MEDICINAL PLANTS BASED FOREST MANAGEMENT : PROBLEMS AND PROSPECTS

P.P. BHOJVAID*

Introduction

Global interest in medicinal plants especially in the western countries has increased recently. The international medicinal plants market is worth US $60 billion year per year, and growing at the rate of 7% per annum. Moreover, 70-80% of global population still depends on traditional health systems, which are based on medicinal plants. Therefore, many international organizations such as the World Bank, the Food and Agriculture Organization, the World Wildlife Fund and national bodies like National Medicinal Plant Board of India, the Planning Commission of India, Indian Council of Forestry Research and Education and the Ministry of Environment and Forests have opined that the commercial extraction of medicinal plant resources does have the potential to provide innumerable economic, social and ecological benefits, and it also provides a unique means of integrating the utilization and conservation of forests – but only if the resources are harvested in a sustainable manner (Anon., 1988; 1999). It is also true that due to rising international demand, many important medicinal plant species are becoming scarce; some are facing the prospect of extinction. It has also been argued that if the supplies of forest resources are depleted over time, either through excessive harvesting or through the gradual death of adult trees without replacement, no new product, marketing scheme or land tenure will make much difference to the economy and ecology of an area. The providers to the indigenous health care systems have begun recognizing that supplies of raw plant materials cannot be guaranteed any longer. As a precaution, they require producers to deliver two years supply now in advance (Ved *et al.*, 1998a). For further precaution, some are establishing captive farms specifically to cultivate medicinal plants. It is also well recognized that at present 90-95% medicinal plants for local use and for national/international trade are being extracted from the national forests in India (Ved *et al.*, 1998b). Consequently, medicinal plants have attracted a lot of attention recently, and innumerable articles, books, seminars, workshops and conferences have focused on the pros and cons of exploiting these natural resources. It is somewhat surprising, therefore, that in spite of all the current analyses, discussions, and debates, several basic questions related to the ecology of medicinal plants in their natural habitat (forests) have yet to be addressed. For example, what are the actual ecological impacts of harvesting commercial quantities of medicinal plants from a forest? Are some species or resources more resilient to the effects of continual harvesting than others? What can be done

* Head, NWFP Division, Forest Research Institute, Dehra Dun (Uttaranchal).

to minimize these impacts? What sort of monitoring activities, management practices, and silvicultural techniques can be used to ensure that the resources being harvested are not overexploited? These types of questions define the ecological bottom line of medicinal plant based forest resource management, and it would be unwise to keep ignoring them.

This paper addresses some of these basic questions, which are essential for medicinal plant based forest management. First the ecological basis of the system of forest management in vogue has been discussed and it is this author's contention that it may not be suitable for a medicinal plant based forest management. In the second part of this paper some issues have been highlighted, which need consideration for evolving a management regime for the sustainable development of medicinal plant species of forest origin.

Traditional forest management and forest stand dynamics

Traditional forest management in India and all over the world had the mandate to produce timber. Therefore, the management systems (silvicultural systems), which have been developed over 200 years by field observations and studies of sample plots, have focused on the aspects of regeneration, care, and harvest of sustained yield of timber from forest areas (Brandis, 1989). These systems mimic the natural development of a forest stand following disturbances. Stand dynamics of a forest area after a management intervention such as clear-felling or a natural calamity such as fire, avalanche, storm etc. can be classified in four stages namely : (a) stand initiation, (b) stem exclusion, (c) understorey re-initiation, and (d) old growth forest. A brief account of these stages in stand development and its implication on timber based forest management is essential to understand silvicultural treatments/prescriptions for timber and medicinal plant based forest management.

Stand initiation : Disturbance in a forest area creates opportunities. These range from a higher intensity of sunlight reaching the floor and resultant changes in soil temperature and moisture content, to a higher nutrient availability due to a faster turnover of residual material following the disturbance. These opportunities offer growing space and facilitate invasion of a plethora of plant species in such areas. A close check on the species composition at this stage of stand development would show that a majority of these are herbs and shrubs, however a large number of seedlings of tree species are also present. Further, the herbs and shrubs tend to complete their life cycles in annual and biannual cycles to steer clear of tree seedlings, which create shade and compete for moisture and nutrient resources available in such areas. In a nutshell the stand initiation stage is highly diverse and the probability of presence of medicinal plants, especially those with herbs and shrub life forms is very high (Lambert *et al.*, 1996).

