PROMOTION OF NON-WOOD FOREST PRODUCE THROUGH SOCIAL FORESTRY

PROCEEDINGS OF A NATIONAL WORKSHOP HELD MARCH 8-11, 1992

Editors : N.G. HEGDE and J.N. DANIEL

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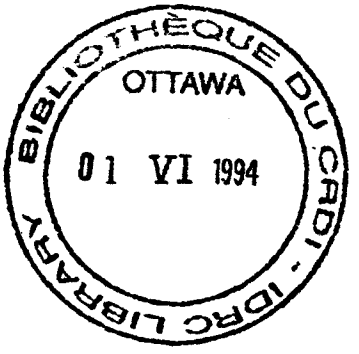

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PREFACE

As part of its efforts to promote research and outreach programmes on multipurpose tree species (MTPS), the BAIF Development Research Foundation has been coordinating the national MPTS Network for India since 1991. A key activity of the Network is to conduct national workshops on specific topics. The inaugural workshop held in 1991 focussed on MPTS for small farmers. The second workshop in this series, held in March 1992, was on MPTS for non-wood forest produce (NWFP).

The workshop on NWFP attracted 103 participants of whom 39 presented formal papers. Majority of the papers highlighted the technical or socio-economic aspects of single species or a group of species while others discussed the socio-economic importance of NWFP in general. Data presented by speakers showed that NWFP contribute significantly towards the national economy by way of revenue and employment. Among those engaged in collection or harvesting, processing and marketing of NWFP are tribals, other forest dwellers and women. These categories, considered to be the weaker sections of the society, can benefit immensely by organised efforts to promote production and utilization of NWFP.

The financial support received from our sponsors – National Wastelands Development Board, New Delhi; Winrock International, F/FRED Project, Bangkok, Thailand; International Development Research Centre, Canada; Swedish International Development Authority, New Delhi; British High Commission, New Delhi; Australian High Commission, New Delhi and Nitrogen Fixing Tree Association, Hawaii, USA – made it possible for us to conduct the workshop and publish the proceedings. We gratefully acknowledge their generous contributions. Our thanks are due to Dr. Manibhai Desai for his advice and encouragement, Mr. R.L. Chowdhary for preparing the comprehensive overview of the presentations, and Ms. Tinku Dhar for providing assiduous editorial assistance.

It was evident from the presentations and subsequent deliberations during the workshop that knowledge about NWFP is often traditional and lack systematic documentation. BAIF is pleased to publish this proceedings which documents valuable information compiled and presented by researchers and extension workers who participated at the national workshop on NWFP.

Narayan G.Hegde

Joshua N. Daniel

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PROMOTION OF NON-WOOD FOREST PRODUCE

An Overview of the Workshop Presentations

R.L. Chowdhary, N.G. Hegde and J.N. Daniel

The approach to development of forest resources has so far laid more emphasis on augmentation of major forest products like timber and fuel whereas the non-wood forest products (NWFP) such as gum, wax, medicinal herbs, fruits, nuts, edible and non-edible oil seeds have received relatively low priority. Traditionally, the tribals and villagers residing in adjoining forest areas have been subsisting on these resources, for meeting their needs and for providing employment and income through collection and sale or barter of these products.

Before developing a programme for promotion of NWFP, it was thought essential to document the traditional knowledge and explore the technology available for optimising the production of NWFP commonly in demand, both in national and international markets.

Against this background, a national workshop was held during March 8-11, 1992 in Pune. Scientists, Foresters, Non-Government Organisations and Government agencies and users of NWFP were invited to share their experiences and suggest suitable strategies for promotion and cultivation of trees for NWFP. 103 delegates participated in the workshop and presented 39 technical papers to highlight the social, technological and economic dimensions of the workshop themes.

Workshop Themes

The plenary sessions and group discussions focussed on the following themes.

1. Identification of Multipurpose Tree Species for non-wood forest produce.

2. Collection, processing, marketing and infrastructural needs for non-wood forest produce.

3. Potential of non-wood forest produce for income and employment generation.

Special sessions were also held on socio-economic significance and technical problems of raising neem (*Azadirchta indica*) and MPTS. More than 60 exhibits and posters, consisting of essential oils, medicinal herbs, oil seeds, gums and other processed products were displayed.

A brief overview of the papers presented in the workshop is presented below.

Important species yielding NWFP

In the papers under this section, some of the MPTS yielding NWFP of economic and social importance have been identified. Useful information has been compiled by several authors on trees yielding products like edible fruits, nuts and oil seeds, essential oils, gums, resins and wax, insecticides, tans and dyes, fibre and flosses, bamboos and canes, medicinal and a variety of other products. Several participants have stressed the need for proper nurturing, preservation and propagation of the species which have special significance for tribals and others residing in forest areas. Case studies on the role of a Tribal Cooperative and women's groups were also presented.

The need for undertaking research on aspects such as regeneration and establishment techniques for several NWFP-yielding trees, suitable techniques for gum and resin extraction, storage methods for oil seeds, fruits and nuts, and genetic improvement of MPTS yielding NWFP has been stressed to secure qualitative and quantitative improvement in the yields of different products.

Herbal medicinal plants are gaining acceptance, both within the country and abroad for several pharmaceutical preparations. Proper identification of regions and resources and further research and development efforts to identify new species yielding superior quality products are urgently required to be initiated by all forest departments in association with research institutions and non-government organisations dealing with these products.

MPTS are an important source of bee forage and species like *Hevea brasiliensis, Nephelium litchi* and *Eucalyptus* are the backbone of honey production in India.

Planting of MPTS in fragile ecosystems is desirable as NWFP can be extracted without cutting down the trees. This helps in maintaining vegetal cover in ecologically fragile areas of dams and hill slopes. Several important MPTS of economic potential such as lac, tannin, soap, oil, dyes, bidi (Indian cigarettes), leaf plates, bamboos, cane, gum, and fibre have been identified for use in forest-based industries.

Special session on Neem *(Azadirchta indica)*

Neem tree yields both durable timber and non-wood products like gum, bark (10-15% tannin), twigs (considered an effective tooth brush), pesticides from leaves, flowers (in drinks), and a powerful tonic (exudate). It can be grown almost anywhere, including rocky areas. Neem based pesticides and insecticides are environment friendly and play an effective role in sustainable agriculture. Extracts of oil and chemicals from the seeds for industrial uses is also attracting worldwide attention. However, cooperative research studies, focussing on ontology, phenology, genetics, medium-term storage and seed handling techniques and studies on foliar diseases (particularly in Africa) are warranted. An effective tree improvement programme for this tree, focussing on the needs of small farmers, is necessary. Evaluation of different eco-types and further selection for wood and seed production are also essential to make neem cultivation more attractive.

Special highlights on species yielding NWFP

The social significance of several species yielding NWFP like kokum (*Garcinia indica*), Mahua (*Madhuca indica*), Sal (*Shorea robusta*), palas (*Butea monosperma*), mogali erand (*Jatropha curcas*), several species of Agave *(Agave sisalana, A. veracruz* and *A. cantala*), several species of cane (*Calamus psed tennius, C. rotang and C. thwaitesii*) and broom grass (*Thysanolaeria maxima*) have been highlighted in the papers presented on this topic.

Socio-economic significance of NWFP

There is an increasing demand for herbal medicines and medicinal plants, mainly an account of its curative properties in chronic diseases like liver and spleen disorders and paralysis with relatively little or no harmful side effects as compared to allopathic

medicines. However, due to considerable overuse of medicinal plants without propagation and nurturing of forest resources, several varieties of valuable plants, like *Raulbia serpetina,* and *Aristolochia indica,* have been depleted.

It is, therefore, necessary to actively promote the cultivation of medicinal plants by educating people about the medicinal value of different trees and plants and their effective utilisation without destruction. Technical help in propagation, processing, marketing and infrastructure development is needed to motivate the people to raise medicinal plants as an income generating activity.

Recommendations

Based on the group discussions, the following recommendations were made by the delegates.

1. A comprehensive list of tree species, based on non-wood uses, is presented for promotion through social forestry (Appendix 1). This list should be further expanded to document the potentials and uses of NWFP from different MPTS by involving local people, NGOs, native medical practitioners, foresters and researchers.

2. Species such as *Azadirachta indica, Artocarpus heterophyllus, Butea monosperma, Derris indica, Emblica officinalis, Madhuca indica, Syzygium cumini* and *Tamarindus indica* are recommended for intensive research because of their significant potential to yield NWFP.

3. Studies on silvicultural techniques for improving the productivity, collection, processing and uses of different non-wood produce and their economics should be initiated to popularise the cultivation of important species.

4. Organisations like ICFRE, ICAR and BAIF should coordinate with other national and international institutions such as agricultural universities, research wings of Forest Departments and International Forestry Organisations to initiate future research on important species.

5. Studies should be initiated to quantify season-wise employment generation

through different NWFP-yielding MPTS.

6. Training should be organised for rural people, particularly the tribals and grass-root level workers, for imparting skill on cultivation of MPTS, harvesting/tapping and collection, processing and marketing of NWFP. A coordinated training programme involving NGOs, Forest Departments and Research Institutions should be organised regularly.

7. Information on various species producing NWFP should be disseminated by setting up of village-level demonstrations, particularly through local NGOs and schools, newsletters, booklets, popular articles, documentary films and seminars.

8. Cultivation of NWFP should be encouraged on forest lands and community wastelands to generate additional employment, income and nutritional supplement without causing deforestation.

9. Local NGOs and Joint Forest Management Committees should be established and encouraged to organise the marketing of NWFP. Popularising the cultivation of MPTS, providing finance and technical assistance, processing of the produce, promoting local uses and identifying marketing opportunities can also be undertaken by these organisations.

10. Nodal agencies should be established/identified at district and state levels to extend support to local organisations in marketing NWFP. These agencies should also be responsible for quality control and organising, processing and storage of NWFP wherever necessary. Minimum support price should be assured to primary producers/collectors.

11. Processing of NWFP should be encouraged in rural and semi-urban areas. Effective and appropriate equipment and machinery of different capacities should be developed.

12. Forest Acts should be amended to give exclusive rights to the local people for collecting NWFP from forests located around their villages.

Appendix 1. List of Tree Species with Non-wood Uses

Species	Common Name	Uses
Acacia catechu	Catechu	Me, Gr, Td
Acacia leucophloea	Hiwar	Td
Acacia nilotica	Gum arabic	Me, Gr, Td
Acacia senegal	-	Gr
Actinodaphne aungustifolia	Pisa	Hi, Oi
Aegle marmelos	Bel	Fo, Me
Agave spp.	Agave	Fi, Mi
Ailanthus malabaricum	Dhup	Gr
Alangium lamarckii	*Akola*	Fo, Fi
Albizia amara	-	Mi
Anogeissus latifolia	Dhavda	Gr, Td
Anthocephalus cadamba	Kadam	Fo, Me
Artocarpus heterophyllus	Jackfruit	Fo, Td
Artocarpus lakoocha	Lakooch	Fo, Td
Azadirachta indica	Neem	Oi, Me, Gr
Balanitis roxhurghii	-	Oi
Bauhinia racemosa	Apta	Fo, Fi
Bixa orelana	Shendri	Me, Td
Bombax ceiba	Silk Cotton	Me, Fi, Mi
Borassus flabellifer	Palmyra palm	Fo
Boswellia serrata	Salai	Me, Gr
Buchnania lanzan	Char	Fo
Butea monosperma	Palas, Flame of the Forest	Me, Gr, Td, Fi, Mi
Caesalpinia sappan	Sappan	Td
Calophyllum inophyllum	Undi	Oi, Me
Canarium strictum	Ral-dhup	Gr
Caryota urens	Indian sago	Fo, Fi
Cassia augustifolia	Sanna	Me, Fi
Cassia fistula	Bahava	Td, Me
Cedrus deodara	Deodhar	Me
Ceiba pentandra	Sarbur	Fi, Mi
Commiphora wightii	Gugul	Gr
Cordia dichotoma	Sebesten	Fo, Fi
Derris indica	Karanj, Pongamia	Oi, Me, Mi
Diploknema butyracea	Indian butter tree	Fo, Oi
Diospyros melanoxylon	Tendu	Mi
Emblica officinalis	Indian gooseberry or Amla	Fo, Me, Td, Mi
Feronia elephantum	Wood apple	Fo, Me, Mi
Garcinia indica	Kokam	Fo, Mi

Gmelina arborea	Shiwan	Me
Indigofera pulchella	Indigo	Td
Jatropha curcas	Mugh esandi	Oi
Lagerstroemia parviflora	Jarul	Mi
Lawsonia intermis	-	Me, Td
Madhuca indica	Mahuva	Fo, Oi
Madhuca longifolia	Macbride	Oi
Mallotus philippinensis	Kumkuphal, Raini	Me, Td
Mangifera indica	Mango	Fo, Me, Mi
Manilkara haxandra	Milk tree, Khirni	Fo
Melia azedarach	Persian lilac	Oi, Me
Mimusops elengi	Bullet wood	Oi, Me
Moringa oleifera	Drumstick	Fo, Ho, Me, Gr, Fi
Morus alba	Mulberry	Fo, Mi
Phoenix sylvestris	Shindi	Fo
Pithecellobium dulce	Vilayti chinch	Td
Prosopis cineraria	Khejdi	Fo, Ho
Pterocarpus marsupium	Bijasal	Me, Gr, Td
Pterocarpus santalinus	Santaline dye	Td
Salvadora persica	Pilu	Fo, Oi, Me,
Sapindus emarginata	Soapnut, Ritha	Ho, Me,Td, Mi
Schleichera oleosa	Kusum	Gr, Mi
Semecarpus anacardium	Bibba, Marking nut	Oi, Td
Sesbania grandiflora	Agastha	Fo, Mi
Shorea robusta	Sal	Oi, Gr, Td, Mi
Simarouba amara	Simarube	Oi, Me
Spendias pinnata	Ambada	Fo, Me
Sterculia urens	Kandola	Me, Gr
Syzygium cumini	Jambhul	Fo, Me, Mi
Tamarindus indica	Tamarind	Fo, Me, Mi
Terminalia bellerica	Behada	Me, Td
Terminalia chebula	Harda	Me, Td, Mi
Terminalia tomentosa	Sadada	Td, Mi
Zizyphus mauritiana	Ber	Fo, Gr, Mi

Fo : Edible fruits and food; Ho : Honey; Oi : Oil; Me : Medicinal Uses;

Gr : Gums and Resins; Td : Tannins and Dyes; Fi : Fibres and Flosses; Mi : Miscellaneous

MULTIPURPOSE TREE SPECIES FOR MINOR FOREST PRODUCE IN INDIA

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ABSTRACT

Income generation through minor forest produce is not new in India, particularly among tribal families. However, large-scale deforestation has resulted in the reduction of importance of species yielding minor forest produce. Nevertheless, their contribution in the foreign exchange earnings of the country is significant. It is necessary to identify tree species, develop processing techniques and create marketing facilities to promote minor forest produce as an income-earning activity. Strategies for popularising minor forest produce are discussed. The paper contains a listing of species yielding different minor forest produce. An annexure lists MPTS having medicinal uses.

INTRODUCTION

With the increasing population pressure, forest resources in India have been depleted during the last few decades. As majority of the rural people are dependent on forests for fodder, fuel and timber, the Government of India has introduced several afforestation schemes, under the programme of 'Social Forestry' and identified people's participation as a key factor for its success.

However, 15 years after the introduction of the social forestry programme, it has been realised that farmers are not keen to plant trees for fodder and fuel, because of uneconomical prices, inadequate marketing facilities and the traditional practice of collecting these produce from community pastures and forests. It is therefore, necessary to review the on-going social forestry programmes and develop a suitable strategy to attract rural people to participate in afforestation as a viable economic activity. Among the alternative strategies available is the planting of multipurpose trees for minor forest produce.

DEMAND FOR FRUIT SPECIES

Several studies on social forestry in India and many other countries in the tropics have identified that profitability, in the form of higher cash income generation is an effective motivational factor for planting trees (Hegde, 1991). It has also been reported that fruit and timber species can generate a higher income as compared to pulpwood and fuel species. Some of the fruit tree species presently planted under the social forestry programme are *Mangifera indica* (mango), *Anacardium occidentale* (cashew), *Annona squamosa* (custard apple), *Ziziphus mauritiana* (ber), *Tamarindus indica* (tamarind), *Artocarpus heterophyllus* (jackfruit), *Moringa oleifera* (drumstick) and *Emblica officinalis* (Indian gooseberry). However, the popularity of these species depends on agro-climatic adaptability and marketing opportunities to sell the produce at remunerative prices.

Marketing of fruits, nuts and vegetables grown on trees is fairly easy compared to timber because farmers have established a practice of selling them in the local fruit and vegetable markets. Cultivation of fruits and nuts is more advantageous to fuel and timber species, as the former type of trees can serve as a sustained source of regular income over a long period of 30 - 50 years without felling the trees. Thus it is possible to meet the objectives of environmental security and assured livelihood by promoting the cultivation of fruit and nut trees. However, in countries like India, where more than 50 per cent of the total land area falls under the category of wastelands which are suitable for afforestation, it is not advisable to restrict to a small number of species to avoid a glut of certain produce. Therefore, it is necessary to identify many other tree species, which can yield different types of non-wood produce and contribute to the income of the farmers. Fortunately, there are many tree species, which can produce fruits, nuts, leaves and barks that have special domestic use or market demand. Hence, these products which are known as 'minor forest produce' have a great potential, provided suitable processing techniques are developed and marketing facilities are created in rural areas.

MINOR FOREST PRODUCE (MFP)

Income generation through minor forests is not new in India. A majority of the tribal families were forest dwellers who collected a variety of forest produce for their livelihood in the past. However, with the increasing rate of deforestation, the tree population of such species is fast vanishing and people have gradually forgotten the

importance of these commodities. In spite of this attitude, minor forest produce is making a significant contribution to foreign exchange earning in India. In countries like Republic of China (Taiwan), MFP is the major source of income generation from the forests and looking to the significance of MFP, international forestry scientists have now renamed MFP as 'Special Forest Produce, (SFP).

The time is appropriate to promote the cultivation of MPTS to generate sustainable livelihood, while conserving the forest vegetation for environmental security. Tree species can produce a wide range of non-wood commodities which are of great economic importance and utility. These commodities can be grouped based on their following utilities :

Fruits, nuts and edible products; Spices; Oil seeds; Essential oils; Gums, resin and wax; Insecticides; Tans and dyes; Fibre and flosses; Bamboos and canes; Other produces; Medicinal products.

Some of the important tree species producing these non-wood products are listed in the following sections.

1. MPTS for Fruits, Nuts and Edible Products

1. *Aegle marmelos* is grown throughout India and commonly known as 'bel'. The sweet fruit pulp is used for preparing cold drink, jam and preserve.

2. *Alangium salviifolium* (Sage-leaved Alangium or Dhera) is a small deciduous tree, grown in South India. Fruits are eaten uncooked.

3. *Anacardium occidentale* (Cashewnut) grows in coastal areas. Fruits are edible. Seed kernel is cashewnut and the seed shell extract is used as wood preservative, insect repellent and for other purposes.

4. *Annona squamosa* (Custard apple) is a small tree, tolerant to drought and produces delicious fruits. Seeds contain oil and chemicals having insecticidal properties.

5. *Annona raticulata* (Bullock's heart or Ramphal) grows into a medium size tree

and needs more moisture compared to custard apple. Fruits are edible, but to bearing is poor.

6. *Anthocephalus cadamba* (Kadam) is a large tree found in tropical and subtropical regions. Flowers are used to produce alcohol, while ripe fruits are edible.

7. *Artocarpus altilis* (Bread food) is a medium size evergreen tree cultivated in the Western Ghats. The unripe mature fruits are a popular vegetable in South India.

8. *Artocarpus heterophyllus* (Jackfruit) is a large, evergreen tree, cultivated throughout India. Tender and mature unripe fruits are used as vegetable while ripe fruit is edible. Seeds are also edible after cooking.

9. *Artocarpus lakoocha* (lakooch) is a large deciduous tree found all over India. Unripe fruits are sour, used for pickles or dried for use as a condiment. Edible ripe fruits are sweetish and sour.

10. *Borassus flabellifer* (palmyra palm) is a tall palm with fan like leaves, grown in Tamil Nadu, Bihar, Andhra Pradesh and West Bengal. Refreshing juice is collected by cutting the flower stalks. Tender fruits contain edible tender gelatinous tissue.

11. *Buchanania lanzan* (Cuddapah almond or 'Chironji') is a medium size tree found in dry deciduous forests throughout India. Fruits are eaten while kernels are eaten raw or roasted.

12. *Carissa carandus* (Karanda) grows throughout India. The fruits are used for pickle, jam and chutney.

13. *Caryota urens* (Indian sago palm or fishtail palm) is used to extract juice ('Nira') and pith yields good quality sago.

14. *Cordia dichotoma* (Sebesten) is a middle sized deciduous tree which produces edible mucilaginous fruits known as 'Sebesten'. Unripe fruits are pickled.

15. *Dendrocalamus strictus* (male bamboo) young shoots yield used as vegetable and for pickles.

16. *Diploknema butyracea* (Indian butter tree) is a deciduous tree found in Sub-Himalayan tract which produces edible berries and oil seeds.

17. *Emblica officinalis* (Emblic myrobalan) fruits are used for pickles, preserves and medicinal purposes.

18. *Feronia limonia* (Elephant apple or wood apple) fruits are used for making cold drink and chutney.

19. *Garcinia indica* (Kokum) grown in Western Ghats, produces edible fruits. Dried rind is used as a condiment and wax is extracted from seeds.

20. *Juglans regia* (Walnut) is a deciduous tree grown in the temperate region.

21. *Madhuca indica* (Mahua) is a large deciduous tree, producing succulent sweet, edible flowers. Seeds are used for extracting edible oil while cake is good for cattle feed.

22. *Mangifera indica* (mango) is a popular fruit tree with multiple uses. Flowers are a rich source of honey.

23. *Manilkara haxandra* (Milk tree or 'Khirni') is a large tree which produces reddish yellow edible fruits .

24. *Moringa oleifera* (drumstick) leaves, flower and tender fruits are used as vegetables.

25. *Morus alba* (mulberry) fruits are eaten and leaves are fed to silkworm.

26. *Phoenix sylvestris* (wild date or date-sugar palm) is the traditional source of 'nira', also used to make jaggery.

27. *Salvadora oleoides* (Pilu) fruits are eaten in Gujarat.

28. *Spondias pinnata* (Hog plum) is a deciduous moist forest tree which produces sour fruits useful for pickle.

29. *Syzygium cumini* (black plum) fruits are popular throughout the country.

30. *Tamarindus indica* (tamarind) is a popular fruit used in Indian cooking.

31. *Ziziphus mauritiana* (Indian jujube or ber) is also a popular fruit species grown in dry regions.

2. MPTS for Spices

Important trees of species found in forests are listed below :

1. *Cinnamomum zeylanicum* - (cinnamon) dried bark.

2. *Cinnamomum tomala* (tamal) - leaves for condiment.

3. *Myristica fragrans* - fruits for nutmeg and mace.

4. *Pimenta dioica* (allspice) - extracted from fruits.

5. *Syzygium aromaticum (Clove) - from flower buds.*

3. MPTS for Oil Seeds

Important MPTS known for producing edible or non-edible oil are listed below :

1. *Actinodaphne hookeri* found in western ghats is a rich source of lauric acid. Oil is non-edible.

2. *Aleurites fordii* (Tung-oil tree) and *A. montana* (wood oil tree) produce tung oil used for paints and varnishes.

3. *Azadirachta indica* (Neem) seed and oil have many uses.

4. *Calophyllum inophyllum* (Indian laurel), grown in coastal regions, produces non-edible oil having insecticidal property.

5. *Derris indica* (Pongamia) produces non-edible oil having pesticidal properties.

6. *Diploknema butyracea* (Indian butter tree) produced edible oil known a 'Phulwara'.

7. *Garcinia indica* (Kokam) produces edible fat, which also has multiple uses.

8. *Hydnocarpus kurzii* (Chaulmugra) oil is used to cure leprosy.

9. *Jatropa curcas* (Physic nut or 'Moglia erand') is a common fencing plant grown in humid and semi-arid regions throughout the country and produces seeds useful for extracting non-edible oil.

10. *Madhuca indica* (Mahua) oil, known as Mahua Butter is edible.

11. *Madhuca longifolia* (Macbride) is grown in Southern India. Oil is edible and cake is a cattle feed.

12. *Mallotus philippensis* (Raini or Kamala) oil has industrial use, particularly to make varnishes.

13. *Melia azedarach* (Persian lilac) seeds produce non-edible oil used for soap and medicines.

14. *Mimusops elengi* (bullet wood), found in gardens in Deccan, produces edible oils.

15. *Salvadora oleoides* (Pilu) produces non-edible oil which is also used for making soap and extracting chemicals.

16. *Semecarpus anacardium* (marking nut tree) - Kernels yield semi-drying oil, useful as wood preservative and lubricant.

17. *Shorea robusta* (Sal) seeds produce edible sal butter.

18. *Vateria indica* (Vellapire) tree is found in Western Ghats and seeds yield edible oil known as piney tallow.

4. MPTS for Insecticides

Important tree species having pesticidal property are *Azadirachta indica* (leaves and seeds), *Annona squamosa* (seeds), *Derris indica* (seeds), *Melia azedarach* (seeds and leaves) and *Vitex nigundo* (leaves). These were traditionally used in India, but with pressure from pesticidal industries, farmers have started shifting to chemical pesticides.

5. MPTS for Gums, Resin and Wax

Important MPTS yielding gum, resin and wax are listed below :

True Gums :

Gum arabic : *Acacia nilotica*

Gum tragacanth : *Acacia catechu, Acacia modesta, A. senegal, Anogeissus latifolia, Bauhinia retusa, Cochlospermum religiosum, Lannea coromandelica, Petrocarpus marsupium, Sterculia urens, S. villosa.*

Hard Resins :

Copal Dammar type resins are produced from *Canarium strictum, Hopea odorata, Shorea robusta, Vateria indica.* This category of resin is low in oil content and hence it is solid and hard.

Oleo resins also contain essential oils. Resins from *Pinus roxburghii* is used known as turpentine. *Boswellia serrata* also produces oleo-resin, known as 'Guggul'.

A gum resin known as Gambaga is produced by *Garcinia morella.* Other MPTS yielding gum resins are *Commiphora roxburghii, C. beryi* and *C. caudata.*

Main MPTS producing lac after the infestation of lac insect *(Laccifer lacca)* are *Butea monosperma, Schelichera oleosa* (Kusum) and *Ziziphus mauritiana* (ber). Other trees producing lac only in certain locations are *Acacia nilotica, Albizia lucida* (Moj in Assamese) and *Cajanus cajan* (tur).

Rubber is produced from the latex of *Hevea brasiliensis.* Latex of Artocarpas spp., Focis spp. and *Achras zapota* are used for commercial purposes.

Some of the important species of exotic origin for wax are *Copernicia cerifera* (Carnuba wax) from South America and *Euphorbia anthisyphilitica* (Candelilla wax) from American desert.

6. MPTS for Essential Oils

Essential oils are used in soap and cosmetics, pharmaceuticals, confectionery, aerated water, perfumes and incense. Essesntial oils are extracted from grass, wood, leaves, root and flowers.

The sources of wood oils are Sandal wood *(Santalum album),* Agar *(Aquilaria aqallocha)* and Deodar *(Cedrus deodara).* Leaves of *Eucalyptus globulus, Eucalyptus citriodora, Cinnamomum camphora* (Camphor), *Cinnamomum zeylanicum* (cinnamon) and *Pinus spp.* Flowers of *Pandanus tectorius* (Keora), *Mimusops elengi, Anthocephalus cadamba* are also used for extracting essential oils.

7. MPTS for Tans and Dyes

Tannin and dyes are economically important products of MPTS. Tannin is used in leather, ink, dyes, medicinal and petroleum industries. The principal sources of tannin in India are *Cassia auriculata* (bark), *Acacia nilotica* (bark), *Terminalia chebula* (nut) and *Cassia fistula* (bark). Other sources of tannin are *A. catechu* (wood), *A. leucophloea* (bark), *A. mollissima* (bark), *Anogeissus latifolia* (leaves),

Anacardium occidentale (leaves), *Casuarina equisetifolia* (bark), *Emblica officinalis* (twig bark), *Pithecellobium dulce* (mature bark), *Shorea robusta* (bark), *Terminalia arjuna* (bark) and *Terminalia bellerica* (nut).

Before the invention of synthetic dyes in the mid-19th century, over 2000 pigments secreted in plants were used for various purposes. However, a few natural dyes are still in use. These are extracted from *Pterocarpus santalinus* (santaline dye), *Caesalpinia sappan* (sappan), *Artocarpus heterophyllus, A. lakoocha* (Artocarpus dyes) and *Acacia catechu* (catechu dye).

Many barks yield brown and black dyes. However, they are also used for extracting tannin and hence are not available in sufficient quantity. The species yielding bark dyes are *Acacia concinna, A. farnesiana, A. leucopholea, Alnus species, Casuarina equisetifolia, Manilkara littoralis, Myrica esculenta, Terminalia tomentosa* and *Ventilago madraspatana.*

Flowers of *Bixo orellana* (Annatto), *Butea monosperma* (Dhale), *Toona ciliata* (toon) are also used to extract dyes. Leaves of Indigo *(Indigofera tinctoria)* and henna *(Lawsonia inermis)* are also used for extracting dyes.

Semecarpus anacardium (marking-nut tree), which grows in Central and South India, produces black resin from the pericarp of fruit. This regin is used for marking of clothes, varnish, paints and in plastic industries. The shell extract of the nuts is rich in phenols, useful for manufacturing varnishes, lacquers, paints and water proofing material. Trees serve as host for lac insect and nuts are used as tan.

8. MPTS for Fibre and Flosses

The species used for fibre production in cottage industries are : *Abroma augusta, Cordia dichotoma, Grewia spp., Hibiscus spp., Trema orientalis, Caryota urens* (Indian sagoplam leaves), *Careya arboria, Albizia odoratissima, Erythrina suberosa, Moringa oleifera* and *Thespesia populnea* and *Kydia calycina* (bark). Leaves of *Pandanus spp. and Agave spp.* are also used for extracting good quality fibre. Important flosses-producing tree species are *Ceiba pentandra* (Kapok), *Bombax ceiba* (Silk cotton), *Cochlospermum religiosum* (yellow silk

cotton tree), *Calotropis gigantea, Calotropis procera* and *Salix daphnoides,. Coir of Cocos nucifera* (coconut) is also a good source of raw material for cottage industries.

9. Bamboos and Canes

Out of 600 - 700 species of bamboo, about 136 species are found in India. Apart from its use as timber and raw material for pulp, bamboo is one of the chief raw material for cottage industries. Bamboo seeds and tender rhizomes are used as human food.

10. MPTS for Medicinal Uses

Different parts of the plants such as root, bark, wood leaves, flowers, fruits and seeds are used for medicinal purposes. Some of the important tree species used for medicinal purposes are listed below :

1. MPTS for Drugs from Roots -: Rauvolfia serpentina (Serpentine).

2. MPTS for drugs from bark :

   Alstonia scholaris (Devil tree), *Cassia fistula* (Lebernum), *Cinchona ledgeriana* (Quinene) and *Holarrhena antidysenterica* ('Kurichi' or Easter tree).

3. MPTS for Drugs from Wood

   The wood extracts of *E. gerardiana* and *E. intermedia* contain ephedrine, an alkolid, useful for treating bronchial diseases.

4. MPTS for Drug from leaves

   Leaves of *Atropa acuminata* (Indian bellandona or 'Sag-angur') and *A. belladonna* (Bella donna) are used as anodyne. Neem leaves *(Azadirachta indica)* used as insect repellent and antiseptic. Sun-dried leaves of *Cassia angustifolia* (Indian senna) are used as a purgative. Datura leaves *(Datura*

innoxia, and *D. stramonium* (thorn apple) are used for treating asthma. *Vatex nigundo* leaves are also used to cure many diseases.

5. MPTS for Drug from Flowers

   Flowers *Artemisia maritima, A. absinthium* and *A. nilagirica* (worm wood) are used to treat intestinal worms. Flowers of *Cannabis sativa* also have medicinal property.

6. MPTS for Drug from fruits and seeds

   Some of the important medicinal fruits are *Aegle marmelos, Cassia fistula* and *Emblica officinalis.* Seeds of *Hydnocarpus kurzii (Chaulmogra), Ricinus communis* (Castor) and *Strychnos nux-vomica* are used for drug preparation.

A detailed list of MPTS having different medicinal properties is presented in Annexure 1.

11. MPTS for Other Products

Trees also produce or support the production of many other products such as silk, honey, wax and soap substitutes. *Morus abla* (mulberry) leaves are needed for rearing silkworms. Tussar silkworm grows on trees of *Anogeissus latifolia, Bombax ceiba, Madhuca indica, Lagestroemia parviflora, Shorea robusta, Syzygium cumini, Terminalia tomentosa* and *T. arjuna,. Eri* silkworm feeds on castor leaves.

Some of the rich sources of nectar for honey are *Acacia rugata* (soap pod plant or Shikikai), *Aegal marmeos* (bel), *Bombax ceiba* (silk coton), *Ceiba pentandra* (Kapok), *Emblica officinalis* (Emblic myrabolan), *Feronia limonia* (wood apple), *Leucaena leucocephala* (Subabul), *Mangifera indica* (mango), *Derris indica* (pongamia) *Sapindus emarginatus* (Soap nut tree), *Sesbania grandiflora* (Agastha), *Syzygium cumini* (Jamun), *Eucalyptus spp., Tamarindus indica* (tamarind), *Terminalia chebula* (chebulic myrabolan) and *Ziziphus mauritiana* (ber). Fruits of *Acacia rugata* and *Sapindus emarginatus* are used as soap. Wax is collected from *Garcinia indica* seeds and bee hives.

Desospyros melanozylon (tendu) leaf collection is a significant source of employment generation in Central India. Tender dried leaves are used for bidi production. Leaves of *Butea monosperma* are also collected for making leaf plates and dishes useful for serving food. There are many other uses of MPTS but in the absence of systematic documentation, it is difficult to quantify the income and employment generated through MFP in rural areas.

STRATEGY FOR POPULARISING MINOR FOREST PRODUCE

In spite of various uses and scope for high cash returns, MPTS which are capable of producing minor forest produce have not been popular so far. However, it is possible to tap the potential of these tree species to the maximum by sorting out the following constraints :

1. **Long Gestation Period**

   Most of the MFP come from flowers, fruits and matured trees and the present metod of propagation by seeds or natural regeneration requires a long gestation period. If the gestation period of these MPTS can be reduced by introducing vgetative propagation, such plants will not only flower within a short period, but also produce true to type fruits of superior quality. Trees like neem which are presently propagated by seeds can also be established by rooted cuttings using growth hormones. Similarly, tamarind plants produced from tissue culture can start fruiting at the age of 3-5 years. Therefore, it is necessary to standardise economic methods of vegetative propagation for commercial multiplication of important tree species which can produce valuable non-wood forest produce.

2. **Technology for increasing the Yield of MFP**

   While the trees may yield a small quantity of flowers, fruits, seeds, wax and gums under natural conditions, it is possible to improve the yield by introducing various techniques. There are also reports of improving the fruit yield by using grafted or budded plants as in the case of mango and ber.

   Recently the University of Delhi has reported the feasibility of inducing edible gum by treating ethylene on Acacia trees. There are othe rexamples where

timely pruning, application of phosphorus and potash rich fertilizers have improved the flowering and fruiting. Such technologies which are already available should be utilised and further research studies need to be initiated to optimise the production of various MFP.

3. **Market for the Produce**

To motivate farmers to cultivate MPTS for minor forest produce, it is necessary to make a cost-benefit analysis of different tree species and highlight economic benefits through popular media. However, assured market and minimum support price are the important criteria on which the return and income are calculated. It is, therefore, necessary to develop an infrastructure for marketing the produce. In the absence of suitable marketing arrangements, farmers will not be able to dispose off their produce on their own. Collection, processing and storage are the important components of marketing.

Recent advances in modern medicines have brought out distinct evidence of toxic effects of several chemical drugs and safe herbal medicines, thus attracting the attention of the developed countries. MPTS produce such as henna, senna, Datura, Belladonna, Rauvolfia, oil of *Eucalyptus cotriodora* and *Eucalyptus globulus* are being exported regularly.

There are several products which can be directly utilised by local people, but appropriate information on their uses and benefits, particularly on medicinal plants, is not easily available. Thus it is necessary to educate people about the use and economic benefits of different minor forest produce. Such extension activities can certainly help in popularising MPTS cultivation and income generation without any deforestation. This is an ideal approach to protect our forest resources and environment.

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Annexure I. MPTS with Medicinal Properties

1. *Acacia catechu* (Catechu, Khair)

   The dried juice extracted from the trunk known as 'katha' is used as an constipative agent. It is also an astringent. Bark decoction with ginger extract is used as mouth wash to cure toothache.

2. *Acacia ferruginea* (Shami)

   Its bark is an astringent, useful for treating cough and asthma.

3. *Acacia nilotica* (Babul or Kikar)

   Tender leaves of this tree are used for diarrhoea and premature ejaculation. The bark decoction is used as a washing solution for quick healing while treating prolapsis of rectum among infants. Decoction of tender sprouts is used to prevent threatened abortion. Extract of the twigs of this species and *A. modesta* are used to treat dysentry, leprosy, oral wounds, trachoma, toothache and veneral diseases.

4. *Acacia pinnata*

   The stem, twig and roots are used for treating aphrodisiac and as an evacuant.

5. *Acacia species*

   Tyramine and Tryptamine extracted from these species are used as vasopressor agents for treating heart diseases.

6. *Adhatoda vasica* (Adhatoda or Malbar nut)

   The leaves of this plant can be used to treat lung diseases and act as an expectorant for expellation of phlegm. This germicidal and antiseptic agent is known for its blood purifying properties. The leaves also help to control ring worms and bleeding of nose.

7. *Aegle marmaloes* (Bael)

   Commonly known as Bel has many medicinal uses. The fruit pulp is used for cold drink, to reduce heat exhaustion and to cure chronic diarrhoea, dysentery and amoebic dysentery and the diseases of intestine and liver. The leaf has antibiotic property and the paste is used for curing sore and inflamed eyes. Leaf is also useful for treating cough, rheumatism and diabetes. The twigs are used to treat dysentry.

8. *Agave sisalana*

   This is used for extracting Hecogenin hormone.

9. *Albizia lebbeck* (Siris)

Its bark decoction is used as a mouth wash to relieve toothache. Bark is also used to treat bronchitis, leprosy, paralysis, gum inflammation. The seed snuff is helpful to treat cold. Seed powder is consumed to control spermatorrhoea and premature ejaculation.

10. *Aloe barbadensis* (Barbados alae or 'Ghikanvar')

This plant is also known as *A. vera.* The mucilaginous pith is used for treating chronic cough, asthma and lumbago. Large dose is given as purgative. Dried juice is a athartic and given in constipation. Root is given in colic.

11. *Alstonia scholaris* (Devil's tree)

The dried bark of this tree is useful to treat chronic diarrhoea, dysentry, malarial fever and skin diseases. Milky juice is applied to ulcers.

12. *Anthocephalus cadamba* (Kadamba)

Its bark is used as a febrifuge, tonic and astringent. The fruit juice is given to treat gastric irritability and thirst during fever. Decoction of the bark is used to treat fever.

13. *Atropa acuminata* (Belladonna)

It is a perenniel herb and the dried leaves and shoot tips collected at the time of flowering are used as strong antispasmodic in intestinal colic and other spasmodic indications. Leaves and roots are also useful for asthma and whooping cough. Leaf paste is useful for external applications on rheumatism, neuralgia and inflammations.

14. *Azadirachta indica* (Neem)

It is an important medicinal tree. Its bark is an astringent and antiperiodic, useful to treat fevers and skin diseases. The leaf paste is used to clean wounds. Its oil and leaves are also used as antiseptic and the root bark decoction is used to treat anthelminitic problems of children. Flower and leaf paste is applied as poultice to relieve nervous headache. Seeds are used in treating rheumatism. The twigs and leaves are used throughout Asia as antipyretic and antiseptic for treating skin diseases.

15. *Bauhinia variegata* ('Kachnar' or Mountain ebony)

The dried flower buds are useful to treat diarrhoea and piles. The flowers are mixed with sugar to act as laxative. The bark decoction is used to treat ulcers and skin diseases. The bark of other species *B. perpurea* is an astringent and the root is a carminative. Seed of *B. tomentosa* is aphrodisiac.

16. *Bixa arellana* (Annatto)

The fruits are astringent and purgative. Root-bark is antiperiodic, febrifage, antipyretic and a good

remedy for gonorrhoea. Leaves are used in jaundice and snake-bite.

17. *Bombax ceiba* (Silk cotton)

The dried root powder is aphrodisiac and the bark is used to treat abcesses. Its gum has haemostatic property and is also used to promote sexual drive and performance.

18. *Boswellia serrata* (Salai)

The gum is used for disphoretic, diuretic astringent, emmenagogue, in rheumatism, nerve and skin diseases.

19. *Butea monosperma* (Palas, Dhak or Flame of the Forest)

The leaves are used to treat boils, pimples, tumors and haemorrhoids. A diluted bark decoction is useful to treat catarrh and cough. Its leaves, shoot, gum and bark are useful to treat spermatorrhoea, premature ejaculation and leucorrhoea. The flowers reduce the inflammation. The flower and leaves are used as aphrodisiac. The flower paste is applied for orchitis (swelling of testicles). The seeds are used for treating fever, malaria, round worms and tape worms. The tapping of tree trunk yields a red colour gum known as Kino, containing kinotannic acid. It is an astringent, useful for treating diarrhoea.

20. *Caesalpinia crista* (Fever nut, Molucca bean or 'Karanjum')

The leaves are used for treating malarial fever. The kernel is antiperiodic, antipyretic, febrifuge and helpful to purify blood, clean intestinal parasites and the seeds roasted in shell are used to cure asthma, flatulence and scabies.

21. *Caesalpinia gilliesii* (Bird of Paradise)

A shrub grown as an ornamental, contains 'cesalin'. *C. nuga* leaf powder is used as an uterine tonic following child birth. Its roots are used for treating calculi in the bladder.

22. *Calophyllum inophyllum* (Indian laurel or 'Surpan')

Its bark, seeds, oil and leaves are used as medicine. Oil is used for rheumatism. Gum exuding from its wounded bark is used for treating wounds and ulcers.

23. *Calotropis gigantea* (Madar - purple flowers) and *C. procera* (Akund - flowers)

The root bark is used for skin disease and flowers are used to treat cough, asthma and loss of appetite. The other parts of this plant also have medicinal properties.

24. *Carica papaya* (Papaya)

Papain is used as a meat tenderiser. Pepsin which is present in the ripe and unripe fruits helps in

digestion and is also used to cure inflammation of liver and spleen. The sap is used to control ring worms and intestinal parasites, including amoeba.

25. *Careya arborea*

Bark and fruit are astringent. Juice of bark is demulcent.

26. *Cassia fistula* (Amaltas)

The pulp of the pods is a laxative, but generally administered with senna. The flowers can be used as laxative and for cough relief. It is also a suitable remedy for diptheria. Root is useful to treat fever and heart diseases.

27. *Cassia species*

Cassia absus ('chaksu') and *C. sophera*('Kasaundi') bark and seed extracts are used as anthelminitics. Roots of *C. alata* ('Dadmurdan'), bark of *C. javanica* (Jawa cassia), dried leaves of *C. angustifolia* (Indian senna), leaflets of *C. marilandica* are used as purgative. Leaves of *C.sophora* and *C. reticulata* and *C. tora* are used to treat skin diseases.

28. *Cedrus deodara* (Devdar)

The oleo-resin collected from the wood is applied to ulcers and skin diseases. The wood is a carminative, while the bark is used to treat fever, diarrhoea and dysentry.

29. *Cinchona species*

C. calisaya (grown in Nilgiris and Sikkim), *C. ledgeriana* (most popular species in Bengal, Assam and South India) and *C. officinalis* (Nilgiri) are found in India. Its bark yields quinine and other effective drugs, useful to treat malarial fevers, bacterial infections, pneumonia, amoebic dysentery, eye infection and rheumatic pains. Quinine is not administered to pregnant women and people with heart ailments.

30. *Cinnamomum tamala* (Tamal or 'Tejpat')

Its bark, leaves and oil are used in medicine. Oil is also used for toothache.

31. *Citrus aurantifolia* (Lime)

The stem is used to treat dysentry, fever, headache, opthalmia, oral infections, vermifuge and vomiting. The decoction of leaf is used for candida mouth infection.

32. *Dalbergia latifolia* (Rosewood)

The sapwood gum is used for treating wounds.

33. *Dalbergia sissoo* (Shishum)

The wood extract is used for blood purification, control of scabies, ring worm and leucoderma. The leaf paste is used to cure saddle sore and snake bites.

34. *Dalbergia stipulacea*

Bark and roots are used for promoting menstruation and to induce abortion.

35. *Datura metel* (Datur)

The leaves are used in asthma and whooping cough. The seeds are used as an astringent for digestive disorders and skin diseases. Fresh juice from leaves is applied externally in rheumatic pains and inflammation caused from mumps. Datura smoke released while burning fresh leaves gives relief during mumps. This plant is the source of 'scopolamine', used for dilating the eyes.

36. *Derris indica* (Pongamia)

The twigs are used for treating skin diseases in Sri Lanka.

