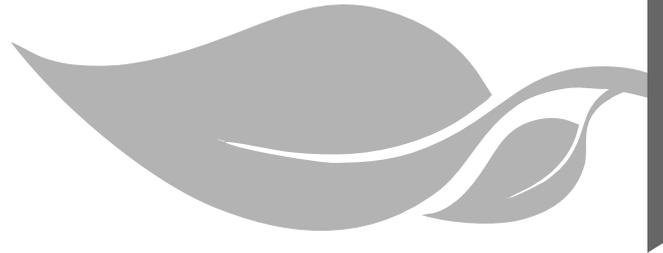


Sustainable Harvesting of
**NON TIMBER
FOREST
PRODUCE**
(NTFPs)

AN
OPERATIONAL
MANUAL



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION, DEHRADUN
(An Autonomous body of Ministry of Environment, Forest and Climate Change, Government of India)



SUSTAINABLE HARVESTING OF NON TIMBER FOREST PRODUCE (NTFPs)

AN OPERATIONAL MANUAL



INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION

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Foreword



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ICFRE with its Headquarters at Dehradun is an apex body in the national forestry research system that promotes and undertakes need based forestry research and extension. The Council that came into being in 1986 has a pan India presence with its 9 Regional Research Institutes and 5 Centers in different bio-geographical regions of the country. Since then research in different fields of forestry has been a major focus of ICFRE.

There is an earnest need of publication of its research to the stakeholders in a simple and lucid manner, to improve the visibility and relevance of ICFRE. Therefore it was decided that the information available on the technologies, processes, protocols and practices developed by ICFRE has to be published in the form of operational manuals/user manuals. It is also desirable that the manuals should be a comprehensive national level document depicting extent of knowledge in applicable form.

Accordingly, 18 scientists of ICFRE were nominated as National Subject Matter Coordinators (NSMCs) to carry out the task on the specified subject. These NSMCs were assigned the task to select and nominate nodal officers from other Institutes of ICFRE as well as other organizations if necessary, collect and collate the information on the subject from various sources in coordination with the nodal officers of ICFRE institutes.

Non-timber Forest Products (NTFPs) constitute an important component of the livelihood of the communities living in and around forests. NTFPs are contributing significantly to poverty reduction and providing a diverse range of products e.g., food, energy, medicines, leaves, fibre, resins and culturally important goods. The harvest of NTFPs for subsistence and trade is ancient, and remains common and



widespread today. This manual is very useful for the NTFP collectors/harvesters, tribals, state forest departments, communities, SHGs harvesting NTFPs, traders, researchers, conservationists as it provides a brief account on sustainable harvesting important non-timber forest products (NTFPs). Simple and doable sustainable harvesting practices of important NTFPs are given in the manual.

I hope that the guidebook will provide useful information to the diverse stakeholders and prove to be helpful literature for planning future programmes.

Dr. Suresh Gairola

Preface



Non-timber forest products (NTFPs) are goods of biological origin other than timber from natural, modified or managed forested landscapes. They include fruits and nuts, vegetables, medicinal plants, gum and resins, flavor and fragrances, bamboo, rattans and palms, fibres and flosses, grasses, leaves, seeds, mushrooms, honey and lac etc. The NTFPs have attracted global interest due to the increasing recognition of the fact that they provide important community needs for improved rural livelihood. NTFPs constitute an important source of livelihood for millions of people from forest fringe communities across the world. In India, NTFPs are associated with socio-

economic and cultural life of forest dependent communities inhabiting in wide ecological and geo-climatic conditions throughout the country. It is estimated that 275 million poor rural people in India, depend on NTFPs for at least part of their subsistence, cash and livelihoods. The NTFPs also serve as a vital livelihood safety net in times of hardship. Furthermore, the NTFP extraction has multiplier effects in the economy by generating employment and income in downstream processing and trading activities. However, depletion of NTFPs resources on account of indiscriminate exploitation, deforestation and forest degradation have a major issue of concern that may affect the NTFP based livelihood and economics. Ensuring the sustainability of NTFP resources requires sustainable harvesting practices by the harvesters.

This manual gives a brief account on sustainable harvesting of important NTFPs. It is very useful for harvesters, state forest departments, trainers, traders, researchers, NGOs for sustainable harvesting of NTFPs. Simple and doable harvesting practices of important NTFPs are given in the Manual. Most NTFPs can be harvested in more than one way. Choose the option with the lowest impact on the individual plant or the population remaining. For example, don't cut the tree but harvest fallen fruit only, take some but not the all leaves and don't harvest young leaves. If a harvest is inherently destructive, such as the roots or bark, then make sure there are also regeneration and planting programmes.

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1 INTRODUCTION

For millennia, forests have provided mankind with a wide range of crucial goods and services: as climate regulator, timber, sacred grove, and the primary raw materials used in household economies. In many developing countries today, nearly 20% of rural households derive income from forests and trees, as cash, or for subsistence needs for food and nutritional diversity (Mahapatra and Panda, 2012; FAO 2018). Several hundred million people in the world live in or near forests and depend on them for sustenance or livelihood. Although timber has assumed a dominant position among forest resources over the last century, for most of human history, forest goods other than timber fed, clothed, and sheltered our ancestors. These included aromatic spices, fruits, roots, seeds, nuts, barks, fungi, resins, feathers, bushmeat, fibers, and leaves (Peters et al., 1989).

The term non-timber forest product (NTFP) is used to describe a wide range of biological resources that originate from forests, but which are neither timber nor industrial wood fibers. Used first by de Beer and McDermott (1989), “non-timber forest products” were intended as a replacement for the term “minor forest products” which implied that the majority of useful species present in forests, and other ecosystem services and benefits, lacked value compared with industrial forms of wood. This was clearly not the case on a cash and commercial basis in areas that produced rattan, Brazil nuts, and other high-value NTFPs in international trade. Moreover, it also failed to account for the substantial subsistence and local trade values of NTFPs in much of the world (Falconer 1990; Scoones et al. 1992; Emery and Pierce 2005; Laird et al. 2011). Later on, the FAO promoted use of the term NWFPs – non-wood forest products – in recent decades, defined as “goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests.” Despite these efforts to harmonize the language of forest products other than timber, “non-timber forest products” persist as the most widely used term (Shackleton et al., 2011).

The role of non-timber forest products (NTFPs), including wild foods, forage, fiber, plant exudates, medicinal plants, construction materials, fuelwood, and raw materials for handicrafts is increasingly being recognized (Angelsen et al, 2014; Delang, 2006; Mahapatra and Tewari, 2005, Ticktin 2014). Many studies have demonstrated the important contribution of NTFPs to fulfilling households’ subsistence and consumption needs. Evidence suggests that poorer households are often more dependent or derive greater benefits from NTFPs for their livelihoods. NTFPs can also serve food security objectives by contributing to diet diversification, providing micronutrients, and providing safety-nets in times of crises. However, fluctuations in NTFP availability may limit this buyer function. Provisions of cash income and subsequent entry into the cash economy are further benefits of NTFPs, although income contribution may strongly vary depending on ecological and socioeconomic settings. The often-overlooked contribution of NTFPs to national economies can be substantial (Peters, 2011; Jalonen et al., 2018).

The economic significance of non-timber forest products is vast and far reaching, particularly for some of the world’s poorest citizens (Ticktin and Shackleton, 2011; Shackleton et al., 2015). Globally, 1.4–1.6 billion people are estimated to use, consume, or trade NTFPs (FAO 2018). Estimating the local, regional, and global



significance of NTFPs is daunting because they are traded in both formal and informal markets. Millions of people worldwide depend on the harvest of non-timber forest products (NTFPs) including medicinal and aromatic plants (MAPs) for their livelihoods. The collections of NTFPs provide critical sources of cash income to the rural communities especially the forest dependent tribals, landless poor and marginalized farmers. With a population above a billion and 147 million people living in 170,000 villages in the proximity of forest areas, majority of whom are poor, their survival is highly dependent on forest. This high dependency is creating tremendous pressure on forest. Collection of NTFPs is one of the few income opportunity and hence is very important for the forest dwellers (Shanley et al., 2002; Kaushal and Melkani, 2005).

Non-timber forest products (NTFPs) in India play an important role in the social and traditional life of millions of forest dependent population, particularly the tribal and landless people, women and other rural poor (Stanley et al., 2012; Shackleton and Pandey, 2014; Pandey et al., 2016). Commercial NWFP collection in India, was estimated to generate nearly US\$1.6 billion, at the forest gate in 2010 (Kumar et al, 2015; Joshi 2003). Today, it contributes over 75% of total forest export revenue in India. Nearly 400 million people living in and around forests depend on NWFP for sustenance and supplemental income, about 70% of the NWFP collection takes place in the tribal belt. In many rural forest-dependent communities across India (Bhattacharya, 2015), NWFP provide half of the cash income for 30% of rural people (FAO, 2018; Meinhold et al., 2019). More than 80% of forest dwellers depend on NTFPs for basic necessities. The collection of NTFPs comprises the main source of wage labour for 17% of landless labourers, and 39% more are involved in NTFPs collection as subsidiary occupation. India has shown remarkable progress during last 15 years for enhancing contribution of forests towards poverty alleviation through empowering people with the ownership of NTFP.

India's long and rich history of traditional medicine practices such as Ayurveda and highly developed herbal and pharmaceutical products manufacturing industry combine with a potential domestic market of over one billion consumers to drive the wild collection, import and export of thousands of tonnes of medicinal plants and products each year. Both finished products and extracts for production of pharmaceuticals are manufactured in India. Ayurvedic products produced in India are sold both in that country and around the world.

Various reports suggest that 75% of the raw drugs used by Indian pharmacies come from wild resources. Approximately, 13 lakhs of plants are found worldwide and about 55000 medicinal plant species are used globally for different ailments. India has innumerable medicinal plants and about 2000 plants are used in preparation of Ayurveda, Unani, Siddha, Homeopathy, modern medicines and other health products (Rastogi and Mehrotra, 1993). Due to increasing demand of medicinal plants in national and international markets threat of survival has increased manifold to wild species though this creates millions of mandays employment for forest dwellers, tribals and villagers of the area (Mukherjee 2001).

As per estimate about 1178 medicinal plant species are in active trade. There are 242 species in high trade in India with annual requirement over 100 metric tons. More than 100 species are rare, endangered and threatened, of these 19 species in high demand. As a result of the overwhelming demand of these medicinal plants by the industries, some of the species have either receded to interiors of forests or are at threat of disappearance from the ecosystem. While serious efforts have been made by the conservation agencies to promote sustainable harvesting of wild medicinal plants and promote best collection practices, guidelines available in India are generic providing little information to collectors as to how, when and how much to collect. They are generally guided, partly by economic considerations and partly on their own wisdom. Often it is the

market and economy which overrides the issue of sustainability. Non-availability of sustainable harvesting practices for such important species of medicinal plants is therefore, one of the reasons for their poor quality.

The last three decades have seen substantial growth in herb and herbal product markets across the world. Rapidly rising exports of medicinal plants during the past decade has raised worldwide interest in these products as well as in traditional health systems. According to the Secretariat of the Convention on Biological Diversity (CBD), global sales of herbal products are estimated US\$60 billion per year. Besides the household consumption the global market of the Medicinal, Aromatic and Dye Plants (MADPs) and other NTFPs is estimated for US \$59 billion per year.

Sustainable management of the non-wood forest resources in India is the joint responsibilities of the national and state governments. In 1988, the National Forest Policy, of India, resulted in a revolutionary shift from regulatory to participatory approach to forest management (Bhattacharya, 2015). Successive forest policy statements have directed attention to the production and trade in NWFP. National legislation (e.g. "Panchayats (Extension to Scheduled Areas) Act 1996" (PESA) provides ownership of NWFP to Gram Sabhas/panchayats (village assemblies). Following legislation entitled "Scheduled Tribes and Other Traditional Forest Dwellers Act 2006" (Recognition of Forest Rights/FRA) gave forest-dependent communities a primary role in forest management. This act directs that "ownership" includes revenue from sale of usufructuary rights that is the right to net revenue after retaining the administrative expenses of the department, additional to the right to regulate access and to control the resource or product. These and other policies indicate a developing awareness of the need to regulate use and exploitation; stakeholder involvement in these is essential in the transitioning process.

In recent years, the growing demand of NTFPs including medicinal plants has accelerated overexploitation of valuable resources in unscientific and destructive manner without considering sustainability and quality issues. Medicinal plants under high demand are under more threat. There is strong competition for harvesting high-value plants results in immature and low-quality harvests, thus jeopardizing future harvests. Furthermore, collectors often destroy other plants or entire plants when they need only gather one part. Those harvesting illegally without permits tend to cause more damage as they hurry for fear of being caught. These problems are less severe in community-managed forests, where users restrict frequency and methods of harvesting.