Stem exclusion stage : The seedlings of perennial species (trees) grow in size with time and their requirement for water, nutrients and sunlight also increases. These growing poles offer a severe competition to understorey species of herbs and shrubs, majority of which vanish eventually from the landscape due to higher shade and competition. Furthermore, the tree poles face

competition from other poles of same species and other tree species, and eventually weaker seedlings are eliminated. This phenomenon of natural thinning has a marked presence in unmanaged woodlands. In fact the various thinning regimes used by forest managers to facilitate tree growth by elimination of competition are mimics of this natural phenomena. Thus, the stem exclusion stage is characterised by a majority of tree species and presence of fewer numbers of herbs and shrubs in the understorey (Lambert *et al.,* 1996).

Understorey re-initiation : Natural thinning and resultant stem exclusion leads to creation of open spaces in a growing stand. Thus, once again sunlight reaches the forest floor and residual material of excluded trees adds organic matter and nutrients to the forest floor. Consequently, the invasion of annuals, bi-annuals (herbs and shrubs) from surrounding areas results into re-initiation of an understorey. These species thrive on biotic and abiotic opportunities available to them and follow their routine life cycle patterns. Thus, the understorey re-initiation stage marks the re-appearance of diverse flora, many of which may be medicinal plants (Murali *et al.,* 1996).

Old growth stage : Depending on the dominant tree species the old growth stage may be realised in a developing stand between 60-150 years of growth. This stage of stand dynamics can be categorized as an equilibrium stage, where the system is self relaint or closed in the ecological sense. This is typically marked by a fewer number of tree stems/hectare of different species, which occupy different strata. Consequently, the landscape is a mosaic of well-lighted and shaded areas that offers a variety of habitats/niches for different plant species and organisms. Thus, with regards to the species diversity the old growth stage is more diverse when compared to the stem exclusion and the understorey re-initiation stage but may be less diverse in comparison to the stand initiation stage.

These natural dynamics of forest stand are mimicked by a forest manager to manage forest areas for timber production. Essentially the forest manager follows traditional silvicultural systems, which are mere manipulation of canopy. These canopy manipulations are timed to suit regeneration requirements of major tree species of commercial value. For example, in case of species which prefer shade for seedling germination, the canopy removal is delayed to give advantage to saplings and facilitate their speedy conversion to poles subsequent to removal of canopy. On the contrary, a light demanding tree species is favoured by large openings to pre-empt other competing species. Furthermore, removal of unwanted vegetation facilitates a higher biomass accumulation in tree species of economic value to maximize timber production. For this a forest manager relies on Working Plans of management units. A forest manager gets adequate information from the Working Plan on growing stock of prominent tree species and regulates canopy manipulation in temporal and spatial scales (felling cycles) to have a sustained yield of timber. Thus, a forest Working Plan of a management unit is a comprehensive account of a written set of prescriptions, which offers directions for silvicultural operations to be carried out over a span of the next 10-15 years. Furthermore, based on physical geographical features and ecological needs

the management unit is sub divided into working circles, and the working plan circle contains a detailed description of silvicultural operations prioritized for these circles.

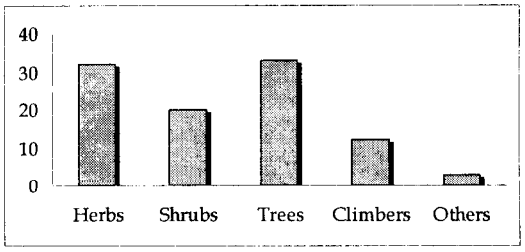
The discussion in the previous section indicates that for a management unit the forest managers have an adequate knowledge of ecology, distribution of tree species and data on resource base specific to life stages of trees. Furthermore, the growth patterns of tree species (increments) are well understood by observations in nature and from sample plots. Therefore, the harvesting limits (volume) and schedules are well defined. Consequently, the training modules of forest mangers at all levels of hierarchy encompass the various aspects of inventory, harvest and regeneration of these tree species of economic value and other related issues.