37. *Emblica officinalis* (Amla)

The fruits, rich in vitamin C, are a liver tonic useful to control hair fall and premature graying. It is also used as a cure for several physical and mental disorders. The dried fruits help in healing bone fractures and treating acidity, cough and haemorrhage. The leaf extract is used as a cure for burning eyes.

38. *Eucalyptus macrorhyncha*

It contains a bioflavonoid called 'Rutin', having medicinal properties. Seeds cure asthma and stomach disorders.

39. *Eupatorium truokuberve* (Joe-pye weed or Ayapana)

Leaves have hypoglycemic activities and also used as cordial stimulant and tonic.

40. *Euphorbia neerifolia* (Milk hedge, Thohar)

The milky sap is a purgative and also helpful to treat syphilis, rheumatism, leprosy and chronic cough.

41. *Feronia limonia* (Wood apple, kawat)

The unripe fruit is used to treat dysentry. A medicated oil is prepared for body massage by using the flowers, roots, leaves, bark and fruit of this tree.

42. *Ferula assafoetida* (Asafoetida, Hing)

The resin of this plant is used to treat flatulence and in formulation of digestive powder. It is a stimulant for respiratory and nervous system. It is also an antidote for opium toxicity (1 : 1 ratio).

43. *Ficus benghalensis* (Banyan Tree)

The leaf sap is used for treating cracking of heels in winter (kibes), bruises and for treating rheumatism. Tender aerial roots are ground in water and administered for preventing vomiting. The extract of different parts of this plant are also used for curing spermatorrhoea, premature ejaculation and diabetes.

44. *Ficus carica* (Fig)

The fruit serves as a laxative and expectorant. It is used to cure inflammation of the spleen and hastens the appearance of rash in case of chicken pox and small pox.

45. *Ficus glabrata* and *Ficus laurifolia* (Fig)

The latex contains a proteolytic enzyme called Ficin which digests living Ascaris and Trichuris worms while non-toxic to human beings.

46. *Ficus glomerata* (Cluster fig., Gular)

The bark, leaves and unripe fruits are used during dysentry. Powder of the seed mixed with honey is prescribed for controlling diabetes. Bark is used to treat ulcers. The root sap is applied to inflammatory glandular enlargements.

47. *Ficus religiosa* (Peepal)

The water after soaking the tender bark for 12 - 18 hours is used as a diuretic. Dried berries are powdered and consumed to cure spermatorrhoea, nocturnal emission, premature ejaculation and leukorrhea. The seeds are laxative and refrigerant. Its leaves and young shoots are used for treating skin diseases. The milky latex is applied to cracked feet. The decoction of its bark with five varieties of figs and neem root is used for washing ulcers.

48. *Garcinia morella* (Indian Comboge tree)

Seeds contain morellin and guttiferin and are used against Gram positive and negative bacteria.

49. *Gmelina arboria* (Melina, 'Gambhar')

The leaf decoction is useful for blood purification and deworming.

50. *Haematoxylon campechianum* (Logwood or 'Patang')

The leaf paste is applied to treat bloody piles, gonorrhea and to reduce the burning sensation in the body.

51. *Holoptelea integrifolia* ('Papri' or 'Kanju')

The tissues of this species have the capacity to increase the rate of fat catabolism.

52. *Lagerstroemia speciosa* (Queen crape - myrtle or 'Jarul')

The leaves have antiglycemic properties.

53. *Lawsonia intermis* (Henna)

The leaves are used as a prophylactic against skin diseases. The paste of leaves is used for headache and burning sensation in feet.

54. *Madhuca indica* (Mahua)

Flower paste with strychos beans is used as an antidote for snake bite. The boiled leaves are used to relieve orchitis pains. Decoction of the bark is applied to cure itch, bleeding gums and ulcers.

55. *Madhuca latifolia* (Madhuka or Mowra)

The leaf juice extracted from boiling water is used as a stimulant. The flower decoction is used for treating cough and chronic bronchitis.

56. *Mallotus philippensis* (Kamela)

The red glandular and hairy substances from the fruits are useful in destroying tapeworms, skin diseases like ring worm and scabies.

57. *Mangifera indica* (Mango)

Mango fruit is rich in vitamin A and C. The unripe fruits are eaten for prevention of heatstroke and protection from scorching winds. The kernel has medicinal value and is used to treat diarrhoea, excessive bleeding during menstruation and piles. The flowers can be used to treat leukorrhea. Fruit juice is an astringent tonic for mucus membranes and for treating diphteria and other throat disorders. Leaf decoction with honey is used to treat the loss of voice power. Tender leaves are used to treat diabetes. Leaves and twigs are used as an astringent to treat bronchitis, catarrh, internal haemorrhage and toothache. The bark decoction is used as a mouth wash to cure tooth ache. Gum is applied on cracked feet.

58. *Melia azedarach* (Persian Lilac or 'Bakan')

The leaves are used for blood purification, scabies, ring worm, leprosy, leucoderma and to reduce inflammation. The leaf extract is also used to treat cataract.

59. *Michelia champalca* (Champac)

The bark decoction is used to treat mild cases of gastritis and the root is a purgative.

60. *Mimusops elengi* (Spanish cherry, 'Maulsari')

Its fruit and bark are astringent. Seeds are purgative. Fruits and flowers are used to prepare a lotion to cure wounds and ulcers.

61. *Moringa oleifera* (Drumstick)

Its roots contain 'Pterigospermin', which is effective against Gram positive and negative bacteria.

62. *Nerium indicum* (Oleander, 'Kaner')

The root and root bark are diuretic and cardiac tonic. The bark and root pastes are used to treat skin disorders. Bark is also used for blood purification.

63. *Nyctanthes abror-tristis* ('Parijat' or Tree of sorrow)

The leaf extract (one tea spoon with honey and salt) is consumed for controlling malaria, instestinal parasites and to control rheumatism. It is recommended to consume 6 - 7 tender leaves ground with fresh ginger and water, thrice a day for control of recurring fever. Fresh leaf juice is a mild and safe purgative for infants.

64. *Ocimum sanctum* ('Tulsi' or Holy basil)

The leaves are used for digestion, controlling cold, cough and fever.

65. *Onosma echioides* (Ratanjot)

It is a herb from sub-tropical to temperate region. The leaves of this shrub are diuretic, blood purifier and help to dissolve calculi in the gall-bladder and kidney. Leaf paste is mixed in oil to treat skin boils.

66. *Pinus roxburghii* (Pine)

Oil of turpentine is obtained from the resin, which is a stimulant and useful to treat chronic bronchitis. Oil is used as a linoment in rheumatic pains.

67. *Populus alba* (White poplar) and *Populus nigra* (Black poplar)

These species also contain salicin and are used for treating rheumatism or as an analgesic. The bark of *P. candidens* and *P. trichocerpa* have antifungal properties.

68. *Prosopis juliflora*

The leaf extract is used to treat conjuctive eyes. Diluted bark decoction is used to cure sore throat.

69. *Pterocarpus indica* and *P. marsupium*

Kino juice, obtained by tapping the trunk, is useful to treat diarrhoea. The gum is useful to treat fever and urinary discharges.

70. *Punica granatum* (Pomegranate)

Many parts of the tree such as leaf, flower, fruit rind and root have medicinal properties. The unripe fruit is used in the preparation of digestive powder. The flowers are used as an ingredient to cure miscarriages. Rind acts as an astringent and has a tonic effect on body tissues. The root-bark is used to cure intestinal worms. The bark decoction is consumed 3-4 times a day to control blood dysentry and intestinal parasites. The flower juice mixed with the juice of *Cynodon dactylon* is administered to stop bleeding from the nose.

71. *Rauvolfia serpentina* ('Sarpagandha' or Serpentine root)

It is a well known shrub and the dried root with bark is useful for treating insanity, heart ailments and blood pressure. Fresh leaves induce sleep and relieve anxiety.

72. *Ricinus communis* (Castor)

The oil is used as a purgative and antidote against poisons like opium, aconite and snake bites. The dry leaf is smoked to provide relief from hiccups.

73. *Salix alba* (Weeping willow)

The extract contains salicin, which is used as pain reliever.

74. *Salvodera persica* ('Chota pilu') and *S. oleoides*('Pilu')

The twigs are used as a diuratic and to treat gastritis, hook worm and veneral diseases.

75. *Santalum album* (Sandal wood)

Sandalwood paste is applied externally to treat inflammation. Oil is used to treat gonorrhoea, dysuria and cough.

76. *Sapindus emarginatus* (Soapnut, 'Reetha')

Fruit rind is an antidote for snake bite and also useful to treat hemicrania, haemorrhoids and sexual disorders.

77. *Saraca indica* (Ashoka)

Bark is a strong astringent and uterine sedative, useful to control excessive menstruation. Powdered flower is used to treat haemorrhagic dysentry. Seeds are useful for treating urinary discharges.

78. *Simarouba amara*

The bark is used as an amoebicide.

79. *Spondias pinnata* (Hog plum)

The leaves and bark are astringent and used during dysentry. The leaf juice is applied to treat ear ache. The decoction is used to treat gonorrhoea.

80. *Sterculia urens* (Karaya)

The gum is used as a mechanical laxative. It is also used to cure throat infection.

81. *Syzygium cumini* (Jambalum, 'Jambhul')

The powdered seed is used for treating diabetes. The bark is an astringent and its decoction is used to treat ulcers, dysentry, bleeding gums, sore throat, bronchitis and asthma. Bark, fruit and seeds also purify blood.

82. *Tabebuia species*

The tissues contain 'lapachol', useful for manufacturing chemotherapetic drugs for cancer.

83. *Tamarindus indica* (Tamarind)

The fruit is used for treating hyperacidity, nausea and thirst. The leaves and seeds are astringent. Fruits of 1-2 years old are good for treating atony of liver, stomach and intestines. Flower juice is administered for curing bleeding piles. Twigs are used for treating dysentry, evacuant fever, leprosy, opthalmia, oral infections, wounds and respiratory ailments.

84. *Tamarix dioica* (Farash or Tamarish)

The fruits are used to treat the swelling of spleen and haemorrhoids.

85. *Tamarix troupii* (Than, Magaphal)

The leaves are used in treating enlarged spleen and fruits are used to stop bleeding.

86. *Tecoma species*

It contains lapachol, useful for manufacturing drug for cancer. *Tecoma stans* (yellow bells) is a hypoglycemic agent and hence used for treating diabetes in Mexico.

87. *Terminalia arjuna* (Arjun)

The bark of the plant is used to treat cough, cold, heart diseases and for healing bone fracture. The bark powder acts as an aphrodisiac when taken with milk regularly.

88. *Terminalia bellerica* (Belleric myrobalan or Behera)

The fruits are used for stomach disorders, cough and asthma. A fine powder of the fruit is used to treat epiphora (watering of eyes). The bark decoction is used for treating skin diseases like leprosy. The bark powder is taken daily for curing digestive problems and heart diseases. Semi-ripe fruit is a purgative but ripe and dried fruit has the opposite property.

89. *Terminalia chebula* (Chebulic myrobalan or Harad)

This fruit is a part of 'Trifala'; prevents hair from turning gray and also helps in digestion and curing piles, urinary disorders. There are different varieties of 'harad' found in India and a variety with round shape fruits known as 'Vijay' is most useful for controlling acidity and rheumatism.

90. *Vitex negundo* (Chinese chaste tree or 'Nirgudi')

The leaves are considered tonic and applied to rheumatic swelling of joints.

91. *Vitex trifoliata* ('Pinki sanbhalu')

The leaves are heated and applied to rheumatic pain, swelling and sprains.

92. *Withania somnifera* (Winter cherry)

This is a shrub, known as 'Astghandh'. Its leaves act as a relief for inflammation. The dried root powder acts as an aphrodisiac for treatment of rheumatism, lumbago and infertility in women.

the hottest months are March to May. The mean relative humidity is about 80% in the mornings, but during the course of the day, the air dries up, particularly in summer.

Susala is thinly populated with about 20 families belonging to Mahadeo, Koli and Gavli Dhangar tribes. Their main occupation is agriculture, predominantly by shifting cultivation. Many of them have cattle, but the milk production is very low.

The vegetation is generally a combination of moist deciduous and semi-evergreen forests. Luxuriant dense vegetation can only be located in remote, unapproachable areas and in deep ravines. The plateaus and spurs of the area are covered with trees of medium height (8.0 to 10 m), with an open canopy and considerable undergrowth. The major tree species of this locality include *Syzygium cumini, Meyna latiflora, Terminalia bellerica, T. chebula, Bridelila swuamosa, Bombax ceiba, Memecylon umbellatum, Kydia calycina* and *Acacia chundra.* Semi-evergreen forests are mostly situated in deep ravines and along the stream beds. Most of the original vegetation includes trees of lofty height and dense canopy.

The extensive undergrowth consists of *Leea spp., Carissa congesta* and *Pavetta indica.* Some prominent climbers and ramblers are *Carissa* sp., *Jasminium malabaricum* and *Dalbergia symnpathetica.* In the open lands, which occupy vast areas, grasses and scrubs are dominant. *Themada quadrivalvis* and *Heteropogon contortus* are among the most common grasses associated with species of *Smithia crotalaria* and *Blumea.* Among the scrub species are *Lasiosiphon eriocephalus, Randia spinosa* and *Zizphhus* sp. Pure stands of *Carvia callosa* are a characteristic feature along steep slopes at higher elevations. Floristic studies of the island have been made during periodic visits in 1989-91. Standard reference work like Cooke (1901-1908), Talbot (1909) and Santapau (1967) have been consulted. Besides the composition of the vegetation, the density and frequency of occurrance of individual species, their local use, if any, by the tribal population were noted.

Ephemerals, grasses, hedges and non-flowering plant species, and vegetation in deep ravines and inaccessible areas remain to be explored. About 530 species, belonging to 358 genera from 110 plant families, have so far been enumerated. We presume that this represents about 70 % of the total number of species indigenously grown in Susala.

PLANTS OF POTENTIAL ECONOMIC IMPORTANCE

Wild Edible Plants

Our surveys show that the local inhabitants depend on several wild plant species as sources of supplementary or subsistence food. They resort to gathering naturally occurring edible plants and materials. Young leaves of some plants like *Smithia* spp., fruits of *Myna laxiflora, Ficus restusa* and *Bombax ceiba,* underground tubers or rhizomes like *Ceropegia lawii* are eaten. In the enumeration of arboreal species , 30 of them have been recorded to have nutritive value. Within the local population of these plants, wide variations were observed both in quality and quantity of the food material. For example, at least three varieties of Karavand (*Carissa congesta*) - black purple rind, white pulp and round shaped fruits, green rind, pink pulp and round fruits have been observed.

The wild mango and jamun trees also show variation in size, pulpiness and sweetness of fruits. Efforts are on to record the available germplasm in the locality. It is possible to identify and select higher potential plants for propagation in the area. Propagation of promising species would create an infrastructure, not only for alternate food sources, but also for avenues of income generation through food processing and marketing.

Fodder Plants

Besides grasses and herbs in the grass lands, there are several arboreal species which provide nutritive fodder for cattle. *Albizia lebbeck, Bombax ceiba, Cassia fistula, Ficus* spp., *Garuga pinnata, Hymenodictyon excelsum, Terminalia crenulata* and *Trema orientalis* are examples of those yielding fodder in the form of leaves and young fruits. In many cases, such trees have other uses for humans like providing shade, fibre, food, fuel or medicine. Cultivation of such multipurpose fodder species can provide green fodder to domestic animals during dry season when pasture availability is low. Growing of trees to provide animal feed, especially in dry regions, is a form of integration between farming and forestry (Evans, 1982 in bibliography).

Source of Bee Forage

There are four honeybee species in Susala : the hive bee, rock bee, little bee and dammar bee. The bees obtain nectar and pollen from a variety of arboreal species, besides herbs and shrubs. *Bombax insigne, Syzygium cumini, Terminalia chebula, T. bellerica, T. crenulata, Dillenia pentagyna, Bombax ceiba and Randia spinosa* flower in sequence from December to May and constitute important sources of bee forage. *Syzygium cumini* and *Terminalia chebula* contribute to honey production. Beekeeping can be taken up profitably in the locality, provided all these forage sources are conserved and propagated.

Medicinal Plants

For ordinary ailments affecting them and domestic animals, the tribal population relies often on folk medicine prepared from locally available wild plants. Many indigenous plant species, well known in Ayurved and Yunani medicines occur commonly in Susala. *Helicteris isora, Holarrhena antidysenterica, Terminalia bellerica, T. chebula* and *Woodfordia fruticosa* are a few examples of common medicinal plants in Susala. An inventory of all such potential species of economic importance in human or veterinary medicine has to be prepared.

Rare and Endangered Species

The indigenous germplasm contain plant species with potential economic importance, and also desirable genes in wild relatives of cultivated crops for incorporation into the latter for their genetic improvement. Due to indiscriminate exploitation of forests, for coal making, timber or other produce, many important plant species have become rare.

It is necessary to preserve the existing germplasm and encourage rehabilitation of the endangered species so that their natural status in the native vegetation can be restored. The Red Book of Indian Plants by the Botanical survey of India (Nayar and Sastry, 1987), and studies by earlier workers (Vartak, 1957,1959,1983) can be used to establish guidelines for identification, conservation and propagation of endangered species.

SUSALA GENE BANK - ITS RELEVANCE

To identify and conserve valuable germplasm, pure seed or seedling material of the best available quality will be collected from Susala and other floristic regions of Western Ghats. The seedling material will represent fast-growing fuel, fodder, food and medicinal plants. Initially, only important arboreal species including climbers and large shrubs will be considered for germplasm collection. Very little is known about the seed viability, germination, growth requirements and ecological preferences of indigenous tree species. The silvicultural work of the departments of forests for afforestation and social forestry programmes has been restricted to a few common plant species and to well known exotics like eucalyptus, Australian acacia, Gliricidia and Leucaena.

The proposed Gene Bank will strive to generate this information for indigenous species of existing or potential economic importance. The Four Eyes Foundation, Pune, which is participating in the Natural Biosphere Conservation Movement by taking up preservation of plant genetic stock in the Western Ghats, has proposed to create a bank of certified seed material of unconventional arboreal plant species.

Annexure I. Enumeration of Indigenous Arboreal Plant Species in Susala, Mulshi Reservoir, Pune

The enumeration has the following sequence for each plant species :

Botanical name, Family,Local/Common name, Occurrence in Susala, and Common economic usage.

Frequency of occurrence is described as abundant, very common, fairly common, occasional and rare.

Acacia chundra (Rottl.) Wild Mimosaceae. (Sonkhair) Fairly common. Timber for agricultural implements and manufacture of Katha. Tannin from bark and wood. Forage for bees.

Adina cordifolia (Roxb.) Hk. ex Brandis Rubiaceae. (Huladu) occasional. Wood for carving and furniture. Forage for honey bees.

Agalia lawii (wt.)Saldanha Meliaceas. (Burumb) occasional. Seed potential source of oil; bark used in medicine.

Albizia lebbeck (L.) Bth . Mimosaceae. (Shirish) very common. Leaves and twigs are used as fodder. Fallen leaves make good manure, dried stems used for fuel. Forage for bees, root, bark, leaves, flowers and seeds used in medicine.

Alstonia scholaris (L.) R.Br. Apocynaceae. (Sativin) Rare. Bark known as 'Data bark' used in medicine. Root, leaves and milky juice are also medicinal. Trees ornamental due to evergreen canopy.

Anogeissus latifolia Bedd. Combretaceae. (Dhabada) occasional. Gum, locally known as "Dhavla dink" used in medicine. Forage for honey bees.

Anlantia racemosa W. & A. Rutaceae. (Makad limbu) Common. Fruit oil used in medicine. Fruits used in fermentation process of "Amadi". Honey bees get pollen and nectar from flowers.

Bauhinia malabarica Roxb. Caesalpiniaceae. (Amti) occasional. Leaves are used for food; bark used for training. Forage for honey bees.

Bauhinia racemosa Lamk. Caesalpiniaceae. (Apta) Common. Flower buds and fruits are edible. Leaves used locally for cigar (Bidi). Forage for honey bees.

Bombax ceiba L. Bombacaceae. (Kate savar) Common. Flowers, fleshy calyx and young fruits are edible. Gum used as adhesive and as medicine. Very good source of bee forage. Wood used for plywood making and for manufacturing of matches.

Bombax insigne Wall. Bombacaceae. (Pandhri savar) Rare. Flowers and young fruits are edible. Gum used as adhesive and in medicine. Flowers provide a source of forage to honey bees.

Bambusa arundinacea Willd. Bombusaceae. (Kate kalak) Very common. Seeds and young vegetative buds used as scarcity food. Root, bark, shoots, leafbuds are medicinal. The secretion (Vanshalochana) from the nodes is also highly valued in medicine.

Bridelia squamosa Ghrm. Euphorbiaceae. (Asana) Common. Bark used for training. Fruits edible. Leaves used as fodder, Forage for honey bees.

Butea monosperma (Lamk) Taub. Fabaceae. (Palas) Common. Flowers yield of orange red dye used for colouring cloth. Leaves for preparing dishes and bowls. Seeds and gum used in medicine. Forage for honey bees.

Canthium dicoccum Merr. Rubiaceae. (Shambra) Common. Forage for honey bees. Wood used for engraving and combs.

Careya arborea Roxb. Lecythidaceae. (Khumbha) Common. Bark fibre used as cordage and sacking. Leaves are used for making bidis. Seeds edible. Wood used for tool handles. Fruits used as fodder. Heavy feeding is harmful to cattle. Forage for honey bees.

Caryota urens L. Arecaceae. (Bherli mad) Common. Fibre known as Kittul fibre, obtained from leaf sheaths. Sap obtained by tapping inflorescence used as "Nira" and for sugar. Oozing sap foraged by honey bees. Pith used in manufacture of sago.

Cassia fistula L. Caesalpiniaceae. (Bhava) Common. Fruit pulp used as milk laxative. Flowers edible. Forage for honey bees. Trees ornamental.

Celtis cinnomoea Lindl. Ulmaceae. Occasional. Wood powder used in medicine. Forage for honey bees.

Cordia dichotoma Forst. f. Boraginaceae. (Bhokar) Common. Source of fibre. Bark, leaves and fruits medicinal. Fruits are edible, bark is a rich source of tannins. Flowers are a food source of bee forage.

Cinnamomum zeylanicum Bl. Lauraceae. (Tamalpatra) Very rare. Bark used as spice or condiment and in medicine. Dried leaves used as spice. Forage for honey bee.

Dalbergia sissoo Roxb Fabaceae. (Shisav) Common. Leaves used as fodder. Dried stems used as fuel. Very good source of bee forage.

Dillenia pentagyna Roxb. Dilleniaceae. (karambal) Common. Fruits are edible. Leaves used as sand paper. Flowers are a good source of bee forage.

Diospros cordifolia Roxb. Ebenaceae. (Govindu) Occasional. Leaves are for stupifying fish; forage for honey bees; wood used for carving and for manufacturing matches.

Dolichandrone falcata Seem. Bignoniaceae. (Meshing) Occasional. Leaves medicinal and are good for green manure; flowers foraged by bees.

Emblica officinalis Gaertn. Euphorbiaceae. (Avla) Common. Fruits medicinal and highly valued in Ayurved. Good source of Vitamin C. Bark and leaves are used for tanning. Good source of bee forage.

Eriolaena guinguelocularis Wt. Sterculiaceae. (Bothi, Kukar) common on plateau. Root medicinal.

Erythrina indica Lamk. Fabaceae. (Pangara) Common. Root, bark, leaves and flowers medicinal. Seeds are used for preparing ornaments. Wood used as fuel. Fast growing tree used as support or shade tree in plantations. An attractive ornamental in flowers. Good source of bee forage.

Erythrina stricta Roxb. Fabaceae. (Pangara) Occasional. Small pieces of woods are used for floating for fish collection, and for making match sticks. Forage for bees.

Fogara budrunga Roxb. Rutaceae. (Chirphal) Common. Fruits used as spice and in medicine. Seeds aromatic.

Ficus religiosa L. Moraceae. (Pimpal) Cultivated. A good shade tree. Fodder for animals. Root, bark, leaves and fruits medicinal.

Ficus retusa L. Moraceae. (Nandruk) Common. Root, bark, leaves, latex and fruits medicinal. Leaves and fruit eaten by animals and birds

Firmiana colorata R.Br. Sterculiaceae. Occasional. Cordage from bark is used for bullock festival (Pola). Leaves used as fodder. Ornamental when in flower.

Flacourtia latifolia Cooke. Flacourtiaceae. (Tambet) Common. Dried branches used as fuel, fruits edible; a good source of bee forage.

Garcinia indica (Du petti-Thou.) Choiss. Clusiaceae. (Kokam) Rare. Leaves used as fodder, bark leaves, fruits and seed used in medicine. Fruits are edible and used as condiment. Kokam butter obtained from seeds is edible and is also used in soap and candle manufacture; a good source of bee forage.

Garuga pinnata Roxb. Burseraceae. (Kakad) Common. Leaves used as fodder, leaf-falls are used for tanning; fruits and leaves are used in medicine.

Glochidion hohenackeri Bedd. Euphorbiaceae. (Bhoma) Very common. Dried stems used as fuel; source of bee forage.

Gmelina arborea Roxb. Verbenaceae. (Shivan) Common. Fruits are edible; wood used for musical instruments and for agricultural implements; source of bee forage.

Grewia tiliaefolia Vahl. Tiliaceae. (Dhaman) Common. Fruits are edible; leaves used as fodder; bark used in medicine; wood used for making agricultural implements; good source of bee forage.

Heterophragma guadriloculare F.Schum. Bignoniaceae. (Waras) Occasional. Root medicinal. Timber used in carpentry, rough work.

Holarrhena antidysenterica (Roth.) Wall. ex. A.Dc. Apocynaceae. (Kuda) Very common. Leaves, bark and seeds are used in medicine. Tree is ornamental.

Holigaarna grahamii (Wt.) f. Anacardiaceae. (Bibu) Rare. Resin from stem used as black varnish; forage for honey bee.

Holoptelia integrifolia Planch. Ulmaceae. (Vavla) Common. Timber used for furniture and for paper pulp; seeds edible, bark used for fish stupifying.

Hymenodictyon obovatum Wall. Rubiaceae. (Sherod, Kadvai) common. Inner bark used in medicine. Forage for honey bees. Wood used for match splints.

Kydia calycina Roxb. Malvaceae. (Warang) Common. Bark fibre used for cordage and ropes. Mucilaginous substance obtained from stem is used for clarifying sugar. Leaves used as fodder, and in medicines; wood is soft and used in matches and pencil making. Good source of bee forage.

Lagerstroemia lanceolata Wall. ex Wt. & Arn. Lythraceae. (Nana) Common. Leaves used in medicine. Wood used for commercial plywood. A very good source of bee forage.

Lagerstroemia parviflora Roxb. Lythraceae. (Bondara) Common. Wood used for rafters; leaves and stem bark are good sources of tannins. Bee forage obtained from flowers.

Lannea coromandelica (houtt.) Merr. Anacardiaceae, (Moya, Shimti) Common. Wood for agricultural impliments, young leaves are edible. Wood pulp for paper and board making. Gum used in confectionery and calico printing. Source of bee forage .

Macarnga peltata (Roxb.) Muell.Arg. Euphorbiacea. (Chanda) Common. Fruits are edible; gum used in medicine, leaves are used for dish making.

Mallotus phillppensis (Lamk.) Muell. Arg. Euphorbiaceae. (Shendri, Kukum) Common. A good source of bee forage; timber used for agricultural implements; fruits medicinal; seed oil in paints and varnishes; seed cake used as manure.

Mangifera indica L. Anacardiaceae. (Amba) Common. Fruits are edible. Root, leaves, flowers, fruits and seed medicinal, source of bee forage.

Memecylon umbellatum Burm.f. Melastomaceae. (Anjan) Common. Fruits edible; Roots and leaves used in medicine, leaves and flowers yield dye; timber used for agricultural implements.

Melia composita Willd. Meliaceae. (limbara, Kadu Kajur) Rare. Fast growing species with potential use as fuel; Leaves and fruits medicinal, source of bee forage.

Myna laxiflora Robyns Rubiaceae. (Alu) Abundant. Fruits are edible and constitute a major sources of food during the beginning of rains; leaves are also edible; a good source of bee forage.

Mitragyna paryifolia (ROXB.) Korth. Rubiaceae. (kadamb) Rare. Bark fibre is used for cordage. Ornamental tree when in flower; a good source of bee forage; wood used as furniture, agricultural implements.

Moringa oleifera Lamk. Moringaceae. (Shevga) Cultivated. Leaves and fruits used as vegetable; roots, leaves, stem yield gum used in confectionery and as adhesive, a very good source of bee forage.

Murraya panicultata (L.) Jack. Rutaceae, (Kunti Pandhari) Occasional. Fruits are edible; ornamental tree; a good source of bee forage.

Olea dioica Roxb. Oleaceae. (Parjamb) Common. Leaves as green manure, bark medicinal, good source of bee forage.

Oroxylum indicum (L.) Vent. Bignoniaceae. (Tetu) Occasional. Root bark is valued in Ayurvedic medicine; leaves and fruits used as vegetable; bark and fruits are used in dyeing and tanning.

Pongamia pinnata (L.) Pierra Fabaceae. (karanj) very common. Seed oil used for soap making, in varnishes and paints; leaves used as manure; root, bark, leaves, flowers, fruits and seeds used in medicine; a very good source of bee forage.

Pterocarpus marsupium Roxb. Fabaceae. (Bibla, Bija) Rare. Leaves, flowers and gum are medicinal; flowers and seeds are edible; valuable timber; a good source of bee forage.

Randia spinosa (Thunb.) Poir. Rubiaceae. (Gela) very common. Unripe fruit and roots used for fish stupifying and as insecticide. Bark and fruit medicinal; a very good source of bee forage.

Sapium insigne Benth.Var. malbaricum (Wt.)Hk.f. Euphorbiaceae. (Khirkind) Very common. Milky juice poisonous and medicinal; wood as timber; for floats; drums, latex used for fish stupifying; a potential source of hydrocarbons.

Schliechera oleosa (Lour.) oken. Sapindacceae. (Kosamb) Occasional. Leaves used for thatching; seed oil used as illuminant, lubricant for soap making and in perfumery; oil cake makes good manure, fruits are edible; raw fruits are pickled; wood is good fuel; bark, fruit and seed medicinal; a good source of bee forage.

Sterculia guttata Roxb. Sterculiaceae. (Goldar) Common. Roasted seeds are edible; bark fibre used for cordage and rough fabrics.

Stereospermum personatum (hassk.) chatt. Bignoniaceae. (Padal) Rare. Roots, flowers and fruits medicinal; leaves used as fodder; wood is used for fancy work, plywood.

Streblus asper Lour. Ulmaceae. (Kharoti) occasional. Fruits are edible; leaves are used for polishing, roots medicinal, wood an excellent fuel.

Syzygium cumini (L.) Skeels. Myrtaceae. (Jambul) Abundant. Bark, sprouts, fruits and seeds used as fodder; bark used in dyeing and tanning; an excellent source of bee forage.

Terminalia bellerica (Gaertn.) Roxb. Combretaceae. (Bheda) Common. Fruits are used for dyeing, tannins, bark and seed also medicinal; seed kernels yield oil used in soap making.

Terminalia chebula Roxb. Combretaceae. (Hirda) Very common. Bark and fruits used in medicine. Fruits are rich source of tannin; a very useful source of bee forage, a potential source of income generation.

Terminalia crenulata Roth. Combretaceae. (Ain) common. Wood is hard; branches and leaves lopped for use to improve soil nutrients; a good source of bee forage.

Trema orientalis (L.) Br. Ulmaceae. (Ghol) Occasional. Fruits edible; bark fibers used for rope making, cordage; bark yields tannin; leaves used as fodder.

Vitex negundo L. Verbenaceae. (Nirgudi) Very common, cultivated. Leaves used as insect repellant; root and leaves medicinal; a good source of bee forage.

Wrightia tinctoria R. Br. Apocynaceae. (kalakude) Occasional Flowers and fruits are source of blue dye; wood used for carving; bark and seeds used in medicine.

Xantolis tomentosa (Roxb.) Raf. Sapotaceae. (Katekombhal) Fruits are edible, wood used as fuel.

Zizyphus rugosa Lamk, Rhamnaceae. (Toran) Very common. Fruits are edible; a very good source of bee forage.

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NON-WOOD FOREST RESOURCE UTILISATION IN WESTERN GHATS OF MAHARASHTRA - AN ETHNOBOTANICAL APPROACH

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ABSTRACT

Ethnobotany, dealing with the role of plants in life and culture of aborigines, plays a key role in documenting traditional relationship between tribals and surrounding forests. This paper describes enthnobotanical usage of indigenous non-wood resources such as fibres and floss, forest oil seeds, dyes and tannins, gums and resins, herbal medicines and non-conventional food plants by tribal communities of Western Ghats of Maharashtra. The resource utility varies with the traditions of tribals as well as the availability of resources in surrounding areas. Use of these data in the implementation of various plantation programmes in tribal regions is recommended to help them achieve self-sufficiency in their natural habitats.

INTRODUCTION

The remote hilly regions of Western Ghats of Maharashtra are inhabited by tribal communities. People belonging to a single tribe live in small groups called 'Wadi' or 'Pada' and 10-12 wadies form a tribal village. Agriculture in these areas is dependent on rainfall and the tribals are engaged in agricultural activities for 6-8 months of the year. For the rest of the year, they hunt and collect forest produce for household as well as commercial utilization.

The minor forest produce (MFP) of commercial importance include collection of fibres and floss, tannin and dye yielding plants, gums and resins, oil seeds, bidi leaves and medicinal plants. They also collect honey from wild honeycombs and other edible

products such as fruits, seeds, leafy vegetables and tubers. Other MFPs of significance include local herbal medicines, fodder, cordage materials, roof thatching materials and leaves for food plates, materials for fish stupefaction, products for liquor preparation, miscellaneous products for festivals and religious ceremonies. They are aware of multifarious uses of forest resources and this information is passed on verbally from generation to generation. Systematic ethnobotanical documentation of such information is likely to bring on record new uses of forest resources and thereby provide potential germplasm for posterity.

Studies on minor forest utilisation having ethnobotanical consideration for social forestry are :

1. **Small timber and bamboo utilization**

   Utilization of *Acacia catechu* (Khair), *Bombax ceiba, Butea monosperma* (Palas), *Cassia fistula* (Bahava), *Lannea coromandelica* (Mogari), *Mellotus philippensis* (Shendri), *Ouoeinia oojeinensis* (Tiwas) and *Soccopetalum tomentosum* for agricultural implements is very common. The wood of *Cassia glauca* and *Murraya paniculata* is used for construction of door sill or threshold in tribal houses in the belief that it will ward off evil spirits. *Dalbergia latifolia, Haldinia cordifolia, Hymenodictyon orikense, Ougeinia oojeinesis and Saccopetalum tomentosum,* though commonly used as small timber, occur rarely and therefore their germplasm needs to be maintained for the future.

   Bamboo is one of the valuable forest products for tribals. Its utilisation is important for household purposes such as construction of partition walls, grain storage, fish or crab traps, containers and water vessels, musical instruments, rain shelters and baskets. The raw bamboo in the form of poles is collected and sold in the nearby market. Basket making also generates supplementary income. Bamboo has other utilities such as foodgrains and fodder. Young shoots and rhizomes of species of bamboo are edible.

   Bambusa arundinacea and *Dendrocalamus strictus* grow abundantly, often forming pure strands. These species are also cultivated by tribals. Other bamboo species such as *Ochlandra talbotii, Oxytenanthera ritchevi and O. stocksii* have limited distribution and are believed to be endemic to Western peninsula only. These species have been recorded very rarely in tribal pockets of Ahmednagar

and Pune. Bamboo has great potential for tribal development. Therefore, conservation of rare and endemic types and large-scale multiplication are needed.

2. **Edible Product Collection**

Collection of wild food products such as roots, tubers, leafy vegetables, flowers, fruits and seeds is done mainly to supplement inadequate foodgrains. While collecting ethnobotanical data from tribal areas of Western Maharashtra, 45 tree species yielding edible products have been documented. Tuberous roots of seedlings of *Bombax ceiba, Firmiana colorata and Salmalia insignis* are edible. Fruits of indigenous species like *Artocarpus heterophyllus* (jackfruit), *Carissa carandas* (Karvand), *Emblica officinalis* (Avla), *Mangifera indica* (Mango), *Syzygium cumini* (Jambhul) and *Zizyphus mauritiana* (Ber) are used by tribals for home consumption and income. Genotypes of some of these species show considerable variation in taste, yield, resistance and longevity. These characteristics are important and need more attention from a germplasm conservation viewpoint. Species like *Bombax ceiba* (Sawar), *Capparis decidue* (Nepti), *Cassia fistula* (Bahava), *Cordia oblioua* (Bhokar), *Dellenia pentagyna* (Karmal), *Elaeocarpus serratus* (Khobardodi), *Firmiana colorata* (Khaushi), *Flacourtia montana* (Attack), *Holarrhena antidysenterica* (Kuda), *Meyna laciflora* (Alu), *Salmalia insionis* and *Semecarpus anacardium* (Bibba) constitute less known but widely and commonly exploited food resources of tribal populations. Studies on the nutritional value of fruits of *Dallenia, Flacourtia* and *Meyna* and tuberous roots of *Bombax and Salmalia* (Ghate et al., 1988; Ghate and Vartak, 1990 and Kulkarni et al., 1991) show that they have potential as food sources.

3. **Collection of Gums, Tannins, Dyes, Fibres, Floss and Oil Seeds**

Collection, processing and marketing of forest products like gums, tannin, dyes, fibres, floss and oil seeds provide seasonal employment for tribals.

Gums : In the region under study, *Acacia chundra* (khair), *A. nilotica, Anogeissus latifolia* (Dhavda) and *Sterculia urens* (Kandol) are the major gum yielding resources. Tribals collect gum from all these species and sell locally. Reports on collection of gum from *Albizia procera* (White Shiris) and *Pterocarpus marsupium* (Bibba, Bija) are also available. Collection of gum does not harm *Acacia* and

Anogeissus trees. However, deep cuts required in *Sterculia* sp. affect the trees.

Tannins : *Acacia intsia* (Chilar, bark), *Acacia nilotica* (Babul, bark and pods), *Anogeissus latifolia* (Dhavda, bark and leaves), *Emblica officinalis* (Avla, fruits), *Semecarpus anacardium* (Bibba, nuts), *Terminalis bellerica* (Behda, fruits) and *T. chebula* (Hirda, fruits) are the major tannin yielding forest resources available in tribal areas of Western Maharashtra.

Collection of myrabalans *(Terminalia chebula)* on commercial scale is an age old practice in tribal areas. Export quality myrabalans namely Rajpores (R's) and Vingloras (V's) of Maharashtra are well known (Anonymous, 1972). This practice is still continuing, but on a small scale, mainly due to illicit cutting of *Terminalia* trees for charcoal making (Vartak, 1989). Utilization of other tannin yielding resources is localized and their commercial use is rarely recorded.

Dyes : With the advent of permanent and cheaper synthetic dyes having wide range of colours, use of vegetable dyes, except for a few, is decreasing. Colle tion of *Butea monosperma* (Palas) flowers for sale is recorded only in tribal areas of Western Maharashtra. Utilization of *Acacia intsia* (Chilar, bark), *A. nilotica* (Babul, bark and pods), *Pterocarpus marsupium* (Bibba, gum) and *Semecarpus anacardium* (Bibba, nuts) for household dyeing has been recorded but there is no evidence of sale.

Flosses : *Bombax ceiba, Ceiba pentandra, Cochlospermum religiosum* and *Salmalia insignis* yield silk cotton or Kopak of commercial importance and have export demand. *Bombax ceiba, Cochlosperum religiomum* and *Salmalia insignis* are naturally growing in the region. However, the collection of floss on a commercial scale is not very common.

Fibres : Important fibre yielding trees include *Bauhinia racemosa* (Apta, bark), *B. superba* (Palasvel, climbing stem), *Grewia tiliaefolis* (Dhaman, stem bark), *Hadlinia cordifolia* (Hedu, bark), *Helicteres isora* (Kewan or Murudsheng, stem, bark), *S. villosa* (udal or Sardol, stem bark), and *Ventilago madraspatana* (Lokhandi, climbing stem). Of these, *Bauhinia vahlii, Butea superba, Sterculia villosa* and *Ventilogo madraspatana* are found rarely. Root fibres of *Butea monosperma, Ficus racemosa* and *Ougeinia oojeinesis* are utilized locally for decorating animals during festivals. Fibre extraction from cultivated plants like

Agave sp. and *Hibiscus cannabinus L.* have been documented at places. However, extraction of fibres on a commercial scale is rarely recorded in tribal areas.

Oil seeds : *Madhuca indica* (Mahua) is the most important oil seed tree in India. This oil is used for cooking by majority of the tribal communities. The seed is collected during the season and oil is extracted in oil mills – 'ghanies'. This potential, however, is partly utilized and therefore, has great demand and scope in tribal economy. Another tree seed oil utilized is *Pongamia pinnata* (Karanj) for burning lamps. *Actinodaphne angustifolia* (Pisa), *Azadirachta indica* (Neem), *Calophyllum inophyllum* (Undi), *Garcinia indica* (Kokam), *Mallotus philippensis* (Shendri) and *Schleichers oleosa* (Kosamb) are some of the potential oil yielding species of the region. But large scale collection and utilization of these species needs to be encouraged to improve the tribal economy.

Herbal medicinal plants : Medicinal flora have a two-fold utility in tribal life. Firstly, for curing human and animal ailments mainly based on traditional knowledge. Secondely, collection of medicinal plants used in recognized ayurvedic preparations generate cash income. A micro-botanical survey of tribal areas has data on 96 medicinally important trees. Among the 20 important species are, *Actinodaphne anqustifolia* (Pisa), *Cassia fistula* (Bahava), *Embelia ribs* (Wavding), *Gardenia gummifera* (Dikemali), *Helictores isora* (Kewan, Murudsheng), *Holarrhena antidysenterica* (Kuda), *Hydnocarpus laurifolius* (Kadu Kavath), *Emblica officinalis* (Avla), *Strychnos nux-vomica* (Kajra), *Terminalia arjuna* (Arjun), *T. bellerica* (Behda). *T. chebu*la (Hirda), *Woodfordia fruticosa* (Dhaity) and *Wrightia tinctoria* (Kala Kuda). Systematic collection, processing and marketing of these potential species will enhance the economic status of tribal communities.

Materials for small scale industries : Collection, processing and marketing of non-wood forest produce can provide seasonal employment to tribal communities. This employment opportunity would be enhanced through development of cottage industries like basket making, bidi, lac, beekeeping and sericulture. Potential forest resources needed for these industries include species like Bamboo and rattan for basket industry; *Bauhinia racemosa* (Apta), *Diospyros melanoxylon* (tendu) and *D. montana* (Temburni) for bidi industry, *Butea monosperma* (Palas), *Schleichera oleosa* (Koshimb) for Lac, *Terminalia*

crenulated (Ain) for tassar silk, *Actinodaphne angustifolia* (Pisa) and *Syzgium cumini* (Jambhul) for beekeeping.

CONCLUSION

Ethnobotanical documentation of tribal traditions brings on record multifarious utilities of wild resources and focusses on their wide application using modern technology. Utilization of such species in social forestry programmes will improve the livelihood of millions of rural and tribal families.

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NON-WOOD TREE SPECIES OF PENINSULAR INDIA FOR SOCIAL FORESTRY

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ABSTRACT

Planting of species that yield non-wood forest produce needs to be encouraged in social forestry programmes. This paper highlights five such species important in the Western Ghat Region of India.

INTRODUCTION

Social forestry aims at meeting the demands of the society and reducing the pressure on existing forests. Various tree species of non-wood importance need to be promoted under social forestry for their food, medicinal, aesthetic, protection and conservation value. Important tree species of Western Ghat Region are described in this paper.

1. *Semecarpus anacardium* (Marking nut)

   Tree of medium size, flowers regularly and bears fruits during December-January, with a roundish nut on top of a pyriform fleshy peduncle. This nut is used by washermen to mark clothes. Fleshy peduncle (fruit) is edible and can be stored in dried form for 4-6 months. It is said to have cooling or soothing effect during summer. The nut has medicinal value. The oil extracted from the nut is applied to the cut end of the umbilical cord of newly born babies and to cure skin infections of both human beings and animals. The nut is fed to animals in case of stomach disorders and the oil alongwith ash is applied to bamboo baskets used in households for smooth handling and to improve durability.

2. *Artocarpus lakoocha* (Vatchuli or Watambe)

   A large deciduous tree found in tropical forests of South India and Western Ghats. It is also planted in homesteads and farms in these areas. The fruit is

eaten either raw or pickled. Raw fruits are dried and powdered for use as a substitute for tamarind and lemon fruits. Seeds are used as a purgative.

3. *Madhuca latifolia* (Mahua)

   Medium sized tree commonly found in forests of South and Central India. The dried sweet waxy flowers are used as food and for distilling liquor. Seeds yield an edible oil which is used to adulterate ghee and as medicine for skin diseases. The fruit is edible. The juice of leaves prepared in boiled water forms a good stimulant. Ashes of burnt leaves are mixed with ghee and used as a dressing for burns. Decoction of flowers is used for treating coughs and chronic bronchitis.