The demand for the certified products are increasing in European and American markets and India being one of the major exporters of NTFPs to these markets, the need for certifying its product cannot be ignored. The demand for certified products calls for scientific certification system to ensure that the resources are managed sustainably. In spite of this increasing demand, the NTFPs including medicinal plants are still not given due recognition in Forest Working Plans in the country which are still timber oriented, as a result of which there is a threat for sustenance of the NTFPs in view of the ever increasing demand in the national and international market, exploitative and unsustainable harvesting practices and discrepancies in the Management Plan.

Earlier, as general rule, traditional healers and plant gatherers collected medicinal plants according to their need, which usually held the amount harvested at a low levels. Most traditional practitioners still adhere to these traditional conservation practices of plant collection. However, as the collecting and selling of medicinal plants have become highly commercialized, harvesting is often undertaken in destructive ways. The modernized and highly commercialized herbal industry often leads to efficient but environmentally unfriendly and unsustainable harvesting methods.



Presently, medicinal plants are collected from wild without any awareness to the stage of maturity and parts required to be collected. It is essential to ascertain the quality of a plant material before it is employed which is governed by following factors:

- Habitat/Place from where the plants are collected.
- Maturity stage of the plant
- Climate, soil, habitat.
- Ignorance about genuine raw drugs, its appropriate time of collection etc.

As the price paid to the collectors/dwellers tends to be very low, hence they apply destructive methods to generate their income. A critical factor in wild harvesting is the non-availability of skilled labour for good collection of herbs. Unmanaged collection practices results in depletion of medicinal plants population and the outcome of drugs are reducing day by day.

State wise, there are certain guidelines for collection of medicinally important plants. There are also restrictions on collection of some threatened medicinal plants species. These species must be protected in nature through in-situ conservation and *ex-situ* cultivation, and existing laws. However, unmanaged and over-harvesting / urbanization, habitat loss and increasing demand have caused considerable threat to many important NTFP yielding species. This has compelled all stakeholders and Government to give a serious thought to evolve methods of sustainable harvesting practices to ensure sustainability. Looking at the concern for its conservation and sustainable management, a manual on Sustainable Harvesting Techniques of Some Important NTFP Species is being prepared.

LACK OF AWARENESS AMONGST HARVESTERS

As the value chain for NTFPs including medicinal plants in India is unorganized, harvesters/collectors at the bottom of the chain are usually unaware of the quality standards followed by exporters and end markets. Thus, they maintain traditional practices with little incentive to adopt new methods of harvesting and processing. In many cases, traders are unable to obtain desired quality and quantity of NTFPs from collectors and cultivators.

Besides, their role in prevention as well as curing of human health problems and global market, Medicinal and aromatic plants (MAPs) are also increasingly being recognized as source of significant livelihood opportunities for many rural communities, especially, primitive forest-dwellers, landless poor and marginalized farmers. Medicinal plants and their by-products constitute an important part of the Indian foreign trade and showing continuous growth in export over import and signify their importance outside the boundaries of the territory. The estimated global herbal industry is valued over 60 billion US\$ mainly in the form of pharmaceuticals (US\$ 40 billion), spices and herbs (US\$ 5.9 billion), natural cosmetics (US\$ 7 billion) and essential oil (US\$ 4 billion) and it is growing at the pace of 7% per year and expected to reach 5 trillion US\$ by the year 2050 (Ministry of Commerce and Industry, 2019).

Increasing demand for NTFPs has raised concerns about the conservation of genetic diversity, habitat loss, quality in terms of clean (free from physical and chemical contaminants/ adulterants), consistent (dependable production and bioactivity levels) and certified (identifiable for origin and history) products. Despite the availability of plenty of resources (biological, human and financial) available, the MAPs sector is facing the

challenges like; inadequate supply of quality raw material, inadequate infrastructural facilities for processing, storage and transportation, standards operating procedures of various products, scientific documentation, marketing linkages, trade regulation, and conservation of resources. Thus, the future of medicinal and aromatic plants sector needs to assure the continuous supply of quality raw material, most likely produced by following the standard procedures (Good agricultural and collection practices, good laboratory practices and good manufacturing practices), uncontaminated by either synthetic pesticides or by genetically modified organisms and certified by accredited agencies. The sustainable harvesting of medicinal plants holds great potential as a method for integrating the utilization and sustainable management of resources (Pandey and Das, 2014). Therefore, sustainable harvesting of NTFPs including medicinal plants is not only essential for conservation of plant species, but also for ensuring livelihoods of many rural communities, dependent on these resources.



2 SUSTAINABLE HARVESTING

CONCEPT OF SUSTAINABILITY

A sustainable system for exploiting non-timber forest resources is defined as one in which fruits, nuts, latexes, barks, roots, rhizomes and other products can be harvested indefinitely from a limited area of forest with negligible impact on the structure and dynamics of the plant populations being exploited. Sustainable harvesting is possible with various safeguards and methods. Generally, protection from fire and grazing, nurturing the young regeneration, regulating extraction, popularizing different uses of medicinal plants as some steps for sustainable harvesting of medicinal plants.

Sustainable use is defined as "The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations" (Convention of Biological Diversity (CBD), 1992, Article 2).

Sustainable harvest of NTFPs including medicinal plants is defined as "the level of harvest at which a species can maintain its population at natural or near-natural levels and the harvest, will not change the species composition". The basic concept behind sustainable harvesting is that a biological resource should be harvested within limits of its capacity for self renewal. More than that, the manner of its harvest should not degrade the environment in any way. Sustainable harvesting practices are useful in providing quality raw material to pharmaceutical industries without destroying precious resources, thereby maintaining the potential of species to meet the needs and aspirations of present and future generations.

Sustainable Harvesting – There is an urgent need to practice sustainable harvesting practices (non-destructive harvesting) and promote cultivation of species that are in higher demand to conserve the wealth of naturally occurring MAPs. The sustainable harvesting of MAPs from the wild may be promoted by creating the awareness among harvesters and forest user groups about the long-term benefits of not picking young plants, only taking the parts of plants needed, and of practicing rotational harvesting at certain times and in certain years (Pandey and Shukla, 2006). There is also an urgent need to support government and user group officials to promote and, where necessary, enforce sustainable harvesting practices. In fact the sustainable harvesting practices do not require any sophisticated or special efforts. Only awareness and certain precautions are required.

Types of Unsustainable Harvesting

- Destructive Harvesting – Uprooting the whole tree/plant or damaging/destroying the tree from bark, cutting, lopping, debarking, tapping for gum/ resin, latex etc.
- Premature Harvesting – plucking of fruits/seeds before maturing resulting in low regeneration
- Overharvesting – extracting more than the limit (carrying capacity/productivity).

The trees, shrubs, herbs and climbers in which fruit or seed is official part and harvested from natural forest are subjected to several problems; some of these problems are as follows:

- Tendency to Collect Unripe Fruits

In most states, collection of fruits and seeds from the forest is free to public; any person can go to forest and collect forest fruits. Therefore, there is large number of people going to forest for collecting forest fruits. Further, these collectors are instigated by the pharmaceutical companies and other industries using these fruits for preparation of several products. So there is a competition among the collectors and also among the industries for the collection of maximum quantity of fruits/seeds; with the result that immature fruits are collected from the forest. Aonla fruit ripens during December-January but many times collection starts from September- October. Similarly, other fruits such as bel, chironji, harra, bahera, etc. are also collected much before these are ripened. The situation is more serious in fruits which are in demand by pharmaceutical and other industries. The problem is not so severe in case of fruits collected and used locally. Even after the formation of JFMCs, the situation has not improved. The collection of unripe fruits is common in almost all medicinally important fruits.

- Tendency to Damage the Tree

It is seen that most trees are damaged by the collectors while collecting the fruits. The branches are lopped; sometimes even the tree is cut disregarding the fact that the tree if cut would not give any fruit from the next year. The collectors look for the easiest way of collection, they do not want to climb the trees as many trees are difficult to climb. Therefore, the collectors tend to fell the branches and some time even the cut the entire tree unmindfully and cause damage to the ecosystem. The damage is more pronounced in old and larger trees. In shrubs and herbs which can be handled from the ground, the damage is comparatively less. In herbs and annuals, the tendency is to uproot the entire plant along with stem and branches is still prevalent which cause damage to the entire ecosystem.

- New Recruitments Poor /Absent

In general, regeneration in forest is poor or absent in most forest types. The medicinal plants which occur in different forest types are no exception. New recruitments and younger plants (seedlings) of trees and shrubs are generally absent. Repeated fires, uncontrolled grazing, illicit removal, etc. cause serious damage to the new recruitment and younger plants. The density of herbs, creepers and climbers is gradually reducing. Several plants occurring as a ground flora are highly susceptible to fire and grazing. Firstly, the fruits/seeds that are medicinally important are collected on a large scale and only a small percent of fruits fall on the ground. These fruits being unripe have poor viability and germination capacity resulting in very poor germination. Even if some seeds germinate, the biotic pressures like fire and grazing destroy the newly germinated seedlings. The result is no recruitment and no regeneration. The situation therefore, is very serious, and after few years when presently fruit yielding trees die there will be no tree to take their place and fruit yield will reduce and there will be no yield one day which will affect the livelihood of the forest dwellers.

UNDERLYING ISSUES OF UNSUSTAINABLE HARVESTING

Some important issues with respect to management of NTFPs are as follows:

1. Technical Issues

- Lack of skilled and trained manpower in harvesting/collection of NTFPs



- Lack of proper scientific techniques of collection of different NTFPs
 - For example Kalmegh (fully matured seed in October but due to demand or competition it has been collected in August-September even before or during the flowering period).
2. Institutional Issues
 - Limited participation of poor, women and disadvantaged groups in decision making and benefit sharing which ultimately affect in sustainable harvesting procedures.
 - Value addition arrangements: Due to the lack of local processing units the traders are getting much benefit, but the primary collectors/producers are getting nothing.
 3. Policy Related Issues
 - Lack of information about policy issues.
 - Frequent ban of species (No uniform policy on ban, it vary from states to states.
 - Cumbersome process to get transit permit in some states.
 4. Market, Marketing and Trade Issues
 - Lack of information about the market (actual price of NTFPs to the producers' level).
 - Lack of communication between the producers and the exporters.
 - Lack of transparency and market information system.

CHALLENGES OF SUSTAINABLE MANAGEMENT AND HARVESTING OF NTFPS

While there is a growing recognition of importance of more accurate assessment and sustainable use of NTFPs from both governmental and other institutions, a number of challenges must be dealt with.

1. Monitoring and Supervision

The SFDs are mainly responsible for the control and management of NTFPs. However, its function is limited to giving permission and issuing license for collection. Practically there is no supervision or control in collection, nor is any rational basis for allotting plots with respect to some species. The highest bidder usually gets the plot for large scale collection of NTFPs, for which the government receives a royalty. Sometimes, Forest officers/officials have difficulties correctly identifying NTFPs because they are often referred to by various local names.

2. Over harvesting and Unscientific Collection

This has triggered by the de-facto property right arrangement and other economic conditions led to the depletion of these resources even from the protected areas like national parks. Current practices or level of skills for NTFP extraction/harvest, production management, and post-harvest operations are not satisfactory (Pandey and Shukla, 2006). Unlike timber producing trees, the management knowledge and techniques of NTFPs are not yet well developed. The species specific information required for in-situ as well as ex-situ management is generally lacking for most of the species. Although there was little pressure

on species that were collected for local use on a subsistence basis, the pressure on some of the commercial species has already resulted in over harvesting, and in some cases, immature and unscientific harvesting have led to the threat of extinction.

3. Integration on Traditional and Scientific Knowledge

The indigenous knowledge and traditional skill of limited individuals on harvesting NTFPs at a subsistence use level are not enough or enforceable to apply to the harvesting of commercially demanded species. The support services for organizing, empowering, and transferring knowledge and skills for the sustainable management to NTFP dependent communities is very limited, if not unavailable. Since the forest and grasslands where NTFPs are collected are considered to be under the government property regime and not under the control of the communities, there is an incentive to harvest as much as possible before someone else gets to it. At the same time, there was little or no awareness for conservation coupled with lack of alternative income generating opportunities that would change the unsustainable practices.

SUSTAINABLE HARVESTING TECHNIQUES

The fundamental questions that one should be able to answer while planning sustainable management of NTFP at operational level are: what is the existing growing stock and the productivity of NTFPs? What is sustainable amount of NTFP that can be prescribed for harvesting? What specific sustainable harvesting techniques in terms of seasons, methods and tools are appropriate for each of the NTFPs? In India, its limited documented knowledge on species as well as ecosystem level is a major constraint to seek appropriate answers to these questions.