Some characteristic features of medicinal plant species will now be highlighted, which will show that their management regimes require different prescriptions and related skills.

Characteristics of Medicinal Plants

Medicinal plant species represent a variety of life form (habit) ranging from lichen, algae, herbs, shrubs, climber and trees (Fig. 1), which are annuals to perennials. Moreover, these species are distributed from canopy to understorey of forests and are characterized by seasonality. The auto-ecology and syn-ecology of medicinal plant species is complex and their proper understanding requires a sound knowledge of the ecology, taxonomy, ethno-botany and quantification techniques for these species. Furthermore,

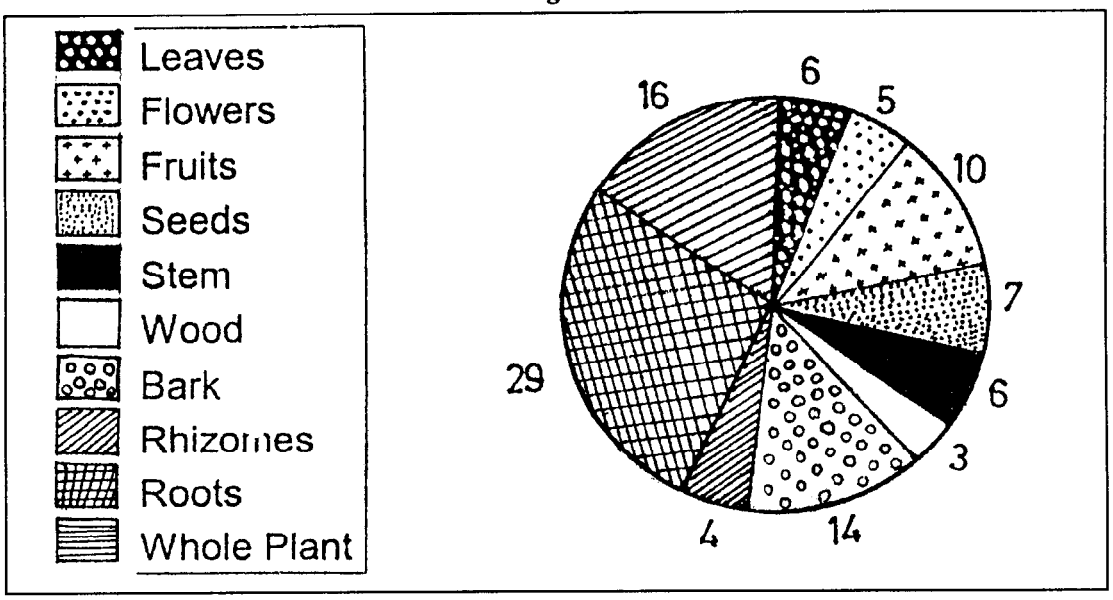
Fig. 1



Distribution of Medicinal Plants by habit (%).

an insight into forest areas reveals that the maximum species diversity is found on edges or ecotones. This is obvious, since the ecotone represents an area, which has higher diversity in terms of soils, light condition, moisture; the energy fluxes are more variable when compared with those of a core area. It is, therefore, not wrong to say that the medicinal plant species may occur more frequently on edges than under the regularly stretched canopies of a continuous forest. Similarly fragmentation of a large area into relatively smaller pockets creates suitable conditions for existence of a variety of life forms, probably due to creation of a large number of edges. Therefore, the chances of distribution of medicinal plants may be higher in such landscapes, which offer a mosaic of abiotic and biotic conditions. The composition of understorey and associated species may change with change in dominant tree species due to specific attributes such as height, crown cover and leave shedding behaviour and their resultant effect on microclimate under the canopy. In timber management forest manager harvests wood, however, the parts used for medicinal properties range from leaves, stem, flowers, seeds, rhizomes, roots to sometimes the whole plant (Fig. 2). Therefore, a manger confronts the issue of growth rates of selective organ growth

Fig. 2



Plant parts used for Medicinal properties (%).