4. *Aegle marmelos* (Bael)

   Medium sized tree cultivated throughout India. The tree is held in great veneration by Hindus. It is sacred to Lord Shiva whose worship cannot be accomplished without the leaves. It has rich medicinal properties. Its fruits are used in chronic diarrhoea and dysentry. Its root is one of the ingredients of the "dusamul" (meaning ten roots) used in Ayurveda. It is also used in preventing growth of piles. The fresh juice of the leaves is used in diabetic treatment.

5. *Feronia elephantum* (Wood apple)

   Medium to large sized tree cultivated throughout India. The unripe fruit is used as a medicine for dysentry. Under the name "Pancha Kapitha" (meaning five products of feronia), a medicine is prepared with its flowers, roots, leaves, bark and fruits. A medicated oil is also made from these five parts.

In addition to the five species described above, there are many others which have uses other than wood and should be preferred in social forestry programmes. Among the important species are : *Euphorbia tirucalli, Caryota urens, Cordia mixa, Alangium lamarckii, Mimuspos elangi, Ochrocarpus longifolius, Acacia ferruginea and Calophyllum inophyllum.*

PROMOTION OF MPTS FOR NWFP BY GIRIJAN CO-OPERATIVE CORPORATION IN ANDHRA PRADESH : A SUCCESS STORY

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ABSTRACT

The Girijan Cooperative Corporation Limited (GCC) has been doing exceptionally well in the promotion of multipurpose tree species for non-wood forest produce in tribal areas of Andhra Pradesh. GCC provides training and technical assistance to tribals on all aspects related to collection, processing and marketing of non-wood forest produce. Produce are procured and marketed by GCC to the best advantage of the tribals. The range of non-wood forest produce and the quantity handled by GCC are listed. Future strategy of the corporation include expansion of procurement of medicinal and non-traditional oilseeds and establishment of processing units for value addition.

INTRODUCTION

Over-exploitation of timber or non-wood produce is the main cause of deterioration of many forest areas. Forest Development Corporations and Girijan Cooperative Corporations should protect forests and promote tree-based activities for sustainable income generation. However, they lack infrastructure and knowledge. However, a few organizations are an exception. The Girijan Cooperative Corporation Limited, Visakhapatnam (GCC) is one such organization that has been successfully promoting multipurpose tree species for non-wood forest produce in tribal areas of Andhra Pradesh.

OBJECTIVES AND ACTIVITIES

GCC was established in 1956 as an undertaking of the State Government of Andhra Pradesh with the objective of socio-economic upliftment of tribals. The Corporation

is serving 2.0 million tribals through its network of 800 Daily Requirement Depots (DRD), 33 branches, eight divisional and two regional offices with about 2300 employees. If is actively engaged in procurement of Non-Wood Forest Produce (NWFP) and Agricultural Produce (AP) from tribals; marketing the produce; supply of essential commodities; and provision of credit for Seasonal Agricultural Operations (SAO) and consumption purposes.

To strengthen GCC for stopping the exploitation of tribals, the Government has awarded monopoly rights to the Corporation over the purchase of 35 items of NWFP in the operational areas of the Corporation. The Government has also decided to meet the staff costs of the Corporation which enables payment of higher procurement price to the tribals. In the year 1990-91, the Corporation achieved a NWFP and AP procurement turnover of Rs. 165 million.

TECHNICAL ASSISTANCE

Tribals are provided training in identification, determination of nature and availability of non-wood forest produce, quality and grading of the product, storage and marketing. This enables them to bring out a quality produce while conserving the tree species providing NWFP. The produce is brought by the tribals to the nearest DRD where it is procured by the GCC staff. Although the staff is instructed to take whatever material the tribals bring, the tribals are advised about the quality and improvement required at the time of purchase of the produce. They are paid immediately for the produce accepted. In the case of collectors of forest honey, considering the risk involved, life insurance coverage is provided at the cost of GCC. They are trained in hygienic and non-destructive methods of collection of honey.

PRODUCT PROFILE

The following is a description of the major NWFP procured, processed and marketed by GCC with remarks on any value addition made. The quantity and the period of collection are given within parantheses.

1. Gums/Resins/Starch

Anogeissus latifolia, Tiruman or ghatti gum. (February to May, 70 tonnes). Used in

pharmaceuticals, cosmetics and food industries as stabilising agent in oil and aqueous emulsions.

Boswellia serrata, gum Olibanum. (February to May, 500 tonnes). Used as astringent in the form of ointment for chronic ulcers, diseased bones, etc. Essential oil, olibene, is a stimulant and is also used in perfumery. Contains oxidising and diastatic enzymes. Used in incense sticks, Calico printing, textiles and distempers. Major markets are in the USA, Middle East and Europe. Olibanum oil and oleoresin are available from GCC.

Gardenia gummifera, gum Dikamali. (February to May, 100 tonnes). Cathartic, anthelmintic, anti-spasmodic, anti- septic and stimulant. Used in Ayurvedic and Unani medicines.

Sterculia urens, gum Karaya. (Throughout the year, 2500 tonnes). Used in pharmaceutical, food, paper, textile and cosmetic industries; superior grade ice creams and sauces; lower grade varnishes, inks, rubber, linoleum, oil clothes, paper coatings, polishes, engraving processes and oil drilling operations. Major markets are in the USA, Japan and Europe.

Tamarindus indica, tamarind seed. (March to July, 1000 tonnes). Raw material for starch; used as sizing material in paper and jute industries.

2. Food Items

Acacia catechu, Kathha. (November to June, 50 tonnes). Used in 'Pan', and in indigenous system of medicine.

Anacardium occidentale, cashew. (April to June, 500 tonnes). Popular dry fruit, used in sweets and as snack. Oil from shell used in paint industry and for brake linings. Major markets are in the USA, CIS, Europe and Japan. Export quality processed cashew are available from GCC.

Emblica officinalis, amla. (February to April). Fresh and dried fruit used in cooking and in pickles. The fresh fruit is refrigerant, diuretic and used as a laxative. A valuable ayurvedic medicine.

Honey. (March to July and October to January; 125 tonnes). Forest honey is produced by *Apis dorsata* and other wild honey bees. Apiary honey is obtained from *Apis carana indica* bees in hives. Honey is collected from rockbees by the tribals in their leisure. About 4000 bee colonies are kept by tribal farmers as a part-time occupation. After procurement, honey is filtered, processed and packed in modern processing plants. Honey is used in Ayurvedic medicine and tonics. There is a potential to export honey to European and Middle East countries. In Andhra Pradesh, *Azadirachta indica, Bridelia* spp., *Coffea spp., Dalbergia* spp., *Erythroxylum monogynum, Lagerstroemia* spp., *Madhuca latifolia, Mangifera indica, Moringa oleifera, Pongamia pinnata, Pterocarpus indica, Sapindus amarginatus, Strychnos* spp., *Syzyqium cumini, Terminalia* spp.,and *Ziziphus* spp. are some arboreal species that contribute to honey production.

Tamarindus indica, Tamarind. (January to June, 6000 tonnes). Used as food and condiment. Major markets are in the Middle East. Besides shell, seeded, deseeded and flower varieties, tamarind is also available in concentrated powder and liquid form at GCC.

3. Cosmetic Items

Acacia sinuata, shikekai. (January to March, 200 tonnes). Dry fruits are used as detergent, and in soaps and shampoos.

Sapindus amarginatus, soapnut. (March to May, 500 tonnes). Detergent commonly used for hair care. Also used for cleaning woollen clothes and jewellery.

4. Non-Edible Oil from Tree Seeds

Azadirachta indica, neem. (May to July, 1000 tonnes). Oil is used in soap making, pharmaceutical and pesticide industries; cake is used as fertilizer and also as cattle and poultry feed.

Madhuca latifolia, mohwa seed. (May to August, 1000 tonnes). Used in soap industry as a wormicide for lawns and golf courses, in vanaspati manufacture, cosmetics, wool and jute industries.

Pongamia pinnata, pungam seed. (February to June, 200 tonnes). Used in soap and

tanning industries; as a skin care item; as a lubricant and as a water paint binder.

Schleichera oleosa, kusum seed. (July to September, 200 tonnes). Oil is used in hair care, as a lubricant and as fuel. Cake is used as manure.

5. Medicinal Items

Butea monosperma, palas. Seed, leaves, bark, flower and gum have important medicinal uses.

Cassia anqustifolia, Swarnapathri. Leaves and fruits have medicinal value.

Emblica officinalis, amla. (February to April). Fruit is used in medicine and hair care items.

Lawsonia indermis, Madayantika. Bark and leaves have medicinal properties.

Strychnos nuxvomica, nuxvomica. (November to March, 500 tonnes). Used in the pharmaceutical industry and as rat poison.

Terminalia chebula, myrabolan. (October to April, 2000 tonnes). Used in tanning industry, ayurvedic medicines and purification of water. Powdered flowers are used in Kalankari printing.

6. Other Items

Bauhinia vahlii, adda leaves. (April to July, 2000 tonnes). Stitched leaves are used as plates and for packing food materials.

Bixa orellana, annatto seed. (January to March, 200 tonnes). Bixin and orallin concentrates are used for colouring edible materials, and in hair oil, floor polish and shoe polish.

Borassus flabellifer, fan or toddy palm. (Fibre throughout the year. 1000 tonnes). Fibre used in brush and broom making and in preparing decorative articles. Major markets are in the USA, Japan and UK.

Semecarpus anacardium, marking nut. (January to May, 500 tonnes). Oil used in paints, chemical and ink manufacturing industries, and in ayurvedic medicines.

Strychnos potatorum, cleaning nuts. (November to March, 500 tonnes). Seeds are used for purifying muddy water, in ayurvedic and unani medicines and in betel leaves.

PROCESSING AND VALUE ADDITION

In order to obtain better price for the produce, GCC is planning to add value to the raw produce through processing and discovering new end-uses. A non-edible oil unit at Vizianagaram is producing 'Kutir' soaps with neem base. A modern unit for tree seed oil extraction, soap-base and soap manufacture is coming up in Nirmal, district Adilabad. A shikakai and soapnut processing and packaging unit in Rajahmundry district produces herbal shikakai and soapnut powder. A modern honey processing and packing facility is being set up in Rajahmundry, which is expected to process all the honey procured by GCC during 1992-93.

FUTURE STRATEGY

GCC has initiated various programmes to expand the scope and area of operation to provide more effective service to the tribals. It is planning to raise the income level of the landless tribal NWFP gatherer by encouraging procurement of a number of products. For this purpose, it has identified various medicinal herbs and non-traditional oilseeds which have potential for increasing the income of tribals, especially during the lean period.

On the marketing front, plans are afloat to set up or revitalise various processing industries including value addition. Some of the units which will be set up in the immediate future are Gum Karaya Processing Unit, Niger Seed Cleaning and Sterilisation Facility, Cleaning Nut Processing Unit, and Turmeric Processing Facility. GCC proposes to widen its consumer base by undertaking processing of forest produce to directly usable end products. The Corporation has also initiated steps to tap the export markets, either directly or through joint ventures with reputed cooperatives of importing countries.

PROMOTION OF NON-WOOD FOREST PRODUCE BY CULTIVATION OF MULTIPURPOSE TREES THROUGH SOCIAL FORESTRY

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ABSTRACT

Tamil Nadu Forest Department, through the Interface Forestry Committee, has leased out forest land for collection of non-wood forest produce. Members of the committee consisting of women, rural poor and tribals have been able to increase their income by collection, processing and sale of non-wood produce. In addition, as a result of the confidence created, villagers feel that the forests are for their benefit. The major species having non-wood forest produce are described in the paper. Forestry related activities such as basket making, mat weaving and rearing milch animals are detailed.

INTRODUCTION

Tamil Nadu Forest Department has endeavoured to uplift the conditions of weaker sections of the society through the social forestry programme. Under interface forestry, a number of watersheds in reserve forests abetting villages have been identified and the areas in the watershed where minor forest produce occur, are leased out to the Interface Forestry Committee at 50% of the fair price fixed. In the past, these units were sold to contractors who exploited the local women and rural poor by paying meagre wages for collection and processing. The Interface Forestry Committee formed Mahila Manrams for collection, processing and marketing.

Now these units are allotted to Interface Forestry Committees which share the benefits among themselves resulting in increased income since collection, processing and marketing are done by the villagers without involving middle men. This has improved the living conditions of women, rural poor and tribals. Confidence created among the villagers has made them realise that the forests adjoining their

settlements are for their benefit and they can take care of it under the guidance of interface forestry staff.

IMPORTANT NON-WOOD SPECIES

The major tree species from which non-wood forest produce are collected, processed and marketed are described below :

Albizia amara (Usil)

Locally known as 'Usil', it is a species occurring in Tamil Nadu. Its leaves are dried and powdered for use as a herbal shampoo. A woman can earn Rs. 25/- to 30/- daily by plucking and drying the leaves throughout the year.

Solanum pubescence (Sundaikai)

This minor forest produce is a fruit from a shrub. Women and rural poor in the interface forestry villages are engaged in collection and processing of these fruits from October to February every year.

Agave

Tamil Nadu Forest Department (Social Forestry) has raised a number of agave plantations inside and outside the reserve forests and a large number of women and rural poor are engaged in collection of agave fiber and making coir which is sold at an attractive price locally.

Cassia auriculata (Avaram Bark)

The bark is used as tannin, leaves for green manure and anthers of flowers act as medicine in dysentry.

Sapindus emarginata (Soapnut)

Soapnut is collected from reserve forests mainly by women in the interface villages.

Annona squamosa (Seethapal)

Tamil Nadu Forest Department under Social Forestry Interface Forestry Programme has planted Annona species in Reserve Forests and Revenue porombokes during the past several years. They have now attained bearing stage and provide seasonal employment for women.

Tamarindus indica **(Tamarind)**

Tamarind pods from both natural and planted trees in Reserve Forests were leased out to Interface Forestry Committee which in turn formed 'Mahila Manrams' to take up collection, processing and marketing. In one particular Interface Division, there are 20,000 tamarind trees leased out to Mahila Manrams.

OTHER ACTIVITIES WITH NON-WOOD PRODUCE

Broom Stick Making

During the summer when there is no work on farm-lands, women and rural poor collect sticks from forests and hillocks and make brooms. After the introduction of the Interface Forestry programme, over-grazing and browsing in the reserve forests and hillocks have been controlled and during summer, there is vigorous growth of raw material for broom sticks which generates employment and livelihood.

Basket Making

Basket making from Bamboo and Alingi is very common in Tamil Nadu. This raw material is collected without deforestation and a number of women in interface villages are engaged in collection of raw materials and making baskets. These baskets are sold at local markets for packaging tomatoes and other vegetables transported to cities from interior villages.

Mat Weaving

Training in mat weaving is given by selecting women living below the poverty line,

socially and economically backward classes, widows and destitutes. Raw material is available throughout the year and each woman earns not less than Rs. 20/- per day.

ALLOTMENT OF PATTA TO RURAL WOMEN

The Tamil Nadu Forest Department - Social Forestry has established avenue plantations of tamarind over several hundred kilometers. These trees have now reached maturity and 2C Patta (a right to enjoy the usufructs only) is given to those living in adjacent villages. Each beneficiary will be given five trees to maintain, protect and collect the usufructs throughout the life of the tree.

SUPPLY OF FODDER AND REARING MILCH ANIMALS BY WOMEN

A variety of fodder yielding tree species are raised under Tamil Nadu Social Forestry Project, apart from those growing naturally in the Reserve Forests. In Tamil Nadu, rural women take an active part in rearing cattle, sheep and goat. IRDP loans are arranged for them by the Forest Department to purchase milch animals and sheep. Milk producers' 'Societies' are formed with guidance from the Social Forestry wing of Forest Department, where women play an active role.

INVOLVEMENT OF 'MAHILA MANRAMS' IN TREE GROWING

In rural areas 'MAHILA MANRAMS' are formed and are allotted 5.0 hectares of land to raise nursery, plant and maintain the plantation. The Tamil Nadu Forest Department's Social Forestry Wing provides technical guidance and funds to these societies. In addition, women are encouraged to form Tree Growers Society and raise multipurpose trees yielding non-wood forest produce.

A list of multipurpose trees, included in the social forestry programme, that yield non-wood forest produce is presented in Table 1.

Table 1. List of Multipurpose Trees with Local Names.

S.No.	Local Name	Botanical Name	Hindi Name
1.	Usil	*Albizia amara*	--
2.	Sundai	*Solanum pubescens*	--
3.	Puli	*Tamarindus indica*	Amli, Imli
4.	Kadukkai	*Terminalia chebula*	Harra
5.	Pungan	*Pongamia pinnata*	Karanj
6.	Velvel	*Acacia leucophloea*	Safeed Kikar
7.	Vembu	*Azadirachta indica*	Neem
8.	Karuvel	*Acacia nilotica*	Babul
9.	Kodukkapulli	*Pithecelobium dulce*	Vilayati Imli
10.	Nelli	*Emblica officinalis*	--
11.	Vila	*Peronia limonia*	Katbal
12.	Mungil	*Bamboosa bamboo*	Kenta Bans
13.	Illuppai	*Machuca longifolia*	--
14.	Kattu Iluppai	*Mahuca indica*	Mahuha
15.	Elandai	*Zizyphus mauritiana*	Ber
16.	Karuveppilai	*Murraya koenigi*	Kethnim
17.	Alingi	*Alangium salrifolium*	Akola
18.	Marudhani	*Lawsonia enermis*	Mehndi
19.	Avaram	*Cassia auriculata*	Tarvon
20.	Gliricidia	*Gliriadia maculata*	--
21.	Naval	*Syzygium cumini*	Jamun
22.	Kalappai Kilangu	*Gloriosa superba*	Karihari
23.	Vettiver	*Vetiveria zinzanodes*	Khus Khus
24.	Kattalai	*Agave sisalana*	--
25.	Kolingi	*Tephrosta purpurea*	--
26.	Beedi Ilai	*Diospyros melanoxylon*	--
27.	Soapnut	*Sapindus emarginata*	Rithe
28.	Mundiri	*Anacardium occidentale*	Kaju
29.	Siyakayi	*Acacia concinna*	--
30.	Pala	*Artocarpus heterophyllus*	Panus
31.	Badam Paruppu	*Terminalia bellerica*	Bahera
32.	Samerani	*Cinnamum camphora*	
33.	Seethappal	*Annona squamosa*	Seethaphal
34.	Elavavam Panju	*Bombax malabaricum*	

NON-WOOD TREE PRODUCTS FROM SOCIAL FORESTRY

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ABSTRACT

This paper discusses the activities in Social Forestry which enables the local population to derive benefits from forests for their livelihood. Activities such as grass gathering from the plantations, collection/tapping of gum, dye, flower, fruits and leaves from various species have also been highlighted.

INTRODUCTION

Although Social Forestry development in India is very recent, the use of trees for various needs is an age-old practice. All the states have initiated tree planting programmes on common lands, roadsides and degraded lands to provide wood-based rural needs and to improve the environment. The Social Forestry initiative was taken to meet the rural needs by utilizing the wastelands for afforestation and to arrest further land degradation. While planning the Social Forestry activity, the basic thrust has been on wood production so that the fuelwood resources are augmented besides minor timber and fodder. But far more is expected from Social Forestry: it should respond to the farmers' overall needs for it to succeed. Farmers are also planting trees on their private lands to meet their own demands and also to generate income.

In the forestry sector, non-wood forest products such as gum, resin, medicinal products, drugs, aromatic products, leaves (for beedi, curry, plate, shampoo), oil seeds, tans and dyes, grasses, reeds, canes, bamboos, fibres and flosses, edible and commercial products, essential oils, spices, honey, wax and lac have great potential to bring in revenue and create employment, particularly for the tribal population. In Andhra Pradesh, Madhya Pradesh and Bihar, more than 50% income of the tribals is from minor forest products collected from the forests. The extraction

of some of them such as tendu leaf (for beedi) and sal seed require organised efforts every year.

Social Forestry

In Social Forestry, emphasis has been on a few tree species which are fast growing, easy to establish and can be marketed for wood besides providing firewood and small timber to the people. This restricts the utilization potential for many products. Since, people have no right on the major products (wood), they resort to illicit felling. In order to establish an intimate relationship between people and trees, it is essential to select species as per local needs and market opportunities. Some species with multiple potential are given in Table 1.

Table 1. Tree species with potential (H - High; M - Medium; L - Low) for non-wood forest produce suitable for social forestry.

Tree species	Leaves	Gum	Food	Tannin	Fodder	Oil	Medicine	Fibre	Lac	Dye
Acacia nilotica		M		M	H	M				
Anogeissus latifolia		M		M						
Anogeissus pendula				M	H					
Azadirachta indica					M	H	M			
Bombax cieba		M								
Bauhinea spp.		L			M					
Butea monosperma	M	H			L	M	L	L	L	M
Cassia fistula				M			L			
Eucalyptus spp.			M			M	L			
Madhuca latifolia			M			H				
Moringa oleifera		M	H		M	M	M			
Pongamia pinnata						M				
Phyllanthus emblica			M	H			H			
Prosopis juliflora		M			M					
Prosopis cineraria			M	M	H					
Terminalia arjuna				M	L		H			
Slichera trijuga						M				
Zizyphus sp.			M		M					

Some of the important species yielding non-wood forest produce are detailed below :

1. *Butea monsperma* : Commonly found in degraded forest areas and roadsides. Leaves are made into leaf plates or cups and sold. Manually operated small machines have been provided to make uniform plates and saucers and an average worker earns more than Rs. 25/- per day during the leaf season. A yellow colour dye is collected from flowers. Seeds are used in medicines and also contain oil. During March-April, the bark is tapped for a crystalline red gum which has a ready market. Besides, the tree is a profuse coppicer and regularly harvested for firewood.

2 *Zizyphus sp.* : The species of *Zizyphus mauritiana, Z. oenoplea* and *Z. nummularia* are lopped heavily for fodder in addition to yielding fruits during winter. Surplus fruits are air dried, powdered and used for food. Dry fruits are boiled and sold during the rest of the year. Twigs are a good host for lac and the wood is preferred for tool handles and minor household timber needs.

3. *Emblica officinalis* : Raw fruits from natural forests and plantations can be sold in the market and the surplus is processed into jam and pickles or used in medicine. It is a good source of vitamin C.

4. *Anogeissus pendula* : This species is heavily lopped for fodder and its wood is used as firewood.

5. *Acacia leucophloea* : It is extensively lopped for fodder and the wood is used as firewood.

6 *Madhuca latifolia* : Although there is no effort towards its planting, the existing trees provide flower, fruits and seeds which are used for food, oil, feed and country liquor manufacture. The wood is a good timber, but there is a ban on the felling of this species.

7. *Pongamia pinnata* : Seeds are used for oil extraction.

8. *Azadirachta indica* : The trees are heavily lopped for fodder. Seeds are collected for oil extraction. Wood is a good timber. Leaves are used in a variety of ways. Every part of this tree is useful in Indian medicines. Several parts are

used as insect repellant in grain storage and agriculture.

9. *Acacia nilotica* : Leaves are used as fodder, the bark is a rich source of tannin and the wood is a good timber. Fruits are eaten by sheep and goat.

Following aspects need to be looked into in the utilization of the species for NWFP :

- Biomass production and growth of a particular part is dependent upon source-sink relationship. One has to choose betweeen the products.

- Applicable and efficient techniques are to be selected for tapping products like gum and resin so that the growth and vigour of the tree are not affected.

- Processing of raw material into processed products is essential to assure higher income and prevent over- exploitation.

FUTURE RESEARCH THRUSTS

There has been little attempt to plant and protect these species. Therefore, it is necessary to :

- evolve easy regeneration and establishment techniques;

- develop techniques for tapping gum for higher yield without damaging the trees and for lopping / harvesting to assure optimum returns without injury to the healthy trees;

- introduce more adaptable tree species with varied uses in areas where the native species are poorly adapted or are not available;

- evolve processing technology for conversion of primary products into high value items on site;

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RESOURCES FOR PRODUCTION OF GUMS, RESINS, TANNINS AND OILS IN TRIBAL AREAS OF CHHOTANAGPUR IN BIHAR

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ABSTRACT

The tribal areas in Chhotanagpur in Bihar are rich in species yielding minor forest produce. Improvement in tapping, collection and grading is necessary. Appropriate type of machinery must be installed for processing. Blending of tannins from different species may also increase the demand for the product. A comprehensive list of species known for gum, tannin and resin is annexed to the paper.

INTRODUCTION

The tribal areas of Chhotanagpur lie between latitudes 22° N and 24° N and longitudes 86° E and 85° E. The tribals who constitute 50% of the total population, about 3.2 million in number, reside on an undulating terrain of plateau and small hill ranges. The forests are of two types : dry peninsular sal or tropical dry deciduous forests. There is more sal in the eastern areas with excellent sal blocks in Singbhum areas while Palamau forests with a drier climate have a preponderance of miscellaneous species. These forests are rich in a large number of minor forest products. The tribals bring them to weekly bazaars which play an important role in trading of minor forest products.

GUMS

People have been using gums from time immemorial for food, medicines, paints and polish. Gums are exuded by plants either due to normal metabolism or due to some fungal or bacterial action. Gums exude naturally from trees, but blazing is resorted to for increasing the yield. Sometimes people even fell gum-trees. Collection is mostly done by people residing in forest areas and the gum is purchased by businessmen in the weekly bazaars.

Babul *(Acacia nilotica)*, one of the main gum species, does not grow in forest areas. The main species that are tapped in Chhotanagpur for gum are *Sterculia urens, Boswellia serrata, Anogeissus latifolia* and *Shorea robusta*. Gum, collected by the tribals is in an impure form, mixed with bark. Skilled workers remove the bark and grade the gums in depots at central places owned by traders. Gums are generaly graded, according to their colour, into four classes - transparent white, orange, black and mixed. Gums collected from *Sterculia urens* and *Anogeissus latifolia,* which are light in colour or are transparent, fetch very high prices. The transparent white gum fetches more than Rs. 2000 per kg. Usually, the tribals get about Rs. 30/- per kg for the mixed collection. *Boswellia serrata* (salai) yields slightly inferior gum but the highest collection is from this species. A mature salai tree can yield up to 1.0 kg. Sal gum, an oleo-resin gum called sal dammar, is used as incense and medicine.

Some of the other gum yielding species in these areas are *Azadirachta indica* (Neem), *Cochlospermum religiosum, Lannea coromandelica* and *Feronia limonia.* Intensive tapping and sometimes felling of trees to collect gum has forced the Forest Department to ban collection of gums. Prospects for tribals can improve if the following steps are taken :

1. Scientific tapping
2. Collection is done species-wise taking care to get rid of the bark at the time of collection.
3. Gradation is done more carefully, especially of the gums of inferior grades.

RESINS

Pines, most notable among the resin species, are not available for tapping in Chhotanagpur though a few patches of *P. roxburghii* are grown on the Netarhat plateau. There are resin yielding species in Chhotanagpur. Among them, *Boswellia serrata* and *Shorea robusta* are common. These species yield oleogum resins, which are used mostly as incense or for manufacture of paints and varnishes.

TANNINS

There are about 44 species in the Chhotanagpur forests which can yield tannin. Babul *(Acacia nilotica)*, one of the most notable sources of tannin, is not found in these forests. But, myrabolans, another important source is available in abundance and its annual potential is reckoned to be 10,000 tonnes. Some of the common tannin

species of Chhotanagpur and those reported to contain tannin are given in Table 1.

Table 1. Tannin yielding species in Chhotanagpur.

Species	Common name	Tannin containing parts	Tannin %
Emblica officinalis	Aonla	Fruits	20
Terminalia chebula	Harra	Fruits	21
Terminalia bellerica	Behera	Fruits	30
Terminalia alata	Asan	Bark	17
Terminalia arjuna	Arjun	Bark	15-20
Anogeissus latifolia	Azlewood	Bark	10-15
		Leaves	32
Shorea robusta	Sal		15-17
Albizia lebbeck		Bark	7-11
Anacardium occidentale		Bark	9
Cassia fistula		Bark	10-12
Cleistanthus collinus		Bark	33
		Fruits	14
		Twig, bark	21
		Leaves	19
Zizyphus xylopyrus		Bark	7
		Fruits	20-25

The experience of the Forest Department in operating a tannin extraction plant presents interesting study in this regard. This plant was commissioned at Latehar in the Eastern part of Chhotanagpur in 1989 by the Forest Development Corporation. Its installed capacity was mentioned to be 4.0 tonnes a day, but the actual production has seldom exceeded 2.0 tonnes a day. The need to frequently clean the pipe lines and the dryer through mechanical brushing holds up production. It is said that the appropriate type of machine was not installed.

Marketing of the tannin has presented another problem for the plant. Railways are the only regular purchaser. They use it for keeping their boilers clean. This tannin has failed to attract leather industry. It is said that if the tannin from myrabolan and *Acacia* are blended, it will be readily acceptable to leather manufacturers. For this, *Acacia* bark may have to be imported from Africa where it is available in plenty. Besides myrabolans, this plant also uses barks of Asan and Sal which are available

in plenty as logging waste. The constraint faced by the plant should not deter any move for setting up similar plants in tropical forests. If the plant could have been fitted with the needed machine, it would have worked better.

OIL

The traditional sources of oil in tribal villages are :

1. *Madhuca indica* (40% oil in seed kernels)
2. *Pongamia pinnata* (37% oil in seeds)
3. *Schleichera trijuga* (50% of oil in seed kernels)
4. *Azadirachta indica* (40% oil in kernels)

Potentiality of sal seeds which yield about 12.5% oil is recognised by the oil industry. It is estimated that the potential is around 1.5 lakh tonnes, but actual collection has been varying between 15,000 to 24,000 tonnes.

The Bihar Forest Development Corporation set up a Solvent Extraction Plant in 1986 at Latehar in the district of Palamu. The main constraint to production is the erratic and short supply of raw material and its inflated cost; 20% of the collection is first placed on open tender sale and rest of the collection is made available to the plant on the highest tender rate. The private purchasers inflate the tender-rates deliberately to create problems for the plant. It is felt that unless this manipulated raise in price of sal seeds is arrested and a more viable mix of sal seeds with mahua and rice-bran is used, the plant will persist to be in the red. The sal oil does not fetch the expected price, but its deoiled cake has found a ready export market.

Some of the non-traditional sources of oil are *Banthulsi* (12-13%), *Cassia tora* (6%), *Xanthium strumarium* (10%), and *Butea monosperma* (17-22%).

The cost of collection of seeds of above noted species is comparatively cheaper.

REFERENCE

Forest Department, Bihar, 1989. Report on Resources Survey of Forest Species Yielding Gum, Resin, Tannin etc. in the tribal areas of South Chhotanagpur Plateau.

Table 2. Plant Species Yielding Gum, Tannin and Resin

(Vernacular names in Parantheses)

Species	Gum	Tannin	Resin
Acacia catechu (Khair)	Sold as gum arabic.	Bark	--
Acacia nilotica (Babul, Kerkar)	Average yield of gum arabic 1.0 kg/yr/tree.	Bark (12%) pod (12-19%)	--
Acacia canescens Syn. A. Pennaca (Arar)	--	Bark (9%)	--
Aegel marmelos Corr (Bel)	Seed is also surrounded by gum.	--	--
Ailanthus excelsa (Ghorkaranj)	Sold as Bassora or hog gum.	--	--
Albizia lebbeck (Siris, sirca)	Gum from bark.	Bark (7-11%)	--
Albizia saman (Vilayati siris)	The bark yields gum.		
Anacardium occidentale (Kaju)	The tree yields a pale yellow to reddish gum which exudes in statact-iform. It is partly soluble in water.	Bark (9%) leaves (23%)	Good baking enamels can be prepared by dissolving the resin, obtained by condensing the shell oil with formalin in linseed or tung oil. The resin yields good varnishes, easter gum and drying oils.
Anogeissus latifolia (Bhaura, Dhauntha)	Gum is used as a substitute for gum arabic.	Bark (10-15%) leaves (32%)	--
Azadirachta indica (neem)	Gum from bark is useful as a stimulant and demulcent tonic.	--	--

Species	Gum	Tannin	Resin
Artocarpus heterophyllus (Kathal)	--	Bark (3.3%)	--
Artocarpus intergra	--	--	Bark and fruit exude a milky latex.
Bauhinia malabarica (Ampti Koteli)	--	Bark (9-15%)	--
Bauhinia retusa Ham (Kanla)	Bark yields gum which is used in sweatmeats.	--	--
Bauhinia vahlii (Mahulan)	--	Bark (17%) stem (8%)	--
Bombax ceiba (Semul)	Bark exudes a gum which has medicinal value. Mixed with ashas & caster oil, it is used as a cement for caulking iron pans for boils.	--	--
Boswellia serrata (Salai,Salga)	Bark yields gum-oleo-resins. Average yield is 1kg/tree/yr.	--	Used as an incense and medicine. Boswellia oil and resin are used in preparation of varnishes and paints.
Butea monosperma (Palas)	On blazing the tree, a red juice exudes which hardens into red gum. It is an astringent and has medicinal use.	Tree yields gum which also contains tannin.	--
Butea parviflora (Lat palas, Maula).	The gum resembles that of B. monosperma	--	--

Species	Gum	Tannin	Resin
Butea superba (lat Palas)	--	Tree yields gum and tannin.	--
Careya arborea (kunbhi)	--	Leaves (10%)	--
Carrisa Payasubervia (Jangli Karaunda)	--	Leaves (9-15%)	--
Cassia auriculata (Tarwad)	--	Bark (15-19%)	--
Cassia fistula (Amaltas)	--	Bark (10-12%)	--
Cassia suanea (Chakundi)	--	Bark (2.5-4%) & fruit (10%)	--
Cleistanthus collinus (Karla, Kargali)	--	Almost all parts of the trees yield tannin. Bark (33%) twig bark (21%) leaves (19%) & fruit (14%)	--
Cochlospermum religiosum (Galgal)	Gum from bark is known as hog gum.	--	--
Chloroxylon swietenia (Bharhul, bhira)	Yields very acrid juice which results in the formation of blisters on the skin.	Bark (17%)	--
Cordia dichotoma (Lasora)	Fruit mucilage is demulcent and is recommended for cough.	Bark (2%)	--
Diospyros melanoxylon (Tiril tend, kendu)	--	Bark (19%) half ripe fruit (23%) & ripe fruits (15%)	--
Elacodendron glaucum (Ratangarur)	--	Bark (8-13%) & leaves (8-15%)	--

Species	Gum	Tannin	Resin
Euphorbia tirucalli (Lanka sij)	--	--	Latex is used as an application for warts, rheumatism neuralgia toothache, cough, asthma and earache.
Feronia limonia (Kait,Kathbel)	Trunk & branches exude a gum resembling gum arabic. Used as an ingredient in writing ink and in dip dyeing and colouring.	--	--
Ficus racemose (Gulab)	--	Bark (14%)	--
Ficus religiosa (Peepal)	--	Bark (4%)	--
Flacourtia ramontchii (Bilanga, Katahi)	--	Bark contains tannin.	--
Gardenia gumifera (Dikamali)	Leaf buds & young shoots yield Dikamali which has medicinal use.	--	The resin is transparent, greenish- yellow with a sharp pungent taste and offensive odour. It is anti-spasmodic, expectorant, carminative, diaphoretic and anthelmintic. It is also extensively used in veterinary medicine.
Gardernia lucida (Dikamali)	Gum is identical to that from G. gumifora & has the same uses.	--	--
Gardenia turgida (Karhar, Dhaunk)	A yellow-green gum exudes from cuts made on the upper parts of the stem. It contains 40% d-mannitiol.	--	--

Species	Gum	Tannin	Resin
Holarrhena antidysenterica (Koraiya, Kurchi)	Exudate has 9.56% gum.	--	--
Hymenodictyon excelsum (Bhurkund)	--	Bark is used for tannin.	--
Lagerstroemia parviflora (Sidha)	Sweet edible gum.	Bark (7-10%) & Leaves (16%)	--
Lagerstriemia speciousa (Jarul)	--	Leaves, fruits & bark (12.8-13.3, 14.3-17.3 & 10%)	--
Lannea coromandelica (Jhingan, Doka)	Muciliginous gum. It has 3/4 of the viscosity of gum arabic; used in calico printing, paper and cloth sizing, inferior varnishes and inks.	Bark (8%) May be used for tanning & dyeing & as a preservative for fishing nets.	--
Larrhena antidy-senterica (Kurchi, Karaiya)	--	1.14%	--
Madhuca indica (Mahua)	--	Bark (17%) Used in dyeing & tanning	A milky latex exudes from incisions and cracks made in the bark. On coagulation, it yields a rubbery product resembling gutta-parcha.
Mallotus phill-pensis (Kamala rori)	--	Bark (6-10%) imparts a deep reddish colour leather. Leaves also contain tannin.	--
Nyctanthes arbortristis (Harsinghar)	--	Bark contains tannin.	--
Ougeina oojeinesis (Sandan, Panjan Panan)	A kino-like exudation from the incised bark is used to cure diarrhoea and dysentry.	--	--

Species	Gum	Tannin	Resin
Pinus roxburghii (Chir)	--	--	Oleo-resin from chir is the main source of turpentine oil. Turpentine is chiefly used as a solvent for thinning paints and varnishes and many other pharmaceuticals and industrial preparations. Resin is principally used in paper, soap, cosmetics, paint, varnish, polish and rubber industries.
Pterocarpus marsupium (Bijasal, bija, Paiser)	A gum-kino exudes when an incision is made in the bark upto the cambium; yield of dried gum is about 340 gms/tree. Kino is used in the treatment of diseases, dyeing, tanning & printing. It has potential use in paper industry.	--	Tree yields a gum-kino which exudes when an incision is made through the bark. Gum-kino contains resin in small quantities.
Semecarpus anacardium (Bhelwa)	--	--	The pericap of the fruit contains black, oily, bitter and highly vesicant resinous juice which has been traditionally used for marking linen. In recent years, it has found a variety of uses in the varnish, paints, plastic and allied industries.
Shorea robusta (Sal)	It is the sal dammer of commerce and is used in medicine and for caulking.	--	--

Species	Gum	Tannin	Resin
Sillenia pentangyna (Rai,Agor)	--	Bark (6%)	--
Spondias pinnata (Amra)	Gum resembles gum arabic except for being darker. Used as a demulcent and for fumigation. Sometimes used as an adhesive.	Bark contains tannin.	--
Sterculia urens (Keonjhi, Kulu)	Mature tree yields about 1.0-5.0 kg gum/tree/season. Gum has medicinal use and is also used in textile paper, and leather industry; baking and dairy industries.	--	--
Stereospernum suaveolens (Paral)	Bark yields a dark colour gum containing a bitter substance.	--	--
Syzygium cumini (Jamun)	--	Bark (10-12%) & is used in dyeing & tanning & for colouring fishes.	--
Tamarindus indica (Imli))	Tree exudes a dark colour gum with poor solubility.	--	--
Tectona grandis (Sagwan)	--	Bark (7-14%) & leaves (about 6%). Leaves also contain a yellow or red dye which is used for dyeing silk yellow, olive or related shades.	--

Species	Gum	Tannin	Resin
Terminalia alata (Asan, sain, saj)	Gel-like fluid dries upto a light yellow to ember coloured gum; used as a purgative and adhesive.	Bark (18.7%) Can be used as a cheap substitute for tanning leather.	--
Terminalia arjuna (Arjun, K'ahua)	--	Bark is used for tanning. Dry bark from the stem (20-24%) and from the lower branches (15-18%). Fruit (7-20%).	--
Terminalia bellerica (Behera)	--	Bark (1.4-7.0%) and fleshy fruit pulp (21.4%)	--
Terminalia chebula (Harre)	In Maharashtra, the gum is mixed with the gum of *Acacia nilotica*, *Anogeissus latifolia*, *Madhuca latifolia* and *Azadirachta indica* and sold in the market either for medicinal purpose or to dyers for mixing with colours.	Dried flesh surrounding the seed is rich in tannin (av.30-32%) whose content considerably varies with the different grades of myrebolans from different areas. Other parts of the tree serve as roots, bark, heartwood, sapwood and leaves also contain tannin but the maximum concentration occurs in the fruits.	--
Woodfordia fruticosa (Dhawai, Phul-dhawai, Dhai-phul)	Gum is used for coating parts of the fabric not to be dyed.	Bark (20-27%) has been extensively used in the tanning of erect leathers. Leaves (12-20%).	--
Zizyphus mauritiana (Ber)	--	Bark (4-9%)	--
Zizyphus xylopyra -- (Kat, ber, ghont)		Bark (7.2%)	--
Zizyphus oenoploia (Makal, Dahora)	--	Bark (12%)	--

SELECTION OF MULTIPURPOSE TREE SPECIES THROUGH PLANTING PROGRAMME - REVIEW AND STRATEGY FOR IMPROVEMENT

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ABSTRACT

A review of 125 species in on-going plantation activities (1988 rains) by the Forest Department and the Forest Development Corporation of Maharashtra Ltd., indicated that multipurpose tree species are being preferred. In Social Forestry, species that give maximum services to the society is a touch-stone on which every species to be planted is tested. Adequate expertise on species in relation to nursery techniques, planting methods and crop husbandry is available. However, there is scope for improving yield, processing of tree products, storage and marketing. Therefore, instead of looking for new species, it would be better to narrow down the scope and concentrate on a limited number of species. Tendency to oversell a particular species has proved to be counterproductive as in the case of Subabul. Unless proper back up for new species is conceived and established, they should not be released for mass-scale planting programme. There is a need for evolving appropriate parameters for selection of superior plant material for Social Forestry. Similarly, new technology should not be transferred unless long-term assessment has been carried out and its ecological compatibility is tested.

INTRODUCTION

The research wing of Maharashtra Forest Department reviewed the massive afforestation programme launched in the State during 1988-89. This was in the form of a sample survey of plantations raised during 1988 rains. It included an area of 19,485 ha covering 438 sites in 24 Forest Divisions and an area of 29,302 ha covering 307 sites in 16 Divisions of Forest Development Corporation of Maharashtra Ltd. Data collected was processed at the National Informatics Centre, Pune. This

exercise revealed that contrary to the common notion, preference is given to planting of multipurpose tree species by forestry sector including Forest Development Corporation of Maharashtra Ltd. A wide spectrum of non-traditional indigenous multipurpose species having varied non-wood forest produce like forage and fodder, non-edible oil and oil cakes, gums, resins, fibres, edible fruits and flowers, green manure, gums and mulches and medicinal produce is being used.

Eight different computer formats were used to collect information from almost all Divisions of Forest Department and Forest Development Corporation of Maharashtra Limited, depicting a wide range of useful information connected with the planting activities. These are :

1. Distribution of area planted by type of soil-working like pits, trenches and wats in different agro-climatic zones.

2. Distribution of area planted by type of planting material used like polypots, naked plants, seeds and stumps in different agro-climatic zones.

3. Distribution of area planted by survival below 40%, 40-70% and above 70% in different agro-climatic zones.

4. Distribution of area planted by growth performance (poor, average, good) in different agro-climatic zones.

5. Working soil types versus planting material for survival above 70%.

6. Species-wise and agro-climatic zone-wise distribution of net area planted.

7. Distribution of area by soil zones (Zone-I, IIA, IIB and III).

8. Agro-climatic zone-wise area planted.

Although more than 125 different species have been included in this planting programme all over the state, only 25 species are discussed here. These account for more than 90% of the total number of seedlings planted and the remaining 100 species are not very significant (Annexure I).

Prosopis, Teak, Neem, Subabul, Agave and Gliricidia have proved to be successful in 60 to 80% of the area. Performance of Babul including Ramkathi, *Acacia auriculiformis*, Anjan, *Acacia tortilis* and *Eucalyptus* (Hybrid) was average, being successful in 40 to 60% of the area. Shiras, Sissoo, *Cassia siamea*, Tamarind, Khair, *Pithecellobium*, Ber and Sitaphal were successful in only 10 to 40% of the area. Performance of Shivan, Bamboo, Arjun, Awla and Kinai can be termed very poor because they were successful in less than 10% of the area. Amongst these species, the area under multipurpose tree species exceeded 75%, while traditional timber and fuelwood species occupied the remaining 25%. (Table 1).

Table 1. Distribution of MPTS and timber species in planting programme

Category	Number of species planted	Number of seedlings	Area covered in hectares
MPTS	20	45,827,073	33,212
Timber and Fuelwood	5	22,688,501	11,242
	25	68,515,574	44,454

The use of a range of multipurpose tree species over large forest tracts implies that expertise in the sphere of nursery techniques, planting methods and crop husbandry is available within the forestry sector. However, there is scope for developing hybrids using state of the art tree-breeding technology for enhanced yield and quality. Therefore, instead of looking for new multipurpose tree species, it would be appropriate to narrow down to a limited number of proven species like *Prosopis juliflora, Azadirachta indica, Acacia nilotica, Tamarindus indica, Agave sisalana, Hardwickia binata* and *Acacia tortilis*. These are comparatively easy to establish, proved reasonably successful even on hostile wastelands having poor site qualities or biotic interference and have multiple non-wood forest produce like fodder, non-edible oil, oil cakes, gums, fruits, fibres, besides having potential for tree produce. Uses of multipurpose tree species along with their limitations and research needs are enumerated in Annexure 2.

The research organisational set-up in the forestry sector is inadequate to cope with the in-depth study of specific areas of research such as tree improvement, assured supply of genetically superior plant types, qualitative and quantitative increase of usufruct by better plant cultivation practices, plant protection measures, harvesting of

produce, storage and marketing. It is here that the services of Universities, and Non-Government Organisations engaged in forestry related activities could be harnessed by allotting certain specific areas of research to develop adaptable techniques and then associate with the research wings of forestry for conducting field trials.