Due to the heterogeneity of the products and different distributional pattern of the NTFPs sampling methods and methods used for quantification are consequently diverse, depending on the product. Similarly, many products are available only during specific seasons; therefore their inventory has to be planned accordingly. The traditional knowledge based on the immediate and lifelong experience of the farmers is key factor to the utility and accuracy of an inventory. Therefore, participatory approach which involves the combination of the technical knowledge of researcher and valuable traditional knowledge of the users should be followed during NTFP inventory. Every NTFP requires different inventory methods, but it cannot be expected to find specific guidelines for each product. Therefore, very often solutions will rely upon the creativity of the technicians and users, to develop for themselves procedures for the assessment of the growing stock and allowable harvest of a given product. Whatever methodology is developed, it is important to make conservative estimates as a starting point, and to adjust these according to the development of the resource. Therefore, periodic monitoring is another key factor in the management of NTFPs.

STEPS FOR SUSTAINABLE HARVESTING OF NTFPs

The following steps determine the sustainable harvesting

- Identify and demarcate the resource base by ecosystem type (forest, pasture, farmland, rock face).
- Identify the resource supply areas of the product(s). Estimate the supply volume based on current harvesting and trade/use. Identify current or potential threats to the resource base. Conduct group meetings and inquire where and how the products have been collected in the last three years. Rank threats. Gather data over several years, as there can be substantial year to year variations.



- Take sample field inventory to assess the growing stock and condition of target products and the ecosystem. Conduct interviews with collectors to learn their perceptions of the product availability and quality changes.
- Keep community members involved in all data collection and study steps. Use the results of the first three steps to design and implement biological monitoring. The monitoring plan should indicate the area being monitored target species; ecosystem changes; and human activity impacting the species and ecosystem. Sampling areas and growth and yield studies become integral parts of the monitoring plan.
- Make a preliminary estimate of a sustainable harvest regiment. Monitor this harvest rate and make adjustments (as necessary) in the biological monitoring plan. Remember that sustainable harvesting involves more than the amount harvested. Sustainability is determined by how and when the plant is harvested and all other impacts on the ecosystem.

Checklist to assess harvesting sustainability

- Knowledge of the natural distribution of the species
- Frequency of occurrence or abundance
- Population structure (age/size/class distribution)
- Dynamics of the species (growth and reproduction rates)
- Variation among habitats
- Role within the ecosystem

HARVESTING IMPACT ON POPULATION DYNAMICS

NTFP harvesting can have short and long term effects on the plant, ecosystem and overall biodiversity. Some consider harvesting to be ecologically sustainable when there is little or no long-term harmful effect on the populations being harvested. However, harvesting impacts on one population can cause ecologically unsustainable conditions for other species and the ecosystem structure. Sustainability must be viewed holistically. Immediate short-term effects of harvesting may be seen in the growth rate or reproduction capacity of the plant, while ecosystem changes may take longer to materialize. To distinguish short and long-term effects of harvesting on population dynamics, monitoring is done at two stages:

- Rapid assessment of the immediate short-term impact of harvesting on current population structure; and
- Long-term change in population dynamics that can be monitored from sampling areas;

3 OBJECTIVES OF SUSTAINABLE HARVESTING

The main objectives of sustainable harvesting of medicinal plants are as follows:

- To ensure conservation of species through sustainable harvest.
- To ensure supply of quality raw material on sustainable basis
- To enhance earning of local people.
- To eliminate drudgery to women and children mostly engaged in collection of NTFPs
- Capacity building among the local people towards conservation of natural resources and organizing themselves for better marketing access and to eliminate the possibility of distress selling of NTFP.
- General welfare of forests dependent communities and weaker sections.
- To ensure sustainable management of forests.



4

GENERAL GUIDELINES OF HARVESTING OF DIFFERENT PLANT PARTS

In order to conserve valuable NTFP yielding species, harvesting of plants and their products have to be sustainable. This manual, therefore, focuses on sustainable harvesting practices of various NTFP yielding species of ecological and economical importance. The NTFPs have been categorized on the basis of the parts used for medicinal and other purposes which are as follows:

- Fruit/seeds
- Flowers
- Leaves
- Root / rhizome leaves and flower
- Bark
- Gum/ resin
- Entire plant (All plant parts being useful)

Five core elements of sustainable harvesting framework are: (i) What to collect (part harvested)? (ii) What stage to collect (quality)? (iii) When to collect (season and frequency)? (iv) How to collect (method of harvest)? and (v) How much to collect (quantity)?

WHAT TO HARVEST

- Identify the plants to be harvested correctly avoiding unwanted mixtures.
- Choose healthy and well-developed plant material
- Be sure the plants you intend to harvest species that have not been sprayed with pesticides, herbicides, or fertilizers.

WHEN TO HARVEST

- Determine the right time for harvesting.
- Determine the best time for collection, e. g. the season, date or time of day.
- Harvest NTFPs under the best possible climatic conditions for the specific species.

HOW TO HARVEST

- Gather only plants those are abundant in that area being conscientious with healthy population.
- Avoid any unnecessary damage to the plant i.e. exercise caution to enable the plant can re-grow.
- Avoid mechanical damage to the harvested material that results in undesirable quality changes.

- Identify and discard unwanted plant materials during sorting.
- Put different plant material in different containers.

EQUIPMENT TO USE

- Make sure that all equipment used is clean and free of remnants of previously harvested plants.
- Keep all containers used during harvesting clean and free from contamination by previously harvested material and other foreign matter.

The general guidelines for NTFP harvesting, transportation and storage are as follows:

GENERAL GUIDELINES OF SUSTAINABLE HARVESTING OF NTFPs (WHICH MAY BE INCORPORATED IN THE WORKING PLAN CODE)

Local forest dwellers had been harvesting and managing non timber forest products even before scientific techniques evolved, hence one should know the general guideline for the harvesting of NTFP and they are;

- Prepare a base map of village forest area (if not already available) indicating the position of the village/hamlets.
- Prepare a manual GIS map showing the occurrence of the key NTFPs (like traditional stock maps).
- Identify the collecting groups from amongst the villagers with care to see that women are duly represented.
- Divide the area into blocks (equitable) for different hamlets/collecting groups and mark them on the map (prepare against item 2)
- Prepare a checklist of all available NTFPs in each block separately
- Categorize the NTFPs in each into three groups
 - a. Threatened ones, to be only given protection- marked red
 - b. Economically important and harvestable- marked green
 - c. NTFPs not falling into either of the categories- marked white
- Prepare a combined list of species available in all the blocks taken together and mark them red, white and green as above
- A list should be prepared of the species from which green leaves are harvested indicating against each coppiceable/non coppiceable/fruit bearing/timber tree/non-coppicers.
- Forest area from which fuelwood is collected should be indicated on the map. Prepare an inventory of trees used for fuelwood extraction. Indicate against each whether coppice/ non coppice/fruit bearing/timber yielding. Try to restrict fuelwood collection to non-fruit yielding coppicers.
- Finally for each species the method of sustainable harvesting has to be established. For this it would be necessary to know:
 - a. The phenological characters



- b. Normal mode of propagation
- c. Methods of vegetative propagation if known
- d. Age at which harvesting should begin
- e. Best time of harvesting
- f. Implements to be used for harvesting
- g. Sustainable method of extraction
- h. Quantity that can be safely harvested consistent with regeneration requirements

Pre Harvest Guidelines:

- Before going for harvesting, the collector should obtain a valid collection permit from relevant authorities.
- Collectors must have sufficient knowledge of the plant they have to collect. This includes identification, characteristics and habitat requirements. It should be ensured that the collector engaged for the purpose is experienced, skilled and can provide guidance to others.
- The collectors must be able to differentiate between the collected species and botanically related and/or morphologically similar species to avoid any risk to public health. He should have sufficient knowledge about the best time to harvest, harvesting technique and the importance of primary processing to guarantee the best possible quality
- Care should be taken not to harvest weeds or other unwanted material with the medicinal plants.
- Clean tools, sacks and containers should be used for collection of harvested material.
- Record books, pencil, diary and labels should also be carried to the field to maintain records.
- Label should contain date, place, time, name of collector, name of species, plant part etc.

General Guidelines for Harvesting and Processing of NTFPs

- Collect only mature parts.
- Do not collect the herbs from roadsides, sea shores, anthills, near sewerage etc.
- Start drying process immediately after collection.
- Ensure complete drying before packing and storage.
- Dry aromatic herbs, delicate fruits etc. in shade.
- Store the herbs in properly constructed stores to minimize losses on storage.

Plant part wise General Harvesting Guidelines

Bark Harvesting Guidelines

- Bark harvesting methods are species specific and are been described in the following chapters' specie wise.
- Does not harvest bark from immature trees/plants. Bark Harvesting should be done at the right stage and right time of maturity to ensure maximum levels of active ingredients and maximum chances of bark regeneration.

SUSTAINABLE HARVESTING OF NON TIMBER FOREST PRODUCE (NTFPs)

- Collect bark from the branches instead of main trunk of the tree.
- Strip the bark longitudinally and not all over the circumference of trunk/branches.
- Bark collection should be from clean locations, away from potential sources of contamination.
- Bark harvest should preferably be done in the east and west side of the tree to facilitate regeneration.
- Place harvested bark in a clean container or sack and label them.
- Ensure not to put these harvested plant parts directly on the ground and harvest when it is raining, or early in the morning when there is dew on the ground.
- Bark should be cut into small pieces to facilitate complete drying.

Whole Plants

- Collect the whole plants after seed shedding until otherwise specified.

Underground Parts

- Collect underground parts (roots and rhizomes) when the mother plant is fully mature.
- Dry fleshy parts (rhizomes and roots) before packing and storing.
- Cut large parts into smaller pieces.

Leaves, flowers, fruits, seeds and floral parts etc.

- Harvest only mature parts.
- Do not collect from unhealthy plants.
- Do not collect parts manifested with insects, fungi etc.
- Dry flowers and floral parts in shade. Fleshy flowers may be dried in Sun.
- Rotten and diseased fruits should be segregated from rest of the supply.

Gums, Oils, Resins, Galls etc.

- Make vertical incisions only on some portions of the tree.
- Do not collect the gums or resins from a tree continuously.
- Collect the gum/resin in the right season.

Post Harvest Guidelines

Post harvest very important role in quality control of NTFPs including medicinal plants (Pandey and Savita, 2017). Debris, dirt, dead bark flakes and other extraneous physical matter after harvest should be removed.

Drying & Sorting

- The fresh bark should be cut into small pieces to facilitate drying and further processing.
- Conditions associated with processing of raw materials, especially drying, have a major impact on raw material/drug quality. Inadequate drying and bad storage leads to microbiological contaminations and



changes in phytochemical composition.

- Use a clean surface, preferably raised platform/cemented floor or a tarpaulin/cloth/gunny sheet, for drying out the harvested/collected bark material.
- The fresh bark should be dried in sun for a day to reduce moisture and thereafter in shade till it completely dries off.
- Dry the bark as soon as possible after harvest preferably by spreading the bark in thin layers.
- Make clear pathways to walk between the spread out bark. Upturn the material frequently to facilitate even drying.
- Label the material with information like place of collection, date on which bark has been put for drying etc.

Storage

Packed material should be stored in a clean and dry room. Sacks should be placed on platform raised off the ground and away from the walls to avoid microbial infestation, rodent and insect attack.

5 TECHNIQUES OF SUSTAINABLE HARVESTING OF MEDICINAL PLANTS

BARK YIELDING MEDICINAL PLANTS

Barks should be harvested in the early spring, prior to any new growth, or in the late fall or winter.

1. ARJUN (*Terminalia arjuna* Roxb.)



Introduction

Terminalia arjuna Roxb. (Arjun) belongs to family Combretaceae, is a large tree with fissured bark and numerous dropping branches. The tree is common throughout the greater part of Indian peninsula along rivers, streams, ravines and dry watercourses. Arjun is a water loving species and typical of dry deciduous forests of central India. The tree prefers humid, fertile loam and red lateritic soils. It grows in low land to hilly areas and can tolerate half submergence for a few weeks. It is also planted for shade and decoration in avenues or parks.

Its bark has been used in traditional Ayurvedic preparation for generations, primarily as a cardiac tonic. It is beneficial in the treatment of coronary artery disease, heart failure and hypercholesterolemia. It is also having antibacterial, antioxidant, antimutagenic febrifuge and anti-dysenteric activities. It is also effective in biliousness, sores, hepatic, congenital, venereal and viral diseases. The wood is used in agricultural implements, water troughs and certain types of tool handles. Another economic importance is that the leaves are fed to tasar silkworms. Demand of *T. arjuna* bark, both in India and abroad has been growing rapidly for over



a decade. The shift from subsistence use to commercial trade of medicinal plants has led to an increase in intensity and frequency of medicinal plants harvested from wild habitats.

About 95 percent of the Arjuna bark requirement is met from the wild, which is collected in a pattern that is not concomitant with sustainable harvesting practices. Harvesting commercial quantity of bark has affected Arjuna population. It is estimated that the annual demand of Arjuna bark is between 2000 to 5000 tonnes. However, the total consumption of Arjuna bark by India's herbal industry was more than 2000 MT during 2005-2006.