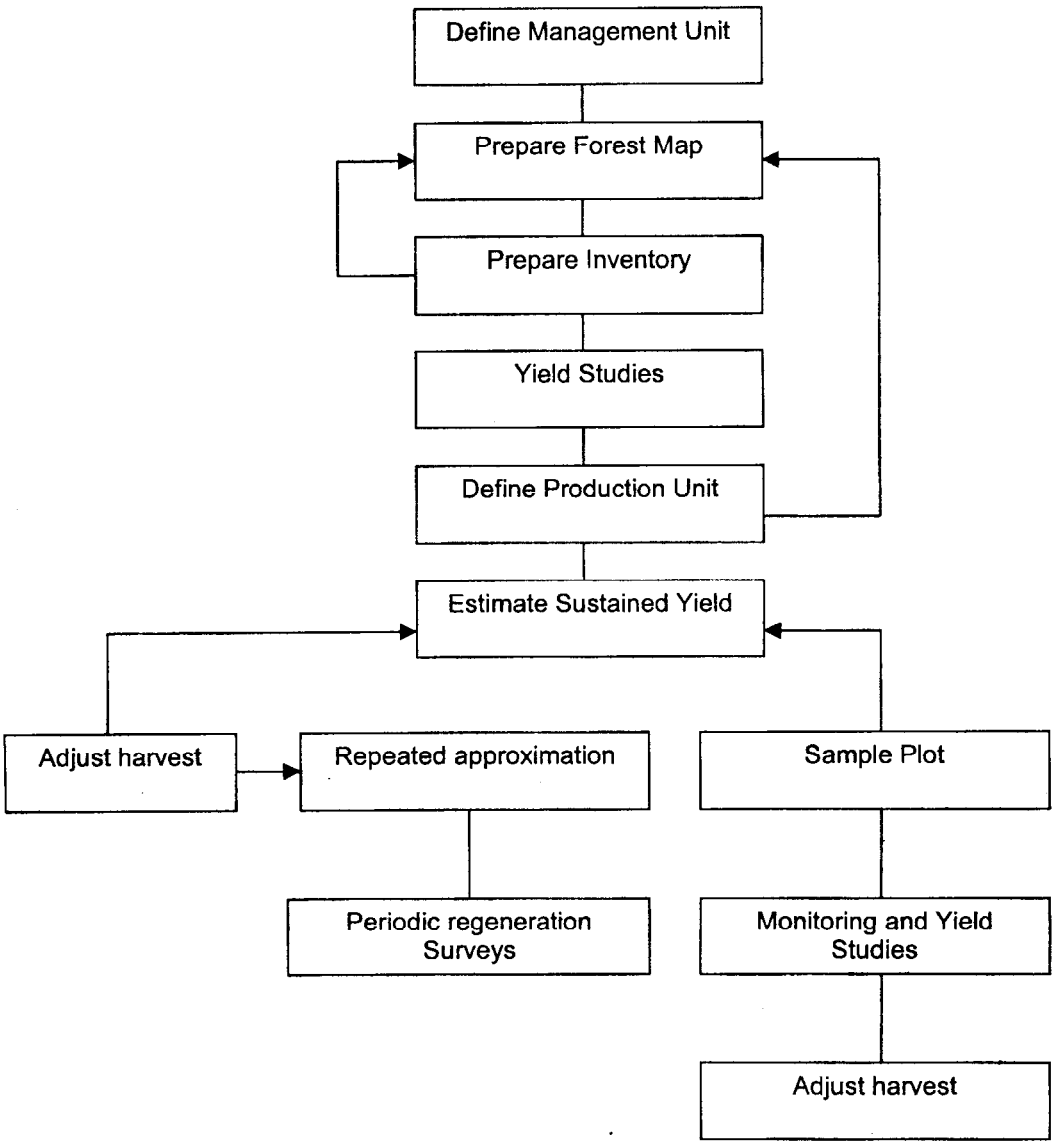
along with the overall growth pattern of the species. This is an important aspect, which will ascertain a safe harvest limit of medicinal plants. Furthermore, the effect of harvesting of these plant parts on the health and survival of medicinal plant species and their regeneration is crucial. Some experts have opined that the stage of growth, the harvest season and the time of day also affect the medicinal properties and therefore, their knowledge is essential for medicinal plant based forest management. It appears on an overall reckoning that medicinal plant based forest management will require specialised skills in managers (Bhojvaid, 2002a).