The tendency in the past to introduce certain exotic species without adequate testing has given rise to controversies as has happened in the case of alleged excess water consumption by the *Eucalyptus* species. Similarly, oversell of Subabul by projecting its multiple uses like fodder, fuel and timber have proved to be counter-productive, as this so-called miracle species is unable to yield quality fuel or timber. Even its value as a good fodder is being questioned because of the toxic contents in its leaf. Under the circumstances, it is always premature to advocate any new species for mass introduction unless proper back-up is established.

Due to lack of genetic variability, planting material multiplied by tissue culture is ulnerable to pest and disease outbreaks. It has come to notice recently that the teak tissue culture plant material developed by the National Chemical Laboratory in Pune has been attacked by pests this year in spite of controlled conditions under which this material was being raised. It would be advisable not to release any new technology unless long term assessment of the same is carried out and the ecological compatibility is ascertained.

It is, therefore, recommended that research efforts must focus on a few selected non-wood tree species and should be field tested before any new species or technology is released for large-scale field planting.

REFERENCE

"Tropical Legumes-Resource for the future" by National Academy of Sciences, Washington, DC, 1979.

Annexure I. Species planted in order of priority during 1988 rains in Maharashtra.

Name of Species			Number of seedlings planted	Area covered	
Botanical Name	Type	Common Name		100%	Where Survival is more than 70%
(2)	(3)	(4)	(5)	(6)	(7)
Prosopis juliflora	MPTS	Vilayati Babul	29,105,967	15,446	9,065
Tectona grandis	Wood	Teak	16,560,121	6,627	4,532
Albizia lebbeck	MPTS	Shiras	4,397,196	3,101	1,362
Dalbergia sissoo	Wood	Sissoo	4,284,759	3,273	1,618
Azadirachta indica	MPTS	Neem	2,450,983	2,691	1,610
Leucaena leucocephala	MPTS	Subabul	2,195,087	3,315	2,656
Acacia nilotica	MPTS	Babul	1,177,290	1,318	688
Acacia auriculiformis	MPTS	Australian babul	903,834	950	497
Eucalyptus	Wood	Eucalyptus	868,065	342	153
Cassia siamea	MPTS	Kashid	787,845	836	382
Tamarindus indica	MPTS	Chinch	780,102	1,502	549
Acacia catechu	Wood	Khair	768,791	758	333
Pithecellobium dulce	MPTS	Vilayati Chinch	577,969	837	249
Anona squamosa	MPTS	Sitaphal	539,660	447	143
Agave sisalana	MPTS	Agave	475,472	On TCM alongwith periphery	-
Gliricidia maculata	MPTS	Gliricidia	485,497	448	318
Zizyphus jujuba	MPTS	Bor	480,440	651	81

Name of Species			Number of seedlings planted	Area covered	
Botanical Name	Type	Common Name		100%	Where Survival is more than 70%
(2)	(3)	(4)	(5)	(6)	(7)
Acacia nilotica (Ramkathi)	Wood	Ramkathi Babul	369,788	380	212
Hardwickia binnata	MPTS	Anjan	335,628	273	136
Gmelina arborea	MPTS	Shivan	206,774	197	-
Albizia amara	MPTS	Kinhai	186,682	164	-
Dendrocalamus strictus	MPTS	Bamboo	164,061	239	-
Acacia tortilis	MPTS	Acacia tortilis	139,039	309	153
Terminalia arjuna	MPTS	Sadada	139,039	139	-
Emblica officinalis	MPTS	Awala	134,712	166	-
			68,515,374	44,454	6,636

Annexure II. Uses, limitations and research needs

Species	Uses	Limitations	Research needs
Prosopis juliflora	FD,FR	Being an aggressive species, it can become a weed.	Germplasm collection; selection for high yield and fast growth; spineless types for fodder.
Albizia lebbeck	FR,GM SE		
Azadirachta indica	NL,IE	Short period of seed viability.	Improvement of seed viability.
Leucaena leucocephala	FR	Toxic effects of fodder, susceptible to wind.	Efforts to reduce toxic substances in fodder.

Species	Uses	Limitations	Research needs
Acacia nilotica	GM,FR		Improved production of gum by genetic improvement chemical, stimulants, tree management harvesting and post-harvest techniques.
Acacia auriculiformis	NF,SE	Shallow roots susceptible to fire. Poor growth under shade.	Investigation on utilisation of gum.
Tamarindus indica	FD	Pods susceptible to beetle infestation in storage. Requires well-drained soil.	Germplasm collection; vegetative propagation techniques for mass production.
Hardwickia binata	FR		Grafting techniques for superior genotypes.
Dendrocalamus strictus	TR		Tissue culture of superior genotypes
Acacia tortilis	FR,FW,SE SS	Shallow lateral spread of roots affects crop fields; foilage toxic to animals; seed attacked by bruchid beetles.	Screening for fast-growing thornless types, non-toxic foliage and desirable methods to control pest attack on pods.
Zizyphus jujuba	FD	Needs to be grafted on established plant in the field	Technologies for grafting at nursery stage.

FD - Food; FR - Fodder; GE - Green manure; GM - Gum;
FW - Fuelwood; NF - Nitrogen Fixation; OL - Non-edible oil;
FE - Fungicide; SE - Shade; SS - Soil stabilization; TR - Timber.

POTENTIAL OF MEDICINAL PLANTS FOR TRIBAL DEVELOPMENT

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ABSTRACT

There are more than 1500 plant species in India which have potential medicinal value, but very little is known about them. The medicinal uses of six species are presented in this paper alongwith a case study.

INTRODUCTION

Although tribals are a part of the forest eco system, they have benefitted least from the forests. Besides wood, forests are rich in minor forest produce (MFP) which are not exploited. Medicinal forest produce, one of the main MFPs, has tremendous potential if its harvesting, processing and marketing is managed scientifically. There are over 1500 medicinal plants in India, but at present, we know very little about them. A few species with potential as medicinal plants are highlighted in this paper.

***Alangium lamarckii* (Alangiaceae)** : A small deciduous tree, generally a straggler having fibrous roots common in dry parts of South India. It flowers from February to April and fruits from May to August. Its leaves are used as poultice in rheumatic pains, root bark is used as a purgative, anthelmintic in piles, inflammations and snake-bite. The juice is emetic and cures kapha, vata, pain, inflammation, biliousness, diseases of the blood, hydrophobia, rat-bite, lumbago, dysentry and diarrhoea.

***Chlorophytum arundinaceum.* (Liliaceae)** : Commonly known as safed musli,it occurs in the forests of Assam, Bihar, Madhya Pradesh, Orissa and Maharashtra. It is prevalent in sal forests. Flowering occurs in June and July. It is a rhizomatous herb with white flowers. Root tuber is used as a tonic and for curing impotency.

***Commiphora Mukul* (Burseraceae)** : A short,scented, thorny shrub, usually 1.0 - 4.0 m in height with smooth or serrated leaves and small red flowers. It occurs in drier parts of Andhra Pradesh, Karnataka, Western Madhya Pradesh, Gujarat and Rajasthan. Fruits are fleshy and turn red when ripe. The bark is yellowish with papery layers.

In summer, due to hot weather, a gum resin,known as 'guggal' is exuded from the main stem and branches. Pure 'guggal' is sweetly scented, bright, greasy and yellowish in colour when fresh. It turns black with time and is used as astringent, antiseptic, expectorant and aphrodisiac. It enriches blood carminative, and is used as an antidote for snake-bite and scorpion-sting.

***Emblica officinalis* (Euphorbiaceae)** : Occurs throughout India, more commonly in deciduous forests with male and female flowers borne on the same tree. The fresh fruits are acrid, cooling, diuretic, refrigerant and laxative. Raw fruit is aperient. Dried fruit is useful in haemorrhage, diarrhoea and dysentery. In combination with iron, it is used in anaemia, jaundice, and dyspepsia. Sherbet of Aonal with lemon juice arrests acute bacillary dysentry. Exudate from incision on the fruit is used as an external application for the inflammation of the eye.

Flowers are cooling, refrigerant and aperient. Root barks are an astringent. Seeds are used for the cure of asthma, bronchitis and biliousness. Fruits are rich in vitamin C and are useful in the treatment of human scurvy.

***Gardenia gummifera* (Rubiaceae)** : This medium sized tree, found in Madhya Pradesh, Maharashtra and Orissa, is known as 'Dikamali'. This species has shining lanceolate leaves and fragrant creamy white flowers, and exudes resin at the apex of stem. It is used as antispasmodic, carminative, antiseptic, stimulant in dyspesia, anthelmintic and as a repellent in veterinary medicine.

Case study :

In Melghat, medicinal plants like 'Aonla', 'Hilda', and 'Safed musli' have great potential. At present, only 'Hilda' and gum collection and marketing are organised by the Tribal Development Corporation (TDC). This agency appoints its agents at various collection centres on a commission basis to collect Hilda and gum from local

villagers for a fixed price. However, due to lack of co- ordination between TDC and forest department, a large portion of the collected produce goes to illegal traders. In Melghat forest, covering 0.3 million ha, a survey of *Emblica officinalis* (Aonla) estimated a minimum of three trees per ha. and yield of 5.0 kg per tree. The total production is 4,500 tonnes per year. At present, this is not made use of due to lack of harvesting and marketing facilities.

Safed Musli found in Melghat forests is in demand in Delhi and fetches Rs.400/- per kg. But collection at present is organised by private middlemen without the permission of the forest department who pay a low price to tribals. The collection of root tubers is done when it sprouts in monsoon as it is difficult to locate them during dry period. Such collection does not allow the plants to set seeds. If this practice continues, the species might get eliminated in the course of time. It is time to give serious thought to the identification of such medicinal forest produce - their assessment, potential, method of harvesting, to ensure a regular supply of the produce and formulating a marketing strategy. This will ensure benefits to the local tribals.

SELECTED MEDICINAL PLANTS : CULTIVATION AND DRUG DEVELOPMENT

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ABSTRACT

Plants and animals have a symbiotic relationship with human life. There is renewed interest in natural products and practices all over the world. We can take advantage of this trend by exporting the much needed value added plant products to the western world in the form of finished products instead of raw material. This could be the beginning of a new era in the Swadeshi Science Movement and a new perspective to 'Gandhian Philosophy'. The importance of such research and development efforts in the area of pharmaceuticals, perfumery, foods and other industrially important chemicals has been recognised. It is proposed that wastelands development with aromatic and medicinal plants be taken up by involving farmers to produce raw materials which could be processed to specified quality required in foreign markets.

INTRODUCTION

Plants and animals have a symbiotic relationship with human life. A new awareness to restore ecological balance of nature has risen over the past 25 years. This has resulted in a new wave for preference for natural over synthetic substances. The present economic crisis in India has to be overcome by a Swadeshi Movement in science and technology. The new strategy should be to develop finished products of valuable drugs, perfumery and other consumables from natural resources for western markets.

Cultivation of Jivaka Vana

Medicinal plants constitute nearly 25% of the higher plants. Nature has endowed the

Indian sub-continent with a gift of different climatic conditions ranging from Himalayan to Nilgiris. Thus it is felt that various belts could be identified to grow specific and appropriate plants based on soil, rainfall and other climatic conditions. The wastelands in the region could also be utilized to grow plants with the help of natives either on cooperative or individual basis. The information for cultivation of most medicinal plants is available through CSIR, CIMPO or CIMAP research stations. The assistance of voluntary organisations and seasoned farmers could be enlisted for promotion of medicinal plants. A model Dhanvantari Van is being established by Karnataka Forest Department. Forest Departments of various states could form a united team to develop a plantation programme with a specific focus to cultivate high yielding varieties of plants.

The objectives of establishing a Dhanvantari Van are to :

1. protect valuable species of plants in their natural environment;

2. develop new species having high yield and superior quality:

3. understand environmental balance to restore eco-systems;

4. develop nursery techniques including tissue culture for selected species;

5. cater to the needs of ayurvedic and rural traditional vaidyas and pharmaceutical industries involved in preparation of medicines.

These efforts would create assets for future generations and would also help overcome present economic crisis. Moreover, we would be able to revalidate our claims on medical science and develop modern technology for Indian system of medicines. Therefore it is suggested that the species listed in Table 1 be used to identify and standardize drugs for specific diseases.

Table 1. Species and their pharmaceutical uses.

Name (Popular in Drug)	Pharmaceutical Use (Main)
Vinca rosea *Cantherantha rosens*	Anti-cancer
Rauwolfia serpentina	Anti-hypertension
Tinospora cordifolia	Anti-biotic & other uses
Withania somnifera	Tonic (Ayurvedic use)
Asparagus racemosus	Tonic & for Gynaec problem & various preparations
Saraca indica	Ayurvedic uses
Azadirachta indica	Number of anti-diabolic anti-implantation & other medicinal uses along with insectidical use for crops
Cinnamomum femala	Medicinal properties & spice
Carica papaya	Papain as digestive and in food processing; use in family planning
Emblica officinalis	Various uses in ayurvedic preparations
Terminalia chebula	-- do--
Terminalia bellerica	-- do--
Tamarindus indica	Spice & useful in number of preparations
Zizyphus mauritiana	Spice
Terminalia arjuna	Anti-hypesternerve
Colchicum autummale	Anti-cancer
Mappia foetida	Anti-cancer
Adhatoda vasica	Anti-cough preparation
Solanum species	Anti-fertility compound
Tribulus	Ayurvedic preparation

Table 2. Gum, Oils and Perfumery Chemicals.

Name	Uses
Garcinia indica	Medicinal substitute for cocoa butter
Jatropha curcas	Oil for diesel substitute
Boswellia serrata	Guggulu preparation
Commiphora muhul	Antilipidemic
Pongamia	Ayurvedic and pesticidical activity

Name	Uses
Acacia nilotica	Number of species giving valuable gums
Semecarpus anacardium	Anti cancer and various other uses
Shorea robusta (Sal)	Edible oil/butter
Santalum album	Oil & wood useful as perfumary and medicine
Eucalyptus species	Oil, medicinal & several uses of plant
Bixa orellana	Food colour
Indigofera tinctoria	Dye
Occimum species	Medicinal oil
Mentha species	Menthol
Jujuba	Oil, medicinal and lubricant for machinery
Lawsonia alba	Colour and medicinal uses in cosmetics
Vetiver	Essential oil
Sapindus emarginatus	Cosmetic and useful in medicine
Ferreola	Medicinal uses, spice

FUTURE STRATEGY

We import chemicals such as gallic acid or pectum for use in drug and food industries. Such chemicals can be prepared in India using our own raw material. Therefore, post-harvest technology is important and a phase-wise development is suggested to implement the programme.

Phase 1 : Plant about 40 medicinal plants listed in Tables 1 & 2.

Phase 2 : Direct sale to pharmacies in various states with specification and avoid agents and middlemen so that growers get the benefit.

Phase 3 : Set up processing plants for crude extraction and subsequent separation of important chemicals from crude extracts such as alkaloids, steriods, peptides, glycosides and acids.

Phase 4 : With analytical and chemical back up, standardize preparations and formulations for foreign markets.

PROMOTION OF NON-WOOD FOREST PRODUCE THROUGH BEEKEEPING

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ABSTRACT

Beekeeping is a gainful occupation for rural poor, particularly tribals and women, which helps in income generation and sustainable livelihood. Honey and beeswax are non-wood forest products. Besides these, honeybees play an important role in pollination of forest trees and agricultural crops. Tree species contribute about three fourth of the honey produced in India. Plantations of multipurpose tree species like *Hevea brasiliensis, Nephelium litchi* and *Eucalyptus* species contribute heavily towards honey production in India. Some multipurpose tree species useful for beekeeping are listed for inclusion in social forestry programmes. Planting them will increase honey production.

INTRODUCTION

Honeybees are anthophilous insects dependent upon flowering plants for their food : pollen and nectar. Bees also collect honeydew and propolis from plants. Honeybees convert nectar and honeydew into honey. It constitutes the carbohydrate food for them. Pollen provides proteins and other nutrients needed for growth and metabolism. Harvest from bee colonies includes honey, pollen and propolis, which are collected by bees from plants; beeswax, bee venom and royal jelly, which are metabolic products of bees.

There are four honeybee species in India : the Indian hive bee, *Apis cerana* indica Fabr., the giant bee or rockbee, *A. dorsata* Fabr., the little honey bee, *A. florea* Fabr. and the dammar bee, *Trigona iridipennis* Smith. Of these, only the hive bee can be reared in movable frame hives and is easy to handle. In the 1960s, the European hive bee, *A. mellifera* Linn. was introduced in agricultural plains of Punjab. About 1.06 million bee colonies (*A. cerana* indica and *A. mellifera*), managed by 246,664

beekeepers, produce 9280 tons of honey annually. Commercially, *A. dorsata* is also equally important. It is estimated that about 50 percent of the honey and most of the beeswax sold in the market comes from *A. dorsata*.

Among the plant species which provide nectar in sufficient quantities to enable honeybees to make and store honey, about 60 are important in India. Most of these plants belong to Leguminosae followed by Acanthaceae and Myrtaceae. Species like *Syzygium cumini* and *Eucalyptus* species are spread in many regions of the country, while some like *Actinodaphne anqustifolia* are confined to a single region. Some bee plants are pleitesials, that is, they flower only once in their life time. During their flowering period, honey production is high and bee colonies multiply in large numbers.

IMPORTANT TREE SPECIES

Many tree species known to be important sources of nectar in India are also sources of latex, oil, fuel, timber, food or fodder. During planting of multipurpose tree species, special emphasis should be given to the plants which provide a honey crop and at the same time, have other economic uses like fuel, timber, soil erosion control, soil enrichment, fruits and oil.

Over three fourth of the honey produced in India is contributed by tree species. Interestingly, most of the honey comes from plantations of *Hevea brasiliensis, Nephelium litchi,* and *Eucalyptus* spp. A few important multipurpose tree species, useful for beekeeping as sources of abundant nectar are described below.

Hevea brasiliensis : The rubber tree is an economically important tree in India. It is even more important since half of the total amount of honey produced in India is from rubber plantations. More than 100,000 bee colonies in rubber plantations yield honey annually. In rubber trees, nectar is secreted from three extrafloral nectaries situated at the joint of petioles of the leaflets. Only young, light green leaves secrete nectar. It is estimated that each tree has potential to produce enough nectar for 3.0 kg of honey. Beekeepers in Kerala and Tamil Nadu extract 5.0 to 25 kg honey/ colony/season depending upon the weather conditions.

Nephelium litchi : Litchi is cultivated for its edible fruits in north Bihar, Punjab,

Western Uttar Pradesh, West Bengal, Assam, Tripura and Orissa. It is an evergreen tree with a long lifespan and grows up to a height of 10 m. It is suitable for cultivation in high altitudes in tropical, sub-mountainous regions. Plantations along coastal belts in the Thane district in Maharashtra have been successful. Seedlings do not tolerate frost. Litchi produces nectar profusely and is the backbone of the beekeeping industry in Bihar and other states. Beekeepers extract 10 to 27 kg of honey/colony/season when litchi is in bloom. Litchi honey is highly valued in the market.

Paulownia tomentosa : Paulownia is a little known nectar source in India. In China, Paulownia tree species are used for extensive agroforestry. *Paulownia* spp. and *Robinia pseudoacacia* are the backbone of honey production in China where 1.0 million ha Paulownia plantations have been established, about half with agricultural crops. Paulownia is useful as a fodder tree for sheep and goats, as a windbreak, timber source and as an excellent shelter tree for horticultural crops.

Prosopis cineraria : It is a medium sized, deciduous, thorny tree distributed in Punjab, west Rajasthan, Gujarat, Uttar Pradesh, central and south India. This multipurpose tree plays an important role in the rural economy in arid and semi-arid areas. It provides fodder, fuel, manure and vegetable. It is an important honey plant in Gujarat.

Robinia pseudoacacia : False acacia is a multipurpose tree highly valued for its ability to grow well in poor and dry soils of warm temperate and sub-tropical zones. It produces maximum honey at 16 years of age. In Hungary, honey production from *Robinia pseudoacacia* increased from 371 kg/ha at 6 years to 418 kg/ha in 15 yrs and then declined to 192 kg/ha by 36 yrs.

The value of honey produced per hectare is half that of the wood from the same area. Besides Hungary, false acacia is important for beekeeping in Korea, Russia, Bulgaria, Yugoslavia, Czechoslovakia and China. *Robinia pseudoacacia* is the third most commonly planted species in the world and produces more honey than any other plant species. Robinia honey is highly prized. It is easy to plant and regenerates easily. There are no serious diseases. Its wood is hard, durable and has high calorific value.

***Sapindus* spp.** : Soapnut is a medium to large sized deciduous tree, growing up to

15 m in height. The fruits are used as soap and detergent. Soapnut is a good source of nectar in Andhra Pradesh and Karnataka. It is estimated that each tree has the potential to yield 1.4 to 2.3 kg of honey per season. This important multipurpose tree is useful for planting in agricultural areas such as field bunds and hedges.

Important MPTS for social forestry, which are sources of bee forage are enumerated in Table 1. The botanical name, local/common name, family, economic utility and ecological preferences of each species are given in the enumeration.

BEEKEEPING AND SOCIAL FORESTRY

Beekeeping in India has to depend both on forests and farms. The tropical and sub-tropical evergreen and semi-evergreen forests and transitional belts between farms and forests hold great potential for beekeeping. Forests are natural locations for wild honeybee colonies. However, large-scale deforestation has led to depletion of bee forage from forests. Consequently, the number of bee colonies and honey production decreased. In agricultural plains, the main constraint for beekeeping is non-availability of bee forage round the year. Bees get food only during crop blooming periods and starve in the remaining period. In farm lands, absence of shade and indiscriminate application of insecticides are problems faced by bees.

Social forestry and agroforestry programmes which include planting of multipurpose trees help in introduction of beekeeping in farm lands. If species selected for these programmes have different flowering seasons, they can bridge the floral gaps in farming areas. MPTS provide bee forage for a longer period, shade to the bee colonies, and alternate sources of food when crop plants are sprayed with agro-chemicals.

By incorporating beekeeping in programmes of wasteland development, afforestation of denuded forests and grasslands, rural and tribal populations can be provided with a sustainable source of income. Afforestation programmes should be so formulated to include MPTS that fulfill their own basic objectives while sustaining apiculture. Planting of trees useful to bees is not only for the survival of honey bees or for honey production alone, but for pollination of crops as well. Afforestation with MPTS bee plants helps to develop forests and adjacent farms as an ecologically balanced biological unit.

BEEKEEPING : AN IDEAL FOREST AND AGRO-BASED RURAL INDUSTRY

Beekeeping does not compete with any other farming activity for land and other resources. Beekeepers have to spend only a few hours in a week for management of bee colonies. The investment and inputs for beekeeping are low, and economic returns are high. The Central Bee Research and Training Institute, KVIC, has evolved appropriate modern beekeeping technologies, suitable to different agro-climatic zones of the country. In areas with rich vegetation, a unit of 10 bee colonies provides sustenance for a rural family through production of honey and beeswax, and indirect benefits of pollination of crops. Beekeeping is an ideal occupation for women, since it is not very strenuous and does not interfere with their household work. It provides them with monetary returns, requiring only a small investment.

CONCLUSION

Beekeeping, besides producing honey, beeswax and contributing to increased crop yields, helps in the maintenance of ecological balance. Unlike other income generating activities, beekeeping does not take away any part of the plant, but contributes to its reproduction and regeneration. It is possible to incorporate appropriate trees useful for beekepping in afforestation programmes. Honeybees are required for pollination of many agricultural and horticultural crops and for increasing India's food production. They repay generously for the food taken from their hosts.

Table 1. Important Multipurpose Tree Species Useful for Beekeeping.

Botanical Name	Common Name	Family	Economic Use other than bee forage	Ecological Preference
Acacia tortilis	Umbrella thorn	Mimosaceae	Leaves, pods for fodder; fuel.	Arid and semi-arid
Actinodaphne anqustifolia	Pisa	Lauraceae	Non-edible oil from seed; fuel wood.	Tropical humid
Averrohoa carambola	Carambola tree	Averrhoaceae	Edible fruits.	Tropical humid
Bombax ceiba	Red silk cotton	Bombacaceae	Seed fibre; pulp.	Deciduous forests
Borassus flabellifer	Palmyrah	Arecaceae	Leaves for thatching, mats, fans, basket work; edible fruits, sap from peduncle for nira and palm sugar.	Sea coasts
Calophyllum inophyllum	Alexandrian laurel	Clusiaceae	Seed yields oil.	Water courses, canals
Ceiba pentandra	White silk cotton	Bombacaceae	Seed fibre; pulp.	Deciduous forests;. Arid and semi-arid
Citrus species	Sweet lime, acid lime, etc.	Rutaceae	Fruits; leaves	Tropical and subtropical
Cocos nucifera *Dillenia indica*	Coco palm	Arecaceae	Oil, copra, fibre Fruits for jams and jellies.	Sea coasts Tropical humid
Diospyros kaki	Persimmon	Ebenaceae	Fruits.	Tropical humid
Eucalyptus species	Nilgiri	Myrtaceae	Oil from leaves.	Species available for different zones
Euphoria longan	Longan	Sapindaceae	Fruits.	Tropical humid
Hevea brasiliensis	Para rubber	Euphorbiaceae	Rubber from latex; seeds yield oil	Tropical humid
Macadamia ternifolia	Macadamia	Proteaceae	Kernel in nut edible	Tropical humid
Melaleuca leucodendron	Kayapati	Myrtaceae	Leaves yield Cajuput oil	Water courses
Moringa oleifera	Drumstick	Moringaceae	Leaves, flowers and fruits used as vegetable, medicinal	Tropical humid

Botanical Name	Common Name	Family	Economic Use other than bee forage	Ecological Preference
Nephelium lappaceum	Rambootan, Rambutan	Sapindaceae	Fruits	Sub-tropical
Nephelium litchi	Litchi	Sapindaceae	Fruits	Sub-tropical
Paulownia tomentosa	Himalayan poplar	Scrophula-riaceae	Fodder, wind break.	Temperate
Pongamia pinnata	Indian beech	Fabaceae	Non-edible oil, medicine, fire wood	Tropical
Prosopis cinararia	Khejri, jand	Mimosaceae	Fodder, fruits, drought resistant.	Arid and semi-arid
Pterocarpus marsupium	Kino tree	Fabaceae	Gum/resin used in medicine.	Deciduous forests
Robinia pseudoacacia	False acacia	Fabaceae	Fodder, controls soil erosion, shelter.	Sub-tropical and temperate
Sapindus species	Soapnut	Sapindaceae	Fruits used as soap.	Tropical and sub-tropical
Sapium sebiferum	Chinese tallow tree	Euphorbiaceae	Fat from seed used in soaps, candles, as fuel.	Sub-tropical
Schleichera oleosa	Kusum	Sapindaceae	Seed oil, host for lac insect	Sub-tropical and tropical
Simmondsia chinensis	Jojoba	Simmond-siaceae	Oil from seeds.	Arid and semi-arid
Syzygium cumini	Black plum	Myrtaceae	Fruits; medicinal	Tropical and subtropical
Tamarindus indica	Tamarind tree	Caesalpinia-ceae	Condiment; fruits and leaves used as vegetable	Semi-arid and humid tropics
Tamarix species	Jhau	Tamaricaceae	Ornamental; twigs for basket making	Tropical
Terminalia chebula	Myrabolan	Combretaceae	Fruits medicinal; bark for tanning and dyeing	Water courses
Ziziphus mauritiana	Ber	Rhamnaceae	Fruits	Arid and semi-arid

STUDIES ON PLANT SPECIES PRODUCING MINOR FOREST PRODUCTS

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ABSTRACT

The emphasis in the afforestation programmes at present is on fuelwood and timber; potential of non-wood forest produce is generally ignored. CASTFORD has initiated research on several species yielding non-wood forest produce. In the first phase, this study will standardise practices for establishing plantations. Subsequent studies will focus on silvicultural practices, pest and disease control, and harvesting techniques.

INTRODUCTION

Increase in human and livestock population in India has led to large-scale destruction of tree cover, causing widespread soil erosion. Although deforestation was primarily done for extraction of fuelwood and timber, it eroded the sources of minor forest products (MFP). Plants yield MFPs such as gums *(Sterculia urens, Anogeissus latifolia),* tannin *(Terminalia chebula)* saponins *(Acacia concinna, Sapindus trifoliatus),* beedi leaves *(Diospyros melonoxylon, Bauhinia racemosa),* non-edible oils *(Pongamia pinnata),* medicines and many other products for human use. Their destruction has deprived the forest dwellers of a major source of income.

At present, social forestry programmes aim mainly to satisfy the fuelwood and timber needs of people, but trees yielding MFP are generally ignored. An important advantage in planting species for MFP is that they can be exploited for their produce without cutting down the entire plant. Thus, a permanent vegetation cover can be maintained in fragile ecosystems like the catchments of dams and other hilly areas.

PHASE 1

In view of the lack of information for popularising the cultivation of MFP species,

CASTFORD has undertaken research for establishing standard practices for raising them on plantation scale. These species are :

Acacia concinna (Shikakai for soap); *Anogeissus latifolia* (Dhawda for gum); *Bauhinia racemosa* (Apta for beedi leaves); *(Buchanania latifolia)* (Charoli for edible seeds); *Calophyllum inophyllum (Non-edible oil); Pongamia pinnata* (Karanj for non-edible oil); *Sapindus trifoliatus* (Soapnut for saponin); *Semecarpus anarcardium* (Marking nut for edible kernel and ayurvedic medicine); *Sterculia urens* (for edible gum); *Terminalia bellerica* (Beheda for medicine) and *Terminalia chebula* (Hirda for tannin).

In the first phase of the project, propagation techniques will be standardised. Since plant breeding work has not been conducted on majority of these species, rooted cuttings and grafts from selected trees will be used as planting material. Being vegetative clones, cuttings possess the same qualities as the mother trees. Cuttings often lack the juvenile phase exhibited by seedlings raised from seeds, so that plantations established with cuttings become productive earlier than those established with seedlings.

PHASE 2

In the next phase, saplings and cuttings produced in the first phase will be used for plantations where standardisation of silvicultural practices like spacing, fertilizer application, pruning techniques, control of pests and diseases and harvesting practices would be undertaken. Economics of plantations would also be studied.

TREE SPECIES FOR NON-WOOD FOREST PRODUCE AND THEIR UTILIZATION

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ABSTRACT

Forest resources play an important role in development of remote and poorly accessible tribal areas. This sector has vast potential to solve the employment problem of the country. Natural forests can be exploited by proper planning and planting of suitable tree species for steady economic growth of the country. The author has described tree species of high potential for non-wood produce in this paper.

INTRODUCTION

India's forest resources have tremendous potential for generating economic growth. Due to heavy pressure, the present area under forest cover is only 10-11 percent of the total geographical area, as against the recommended cover of 33 percent. Afforestation with suitable species is the only way to bring a large area under forest cover. Flora of the Konkan region of Maharashtra, has a high potential, and can thus be used for large-scale afforestation.

At present, social forestry schemes envisage planting of fruit trees like mango, cashew, ber, jamun, awla, imli and other tree species to produce nutritious fruits. Minor forest products such as harda, behada, mohua, soapnut, khair, bamboo, neem shikakai, tendu, palas, shewar, semul and rui, which produce raw material for cottage industries are also attractive alternatives.

TREE SPECIES FOR FOREST-BASED INDUSTRIES

1. Lac

Lac from which shellac is obtained is a forest produce with commercial value. India is the major producer of lac and about 90 percent of the product (50,000

tonnes) is exported which fetches over Rs. 100 million every year. More than 100 species are recorded as host for lac insects and the most important trees of Konkan region are *Butea monosperma* (Palas), *Zizyphus mauritiana* (ber), *Cajanus cajan* (tur), *Acacia nilotica* (babul) and many ficus trees.

2. **Tannin**

Tannins are widely found in wood, bark, leaves and fruits of many forest trees. Some of the important species and their percentage contribution are listed below:

Bark tans : *Acacia nilotica* (babul) (18%), *Cassia auriculata* (tarwad) (23)%, *Cassia fistula* (bahawa) (10-12%), *Terminalia arjuna* (arjun) (20-24%).

Fruit tans : *Terminalia chebula* (behda) (32%), *Terminalia bellerica* (hirda).

3. **Soap**

Important species are *Sapindus trifoliate* (soap nut) and *Acacia conciana* (Shikakai)

4. **Oil**

Oil obtained from forest trees is of varying commercial importance. Some oil yielding species are *Derris indica* (Pongamia), *Salvadora percaia* (Pilu), *Azadirachta indica* (Neem), *Madhuca indica* (Mahua) and *Minisops clengi* (Bakuli).

5. **Dye**

A well known dye is the annato dye of commerce obtained from the seeds of *Bixa orellana* containing 10-12% colouring substance called bixin. A popular flower dye is obtained from *Butea monosperma* (Palas). It yields a bright yellow dye used for colouring wood, silk and food items.

6. **Bidi and Plates**

Leaves of *Hollerehna antidysentrica* (Kuda) and *Diospyros melanozylon* (Tendu)

are used for rolling tobacco. Leaves of *Butea monosperma* and *Ficus bengalensis* (Banyan) are used to make plates.

7. **Flosses**

Important forest tree species which produce flosses are *Ceiba pentandra* (Shewar), *Bomabax ceiba* (Semul) and *Calotropis gigantea* (Rui).

8. **Bamboo and cane**

Bamboos are used for manufacturing mats, baskets, toys and other utility articles. Important species are *Calamus tenuis, Calamus rotang* and *Calamus guruba.*

9. **Gum**

Important tree species which yield gum are *Acacia catechu* (Khar), *Acacia nilotica* (Babul), *Pterocarpus marsupium* (Biwala), *Butea monosperma* (Palas), *Sterculia urens* (Kandol) and *Bombax* spp.

10. **Fibre**

Fibre is obtained from the bark tissue of many woody species such as *Hibiscus subderiffa* (Mesta), *Cordia myxa* (Bhokar), *Erythrina suberosa* (Pangra), and from agave leaves.

Presently, minor forest products are collected from forest area, and hence there is no effort to increase the production. Social forestry programmes should undertake large scale planting of important MFP species which will help to generate employment and achieve economic growth.

ACACIA SENEGAL (WILLD.) : A PROMISING LEGUME FOR RURAL DEVELOPMENT PROGRAMME IN MAHARASHTRA

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ABSTRACT

Acacia senegal (Willd.), commonly known as gum Acacia or gum arabic tree, was introduced by the State Forest Research wing about 20 years back in Maharashtra. Multilocation trials in drier parts of Maharashtra found it to be a promising species. *Acacia senegal* is a native of Sudan, Central Africa and Senegal. In India, it is found in restricted parts of Punjab and Rajasthan. It has multiple uses as small weed, fibres for rope-making, valuable gum, rich protein fodder and seeds as human food. Moreover, it can be used to reestablish a vegetation cover in degraded areas, sand dune fixation and wind erosion control. Since the tree can survive adverse conditions on poor soils, it is ideal for reclamation of refractory sites.

INTRODUCTION

Different models are being suggested for bringing about economic revolution for rural development. Until recently, rural economics chiefly centered around increased farm production by the use of improved seed and agricultural practices. The potential of non-wood forest produce to contribute towards rural development through employment and income generation is being highlighted lately. Production and processing of non-wood products are generally environmentally harmless. Tribal cooperatives and Tribal Development Corporations were created to organise collections and Forest Development Corporations have played a key role in this activity. However, no agency has cared for the regeneration of non-wood forest products. Rapidly growing biotic pressure and consequent site degradation do not allow regeneration in natural forests. Research is needed to propagate non-wood species. People have to be convinced that forestry offers the best cause of action because of its economic viability, social acceptability and long term ecological

stability. Even on agricultural land, agroforestry plays an important role to safeguard the stability of soil.

A. senegal, commonly known as gum acacia belongs to family Leguminosae sub-family Mimosoidae. It is a thorny deciduous small tree and grows to 4-6 m, occasionally to 15 m tall with a flat to rounded crown. The girth of a well grown tree is generally 30-60 cm. *Acacia senegal* is a multipurpose African tree highly valued for centuries for gum arabic production.

It produces the only acacia gum evaluated toxicologically as a safe food additive (Anderson, 1989). In addition to producing gum, *A. senegal* is a useful plant for dry environment. In India and Sudan, it is useful as a wind break. Its pods and foliage provide good fodder for livestock, the tough wood of its tap root and stem are used for tool handles and a strong fibre can be obtained from the long, flexible surface roots. Furthermore, the dense wood yields excellent charcoal, and the trees enrich the soil through their ability to fix nitrogen. The plant thrives on rocky hills, dry sandy flats, or dunes where the annual rainfall is between 200-300 mm. It can be grown to support other crops.

MATERIALS AND METHODS

A. Multilocation trials

Multilocation trials were carried out in four sites in drier parts of Vidarbha of Maharashtra State (Table 1). All these sites were degraded barren lands near village habitations. For comparatives studies, eleven species viz., *Acacia senegal, Leucaena leucocephala* (Var. K-8 and K-28) *Acacia tortilis, Acacia nilotica* (Jodhpur), *Acacia catachu, Acacia planifrons, Albizia procera,* (white sirus), *Albizia lebbeck* (Black sirus), and *Acacia nilotica* var. Telia and Ramakathi were selected, Polybag seedlings were raised in November / December, 1981. Seeds of all *Acacia* spp. were soaked in lukewarm water overnight prior to sowing. Randomized block planting in six replicates of each site was done in June-July, 1982 in 30 x 30 cm size pits. Two weedings in first year and one weeding in second year were carried out. Trench cum mound fencing (TCM) was not provided to these plantations and watering was not done. Yearly measurements of height and survival were recorded for five years.

B. Trial Plantation of *Acacia senegal* at Karanja Bahiram.

Seedlings of *A. senegal* raised in polybags for 6-7 months were planted in 1990 on a barren degraded 1.0 ha area at Karanja-Bahiram in Paratwada Range of Amravati Forest Division at an espacement of 3.0 x 1.0 m. The plantation was provided with TCM. Two weedings and one soil working in first year and one weeding-cum-soil working in second year were carried out. No fertilizer application and watering was done. Yearly measurements of height and survival of plants were recorded.

Table 1. Relative Height (HT) and Survival (SUR) of *Acacia Senegal* in Multilocation Trials Carried Out in 1982-83.

	Performance after five years							
	Location-I		Location-II		Location-III		Location-IV	
Species tried	Ht cm	Sur. %	Ht cm	Sur. %	Ht cm	Sur. %	Ht cm	Sur. %
Acacia senegal	95.61	30.60	20.35	18.33	122.27	23.26	151.74	75.46
Leucaena leucocephala (K8)	-	Nil	-	Nil	-	Nil	49.33	6.94
Acacia tortilis	75.39	17.40	30.25	18.51	75.62	10.88	78.95	27.70
Acacia nilotica (Jodhpur)	63.61	6.10	25.35	12.96	71.66	1.02	92.85	3.24
Acacia catechu	-	Nil	35.00	1.85	87.14	26.80	42.14	6.68
Leucaena leucocephala	-	Nil		Not planted	-	Nil		Not planted
Acacia planifrons	-	Nil		Not planted	242.85	2.38	101.25	1.85
Albizia procera	-	Nil	32.00	4.62	41.66	1.02	22.50	14.81
Albizia lebbeck	-	Nil	25	2.77	53.75	2.72	22.69	12.03
Acacia nilotica Telia	77.00	1.70	27.80	6.84	-	Nil	98.67	2922.62
Acacia nilotica (Ramkathi)	66.88	8.80	28.61	16.66	50.00	0.34	126.17	61.11

Location-I Kolari, Buldana Forest Division, Espacement 3 x 3m, 294 plants of each species.

Location-II Lasura, Social Forestry Division, Buldana. Espacement 2.5 x 2.5m, 100 plants of each species.

Location-III Chicholi (Gawali), Amravati Forest Division. Espacement 4 x 4m, 294 plant of each species.

Location-IV Chirodi, Amravati Forest Division. Espacement 4 x 4m, 216 of each species.

RESULTS

Multilocation trial

Relative performance of 11 species under trial after five years of planting is given in Table 1. All the sites were vulnerable to grazing, fire and other biotic factors. Grazing and trampling of seedling was observed in all the plantation sites which resulted in considerable mortality in locations I, II and III.

In Location-I, 5 years after planting, *A. senegal* showed 30.60% survival and attained an average height of 95.61 cm, while *A.nilotica* varieties and *A. tortilis* had lower height and survival. All the other species succumbed to biotic pressure and their survival after 5 years was nil. Due to grazing, coppice shoots were predominant in all the surviving species.

Location-II (a panchayat land) was adjoining a nalla and a cart tract was passing through it. There was lot of movement of local people and cattle in the plantation area. Under such conditions, *A. senegal* showed 18.33% survival and 20.55 cm height. This survival percentage was among the highest for this site but the plants of almost all the other species were taller than *A. senegal.* Leucaena (K-8) was a complete failure while K-28 and *A. planifrons* were not planted on this site.

Location-III was a degraded forest land adjoining Chicholi (Gawali) village. In 1983, there was a fire in this plantation and grazing was frequent. Under these conditions, *A. senegal* showed 23.26% survival with an average height of 122.27 cm after five years of planting. Ramkathi failed completely, *A. catachu* had 26.80% survival with 87.14 cm height, while other species showed meagre survival (Table 1), though *A. planifrons* showed considerable growth (242.85 cm).

Location-IV was again a degraded forest land near Chirodi village, Wadali Range of Amravati Forest Division. Grazing to some extent was observed in the plantation, but other biotic factors did not have much effect. Hereagain, *A. senegal* showed 75.46% survival with average growth of 151.74 cm in five years. *A. nilotica* (Ramkathi) showed 61.11% survival and 126.17 cm average height. Other species showed very low percentage survival.

Trial Plantation of *A. senegal* at Karanja-Bahiram

After 8 months, the survival percentage was 73.29% and the average height of plants was 121.16 cm. In December 1991, 165 plants were in flowering and 158 plants (10% of surviving) had fruits.

DISCUSSION AND CONCLUSION

Survival of *A. senegal* was comparatively better than most other species. It indicates that the species can tolerate grazing to some extent. *A. senegal* plants were susceptible to fire in location-II. Dipierre (1969) and Duke (1981) suggested strict protection for *A. senegal* from fire and livestock grazing at least during the first two years.

It is reported that *A. senegal* flowers in August to November and fruiting is from October to November (Brenen, 1983). In tribal plantations, *A. senegal* flowered one year after planting. Moreover, flowering and fruiting were not restricted to any season because even in December, plants are seen in various stages of flowering and fruiting. The phenomenon, thus, appears to be the effect of location. In tribal areas, *A. senegal* showed natural regeneration indicating its adaptability to the locality.

A. senegal is grown in agroforestry systems, especially in Sudan in "gum-gardens" for gum. In addition to producing gum, *A. senegal* is valued for fuelwood, food and fodder, dune stabilization and soil fertility (Booth and Wickens, 1988). Trees are ready for tapping at five years and production peaks between 7 and 15 years (Awouda, 1974). In Sudan, traditional bush fallow system is followed with a 20 year rotation. For enhancing exudation of gum, organic compounds releasing ethylene such as ethylprophyl phosphonate, monoethylsulphonate or ethephon could be used (Abeler, 1973, Babu and Menon, 1989).

A. senegal is ideal for large scale plantation on fallow lands and degraded forest lands. It can also be introduced in agroforestry systems in Maharashtra.

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KOKUM (GARCINIA INDICA) CULTIVATION IN KONKAN AREAS OF MAHARASHTRA

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ABSTRACT

Kokum (*Garcinia indica*) occurs in evergreen forests of Western Ghats. It is a slow growing, rarely cultivated dioecious tree. Its fruits, rind, pulp and seeds are used for a variety of purposes. "Kokum butter", extracted from seeds, is exported. There is good scope for raising kokum trees, and efforts are being made by the Forest Department to popularise this species.

INTRODUCTION

Kokum is a tropical fruit tree belonging to the family Guttiferae or Clusiaceae. Kokum fruits and seeds are used for a variety of purposes, especially along the west coast. Although there have been promotional attempts both by Forest Department and Konkan Krishi Vidyapeth (KKV) in Dapoli, farmers have not taken up commercial cultivation of kokum in Maharashtra. Therefore, there is a need to encourage commercial cultivation of this species in forest land, wastelands and farm bunds .

SILVICULTURAL CHARACTERISTICS

Kokum requires a well drained light to bouldery soil. It grows well in lateritic soil. The optimum temperature range is from 15° C to 35° C. It requires a well distributed rainfall of about 4000 mm to 4400 mm. It is a moderate sized, slender, evergreen tree with dark green ovate or lanceolate leaves. The branches are droopy in nature. The tree attains a height of 16- 20 m and a girth of 30-60 cm. Wood is fairly hard and light brown in colour. It is a shade bearer. The tree is dioecious. The population of male trees is predominant both in natural forests and plantations. Flowers are solitary and light green in colour. Fowering occurs from November to February. Immature

fruits are green and the ripened purple fruits appear from March to May. The spherical fruits are 2.5 to 5.0 cm in diameter. Tree regeneration is mainly through seeds and root suckers. It is also propagated vegetatively.