Sustainable Harvesting

Sustainable harvesting is possible with various safeguards and methods. Generally, protection from fire and grazing, nurturing the young generation, regulating extraction, popularizing different uses of medicinal plants are some steps for sustainable harvesting. Systems for sustainable bark harvesting largely depend on the response of the target species to bark harvesting. Different forest and woodland species react differently to bark harvesting, both in terms of wound closure and susceptibility to insect and fungal attack (Pandey and Mandal, 2012; Pandey and Kori, 2011). To standardize sustainable harvesting practices for Arjuna bark study has been done in Tropical Forest Research Institute, Jabalpur. Major recommendations are as follows.

- For sustainable harvest only 1/4 or 1/3 of the mature trunk bark (tree girth) of the tree should be extracted.
- Only outer and middle bark should be removed leaving the inner bark for regeneration.
- The length of the blaze may vary depending upon the girth of the tree.
- Bark of the old branches can also be harvested from a mature tree.
- About one quarter of the bark has to be removed alternately to the upward direction from the main trunk.
- Sustainable bark harvesting can be done after two years by removing opposing quarters.



2. MAIDA (*Litsea glutinosa* C.B. Robinson)



Introduction

Litsea glutinosa C.B. Robinson (Maida) belongs to family Lauraceae. It is an evergreen tree with somewhat corky and lenticellate bark. It is found in mixed primary and secondary forests upto the altitude of 1300 m. It is native to India and distributed through Indo-China towards Malaysian area where it occurs in all parts. Earlier the species was abundantly available in the forests of Madhya Pradesh and Chhattisgarh. However, mass scale collection of the bark of this plant for agarbatti industry from natural habitats has led to the depletion of this important plant. This has threatened the survival of this species from the natural sources. Therefore, it is necessary to develop non-destructive harvesting practice of this important tree species. The root, bark, leaves, fruits and seeds of Maida are used as medicine.

Maida bark is being used for incense sticks making (Agarbatti). According to Ayurveda, roots are cooling, aphrodisiac, galactagogue and useful in treatment of biliousness, burning sensation, bronchitis, fever, leprosy etc. According to Unani system of medicine, root is astringent, tonic, expectorant, aphrodisiac and useful in treatment of inflammations, overheated brains, thirst, throat troubles, spleen diseases, paralysis etc. The bark is powdered and paste is applied on boil. Local people have belief that it is excellent remedy for boil (Baltod). The bark of *L. glutinosa* plays a key role for the survival of the agarbatti (incense stick) industry in India. Powdered bark of *L. glutinosa* and *Machilus macrantha* is known as JIGAT in trade, functions as an adhesive or binder in agarbatti manufacturing. It has great demand in market.

Sustainable Harvesting

The availability of Maida trees in the forest areas is very less. In Maida it was very difficult to find out mature trees having GBH more than 60 cm. Only few mature trees could be found in protected areas like farmers homestead or rest house etc. Keeping the threatened position and importance of the species into consideration a study has been taken up by Tropical Forest Research Institute, Jabalpur to develop non-



destructive harvesting technique of Maida bark. Bark harvesting should be done by considering following steps (Pandey and Mandal, 2012).

- Strip harvesting is superior method in comparison to making blazes on the tree trunk as only young trees were available for harvests.
- Sustainable bark harvesting can be done by removing a strip from the main trunk.
- For sustainable harvest only 1/4 or 1/3 of the mature trunk bark (tree girth) of the tree should be extracted by making a strip.
- Only outer and middle bark should be removed leaving the inner bark for regeneration.
- The bark can be harvested after one year from the opposite quarter of the tree.
- The best time to harvest bark was found between December and March.
- The regeneration of bark in young trees was fast in comparison to older trees and completed regeneration within one year.
- After one year, young stripped trees having GBH less than 40 cm exhibited an average of 82% recovery per year (based on surface area covered with regenerated bark).
- Younger trees contain higher amount of mucilage and tannin in comparison to mature trees.

3. KUTAJ (*Holarrhena antidysenterica*)





H. antidysenterica (commonly known as Kutaj) belonging to family Apocyanaceae, is a small tree or shrub. It is found in Asia, Africa, Madagascar, India, and Philippines. This tree grows throughout India up to an altitude of 4,000 ft. and often gregariously found in deciduous forests, open waste lands and is especially abundant in the sub-Himalaya tract. *H. antidysenterica* is up to 13 m in height, with milky latex, its bark peels off in flakes and is grey to pale brown in color. The leaves are shiny on the upper surface, dull and hairy on the lower, opposite, subsessile and elliptic. The flowers are white, in terminal corymbose cymes; the fruits are cylindrical, dark grey with white specks and occur in pairs; the seeds are light brown and 0.5?1.5 cm in size. Around 30 alkaloids have been isolated from the plant, mostly from the bark. These include conessine, kurchine, kurchicine, holarrhimine, conarrhimine, conaine, conessimine, iso-conessimine, conimine, holacetin and conkurchin.

Leaves, barks and fruits of Kutaj are useful in various diseases. However, bark is the most useful part and used as an astringent, anthelmintic, antidontalgic, stomachic, febrifuge, antidropsical, diuretic, in piles, colic, dyspepsia, chest infections and as a remedy for skin and spleen diseases. A hot decoction of the drug is used as a gargle in toothache. It is a well-known drug for amoebic dysentery and other gastric disorders. Till now the bark is being harvested by cutting down the entire tree and chopping the main stem and branches and removing the entire bark from the existing tree. The bark exploitation has caused serious damage to wild populations, including trees inside the forests.

Sustainable Harvesting Practices

Systems for the sustainable harvesting of bark for medicinal use should thus be species specific. Strip harvesting to ensure a sustainable supply of medicinal bark is thus only a harvest option for those species that recover after bark stripping through sheet or edge development. Key aspects to a harvest system for strip

harvesting include strip width and length, harvest rotation, minimum diameter of harvest trees, percentage of the trees in the population to be exposed to bark stripping, and the number and rotation of strips on selected trees (Pandey et al., 2011).

- Bark should be harvested longitudinally, not all over the circumference of trunk and branches.
- In younger trees having GBH less than 30 cm bark should be extracted by removing 5?6 cm wide strips from the main trunk of the tree.
- For sustainable harvest, strip harvesting should be done on the tree trunk.
- Only outer and middle bark should be removed leaving the inner bark for regeneration.
- Sustainable bark harvesting can be done after every 18 months by extracting opposite strip of the trunk bark.
- The affect of harvesting season on bark regeneration showed that the bark regeneration was faster if when the bark was harvested in the month of March. However, the bark regeneration was slower when the bark was harvested in the month of June.

4. SHEONAK (*Oroxylum indicum*)



Oroxylum indicum (Hindi: Sheonak) belongs to family Bignoniaceae. The plant grows all over India in deciduous forests and in moist areas. In India it is distributed in Eastern and Western Ghats and North-East regions. The existence of Sheonak in natural population is highly threatened and it has been categorized as

vulnerable medicinal plant by the government of India. It is a medium sized deciduous tree growing 8-12 meters in height. The bark is grayish brown in color with corky lenticels. The leaves, very large, 0.5-1.5 meter in length, 2-3 pinnate, leaflets 12 cm long and 8 cm broad. The flowers are reddish-purple outside and pale, pinkish-yellow within, numerous, in large erect racemes. The fruits are flat capsules, 0.33-1 meter long and 5-10 cm broad, sword-shaped. The seeds are numerous, flat and winged all around, except at the base. The plant flowers in June-July and bears fruits in November.

Sheonak is mainly used as a constituent of the ayurvedic preparation Dasmularista. The popular preparation Dasmularista is used by Ayurvedic physicians since ages, for the treatment of vitiated conditions of vata dosha, like rheumatic disorders. Sheonak is one of the herbs mentioned in all ancient scriptures of ayurveda. It possesses analgesic, antibacterial, anticancerous, antioxidant, hepatoprotective, gastroprotective and immunomodulatory properties. Many flavones and traces of alkaloids are present in pods, seeds, stem and root barks. The plant contains flavonoids like chrysin, oroxylin and baicalein as active principles. A flavone glucuronide – oroxindin – isolated from seeds and characterized.

Sustainable Harvesting Practices

O. indicum bark can be obtained on sustainable basis if the bark is harvested through non-destructive harvesting techniques and sufficient time is allowed between two successive harvests for the plant to regenerate new bark. Sustainable bark harvesting techniques should be practiced in order to conserve and sustainably utilize the resources.

- Bark should be harvested longitudinally, not all over the circumference of trunk and branches.
- In younger trees having GBH less than 30 cm bark should be extracted by removing 5-6 cm wide strips from the main trunk of the tree.
- For sustainable harvest, strip harvesting should be done on the tree trunk.
- Only outer and middle bark should be removed leaving the inner bark for regeneration.
- Sustainable bark harvesting can be done after every 18 months by extracting opposite strip of the trunk bark.



5. Kachnar (*Bauhinia variegata* Linn.)



Bauhinia variegata Linn. (Hindi: Kachnar) is a small to medium sized deciduous tree with a short bole and spreading crown, attaining a height of up to 15 m and diameter of 50 cm. In dry forests, the size is much smaller. The bark is light brownish grey, smooth to slightly fissured and scaly. Inner bark is pinkish, fibrous and bitter. The twigs are slender, zigzag; when young, light green, slightly hairy and angled, becoming brownish grey. It is distributed throughout India growing wild and as a garden plant. The various parts of the plant viz., flower buds, flowers, stem, stem bark, leaves, seeds and roots are practiced in various indigenous systems of medicine and popular among the various ethnic groups in India for the cure of variety of ailments.

The flower buds are used for the treatment of diarrhoea, dysentery and haemorrhoids. The flowers are used in piles, oedema, dysentery, as laxative and anthelmintic. The bark is used in fever as tonic and astringent, as antileprotic, in skin diseases and wound healing, antigoitrogenic and as antitumour. It is also reported to be useful as antitumour and in obesity. The leaves are used in treatment of skin diseases and stomatitis. The roots of the plant are used as an antidote for snake poisoning, in dyspepsia, flatulence and as carminative. The stem bark is reported to contain 5,7 dihydroxy and 5,7 dimethoxy flavanone-4-O-L rhamnopyrosyl-D-glycopyranosides, Kaempferol-3-glucoside, lupeol and betasitosterol. Seeds contain protein, fatty oil-containing oleic acid, linoleic acid, palmitic acid and stearic acid. Flowers contain cyanidin, malvidin, peonidin and kaempferol. Root contains flavanol glycosides.

Sustainable Harvesting Practices

- Bark should be harvested longitudinally, not all over the circumference of trunk and branches.
- In younger trees having GBH less than 30 cm bark should be extracted by removing 5-6 cm wide strips from the main trunk of the tree.
- For sustainable harvest, strip harvesting should be done on the tree trunk.
- Only outer and middle bark should be removed leaving the inner bark for regeneration.
- Sustainable bark harvesting can be done after every 18 months by extracting opposite strip of the trunk bark.

6. ASHOKA (*Saraca asoka*)



Ashoka is a small or medium sized tree with beautiful dense clusters of yellow and orange-red flowers belongs to the Caesalpineaceae family. *Saraca asoka* is sacred to the Hindus and the Buddhists. It is among the trees that add beauty to the outdoors. Its leaves are peri-pinnate, 15-20 cm long, leaflets 6-12, oblong, lanceolate, flowers orange or orange-yellow, fragrant, pods flat, leathery, seeds 4-8, ellipsoid-oblong. The yellow and red colours of the flowers contrast well with the deep green colour of the leaves. Flowering starts from January and continues till May, though sometimes the flowers are visible during other months also. Ashoka means "without sorrow", possesses several medicinal properties. Its bark is reputed for keeping women healthy and youthful.



Crushed flowers and leaves are rubbed on the skin to get relief from skin diseases. The plant is used also in dysmenorrhoea and for depression in women. It is also reported to cure biliousness dyspepsia, dysentery, colic, piles and pimples. Leaves possess blood purifying properties. Flowers are used in dysentery and diabetes.

Ashoka is well known for its use in treating gynecological disorders. Many Ayurvedic physicians believe that women should use this herb frequently to avoid gynecological and reproductive disorders. Bark is removed and sun dried for use in preparation of various herbal medicines. Domestic consumption of bark is quite high in pharmaceutical industries. It also has good export potential. Decoction, Ghrit, Arishta and many other formulations like Sundareekalp, M2 Tone, Leukonil. Ashokarishta, Ashokaghrita are available in the market. This increased demand of the bark has threatened this beautiful tree from the wild. It need conservation and only way to conserve the valuable resource is non-destructive harvesting (Pandey 2015).

Sustainable Harvesting Practices

- Bark should be harvested longitudinally, not all over the circumference of trunk and branches.
- For sustainable harvest, strip harvesting should be done on the tree trunk.
- Only outer and middle bark should be removed leaving the inner bark for regeneration.
- Sustainable bark harvesting can be done after every 24 months by extracting opposite strip of the trunk bark.