Implications on medicinal plant based forest management

The stepwise details of a medicinal plants based forest management regime (Fig. 3) would require following considerations :

Delineation of area and canopy manipulation : The distribution patterns and habits of medicinal plants are diverse. Therefore, to maintain their higher abundance and resultant higher yields a manager would aim for maximization of area in a forest, which are at the stand initiation and the old growth stages of stand dynamics as described earlier. This may not always be commensurate with the main objective of timber production, where understorey, climbers and other less important tree species are removed to avoid competition. Similarly, in a traditional production forest management, a stand is never allowed to reach the old growth stage for the purpose of realization of economically optimal yield, with the exception of wildlife sanctuaries and national parks. Thus, canopy manipulations for these two types of management regimes focused on wood harvesting and medicinal plant production may result in a basic management conflict.

Fig. 3



Schematic model for Medicinal Plant based Forest Management on a sustained yield basis

Consequently, a forest manager will have to prioritize the objectives and if the aim is focused on conservation and production of medicinal plant species then the manager may have to maintain a forest with the majority of patches in the stand initiation and the old growth stage. This stage of conflict has been prominent in many development projects of Forest Departments in India. It has been observed

during the preparation of micro-plans for forest areas that locals showed a higher preference for NWFP/medicinal plant species such as mahua, chironji and tendu etc. over timber species. The forest managers on the other hand were more concerned on management aspects of prime tree species such as teak and sal. Consequently, the mangers and the locals had to prioritize the objectives of management for such areas by negotiations. And if priority was conservation and production of NWFP/medicinal plants, it was decided to maintain forest area with majority of patches in the stand initiation and the old growth stage. It may be appropriate to set aside such areas exclusively for production of medicinal plants and designate these as Medicinal Plant Circles in the working plans (Bhojvaid, 2002b).

Inventory : It is essential to have precise information on frequency of occurrence and distribution of medicinal plant species in a forest area for its sustainable management. Although forest working plans do have a chapter on Minor Forest Produce (MFP)/ Non Wood Forest Produce (NWFP), it is a mere enlistment of species, which have economic value. There is hardly any mention on the aspects of their actual distribution in specific compartments and quantitative data such as abundance and relative density etc. Therefore, development of an inventory of medicinal plants in a specific management regime is the foremost requirement. As explained in the previous sections, this process should be based on actual survey, in which areas of closed canopy, edges and gaps should have an equal representation to capture maximum diversity (Nei, 1973). Furthermore, quadrats should be laid in different seasons to ensure representation of maximum medicinal plant species, which are characterized by season specificity and short life spans. Though it may appear impractical to forest managers due to various constraints such as lack of expertise, funds and time, a reliable inventory is a prerequisite for management of natural resource. The Forest Survey of India (FSI) has taken a lead to develop inventory for NWFP species and field foresters can take advantage by collaborating with the FSI (Bhojvaid, 2002). One may argue that a complete inventory of a large number of species may not be feasible due to lack of trained human resource and budget constraints. In such situations the area specific species of higher economic value can be considered initially and the list can expand gradually in the subsequent assessments. An alternate approach may be to consider and prioritize species, which have been declared vulnerable elsewhere. The role of ecosystem people, forest dwellers and traditional healers in the prioritization process may also be very crucial. Furthermore, these people can also facilitate the identification of medicinal plants, help provide their local names and contribute towards the knowledge of traditional silivicultural systems used by them to manage medicinal plants (Pushpangadan, 1996).