APPLICATION OF FERTILIZERS

The following fertilizer doses are prescribed by the Konkan Krishi Vidyapeth, Dapoli :

Operation/Time	Quantity
Before planting, per pit/May	1.0 kg superphosphate or bone meal per pit plus 10 g BHC powder.
Ist year, per plant/August	1. FYM 2.0 kg 2. NPK 50 g or Urea 100 g or Ammonium sulphate 260 g 3. Bone meal 150 g or Superphosphate 150 g 4. Murate of potash 25 g
Up to 10th year /August	Increase the dose annually by 2 kg FYM, 20 g NPK, 25 g spurad and 26 g urea, 50 g potash.
10th year and after/August	20 kg FYM, 500 g NPK, 250 g spurad and 250 g potash.

NURSERY TECHNIQUE

Fruits, collected from plus trees or mother trees, are depulped and the seeds sown either directly in ploythene bags or germination beds. Seeds are given pre-sowing treatment by soaking in water for 24 hours to ensure better germination. If the seeds are sown in the germination beds, they are pricked out into polythene bags. The polypot seedlings are watered, weeded and retained in polybags for 1-2 years, because seedlings of 30-35 cm in height establish well.

PLANTING TECHNIQUE

The site is cleared in March-April. Pits of 60 x 60 x 60 cm are dug in April-May at 6.0

x 6.0 m spacing and planting is done during active monsoon, especially in the months of June-July. Three weedings are carried out in the first year, and two and one weedings in the second and third year, respectively. Seedlings are provided with shade to protect them from heat. It is desirable to water the plants in the first year.

STUDIES WITH KOKUM

Early survey revealed that 43000 trees existed in Ratnagiri district, but the number is decreasing. As per the instructions of the Chief Conservator of Forests, Maharashtra, pilot plantations of kokum were established over 2.0 ha in Raigadh and Satara districts in 1969. One year old seedlings were planted at a spacement of 4.0 x 4.0 m. Planting was done in 30 x 30 x 30 cm pits.

Divisional Forest officer, Sawantwadi has raised 60 ha of kokum plantations during 1970 to 1979. KKV has conducted research to standardise nursery and plantation techniques including vegetative propagation. Directorate of Social Forestry has popularised kokum planting in Sindhudurg district. About 27,000 seedlings of kokum were distributed among farmers in Sindhudurg district.

FRUIT YIELD

Female trees of kokum start yielding from the 7th year. Blooming is from November to February. Flowers are solitary and the occurrence of bi-sexual flowers, along with female and male flowers, has been reported. Fruiting occurs from March to May. Mature fruits are dark purple, spherical in shape with a diameter ranging from 2.5 to 5.0 cm. Each fruit has 5-8 seeds embedded in acidic pulp.

The fruit yield in kokum varies with age, genotype, weather conditions and fertilizer treatment. Research at KKV, Dapoli confirmed that the fruit yield varies with genotype and environment. Observations on fruit yield were carried out from 1979 to 1983. One of the 25 trees, number K.K.87, yielded 48.56 kg in 1983.

USES OF KOKUM FRUITS AND SEEDS

The fresh ripe rind is utilised for preparing an acid drink called "Sodakadhi" which is a substitute for butter milk. The rind is used for preparing a syrup locally known as "Amrit kokum". This is an excellent cool drink. Medicinal uses of kokum fruits are well known. Salted and unsalted kokum of commercial use are prepared from processed rind. The salted variety known as "Amsol", is used as a condiment in curry. Kokum seed is a good source of edible fat called "Kokum butter", used in chocolate and confectionery preparations as a substitute for cocoa butter. It is also used in candle making, stearic acid and pharmaceuticals. The oil cake is used as cattle feed.

KOKUM BASED INDUSTRIES AND EXPORT POTENTIAL

Kokum oil extracting mills, located in Sindhudurg district, export both kokum oil and kokum butter. Kokum oil and butter are exported to the Netherlands, Italy, Japan, Singapore, United Kingdom and Malaysia. In 1976-77, kokum products worth Rs.440,000/- were exported, and this can be increased to Rs. 800,000/-. Some private firms have shown interest in kokum cultivation and marketing. Production of kokum seeds/fruits can be stepped up by increasing the area under kokum to about 4800 ha in Kudal, Vengurla, Kankavali and Sawantwadi talukas.

RESEARCH NEEDS

Since kokum is a dioceious tree, more than 50% of the seedlings develop into male trees. Therefore, there is an urgent need to develop vegetative propagation methods. KKV has reported a measure of success in grafting. However, adequate quantity of grafts are not yet made available to farmers.

Only one male tree is required for every ten to twelve female trees. It is also necessary to standardise horticultural aspects pertaining to increasing the yield and quality of fruits. The selection of mother trees, clonal multiplication and establishment of gene bank and clonal orchard should receive priority.

THE MAHUA TREE IN A TRIBAL VILLAGE : A CASE STUDY OF VILLAGE CHONDA IN VANSDA, SOUTH GUJARAT

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ABSTRACT

The BAIF Development Research Foundation (BAIF) has been involved in a tribal development programme in Vansda block, Valsad district of South Gujarat for the last 10 years. During the implementation, it was observed that the mahua tree plays a significant role in tribal life. A case study, taken up to document the significance of the tree in tribal life, confirmed its important cultural and economic role in the survival of the community. Existing stands can be used for further ecoonomic development. In areas where the tree is not so common, planting of only a few thousand appropriate trees in the whole village can boost community development activities.

BACKGROUND

BAIF has been involved in a tribal development programme in the tribal village Chondha in Vansda block of Valsad district in South Gujarat since last five years. Chondha is located in a very hilly terrain about 15 km off a district highway. Thus it is a remote, interior tribal village. As mahua has an important place in tribal society, the documentation of the role of mahua in the life of the villagers was taken up.

The village Chondha consists of eight hamlets which are very scattered habitations. More than two thousand mahua trees are standing in the Chondha village area, spread out almost uniformly on the forest lands as well as on the agricultural land. The total population of Chondha village is 354 families and thus there are more than five trees per family. The list of the Chondha hamlets and the number of families and mahua trees in these hamlets is presented in Annexure 1.

MAHUA : THE TREE AND ITS PRODUCE

Mahua *(Madhuca indica)* is an important tree of the tribals all over India because of its religious importance and contribution to their economy and life style. The tree yields a number of products of daily utility. Its flower, available in early summer, is dried, ground and stored as flour. Very often, this is the only food available in summer. In some parts, the flowers are brewed to make wine. Mahua seed, which is also available in summer, is an important tree-based oilseed. The oil is conventionally classified as a non-edible oil because of the presence of toxic chemicals. Mahua seed contains a saponin called Maorin which is toxic to animals. The seed cake is hence not used as cattlefeed. Though the saponin is water soluble and can be removed by washing, the process also washes away many other nutrients which reduces the nutritive value of the cake considerably. The high water solubility of the saponin in seed cake is used by tribals to kill fish in water streams which are then easily harvested. The oil has mainly an industrial application for producing soap. However, in many tribal areas, it is used as edible oil, often as the sole edible oil.

In view of its many uses, collection of flowers and seeds of Mahua is an important activity in the annual calendar of tribal families. Mahua trees in natural forest stands are common in most tribal areas in India. Very rarely mahua is planted manually, and mostly flourishes through natural regeneration. The tribals in Vansda have a belief that if the tree is planted, its growth is stunted. The tree has a fairly long natural life. In the village Chondha where this documentation was carried out, some of the trees are claimed to be more than 100 years old. Most of the people with whom discussions were held, had never seen or heard of natural death of a Mahua tree except when struck by lightning. Cutting of Mahua trees is, quite understandably, taboo.

In some Mahua trees, according to the villagers, flowers drop off long before sunrise, around 3.00 am. Traditionally, these trees are considered to be of significant medicinal value. The bark of these trees is cooked and applied to relieve severe muscular pain arising from injuries or insect bites.

COLLECTION OF PRODUCT

About 40% of the trees in Chondha village are privately owned. The remaining 60%

are either on forest land or on village common land. As the number of trees are large, there are no conflicts during collection of seeds. Moreover, seed collection is a laborious process. On the other hand, collection of flowers is relatively simple as most of the flowers drop at about sunrise and one needs only to lay claim on the flowers by sleeping under the tree overnight or rising early.

April and May are the flowering months. Seeds are available from May to July. The fruits drop off after ripening or sometimes the fruit is eaten by birds and the seeds are dropped off. As the seeds/fruits are dropped off in the evening and night, the collection is from late evenings to early mornings.

Typically, it is the women and children who collect mahua seeds and flowers. Collection is also done by the cowherds when they take cattle for grazing. Generally, about 5.0 kg of seed is collected by a person per day. If there is stiff competition, the collection may be only 2-3 kg/day. The pulp of collected fruits is removed and seeds are dried in sunlight for 5-8 days. Seeds are then stored in a jute bag or in a bamboo basket before crushing.

Poorer households generally collect about 100 kg of seeds in a season compared to about 40 kg by better-off households. The total quantity collected in the village is about 6-10 tons. A sample survey of 35 families indicated that during the 1991 season, they had collected about 176 kg of mahua flowers and about 1400 kg of mahua seeds. This works out to about 25 kg flowers and 40 kg seeds per family. Annexure 2 provides details of the sample survey data.

PROCESSING AND UTILISATION

Out of the 10 tons of mahua seeds collected, about 70% is crushed for home use and the remaining 30% is sold. For oil crushing, the farmers have to carry the seeds to distant villages/towns ranging from 8-30 kilometers away. Oil crushing units exist at five such locations in the vicinity of Chondha village. Crushing is a batch process and the batch size is 10 kg. Therefore, during the Mahua season, there is a heavy rush for crushing and the tribal families have to wait in a queue day and night to get their batch crushed.

The terms of crushing are also quite exploitative. Charges for crushing are about

Rs.1-2 per 10 kg and the seed cake is retained by the mill owner. This is his main income because the cake sells for about Re.1.00 per kg and the tribals are not aware of it. As a result, when a tribal goes to the town with his mahua seeds, he is literally physically pulled by mill owners and their touts, and often, there are clashes between different oil crushing units. The oil yield is about 40% of the weight of seed. The oil is heated and allowed to cool and the precipitate is thrown away. The clear oil is used for cooking.

Dry seeds are sold at Rs.80-110 per maund (20 kg). Generally, the oil crushed by the farmer is enough for the family's annual requirements. Most of the mahua flowers collected in Chondha village are sold. The rate is about Rs. 60 per maund. A small quantity of flowers were used by a few families to brew wine. As this is brewed without addition of Navsagar (Ammonium chloride), it is supposed to have some medicinal use, especially for stomach ache. However, since the introduction of BAIF's Tribal Development Programme, wine consumption has been given up by the tribals.

ECONOMIC VALUE

Analysis of the total economic role of mahua indicates that the value of the produce is to the order of Rs.115,000 per year as detailed below :

1. Mahua flowers, 3000 Kg @ Rs. 3/Kg	Rs.	9,000
2. Mahua oil, 4000 Kg @ Rs. 25/ Kg	Rs.	100,000
3. Mahua cake, 6000 Kg @ Re. 1/Kg	Rs.	6,000
Total	Rs.	115,000

Though the sale of mahua seed is only about 3.0 tons (with a value of about Rs.15,000/-), the overall economic value of the produce including self-consumption is over Rs.100,000. This is a sizeable quantity and has a number of implications for development planning. There is also good scope to increase the activity as a lot of mahua seed still goes uncollected.

Mahua cake is traditionally used only as a manure. But research at BAIF has shown the tremendous potential of its usage for biogas production alongwith cattle dung. This new use can be introduced in the area to reduce domestic fuel costs.

Through the efforts of BAIF, a local people's organisation called Manav Vikas Mandir (MVM) has started functioning in village Chondha. MVM has plans to establish a crushing unit in Chondha and organise crushing of seed as well as sale of cake, oil and seed to generate revenue for local development activity.

DEVELOPMENT IMPLICATIONS

The case study of Chondha village indicates the following directions for development planning.

1. Tree based non-wood produce (such as the Mahua oilseed) can contribute to a significant economic activity, even through a small stand of only 2000 trees in Chondha.

2. The produce can meet the consumption needs of the local population, and also provide a marketable surplus.

3. With a better input in terms of planned plantations, the activity can grow further into a significant income generation activity, beyond just meeting the home consumption needs.

4. There is good potential for introducing forward linkage activities such as oil crushing as a rural industry.

In view of the above observations, it would be important to note that planning of afforestation/ plantation programmes needs to be done, keeping in mind, not just one produce (such as wood), but a range of produce from the trees as well as the role of the trees in the socio-cultural context in the area.

ACKNOWLEDGEMENT

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Annexure 1. Hamlet-wise Distribution of Families and Mahua Trees : Village Chondha.

Name of Hamlet	No. of families	No. of Mahua trees
Nichala	52	250
Patel	55	150
Dukan	37	370
Navi nagari	26	85
Upla	70	500
Pawar	30	135
Mahal	46	325
Patali	78	250
Total	394	2065

Annexure 2. Collection of Mahua Seeds and Flowers by Farmers During 1991 Sample Survey.

No.	Names of Farmers	Hamlet	Mahua seeds Kg	Mahua flowers Kg	No.of Families
1	Ramatubhai Sonniabhai	Patel	60	15	06
2	Sitaram Sonubhai	"	40	--	05
3	Ramanbhai Kalubhai	"	60	70	05
4	Bablebhai Radakiabhai	"	80	100	05
5	Radakbhai Devalubhai	"	20	60	05
6	Kalidas Gabhanbhai	Nichalu	40	30	05
7	Selubhai Bhatiabhai	"	30	25	05
8	Jashubhai Manchhubhai	"	35	30	04
9	Dharmbhai Gandabhai	"	25	15	04
10	Kashubhai Hagrabhai	"	40	20	05
11	Dilipbhai Chhitrubhai	Dukan	40	25	04
12	Kashubhai Bhayajanbhai	"	65	20	05
13	Ballubhai Zinubhai	"	30	15	04
14	Raysigbhai Ramubhai	"	30	20	03
15	Bipinbhai Zinubhai	"	40	30	05
16	Ikalubhai Navasubhai	Upalu	60	40	08
17	Ramanbhai Malajibhai	"	30	15	02
18	Ramajibhai Radakabhai	"	35	20	10
19	Kajubhai Navasubhai	"	40	35	13
20	Ganavajebhai Adabhai	"	36	20	08
21	Mohanbhai Babalubhai	Mahal	30	25	04
22	Laxmanbhai Kolghubhai	"	45	30	05
23	Janubhai Dhedubhai	"	70	30	05

No.	Names of Farmers	Hamlet	Mahua seeds Kg	Mahua flowers Kg	No. of families
24	Kanubhai Kalabhai	"	45	25	08
25	Malubhai Zuliabhai	"	30	15	06
26	Jatarbhai Ganajubhai	Patali	30	20	04
27	Jarajibhai Bachubhai	"	35	20	04
28	Posalebhai Kolghubhai	"	40	20	06
29	Sukarbhai Jagalbhai	"	35	20	04
30	Lalajibhai Ganajubhai	"	40	15	05
31	Lachhubhai Kakadebhai	Pawar	30	20	06
32	Radakiabhai Babalubhai	"	35	10	05
33	Shivalubhai Dayajubhai	"	26	15	04
34	Ganajubhai Mukabhai	"	35	20	05
35	Bhayajanbhai Sonajibhai	"	60	30	04
	TOTAL		1392	920	176

SAL SEED IN RAIPUR DISTRICT OF MADHYA PRADESH

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ABSTRACT

Sal (*Shorea robusta*) is an important timber species confined to tropical deciduous forests in India. Lately, sal seed is used as a substitute for cocoa butter. The paper stresses on the effect of sal seed collection on natural regeneration. There should be no collection after the first shower in view of the short regeneration period. Protection measures against grazing and fire should be strictly enforced.

INTRODUCTION

Sal tree has been known for ages to provide durable timber for construction purposes and the oil seed is used in soap industry. Recently new possibilities have been found for the utilisation of sal seeds as a substitute for butter.

Sal forests occur between 76^0E to 93^0E longitudes and 31^0N to 18^0N latituides and may be placed under two distinct regions, that is, the northern region (Kangra district of Punjab to Dorray district of Assam) and the Central Indian region (Madhya Pradesh, Bihar, Orissa, West Bengal and Vizag district of Andhra Pradesh). The most favourable soil for sal is deep sandy loam with good sub-soil drainage. The total geographical area of Raipur district is 17,855 sq. km. and the forest area is 7234 sq. km. which is about 40% of the total geographical area. An area of 1175 sq. km., which is about 16% of the forest area, is under sal forests.

PRODUCTION AND UTILISATION

Flowering in sal occurs from February to March depending on local climatic conditions, and fruits ripen from May to July. Sal seed contains starch, tannin and residual matters. The export of sal oil is continuously increasing because of its use as a substitute for cocoa butter. Sal seed production per tree varies from 2.0 kg to 35

kg. The number of winged sal seeds per kg varies from 450 to 600.

The season for sal seed collection commences from mid-May and continues for 4-6 weeks. After collection, the seeds are spread in an open place for drying for 2-3 days. Generally, the kernel is separated from the shell by collectors and then brought to the local market for sale. The average collection of sal seed in Madhya Pradesh is about 60,000 tonnes per year.

Collection of sal seed provides employment to a large number of villagers, mostly tribals in Raipur, for a short period of six weeks. On an average, a person collects 20 kg of kernal per day, so the average earning of a sal seed collector varies from Rs.15/- to Rs. 20/- assuming a collection charge of Re.1/- per kg.

The Madhya Pradesh Forest Department nationalised trade in sal seed in 1975. Prior to the nationalisation, sal seed used to be auctioned like other minor forest produce. In 1973, collection charges laid down in the agreement were Rs. 30./- per quintal. In 1983, the monopoly of sal seed collection in all the 88 units in the state was given to the MARKFED. Subsequently in 1984, the sal seed trade was entrusted to the Madhya Pradesh Rajya Laghu Vanopaj (Vyapar and Vikas) Sahkari Sangh Maryadit, Bhopal. The market rate of sal seed for the last three years (1985-87) in various states is given in Table 1.

Table 1. Comparative rates for sal seeds from 1985-87 in three states.

State	Rate (Rs./ m ton)		
	1985	1986	1987
Bihar	1875	1925	2255
Orissa	2200	1925	1860
West Bengal	1801	1861	1851

Considering the sal seed yield and demand, it would be necessary to invest a large amount of money for the development of infrastructure in forest areas for facilitating extraction. Storage capacity should also be provided in forest areas which are inaccessible.

Sal seed is an important forest produce. Its collection generates rural employment and enriches the state economy. Therefore, natural self regeneration from seed must be safe- guarded and strictly protected. There should be no seed collection after the first shower. The crucial time for sal regeneration from seed is a short period of seven days when the seed fall coincides with good rains.

PLATE MAKING WITH *BUTEA MONOSPERMA* LEAVES AS A PART-TIME EMPLOYMENT

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ABSTRACT

Butea monosperma has several non-wood uses for the rural population. Among them, plate making is a well established income-generating activity, particularly for women and children. This case study details how leaves of Butea are harvested, dried and made into plates. The economics of the plate making activity in the study area of Karnataka and the constraints are examined. *Butea monosperma*, is commonly known in Karnataka as 'Muttuga', in Hindi as 'Palas', and in English as Flame of the Forest. It is found in most parts of our country except in very wet areas and above 800 m elevation in Himalayas and 1500 m in the hills of South India. The tree is medium in size with a crooked trunk and trifoliate leaves which are shed in winter. Scarlet red or orange flowers bloom in clusters in February-March. Few white or yellow flowers are also found. Pods mature in May-June. Regeneration is by seeds or root suckers. Trees withstand lopping and pollarding.

USES

Young leaves are sometimes used as fodder. Older leaves are not browsed. When trees are pollarded, young shoots appear on which lac is formed. The exudate from the trunk and stem is known as 'Bengal Kino' and is used in treatment of skin diseases. Chopped leaves are put into boiling water and then used for bathing. Flowers are collected for preparing natural yellow dye. Twigs and sticks are used in religious functions. Wood is used as a support in construction of wells. Wood is also good for fuel and charcoal making. Roots are used in making whips.

Leaves of Butea are a good source of livelihood for women and children. Collection

of leaves, drying and storage, treatment of stored leaves, collection of grasses for rope making, splint for pinning, pressing and bailing for marketing are activities for women throughout the year.

In Devar hubballi village in Kalghatagi Taluka of Dharwad, out of 386 houses, except for 5-6 families, others are engaged in leaf plate making. They go to the forest early in the morning at about 5 a.m and return by 3 p.m. with 800-1000 green leaves. Sometimes 7-8 persons go in a tractor for a night halt and return next day with 8000 to 10000 leaves. This leaf collection is from April to June and all the women and children are self employed.

Uniformly matured large leaves are obtained from coppice growths. From such trees, a woman can harvest 2500 to 4000 leaves. Very tender and over matured leaves are not good for plate making. A medium sized well grown tree will yield about 3000 leaves sufficient for 375 to 425 leaf plates. The quality of fresh green leaves are judged by touching. Dried leaves are judged by their colours.

Collected leaves are brought home and made into garlands by passing a strong jute thread through a hole near the petiole; 600 to 800 leaves are used for making a garland. These leaves are dried in the sun for 3-4 days, turning the leaves to three different positions. The garlands are then stored inside the house on rafters or beams for up to two years.

From July onwards, leaves are brought down for preparing 'leaf plates'. The dry, brittle and wrinkled leaves are sprinkled with cold water (or hot water if time is short) so that in about half an hour, the leaves achieve maximum softness. The leaves are stacked up and a weight is kept on them for about an hour for flattening them. All the leaves are cornered off near the petiole and are now ready for pinning together to make plates.

Splints are used for pinning. Bamboo splints and midribs or veins of leaves of coconut are not good for pinning. They cause injury to hands while washing or eating. Fine splints can be made from sorghum, sugarcane inflorescence or wild grasses. Collection, drying and splitting into fine splints of about 15-20 cms long is a difficult job. If it is from grasses, these are collected during December-February months. The women in these villages also store them in bundles for preparing thin ropes used for tying bundles of prepared leaf plates.

The leaves of *B. monosperma* are trifoliate. The centre top leaflets are bigger; small leaves are pinned around the big one, and usually 7-8 leaves go into the stitching of a leaf plate. Each plate is about 25-30 cms in diameter. Leaf cups are also made by stiching together two leaves. About 150 to 200 plates can be made in a day.

The plates are of two types :

1. Sada kattu (ordinary plates)

2. Thibbi kattu (special or good quality plates)

'Sada kattu' is made up of small, young and discoloured leaves with fewer splints ; 5-6 leaves are required for each plate. 'Thibbi Kattu' are prepared with 8-9 big uniformly good quality leaves and closely pinned.

Plates are sometimes trimmed to give a better appearance. Plates are bundled and tied with grass ropes. Each bundle has 100 plates and 10 bundles are bailed into a one bigger bundle (kattu).

In the village, a bundle of 100 ordinary plates fetches Rs.6/- in July-August and Rs.8/- in February-March. A bundle of special plates fetches Rs.8/- in July-August and Rs.10-11 in February-March. The selling rate for a bundle of 100 plates in the nearby city is Rs. 20/- to Rs. 25/-.

The total income to Devar, Hubballi Village from this occupation is estimated at about Rs. 500,000 per year. Some villagers earn Rs. 2000 to 3000 per year. All the villagers irrespective of caste are engaged in this profession.

The women in Hultikote village in Dharwad have formed three registered societies, each having 10-15 members. They are well organised and earn Rs. 500 to 4000/- in a year. They received an assistance of Rs. 15,200/- under DWARKA from Zilla Parishad Dharwad. They also collect other forest produce like gum from 'Dindal' (*Anogeissus latifolia*) and wild cashew (*Semecarpus anacardium*). A woman collects about 2.0 kg of good quality gum a week which fetches Rs. 40-50.

Table 1. Average income of women from leaf plates around the village near Lakkihalli farm in Tiptur taluka of Tumkar district of Karnataka.

Particulars	Quantum of work done in half an hour 4 wkg hours	Amt at Rs.12/- wage rate per day of 8 wkg Rs. Ps.	Quantity required for preparing 400 leaf plates	Amt. of wages for producing 400 leaf plates. Rs. Ps.
Collection of Leaves	2500 leaves	6.00	2500 leaves	6.00
Preparing garlands of drying and storage	1000 leaves	3.00	2500 leaves	0.75
Collection of grass sticks for stitching leaves	2000 sticks	6.00	400 sticks	1.20
Drying, cleaning and storage of sticks (grass)	10000 sticks	6.00	400 sticks	0.24
Pretreatment of dried leaves	5000 leaves	6.00	2500 leaves	3.00
Drying and preparation of splints from grass sticks	1600 sticks	3.00	400 sticks	0.75
Preparation of leaf-plates by stitching	100 plates	6.00	400 plates	24.00
	Total wages earned for preparing 400 leaf plates			Rs. 35.94
	Total wages earned for preparing 100 leaf plates			Rs. 9.00
	Present market value for 100 leaf plates			Rs. 20.00

CONSTRAINTS

Leaf plates and cups made out of Butea leaves are disposable and hence are hygienic, labour-intensive, cheap and environment friendly. Farmers need financial assistance for storage, marketing and development of Butea forests. DWARKA can assist wherever women groups are formed for these purposes.

The new buffet system, abundant banana leaves, duplicate leaf plates made of Bauhinia leaves and Ficus leaves are causing concern since the demand for Butea leaf plates has declined. Bauhinia leaves and ficus leaves are hard, thick and brittle. It is necessary to carry out research for standardised selection, drying, processing and preserving of butea leaves, selection of plus trees, reproduction, package of practices for pollarding, topping and lopping, and economic harvesting cycles, marketing, innovative equipments not only for leaves but also for flower petals, gum exudates, bark, seeds and roots.

Even though broomstick splints, bamboo, sugarcane inflorescence and sorghum splints are used for pinning, sorghum and sugarcane splints are the best because they are hard and brittle when dry, and become soft quickly by sprinkling water just before food is served.

Dharwad district has mooted the establishment of a Federation of Forest Produce Users Association. There are also women's groups of Butea leaf plate makers. These associations are confident that they can guide and guard the interest of forest produce users around the forest and tribals inside the forest.

TODDY PALM

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INTRODUCTION

Toddy Palm grows in all the soils with a maximum height of 40 - 50 ft. The leaves are very small and resemble coconut leaves. Fruits are very sweet to eat. The seeds are used as substitute for chicory in mixing with coffee powder. The leaves are used for making mats and brooms. The midribs are used for making Mulberry rearing material, small and big baskets to preserve foodgrains in the houses and also prepare thatches for house roofing.

Toddy palm yields a pleasant liquor known as Toddy (Kallu-Telugu) and earns much revenue for the Government. Each tree gives Toddy for a period of 4 months. Toddy (Neera - Telugu) has to be tapped from the terminal area of the plant. The tappers get 120 days employment during the year. Some years back, they were preparing jaggery out of Toddy which is very sweet and nutritive. The main trunk is used as rafters in house construction.

ECONOMICS AND INCOME GENERATION

1. Toddy contractors give Rs.120 to 150 to the tree owners to tap Toddy for 4 months.

2. Each family gets employment for nearly 250 to 300 days in a year.

One mulberry rearing Tahatta costs about Rs.15 in the market; one woman can make two of this thattes in one day.

To make one mat out of leaves, a woman will need 3 days, which costs about Rs 18/- in this area. Brooms can also be prepared out of leaves.

Each tree yields about 3-4 litres of concentrate Toddy everyday and it is diluted to make 6-8 litres and sold @ Rs.5/- in the villages.

CULTIVATION PRACTICES AND ECONOMIC FEASIBILITY OF JATROPHA PLANTATIONS AS A NON-WOOD FOREST PRODUCE

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ABSTRACT

Jatropha curcas is a hardy plant adapted to dry environments. It can be grown as a non-edible oil crop profitably. Its environmental requirements and cultural aspects are detailed in the paper. At current market price, Rs. 48,000/- per ha per year from irrigated and about a third of that amount from rainfed plantations can be expected. Improved practices such as drip irrigation and hormonal application can increase yields. Financial institutions such as Cooperative Land Development Bank of Maharashtra have come forward to finance Jatropha plantations. The diverse uses for Jatropha oil suggest that the prospects for an expanding market are bright.

INTRODUCTION

Jatropha curcas, a hardy plant well adapted to arid and semi-arid conditions, has low fertility and moisture demand and can grow on stony, gravelly or shallow and even calcareous soils. It can be easily propagated from seeds as well as naked seedlings. Therefore, large areas can be planted with Jatropha without requiring plants raised in polythene bags. This saves foreign exchange as the material for polythene bags has to be imported. It can be grown as a profitable non-edible perennial oil crop on irrigated and partially irrigated lands.

CLIMATIC REQUIREMENTS

Jatropha can be grown under a wide range of arid or semi-arid climatic conditions. For seed emergence, hot and humid climate is preferred. Therefore, moderately warm summers with rains are beneficial for proper germination of seed. Flowering is induced during the rainy season with the reduction in temperatures. Fruits are borne

in winter. Jatropha can be cultivated successfully in areas with scanty to heavy rainfall.

SPACING AND SEED RATE

About 6.0 kg of seed is required for planting 1.0 ha at the prescribed 2.0 x 2.0 m spacing. This spacing will accommodate 2500 plants/ha under irrigated or partially irrigated conditions. On rainfed wastelands, high density plantations at 2.0 x 1.0 m or 1.5 x 1.5 m accomodating 5000 or 4444 plants per ha, respectively, are desirable.

ESTABLISHMENT

Jatropha can be directly sown in the field or seedlings grown in polybags can be transplanted. Direct seeding is done in ploughed fields at the onset of monsoon rains. Usually, two seeds are dibbled at each planting hill and the weaker seedling is removed at four weeks. In the nursery, seedlings should be grown in polybags of 0.5 kg capacity filled with 400 g soil and 100 g organic manure. They are transplanted in pits of 30 x 30 x 30 cm. Pits are filled with 400 g of soil and compost or organic manure. By transplanting one-year-old seedlings raised in the nursery, gestation period can be reduced.

FERTILIZER APPLICATION

Besides organic manure, fertilizers containing N,P,K should be applied. For direct planting, 20 g urea + 120 g single super phosphate and 16 g murate of potash should be applied near the planting hole and the fertilizers should be covered with soil. If seedlings are raised in the nursery, the above mentioned fertilizers should be applied at the time of transplanting or immediately after the plants establish in the pits. The remaining dose of urea should be applied in two splits at the rate of 10 g per plant. The first split should be applied one month after basal dressing and the second two months after basal dressing. Jatropha oil cake can also be used for recyling of nutrients to maintain the productivity of soil.

INTERCULTIVATION

The field should always be kept free of weeds. Around 3-4 weedings in the initial period are enough to keep the field free of weeds until the crop reaches the growth stage. Light harrowings are also beneficial.

IRRIGATION

In case the monsoon is normal and well distributed, additional irrigation during rainy season is not required. During dry period, the crop should be irrigated as and when required. Usually irrigation is not required from the second year onwards unless the soils are shallow and sandy.

EXPECTED YIELD

With good care, the average production of seed is expected to increase every year as follows :

Year after planting	Expected yield kg per/ha/yr	
	Rainfed	Irrigated
1	--	250
2	250	1000
3	1000	2500
4	2000	5000
5	3000	8000
6 - 50 years	4000	12000

A yield of 12,000 kg of seed per ha from irrigated and 4000 kg from rainfed plantations can be expected from the sixth year onwards. At the current market (1991-92) price of Rs. 4.00 per kg of seed, a gross return of Rs.48,000 per ha per annum from rainfed plantations can be expected. From denuded wastelands, even at the most conservative estimate of a return of one rupee per plant per annum, the income will be much higher than any other energy crop. The added advantage is the permanent green cover to conserve soil and moisture. The handsome economic returns make it an ideal proposition for procuring bank loans. Afforestation and reforestation of degraded wastelands with *Jatropha curcas* can convert wastelands into productive national assets.

POSSIBILITY OF INCREASING THE YIELDS

A number of possibilities exist to increase the yields in future. In *Jatropha curcas,* both male and female flowers are borne on the same plant. The longer the exposure to sunlight, the higher the number of female flowers. A mild spray of gibberellin (a plant hormone), which increases the number of female flowers in castor, may also increase the number of female flowers and thereby seed yield in Jatropha. Drip irrigation could also result in higher yields as the plants remain evergreen and productive for a longer period than under rain-fed condition.

PROSPECTS OF EXPANDING MARKET FOR USE OF JATROPHA OIL

At present, Jatropha oil is being used mainly for manufacture of soap. Research on conversion of this non-edible oil into edible oil can prove to be beneficial. It can be cultivated in wastelands which are otherwise considered unsuitable for conventional agriculture. Continued research on its use as substitute for diesel, kerosene, liquid petroleum gas and polymers may open up a wide market to prevent any future glut in the market and could serve as a panacea for energy shortages in the future.

SCOPE FOR AGAVE PLANTING IN SOCIAL FORESTRY

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ABSTRACT

Being well adapted to dry environments, agaves are well suited for social forestry programmes in India. Agave species that thrive well under local conditions are *A. sisalana, A. veracruz* and *A. americana. A. sisalana* is the most widely planted species producing the highest fibre yield. The paper discusses the management, harvesting, processing and economic aspects of agave planting.

INTRODUCTION

Agave, a native of Central America and Mexico, was introduced in India for ornamental and soil conservation purposes. The species of Agave that are thriving in India are *Agave sisalana, A. veracruz, A. americana* and *A. mexicana. A. sisalana* is short with dark greenish leaves, less than 1.0 m in length with a solitary spine at the tip of each leaf. *Agave veracruz* has leaves longer than 1.0 m with ashy bloom over the leaves, almost equally spaced spines all along the edge of lamina and a spine at the leaf tip; its leaves are comparatively fleshy, yielding more fibre than any other species of Agave. *A. americana* is mostly ornamental with long (1.5 to 2.0 m) light green leaves with inconspicuous spines along the leaf margin and one at the tip. *A. cantala* is short with greenish leaves with a spine at the tip and is commercially not well-known.

Among the species of Agave, *A. sislana* (sisal) is the most popular and produces the highest quantum of fibre (except the recently developed *Agave* hybrid). It has a regular yield and wide adaptability. *A. veracruz* is the second best known Agave species and is most popular in Karnataka, Andhra Pradesh, Tamil Nadu and Kerala. Farmers use it as live hedge for soil conservation purposes and to meet their

requirement of fibre for construction of ropes, sacks and coarse cloth. A decorticating factory at Penukonda in Andhra Pradesh utilises leaves from surrounding areas and extracts a by-product Hecogenin used in contraceptives.

CULTURAL REQUIREMENTS

Agave in general is well adapted to arid environments, but sisal is capable of withstanding even desert conditions where other species cannot survive. It thrives best on dry, permeable, sandy loam soils with some lime but can grow on well-drained black cotton soils in low rainfall areas and on bunds, boundaries and railway embankments. For good growth, sisal requires a high temperature and evenly distributed rainfall of 100-125 cm. Excessive rains and frost tend to damage the plantations. *A. sisalana* and *A. veracruz* can be vegetatively propagated through bulbils or suckers. Suckers were used as a planting material, but the modern practice is to use bulbils for propagation. Bulbils, emerge on the branch of giant infloroscence known as poles and are collected from mid-February to April and raised in nurseries. They are kept in nurseries for 12 to 18 months without causing any injury to the plant. Roots should be trimmed and some lower leaves should be removed. Planting materials can be kept for up to 45 days without any adverse effects, if spread out in a single layer. Planting may be done 1.8-2.4 m apart after the onset of monsoon. Gap filling can be done preferably with sisal waste which is an excellent mulch. Hoeing along the row after winter rains is beneficial. Application of fertilizer can be useful.

HARVESTING

Harvesting of leaves is done in stages. The first cutting is generally done at about 3-4 years after planting when the leaves touch the ground or when they begin to wither. Thereafter successive crops of 25 to 50 or more leaves can be harvested once or twice a year. As a thumb rule, leaves inclined more than 45^{o} from the vertical axis are cut. A sisal plant lives for ten years, and on average, produces about 150 leaves during its life span. At least 25 leaves should be left after the first cut and 16 to 18 leaves at subsequent cuts. The green leaves weigh between 500-700 g

each and contain between two to five percent fibre or about 1,000 individual fibres. After the removal of the terminal spine, the leaves are tied into bundles of 30-100 leaves and transported to processing units.

DECORTICATION AND FIBRE PROCESSING

1. Old country method :

Tribals use large leaves to protect their mud walls during the rainy season. While protecting the wall, cells other than fibre decay and wash away. The discoloured fibres, left behind after the rainy season, are washed and used for domestic purposes. The leaf is cut to the desired length and boiled to make a brush. After boiling and beating, it is washed to extract the fibre. Alternatively, leaves are kept in water for sometime and then beaten and washed to extract the fibre. However, these methods are crude, slow and suitable only for a small quantity of leaves.

2. Hand decorticator :

It is made locally by wooden and iron pieces and is operated by a single person. Wooden pieces are separated, using the hand and foot before feeding the leaves into the machine. Adequate pressure is necessary for decortication. If the pressure is less, the leaves come out intact.

3. Raspadors type decorticators :

Jute Agricultural Research Institute, Barrackpore (West Bengal) has developed a drummed man-fed decorticator of 3.5-5.0 H.P. The machine is operated by two people, one, feeding the leaves and the other, pulling out the fibre. This machine is also available in a portable type. It can decorticate 100 kg fibre daily and costs about Rs. 10,000/-.

4. Automatic decorticators :

Two drums at right angles to each other are used which can decorticate even up to 25,000 leaves (weighing 10-20 tonnes) per hour.

After decortication, the fibre is washed in ordinary water and spread on iron wires till it is free of moisture. It is then beaten on wooden or iron round poles to remove foreign materials. Next day, the fibre is spread on the floor to dry. If the greenish colour remains, water is again sprinkled and then dried. The dry fibre is bundled/baled and marketed.

USES

1. Sisal tow is used for padding materials for use in motorcars, upholstery, etc.

2. Sisal fibre is used for manufacturing ropes, twines and cordage. It finds extensive use in shipping industry because of its tensile strength and high degree of resistance to sea water.

3. Sisal waste, a by-product, serves as raw material for production of sisal wax, which resembles Carnauba wax and is useful in the production of polishing, composition and carbon papers. Residue of leaf is a good manure.

4. Hecogenin, a raw material for manufacture of Cortisone and sex hormones, is isolated from pulp.

5. Sap can be used for extraction of furfural.

6. In arid and semi-arid regions of Central America, natives tap the stems of *Agave* spp. to collect the exuded sweet sap which is fermented into a beverage called pulque. Pulque can also be made by severing agave plants at the base and cutting the leaves. The stem portions are baked to render them sweet. The cooked plant material is mashed, mixed with water, and allowed to ferment into a beverage of low alcoholic content. After the Spaniards taught the practice of distillation, natives began to distill the beverage into tequila and mescal. Pulque is still locally available in parts of Mexico, but the primary use of pulque today is as a precursor of tequilla.

7. A recent report published by the Swedish Council for Building Research has revealed that concrete can be reinforced significantly by the admixture of sisal and other vegetable fibres. The strength of sisal fibre was found to be equal to

that of normal reinforcing steel. However, the report suggests that more research is necessary before sisal fibres can be recommended for this use.

8. Agave is useful for ecological restoration of mine spoils (lignite & haematite) and wastelands. It also forms an impenetrable live fence for protection from peripheral encroachment and forest fires.

SCOPE FOR PLANTING

Agave is useful for gully plugging, check dams and for planting on steep barren hillocks to prevent soil erosion. It can be planted all along the boundary fence at 1.0 m apart to protect forest plantations from cattle. Where cattle proof trenches are in practice, planting can be taken up in two rows at 1.0 m apart, thereby doubling the agave population. Agave can also be planted in trench mounds of 4.0 m long or in between the trenches where the interval between two contour trenches is normally 5.0 m.

Agave can be planted along fence and harvested after 3-4 years. On an average, each plant yields about 10 to 15 leaves annually and each leaf fetches 15 paise at site. There are people who operate portable decorticators on a rotation basis. This is common in Tamil Nadu, Andhra Pradesh and Karnataka. If a farmer grows 100 plants of Agave, 3 to 4 years after planting, he can get an annual income of Rs. 150/-. A small farmer can easily find room to plant about 250 Agave plants in his sub-marginal or marginal land, along dung pits, fence and farm bunds to earn Rs. 375/- annually. Agave-based cottage industry can increase a farmer's income. For live hedge fencing, *A. veracruz* is found to be effective compared to *A. sisalana* due to the presence of spines along the edge of leaf lamina. They are also comparatively robust and can form a thick impenetrable wall within 2-3 years. During summer, monkeys break the inner terminal leaf buds for extracting moisture in *A. sisalana* whereas *A. veracruz* is free from damage due to the presence of a larger number of spines along the leaf tip. The fibre yield is more in *A. veracruz* than *A. sisalana* but sisal fibre is comparatively superior in quality and texture.

The annual income from a 10 ha plantation of forest department would be around Rs. 3,000/- from the fourth year onwards. Although the plants flower and die in about 10 years, the continuous production of root suckers and annual production of bulbils

provide continuous revenue. Under the present conditions of large scale degradation and biotic pressure, agave can only be planted with success by farmers with all the added advantages. Farmers can also obtain ropes, sacks and coarse cloth out of Agave fibre as a cottage industry, thereby increasing their periodical income. For livehedge fencing, *A. veracruz* is very effective compared to *A. sisalana* due to the presence of spines along the edge of the leaf lamina. They are also robust, and can form a thick impenetrable wall within 2-3 years. During summers, monkeys break the inner terminal leaf buds for extracting moisture from *A. sisalana* whereas *A. veracruz* is untouched due to a larger number of spines along the leaf tip. The fibre yield is more in *A. veracruz* but sisal fibre is comparatively superior in quality and texture.

SOME ASPECTS OF SISAL CULTIVATION

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ABSTRACT

In a comparative study of *Agave sisalana, A cantala* and *A. veracruz* at the Pachgaon Parvati Research Centre near Pune, *A sisalana* produced 7.54 t of sisal fibre per/ha/annum while *A. veracruz* and *A. cantala* yielded 8.43 t and 3.05 t, respectively. Economics of agave cultivation, employment opportunities generated by sisal cultivation and utilization, and the area that can be successfully brought under sisal cultivation are discussed in this paper. Agave is usually propagated with suckers or bulbils, but the number of propagules produced by a plant is only 8-20 suckers and 250-1800 bulbils. In comparison, the number of seeds produced is manifold. The possibility of increasing planting material in *A. veracruz* by seed propagation is discussed.

INTRODUCTION

Agave which yields a commercial fibre known as sisal was introduced in India by the Portugese. Although various species of agave are grown in a sporadic manner, as hedge plant or ornamental, the systematic cultivation of this crop for commercial exploitation is limited. Since the beginning of the last decade, agave has been included in afforestation programmes. It was usually planted as a hedge plant along the periphery or on the trench-cum-mounts. However, information on agave plantations and its commercial exploitation is inadequate.

Various species of agave are propagated either with suckers or bulbils. A plant produces only 8-20 suckers and 250 to 1800 bulbils in its life time (Ghosh and Dyani 1975). Although seed setting in agave is not unknown, it is a rare phenomenon (Oliver as quoted by Bailey 1958). Rose (as quoted by Bailey 1958) reported that many species are not yet known to flower in cultivation. In the Pachgaon Parvati Research Centre (PPRC) near Pune, *A veracruz* has flowered and seed setting is

noticed regularly.

MATERIAL AND METHODS

PPRC falls under agro-climatic Zone V where the average annual rainfall is between 700 to 1000 mm. However, this particular site receives only 300 to 600 mm of annual rainfall. The details of the agave plantations at PPRC are given in Table 1.

Table 1. *Agave sisalana, A. cantala* and *A. veracruz* plantations established in PPRC, Pune (Maharashtra) for the present studies.

Species	Year of establishment	Spacement m	Number of plants
Agave sisalana	1976	0.9 x 0.1	3240
Agave sisalana	1978	0.9 x 0.1	3240
Agave cantala	1976		3240
Agave veracruz	1969	0.9 x 0.9	3240

A sisalana, A. cantala and *A. veracruz* were planted in plots of 8.0 x 8.0 m. Number of surviving plants and suckers produced, number of leaves in each plant, leaf length and fresh weight were recorded. Fibre was extracted by the local method of cutting the leaves and splitting them longitudinally. It was then dried for two days and kept under water for six days. After eight days, the weight of fibre was determined. Sisal rope production by a family and average earning was also studied. In *A. veracruz,* total number of flowering branches, number of seeds per fruit, weight of seeds and rate of germination were recorded.

RESULTS AND DISCUSSION

The average number of leaves per plant in *A. sisalana, A cantala* and *A. veracruz* was 38, 48, and 86, respectively (Table 2). Leaf length ranged from 85-126 cm, 100-130 cm, and 30-59 cm for *A. sisalana, A cantala* and *A. vercruz* and the yields were 6.19, 5.73 and 3.05 tonnes per ha, respectively. Ghosh and Dyani (1975) considered 2.0 tonnes per ha to be a satisfactory yield. However, some hybrids are known to produce as much as 7.0 tonnes of fibre per ha (Anon 1976). In the present study, the yield of the three species was considerably higher than reported average

yields probably due to protection provided by fencing, the small size of the plantation and close supervision.

Table 2. Average number of leaves per plant, leaf length, fibre yield per plant, maximum fibre yield and average fibre yield of three agave species at Pachgaon Parvati Research Centre, Pune.