7. LODH (*Symplocos racemosa* Roxb.)

Distribution

Symplocos racemosa Roxb. (Commonly known as Lodh, Lodhra) is belonging to family Symplocaceae. It is found in the plains and lower hills throughout North and East India, ascending in the Himalayas up to an elevation of 1400 m, Bengal, Assam and Chota Nagpur. It is found in Assam, Maharastra, Madhya Pradesh, Karnataka, Chhattisgarh, Odisha, Gujrat and Bihar.

Botanical Description

A small, evergreen tree, upto 6-8.5 m tall; bark dark grey, rough. Leaves elliptic oblong or elliptic-lanceolate, 9-18 x 3-5 cm, serrulate or obscurely crenate, rarely entire, glabrous and dark green above, pubescent beneath. Flowers white, fading yellow, in simple axillary racemes. Fruit (drupe) oblong, 1-1.3 cm long, purplish black when ripe, crowned with persistent calyx. Flowering commences from October to January and fruiting takes place December to May.

Medicinal Uses

Stem bark is used to treat haemorrhage, eye diseases, spongy and bleeding gums, leucorrhoea, wounds, ulcers, tumors, leprosy, skin diseases, asthma, bronchitis, dropsy, arthritis, fever, liver diseases, menorrhagia,

diarrhea, dysentery and uterine disorder. It also has great potential in the treatment of diabetes, blood clotting, ulcers, cancer prevention, tumors, immunity and inflammation. *Symplocos racemosa* is categorized as vulnerable species. In India, the demand of its bark is more than 100 MT per annum.

The bark is astringent, refrigerant, alterant, ophthalmic, expectorant, antiinflammatory, depurative, febrifuge, haemostatic, stomachic, constipating and suppurative. It is useful in eye diseases, spongy and bleeding gums, asthma, bronchitis, dropsy, arthritis, ulcers, tumours, leprosy, skin diseases, acne and pimples, fever, haemorrhages, haemoptysis, menorrhagia, dyspepsia, flatulence, leucorrhoea, diarrhoea, dysentery, hepatic disorders, chyluria (filarial), elephantiasis, haemorrhoids, baldness, scrofula, ear diseases and gonorrhoea.

Lodh is antimicrobial, antidiarrhoeal, spasmogenic, heart depressant, blood pressure depressant. Bark showed inhibitory effect on the growth of *Micrococcus pyogenes* var. *aureus*, *E. coli*, and enteric and dysenteric groups of organisms and reduced the frequency and intensity of the contractions in vitro of both pregnant and non pregnant uteri of some animals.

Chemical Constituents

Monomethyl pelargonidin glucosides (I & II), loturine, colloturine, loturidine, reducing sugars, oxalic acid, phytosterol, 3-monoglucofuranoside of 7-O-methyl leucopelargonidin (bark); pelargonidin-3-O-glucoside, butulinic, acetyloleanolic, oleanolic and ellagic acids (plant).

Formulations and Preparations

Rodhrasava (Lodhrasava), Pushyanuga churna, Brihat gangadhara churna, Kutajashtaka churna, Asthisandhanaka lepa, Laghugangadhara churna, Nagarjunanjana, Vajrakapata rasa, Lodhradi kvatha.

Harvesting

Excessive bark harvest affects availability of the targeted species population in the forest areas of central India. These species have decreased alarmingly due to illegal logging and unsustainable harvest of bark. There is need to harvest the bark in nondestructive manner.

- Bark should be harvested using alternate strip harvesting method along the diameter of the tree.
- Bark harvest should be done by removing alternate vertical strips of 5-10 cm width and 60-90 cm length using a sharp tool from mature trees having GBH > 30 cm.
- Bark should be extracted 30 cm above the ground from main stem of the tree to avoid insect/fungal infestation. Approximately, 150-400 gm of fresh bark can be extracted from a tree at a time.
- While harvesting the bark, polythene/tarpaulin sheet or cloth/gunny bag should be spread around the tree to ease unsoiled bark flakes/chips collection.



8. CINNAMON (*Cinnamomum zeylanicum*)

Cinnamon is a valuable spice that is obtained from the bark of an evergreen tree (*Cinnamomum zeylanicum*) that belongs to the Laurel family (Lauraceae). Cinnamon is native to Sri Lanka, Myanmar (Burma) and the southern coastal strip of India. It is an evergreen tree, attaining the height of about 6-8 m with thick, smooth, reddish brown bark. Opposite or sub-opposite leaves are ovate or ovate-lanceolate, hard and coriaceous, glabrous and shining above, slightly pale beneath with 3-5 main nerves. Many minute flowers are present in axillary or sub-terminal cymes or panicles. Fruit is ovate or oblong, about 1.5 - 2 cm long, minutely apiculate, dry or slightly fleshy and dark purple in colour with single seed and persistent perianth.

Cinnamon gets its distinctive smell and aroma from a volatile oil that is in the bark. The oil can be distilled from off-grade bark, leaves and roots. The major compounds present in both stem and root bark is cinnamaldehyde (75%) and camphor (56%) respectively. The oil extracted from leaves containing 70-80% of eugenol, oil from bark contain cinnamon oil which is brown and viscid and the root oil has a strong camphoraceous smell with yellow colour and is lighter than water. Eugenol, cinnamaldehyde, cinnamyl acetate, caryophyllene, linalool, cinnamic acid, coumaric acid and cinnamyl alcohol are the active constituents.

Sustainable Harvesting Practices

Cinnamon is ready for harvesting after 2-3 years from planting when the plant reaches height of 1.5-2 m with three to four shoots and the bark turns brown in colour.

Cinnamon bark is harvested twice a year immediately after each of the rainy seasons when the humidity makes the bark peel more easily. The trees are first harvested when they are three years old, one year after pruning. The side stems that are about three years old are removed and the bark is stripped off. Cinnamon bark is only obtained from stems that are between 1.2 and 5cm in diameter.

The main shoot is coppiced or cut back to a height of about 6 cm from ground level. Two to three crops are taken annually depending upon the rainfall. Ideal time for harvesting shoots is from September to November. Side shoots having finger thickness and uniform brown colour are ideal for bark extraction. A 'test cut' can be made on the stem with a sharp knife to judge the suitability of time of peeling. If the bark separates readily, the cutting can be commenced immediately. The stems are cut close to the ground when they are about 2 years old, as straight as possible, 1.0-1.25m length and 1.25cm thickness. Harvested shoots are bundled together and transported to the pack house for further post harvest procedures.

Post Harvest Method

Processing accounts for about 60% of the cost of production of cinnamon. This is because the peeling of bark from the stems is labour intensive and is usually done by hand, by skilled peelers. The quality of cinnamon depends on how well the bark is removed from the stems. The larger pieces or quills can be sold for more than the smaller broken pieces. Drying is also an important stage of the processing of cinnamon. It contributes to the quality of the final product.

- Peeling of the inner bark- During peeling outer skin is scraped with a special knife and the peeled bark is allowed to dry under sun for few hours and when rolling of the bark starts, pieces of bark are connected together and to make a pipe like structure (called as a quill) and the standard length of the tube is 42 inches.
- Drying of the Peels - The compound quills are placed on coir rope racks and dried in the shade to prevent warping. After four or five days of drying, the quills are rolled on a board to tighten the filling and then placed in subdued sunlight for further drying. In humid climates or during the rainy season it will be necessary to use a mechanical dryer to complete the drying process.
- Grading of Cinnamon Rolls- The quality of cinnamon is judged by the thickness of the bark, the appearance (broken or entire quills) and the aroma and flavour.

Packaging for Transportation

Cinnamon quills are cut into pieces up to 10cm in length and packed into moisture-proof polypropylene bags for sale. The bags should be sealed to prevent moisture entering. Dried cinnamon quills must be stored in moisture-proof containers away from direct sunlight. The stored cinnamon quills should be inspected regularly for signs of spoilage or moisture. If they have absorbed moisture, they should be re-dried to a moisture content of 10%. The storage room should be clean, dry, cool and free from pests.

Ensuring Natural Regeneration of Species

Bark should be harvested sustainably without killing the tree.



FRUIT YIELDING NTFPs

Fruits should be harvested only when they are mature and ripe, unless specification requires collection of immature fruits. Only unbruised fruits should be collected and handled in a manner that prevents bruising after harvest. If collection is done by shaking fruits from trees, collection should be done onto a clean tarp to prevent direct contact with soil. Lopping and tree felling is prohibited. Some un-harvested fruits should be left on the plant. Seeds should be thrown during transportation.

1. AONLA (*Phyllanthus emblica* Gaertner)



Introduction

Phyllanthus emblica Gaertner (Aonla) belonging to family Euphorbiaceae is a wonder tree and one of the precious gift of nature to man. *Phyllanthus emblica* grows as an associate in tropical dry and moist deciduous forests in large parts of India. It is native of tropical south-eastern Asia, particularly central and southern India. Commercial cultivation of Aonla has come up in some parts of Tamil Nadu, Uttar Pradesh, Rajasthan, Madhya Pradesh and Chhattisgarh. The fruits are rich source of vitamin C and are used extensively in all the Indian systems of medicine. According to the two main classic texts on Ayurveda (Charak Samhita and Sushrut Samhita) Aonla is regarded as the best among rejuvenative herbs, useful in relieving cough and skin disease and the best among the sour fruits.

It is commonly known as Indian gooseberry and easily steals the march over other ayurvedic herbs because of its versatility, recuperation, vitality, potency and rejuvenating powers. Its innate goodness and dosha-neutral nature is so valuable that it finds a role in large number of ayurvedic preparations. The fruits are widely consumed raw, cooked or pickled. Aonla fruits form an integral part of various formulations including Triphala

(three fruits), and the famous Chyawanprash, a general tonic for people of all ages, which improves mental and physical well being. It decreases serum cholesterol, binds heavy metals and is useful in jaundice.

Aonla is an important rasayana drug used for the treatment of diseases caused by morbid vata, pitta and kapha and regarded as being able to impart youthful vigour and strength. It is considered astringent, bitter, digestive, aphrodisiac, laxative, diuretic and tonic. It has been used in treating vomiting, haemorrhage, fever, cough, eye inflammation, ulceration, anorexia, emaciation, scurvy, diabetes, menorrhagia, leucorrhoea and toxicosis. It is also said to relieve thirst, burning sensations, impurity of the blood and to promote abundant hair growth and has been used for the treatment of common cold, cancer and heart diseases. In recent years, the growing demand for herbal products has led to a quantum jump in the volume of plant materials traded within and across the countries.

In India, the total annual demand of botanical raw drugs for the year 2005-06 has been estimated as 31,9500 tonnes with corresponding trade value of Rs. 1,0690 million (Ved and Goraya, 2007). Wherein Aonla is the highest consumed botanical raw drug used by the domestic herbal industry with present annual trade of 16000 MT. The economic value of Aonla fruits (including processed products) was estimated at between 200-250 million rupees (US\$ 6 to 6.25 million) in 1996, and market potential is considered to be much higher (Balachander, 2002) with an annual growth rate of 22.5 %. The estimated value of collected NTFPs in the state of Chhattisgarh is approximately Rs. 5250 million per year and the current production of Aonla in the state is 3100 tonnes worth Rs. 93 million (CGMFP Market Survey Report, 2006).

Sustainable Harvesting

A sustainable system for exploiting non-timber forest resources/medicinal plants is defined as one in which fruits, nuts, latexes, barks, roots, rhizomes and other products can be harvested indefinitely from a limited area of forest with negligible impact on the structure and dynamics of the plant populations being exploited. Sustainable harvesting is possible with various safeguards and methods. Generally, protection from fire and grazing, nurturing the young regeneration, regulating extraction, popularizing different uses of medicinal plants are some steps for sustainable harvesting. To standardize sustainable harvesting practices study has been conducted in different areas of Chhattisgarh (Pandey and Kori, 2011). Aonla fruits should be harvested as per following instructions.

- The variation in annual regeneration of Aonla is significant in respect of different harvesting regimes and years.
- For sustainable harvesting the fruits are harvested after maturity i.e. in the month of January and 20% fruits are left for regeneration.
- If it is difficult to leave 20 % fruits on every fruited tree, at least 10 % trees should be left for regeneration purpose. If 10 or more fruiting trees are present in one hectare then 10% fruits are enough for optimum regeneration.
- The fruits should be harvested during December- January when they become dull greenish-yellow from light green. At this stage fruits accumulate maximum ascorbic and gallic acid.
- The mature fruits are hard and did not fall at gentle touch therefore, vigorous shaking was required. Fruits should be harvested using long bamboo poles attached with hooks.
- The status of fruits yield per tree was better in People Protected Areas (PPAs) than in multiple use forest areas.



2. BAIVIDANG (*Embelia tsjeriam-cottam* A. DC.)



Introduction

Embelia tsjeriam-cottam A. DC. belongs to family Myrsinaceae and is commonly known as Baividang. It is a climbing shrub and widely distributed in India, Sri Lanka, Malaysia and South China. It is found in the forests of Chhattisgarh. The sizeable proportion of Baividang presently seems to be collected from Dhamtari, Bastar and Marvahi region of the state. It is an anthelmintic and a well known ayurvedic drug. It is a large woody scandent or straggling shrub (rarely erect shrub) and more accessible source for the raw drug. It is a deciduous plant and become leafless during March.