Identification and Field Keys : To some it may be exaggeration, but there is a need for development of identification keys for field staff in vernacular languages. This may contain simple information on the aspects of identification, phenology, economic value, medicinal property, part used for medicine, and local (ethnic) use, which are vital for a forest guard and other field level functionaries involved in forest management (Annexure 1). This

field key would not only improve the management skills of field workers but also check and prevent the illegal removal of medicinal plants/medicinal plant parts, which are not recognized at present due to ignorance of forest managers, and are being removed as fodder and waste from forests. This would further help in regulation of trade and realization of right price by collecting agencies to ensure equitability. Local colleges, the State universities and research institutes can help the State Forest Departments in preparation of these keys and to prepare these, financial assistance can be obtained from the National Medicinal Plant Board and such other organizations.

Yield estimations and safe harvest limits : Estimation of medicinal plant yield per unit area is the next step for medicinal plants based forest management. This will also facilitate the decision on safe harvest limits of medicinal plant species. Once again it is a tricky business as different plant parts can be utilized in different species. So unlike timber, which can be directly and indirectly expressed by biomass, basal area, height and diameter relations and volume these parts will need specific determinants.

For accurate estimation of this parameter, there is a need to establish sample plots in different forest types. It is envisaged that such plots should be laid by a stratified random sampling to include different stages of stand development in a forest area. Furthermore, a number of quadrats will have to be sampled for sampling and statistical analysis. A series of harvesting regime (destructive sampling) ranging from 0, 25, 50, 75 to 100% removal of medicinal plants/ medicinal plant parts should be tried to arrive at a potential total (maximum) yield per unit area. These sample plots should be surveyed again in the next regeneration season and the observations on the density and distribution of medicinal plants to determine a safe harvest limit. Furthermore, the regeneration surveys will be seasonal in nature and thus their frequencies will depend on the type of forest and diversity of habits of medicinal plants. Such studies will also characterize non destructive harvesting methods, which can be adopted by collectors.

It is important to note that the establishment of the sample plots for medicinal plants will generate data on the aspects of species richness, density and abundance, population structure, growth pattern of medicinal plants/medicinal plant parts, potential yield, safe harvest limits and regeneration potentials at a much faster rate due to shorter life cycles of the majority of medicinal plant species. Furthermore, these parameters are essential for certification of medicinal plants for trade in national and international markets.

Adjustments in Working Plans : As discussed earlier, the forest working plans in vogue for management units are incomplete on the many aspects of medicinal plant management. Therefore, it is essential to include a separate chapter or a subsection under NWFP/MFP chapter on medicinal plants in the Working Plans. It should contain essentially inventory, yield potential, threat status, and management prescriptions for medicinal plants. A Working Plan Officer (WPO) may decide to constitute a separate Medicinal Plants Circle or overlapping circles depending on the main objectives, legal status and type of forest. It would be

worthwhile to include information on ethnic uses, local markets ('haats') and traditional systems of management practiced by forest dwellers and tribal populations. Based on inventory the WPO should prioritize species, which require conservation efforts and suggest methods to conserve them. A WPO may recommend direct seeding/ sowing of such species or planting of seedlings to achieve *in-situ* conservation. It is important to note that creation of nurseries and field plantations of medicinal plant species may be conducted to increase the population to optimal numbers. In such a case the methods of mass propagation, plantation techniques and tending operations may be considered as a part of the working plan. Alternatively, the experts in the State Forest Departments can think of making manuals or technical notes for these medicinal plant species. The working plans may also contain information on rights and concession of local people for collection for self-use and sale.

Storage and Marketing : Unlike wood, which requires little post-harvest care, the medicinal plants have varying shelf-life ranging from a few days to many years. Therefore, these species require a variety of post harvest treatments, which include drying regimes and storage methods. Majority of medicinal plants would require shade drying for a fixed duration followed by grading and sorting. Similarly, the storage material for aromatic plants has to be airtight while many roots and seeds etc. can be stored in ordinary gunny bags of jute. It would be important to include this information in the field key prepared for forest staff.