Species	Leaves per plant	Leaf length range in cm	Fibre yield kg/plant	Maximum fibre yield t/ha	Average fibre yield t/ha
Agave sisalana	38	35-126	0.630	7.54	6.19
Agave cantala	40	100-130	0.705	8.44	5.73
Agave veracruz	86	30-59	0.255	3.05	3.05

An area of 3.14 ha under *A. sisalana, A. cantala* and *A. vercruz* was sold for fibre in an open auction for Rs. 4705/-, resulting in an income of Rs. 1446.50 per ha. Elaborate studies in farmers' fields are required to determine viable units and to promote agave cultivation. If planted on field bunds, cooperative marketing is essential to make it a viable enterprise. Search for high yielding and drought resistant varieties is also necessary.

Agave should be planted in areas where the rainfall is above 650 mm, preferably between 900-1300 mm, distributed over six months (Ghosh and Dhyani, 1975). However, the high yield of agave at PPRC indicates the possibility of commercial cultivation in arid zones as well.

The Indian rope industry requires large quantities of sisal fibre. Besides rope, sisal is also used for making brushes, dusters, door mats, carpets, bags, shoe soles and twines. A study conducted in Pune showed that professional rope makers use sisal only as fibre. They are unaware of its utility in making other articles. They buy agave fibre at the rate of Rs. 8/- per kg. A family of three workers collectively make 10 kg rope in a day. The fibre required for making rope is sold at Rs. 15/- per kg. Thus the earning is Rs. 70/- per day. Based on the yields at PPRC, an *A. sisalana* plantation can generate 1857 mandays of work while the corresponding figures for *A. cantala* and *A. veracruz* are 1719 and 915 mandays, respectively.

Seed setting in agave is a rare phenomenon. Rose (as quoted by Valley 1958) has reported that many species are not known to flower in cultivation. In *A. veracruz* at PPRC, the number of clean seeds per plant was between 4,150 to 18,094 with an average of 8016 per plant. A flowering axis carried 94 to 267 fruits with every fruit bearing 55 to 75 seeds. Seeds are very light, about 830 seeds weigh 10 g. Production of bulbils was found to be relatively less; only 2-4 bulbils per plant were noticed. Seeds had a germination percentage of 42% and required no treatment.

Agave is mainly propagated with suckers or bulbils. The suckers are miniature plants emerging from rhizomes, whereas bulbils are vegetative buds produced at the node of the flowers on the flowering axis. Production of suckers and bulbils is inadequate to meet the planting material requirement. Seed setting in *A. veracruz* will not only help produce sufficient quantities of planting material, but will also enable breeding to evolve superior varieties based on yield, quality of fibre and resistance to pests and diseases.

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PROSPECTS FOR CANE CULTIVATION IN MAHARASHTRA

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ABSTRACT

Cane has great potential as a commercial species. In certain areas of Maharashtra, *Calamus pseudotenuis, C. rotang* and *C. thwaitesii,* grow naturally. Canes are not only of great significance in protecting special geomorphic features, but can also provide handsome returns. However, owing to unscientific harvesting and lack of research support for commercial cultivation, these species are almost on the verge of extinction. The potential of cane for cultivation in forest as well as non-forest areas is discussed in this paper.

INTRODUCTION

Cane, known as rattan (*Calamus* species), occurs naturally in the tropical and semi-evergreen forests of the Western Ghats. Cane is one of the important non-timber forestry species with tremendous economic and employment potential because of its use since ancient times. Cane is used for making furniture, baskets, chairs and ornaments. However, the recent decline in forest area not only resulted in the collapse of cane-based industries, but also genetic depletion of its resources. A survey conducted by the Botanical Survey of India during 1982-85 (Basu, 1992), revealed that the population of a large number of species of cane is markedly reduced in their original habitat. There are three main species viz. *Calamus pseudotenuis, C. rotang* and *C. thwaitesii.* There is great potential for cane cultivation in the forest as well as non-forest areas.

NURSERY ACTIVITIES

The genus *Calamus* being dioceious, male and female infloresences are separate.

Flowering and fruiting of *Calamus* species in Maharashtra are as follows :

Species	Flowering period	Fruiting period
C. pseudotenuis	December to April	May to June
C. thwaitesii	November to January	February to May
C. rotang	October to January	February to May

Seeds contain 40% moisture and need to be kept moist to maintain viability. Soon after harvest, ripe fruits should be soaked in water for about two days and then sown to obtain good germination. Germination starts after 15 days and may continue up to 35 days. The germination of seeds is about 85%. For establishing a plantation of 1.0 ha, 1000 seedlings are needed, 600 seedlings for establishment and an additional 400 seedlings for gap filling. Raising of seedlings for one year requires 78 mandays costing Rs. 2,000/-.

ECONOMICS OF CANE CULTIVATION

A year-old seedling of 50 cm height is ideal for planting. The plantation can be established in forests with 20-25 year rotation. The seedlings are to be planted with a spacing of 4.0 x 4.0 m or 2.0 x 4.0 m.

The details of activities, mandays generated and costs are as follows :

Particulars	Mandays (MD)	Amount (Rs)
First year nursery	78	2000.00
Site preparation	10	200.00
Staking and pit digging 600 pits (size 30x30x30 cm)	20	500.00
Transport of seedlings	10	300.00
Planting	12	250.00
Weeding	30	750.00
Casualty replacement (incl. transport cost)	4	200.00
	164	4200.00
Sub-total in first year		4200.00
Second year		800.00
Third year		500.00
	Total	5500.00

Major part of the Western Ghats of Maharashtra fall under Kolhapur circle comprising Satara, Sindhudurg, Ratnagiri, Sangli and Kolhapur districts which comprises a total forest area of 371,942 ha. The annual supply of the canes during the year 1990-91 was 31.50 tonnes (315,420 poles) which fetched a revenue of Rs. 133.100/-. It can also be taken up as underplanting in some forests as cane requires support for climbing. Besides forest area, cane cultivation can be extended to private land. The profit appears to be lower as compared to cash crops. However, if cane is taken up as an underplant, the income from cane alongwith that of the main crops make it a viable combination.

Studies should be initiated to identify the problems of artisans in marketing the produce. Most of the articles are sold within the state. Efforts should be made to export the articles. It is necessary to impart knowledge to cane workers to develop skill and craftsmanship.

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SCOPE FOR INTRODUCTION OF BROOM GRASS THROUGH SOCIAL FORESTRY

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ABSTRACT

The paper describes the use of *Thysanolaena maxima* (Broom grass) as a vegetative hedge on slopy lands for control of soil loss and reduction of surface run off in non-arable lands. The requirement of broom grass is increasing and the production is not adequate to meet the demand. Therefore, its cultivation may be taken up in a large way. The paper also describes the agronomic characteristics of broom grass that establish its potential use as fodder and as door mats. This grass may be introduced in the Social Forestry programme for development of wastelands.

INTRODUCTION

Broom grass is found throughout India as an undergrowth in tropical forests. It is used as cattle-feed, the panicles are made into soft brooms and the stems are used as reed- pens for writing and for hanging on the doors and windows as screens. Its use as broom is increasing since a suitable substitute has not been found. It is a minor forest produce collected by the tribals throughout the country and is an important source of income for them during November to March. These tribals also present their kith and kin with broom grass during family gatherings. But the forest wealth is depleting gradually, and the tribals have to scour miles in the hilly tracts to collect a headload of broomgrass. Therefore, cultivation of broom grass should be taken up in areas where the grass grows naturally.

Besides its direct uses, broom grass is important from the point of view of soil conservation. Its use as a soil conservation plant has recently been highlighted (Rath, 1988; Rath and Patnaik, 1991). It can be grown on slopy lands along the

contours as a vegetative hedge to provide additional income to the grower.

Botanically, *Thysanolaena maxima* is a tall reedlike perennial grass of 1.5 to 3.2 m height. It has an adventitious root system and can penetrate up to 2.0 m deep and spread 1.5 m wide giving firm anchorage to the plant. The rhizomes form an impermeable layer on the soil to restrict soil erosion. If planted on contour bunds at high altitude or on stiff slopes, broom grass can check soil erosion effectively. On stream banks, it can control erosion with its elaborate mesh of roots and tenacious hold, by which it prevents soil being washed away.

Cultivation practices for broom grass have been standardised under Phulbani (Orissa) conditions by the Tribal Area Research Centre of the Orissa University of Agriculture and Technology, but further work is required before recommending any specific package for its cultivation. Spacing and fertilizer requirements have been standardized, but propagation, breeding and nutrition aspects need to be studied. At present, there are four distinct cultivars distinguished by the size and colour of panicles, height, diameter of stem, number of leaves and shape of the flag leaf. The growth is optimum under 1200 to 1500 mm rainfall. In Phulbani, it grows in drought-prone, hilly tracts having laterite soil. However, it does not seem to have specific soil and climatic requirement and grows well on stream banks.

The rhizomes are collected in the early part of the rainy season for planting. These are cut into pieces of 5.0 to 10 cm, each weighing 40 to 60 g and having one or two dormant buds. They are planted at a distance of 50 cm between and within rows. Prior to planting, the land should be ploughed 3-4 times and 0.25 m cube pits must be prepared. No levelling is necessary. On slopy land, instead of regular rows, the rhizomes can be planted in a triangular method in order to arrest run-off and soil erosion. For quick growth and development, NPK at a ratio of 20:20:20 can be given. In the first year, some intercultivation is necessary, but in subsequent years, only application of fertilizer and regular weeding are required. The yield is low in the first year, but subsequently, production of panicle increases. The panicles are harvested from January to March. They are severed at 5.0 to 10 cm above the ground and are separated. However, the panicles in the second flush are not as luxuriant as the earlier flush.

Under Phulbani conditions, a bundle of broom is made from 85 to 130 panicles. It is observed that the broom bundles made in the southern part of Phulbani are superior

to those available in G.Udayagiri or Charichhak areas in the northern or eastern side of the district.

The brooms of Orissa have a good market in Bombay. On an average, 70 to 80 wagon loads of broom are sent to Bombay every year. Broom grass can fetch an annual income of Rs. 1,500 to Rs. 1,750 in the first year and Rs. 2,000 to Rs. 2,500 from the second year onwards from each acre of land without much investment. It produces 8.0 to 10 tonnes of fresh biomass. After the brooms are made, the residual leaves can be fed to cattle and the stem can serve as fuel for cooking.

The employment generated in rural areas and the secondary income available to rural poor cannot be ignored. If it is taken up under social forestry along with fuelwood species, it can profitably serve as a vegetative hedge and provide additional income as well. Therefore, the cultivation of broom grass deserves promotion, instead of allowing it to just grow naturally.

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BENEFITS AND USES OF NEEM TREE

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ABSTRACT

Products from neem have extensive use in medicine and agriculture. Constituents of leaf, stem, flower and seed have been used traditionally to cure many diseases. In agriculture, neem cake is used as a nitrification regulator, cattle feed and pesticide while the oil has uses as pesticide and non-edible oil. The paper describes the collection and processing of seeds and the benefits of growing neem tree. Neem tree is a reliable source of supplementary income since a farmer can earn about Rs. 1000/- by collecting 100 kg seeds from three trees.

INTRODUCTION

Mythology has it that when *Amrita* (heavenly nectar) was being taken to heaven from earth for use by Gods, a few drops fell on the neem tree. Hence on new year's day, Hindus eat neem leaves and bathe with water boiled with a few such leaves as it is supposed to ensure freedom from diseases. For centuries, the tree has been held in esteem by Indian folk tales because of its medicinal and insecticidal values. Mixing neem leaves with grains before storage and placing dried leaves between the folds of woollen and other clothes to protect them against insect attack are well known to Indians. While neem was valued mainly for its medicinal use in the past, today it has emerged as one of the most important trees having multifarious uses.

DOMESTIC USES AND GENERAL BENEFITS

All parts of the neem tree are useful. In addition to routine uses, the tree also has industrial uses. The bark contains about 10% tannin, a chemical required by the leather industry. The tree also provides durable timber used for constructing door

panels, carts and toys.

The wood is termite resistant and hence cupboards and trunks made from this wood are believed to provide protection to stored materials. The tree is considered as a prophylactic aganist malarial fever because substances leached out of the seeds by rain water can drain into stagnant water and inhibit development of mosquito larvae. It is also believed that mere presence of neem tree improves the environment of the neighbourhood. Water extracted from seed kernel at a very low concentration of 62.5 ppm has been reported to delay the development and kill mosquito larvae (Singh, 1984). In addition, germicidal properties of neem coupled with the release of high amounts of oxygen by the tree can also improve the neighbourhood. This is supported by the recent finding of Chaurasia and Jain (1978) that essential oil of neem has antibacterial activity.

MEDICINAL USES

Neem oil is perhaps the oldest oil used as medicine. In India, its presence has been confirmed through its Sanskrit names 'Nimba' and 'Arishta' showing that the tree has been in use in Artgasgastra of Kautilya in 4th century B.C. Various parts of the tree (leaves, bark and fruits) have been used in Ayurveda by the famous Hindu physician Susruta (1000 A.D.). There is hardly any disease in which efficacy of neem has not been mentioned. The most extensive use in the past, however, was in treatment of skin diseases, wounds and ulcers. Even today, neem is often used for treatment of a variety of diseases in rural India. Medicinal values of different parts of neem tree as mentioned in ancient literature are given below.

Bark

Uses of bark include tonic, astringent, antipyretic, thrust, nausea, vomitting, skin diseases, ulcer, antiperiodic and febrifuge. The bark also has purifying and anthelmintic properties.

Leaf

Used as an antiseptic, uruticaria, earache, glandular tumour, postural eruptions (pimples containing pus, more especially in the eruption of small pox), anthelmintic,

jaundice, pruigo (eruption of skin causing itching), boils, ulcer and liver ailment. Leaf extraction markedly delayed plasma clotting time using Russel's viper venom.

Seed oil

Used to cure diseases related to glands (tuberculosis of lymphatic glands), leprosy, rheumatism (external application), vermifuge, and mango. It can be used as a hair tonic. The oil of neem leaf inhibited the growth of *Mycobacterium tuberculosis* and three other bacteria (Chopra, 1958).

Nibidin

A compound present in the seed oil, nibidin, was found effective against many skin diseases, pyorrhea, bleeding gums and sore throat. It is also diuretic. Lotions, paste and tooth pastes prepared according to usual prescriptions have proved effective in the treatment of pyorrhea and bleeding gums.

Branchlets

Twig/sticks have antiseptic and refreshing qualities when used as a chewing stick.

Flower

Stimulant tonic, atonic dyspepsia (indigestion).

Gum

Stimulant, demulcent and tonic.

Tree exudate or toddy

Neem tree exudate appears to be effective aganist some chronic and long standing cases of leprosy and other skin infections, atonic dyspepsia and general debility (Mitra, 1963).

The tree is also reported to have emmennagogue (to restore menstruation) property. It is also said that a village with plenty of neem trees does not suffer from diseases.

Neem as nitrification regulator

Bains et al. (1971) at the Indian Agricultural Research Institute, New Delhi, showed that treatment of urea with an acetone extract of dried and crushed neem kernel compared well with proven nitrification inhibitors. Neem coated urea was as effective as sulphur coated urea, lac coated urea and N-serve treated urea (Prakash Rao and Prasad, 1980 ; Sharma and Prasad, 1980).

In field experiments in Delhi, neem coated urea (160 kg urea + 40 kg neem cake) produced 6.0 quintals more of rough rice than 200 kg urea/ha used alone (figure 2). Thus, farmers not only saved 40 kg urea but got an additional yield. The net profit was Rs. 940.00 per ha. In trials in Karnal, urea physically mixed with neem saved 50 kg urea and produced an additional yield of 10 quintal/ha of grain. The net gain was Rs. 235.00 per ha.

Coating of urea with neem cake can be easily done by a farmer. A simple technology was developed at the Indian Agricultural Research Institute to enable farmers to coat urea for effective utilization of N-fertilizers. The process of coating is as follows : one kg of coat tar is dissolved in 2.0 litres of kerosene oil. This solution is gradually added to 100 kg urea kept in a rotating seed treating drum. By rotating the drum, a thin film of coal tar is formed on the urea pills. Finely powdered 20 kg of neem cake is then added and mixed thoroughly to get the urea coated. It can also be stored. Neem coated urea also provides protection against insect pests. A commercial product 'Nimim' is now being marketed by Godrej company in India.

Neem as Pesticide

Releasing tonnes of synthetic pesticide in the environment is certainly not an appropriate approach for managing insect pests. According to Almeida (1984), there are an estimated 375,000 cases of human poisoning by pesticides in developing countries every year with some 10,000 deaths.

Further, due to increasing cost of synthetic pesticides and increasing doses to combat resistance, pesticides are becoming an unprofitable input in agriculture. About 22 sprays are needed to contain cotton pests. Virtually, all insecticides failed to control *Helicoverpa armigera* (cotton ball worm) in Guntur and Prakasam districts of Andhra Pradesh. A similar situation may emerge soon in the case of paddy in South India because of intensive use of insecticides. Therefore, it has become imperative to identify sources which are not only effective but also safe, available and renewable.

While the value of neem leaves as grain and cloth protectant was known in the past, the active material at a concentration of 0.1%, completely protected the standing crop against desert locust *Schistocerca gregaria* (Pradhan et al., 1962). Later in laboratory tests, 0.05% and 0.001% suspension offered complete protection to cabbage and maize against locusts, *Locusta migratoria* and *Schistocerca gregaria*, respectively.

Studies conducted during the past 20 years have revealed that neem has diverse biological effects on insects. It acts as a repellent, feeding and oviposition deterrent, arrests growth of developing stages, causes sterility and also has mild direct toxicity. No other plant or synthetic substance is known to have such a diverse activity against insects. More than 250 insect species have already been reported susceptible to neem extracts. In India alone, neem has been evaluated aganist 105 insect species (Singh and Kataria, 1991). Of the various biological effects of neem on insects, growth regulatory activity is the most important and rarely have insects not succumbed to this effect of neem.

Field evaluations

Field evaluations conducted in the past have offered encouraging results against numerous insect pests including some key pests : desert locust, *Schistocerca gregaria* (Pradhan et al, 1962) ; gram pod borer, *Helicoverpa armigera* (Singh et al, 1985); maize stem borer, *Chilo partellus* (Anonymous, 1983); green leaf hopper, *Nephotettix* spp. (Rajsekharan et al., 1988); mango hopper, *Idioscopus clypealis* (Singh and Srivastava, 1991); mustard aphid, *Lipaphis erysimi* (Srivastava and Parmer, 1985) and others.

Neem has also been found to possess nematicidal and fungicidal properties. About a

dozen nematodes have already been reported to be susceptible to neem. Soil treatment with neem cake at the rate of 1225 kg/ha has given effective control of *Meloidogyne incognita* in tomato and egg plants (Srivastava et al., 1971). Cardamom growers in South India regularly use neem cake for management of nematodes. Neem also has acaricidal property.

Aqueous extracts of neem leaf, seed karnel and cake can be effectively used for disease management of several fungi e.g. *Puccinia arachidis* (Muthuswamy et al., 1966) and *Sarocladium oryzae* (Eswaramurthy et al., 1989). The cake has been used at the rate of 5.0 t/ha for soil-borne fungi. Neem seed kernel derivatives have not shown promise against some storage and rice fungal pathogens (Garcia and Garcia, 1988).

Neem seed collection and processing

Increase in cost of insecticides and fertilizers has mostly affected poor and marginal farmers. Unfortunately, a few commercial neem products available for use are nearly as costly as conventionally used synthetic insecticides. Fortunately, crude neem seed kernel extracts are less costly and hazardous than synthetic insecticides. Following precautions are necessary to obtain good quality seeds for utilisation.

1. Ripe fruits fallen on the ground must be collected and depulped immediately by hand or mechanical depulper.

2. Seeds must be washed and sun-dried to remove moisture. A drier can also be used for this purpose. Drying is important as wet seeds easily get mouldy, resulting in development of aflatoxin and get charred on account of heat produced by auto-oxidation which affects both oil content as well as biological efficacy of seeds.

3. Dried seeds should be stored in airy containers like jute bag, basket or cloth bag in cool and dry places. Seeds can be stored up to one year without loss of activity, but must never be in plastic bags.

Preparation of crude extracts

Aqueous extract, neem oil and ethanolic extract are the most commonly used extracts. The first two extracts are easy to prepare, even an illiterate farmer can make it without any difficulty. Preparation of ethanolic extract is not only tedious but also involves ethanol, a licenced commodity which cannot be provided to farmers for fear of consumption. However, small scale industries can be established through village cooperatives for this purpose. Therefore preparation of aqueous extract and neem oil emulsion are described here.

Aqueous extract

In literature, aqueous extract of seed kernel is also referred to as 'Neem Seed Kernel Suspension (NSKS)', neem seed kernel extract (NSKS) or simply as water extract of neem kernel (NSK)'. It can be prepared in the following manner.

1. Decorticate seeds to separate the kernal (decorticator is available for large scale decortication).

2. Pound two handfuls of kernel (200-300 g) with pestle in a mortar until it becomes a coarse powder.

3. Transfer the powder to a bucket. Add 10 litres of water and stir it again for 20 minutes with the help of a wooden or metal rod. Filter it using a muslin cloth or any other fine gauze to separate the particles. Milky filterate is now ready for use as aqueous neem seed kernal extract.

4. Spray the extracts as conventional insecticides. Depending on type and size of crop, 500-1000 litres of spray fluid will be required to cover one hectare.

5. Repeat the spray after 5-6 days. Wait for results as neem does not kill insects instantly, but inhibits feeding, deters oviposition and retards growth of insects.

Neem oil emulsion

Neem oil is more suited for control of soft-bodied insects such as aphids, jassids and

white flies. Oil can be extracted with 'Kohlu Ghani' or a solvent. The former is better as insecticide because of its higher concentration of azadirachtin, the most important constituent.

Preparation

Take 500 ml oil in a bucket of 10 litre capacity. Add 50 ml emulsifier Triton-x-100 and stir it well. Add water to fill the bucket and stir it again until white emulsion is formed. If the oil floats on the surface as a separate layer, add more emulsifier and stir it again. The emulsion is now ready for spray. The rate of application is same as that for aqueous extract.

Oil may cause phytotoxicity. Therefore, users are advised to test the spray fluid on a few plants before large scale spraying because phytotoxicity symptoms appear within two days.

Neem as grain protectant against stored grain pests

Except saw-toothed beetle, *Oryzaephilus sunamensis* which feeds and breeds on neem seed kernel, all the other storage pests have been found to be susceptible to neem. Concentration of 1-2 parts of powdered seed kernel/100 parts of mung bean, gram, cowpea, pea, and wheat have generally been found to provide satisfactory protection against pulse beetle (*Calosobruchus maculatus*), wheat pest rice/weevil (*Sistopilus oryzae*), lesser grain borer (*Rhzopertha dominica*) and khapra beetle (*Trogoderma granarium*) (Jotwani and Sirkar, 1965, 1967). Neem seed kernel powder at the same concentration offered protection of sorghum aganist *S. oryzae* (Deshpande, 1967), and at 2% concentration protected paddy for six months which was as effective as treatment with 0.01% malathion (Nair, 1976). Neem leaf powder had lower activity than seed kernel against stored grain pests.

Neem oil at 0.025% concentration exhibited high activity against *Sitotroga cerealella* affecting stored paddy (Prakash et al., 1980) At 0.5 and 1% concentration, oil also effectively controlled the pulse beetle, (*Callosobruchus* spp.).

Deoiled neem seed kernel powder (cake) was highly effective against khapara beetle (*T. granariumd*), a serious pest of wheat in storage. Concentrations as low as

0.06 part/100 parts of wheat seed completely arrested the development of larvae (Singh and Kataria, 1986; Singh and Singh, 1985). Deoiled neem kernel powder was also found effective against red flour beetle (*Tribolium casteneum*) and rice moth (*Corcyra cephalonica*) (Jhansi Rani, 1984). Mixing of insecticides with foodgrain is legally prohibited. In practice, however, BHC is being mixed with grains by farmers for protection from insects. To avoid hazards associated with the use of BHC, farmers are advised to use neem seed kernel powder or cake for mixing with the grain and using it for seed purposes. The cake may be better than neem seed kernel powder as the former will not leave any obnoxious smell and is easily removable. Neem seed kernel powder or cake at 1-2 parts per 100 parts of grain can provide satisfactory protection for over six months.

Use of neem cake

Neem seed kernel has only 15% biologically active material which is easily removable. About 12% of this is in oil and 3% is in the cake. The residue (cake), after removal of the active compounds, has about 28% protein and can be used as cattle feed and for soap making.

Availability

Neem tree grows well in almost all types of climates below an altitude of 1800 m. Saline and alkaline (usar) soils are suitable for its growth, but not water logging and frost. Because of climate hardiness, neem grows abundantly throughout the country. A census of 1959 (Ketkar, 1976) shows that there are about 14 million trees in India with a yield potential of 414,633 tonnes of seed per year (Table 1). This census did not cover some important states like Bihar, Uttar Pradesh, Kerala, Jammu and Kashmir, Delhi and other Union Territories, and certain parts of the north-eastern region. Assuming there are only 3.0 million trees in the above states and adding the recent plantation of 2.0 million trees (now 3-4 years old) by the Maharashtra Government, the total figure for the country is 19 million trees.

Table 1. Distribution of Neem Tree in India and Estimated Production and Collection of Seeds (Tonnes).

State	No. of trees	Total production of seeds	Actual collection
Andhra Pradesh	634,855	11,473	3128
Gujarat	617,632	19,697	139
Madhya Pradesh	714,187	17,060	368
Tamil Nadu	2,470,000	53,555	15451
Maharashtra	669,419	26,397	210
Karnataka	767,581	18,804	3705
Orissa	--	1,103	--
Punjab	--	11,287	Not available
Rajasthan	--	3,696	Not available
Uttar Pradesh	7,740,393	249,241	Not available
West Bengal	265,000	2,339	651
Total as per 1959 survey	13,899,067	414,633	23,617
As per estimate	418,000		100,000

Value of Seed, Oil and Cake

Neem starts bearing fruits in 4-5 years and this continues for over 100 years. Assuming that an average size tree yields 30 kg seeds (range 30-50 kg) annually, the total seed yield of 570,000 tonnes in the country is worth Rs. 5700 million. Unlike in the past, neem is now an established commercial commodity with a ready market. The greatest problem associated with neem is the collection of seeds from scattered trees. The collection of seeds alone can provide employment to nearly 0.6 million people in the country for 60 days (Ketkar, 1976).

Neem as a source of supplementary income

Whereas collection of seeds from scattered trees for industries is a constraint, its availability locally is a blessing to farmers. Farmers can supplement their income by neem seed collection for industries. The seed yield from three trees is about 100 kg which is worth Rs.1000/-. Crushing 100 kg seeds in local 'Khoul' will yield 25 kg oil valued at Rs.1250/-.

The crushing cost is about Rs. 250/- so the profit is Rs. 1000/-. The advantage of selling oil rather than unprocessed seed is that the farmer gets neem cake as a by-product which can either be sold for about Rs. 5/- per kg or used for coating urea to increase its efficiency. Cake can also be used as a pesticide.

Other benefits

1. Toxicological data generated so far show that neem is the safest of all the currently used insecticides and hence most suited for developing countries. Neem-based insecticides are reportedly environment friendly and conserve beneficial fauna, especially parasites and predators of insect pests. Neem has positive effects on earthworms which contribute to soil fertility and reduce ostractods population which feed on nitrogen fixing algae. Unlike synthetic insecticides, neem based pesticides have several compounds having diverse biological effects. Therefore, insects are unlikely to develop resistance quickly.

2. It does not compete with agricultural crops as it can be grown almost anywhere including rocky land without much care.

3. Being a perennial species it requires almost no care after establishment and produces fruits for more than hundred years.

4. Being renewable biological products, the cost of neem derived pesticides can never be out of reach of the poor and marginal farmers.

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NEEM : SILVICULTURE, PRODUCTION AND USES

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ABSTRACT

Neem is a versatile tree native to India with several uses. However, systematic efforts have not been made to improve productivity or optimise its use. Being hardy, it can be an excellent tree species for afforestation of wastelands and rehabilitation of rural families on a sustainable basis. Neem seed production is heavily dependent on soil moisture availability and hence research is necessary in this field. Post-harvest handling of seeds is another important aspect which needs to be standardized to improve the profitability. Evaluation of different ecotypes and further selection for wood and seed production are also essential to make neem cultivation more attractive. Organic farming with neem-based botanical plant protection can be popularised if a suitable extension programme backed by appropriate research is implemented.

DISTRIBUTION

Neem (*Azadirachta indica*) is a versatile, hardy tree with several uses. This species originated in the region around North-east India and Burma, and spread to Pakistan, Sri Lanka, Thailand, Indonesia, Middle East, Sudan and Niger. In India, neem is found throughout the country except in high rainfall and cold hilly regions.

AGROCLIMATIC NEEDS

Neem is adapted to a wide range of temperatures between 0^0C and 45^0C, and an altitude up to 1500 m. It is a tree of semi-arid tropics, requiring a minimum rainfall of 450 mm for its survival. It cannot withstand water-logging and hence, well-drained soils are essential in areas receiving more than 1200 mm rainfall or irrigation. Neem

can grow on a variety of soils including dry, shallow, rocky, sandy or clay, but does not survive on highly saline or deep dry sand. Neem is one of the few species capable of growing well on calcarious soils with soil pH up to 8.5, even in the presence of hard pan at a soil depth of 1.5 - 2.0 m.

PROPAGATION AND SEED STORAGE

Seed is the only means of propagation so far. Research on neem has not advanced on the study of genetic variations either on research stations or in the field, although there exists a wide variation. It has been reported that provenances grown in Africa are rich in Azadirachtin and the strains in Thailand grow very tall without many side branches. Even in India, there is wide variation in the size of leaflets among trees growing in the same locality.

Plants can be established directly by sowing seeds or raising seedlings. So far, very little effort has been made on establishing neem plantations, probably because of problems associated with seeds, such as late fruiting and poor viability.

The flowering season varies from January-February in South India to April-May in North India. A good rainy season facilities better vegetative growth and delays the flowering by a few weeks.

Fruiting in neem starts in early June and continues till the end of August, spread over a period of 8 - 10 weeks, with a peak between the third and seventh week. Fruiting starts earlier in South India than in the North.

Neem seeds are not available for propagation when seedlings are generally raised in February - March. By the time the seeds ripen in June, it will be too late for raising the seedlings which are needed for planting in July - August. So it will be ideal to raise the seedlings in August - September and maintain them till the next planting season as the tall and healthy seedlings can establish well in the field. However, the cost of maintenance and availability of water are limiting factors. Another possibility is to collect seeds from South India, where some trees start fruiting from February onwards, for raising seedlings in March - April.

Short period of viability of the seeds is another serious problem. Seeds lose their

viability within 6 - 8 weeks, even after taking necessary precautions. Ripe fruits drop naturally on the ground, which need to be collected within 1-2 days for further processing. The seed is surrounded by sweet pulp and enclosed in a thick yellow skin, attractive to birds. Seeds are rich in oil (35-40%) and moisture (50%) and hence biochemical degeneration starts within a few days after dropping. As this will affect the viability and quality of the seeds, proper drying and storage of the seeds is essential.

The ideal method of seed processing is to collect the fruits every day and depulp immediately without washing in water. Then the seeds can be dried under sunlight for a few days to reduce the moisture content to 10%. This seed is good for commercial purposes.

The seeds needed for propagation should also be depulped immediately but stored in shade by spreading thinly in a well ventilated area to bring down the moisture content to 16 - 18%. The dried seeds can be then stored in tin containers or gunny bags up to two months. The germination rate of fresh seeds is 90%, which will drop down to 40% in 30 days and less than 5% in 60 days when stored in room temperature. Cold storage can prolong the viability to some extent, but no scientific studies have been carried out so far.

Seeds contain certain chemicals which inhibit germination. Hence it is advisable to soak the seeds in warm water at 65 - 70^0 C for 30 minutes to improve the germination.

GROWTH AND YIELD

No information is available about the effect of planting material on the overall performance of the trees. Presumably, trees grown from either seeds or seedlings should produce good trees. Most of the giant trees seen in the field have grown naturally from seeds, although planting of seedlings helps in better establishment at the initial stage.

Neem being a spreading type tree with a wide canopy and long economic life, wider spacing is needed. However, it is very difficult to maintain such a plantation, particularly by suppressing the weeds, if the spacing is too wide. Therefore, it is

advisable to establish initially with a spacing of 3 x 3 m and subsequently thin the trees as and when needed. It is also risky to establish neem in a mixed plantation as the other fast growing species may suppress this species. The Forest Department in India has recommended a spacing of 8.0 x 8.0 m to establish 150 trees per hectare. Neem is an ideal species for planting along roadsides, along canals and around the farm boundary to establish an effective windbreak.

Neem seedlings are hardy and drought resistant. However, it has been observed that in hot summer months, when the soil temperature around the plant is high, the tender tips dry off, which probably is a phenomenon to attain dormancy and withstand the moisture stress. New shoots emerge from the axillary buds when the climate is favourable. In such areas, mulching the base of the plant with organic matter or other material would help prevent the tip burn, which might facilitate continuous growth with few straight branches.

Neem, an evergreen tree, reaches a height of 15 - 20 m with a semi-straight trunk of 30 - 80 cm in diameter and spreading branches forming a canopy up to 12 - 15 m in diameter. Being a drought tolerant tree, neem grows better than many fast growing species in dry areas.

In a multilocational silvicultural study carried out at Urulikanchan (Maharashtra), Lakkihalli (near Tiptur in Karnataka) and Nanodara (near Ahmedabad in Gujarat), neem was superior to many other multipurpose tree species during the first three years of establishment (Table 1).

With a close spacing, the annual increment in biomass may vary from 3.0 to 10 cubic m per ha, and the trees generally start fruiting from the 6th year onwards although fruiting in the third year is common under ideal agro-climatic conditions. Well drained, deep soils with adequate moisture enhance tree growth and fruit yield. Trees of 10 - 12 years yield 5.0 - 8.0 kg seeds, while fully grown trees of 20 years and above yield 20 - 30 kg seeds every year. Seed yields vary with the area (influenced by soil) and season (influenced by moisture supply). Table 2 shows the yield of neem seeds from trees of different ages located in Gujarat, Maharashtra and Karnataka. The yield may go up or down by 50 - 100% depending on the rainfall in the previous season. There are reports of isolated trees yielding up to 250 kg seeds in a year.

Table 1. Performance of different MPTS in shallow (Urulikanchan), poor sandy (Lakkihalli) and sandy loam (Nanodara) soil types.

Species	Average Growth Rate Per Year					
	Urulikanchan		Lakkihalli		Nanodara	
	Height cm	DBH mm	Height cm	DBH mm	Height cm	DBH mm
Acacia auriculiformis	119	7	172	12		*
Acacia nilotica var cup.	127	13	25	02		*
Acacia nilotica var tel.	104	11	55	03	192	28
Albizia falcataria	--	--	84	07	--	--
Albizia lebbeck	119	18	151	12	158	24
Azadirachta indica	130	19	99	07	199	30
Cassia siamea	151	13	111	09	--	--
Casuarina equisetifolia	159	9	164	09		*
Dalbergia sissoo	119	10	106	05	--	--
Derris indica	68	05	48	04	96	13
Eucalyptus camaldulensis	211	16	200	17	--	--
Eucalyptus hybrid	200	17	176	15	--	--
Gliricidia sepium	167	13	87	06	--	--
Gmelina arborea	120	27	--	--	--	--
Leucaena leucocephala	197	21	114	08	134	28
Melia azedarach	170	20	140	11	113	18
Pithecellobium dulce	123	13	74	04	83	13
Prosopis juliflora	99	11	78	04	113	19

* Poor survival, Not Planted

Table 2. Annual Neem Seed Yield.

Age Group	Fresh Fruit Yield in kg/tree			
	Maharashtra	Gujarat	Karnataka	Average
8 - 10 years	08.06	10.03	09.00	09.03
15 - 20 years	11.07	16.00	12.00	13.03
Above 20 years	17.05	20.03	21.75	19.18
Average	12.06	15.05	14.23	14.01

Drought during the previous season reduces fruit size and quantity. As a result of moisture stress, fruiting starts early by 3 - 4 weeks. This shows that any effort in conserving the soil moisture in neem plantations will improve the seed yield.

It is estimated that with about 250 grown up neem trees on a hectare of wasteland with an average yield of 20 kg seeds per tree, the total yield can go up to 5000 kg seeds every year. At the current price of Rs. 1.50 per kg, the annual gross income of Rs.7500/- (US $ 300) is very attractive, even comparable to many agricultural crops.

Seed collection, depulping and drying should be carried out regularly to fetch better price for the produce. Seeds being rich in oil, are damaged due to bio-chemical action if stored without proper drying. Neem seeds are used for extracting oil, preparing Ayurvedic medicines, fungicidal and pesticidal preparations for plants and animals. Cake serves as manure and pesticide to control soil borne pests. Oil is used for pesticides, medicine, soap production and coating urea to reduce nitrogen loss of the fertilizer in the soil.

It has been reported that the annual biomass yield can go up from 3.0 - 10 cubic m/ha and the trees can be cut for poles and fuel after 12 - 15 years. Trees have to be maintained for 40 - 50 years to produce good quality timber.

Wood with a specific gravity of 0.56 to 0.85 is hard and resistant to pests and decay. It is used for ship building, house construction, furniture and charcoal making. Twigs and branches make good fuel. Leaves are fed to sheep and goat, particularly during times of scarcity. With better soil and water conservation measures, neem plantations on wastelands can be a sustainable source of income for the rural people throughout the tropics.

USE OF NEEM IN PLANT PROTECTION

Neem is a widely used botanical pesticide in traditional farming systems of India, particularly for cultivating high value crops. Before the introduction of pesticides, most of the farmers cultivated local varieties resistant to pests and diseases. However, crops like cardamom, turmeric and fruit crops like grapes and mango did require protection from soil borne diseases and pests and the farmers heavily depended on neem products, mostly the cake. Use of dried neem leaves for storing

food grains and fresh neem leaves while transporting fruits and vegetables was a common practice in rural India. However, with the introduction of plant protection chemicals, many farmers switched over from botanical to chemical pesticides.

A survey conducted during 1986-88 in Gujarat, Maharashtra, Karnataka and Tamil Nadu, found that there were still a large number of farmers using neem products for plant protection. In Maharashtra State, about 75 per cent of the farmers in neem growing areas were aware of the beneficial effects of neem cake on different crops. However, only a small number of farmers were using neem cake for crops like hybrid tomato, potato, groundnut, vegetable and fruit crops. The dosage and method of application are given below :

Crops	Method of Application	Dose t/ha	Time of Application
Potato	in furrows	0.5 - 2.0	before planting
Tomato	in furrows	0.5 - 2.0	before transplanting
Groundnut	broadcasting	0.5 - 2.0	before sowing
Grapes	ring method	0.5 - 2.0	after pruning in October

None of the farmers considered the use of neem cake as a complete measure to control pests and disease, but felt that it would help in reducing the incidence of pests and diseases. In addition, farmers also expected the following additional benefits:

1. supply of nutrients;

2. improvement in the quality of the produce, particularly the keeping quality of tomato and fruit crops;

3. reduction in the loss of nitrogen from ammonia-based fertilizers.

In Tamil Nadu, farmers are still using neem cake on crops like cardamom, grapes, turmeric and rice to control soil-borne nematodes and to improve the fertility status of the soil. Neem leaves and cake are also used as a bactericide for controlling several plant and animal diseases. Exploiting this property, neem cake is commercially used to blend with urea in the ratio of 1 : 9 to reduce the process of nitrification of urea in the soil. Thus, neem-coated urea reduces fertilizer doses up to 30 per cent for crop

production. However, use of neem products has been gradually declining during recent years, due to the following reasons:

1. non-availability of neem cake whenever required;

2. lack of authentic information on proper dosage for controlling different pests and diseases and variation in the quality of material;

3. lack of sales promotion to use botanical pesticides compared to the well established inorganic pesticide market network.

As a result, several farmers felt that using botanical pesticide was an out-dated, ineffective method and discontinued it. However, during recent years, several state governments have recommended the use of neem for controlling important diseases like white fly of cotton. This is helping to slowly reestablish the confidence of rural people, particularly small farmers, who are unable to buy expensive pesticides.

PROMOTION OF NEEM PRODUCTS

With proper research and extension, there is good scope to promote the use of neem products for plant protection. The following strategies would help in easy adoption of neem products for plant protection on a large scale :

1. standardisation of dosage and application schedules;

2. development of easy techniques to obtain standard material from local sources;

3. field demonstrations;

4. setting up of an extension agency to motivate farmers to use neem products and other botanical pesticides for plant protection;

5. it is better to concentrate on the crops to start with where intensive plant protection measures are not being followed by the farmers, so that a large number of small and poor farmers can take advantage of this practice;

6. priority for fruits and vegetables, in view of the growing concern for providing chemical free produce.

Thus neem can boost the economy of farmers by protecting crops at a low cost, while ensuring safety for the consumers and environment. It is estimated that about 90 per cent of the total neem oil produced in India is presently used as non-edible oil by the soap industry and fetches only Rs. 15 (US $ 0.55) per litre. With an alternate use as pesticide, the value of the produce will increase and benefit the neem tree growers.

STUDIES ON SEED GERMINATION AND OIL CONTENT IN NEEM (*AZADIRACHTA INDICA* A. JUSS)

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ABSTRACT

Studies were carried out for devising a cheap method of seed storage for neem. Seeds stored at an ambient temperature of 33.8°C recorded a germinability of 8% at the end of three months compared to 90% when freshly collected because of the drop in moisture content from 30.8 to 15.5%. Seeds stored in earthern pots buried in moist sand bed recorded a germinability of 62% at the end of three months. Grading of depulped fruits by the flotation method gave 18% floaters which recorded low viability and vigour. Rooting in stem cuttings was highest when treated with 1000 ppm IAA and IBA treatments. The Ca content of neem kernals ranged from 0.2-0.4%, Mg from 0.29-0.48%, P from 0.24-0.38% and oil content from 30.6-43.5% .

INTRODUCTION

Native to the Indo-Pakistan sub-continent (Chaney and Khudson, 1988), neem is a versatile tree having industrial, medicinal, energy, aesthetic and timber uses (Ketkar, 1976; Radwanski, 1977,1981 : Fagoonee, 1982). Neem bark contains 12-14% tannin which compares favourably with conventional tanning chemicals. Because of these manifold uses, neem is widely recommended for rural development projects and has been successful in arid tropical and sub-tropical regions the world over (Goor and Barney, 1976). The pesticidal proclivities of leaves and fruits (Atwal and Panji, 1975) kernels (Girish and Jain, 1974), oil (Attri and Ravi Prasad, 1980; Ali et al. 1983) and seed cake (Prughi, 1937) have generated great interest among scientists, especially entomologists. Based on this virtue, the need for developing countries to minimize

their dependency on imported pesticides by utilizing indigenous resources has been emphasised by many workers (Fagoonee, 1980 ; Jacobson, 1981).

STUDIES ON PROLONGING SEED LONGIVITY

Neem is a recalcitrant species. Besides being shed at relatively high moisture content (Maithani et al., 1989), seeds do not store well under conditions suitable for most seeds as they are prone to dehydration and chilling injuries (Emah, 1986; Maighani et al., 1989). Under ambient conditions, seeds retain their viability only for 2 to 3 weeks after collection. To date, there has been no successful method for long term storage of neem seed. Studies were therefore carried out to devise a cheap method for seed storage.

Sinkers separated by the flotation method and air dried after treatment with Dithane M-45 were transferred to 12 earthern pots (50 seeds per pot) and the pots buried up to neck level in 20 to 25% moist sand bed under a thatched shed. The mouth of the pot was kept open. Moisture content of sand was maintained by replenishing water once every three days. Similar number of seed lots stored in the ambient served as control.

The treatments were set up in quadruplicate in a completely randomized block design. At monthly intervals, for three months, four pots (replications) each were drawn from the storage media and 25 seeds from each pot tested for germination. Ten seeds were assayed for moisture content by the method of Willan (1985). Initial moisture content and germinability were determined prior to storage. While the mean temperature during the storage period was 33.8° C in the ambient, it was 25.6° C inside the pots buried in moist stand. Data were subjected to statistical analysis. The initial moisture content of the air-dried seeds was 30.8% and the initial germinability 90.0% (Table 1). Seeds stored in the ambient, exhibited a progressive decline in moisture content over time. The reduction during the first, second and third months of storage was 8.2, 5.2 and 1.9%, respectively. The cumulative loss was 15.3% or half as much as the initial moisture content. Concomitant with this fall in moisture, viability of seeds, measured as maximum germinability, also progressively decreased to a low of 8% at the end of three months. The magnitude of reduction in germinability was as high as 82.0%. In contrast, the seeds stored in earthern pots recorded a germinability of 62% at the end of three months, the loss compared to the

original being only 28.0%. The moisture content of these showed no appreciable loss over time and was maintained at an almost constant 30%.

The poor storability of seeds in the ambient may be attributed to their rapid dehydration. Seeds of four species high in moisture, *Mangifera indica, Shorea roxburghii, Hopea odorata* and *Symphonia globulifera*) lost moisture during dry storage (20 C, 55% RH) and lost their viability as they dried, though sensitivity to dehydration varied with species (Corbineau and Come, 1988). Complete loss of viability was observed when the moisture content fell to about 17% in *S. roxburghii* and *H. odorata,* 30% in *M. indica* and 37% in *S. globulifera.* Neem seeds contain a high percentage of both saturated and unsaturated fatty acids and free fatty acids within seeds could be responsible for loss of viability (Chaney and Knudson, 1988). Absence of appreciable seed senescence in earthern pots may be ascribed to maintenance of moisture content and non-formation of free fatty acids. This inexpensive method is recommended for storage of neem seeds for three months (Ponnusamy et al. 1991).