It is a constituent of various formulations marketed for liver ailments. Fruits of Baividang have been known to possess analgesic, antipyretic, antibacterial and antifertility activity. It has also been reported to be useful in jaundice. It has been used traditionally to maintain a healthy skin and to support the digestive function. It has a mild laxative activity and clinical studies have shown that extracts are effective against ascarides. Dried berries of the plant are also used in the treatment of constipation, colic, dyspepsia, flatulence and piles.

The commercial importance of Baividang has estimated the domestic consumption of Baividang to be of the order of about 400 tons, valued approximately at Rs. 400 lakhs, for the year 1999-2000 and is one of the top 50 traded plant drugs in India. This study has also estimated the annual growth rate of about 23%. At present the market price is on an average Rs. 75/kg. The demand for Baividang is being met entirely from wild collections and no commercial cultivation is underway anywhere in India. It constitutes an integral part of Non Timber Forest Produce (NTFP) collection and trade by the tribal and locals living in and around the forests, thus playing an important role in the household and local economy of a community or a village. Besides this, the dried fruits of the species under the name *Embelia* are also reported to be exported to Europe.

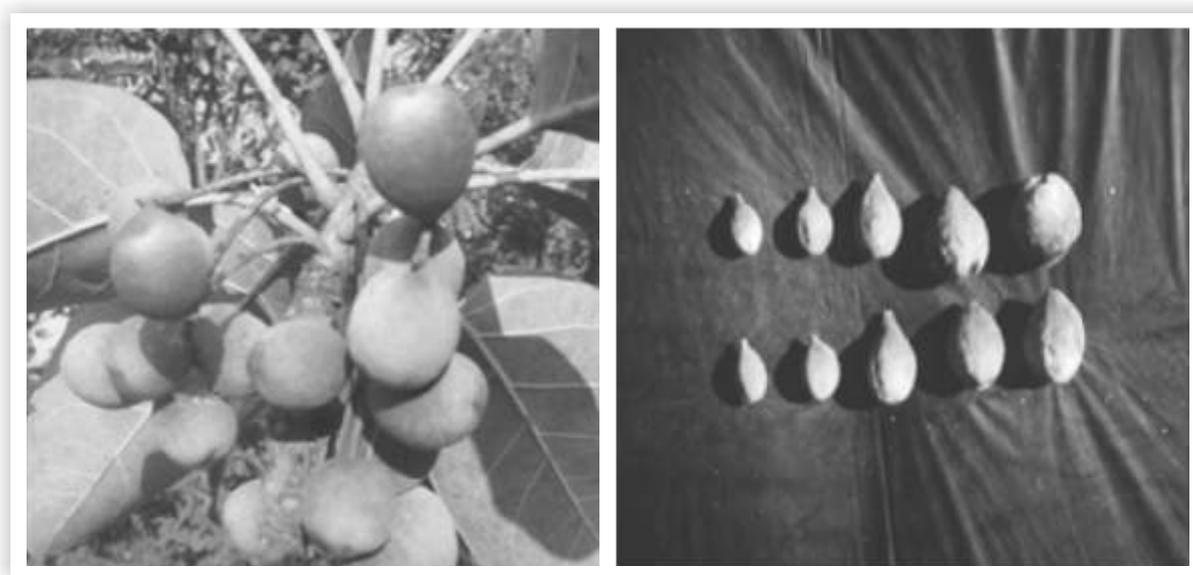
Sustainable Harvesting

There cannot be uniform harvest regime to maintain the sustainability of Baividang. The quantity of fruits to be

harvested to maintain the sustainability depends upon population of species and other factors like topography, climate and anthropogenic conditions of the region and varies from place to place. Harvestings regimes may be modified accordingly to place and population (Pandey and Shackleton, 2012). Moreover, fruits should be harvest in proper time of maturity by considering the following points.

- Baividang fruits should be collected/harvested after maturity when they change their colour from green to pink or red.
- Fruits should be plucked by hand instead of cutting the branches.
- If collectors harvest Baividang mature fruits by plucking by hand instead of cutting the branches some fruits will fall and help in maintaining the population.
- The amount of fruits to be harvested depends upon the population of Baividang. If the population of Baividang is more (20 fruited plants per 10x10m) then 5-10 % fruits are enough for regeneration whereas in the areas where population is less (10 fruited plants per 10x10m) 10-20% fruits should be left for regeneration. If the population is very less (5 plants per 10x10 m) then 20-30% fruits should be left for regeneration.
- If collectors feel difficulty in deciding the percentage of fruits left for regeneration they can leave one or two fruited branches per plant at the time of collection.

3. BAHEDA (*Terminalia bellerica* Roxb.)



Introduction

Terminalia bellerica Roxb. (Baheda) belongs to family Combretaceae. *Terminalia bellerica* (Belliric Myrobalan) is a large deciduous tree. This species is distributed in Indo-Malaysian region, Srilanka and Indo-China. It is



distributed throughout the forests of India at an altitude below 10,000m except in dry and arid regions. Within the country it is found throughout the plains and low hills in Arunachal Pradesh, Karnataka, Tamilnadu, Chhattisgarh and Madhya Pradesh. Baheda is one of the important NTFP species available in the forests of Chhattisgarh. The fruits are green and inflated when young and yellowish gray and shrink (nearly seen as ribbed) when mature. Mature fruits are ovoid gray with a stony nut. The bark is bluish gray with many fine cracks.

Terminalia bellerica is also known as Vibhitaki in Sanskrit, meaning fearless. It is so safe to use and highly valued for its efficacy. It is unique in being both laxative and astringent, so it purges the bowels, while simultaneously toning the tissues of the digestive tract. Among the array of medicinal properties attributed to it, a significant one is its therapeutic value in the treatment of liver disorders. The fruit is also reported to have purgative, cardiac depressant, hypotensive and choleric effects. It reduces lipid level from the liver and heart, which can lower the disease risk associated with those organs. It is one of the constituents of the famous ayurvedic preparation Triphala which is used in a wide array of areas ranging from rejuvenating, astringent, cardioprotective, antacid and antibacterial properties. The overall tonic effect of this fruit has been known for thousands of years in India and other Asian countries.

Baheda bark is a good source of tannin. Baheda fruit pulp is a good source of gallic acid which has good antioxidant property. Baheda kernel is a source of edible oil. The oilcake obtained after extraction of oil can be utilized as cattle feed and biofertilizer. The oilcake contains high amount of nitrogen (8.34%). On biochemical evaluation from the oil cake it is evident that about 60% NaCl extractable protein is digestible which can be converted into biofertilizer or some useful fodder. The extractable high quality of tannin present in fruit pulp is being used in the leather industry and herbal medicines. Baheda is used in several Ayurvedic and pharmaceutical preparations, therefore the demand is high. Market demand of Baheda is approximately 35000 quintal annually. Rate of Baheda as a whole is Rs. 4-5 / kg and Baheda kachari Rs. 6.50/kg.

Sustainable Harvesting

To maintain sustainability, Baheda fruits should be harvested after maturity i.e. in the month of December-January. The harvest time may vary according to use of Baheda. The harvest regime depends upon number of fruited trees per unit area and other conditions like topography, climate and anthropogenic pressure. If Baheda population is more i.e. 5 fruited trees per ha. 5-10% fruits should be left for regeneration at the time of harvest to maintain population (Pandey and Bhargava, 2014). However, if Baheda population is less (1-2 tree/ha.) minimum 10-20% fruits should be left for regeneration. Following points should be considered at the time of fruit harvesting.

- To maintain sustainability, Baheda fruits should be harvested after maturity i.e. in the month of December-January.
- There is significant increase in the fruit size harvested in October - January.
- If Baheda population is more i.e. 5 fruited trees per ha 5-10% fruits should be left for regeneration at the time of harvest to maintain population. However, if Baheda population is less (1-2 tree/ha) minimum 10-20% fruits should be left for regeneration.

- Good regeneration is observed in the experimental areas where 10% fruits left for regeneration at the time of harvest.
- Newly immersed seedlings were found under the trees but no or very less seedlings found at the distance of 100 m show the poor dispersal of seeds.

4. HARDA (*Terminalia chebula*)

Distribution

Terminalia chebula (Harhha or Harda) is called the "king of medicines" and is always listed first in the Ayurvedic materia medica because of its extraordinary powers of healing. In Ayurveda it is considered to destroy all diseases and eliminate all waste from the body. It is found throughout the greater part of India including sub-Himalayan tract from Punjab eastwards to Bengal, Bihar, Assam and Southward to Madhya Pradesh, Maharashtra, Orissa, Andhra Pradesh, Tamil Nadu and Karnataka. It is ascending upto 1500 m in the outer Himalayas and upto 900 m on dry slopes in the Western Ghats. It is also found in UP, Uttaranchal, Rajasthan, and Himachal Pradesh (Kangra). It also occurs in Sri Lanka and Myanmar and to a large extent in deciduous and moist forests in rocky and dry places in the outer Himalayas. It can be grown on wide range of soils from loam to lateritic soils. The plant attains the best development on loose, well-drained soil.

About the Species

Terminalia chebula (Combretaceae) chebulic Myrobalan is a moderate sized or large deciduous tree with round crown and spreading branches, attaining a height and girth of 20-30 m and 1.5-2.4 m respectively. Bark is dark-brown, often longitudinally cracked, exfoliating in woody scales. Stem is cylindrical, bole 4-9 m. Leaves are alternate-opposite, elliptic-ovate, coriaceous with a pair of large glands at the top of the petiole. Flowers dull white –Yellowish –white or greenish-white (cream coloured) in spikes at the end of branches. March-August; depends upon places; March to May or June in the hills, sometimes also occurs during July – August. Fruit-ellipsoidal, obovoid or ovoid, yellow to orange brown, sometimes tinged with red or black and hard drupe when ripe, 3-5 cm long, becomes 5-ribbed on drying. *Terminalia chebula* (Harda) fruits have high medicinal value. Apart from this, the fruits of Harda are used in tanning industry. In India, it is traded more than 10000 MT/year.

Medicinal Uses

Harda is used in India to treat many diseases such as digestive diseases, urinary diseases, diabetes, skin diseases, parasitic infections, heart diseases, irregular fevers, flatulence, constipation, ulcers, vomiting, colic pain and hemorrhoids. Fruit pericarp contains 30-50% tannin used in India for a long time. Commercial extracts are prepared. Suitable for treating locomotive water, oil drilling composition, ink making, petroleum purification, cement, colouring slate-stones, and as flocculent and anti-corrosion agent. Spent pulp can be used for activated carbon, furfural, cardboards, adhesive resins, etc. Possesses purgative, stomachic, anthelmintic, tonic and alternative properties; exhibits anti-inflammatory and anti microbial activities. The tannin when hydrolysed Chebulic acid and D-galloyl glucose are obtained. Besides, it contains anthraquinones and linoleic acid. Seed kernel yield 40 % oil. Possesses purgative properties. One of the



constituents of "Triphala"-used as laxative and in treatment of enlarged liver, piles, stomach complaints, pains in eyes etc. The paste of this fruit can be applied externally on chronic ulcers, wounds and scalds or used as a gargle in inflammation of mucous membrane of mouth. powder of the fruit is used as a dentifrice for strength of gums. Constipation, chronic ulceration ulcerated gums, bleeding piles, cough, dyspepsia, indigestion, gastric trouble, flatulence, alopecia, night blindness, asthma, dysentery, tumour, worms, colic pain, vomiting, jaundice, oral inflammation, skin diseases, mumps, vaginitis, hair disorders.

Chemical Composition

Main alkaloids – Chebulin from flowers, fruits contain about 30 % astringent substance. Chebulin exhibited antispasmodic action on smooth muscle similar to papavarine. Chemical constituents: Myrobalans, Chebulinic acid.

Traditional Harvesting Technique

Due to the high demand for fruits in the herbal as well as in tanning industries, the fruits are collected by following destructive harvesting methods such as lopping the branches and plucking immature fruits. This has resulted in increased mortality of the trees and decreased regeneration, thereby decreasing the fruit yield year by year. Regeneration in Harda is also difficult as the percentage of seed germination is very low. As it is a tree species, fruiting starts at the age of 10-15 years.

Collection Time and Procedure

January to March is the best period for fruit collection. Fruit should be collected in the first half of January from the ground as soon as they have fallen.

The best time for collection of the fruit for optimum tannin content is January. Collection prior to or after January will yield inferior quality of Harda.

A good sample contains 32 % tannin, range of which usually varies from 12 to 49%.

Harra freshly collected and dried immediately have yellowish colour and fetch a better price. The fruits when allowed to lie on the ground have darker colour with sometimes mould attack. Tannin content in such decaying fruits is also very low. Mould attack also sometimes occurs on the tree and this is mentioned as the major cause of poor quality of myrobalans.