At present marketing medicinal plants is a very difficult proposition. The medicinal plant trade is regulated by variety of forces such as market, industrial demand, tribal needs, international pressures, forest management and government policies. Although 9,000-10,000 small pharmacies and around 60,000 practitioners of local health traditions have also been reported, only 7-8 big industries in India are involved in production of medicinal plant based formulations and other health products. Moreover, the bulk of traded medicinal plants is illegally removed from forest areas. Consequently, trade in medicinal plants is unorganized and the prevailing market is the buyers' market. Therefore, past efforts of State Forest Corporations to sell and market medicinal plants have had a mixed success. It is, therefore, suggested that until proper linkages with industrial and trade houses are established a forest manager may consider a more realistic fixation of royalties based on inventory and market surveys rather than directly trading the medicinal plants.

Medicinal Plant Management and Joint Forest Management (JFM)

Joint Forest Management (JFM) has been practiced since late 1980s to different extent by various State Forest Departments in India. Initially, the concept was designed for rehabilitation of degraded forests by peoples' participation in planning process and management of such forests. However, of late it has been opined that JFM should be applied even for managing good forests. This notion is based on the premise that sustained livelihood opportunities based on judicious extraction of medicinal plants and other NWFPs can sustain peoples' interest in participation process (Anuradha, 1999). Therefore, it may be worthwhile to involve people in different processes

described in previous sections such as delineation of forest areas, inventory, field key preparation, harvest, value addition and marketing of medicinal plants. This will result not only in tying the interest of people with ecosystem but would also make for the shortage of resources in term of man power required for achieving the goals of sustainable management.

Conclusions

It is clear from the discussion that a successful management strategy for medicinal plant species should involve economic, silvicultural, social and environmental inputs. An effort based only on ecological considerations such as, creation of *ex-situ* and *in-situ* conservation areas or reserves without addressing the socio-economic, and technical issues is not a viable option. Moreover, the basic conflict between the timber-based forest management and medicinal plant oriented management regime has to be resolved to achieve sustainable livelihoods and resource management. Furthermore, despite the potential for disaster, a few of the vulnerable medicinal plant species are today protected by legislation, which would require rethinking on the part of policy makers. The new Biodiversity Act and the Biodiversity Action Plan may be a great help in protecting such a resource. However these legislative plans should also focus on agricultural, marginal, and degraded lands, all of which are important sites of threatened medicinal plants biodiversity apart from their present focus on protected natural reserves.

SUMMARY

Global trade of Medicinal Plants is worth US $ 60 billion and is increasing at the rate of 7% per year. This has led to scarcity of medicinal plants in natural forests. Many national and international organisations have opined that the sustainable management of medicinal plants has a potential for income generation sand poverty alleviation provided that the resources are extracted sustainably. However, there is lack of information on inventory methods, safe harvest limits, regeneration status and management prescriptions, which are essential for management of this important resource in natural forests. This is attributed to traditional forest management systems, which are timber oriented. The characteristic features of medicinal plants are described and it is argued that some modifications are required in traditional forest management to make it suitable for management of medicinal plants in natural forests.

औषधीय पादपों पर आधारित वन प्रबन्ध – समस्याएं और संभावनाएं

पी॰पी॰ भोजवैद्य

सारांश

औषधीय पादपों का विश्वव्यापार 60 बिलियन अमेरिकी डालरों का है और यह 7% वार्षिक दर से बढ़ रहा है । इसकी वजह से प्राकृतिक वनों में औषधीय पेड़पौधों की कमी हो गई है । बहुत से राष्ट्रीय और अन्तर-राष्ट्रीय संगठनों की राय है कि औषधीय पेड़पौधों के दीर्घकालिक प्रबन्ध में आमदनी बढ़ाने और गरीबी दूर करने की क्षमता है बशर्ते कि उनमें से संसाधनों का निष्कर्षण लम्बे समय तक चलने वाले आधार पर किया जाए । परन्तु तालिकाएं बनाने की रीतियां, निरापद कटाई सीमा, पुनर्जनन स्थिति और प्रबन्ध करने के ढंगों के बारे में जानकारी का आभाव है जिसका होना प्राकृतिक वनों के इस महत्वपूर्ण संसाधन के लिए अपरिहार्य है । इसका सम्बन्ध पारम्परिक वन प्रबन्ध प्रणालियों से जुड़ा हुआ है जो प्रकाष्ठ की तरफ उन्मुख हैं । औषधीय पादप जातियों के विशिष्ट लक्षणों का यहां वर्णन किया गया है तथा तर्क दिया गया है कि प्राकृतिक वनों में औषधीय-पादपों के प्रबन्धकार्य मे उसे उपयुक्त बनाने के लिए पारम्परिक वन प्रबन्ध प्रणालियों में कुछ संशोधन किए जाने की आवश्यकता है ।