EFFECT OF GRADING DEPULPED FRUITS ON SEED VIABILITY AND VIGOUR

Ripe fruits collected from a 20 year old tree were depulped, washed thoroughly, air-dried for eight hours and graded into sinkers and floaters by the liquid floatation technique. The two grades were germinated separately on sterilized quartz sand filled in enamel trays. The number of germinants was counted 21 days after sowing, and the percentage germination computed. Dry weight of 10 random seedlings was obtained and vigour index calculated as the product of percentage germination and seedling dry weight.

In the total depulped seedlot, floaters accounted for 19% and were characterised not only by lesser weight but also by higher proportion of endocarp (Table 2). This may be attributed to ill-filling of kernels. In addition, their germinability (55%) and vigour index (3850) were also low. The sinkers, in contrast recorded higher values for not only viability measured as a maximum germinability, but also vigour measured in terms of seedling dry weight and vigour index. The magnitude of increase over the floaters was 35.0, 17.1 and 91.6% respectively. A close parallel between seed/fruit size/weight and seed viability and vigour has been documented in *Tectona grandis* (Edimann, 1934), *Leucaena leucocephala* (Pathak et al, 1974; Natarajan and Vinaya

Rai, 1984) and *Ceiba pentandra* (Gawande, 1985) which emphasises the need for fruit or seed grading. But grading by weight or size alone was reported to be ineffective in eliminating inferior seeds from a seedlot and density grading based on fullness of seed was emphasised (Ferguson and Turner, 1971). It is a reliable index of seed maturity (Bartee and Kreig, 1974) as well as seed quality (Kreig and Bartee, 1975). Density grading in preference to size or weight grading has also been advocated by Tupper et al. (1971). Enhanced germination obtained with density graded fruits in the present study is consistent with similar associations reported earlier in *Casuarina equisetifolia* (Kaja Maideen et al., 1989). It is, therefore, advocated that depulped seeds in neem be density graded and only the sinkers used for sowing.

VEGETATIVE PROPAGATION THROUGH STEM CUTTING

The poor storability of neem seeds (Chaney and Knudson, 1988) underscores the need for devising suitable clonal propagation methods. A tonne of seeds procured from Burma is reported to have failed to germinate in the Philippines (Ahmed and Grainge, 1986) owing to loss of viability in transport. Clonal propagation is advocated as a viable alternative to conventional breeding which has a long waiting period. Thus studies were carried out to delineate a suitable method for producing vegetative propagules in the species.

Hardwood cuttings 20 cm long and 0.5 cm wide were collected from the lower half of the crown (Girouard, 1970) in a eight year old woodlot. The basal end of the cuttings was cut to increase the surface area for rooting and quickly dipped for 60 seconds in growth regulators like IAA, IBA and GA, each at four concentrations of 500, 1000, 1500 and 2000 ppm. The cuttings were planted to 10 cm depth in 20 x 10 cm polypots holding 750 g of a mixture of field soil, sand and FYM in the proportion of 4:1:1. After planting, the polypots were transferred to a mist-chamber maintained at a RH of 80% and a temperature of 30 + 2° C. The following parameters were assessed 135 days after planting (1) percentage rooting; (2) no. of primary roots; (3) root length; (4) no. of sprouts; (5) no. of leaves and (6) leaf length.

Percentage rooting was highest under 1000 ppm of IAA and IBA (Table 3). Besides, under IBA, number of sprouts, number of leaves and leaf length were also higher. Therefore, IBA at 1000 ppm is recommended as a promising treatment for promoting

rooting in stem cuttings of neem.

MINERAL CONSTITUENTS OF NEEM KERNELS

Neem kernels collected from different agro-eco zones were analysed for minerals like calcium, magnesium and phosphorus. The calcium content of kernels ranged from 0.2% to 0.4%, magnesium content from 0.29% to 0.46% and phosphorus content from 0.24% to 0.38% (Table 4).

OIL CONTENT IN NEEM KERNELS

The oil of neem kernels collected from different eco-zones was estimated using nuclear magnetic resonance. Preliminary standardisation was done using Soxhlet apparatus. The district-wise comparison indicated a maximum of 40.6% in Nellai Kattabomman district followed by Coimbatore (40.4%), Changai Anna (40.4%), Kanyakumari (40.4%), Ramnad (40.4%), North-Arcot (4-%) and Chidambaranar (40%) (Table 5).

SOILS

Soils of the different agro-eco zones vary considerably in their physico-chemical characteristics. The different soil types encountered in the various zones were red loam, black soil, alluvial and lateritic soil. Soil samples were collected under the neem trees from which seeds were taken. The chemical characteristics of these soils were assessed using standard techniques. The data on soil analysis indicated wide variations in the characteristics like pH, organic carbon, available nutrients like N, P, K as well as Ca and Mg.

AZADIRACHTIN

Azadirachtin is a triterpenoid found in seed kernals. In addition, two other active feeding deterents, meliantriol and salannin (Jacobson 1986) have been found in the kernel. Vepaol is another compound isolated from the kernel which has anti-feedant properties (Sankaran et al., 1986). Another new triterperoid has been isolated from the undried leaves (Salimuzzaman Siddiqui et al., 1984).

Azadirachtin content in trees from various zones was analysed using High Pressure Liquid Chromatography. Highest Azadirachtin content of 10,000 mg/kg of seed was recorded in seeds from Western zone (Banhari). The lowest quantity was in seeds of South eastern zone (Virudachalam, 1307 mg/kg of seed). Thus a wide variability of Azadirachtin content among the zones was observed. The soil content and azadirachtin content in respect of nine locations was correlated with corresponding oil contents, but no relationship was evident.

Table 1. Effect of Wet Storage on Seed Viability and Vigour in Neem.

Storage Medium	Months after storage							
	Seed Germination %				Seed Moisture Content %			
	0	1	2	3	0	1	2	3
Earthern pot	30.8	30.5	30.4	30.1	90.0	86.0	78.0	62.0
	(-33.7)	(33.5)	(83.4)	(33.2)	(71.5)	(68.3)	(61.7)	(51.1)
Ambient	30.8	22.6	17.4	15.5	90.0	74.0	26.0	8.0
	(33.7)	(28.3)	(23.6)	(23.1)	(71.5)	(58.6)	(30.4)	(16.3)

(Figures in parentheses are arc-sine transformations)

Table 2. Effect of Fruit Density on Seed Viability and Vigour in Neem.

Fruit Density Grade	Percentage to Total Depulped	100 Fruit Weight Depulped Fruit-lot	Proportion to Total Depulped Fruit Weight %		Percentage Germination	Dry Weight MS per Seedlings	Vigour Index
			Kernel	Endocarp			
Sinker	82.0 (64.9)	24.8	64.0	36.0	90.0	82	7380
Floater	13.0 (25.1)	31.5 (49.9)	57.0 (47.8)	42.0 (47.8)	55.0	70	3850
SZD	0.35	0.10	0.46	0.33	0.66	0.7	1.7
CD (52%)	0.75	0.21	1.00	0.72	1.47	1.5	3.7

(Figures in parantheses are arc-sine transformations)

Table 3. Effect of Growth Regulators on Rooting of *Azadirachta Indica.*

Growth Regulator	Levels (PPM)	Percentage Rooting	No. of Sprouts	No. of Leaf	Root Length (CM)
1 AA	500	54.6	1.3	9.0	9.4
	1000	72.6	2.0	13.3	13.4
	2000	65.3	1.6	16.6	12.6
Mean		63.7	1.6	12.8	11.6
1BA	500	48.3	1.6	13.7	7.7
	1000	66.6	3.3	17.6	8.5
	1500	60.6	2.3	16.0	12.1
	2000	63.6	3.3	16.0	17.9
Mean		59.7	2.6	15.8	11.5
GA	500	53.0	1.6	11.0	12.8
	1000	58.6	2.0	17.0	17.0
	1500	53.0	1.6	16.0	16.3
	2000	60.0	2.3	11.0	12.5
Mean		56.1	1.8	13.7	14.6
Control		52.8	1.3	8.0	7.8

Table 4. Mineral Constituents of Neem Kernels from Different Districts of Tamil Nadu.

District	Ca %	Mg %	P %
Coimbatore	0.32	0.24	0.35
Periyar	0.32	0.33	0.36
Pudukottai	0.30	0.27	0.32
Madurai	0.20	0.30	0.26
Trichy	0.40	0.24	0.36
Nellai Kattabomman	0.30	0.41	0.36
Ramnad	0.12	0.46	0.35
North Arcot	0.32	0.30	0.24
Tanjore	0.24	0.30	0.36
Kamarajar	0.30	0.33	0.36
Pasumpon	0.28	0.32	0.31
Dindigal - QM	0.31	0.29	0.31
Chidambaranar	0.32	0.31	0.36

Table 5. Range and Mean of the Oil Content of Neem Kernels from Different Districts of Tamil Nadu.

District	Mean Oil	Content (Kernel)	Content (Kernel)
Coimbatore	40.4	30.9	43.0
Periyar	39.0	37.0	41.3
Pudukottai	39.5	34.7	41.5
Madurai	36.0	30.6	41.7
Chengai Anna	40.4	40.0	40.9
Trichy	39.6	39.0	41.3
South Arcot	39.5	38.0	41.4
Kanyakumari	40.4	39.5	41.4
Nellai Kattabomman	40.6	38.2	42.2
Ramnad	40.2	38.8	41.7
North Arcot	40.0	38.0	42.2
Tanjore	39.4	39.2	41.3
Kamarajar	39.8	38.8	41.7
Pasumpon	39.6	38.1	41.5
Dharmapuri	39.6	39.0	40.1
Dindigual - QM	39.0	36.2	40.5
Chidambaranar	40.0	36.7	40.6
Salem	39.5	38.5	40.5

THE NEED FOR COOPERATIVE RESEARCH ON NEEM

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ABSTRACT

Azadirachta indica A. Juss. (neem) is native to dry forest areas of South and Southeast Asia, but has been introduced to many semi-arid regions around the world. In its native range, particularly in India, it has provided raw materials for rural industry for probably thousands of years. It is an important forestry and agroforestry species throughout arid and semi-arid Africa. Extracts of oil and chemicals from the seed for industrial uses is gaining worldwide attention, and numerous investigations have been made in this area. Despite this interest, there are no reports of provenance studies in international literature. Studies of ontogeny, phenology, and genetics are also lacking. Proper seed handling techniques for medium-term storage are not widely used. Studies in these areas are warranted, given recent indications of substantial variations in azadirachtin content and foliar disease in Africa. Recently, the F/FRED project, in collaboration with the Technical Centre for Tropical Forestry (CTFT, France) have advocated the development of a neem research network that would exchange germplasm intra- and inter-regionally. It is hoped that modest collections and preliminary studies can begin in 1992 and lead to more formal efforts in 1993 and 1994.

INTRODUCTION

Neem (*Azadirachta indica* A. Juss.) needs no introduction in this forum of Indian foresters and development workers. The uses of this quintessential model of a multi-purpose tree are well known on the sub-continent. It provides important products at just about every level of the economy: personal, household, cottage and rural industry, and the capitalized manufacturing sector. The products are varied: toothbrushes and toothpaste; fodder, fertilizer and fuelwood; insecticides and

industrial oils; soap and shampoo; birth control products and medicine. The list seems endless. Despite the great demand in India for the products of neem, there is yet little coordinated effort to improve the tree or even study the vast range of genetic variation in the species.

There have been provenance studies attempted in the past (A.N. Chaturvedi, personal communication, 1991), but seed viability loss during transport and other problems limited the impact and outcome of the studies. Similarly, there have been limited all-India studies on phenology (Narayan Hegde, personal communication, 1987), but these ran only for a year, and information, although often cited, was inconclusive.

This paper argues for the establishment of a series of provenance trials of neem, based on range-wide collections in collaboration with colleagues and scientists throughout the world where neem is grown and used by rural folk.

BOTANY AND DISTRIBUTION

Neem is native to the dry forests of Burma (particularly the Irawaddy Valley) and probably India, but may also occur naturally in parts of Pakistan, Sri Lanka, Malaysia, Indonesia, Bangladesh, and Thailand. Several varieties are known. In Thailand, for example, *A. indica* var. siamensis occurs in the central plain (Bhumibhamon 1988).

Neem is widely cultivated by farmers in peninsular India, and has been included in reforestation schemes in drier areas of Thailand, Philippines, and elsewhere. It has also been successfully introduced throughout semiarid Africa, notably in the Sudan, Sahel, and East Africa. In northern Niger, it is the premier forestry species, outgrowing most other exotics and local species.

The successful adaption of neem to West African conditions deserves special mention. Initial introductions were most likely limited to a very few seedlots in the early 1900s by the French in Senegal and the English in Nigeria. During the last 50 years, it has become the paramount plantation species in most Sahelian countries, and has been featured in major projects of donors like FAO/UNDP and the World Bank. It is the basis for several important agroforestry projects, notably the Majjia Valley windbreak project of CARE International. It is not uncommon for plantations to

yield 20 m^3 ha^{-1} Yr^{-1} on 8-year rotations (NAS 1980).

Although neem in Africa is not exploited for the wide range of products as in India, it is a valued fuelwood and polewood. Common practice in agroforestry schemes is to pollard it at 2.0 m height on an 8-year rotation and harvest the regrowth for poles after another three years.

In Africa, neem has enjoyed pest- and disease-free growth which no doubt accounts for its successful adoption. However, the outbreak of a fungal disease (Appendix 1) recently is devastating the Sahelian populations over an east-west range of about 1500 km from Chad to Mali. The disease expresses symptoms early in young trees and pollarded stems, but is invariably fatal even in mature trees.

GENETICS AND PHENOLOGY

Little work has been done on the genetic diversity of neem in either its native range or areas of introduction. Yet phenotypic differences have been shown to occur in several parameters. The most important among these is azadirachtin content, which is one of the active insecticidal components of the seed. For example, Jacobson (1985, cited by Benge 1986) reported that seed from Indian sources contained only 1-3% of the compound, whereas seed of African sources averaged 5-6%, with some lots exceeding 9%. The sources if this variation could be linked to a host of non-genetic factors such as environment, seed handling, age of tree and harvest period. Nonetheless, it deserves closer study. It may prove useful for India to import some of the landraces from West Africa showing higher azadirachtin content.

Another example of probable genetic variation is the recognition of two non-astringent vegetable cultivars of neem (var. siamensis) by farmers in Thailand (Bhumibhamon, 1988). This race is characterized by larger leaves and smoother leaf margins than the Indian type. Again, it may be valuable for such varieties to be tested in India for fodder and vegetable use.

Of possible interest here is the difference in animal browsing behavior between Indian and African types. Unlike in India, where neem is recognized as a good fodder, it has the reputation of being undesirable for this purpose in West Africa, except in areas where forage is extremely limited. This is very advantageous when neem is

planted in agricultural areas where it can be damaged by browsing livestock. The phenomenon has been explained by some as a mere difference in livestock preference, but it could in fact be related to different levels of astringents between the two types.

The flowering pattern of neem apparently varies in latitude. Singh (1982) reported that the species flowers in February in Mysore, March in central India, and April in North India and Tamil Nadu. In the sub-Himalayas, the species does not flower until the first week of May. This can have a profound influence on seed collection, and it would be desirable to work this ralationship out beforehand before proceeding with seed collections.

Neem seed has a reputation for being short-lived, but it is not clear whether this in fact is true recalcitrance. Recalcitrant seed have short life spans, and can tolerate neither low temperatures (below 20°C) nor reduction of moisture content below relatively high values (Willen 1985). Since neem seed can be dried and stored at a temperature as low as 4°C, it may not be a recalcitrant species, but rather simply an orthodox short-lived one. Studies by CTFT in Africa have shown that with proper handling, the seed can be stored for up to a year (Appendix 2).

THE CASE FOR RANGE-WIDE PROVENANCE TRIALS

The argument for further study of neem is self-evident. Collections in the presumed center of origin in the Burma-India region may capture useful genetic diversity and ultimately lead to varieties with improved disease resistance, form, or growth rate. Sampling landraces and cultivated types thoughout its range in Asia could yield important food and fodder types. Seed collections in Africa could well lead to superior chemical (azadirachtin) content, and varieties for wood production that are browse-resistant. However, before an expensive collection and progeny trial program commences, several important related activities and studies must be done. These include :

1. Formation of an inter-regional neem improvement network, preferably with membership institutions in Bangladesh, Burma, India, Indonesia, Malaysia, Pakistan, Thailand in Asia; and Burkina Faso, Chad, Mali, Niger, and Nigeria in W. Africa. Besides F/FRED, other institutions have expressed an interest in this

work: CTFT, (France), FAO, USAID, OFI (Oxford Forestry Institute, UK), and CARE. CTFT and F/FRED have recently signed a Memorandum of Understanding to develop a workplan for the network among other activities. It is crucial that we have the input of interested scientists attending this meeting.

2. Preparation of monographs of neem in the major countries of native diversity, emphasizing and synthesizing information on distribution, variability, phenology, past provenance studies and the like. In the case of India, this could be regionalized further to northern, central and southern India and combined at a later date.

3. Technical backstopping studies to verify seed collection and storage methodologies, and confirm or amend theories on phenology and genetic variation in neem. Clearly, the seed handling procedure is a major constraint.

F/FRED envisions the creation of a core network in 1992 including backstopping studies, modest landrace collections and pilot provenance/landrace trials in a few chosen locations. This would allow collaborators sufficient time to become familiar with the species and to develop suitable methods for working with colleagues in other countries. Possibly an inter-regional workshop could take place in late 1992 or early 1993 to address the issues and workout a plan for major collection, germplasm exchange and trial establishment in 1993. Given the supposed short life of neem seed, the logistics of the operation could prove to be limiting.

CONCLUSION

The real purpose of any network is to address the felt needs of its members. Neem has been identified as a priority species for the MPTS by the Network Research Committee (Bhumibhamon et al. 1991). Recent disease problems in West Africa need to be addressed by classic improvement strategies. Well-developed international and local markets for a wide range of products need to be served. We are confident that the MPTS network can rise to the challenge and develop an effective tree improvement program for this tree of the small farmer.

Appendix 1. The neem disorder of West Africa: Some characteristic symptoms (after Batra, 1991).

- Young leaves change color from a shiny green to a dull olive green or a pale yellow.

- Leaves are often deformed, crinkled, curled, in-folded, and compressed together near branch tips. Older leaves dehisce early.

- Shortened internodes near apex and leaf fall towards the tree give branches a bushy and spindly appearance.

- Denuded shoots exhibit permanently wilted, yellow, gummy tips.

- Shining clear white to translucent yellow gum exudes from branch tips.

- Shunting and yellowing of young branches precede die-back of branch and apical tip, leaving behind bare, dead, scorched branches, leading eventually to death of entire tree.

- Tell-tale red stain under bark at the outer limit of the cambium.

Appendix 2. Draft guidelines for *Azadirachta indica* provenance seed collection (derived from Souvannavong, 1992).

Despite the widespread use of neem (*Azadirachta indica* A. Juss., Meliaceae), attempts to widen the narrow genetic base in areas of introduction have failed. This is because of its rapid loss in viability, which hinders germplasm collection, forwarding, and storage (Webb et al. 1984).

Recent studies have shown that, if properly handled, neem seed can be stored for sufficient periods to allow germplasm exchange (Roberts et al., 1984). Using proper techniques, neem seed can have up to 42% germination after five years of storage at $4^{o}C$ (Roederer and Bellefontaine 1989). More recent studies (Bellefontaine and Audient, in press) have developed precise methods to ensure good conservation and germination. Seedlots properly collected and processed still have between 60% and 95% germination rates after nine months of cold storage.

To ensure medium-term storage, the following guidelines, based on the studies mentioned above, should be followed :

Time of collection. The optimum time for collection is when the color of the drupes turns yellowish-green and are still on the trees. Yellow-brown, wrinkled drupes, or drupes already fallen should be avoided, as their viability declines repidly in storage.

Collection methodology. The following method has proved satisfactory in obtaining seed suitable for medium-term storage:

1. Clear the ground under the tree of previously dropped drupes.

2. If possible, spread a cloth or tarpaulin under the tree, and shake the tree branches with poles. Drupes fall easily when they are at the optimum period for collection. Climbing may be necessary for very tall trees.

3. Seeds collected from one tree are bagged in muslin (not plastic) bags and labelled inside and out using an agreed, standard labelling method.

Seed handling. Collected seed should be processed as soon as possible to ensure conservation of viability using the following techniques :

1. Remove the fleshy part of the drupe leaving only the stone and with the kernel inside. With fresh and turgid drupes, stones can be easily extracted with mild pressure of the fingers. Dried or yellow-brown drupes should be discarded.

2. The stones are rapidly and carefully washed in clean water, taking care to remove flesh. Stones should not be soaked.

3. Stones are spread in one layer on sheets and are dried in the shade. Proper drying is absolutely necessary to ensure longer viability and minimize sanitary problems. Time for drying depends on weather conditions (about 5-10 days).

Documentation. Complete and standard identification of seedlots is necessary throughout the collection and dispatch process. Mother trees should be labelled and mapped if relocation is necessary, and a standard description (total height, dbh, etc.) recorded using an agreed-upon and uniform seed collection form.

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THE NEED FOR PROTECTION AND CULTIVATION OF MEDICINAL PLANTS AS AN INTEGRAL PART OF SOCIAL FORESTRY PROGRAMMES

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ABSTRACT

The indigenous system of medicine in India is known by many names, but the common element in the different branches of this system is the use of medicinal plants. These plants, an essential component of natural forests, are being used in greater quantity than synthetic drugs. However, many of these species are endangered due to indiscriminate deforestation. Therefore, involvement of individuals and voluntary organisations to protect and propagate these species, and their inclusion in social forestry programmes by Forest Departments is necessary.

India is known for its own indigenous system of medicine, variously known as "Folk medicine", "Naturopathy", "Ayurveda" and "Siddha" which are prevalent with varying popular appeals and or acceptance in different parts of our country. All these branches of the indigenous system have a common element in that they use medicinal plants and herbs in various forms in their treatment.

Medicinal plants, have been a valuable component of natural forests. But recent mass deforestation has created concern among practitioners about availability of the basic requirement of conventional systems of medicine in the form of plant resources. Villagers usually go to the folk medical practitioner available at their doorsteps. Therefore, the quantity of medicinal plants used is relatively more than the synthetic drugs. In recent years, the popularity and demand of herbal medicines has been increasing in our country and abroad in view of their curative value and absence of harmful side effects.

Curative value of herbal medicines is demonstrated in chronic diseases like liver and spleen disorders, diabetes, asthma, rheumatoid or osteo-arthritis conditions, piles, nephrotic-syndromes and diseases like urinary calculi and nephritis, paralysis, nerve lesions and myopathies, viral diseases like chicken pox and small pox, mumps and

coryza. Herbal medicines are used in the treatment of cough, bronchitis, diarrhoea and dysentry.

Due to the popularity of the indigenous system and continuous usage of medicinal plants without propagation and cultivation, forests have been depleted of these valuable plant resources. In order to facilitate successful and simple medical services to the poor, it is necessary to protect and promote systematic cultivation of medicinal plants. It should be an integral part of social forestry. This vital component seems to have been overlooked in our social forestry programme. There is also the danger of losing rare species like *Raulfia serpentina* and *Aristolochia indica*. Hence there is a need to cultivate and protect medicinal plants as an integral part of the social forestry programme.

Enriching the forests with medicinal plants is a difficult task which can not be done by the Government alone without the help of public and volunteer organisations. People should be educated about the medicinal value of plants and encouraged to propagate them. Financial aid should be given for intensive cultivation of medicinal plants. When plantations start yielding, voluntary organisations can take up responsibility to regularise harvest and distribution. Government should promote planting of medicinal plants in social forestry programmes.

NON-WOOD FOREST PRODUCE FOR EMPLOYMENT AND INCOME GENERATION : PROBLEMS AND PROSPECTS

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ABSTRACT

Nearly 60% of the output of Non-Wood Forest Products (NWFP) are consumed as food and medicines and have other uses to the tribals and others in areas adjoining the forests. Approximately one tenth to three fifth of the incomes in such areas are derived from wages received from collection of NWFP and other forestry activities. Although the current annual production of various NWFP is estimated to be 3.2 million metric tonnes, this can be increased to 12.5 million metric tonnes with proper identification of resources, providing training on collection and storage of NWFP for tribals and rural population and strengthening of the existing infrastructure. Such a step will not only boost the estimated current annual employment in NWFP collection from 1.6 million man years (one man year = 300 man days) to nearly 4.0 million man years, but will also rejuvenate the rural base of the economy.

INTRODUCTION

India's forests are a rich depository of a multitude of tubers, herbs, shrubs and trees which yield a variety of wood and non-wood products for domestic consumption as well as trade. Gupta and Guleria (1982) have estimated that nearly 60% of the output of Non-Wood Forest Products (NWFP) from forests are consumed locally as food, medicines or have other uses for the tribals and rural population adjoining the forests. Some of these products are also bartered by tribals and others for meeting their needs of essential commodities. It has been further revealed in several surveys carried out in the states of Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh and Orissa that nearly one tenth to three fifth of the income of the tribal population is derived from the wages received in collection of NWFP and other forestry activities (Tewari 1986).

For the economy as a whole, out of a total forest revenue of Rs. 4725 million in 1980-81 (0.003% of Net National Revenue), nearly 36% was derived from the sale of NWFP. A study conducted by Gupta and Guleria (1982) estimated that compound rates of growth of revenues derived from sale of NWFP grew at the rate of 15.1% between 1968-69 to 1976-77, compared to 10.8% from wood products during the corresponding period. This indicates the vast potentialities for increased revenues through intensification of management efforts for scientific collection and processing of NWFP.

As of 1981-82, export earning from forest based products was Rs. 1731 miliions (1.3% of all commodities), of which nearly 70% comprised of revenues from the sale of NWFP. Although the trade balance for forest commodities as a whole was unfavourable during that year, [total imports Rs. 2632 million (1.2% of all commodities)], NWFP, taken separately, accounted for a favourable trade balance. There is considerable overseas demand for items like essential oils, gums and resins, plant materials used for dyeing and tanning. Production of these items can be increased manifold.

Efforts have been made in this paper to highlight the income and employment generation potential of some of the NWFP. The problems concerning collection, processing and marketing have also been briefly discussed. Measures have been suggested for strengthening of institutional infrastructure to organise these activities suitably.

NON-WOOD FOREST PRODUCTS OF ECONOMIC IMPORTANCE

Table 1 indicates NWFP which have good income generation and employment potential. Authentic and recent data on the production, value, income and employment generation is not available. The data collected by Gupta and Guleria (1982) has been used for this analysis. Of the current production of 3.2 million tonnes of various NWFP, the products of considerable economic importance are non-edible oils derived from tree species like *Madhuca indica, Azadirachta indica, Derris indica* and *Shorea robusta*, tendu leaves *(Diospyros melonoxylon* used for Indian cigarette manufacture), drugs species, insecticides, gums and resin. The full production potential of NWFP has not been realised, chiefly on account of lack of information on

resources, inaccessibility of areas and lack of storage facilities. Activities like collection and processing of seeds from tree species yielding non-edible oils, collection and, cultivation of grasses and trees yielding essential oils need urgent attention, as these activities have tremendous scope for increasing rural incomes and job opportunities. The actualisation of this potential will increase the annual production of NWFP to 12.5 million metric tonnes.

Table 1. Current and Potential Production of Non-wood Forest Products in India.

Sr. No.	Kinds of Produce	Production ('000 Tonnes)		Assumed*2 forest depot prices ('000) Rs. mt	Estimated value of produce (million Rupees)		% of Potential production annually utilised	% of the value to total value of production	
		Current	Potential		Current	Potential		Current	Potential
1	2	3	4	5	6	7	8	9	10
A.	**Fibres & Flosses**							0.0	1.9
1.	Fibre	2.5	45.0	2.60	6.5	117.0	5.6		
2.	Kopok floss	3.0	4.5	5.00	15.0	22.5	66.7		
B.	**GRASSES**							72.5	35.9
1.	Grass	350.0	525.0	5.10	1785.0	2677.5	44.8		
C.	**BAMBOOS & CANES**							3.2	2.3
1.	Bamboo	1932.0	4309.0	0.04	77.3	172.4	44.8		
2.	Canes	14.0	21.0	0.08	1.1	1.7	66.7		
D.	**ESSENTIAL OIL**							1.6	20.9
1.	Lemon Grass	1.3	1.9	25.04	32.6	47.6	68.4		
2.	Palmarosa	0.1	0.1	25.04	2.5	2.5	100.0		
3.	Eucalyptus	0.1	0.2	25.04	2.5	5.0	50.0		
4.	Cinnamon	0.0	0.0	15.06	1.5	3.0	50.0		
5.	Sandal	0.1	0.2	15.06	1.5	3.0	50.0		
6.	Pine	NA*1	100.0	15.00	NA*1	1500.0	0.0		
E.	**NON EDIBLE OIL**							6.7	30.71
1.	Mahua	85.0	490.0	0.51	43.4	249.9	17.3		
2.	Neem	6.0	418.0	0.26	1.6	108.7	1.4		
3.	Karanj	56.0	111.0	0.51	28.6	56.6	50.4		
4.	Kusum	30.0	90.0	0.33	9.9	29.7	33.3		
5.	Sal	240.0	5504.0	0.33	79.2	1816.3	4.4		
6.	Other oils	2.2	57.8	0.51	1.1	29.5	3.8		
F.	**TAN & DYES**							1.4	0.0
1.	Babul Avaram & Wattle bark	87.4 30.0	140.0 45.0	0.26	22.7	36.4	62.4		
2.	Myrabolans	100.0	150.0	0.11	11.0	16.5	66.7		

Sr. No.	Kinds of Produce	Production ('000 Tonnes)		Assumed*2 forest depot prices ('000) Rs. mt	Estimated value of produce (million Rupees)		% of Potential *3 production annually utilised	% of the value *4&5 to total value of production	
		Current	Potential		Current	Potential		Current	Potential
1	2	3	4	5	6	7	8	9	10
G.	**GUMS & RESINS**							5.3	
1.	Karaya gum	15.0	22.5	5.01	75.2	112.7	66.7		
2.	Ghatti and Babul gum	2.0	3.0	5.25	10.5	15.8	66.7		
3.	Resin	74.2	150.0	0.60	44.5	90.0	49.5		
H.	**LAC & TASAR SILK**								
1.	Lac & lac products	22.0	33.0	0.50	11.0	16.5	66.7		
2.	Tasar Silk	0.3	1.9	7.50	2.2	14.2	15.8		
I.	**LEAVES**							4.6	2.2
1.	Tendu leaves	210.0	300.0	0.54	113.4	162.0	70.0		
J.	**DRUGS, SPECIES & INSECTICIDES**							3.4	2.1
1.	Sarpagandha	0.6	1.6	40.00	24.0	64.0	37.5		
2.	Kulli	0.6	1.0	40.00	24.0	40.0	60.0		
3.	Cinchona	1.4	2.0	25.00	35.0	50.0	70.0		
	Total	3235.8	12482.7		2461.3	7458.04	25.9	98.7	98.9

Source - Gupta and Guleria (1982)

NOTE : * (1) NA : Not available

(2) See Text for Forest Depot price estimation

(3) Quantity wise = 25.9 $\left(\frac{\text{col 3}}{\text{col 4}} \times 100\right)$

(4) Errors due to rounding off

(5) Value wise = 33.0 $\left(\frac{\text{col 6}}{\text{col 7}} \times 100\right)$

An effort has been made to estimate the value of NWFP annually collected from the forests and the potential production there of. The estimates of Forest Department prices for each of these commodities has been calculated based on the author's experience in Chandrapur district of Maharashtra (Chowdhary 1975). Further, it is assumed that 50% of the value of the produce comprises of wages paid, 15% towards royalty paid to Forest Department, 10% towards administrative and storage expenses, 5% towards handling and transportation, and 20% towards the profit margin. Several intermediaries are involved before the products reach the final

consumers and at each of these stages, the intermediaries reap a substantial portion of the value additions derived in processing and marketing.

From the above account, it is obvious that the accrual of revenue in the shape of royalty received by the Forest Department is a mere fraction of NWFP collected from the forests. The value of the annually collected NWFP is estimated to be Rs. 2461.3 million, and if the production potential is fully realised, the value can be expected to be around Rs. 7458.0 million.

INCOME AND EMPLOYMENT GENERATED IN COLLECTION OF NWFPS

Table 2 gives the estimates of employment generated in the collection of NWFP. Nearly 1.6 million man years of work of the total estimated 6 million man years available in forestry annually are created in collection of NWFP. Assuming a national work force of 216 million in 1981 and availability of works for 150 days in a year, the equivalent man year employment annually at national level in all jobs works out to 108 million man years. The employment created in forestry operations and NWFP collection works out to, respectively, 5.5% and 1.5%. On the assumption of an average wage rate of Rs. 25/- per man day, it is estimated that the annual current wage disbursement is of the order of Rs. 12,354 million. Considering the fact that these constitute between 30% to 60% of the tribal incomes, the social significance of these wages is considerable, specially for the areas where alternative job opportunities are limited. Further, with the intensification of management efforts, the production of NWFP can be increased and the wage accruals are likely to rise to Rs. 29970 million, and with consequent benefits to tribal and rural population on realisation of full production potential. Collection of grasses and non-edible oil seeds have the largest potential for income and employment generation in NWFP.

Further, the major portion of NWFP is collected between March to June and a part of this season overlaps with agricultural operations (Table 2). As pointed out by Gupta and Guleria (1982), this will generate healthy competition in rural labour markets for agriculture and NWFP collection operations and would also mitigate under-employment of labour force which is reported to occur even during agricultural operations.

PROBLEMS IN NWFP COLLECTION

There are several impediments in increasing the annual production of NWFP. The main limitations are the lack of knowledge about the occurrence of various NWFP, inaccessibility of areas, lack of infrastructure and storage facilities and labour shortages, particularly in remote areas. The collection period being short, rapid mobilisation of resources is necessary, but is not readily forthcoming. In a large number of states, organisations like Tribal Development Corporations, Minor Forest Produce Development Corporations and Forest Labourers Cooperative Societies are in existence, but the fact remains that the bulk of NWFP remains uncollected and unutilised.

Besides the above factors, collectors, who are mostly tribals and unskilled workers, are ignorant about collection and storage methods and a large portion of the produce is wasted. Therefore, appropriate storage facilities, along with proper training for collection and handling of these products, need to be taken up on priority.

MEASURES FOR AUGMENTING NWFP COLLECTION

Appropriate organisations, with linkages at block, district and state levels and with an apex body for networking at the national level, need to be created to coordinate collection, processing and marketing of NWFP. These organisations will also have to arrange for finance and infrastructural facilities to harness the full production potential of NWFP. At present, several intermediaries and contractors are taking undue advantage of the simplicity and ignorance of tribals and other rural population in organising collection of NWFP. To avoid undue exploitation of tribals and others and to ensure fair wages, most of the states have enacted legislations and nationalised several important NWFP like tendu leaves *(Diospyros melanoxylon)*,

Table 2. Estimated Income and Employment Generated in Collection of Non-wood Forest Products.

Kinds of Produce	Collection Period	Estimated current employment ('000 man years)	Estimated* wages disbur-sement (Rs. in million)	Estimated Potential employment ('000 man years)	Estimated wages likely to accrue (Rs. in millions)	% of wages to total wages disbursement in NWFP	
						Current	Potential
Fibres & Flosses	March -June	14.4	108.0	94.0	705.0	0.0	2.3
Grasses	Oct-March	1200.0	9000.0	1800.0	13500.0	72.0	45.0
Bamboos & Canes	All year round	49.0	367.5	111.1	833.2	3.0	2.8
Essential oil	May- June for lemon grass Oct-Nov for palmrosa & All year round for the rest	27.2	204.0	140.9	1056.8	1.6	3.5
Non edible oil seeds	Apr-Jul Oct-Nov for Mahua in North & South respectively	109.1	818.2	1440.9	10806.8	6.6	36.0
Tans & dyes	All year round for all barks Myrabolans Jan-Mar	27.2	204.0	140.9	1056.8	1.6	3.5
Gums and resins	Apr-June	87.0	652.5	145.7	1092.8	5.3	3.6
Lac and Tasar	Oct-Jan and Apr-Jul for lac & Aug-Dec for Tasar silk	8.8	66.0	20.5	153.7	0.0	0.0
Tendu leaves	Apr-Jun	74.9	561.8	107.0	802.5	4.5	2.7
Drugs, spice & insecticides	Oct-Dec	55.6	417.0	102.7	770.2	3.4	2.6
Total		1647.2	12354.0	3996.0	29970.0	98.5 *	98.5 **

Source : Gupta and Guleria (1982)

* Wages assumed to be Rs. 7500/- per man year

** Errors due to rounding off

Mahua flowers and fruits *(Madhuca indica),* Gum Karayya *(Sterculia urens)* and other gums and resins, making the state the sole purchaser of these commodities. In practice, however, the states appoint agents through whom the purchases are made and subsequently channelised to the ultimate buyers. Malpractices in such a system cannot be altogether ruled out. Instead, the respective states will have to evolve suitable mechanism for direct purchases of NWFP from collectors and its eventual disposal to consumers. This will not only ensure fair wages to collectors of the produce but will also bring about a fuller utilisation of the production potential of NWFP.

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MINOR FOREST PRODUCE COLLECTION AND MARKETING IN H.D. KOTE TALUK, KARNATAKA : A CASE STUDY

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ABSTRACT

H.D. Kote Taluk in Mysore District, Karnataka has 5000 tribal families. Minor Forest Produce (MFP) collection and marketing is a major employment avenue for these tribals who have been given exclusive rights through a Co-operative society. During 1990-91, 250 families were engaged in MFP collection earning an income of Rs. 5.6 lakhs and generating 35,085 mandays of employment. Unauthorised collection and marketing of MFP by tribals and non-tribals is widely prevalent, but this has not been estimated. The paper describes the role of the tribal cooperative society in MFP collection and marketing.

INTRODUCTION

H.D. Kote Taluk in Mysore district, Karnataka is located in the southern transitional belt. The area is characterised by a rolling topography with seasonal rainfall of 700 mm and forms part of the tribal belt in Mysore district. The collection of minor forest produce (MFP) is restricted to the reserve forest area. The forest cover is deciduous in nature. The area permitted for MFP collection is over- exploited and is bushy.

The rights of MFP collection and marketing in H.D. Kote taluk is exclusively reserved for tribals of the area. This activity is formally organised through a 'Scheduled Tribe large-sized Multipurpose Co-operative Society' (LAMPS). LAMPS obtains the right for MFP collection and marketing by paying a royalty to the government which is fixed by the Forest Department and varies from time to time. Royalty is fixed for a period of two years and the amount for the last three block periods of 1987-89, 1989-91 and 1991-93 are Rs. 30,250/-, Rs. 54,000/- and Rs. 97,600/-, respectively.

REGULATION OF MFP COLLECTION THROUGH PERMITS

LAMPS has the rights for collecting and marketing of MFP issues. This permits its members to collect and supply MFP to the society. The rates paid to the tribal members for various items collected is fixed every year by the Board of Directors of the society. Tribals having legal permit are only allowed to enter the reserve forest area for MFP collection. But there is large-scale pilferage, smuggling and black marketing. Many tribal members of the society are also known to dispose off some of their collection to private traders. Table 1 gives an estimate of the MFP collection and marketing in the taluk during 1990-91. These figures are extracted from the account books of the society. The figures given below represent only fifty percent of the total MFP collected and marketed in the area.

Table 1. MFP collected by LAMPS in H.D. Kote Taluk.

Items Collected	Quantity kg	Labour paid for collection Rs./kg	Total collection charges paid to members Rs.	Value realised by auctioning Rs.
Tree moss	26,447	12	317,365/-	493,257/-
Gum	2,430	14	34,027/-	* 29,091/-
Tamarind	185,588	1	185,588/-	* 5,366/-
Terminalia bellerica	3,514	0.50	1,757/-	1,950/-
Honey	154	13	2,004/-	9,445/-
Amla (Fresh)	1,668	7	11,680/-	21,967/-
Amla (Dry)	96	70	6,762/-	9,702/-
Ceiba pentandra flower buds	4	12	50/-	70/-
Brooms (Rhoenix grass)	945 (nos.)	2.25/Broom	2,127/-	3,620/-
Total			571,360/-	574,468/-

* Complete stock not disposed during the year.

To collect the above items during the year 1990-91, 250 persons were issued permits. Most of the collection activity was concentrated during June to September for tree moss and honey and during January to March for tamarind, amla, gum etc. All the MFP are generally sold by the society either by calling tenders or by public auction.

MFP COLLECTION AND EMPLOYMENT GENERATION

If the quantity of MFP collected is small, it is transported to the society by the tribals on headloads. During the peak season, if the quantity is large, the society will arrange for transportation at its own cost. The society also appoints agents among the tribals by paying 15% commission to collect and pool the MFP from individual tribal families and then supply in bulk to the society.

Based on the MFP routed through the society, it is estimated that 35,085 mandays of work has been generated during 1990- 91. No MFP is processed at the society level except tamarind dehusking. If simple processing like powdering, pickling and packing are taken up by the society, more people can be employed in this activity.

NON-WOOD FOREST PRODUCE : A POTENTIAL SOURCE FOR GENERATING EMPLOYMENT IN WESTERN GHAT REGION OF UTTAR KANNADA DISTRICT IN KARNATAKA

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ABSTRACT

Traditional practices of resource use, conservation, collapse of local community control over resource use and management, and the results of take over of woodlot by the state were studied. It was found that for rural people in Uttara Kannada district, the only alternative subsistence means next to seasonal agricultural operations, was procuring non-wood forest produce (NWFP). If properly managed, NWFP can support the families and provide commodities to run industries. It also has potential to generate employment during the lean period. Efforts are needed to select and augment locally useful species by involving the local community in developing, managing, harvesting, sharing and marketing the forest resources. Educating the local community to convince the ecological and economic values of resources has been stressed.

INTRODUCTION

Uttara Kannada district is situated along the Western Ghats between 13° 55' to 15° 31' N latitude and 74° 9' to 75° 10' E longitude. High annual rainfall (1000-3500 mm), temperature (13° to 32° C) and humidity have made this area very rich in floristic wealth and an important botanical region of India (Arora, 1960). The Forest Department owns 80% of the land of the total geographical area of 10,200 km^2. One

of the last districts to be colonised by agriculture and industry, it is famous for its forest produce. (Gadgil and Subashchandran, 1988). In spite of the low population, local people's reliance on agriculture is seasonal. During the off-season, local people subsist on non-wood forest products (NWFP) from the species-rich forest of the locality.

Biologically diverse and rich forests of Uttara Kannada district were well protected, managed and sustainably used by the local communities before being taken over by the ruling British. But over the years, this district has witnessed severe logging, replacement of local species by monoculture and deprivation of local people's diverse use of forest resources (Gadgil et al., 1990). To meet the growing demands of the community and industries, a massive programme of restocking the barren hills was initiated under the social forestry programme by the State Forest Department during 1979-80. While implementing the programme, emphasis was laid on those species which were useful as fuelwood, timber or pulp (Chandrashekar et al., 1987). However, in a region with limited scope for agriculture, the importance of locally useful species was ignored. This paper attempts to highlight the need for revegetating the degraded hills of the district with species yielding non-wood forest produce which generate employment during the lean period.

TRADITIONAL USE AND CONSERVATION OF FOREST

In the past, extensive areas of land and water were controlled by local communities and were presumably used on a sustainable basis (Dharampal, 1983). The community had practised several modes of resource conservation. These included quantitative quotas of biomass removal, closed hunting seasons, protected life history stages, protection of individual species and protection of entire patches of forests (Gadgil et al., 1990). Such traditional systems of prudent resource use and conservation of resources are still prevelent in some parts of the district. To collect honey, the local people wait for the celebration of a traditional fair which falls in the pre-monsoon period in a religious centre. Such a system may be to facilitate the multiplication of bee colonies and also to obtain maximum honey as that period happens to be the post-flowering season.

Another form of conservation is to leave some of the wild fruits while gathering or by throwing away some of them. Usually, the first few fruits plucked are left at the site as

an offering to God. This could be either for regeneration or as a token of gratitude. Administration of herbal medicines is confined to particular day(s) and such practices are often kept a secret by the local vaidyas. Such a measure may be to control the misuse of the plants having medicinal values. In spite of restrictions for collection, there was free access to forest resources. After the seasonal agricultural operation, local people used to derive some subsistence from the seasonally available forest produce.

LEAN PERIOD AND AVAILABILITY OF NWFP

A study conducted by the Centre for Ecological Sciences of the Indian Institute of Science in two micro-catchments of the district revealed that after completion of the major seasonal agricultural work, there was insufficient work for the landless labourers twice during the premonsoon-monsoon period which lasts 2 months for men and 3 months for women. Men are devoid of work for 3 months in a year while it is 5 months for women. Another study conducted in an orchard village of Uttara Kannada district revealed that people collect the produce of at least 85 species which altogether have more than 175 uses.

