>
<tr>
<td>2</td>
<td>Justicia adathoda</td>
</tr>
<tr>
<td>3</td>
<td>Embelia ribes</td>
</tr>
<tr>
<td>4</td>
<td>Hibiscus rosa sinensis</td>
</tr>
<tr>
<td>5</td>
<td>Holarrhena pubescens</td>
</tr>
<tr>
<td>6</td>
<td>Lawsonia inermis</td>
</tr>
<tr>
<td>7</td>
<td>Leptadenia reticulata</td>
</tr>
<tr>
<td>8</td>
<td>Punica granatum</td>
</tr>
<tr>
<td>9</td>
<td>Withania somnifera</td>
</tr>
<tr>
<td>10</td>
<td>Aloe barbadensis</td>
</tr>
<tr>
<td>11</td>
<td>Asparagus recemosus</td>
</tr>
<tr>
<td>12</td>
<td>Bacopa monieri</td>
</tr>
<tr>
<td>13</td>
<td>Centella asiatica</td>
</tr>
<tr>
<td>14</td>
<td>Hemidesmus indicus</td>
</tr>
<tr>
<td>15</td>
<td>Impomea mauritiana</td>
</tr>
<tr>
<td>16</td>
<td>Piper longum</td>
</tr>
<tr>
<td>17</td>
<td>Tinospora cordifolia</td>
</tr>
</tbody>
</table>

In recent years pharmaceutical companies like Dabur, Zandu, Indian Herbs, AVS
Kottakkal, AVP Coimbatore, KAPL Aluva and others have made earnest efforts to initiate large scale cultivation of medicinal plants. But the output was only a limited fraction of their annual requirements. Sporadic cultivation by entrepreneurs on large scale and small scale are not being evaluated so far. It constitutes only an infinitesimal part of the total requirement.

Since 1984, NABARD has formulated schemes for financing cultivation and processing of medicinal plants. In 1996, World Bank considered investing funds on 'medicinal plants' as a special sub-sector in its agricultural programmes (World Bank 1996). The impacts of these measures are not yet felt in terms of demand or cultivation of commonly used medicinal plants in the country.

Given India's large population and food security needs, there is no way in which agricultural lands committed to food crops can be diverted to grow medicinal plants. Thus growth and cultivation of medicinal plants can be better promoted in household gardens, bunds, degraded forests and wastelands.

### 2.2.2.3. INTER CROPPING

After having studied the adaptabilities, certain medicinal plant species can be integrated with different plantation crops as intercrops. This is a viable method, which enables the farmer for increasing the economic productivity and optimum utilisation of the land. Intercropping is in vogue in the practice of conventional farm management. Since land availability is the major problem as far as cultivation of medicinal plants are concerned, intercropping appears to be an appropriate solution.

Gupta (1984) studied various aspects on the possibilities of introduction of medicinal and aromatic plants in cropping systems of North-Western India and opined...
that intercropping can be employed as a potential method in the cultivation of certain species which possess wide range of adaptabilities.

Mahaswari et al (1985) demonstrated a successful intercropping model for Rauvolfia serpentina and highlighted the possibility of higher monetary returns to the farmer.

Prakash Rao et al (1988) and Pareek et al (1991) later evaluated intercropping models in Vetiveria zizanoides and Java citronella respectively and commented the system of intercropping to be feasible both in small and large scale plantations.

Inspite of early encouraging results from cultivational researchers across India, the method of intercropping has not yet gained popularity and acceptability among farmers.

Though most of the households in the villages in Kerala are interested in taking up intercropping, they are diffident due to uncertain financial profitability.

2.2.2.4.MEDICINAL PLANTS DEVELOPMENT AREAS (MPDAs)

Medicinal plant development areas (MPDAs) are selected, degraded forest areas taken up for 'production' of medicinal plants, preferably indigenous species (Native medicinal plant species) MPDAs would be rehabilitated through systematic and intensive planting of medicinal species—like of trees, shrubs and herbs in a mixture within 3—4 years time frame. The species raised are relatively easily grown and marketable, and a system of sustainable harvest aimed at supplementing income to local communities can be developed. Management of MDPAs would be a joint venture of the Forest Department and the identified local community. Major returns obtained from harvested raw materials will be handed over to the local community as incentive. This is a method of participatory management of forest areas with the
involvement of local communities.

This model envisages intensive community organisation under the JFM (Joint Forest management) network and needs reliable technical advice related to selection, planting, harvesting and storage of species. It also requires securing market linkage for the sale of produce.

The concept of MPDA was introduced by FRHLT in 1993 as a part of its Medicinal Plants Conservation Network. The project MPDAs have been set up in Tamil Nadu and Karnataka, after having executed MoU with State Forest Departments on behalf of the Project (Rai 1999) (Appendix XI). Kerala FD is yet to come into the scene with MPDAs.

The programme has 2 salient features:—

1 Involvement of local people (NGOs) to provide continuity and stability in MPDA management.

2 It is essentially an in situ method which ensures maximum quality of cultivated/harvested medicinal plants.
Chapter 3

MATERIALS AND METHODS

3.1. DEVELOPMENT OF PRINCIPLES

The aim of the present study is the qualitative and quantitative (as far as possible) evaluation and assessment of the trends in the practice of (i) preservation of medicinal plant species (ii) cultivation of medicinal plant species.

3.1.1. PRELIMINARY STUDY

Since the medicinal plant users and growers happen to fall in an unorganised sector the availability of data regarding medicinal plants is really a problem. Therefore a preliminary survey was designed to identify the various user groups of medicinal plants and collect the data on the utilisation of medicinal plants/plant products by them. The proposed study involved samples starting from poorly studied and inadequately estimated petty Ayurvedic pharmacies to industrial giants. Selected species of medicinal plants were considered in terms of requirement /supply. It is hoped that the gravity of non/reduced availability of medicinal plants could be readily