Annexure 1

Botanical Name	:	*Emblica officinalis* Gaertn.
Vernacular Name	:	Amla
Trade Name	:	Amla, Amalki
Distribution	:	Throughout India up to asl
Part Used	:	Fruit (Fresh and Dried)
Flowering Time	:	April - May
Fruiting Time	:	June - August
Harvesting Time	:	October - December
Harvest Method	:	Manual Collection

Grading, Storage and Value addition : Good and Big; Good and Small; Shade dry and store in dark and cool place in airtight bags. Could be converted into paste/ juice and stored in poly-jars/cans.

Major Uses : The fruit is used as a diuretic, laxative, in hair dyes, detergents, shampoos etc. It is also used as a cardio-protective agent, useful in hemorrhage, leucorrhoea and discharge of blood from uterus. Poultice used to stop bleeding from cuts. The fermented fruit liquor is used in jaundice, dyspepsia, cough, indigestion, anemia, heart complaints and promotion of urination.

Major Markets : New Delhi, Amritsar, Haridwar

Market Rate : Rs. 15 - 20/kg

Major Chemical Constituents : The major constituent is Vitamin C (up to 720 mg/ 100 g of fresh pulp) and (921 mg / 100 cc of pressed juice). The fruit is probably the richest natural source of Vitamin C.

References

Anon. (1988). *National Forest Policy 1988*. MoEF, GoI, New Delhi, India.

Anon. (1999). *National Forestry Action Plan*. MoEF, GoI, New Delhi, India.

Anon. (1999). *State of Forests Report*. Forest Survey of India, MOEF, GOI, New Delhi. India.

Anuradha, R.V. (1999). Sharing the Benefits of Biodiversity. Theme paper for *South Asian Regional Review of Community Wildlife.Management*, Kalpavriksh, New Delhi and IIED, London.

Bhojvaid P.P. (2002a). Role of resource inventory and quantitative ecology in establishment of Vanaspati Van for *in-situ* conservation in Chakrata Forest Division, Uttaranchal. Paper presented in *Workshop on Vanaspati Van action plan*. 24-25 June, 2002. Wildlife Institute of India, Dehra Dun.

Bhojvaid P.P. (2002b). Issues in resource inventory of NEFP species in India. Paper presented in *Consultative Workshop on Resource Inventory of NEFP species in India*. Organized by Forest Survey of India. 26-27 August, New Delhi, India.

Brandis, D. (1989). *Indian Forestry*, Oriental Institute, Woking (UK).

Lambert, J., J. Shrivastava and N. Vietmeyer (1996). *Medicinal plants: rescuing a traditional heritage*. Agricultutre and Natural Resource Department, The World Bank, Washington DC, USA.

Murali, K.S., Uma Shankar, R. Uma Shankar, K.N. Ganeshaiah and K.S. Bawa (1996). Extraction of Non-Timber Forest Products in the forests of Biligiri Ragan Hills, India – Impact of NTFP extraction on regeneration, population structure, and species composition. *Economic Botany,* **50** (3): 252-269

Nei, M. (1973). Analysis of gene diversity in subdivided populations. *Proc. Natl. Acad. Sci,* USA. **70** : 3321-3323.

Pushpangadan, P. (1996). Tropical Garden Research Institute: People Oriented Sustainable Development Programme. Paper presented at *UNEP/GEF Indigenous Peoples' Consultation Meeting*, Geneva, 29-31 May.

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., Vijay Barve, Noorussisa Begum and R Latha (1998). Eco-distributing mapping of the priority Medicinal plants, of Southern India. *Current Science*, **75** (3): 205-208.