Grading

The different grades of myrobalans are at present known by the names of the areas from where they are exported. The grades are based on shape, colour, compactness of the nuts and freedom from insect attack.

Following four grades are known:

- Jabalpur coming from MP and partly from Odisha,
- Bimilipatnam coming from Andhra Pradesh and partly from Tamil Nadu,
- Rajpores or Bombay variety coming mostly from Kolhapur and other parts of Maharashtra,
- Salem or Madras variety coming mostly from Tamil Nadu

The fruits fall on the ground soon after ripening. The harvested seeds are dried in thin layers, preferably in shade and graded for marketing. In trade parlance, Harda is divided into three categories.

Bal/ Choti/ Jawa Harda - Harvesting period of this is usually January and is primarily used for Ayurvedic medicines. Price is around Rs. 40 per kg. The fruit of this category is collected before maturity as small Harda has more medicinal value. However harvesting at such an early stage is not considered sustainable. Forest dwellers are forced to do it as it fetches more prices. When Harda becomes mature, it loses medicinal value thereby fetching less money.

Badi Harda – It is used in Tanneries and not very useful for Ayurvedic medicines as it has lesser medicinal values. Average price is about Rs. 3 per kg. February is considered the best month for collection of this variety. Badi Harda is losing its ground rapidly as it is believed that tannin production companies have developed a substitute.

Kacheria - It is the crushed pulp of Badi Harda as the astringent quality is found in the same. It can be used as substitute of bal Harda. The crushed Myrobalans are preferred as it reduces bulk and weight of the material while whole fruits are preferred to avoid adulterations. But transport difficulties force exporters to send Myrobalans in crushed form.

Collection and Processing

The sustainable harvesting techniques emphasised collection of 80% matured/ fallen fruits. The collection of fruits is generally done by shaking the trees and picking up from the grounds. Then the fruits are dried in the sun with arrangements for avoiding contamination. It takes about 3 to 4 weeks for complete drying. For this purpose contractors generally erect temporary sheds to store myrobalans in the event of rain as rains destroy the valuable properties of fruits. The raw myrobalan is graded under different trade names, selection being based upon their solidity, colour and freedom from insect attack. Grading generally consists of separating inferior fruits, which constitute a second grade, the remainder being the first grade.

As previously reported, the dried myrobalans were graded at the premises of the wholesale merchants into different grades based on colour, solidity of the nuts and freedom from insect attack. And these were graded by appearance for the export market and for some tanneries within the country. In the trade, myrobalans were usually known by the place of origin.



5. CHIRONJI (*Buchnanania lanzan*)



Introduction

Buchanania lanzan Spreng. (Chironji) belonging to family Anacardiaceae, is a medium-sized deciduous tree, growing to about 20 m tall. It bears fruits (commonly called Char) each containing a single seed, which is popular as an edible nut, known as Chironji. The fruits of this tree contains a hard nut that on decortication yields kernel containing about 52% oil. This species is globally distributed in Indo-Malaysia. Within India, it is commonly found throughout the greater part in wet to dry deciduous forests, up to an altitude of 1200 m and in the sub-Himalayan tract up to an altitude of 900 m. It is common in forests of Madhya Pradesh and Chhattisgarh mostly in eroded ravine lands (Tewari, 1995). It avoids waterlogged areas, but occurs locally in clay soils. It can be identified by the dark grey crocodile bark with red blaze. *B. lanzan* is a very good species for afforesting bare hill slopes. It has tickly leathery leaves which are broadly oblong, with blunt tip and rounded base. Leaves have 10-20 pairs of straight, parallel veins. Flowering takes place from January to March. Pyramidal panicles of greenish white flowers appear in early spring. Fruits ripen from April to May and remain on the tree for quite a long time.

Uses

The Chironji fruits are considered as one of the delicious wild fruits. The fruit pulp is eaten by local population. The kernels are regarded as substitute for almonds. The bark yields tannin (up to 13 percent) which is used in tannin industries. The natives also extract oil from seed and use it as almond oil. Chironji oil is also good substitute to olive-oil. It is also used for coating tablets for delayed action. The roots are acrid, astringent, cooling, depurative and constipating, and are useful in treatment of diarrhea. Leaves are used in the treatment of skin diseases. Fruits are used in treating cough and asthma. Chironji has great demand in local, national and international market. The annual market potential of Chironji is about 75000 qtl. Generally five kg mature fruits produce 1 kg Chironji kernel and currently kernel is being sold in market at the rate of Rs. 1000 to 1200 per kg.

Present Harvesting Practices

The fruits of Chironj mature in 4-5 months and are harvested manually in the month of May and June. The fruits are plucked from branches by climbing the tree. But, very often collectors harvest immature Chironji fruits in destructive and unsustainable manner. These unsustainable harvesting techniques have reduced the number of Chironji trees in the forests of central India. The collectors cut entire branches in order to reduce their effort in plucking (harvesting) the fruits. Moreover, they do not leave any fruits for regeneration. Such destructive harvesting practices have reduced the availability of Chironji trees and amount of Chironji collected over the years (Bhatnagar and Jain, 2002). However, collectors harvest mature fruits in non-destructive manner from the trees situated in their farm land. Generally destructive harvesting practices are prevalent in trees growing in forest and community land. The green coloured skin of harvested fruits turned black on storage which has been removed before shelling. In order to remove the skin, fruits are usually soaked overnight in plain water and rubbed between palms or with the jute sack. The water containing fine skin is decanted and seeds are washed with fresh water to get clean nuts. The cleaned nuts are then dried in sun for three to four days and stored for further processing i.e. shelling. The dried nuts are shelled by rubbing with a stone slab on a rough surface (Attat chakki) followed by manual separation of kernels.

Sustainable Harvesting

Premature harvesting results in poor quality of seeds thus bringing down returns or market value. As Chironji is a fruit yielding tree species and its seeds have potential commercial value in national as well as international market. The present destructive harvesting practices need to be checked or reversed by encouraging tribal/villagers to collect ripe fruits at proper maturity time without damaging the trees by organized collection through village forest societies. Judicious harvesting time, amount and processing of it, can enhance rural incomes and can contribute to gross national product without degrading forests. Sustainable harvesting of Chironji should be done as per following points.

- Fully ripened fruits turning black from green in colour should be collected.
- Fruits should be collected after April preferably in the 2nd or 3rd weeks of May.
- Immature green fruits should not be collected.
- Fruits should be collected non-destructively by hand or long bamboo sticks.
- Only 70% to 80% fruit should be harvested.
- 20-30% fruits should be left for regeneration and wild animals.

Chironjee fruits collection should be done from second to third week of May for quality seed collection with respect to fruit weight, kernel weight, germination percent and chemical content i.e. oil, protein and sugar contents (Sharma, 2012).

Destructive harvesting could be checked by educating forest dependent communities/tribal population about collection of ripe fruits at proper time i.e. from 2nd to 3rd week of May without damaging the trees by organized collection. Training and awareness campaigns can stop the unhealthy competition for fruits collection.

Unripe fruits collected in the 2nd to 3rd week of April has adverse effect on natural regeneration of Chironji. Therefore, fruits need to be retained on trees till peak maturity period i.e. 2nd to 3rd week of May, in order to increase the chances of natural regeneration.



6. BAEL (*Aegle marmelos*)

Aegle marmelos commonly known as Bael or Bel belonging to family rutaceae is a very important tree of medicinal importance. It is indigenous to dry forests on hills and plains of central and southern India, Sri Lanka, Myanmar, Pakistan, Bangladesh, Nepal, Vietnam, Laos, Cambodia and Thailand. It is cultivated throughout India, as well as in Sri Lanka, northern Malaya, Java and in the Philippines. It is also popularly known as Bilva.

About the species

Bael is a medium sized tree (average height is 8- 10 meter), with spines on the branches. Leaves are pale green, trifoliolate. Flowers are greenish white, sweetly scented. It has a woody-skinned, smooth fruit 5 -15 cm in diameter. Fruits are yellowish green, with small dots on the outer surface. The skin of the fruit is hard. It has numerous seeds, which are densely covered with fibrous hairs and are embedded in a thick, jelly, aromatic pulp. They have an unusual texture and aroma. The pulp is yellowish to brown and mucilaginous. The pulp of dried fruits retains its yellow, and also remains intact.

Medicinal Uses

The bael fruit is highly nutritious. Bel is used commonly for the treatment of heart disease in the Indian system of medicine. It has a great demand from native system of medicine. The ripe fruit is laxative and unripe fruit is prescribed for diarrhoea and dysentery. Ripened fruit pulp is laxative, and it has been reported that it is good for the heart and brain and in dyspepsia. The fruit is eaten fresh or dried. If fresh, the juice is strained and sweetened to make a drink similar to lemonade, and is also used in making Sharbat, a refreshing drink where the pulp is mixed with tamarind. If the fruit is to be dried, it is usually sliced first and left to dry by the heat of the sun. The hard leathery slices are then placed in a pan with several liters of water which is then boiled and simmered. The unripe dried fruit is astringent, digestive and stomachic, used to cure diarrhea and dysentery. As for other parts of the plant, the leaves and small shoots are eaten as salad greens. The aqueous extract of leaves has been shown to have a significant hypoglycemic effect. Leaf juice extract is applied externally in abscess. The leaves are said to cause abortion and sterility in women. The bark of the tree is used as a fish poison in the Celebes.

The roots of Bel are reported to be useful in cases of seminal weakness, uropathy, swellings, intermittent fever and gastric irritability in infants. Root bark is reported to be useful in hypochondriasis, melancholia and palpitation of heart and stomach pain. Root bark is also one of the ingredient in an Ayurvedic preparation Dasmularista. Root bark is also one of the ingredients of dasmularista. The bel fruits are rich in protein and carbohydrates and are used in making a very good drink and jam. Sweet drink (sherbet) prepared from the pulp of fruits produce a soothing effect on the patients who have just recovered from bacillary dysentery. The unripe and half-ripe fruits of Bel improve appetite and digestion. The ripe fruit is a good and simple cure for dyspepsia (indigestion). The pulp from the unripe fruits is soaked in gingelly oil for a week and this oil is smeared over the body before bathing. This oil is said to be useful in removing the peculiar burning sensation in the soles.

The roots and the bark of the tree are used in the treatment of fever by making a decoction of them. And it is good against malarial. The leaves are made into a poultice and used in the treatments of ophthalmia. The roots are sweet, cure the fevers caused by tridosho, stop pain in the abdomen, the palpitation of the heart, and urinary troubles.

In homeopathic treatments it is largely used for Conjunctivitis & Styes (Pain, stitching with sensation of dust particles in eyes with lachrymation. Stye (orzaiolo), mostly over upper eyelids; Rhinitis (Cold & Coryza with the symptoms of coryza, sneezing, redness of eyes and blockage of nose); Coccygodynia (Pain in coccyx especially on getting up and better by walking); Nocturnal seminal emission with amorous dreams; Chronic dysentery (Alternate diarrhea & constipation, stool, loose with mucus). Ayurveda prescribes the fruit of the tree for heart disease, stomach, Kapha disorders, intestinal tonic, chronic constipation and dysentery, some forms of indigestion, mucus membrane, chronic, obstinate mucus and catarrhal diarrhea, early stages of consumption (tisi), typhoid (febbre tifoidea), debility, intestinal disorders, prevents cholera and hemorrhoids; intermittent fever (stem bark), hypochondria, melancholia, and for heart palpitation.

The unripe fruit of Bel is better medicinally than the ripe fruit. Leaf poultice is applied to inflammations, with black pepper for edema, constipation, and jaundice (itterizia); with water or honey it is good for catarrh and fever. Rind is used for acute and amoebic dysentery, griping pain in the loins (lombari) and constipation, gas, and colic, sprue, scurvy (scorbuto). Pulp heals Vayu, Kapha, ama, and colic, is constipative. Fruits are useful in the disorders of vata, pitta and kapha. It is one of the ingredients used in the preparation of mouthwash liquid, etc. *Aegle marmelos* is mainly used to treat diarrhea, fever, poor absorption, worms - round and tape, bleeding, vomiting, nausea with blood, bed wetting, glossitis with ulceration, herpes simplex, stomatitis, inflammation of tongue, obesity, chronic diarrhea, dysentery, diabetes, bronchitis, bronchiectasis, fever of non-specific origin, gingivitis. Decoction of leaves is febrifuge, expectorant, asthmatic complaints. Decoction of root bark is for intermittent fevers, melancholia, and palpitation of heart. Best for sub acute or chronic cases of diarrhea and dysentery and in irritation of alimentary canal, Powdered pulp 2- 4 gram is used to treat acute dysentery with griping pain bedwetting, glossitis, stomatitis, glossitis, obesity, diabetes, bronchitis, bronchiectasis and gingivitis.