The study on the use, season of collection, season of harvest and the parts of the plants collected as NWFP revealed that the lean period of the rural people could best be made use of by collecting, harvesting, processing and marketing. It was also noticed from the study that with the available resource, the women workers may be gainfully employed to earn subsistence during the lean period. Seasonal agricultural activity in the locality, lean period for male and female workers, season of availability of NWFP are given in Table 1.

In the case of a migrant who settled in the district, subsisting initially on the sale of areca, the annual turnover has reached more than Rs. 62,000/-. His involvement was in trading of 12 NWFP. Similarly, the annual turnover of a petty grocery merchant trading with nine commodities was Rs. 20,000/-. A honey collector alongwith 10 assistants earns Rs. 12,000/- as remuneration from his contractor (refer case histories in Annexure 1).

Table 1. Availability of Employment Through Agricultural and Forest Produce in a Year in Uttar Kannada District.

Month	Seasonal agricultural operations	Type of labour required Male (M) Female (F)	Availability of NWFP
January	Tree lopping for leaf manure in forests	M	Fruits of marking nuts, Soapnut
	Chopping of lopped branches	F	
February	Ploughing paddy land	M	Edible tendu fruits
	Manuring and mulching in areca garden	M F	wild pepper
	Transporting lops & tops Fuelwood sticks	F & M	
March	Dry leaf collection & transportation from leaf manure forests	F & M	Unripe mangoes, Tendu leaves, dry leaves
April			*Fruit of Ziziphus, Carissa carandas, Eugenia jambolana, Mangoes, Elacgnus confera, Buchania lazan, Garcinia indica, Artocarpus lakoocha, Myrstica, Honey collection, Pandanus leaves, Phoenix leaves, Eriocolan.*
June	Manuring paddy field		Bamboo shoots.
	Ploughing & sowing	M	
	Spraying in areca garden	M	
	Paddy transplanting	F	Herbal underground parts like corms, rhizomes roots.

Month	Seasonal agricultural operations	Type of labour required Male (M) Female (F)	Availability of NWFP
July	Ploughing	M	
	Paddy transplanting	F	
	Weeding in paddy land & areca garden	F	*Garcinia combogia*
August	Green matter/bushes harvesting	M	
September	--	--	Green Grass
October	--	--	Green Grass
November	Paddy harvesting	M & F	*Myrobilans, Terminalia chebula, T. bellerica, Phyllanthus emblica*
	Green grass collection		
	Areca plucking	M	
	Dehusking of areca nuts	F	
December	Dry grass harvest	M & F	Dry grass

DRAWBACKS IN THE CURRENT SYSTEM

Before the takeover of the wood by the state, the community had free access to resource. Resource use was on a sustainable basis and due importance was given to conservation. However, the takeover of forests led the local people to believe that their ancient right over the usufructs was taken away and that resource was mainly meant for exhaustion. Ruthless exploitation of the resources has become detrimental for several NWFP (Gadgil et al., 1987; Campbell, 1991). In many instances, there is lack of knowledge of collelcting, processing and preserving the produce. Little is known about the nutritional, medicinal, ecological and economic values of the forest products (Bhat, 1989).

Since the state took over the forests, the local people's free access was curtailed and NWFP are auctioned to provide contractors who exploit the resource. In an attempt to

maximise the collection of NWFP and to earn more money, the contractors keep away the local people from collecting and selling the products. Moreover, these contractors are not sure of bidding the auction in the subsequent years. So they over-exploit the resources with least concern for sustainable regeneration. Such a system and practice was an obstacle for locals who depended on these forest resources.

FUTURE ACTION

Considering the variety, value and end use of NWFP, there is a need to develop proper database about resource availability and its economics. There is also the need to develop scientific methods of harvest, processing and technology for preserving them. Developing marketing facility at the local level through a representative body may help the dependents to fetch reasonable prices for the materials. Collection of the produce, managing the resource base, sharing and distribution, if entrusted to the local people, are likely to help conserve the resource base. Private land holders with credit/loan facility for growing trees must be encouraged to harvest only usufructs. Choice of species, area to be brought under planting and requirement for local consumption are important aspects to be borne in mind while acting in future.

Annexure 1. Case histories.

1. Chogaru Shetti :

   Mr. Chogaru Shetti of Umachi village trades in 12 items of non-wood forest produce. His business is worth more than Rs.62,000/- and his profit margin is 10-25%. He buys non-wood forest produce collected by 25 families during March to May. The rigid forest protection laws and lack of credit facilities have affected his business lately.

2. Kanenalli Krishna :

   Another merchant, Mr. Kanenalli Krishna of Mavinakatta village, deals in nine items of non-wood forest produce. His profits are higher because he sells some of the produce directly in big cities like Hubli. He thinks simpler forest protection

laws and bank credit facilities can benefit him as well as rural people engaged in collection of non-wood forest produce.

3. Appu Siddi :

Extraction of honey from colonies of wild bees is the occupation of Mr. Appu Siddi. It requires skill and courage to climb up the big trees in the night, drive away the bees with smoke and extract the honey. Mr. Appu Siddi employs 10 people to assist him and earns about Rs.12,000/- per season. They extract about 50,000 kg of honey and 2000 kg of wax. Appu Siddi's experience is that the yield of honey depends on the flowering status of species like *Lagerstroemia microcarpa, Dalbergia* species and *Terminalias.*

4. Oil extraction

Processing of Calophyllum oil seeds in his oil expeller unit at Hannavar taluk is generating income for Mr. D'Souza. He processes 300-400 quintals of Callophyllum seeds per year. He buys raw fruits at Rs.5/- per kg and seeds at Rs.14/- per kg. A kg of oil fetching Rs.26/- can be extracted from about 1.7 kg of seeds. Oil cake used as manure is sold for Rs.2/- per kg. Oil is mostly used by poor people to varnish boats and houses.

5. Pickle making

Mr. Bhat buys 50 tons of tender mangoes per year at the rate of Rs. 2/- per kg for pickle making. He also purchases 15 quintals of *Carissa carandas* at Rs. 1.50 per kilo. The selling rate of pickle is Rs. 28/- per kg.

ACKNOWLEDGEMENT

We thank staff members of the Centre for Ecological Sciences, Field Station, Sirsi and staff of BAIF Centres in Uttara Kannada district for their assistance in collecting information. Thanks are also due to the persons we interviewed for the study. We also thank Shri. K.M. Hegde, Bhairumbe for his valuable suggestions and encouragement while preparing this paper.

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SCOPE FOR EMPLOYMENT GENERATION THROUGH TREE SPECIES YIELDING NON-WOOD FOREST PRODUCE AND SERICULTURE

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ABSTRACT

Planting of tree species producing non-wood forest produce on wastelands can generate employment, particularly in remote and poorly accessible tribal areas. In Konkan region, it is estimated that if 50 percent of the wasteland is to be covered with tree species and mulberry, employment generated for planting would be 196.2 lakh mandays. Five years after planting, there is potential for generating employment of 113.1 lakh mandays for harvesting, collection of produce, processing and marketing.

INTRODUCTION

The Social forestry scheme envisages planting of fruit trees like mango, cashew, ber, jamun, amla, tamarind, mulberry and other tree species in suitable areas which will provide nutritious fruits to the rural poor. Planting of trees like harda, bheda, mohua, soapnut, khair, bamboo and neem will provide raw material for rural cottage industries like basket making, oil extraction, sports goods, pulp for paper and silk. Social forestry schemes should be visualized as instruments of integrated development. Social forestry is a concept, a programme and a mission, which aims at insuring and providing ecological, economic and social security to the people, particularly to the tribals and those who live below the poverty line in rural areas.

FORESTRY AS AN INSTRUMENT FOR RURAL DEVELOPMENT

Rural development is possible only through harnessing land and manpower resources. Forestry can be achieved with suitable technology that does not involve high skill, much investment or sophisticated machinery to ameliorate the economic conditions of those who live below the poverty line.

The Konkan region, which has a hilly terrain and high rainfall, is ideally suited for the development of forests. The present cover of only 19.4% of the land area of the region under forests is not satisfactory. Hence, massive efforts are necessary and 327,000 ha is designated for afforestation. In such areas, the Forest Department may consider introducing tree species of different economic uses viz. gum, flosses and fibres, tannin, oil, soap and bidi, lac and dye. Most of the forest planting can be undertaken by individual cultivators with the help of Social Forestry Department. The financial provision will have to be made through institutional agencies. However, the extent of planting on Government and semi-government lands, institutional lands and by private cultivators needs to be worked out and financial allocation decided accordingly.

SERICULTURE

Sericulture is an important labour intensive agro-based industry providing gainful occupation to the unemployed/under-employed in rural and semi-urban areas. While the activity relating to mulberry cultivation and production of cocoons are agricultural in character, the reeling of raw silk and production of hand-spun silk yarn are cottage-based industries practised in rural and semi-urban centres, employing hand and power driven appliances with skilled labour.

Mulberry is a perennial plant which can be grown on any type of soil. It has a deep rooting system with low water requirement. In the Western Ghats, mulberry can be grown as a high bush or midling trees (1.5 - 2.0 m height). The Konkan region is most suited for growing mulberry. The present area under mulberry in Ratnagiri and Sindhudurg districts is hardly 48 ha. There is great potential to increase the area under mulberry in Konkan region. Mulberry plantation, harvesting, collection, rearing and processing can generate 309.3 lakh mandays in Konkan region.

CULTIVATION OF MEDICINAL PLANTS IN AGROFORESTRY

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ABSTRACT

Ayurveda has gained recognition for curing chronic diseases. Several pharmaceutical companies in India manufacture ayurvedic drugs which require a steady supply of medicinal plants. Therefore, people must be made aware of the medicinal value and income potential of these plants. Identification of species, technical assistance to grow, harvest and process them, and marketing are required to promote medicinal plants alongwith coordination between health and plant scientists.

INTRODUCTION

India has a rich heritage of knowledge on plant-based drugs for use in both preventive and curative medicine. The ayurvedic system of medicine is predominantly a plant-based materia medica, making use of native herbs, shrubs and trees. It makes health care less costly and easily available. Ayurveda has proved its worth and capabilities in the treatment of chronic diseases for which allopathy appears to have no cure. As a result, interest and preference in these organic drugs and preparations is increasing.

There are several pharmaceutical companies in our country manufacturing ayurvedic drugs. These companies require a constant supply of medicinal plants or those parts of plants which have medicinal value. The price offered for these is attractive. The rates offered by a government pharmacy in Maharashtra are cited in Table 1. It is necessary to educate people about the medicinal value of different trees to utilize them effectively and about the income gained by cultivating them.

Three important steps to promote the cultivation of medicinal plants are listed below :

1. selection of suitable tree species having medicinal value;

2. technical assistance to grow them;

3. processing and marketing infrastructure development;

Table 1. Price for Medicinal Parts of Selected Trees Offered by the Department of Ayurveda, Government of Maharashtra.

Botanical name	Common name	Parts used for medicine	Price/ kg Rs.
Saraca indica	Ashok	Bark	18/-
Acacia catechu	Katha	Catechu	210/-
Holorphaena antidysentrica	Kuda	Bark	12/-
Rubia cardifolia	--	Bark	40/-
Commiphora mukul	--	Gum	80/-
Raria picta	--	Bark	15/-
Ugenea sp.	Jamun	Seeds	25/-
Salamala *malabarica*	--	Gum	60/-
Oroxylon indicum	--	Roots	12/-
Aegle mamelos	Bel	Leaf	12/-
Aegle marmelos	Bel	Fruit Pulp	16/-
Cedrus deodara	Deodar	Bark	13/-
Woodfordia fruticosa	--	Flower	15/-
Glycchirhiza glabra	--	Bark	35/-

EQUITY IN USER GROUP FORESTRY : IMPLEMENTATION OF COMMUNITY FORESTRY IN CENTRAL NEPAL

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ABSTRACT

Community forestry programmes in Nepal were introduced in the late 1970s. The Nepal-Australia Community Forestry Project has achieved considerable success in establishing community plantations and handing them over to user groups. Case material from six community forests are presented in the paper. Information for the case study was collected by field observation and informal interviews. Results show that the users in the study area make an equitable contribution towards protection and management of community forests and in return expect equitable distribution of products. Equity in product distribution exists in most of the cases, but more equitable decision making and resource allocation need to be achieved. Recommendations for improved resource management are listed.

INTRODUCTION

Forests form an intregal part of the farming system for majority of the farmers in the hills of Nepal. Life becomes unsustainable without trees and forest products like leaf litter, grass and leaf fodder for farm animals, firewood for cooking, and timber for agricultural implements as well as construction work. Except for timber, other forest and tree products mentioned above are required by an average farming household on a regular basis. It is, therefore, imperative that a systematic knowledge of the relationship between population and forest resources as perceived by a common farmer in the hills of Nepal is essential. Some of the fundamental questions in this regard are : where do people get their required tree and forest products from; do people feel that there is an adequate supply of such products; and does an average farmer have equal access to forest products in a community forest?

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In Nepal, community forestry is defined as the control, protection and management of forest resources by rural communities for whom trees and forests are an integral part of their farming systems (Gilmour and Fisher 1991). The recognition of the inter-dependence between forests and farmers came about only towards the late 1970s when community forestry programmes were introduced. Today, community forestry is the major forestry programme of His Majesty's Government in Nepal (HMGN) as embodied in the Master Plan for the Forestry Sector (HMGN 1988).

The Nepal-Australia Community Forestry Project (NACFP), facilitating the implementation of community forestry programmes in Kabhre Palanchok and Sindhu Palchok districts since 1978, has achieved considerable success in establishing community plantations and in handing over natural and plantation forests to user groups. More than 16,000 ha of new plantations have been established and handed over after a management agreement (known as an Operational Plan) was negotiated between the District Forest Office (DFO) and the user group and approved by the former on behalf of the government.

While implementing the Operational Plan, attention is needed towards solving any problems inherent in the plans or in the user groups involved. There are at least two ways of monitoring and evaluating the Operational Plans until at least a few years after their implementation. One of the possible ways is to find out forest and tree product use practices among the user groups and to evaluate the effectiveness of user group forestry (Bartlett et. al 1992). Another approach is to examine the functioning of the user groups and their Operational Plans through the issue of equity with regard to product distribution, decision making, and allocation of funds generated from sale and use of products from the community forests. A systematic knowledge of the forest product use practices of the user groups is crucial in understanding how important the community forest is for them. This study examines the forest and tree product use practices, but its primary focus is on the study of equity which has received litle attention in studies (Malla and Fisher 1987; Fisher 1990). We present case material from six different community forests in support of the view that successful implementation of an Operational Plan in community forestry is possible when there are perceived or actual short-term and long- term benefits for the user group.

BACKGROUND OF THE STUDY AREA

The present study covers six user groups, three each in Nalako Thulo Ban and Tukuchako Sano Ban. The three user groups in Nalako Thulo Ban will be referred to as Nala-I, Nala-II and Nala-III user groups while those in Tukuchako Sano Ban as Amaldol, Panday Gaun and Thapa Gaun user groups in this study. The forest area within individual user groups have been divided into smaller blocks based on geographical features. Blocks are not necessarily of identical size within one user group forest, but they fulfil the objective of ensuring product availability over a defined period (the number of blocks gives the number of years), whilst accommodating an annual harvesting programme by the users. The harvesting of green products is generally in the winter period to coincide with labour availability. The blocks are designated by the HMG field worker, ideally in close consultation with the user group.

The two forests under study happen to be among the first forests in Kabhre Palanchok district for which Operational Plans were prepared. All six plans in the study area have been implemented in varying degrees since their approval. Both Nalako Thulo Ban and Tukuchako Sano Ban are natural forests which have their own history of indigenous management before formal hand over took place. The primary users of the two forests come from several settlements in five adjacent VDCs.

HISTORY OF FOREST MANAGEMENT IN THE STUDY AREA

Nalako Thulo Ban is a single forest land of more than 100 ha, out of which approximately 65 ha is divided among three user groups. There was an indigenous system of protection and management initiated by the farmers of Tusal, Angal, Swara and Nala. An user group committee was also present. During the period of indigenous management, people were allowed to collect leaf litter and dry firewood whenever required, while for timber, they had to secure the approval of the committee before felling or cutting a tree.

The indigenous system of protection and management in Nala lasted for almost 30 years until the begining of the 1980s. In 1984, this forest was declared as Panchayati Protected Forest under the regulations of the Community Forestry rules. In mid 1986, the forest was handed over to three user groups under the written Operational Plan approved by the DFO in Kabhre Palanchok district.

Tukuchako Sano Ban is about 80 ha. With an additional 42 ha of forest land from Bhagwan Thumki Ban, this forest is also divided among three user groups. The histories of Nalako Thulo Ban and Tukuchao Sano Ban clearly indicate that the users in this area already had a strong motivation for the management of forest since the beginning of this century. Natural calamities like snowfall destroying the trees directly and an earthquake destroying the houses and thereby raising the demand for construction timber indirectly resulted in the degradation of Nalako Thulo Ban by the early 1950s. An increased demand and market for construction timber and induced increase in the consumption of firewood because the trees damaged by snowfall were decaying, seem to have brought about changes in the forest and tree product use practices of the people around Nalako Thulo Ban. The indigenous management for Tukachako Sano Ban has been stimulated initially by the need to protect the forest above their villages against landslides and later due to shortage of forest products.

METHODOLOGY

Information for the present study was collected by means of observation in the field, informal interviews with users and user group committee (UGC) members of the forests and users under study, and from secondary sources like the UGC records of harvesting operations. A qualitative as well as a quantitative mix was favoured in data collection as well as in presentation of results. Thus, the methodology of this study is one of triangulation of data from a variety of sources, using the techniques inherent in Participatory Rural Appraisal (Chambers 1987).

Definition of Equity

The issue of equity was felt useful for the present study in three different contexts : 1) equity in product distribution by type of products, 2) equity in decision making, and 3) equity in allocation of funds. Whether there was equity or not in these three contexts was determined by asking a series of questions from the user groups and UGC members. An attempt was made to talk to members living in different settlements as well as to people from different castes.

The basic questions may be summarized as : does every one have access to

community forests and get the required amount of leaf litter, firewood and other products from the forest; what proportion of these requirements come from what kind of sources; is there any feeling of discrimination at the time of product distribution; do all users have equal opportunity to express themselves in the meetings and assemblies; are women and "lower caste people" invited to these meetings and assemblies; do they attend them; if they do, is their voice heard; what have been the user group's priority areas for spending funds so far; are all the user group members happy with the allocation of funds by the UGC; and do users from a particular settlement feel that they have not received a fair share of the funds by way of development works like drinking water, electricity and school? The basis for determining the presence or absence of equity has been the response of user group members representing various settlements as well as caste and sex.

RESULTS

Product Use Pattern

The tree and forest products most commonly needed by farmers in the hills of Nepal are leaf litter for animal bedding and compost, grass and leaf fodder for animal feed, firewood for cooking and heating and timber for construction, furniture and implements. The use pattern of these products vary from one village to another and between households within a village depending on average land holding availability of trees on private lands.

Their dependence on trees and forests for meeting their requirements is certainly high, but not total. For instance, most of the farmers use leftover grass and leaf fodder as bedding for animal before it goes into the compost pit. Crop residues like straw and millet stems are used as feed for cattle during winter. Similarly, maize stems and cobs are used as a supplement for firewood. Given these realities, a better assessment of product use pattern among the farmer in the hills of Nepal should take into account the forests as well as private trees and other potential sources of energy.

Leaf litter is one of the major products collected from community forests. It is required for animal bedding and compost. In areas where compost is not available in sufficient quantities from any source, farmers abandon the land and seek alternative

wage labour in nearby towns and cities. Soil fertility may be a crucial element in the sustainability of Nepali farming systems (Brian Carson, personal communication). In the study areas, farmers had constructed storage shelters for leaf litter and pine needles, and collected material from the community forests according to availability and preference. Pine needle was generally collected from mid-March to mid-August, and leaf litter during mid-August to mid-March.

Fodder is only a minor product from community forests in terms of quantity, but it is important to sustain village farming systems, and its regular availability and quality are major constraints on livestock productivity. The community forest in Amaldol at present provides small amounts of leaf fodder and grass during July to September. Some leaf fodder is available from private sources, depending on the landholding size, but heavy reliance is placed on agricultural residues for about six months of the year. There is potential for fodder development in community and private forests.

Firewood is harvested as pruning, singling and/or thinning and as dry product, from all of the community forests under study. There appeared to be no acute firewood shortage, and there were reports of sale of surplus products from some Thapa Gaun users to Nala bazaar. Pandey gaun users take 85% of their total firewood collection from the community forest.

Timber products can be divided into large construction timber and smaller products used for making agricultural implements. There is little demand for construction timber from the community resoruce and it is used only when the private resource is insufficient. For agricultural implements, however, about half the requirements would be satisfied from the community resource.

Equity

Most of the users in the study area perceive that the community forest belongs to all the users and that they now have equal rights to forest products as well as responsibilities towards their forest. In general, equitable contributions are made by the users towards the protection and management of their community forest. In Amaldol, there is a forest watcher appointed by the users while in Panday Gaun and Thapa Gaun, users keep an eye on each other (and outsiders as well) to prevent any unregulated and illicit removal of forest products. In Nala II and Nala III, Rs. 6 /

person (aged 12 and over) is collected annually as contributions towards protection and management of their respective forests.

Distribution systems for forest products vary according to different user group decisions made at a general assembly and the product type. A harvesting day or days are specified at the meeting. For minor forest products like leaf litter, this might be all that is necessary. For green products, however, the number of family members eligible to come, and age limit may also be specified. For firewood and pole sized timber, the size of one unit and unit price will be agreed.

A committee may or may not be present within an indigenous management system, but is always present in community forests handed over by the Forest Department with an Operational Plan. The committee will implement decisions of the user group, help resolve internal conflicts, impose sanctions, and liaise with the HMG field workers. The correct functioning of the committee is crucial for the effectiveness of the Operational Plan. Committees in the study area represent all settlements and most castes/ethnic groups of the users. Membership of the user groups themselves tends to fluctuate since households divide as a result of expansion of families, migration of households or whole settlements being excluded or included or adjusted as primary or secondary users due to incomplete identification of the user group initially by the field worker. An extreme example of this point is at Nala I, where less than 10% of the users were correctly identified at the time of negotiation of the Operational Plan.

The correct functioning of the committee was crucial to the effectiveness of the Operational Plan. Amaldol user group committee which collected only 50% of the funds from the last harvesting of green products, faced problems imposing sanctions on offenders, and received little support from the Forest Department when it approached them to intervene and punish offenders. Decision making had also tended to be dominated by the male elite, with little representation from women or the users from lower caste groups. The disparate nature of income status, caste status and interests is in part responsible for the lack of consensus in decision making. In contrast, Thapagaon, despite having such divergent interests, generally functioned well, probably due to the influence of a very strong and committed UGC chairman. It was also noted that a very large user group such as Nala II was having difficulty in implementing decisions effectively, and this has been a factor in the inability to harvest regularly.

DISCUSSION

Table 1 provides an Effectiveness Rating for Operational Plans under implemention in the study area, building on the methodology introduced by Bartlett et al. (1992). Each indicator of effectiveness is given a rating of 0 (not effective), 1 (partially effective) or 2 (fully effective). The column for self-reliance is an assessment of the sustainability of the user group.

Table 1. Effectiveness rating for operational plans in the study area.

Forest Name / user Group	Forest Type	Plan Appro-val	Use Iden-tifi-cation	Prot-ecti-on	Dry prod-ucts	Green prod-ucts	Self-reli-ance	Con-fli-cts	Pro-duc-ts	Deci-sion maki-ng	Fund Alloc-ation	Over all Rati-ng
Amaldol	N/P	MAR89	2	2	2	1	1	0	2	0	0	1
Pandeygaon	N	JUL87	2	2	2	1	2	2	2	2	2	2
Thapagaon	N/P	OCT90	2	2	2	1	2	2	2	1	1	2
Nala 1	N	JUN89	1	1	1	1	0	0	0	0	0	0
Nala 2	N/P	JUN89	1	1	1	1	2	1	1	1	1	1
Nala 3	N/P	JUN89	1	1	1	1	2	2	2	2	2	2

Note : Self-reliance is measured in terms of decision making, cost sharing and conflict resolution within the user group.

The overall effectivenes is a subjective assessment of all indicators, and reveals that three of the six plans can be considered fully effective (Pandeygaon, Thapagapn and Nala III), a further two partially effective but functioning (Amaldol and Nala II) and one not effective and non-functioning (Nala I). The Nala I Opertional Plan has failed because the user group was incorrectly identified at the time of investigation.

Another problem has been the rules regarding harvesting of major timber products. The plan emphasises that the Forest Department must give permission for harvesting of the whole tree for construction timber. This has restricted such harvesting in all user groups, and removal of such restrictions is recommended. Fund allocation seems to be the major equity problem perhaps because villages often have little experience of managing large amounts of money for community benefit. In Thapagaon and Amaldol, where major divergent interest are present, equity in fund allocation is a problem and it can improve through experience.

CONCLUSION AND RECOMMENDATIONS

On the basis of this study, it can be concluded that community foresty is a viable strategy for the Department of Forest to manage the forest resources in the middle hills of Nepal. The users in the study are generally satisfied with the product distribution practices prevalent in their group. The users make an equitable contribution towards protection and management and in return expect eqitable distribution of products. It is also clear from the discussion, that not all requirements of farmers are met by products available from community forests. There is perhaps a need to address private plantations and agroforestry as supplementary components of community forestry approach.

Equity in product distribution is observed in most of the cases under study by adopting a proportionate distribution of products based either on household size or the contibutions of households towards community forest management. In general, the users perceive that they are getting an equitable share of the products currently available from their forests. Equity in decision makng and allocation of resources/funds seem to be faring relatively well and may be improved further when these user groups become stronger, experienced and more effective.

A number of recommendations can be made to improve the way in which the resource is managed, in terms of external extension to support policy initiatives and resource development:

i The forest department needs to relax control, particularly in harvesting of major timber products. The user group should be able to harvest timber by specifying their requirements in the Operational Plan. The forest Department field staff may then be informed before harvesting takes place, so that they may take their role as advisors and extensionists, as specified in the Master Plan policy (HMGN 1988).

ii Users should be encouraged to deposit their funds promptly into their bank accounts, and account for finances in an open system.

iii Users should be encouraged to disseminate information with special emphasis on the poor and women. There are endogenous cultural factors that provide inequity in communities which external sponsorship cannot solve completely.

iv Grass and fodder are important forest and tree products required by average farmers to feed their livestock. Resource development programmes are required to increase the availability of fodder on community and private land, with special emphasis on the lower income groups.

v The user group should be defined carefully. The practice of using ward boundaries for this purpose may not be correct in most cases. Using the hamlet or other locally recognized natural boundaries may be a better way to define user groups.

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PERFORMANCE OF MPTS IN ADVERSE EDAPHO-CLIMATIC ENVIRONMENTS

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ABSTRACT

Relative performance of MPTS under different agro-climatic conditions was evaluated for four years. Soil and moisture related factors, which were highly location specific, influenced growth parameters and survival of different species. The growth parameters for most species were highest at Nanodara, followed by Urulikanchan and lowest at Lakkihalli due to soil and water-related stresses. At Nanodara, under saline conditions, *Leucaena leucocephala, Azadirachta indica, Acacia nilotica, Albizia lebbeck, Eucalyptus tereticornis* and *Acacia nilotica* (cupressiformis) showed the best performance while at Urulikanchan under shallow gravelly soils, *Gliricidia sepium, Leucaena leucocephala, Eucalyptus camaldulensis, Melia azedarach, Azadirachta indica, Eucalyptus tereticornis, Gmelina arborea* and *Acacia nilotica* var. cupressiformis recorded higher growth rates. At Lakkihalli where soil moisture was the major constraint, *Eucalyptus camaldulensis, Eucalyptus tereticornis, Casuarina equisetifolia, Albizia lebbeck, Acacia auriculiformis, Eucalyptus microtheca, Leucaena leucocephala* and *Melia azedarach* proved to be better than others.

INTRODUCTION

About 150 million hectares of land in India are lying waste and are in various states of degradation. Since most of the traditionally grown agricultural crops generally fail to produce economic returns from such sites, a more reliable alternative strategy appears to be to rehabilitate these lands by growing tree species tolerant to adverse soil-water-climatic conditions. To achieve this objective, it is necessary to screen a large number of multipurpose tree species on a few sites in different states of India and select those which are tolerant to heat, drought and poor soil conditions and exhibit a fair degree of productivity, stability and sustainability. Lastly, they should

have a sound socio-economic basis and market acceptability. On-station trials were carried out at the three research stations of the BAIF Development Research Foundation in the states of Gujarat, Maharashtra and Karnataka representing diverse agro-ecological zones of the country.

MATERIALS AND METHODS

The site descriptions and experimental details are shown in Table 1.

Table 1. Description of sites (a) and experimental details.

State	Gujarat	Maharashtra	Karnataka
a. Site description			
Location	Nanodara	Urulikanchan	Lakkihalli
Latitude	23°N	18.30°N	13.12°N
Longitude	72°E	73.94°E	76.24°E
Altitude (m above sea level)	44.50	560.00	938.20
Rainfall (mm)	860	450	615
Temperature range	6 to 44°C	8 to 42°C	15 to 38°C
Soil Texture	Sandy loam and saline with calcareous hard pan at 1.0 to 1.2 m depth	Gravel overlying basaltic rock	Loamy sand with more than 2.0 m depth
pH	8.7	7.8	6.4
b. Experimental details			
Sub species (In 4th replication)	10	17	24
Gross Plot Size(m)	16 x 12	21 x 21	21 x 21
Spacing (m)	2.0 x 2.0	3.0 x 3.0	3.0 x 3.0
Planting date	19.07.1987	24.11.1986	04.10.1986

The seedlings were raised in poly bags and transplanted in the field. The experiment was laid out with an augmented block design with four replications for main treatments and 10-24 subtreatments at different sites. The plants were hand watered during the first summer season and the observations were recorded for four years.

RESULTS AND DISCUSSION

Eucalyptus species and *Leucaena leucocephala* recorded higher growth rates at all the three locations than others (Table 2). Leucaena leucocephala growth was affected by psyllid (*Heteropsylla cubana)* attack at Lakkihalli and Urulikanchan, particularly in the first two years, but the pest intensity progressively decreased with maturity of the foliage. The incidence of pysllid so far has not been recorded at Nanodara, even four years after its first appearance at Lakkihalli and Urulikanchan.

At Nanodara, the high rainfall of 1233 mm in the rainy season of 1988-89 caused waterlogging for a long period. This accelerated the growth of *Eucalyptus tereticornis, Azadirachta indica, Leucaena leucocephala, Acacia nilotica* var. *telia, Albizia lebbeck, Acacia nilotica* var. *cupressiformis* and *Sesbania sesban* followed by *Parkinsonia aculeata* and *Prosopis julilflora. Sesbania sesban* which grew vigorously initially, almost ceased growing by the end of the second year after profuse pod formation and damage to the root system by white ants. Under the conditions of the experiment, *Azadirachta indica, Albizia lebbeck, Acacia nilotica, Eucalyptus tereticornis* and *Leucaena leucocephala* showed the best performance.

At Urulikanchan, although the average annual rainfall was low, most of the rain water infiltrated. The presence of hard basaltic rock, about 10 cm below the gravelly soil, however, restricted root development and penetration resulting in lower growth rates than at Nanodara. The best performance was by *Eucalyptus camaldulensis* and *Leucaena leucocephala. Eucalyptus tereticornis* grew very fast, but its survival rate was low compared to *E. camaldulensis* which is drought tolerant. *Azadirachta indica, Gliricidia sepium, Melia azedarach, Acacia nilotica* var. *cupressiformis, Albizia lebbeck, Cassia siamea* and *Parkinsonia aculeata* formed the second best group on the basis of growth and survival. *Acacia auriculiformis, Albizia procera, Casuarina equisetifolia* and *Derris indica* showed poor to very poor survival.

The average growth rates at Lakkihalli were lower than at Urulikanchan in spite of higher average rainfall, more equable climate, lower latitude and higher altitude. The major constraint appeared to be lower moisture retention capacity of the open textured red soil. The best performance was shown by *Eucalyptus camaldulensis, Eucalyptus tereticornis* and *Acacia auriculiformis. Casuarina equisetifolia* grew rapidly in the initial stages, but the casualties were heavy subsequently due to moisture stress. The other species to perform fairly well were *Eucalyptus*

microtheca, Leucaena leucocephala, Melia azedarach, Cassia siamea, Azadirachta indica, Leucaena diversifolia and *Parkinsonia aculeata.* The species that showed poor survival and performance were *Sesbania grandiflora, Thespesia populnea, Casuarina glauca, Albizia falcataria, Calliandra calothyrsus, Acacia nilotica* var. *telia, Derris indica, Ailanthus excelsa, Albizia procera* and *Colospermum mopane.*

Data on survival and growth have helped to identify species suited to three distinctly different soil climatic complexes. However, it may be admitted that the productivity levels of even the best species are not very encouraging at the three sites. At Nanodara, heavy showers of rain and slow infiltration rates caused waterlogging. Perhaps this can be remedied by raising the seedlings on ridges to ensure aeration of the upper portion of the root system. Shallow drains will also be helpful in quickly removing excess water. Later on, roots of well established trees can penetrate vertically and laterally through the hard pan and break the barrier.

At Urulikanchan, the major constraint appears to be the hard rock below the shallow gravelly soil. This prevents root penetration and expansion. Deeper and wider pits and incorporation of organic matter may help in mitigating this situation. At Lakkihalli, the problem of conserving rain water in sandy type of red soil is indeed formidable as more mortalities continue to be observed every year. Addition of organic manures and application of mulches or even use of water absorbing polymers may help overcome this constraint. But these innovations need to be thoroughly tested under field conditions to ensure their economic feasibility and social acceptability.

Table 2. Performance of MPTS at Different Locations.

Species	AVERAGE ANNUAL GROWTH														
	URULIKANCHAN					LAKKIHALLI					NANODARA				
	Surv. %	HT cm	BD cm	DBH cm	Canopy cm	Surv. %	HT cm	BD cm	DBH cm	Canopy cm	Surv. %	HT cm	BD cm	DBH cm	Canopy cm
Acacia auriculiformis						86(M)	127	1.96	1.12	75	2(M)	188	3.42	12.31	83
Acacia nilotica var. *cupressiformis*	98(M)	103	1.79	1.06	54										
Acacia nilotica var. *telia*						69(M)	40	0.89	0.39	31	94(M)	191	2.81	2.65	103
Albizia lebbeck	89(M)	96	2.07	1.29	84						90(M)	172	3.27	2.52	148
Azadirachta indica	94(M)	99	2.00	1.44	68						96(M)	192	3.28	2.73	114
Cassia siamea						94(M)	78	1.51	0.80	69					
Casuarina equisetifolia						56(M)	127	1.53	0.98	68	Died except 4 plots				
Derris indica						88(M)	36	0.75	0.43	20(M)	38	82	1.79	1.22	79
Eucalyptus tereticornis											70(M)	260	3.65	3.05	50
Gmelina arborea	97(M)	95	2.05	1.29	67										
Leucaena leucocephala	94(M)	159	2.09	1.66	75	90(M)	84	1.26	0.73	35	78(M)	211	3.35	2.83	89
Melia azedarach						82(M)	89	1.35	0.82	28					
Pithecellobium dulce	82(M)	110	1.85	1.19	89										
Prosopis juliflora	98(M)	81	1.52	0.89	108	82(M)	52	0.62	0.38	61					
Sesbania sesban	(M) Died after 1st year														
Acacia auriculiformis	29	107	1.86	0.79	62										
Acacia nilotica var. *cupressiformis*	98(M)	103	1.79	-	-	37	18	0.37	0.00	16	92	182	2.8	42.44	51
Acacia nilotica var. *telia*	78	63	1.32	2.17	58										
Ailanthus excelsa	86	51	1.69	1.06	43	98	37	1.39	0.94	13	33	76	2.7	5 1.95	50
Albizia falcataria (*Paraserianthes falcataria*)						27	58	1.10	0.64	37					
Albizia lebbeck	94	102	1.44	0.94	51	94	102	1.44	0.94	51					
Albizia procera	18	72	1.49	0.86	48	62	50	1.26	0.66	36					
Azadirachta indica						100	61	1.23	0.66	34					
Bauhinia purpurea	84	61	1.37	0.64	51										
Calliandra calothyrsus						21	72	0.82	0.7	41					

Species	AVERAGE ANNUAL GROWTH														
	URULIKANCHAN					LAKKIHALLI					NANODARA				
	Surv. %	HT cm	BD cm	DBH cm	Canopy cm	Surv. %	HT cm	BD cm	DBH cm	Canopy cm	Surv. %	HT cm	BD cm	DBH cm	Canopy cm
Colospermum mopane						87	27	0.55	0.41	33					
Cassia siamea	90	111	2.40	1.21	70										
Casuarina equisetifolia	12	118	1.34	0.71	73										
Casuarina glauca						22	63	0.91	0.48	37					
Dalbergia sissoo	92	84	1.36	0.94	50	86	71	0.96	0.50	40					
Derris indica	37	51	1.18	0.57	52										
Eucalyptus camaldulensis	96	168	1.89	1.29	60	99	162	2.28	1.55	57					
Eucalyptus microtheca						94	108	1.88	1.19	58					
Eucalyptus tereticornis	45	194	2.34	1.71	52	90	145	1.83	1.46	50					
Gliricidia sepium	100	130	1.47	1.91	83	83	63	0.96	0.50	48					
Gmelina arborea						97	46	1.28	0.52	39					
Leucaena diversifolia	51	91	1.23	0.84	60	97	74	0.90	0.63	38					
Melia azedarach	88	131	2.16	1.53	73										
Moringa oleifera	73	60	1.52	0.71	43	85	62	1.37	0.66	22	8	46	1.33	0.71	26
Parkinsonia aculeata	100	91	1.65	0.79	85	97	71	1.23	0.52	86	40	142	2.40	1.78	128
Pithecellobium dulce						76	51	0.73	0.48	51	2	27	0.40	0.13	10
Prosopis juliflora						82	52	0.62	0.38	61	96	125	2.58	1.95	142
Prosopis cineraria						61	19	0.52	0.00	19					
Sesbania bispinosa						Dried up due to drought and white ants									
Sesbania grandiflora						Dried up due to drought and white ants					2	107	204	1.60	58
Sesbania sesban						Dried up due to drought and white ants									
Thespesia spp	55	52	1.02	0.50	28	13	21	0.5	5 0.	15	29	42	1.33	0.00	83
Tamarindus indica											17	33	1.24	0.53	26

MULTIPURPOSE TREE SPECIES DEVELOPMENT PROGRAMME UNDER SOCIAL FORESTRY IN TAMIL NADU

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ABSTRACT

Social forestry in Tamil Nadu, started in 1960 by the Forest Department, is being supported at present by the Swedish International Development Authority. Emphasis has been placed on multipurpose trees to increase the productivity of the plantations. Plus trees have been identified for several species and their seeds are being distributed. A neem tree development programme, implemented by the Krishnamurthi International Agricultural Development Foundation, has identified 37 provenances and future work will include breeding and standardisation of vegetative propagation techniques.

INTRODUCTION

Traditionally, wood is considered to be the main forest produce and others are classified as minor forest produce. This includes all the animals, plants and their produce other than timber. In tropical moist forests, the number of different minor forest produce exploited by millions of people is incredibly large. Compared to the uses of timber, the other produce such as fruits, nuts, seeds, bamboo, rattan, leaves, gum, fish and many others are easily dwarfed in our perspective. In the course of time, minor forest produce have been termed as non-wood forest produce as their importance increased.

As scientific knowledge grew, more uses for various forest produce were discovered and the forests continue to be a store house of raw materials for the industries. The important non-wood produce are fibre and floss used for manufacture of ropes, grasses for oil extraction, bamboos and canes for construction of houses and furniture and tannins for human beings and animals. These edible products became

very effective in times of famine and drought. Thus, non-wood produce play a more important role in the day-to-day lives of human beings than wood produce which are used only occasionally for construction purposes.

SOCIAL FORESTRY IN TAMIL NADU

The forest area of 2.03 million ha, out of a geographical area of 12.99 million ha in Tamil Nadu, is about 17%. A number of forest produce are available from these forests and the most important non-wood produce besides timber are sandalwood, bamboos, reeds, lichens, tannin materials from wattle and myrabolam, rubber, essential oils from lemon grass, eucalyptus leaves and geranium, spices like cardamom, cinnamon and other edible products like cashew and tamarind. Non-wood produce are of considerable importance in Tamil Nadu as they (sandalwood oil, wattle bark, cashewnuts and rubber) account for more than half the gross revenue earned by the Forest Department.

In 1960, the Forest Department pioneered planting trees in village common lands in the country. Efforts to plant trees in community wastelands continued throughout the Five Year plans. By the end of the Sixth plan in 1980, about 150,000 ha of babul was established. In 1981, Swedish International Development Authority (SIDA) provided funds for a Social Forestry scheme. During phase I, which ended in 1988, another 150,000 ha were covered under babul. The Social Forestry programme with assistance from SIDA, is being continued in phase-II (1988-89 to 1992-93) and the important components of the programme are: community wasteland development, interface forestry programme, seedling production and extension programme, agroforestry in drylands and supporting activities like research and development, education and training, publicity and communication, cooperation with NGOs and monitoring and evaluation.

As a project activity, "Society for Social Forestry Research and Development, Tamil Nadu" was formed to further the cause of research and development in Social Forestry, particularly in fields not covered by the Forest Department and by involving various research organisations like universities and NGOs. In the Social Forestry project, emphasis has been on growing multi-purpose trees, that provide edible products, additional income and employment opportunities.

Under the phase-II activities of the project, the main aim is to increase the productivity of the plantations and trees through better quality planting material, improved nursery and planting techniques, and cultural and tending operations. This is necessary to maximise the productivity to meet the increased needs of a growing population with limited land.

MPTS DEVELOPMENT PROGRAMME

Increase in productivity can be achieved through increased production per tree by bio-technological methods. Since more than thirty tree species are used in the Social Forestry project, the development programme for all the tree species will have to be spread over a number of years. Therefore, the Forest Department decided in the first instance to take up work on *Acacia nilotica, Acacia leucophloea, Acacia planiforns, Casuarina equisetifolia, Eucalyptus tereticornis, Derris indica, Tamarindus indica, Tectona grandis* and *Grevillea robusta.* Identification of plus trees of these species has been completed and seeds collected from these plus trees are supplied for various activities under the Social Forestry project.

TREE-BORNE OIL SEEDS

India has more than 100 species of tree-borne oil seeds, popularly known as non-edible or minor oil seeds. But only 10 to 12 species have been tapped so far and about 0.2 million tonnes of these oil seeds have been utilised against the estimated potential of 7.0 million tonnes per annum. The nature of oils produced by these trees varies from hard to soft. Some of them are edible as cooking media and as substitutes for butter while others are used for producing soaps. It has been reported that though the oilseed output has increased from 12 to 13 million tonnes in 1987-88 to 17 to 18 million tonnes during 1991, the demand for edible oils has outstripped the indigenous supply by more than a million tonne. This deficit is taken care of through import, causing a drain on the scarce foreign exchange resources of the country. In this context, non-edible oils obtained from trees have assumed importance. With the increased use of non-edible oils for industries and non-diversion of edible oils for industrial purpose, it is possible to reduce the import of edible oils. Though tree-based oil seeds have not been harvested to any noticeable extent, the economic and social desirability of harnessing this resource need no emphasis. The likely

benefits from concentrated efforts in this direction would be considerably higher compared to the costs. Unlike cultivated oil seeds, they do not place much demand on soil nutrients. On the contrary, the trees are known to replenish nutrient contents in the soil. More importantly, most of the tree species which provide oil seeds are being grown on comparatively less fertile soils, generate considerable amount of intangible benefits and provide a number of tangible produce besides oil seeds. Efforts to harness the potential of tree-based oil seeds would minimise pressure on agricultural lands, improve rural economy, and utilise better the installed oil crushing capacity in the country.

NEEM TREE DEVELOPMENT

In Tamil Nadu, the important oil yielding trees are *Azadirachta indica, Derris indica, Calophyllum inophyllum,* and *Actinodaphne madraspatana.* In addition, small quantities of various other oils are available from *Madhuca latifolia, Mesua ferrea,* and *Ceiba pentandra.*

Krishnamurthi International Agricultural Development Foundation, Madras (KIADEF) took up a neem development programme under the Society for Social Forestry Research and Development, Tamil Nadu. During 1991, about 100,000 neem trees in various agro-climatic zones and soil types of Tamil Nadu were examined and 3290 candidate trees were selected. After analysing the parameters of candidate trees, 361 have been shortlisted and the oil content of seeds from these trees has been assessed. On the basis of oil content plus trees have been selected and 37 provenances have been identified. Seedlings from the seeds collected have been raised in the nursery. With the help of mist tents, branch cuttings will be used for raising vegetative propagules of the various provenances. During 1992, the performance of selected plus trees will be evaluated further to confirm the selection.

The planting material collected are maintained in the Van Vigyan Kendras and other research nurseries of the Forest Department to enable them to take up breeding work. It is proposed to raise "Provenance Conservation Stands" and "Provenance Seed Stands". After breeding and selection of the best provenances for various localities, the Forest Department is expected to produce nursery stock of these provenances and KIADEF will assist in popularising these varieties among the people through extension activities.

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This will be achieved through development research, effective use of local resources, extension of appropriate technologies and upgradation of skills and capabilities with community participation.

BAIF will be a non-political, secular and professionally managed organisation.

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