Chemical Constituents

The bael fruit is one of the most nutritious fruits. It contains 61.5 g water, 1.8 g protein, 0.39 g fat, 1.7 g minerals, 31.8 g carbohydrates, 55 mg carotene, 0.13 mg thiamine, 1.19 mg riboflavin, 1.1 mg niacin and 8 mg vitamin C per 100 g of edible portion. No other fruit has such a high content of riboflavin. Chemical analysis of bael seeds reveals that the seed contain 62% protein (water soluble 2% and 60% insoluble) 32% oil, 3% carbohydrate and 3% ash. Marmelosin is most probably the therapeutically active principle of bael fruit. It has been isolated as a colourless crystalline compound. Different parts have been investigated by several workers and found to contain coumarins, alltriterpenes, sterols and essential oils. The extract of *Aegle marmelos* contains cineole, P-cymene, citronellol, citral, cuminaldehyde, D-limonene and has shown a broad spectrum of antibacterial and antifungal activities. The fruits of *Aegle marmelos* contain furocoumarin marmelosin, which is responsible for its medicinal properties as an antimicrobial activity. The seeds yield, about 34% of oil on dry basis, the leaves and twigs also yield an essential oil.

Propagation

Bael is commonly grown from seed in nurseries and transplanted into the field. Seedlings show great variation in form, size, texture of rind, quantity and quality of pulp and number of seeds. The flavor ranges from disagreeable to pleasant. Therefore, superior types must be multiplied vegetatively. Occasionally, air-layers or root cuttings have been used for propagation. Good success has been achieved (80% to 95%) when budding was done (budded 1-month-old shoots onto 2-year-old seedling bael rootstocks in the month of June).



Harvesting

Harvesting Time to harvest Bel fruits depend upon utilization of fruit. Proper care is required for harvesting bael fruit. At the time of harvest, the tree generally gets defoliated and the fruits are completely exposed. Harvesting by shaking the tree is discouraged as the fruits are likely to develop cracks on impact because of the very brittle peel.

- Mature ripe fruits are ideal for harvesting.
- Fruits become fully mature after eight months after fruit set.
- Fruit should be harvested when it changes its colour to yellowish-green from green and kept for 8 days while it loses its green tint. Then the fruit coat readily separates from the fruit.
- The fruits may be harvested in February- March.
- Fruits should be harvested individually from the tree along with a portion of fruit stalk
- Care is needed in harvesting and handling to avoid causing cracks in the rind.
- Only 60–75% of the fruits should be harvested and the remaining should be left out for birds to help in dispersal of seeds.
- They should not be allowed to drop or fall on the ground otherwise a minor crack in the shell can cause spoilage during storage.

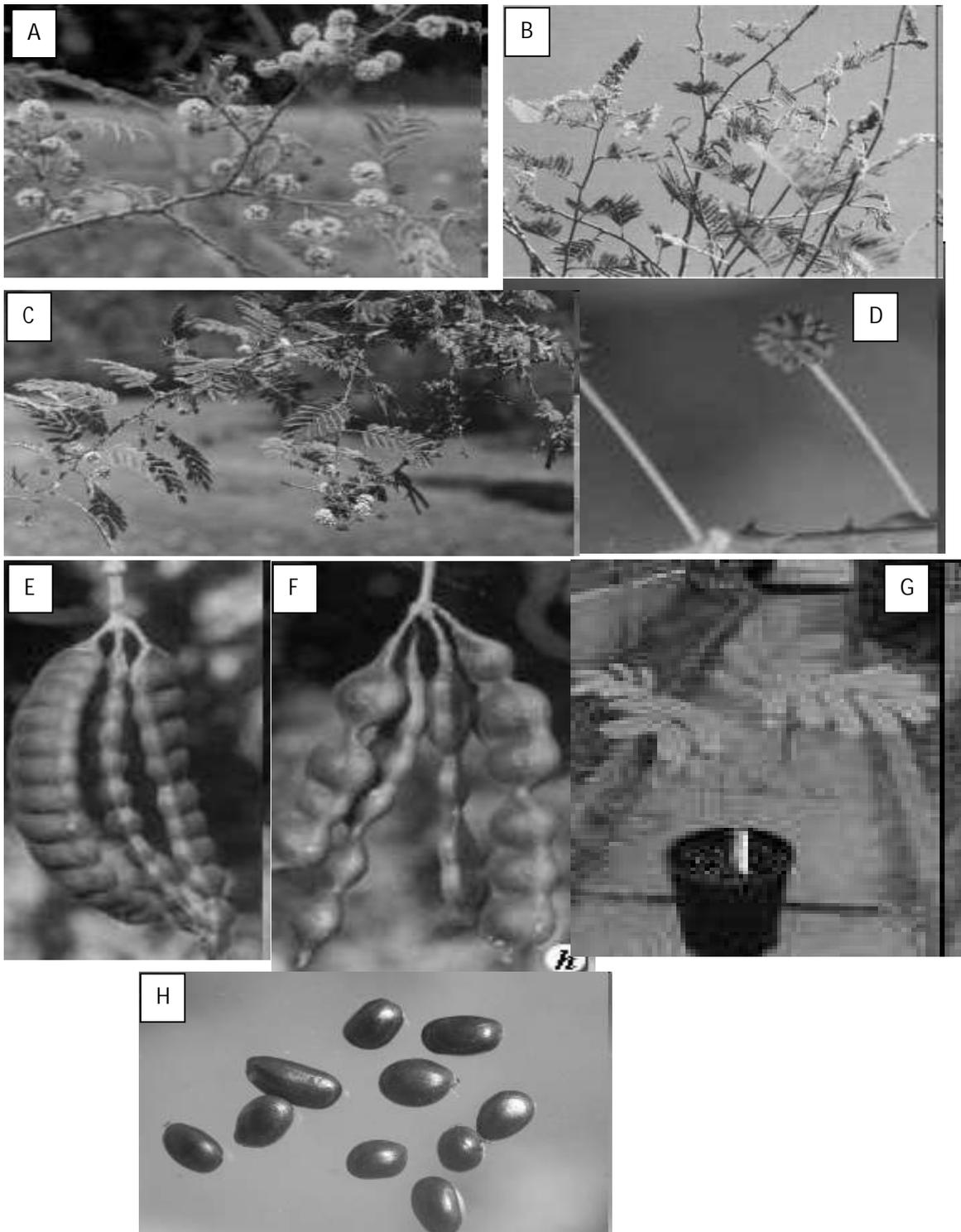
7. SHIKAKAI (*Acacia concinna* Willd D.C.)

Acacia concinna (Hindi name - Shikakai) is a climber shrub native to Asia, common in the warm plains of central and south India. *Acacia concinna* is widely distributed in Burma, southern China and Malaysia. It is a climbing shrub with thorny branches having brown smooth stripes. Thorns are short, broad-based, flattened surface. The main stem is brown in color. The stem is strong, woody and armed. The barks present on the stem have longitudinal striations. The bark is generally thick and rough. The stem is dotted with white dots on its bark. Its bark contains thorns on its surface.

Acacia concinna pods has been used traditionally for hair care in the Indian subcontinent since ancient times. Shikakai is a commonly used herb that has many remedial qualities. It is popularly referred as "fruit for the hair" as it has a naturally mild pH that gently cleans the hair without stripping it of natural oils. Shikakai is used to control dandruff, promoting hair growth and strengthening hair roots. It is very effective in removing oil and dirt from hair. The powdered Shikakai is used as a shampoo to wash off the oil. The fruit of soapnut is high on saponins which act as foaming agents. Therefore, Shikakai is such a good cleaning agent and hence has been traditionally used as a detergent. Collectors earn cash income by collecting/harvesting Shikakai pods.

Prevalent/traditional Harvesting Practices

The gatherers either climb on tree and shake its branches or lop the branches for collection of pods. Sometimes even the entire tree is felled to ease collection of pods. Sometimes, the individuals involved in gathering and collecting were largely untrained regarding the pre-harvest and post-harvest treatment of collected material.



Photographs of Shikakai (different parts)



Sustainable Harvesting Practices

- The matured trees should be marked to be harvested for the collection of pods
- The harvest season of soapnut pods is from February to May.
- The trees or its branches should not be lopped. Only ground fallen pods should be collected.
- Tarpaulin sheets could be spread under identified trees for easy collection of fallen pods
- Pods are plucked by hand or by bamboo sticks.
- Only ripe and mature pods should be collected without causing damage to the branches. Few of the pods (5%) should be left on the tree for its natural regeneration.
- Only elongated and broad pods should be sold. The remaining pods should be left behind for birds to help in dispersal of seeds and regeneration.
- After collection, the pods are dried thoroughly.
- Cleaned pods are spread on plastic or gunny bags sheets for drying. Mature fruits are sun-dried & the weight loss is approx. 60%. Such fruits appear thicker & reddish and are better priced. Immature fruits are often collected by certain collectors which may take approx. 15 days for drying along with a weight loss of up to 85%. Such fruits usually turn black and are considered to be of inferior grade than the former one. The yield (from drying) ratio of immature pods is 6:1 whereas that for mature pods is 3:1.
- The collectors/JFMC members should be sensitized on the need for the sustainable harvest of the species.

8. KOKAM (*Garcinia indica* Choisy)

Kokum (*Garcinia indica*) is one of the most important indigenous tree species having numerous medicinal properties. It belongs to the family *Cruciaceae*. It is popularly known in India as Kokum or Indian Butter tree. *Garcinia* species are distributed throughout the tropical Asian and African countries and have a tremendous potential as a colorant, spice with medicinal value. It is found in India in tropical humid evergreen rain forests of Western Ghats of south India as well as in northeast states of India. Kokum or murgalu as known in Kannada is one of the important tree species widely distributed in the forests of the district from which people harvest fruits and seeds. The trees are seen growing in all categories of forests and in private lands in the talukas of Bhatkal, Honnavar, Kumta, Ankola, Karwar, Joida, Siddapur, Sirsi, and Yellapur. In Karnataka it occurs along the windward side of Western Ghats in Dakshina Kannada, Coorg, Chickamagalur, Shimoga and Uttara Kannada districts. However, its population is declining fast in the wild. In Tamil Nadu, it is absent in the wild but planted in Nilgiris. In Maharashtra, it is common along the entire coastal forest and Western Ghats. It is abundant almost throughout Goa (Miguel et al., 2012).

It is commonly cultivated for its fruit. It is found in coastal to evergreen forests in the west coast of India, in northern Kerala, coastal Karnataka, Goa and Konkan belt of Maharashtra. It requires a warm and humid tropical climate. It thrives well in coastal areas receiving over 250 cm of rainfall. It grows well in lateritic, alluvial

soils having depth of 1.0 m and pH of 6.7. The life of the tree is around 70 years and gives maximum bearing of fruits between 20–50 years.

Kokum is a slow growing slender tree with drooping branches growing to a height of 10–18 meters. It belongs to *Garcinia* genus and is either dioecious or polygamous. The flowers of kokum tree are small and unisexual; the male and female flowers are found on the same tree. It is a tree with a dense canopy of green leaves and red-tinged tender emerging leaves. The tree is large and handsome, having elliptic, oblong or oblong-lanceolate, deep-green glossy leaves, 5.5-8 cm long and 2.5-3 cm broad. The flowers are fleshy, dark pink, solitary or in spreading cluster. The fruit is brownish or brownish-gray, marbled with yellow, and is crowned by the 4-parted, stalkless stigma. There are from 6 to 8 seeds, and the pulp is juicy, white, and delicious in taste and odor. It is about the size of an orange. An average kokum tree bears hundreds of fruits during summer. When they are tender, they are green in color. As they ripen, they get the beautiful purple color. The fruits are plucked when they are ripe (Mathew et al., 2008).

Chemical constituents: The tree is a source of kokam butter which is used in cosmetics and confectionary. Kokum is rich source of anthocyanin. It is natural source of red color natural pigments, which constitute approximately 2.4% of total fruit biomass. These pigments are water soluble and help in scavenging free radicals. Cyanidin-3-glucoside and cyanidin-3-sambubioside are the major pigment present in kokum and these occur in the ratio of 4:1. The sugars present along with these cyanidin are glucose and xylose, respectively. Hydroxy citric acid (HCA) is mainly found in the fruit. It is also known as *Garcinia* acid and has a large number of commercial applications. Kokum fruit contains 1.5% of poly isoprenylated benzophenone derivative called Garcinol, a potential anti-cancer agent. HCA consumption was reported to enhance fat mobilization and fat burning. The HCA is used as an ingredient in anti-obesity formulations. Minor quantities of hydroxycitric acid lactone and citric acid are also present along with the HCA (George et al., 2002).

Prevalent Harvesting practices

People collect/harvest fruits and seeds of Kokam or murgalu for domestic consumption and also many households market a substantial quantity of their collection. People use its rind as food as a souring agent, its syrup as a drink, and use seeds for oil and medicine. In forest divisions of Honnavar and Karwar, murgalu where it is more concentrated is tendered for auction by the Forest Department in the name of amsol or bhirand. Traditionally, fresh fruits are collected from the forest areas and are pooled and marketed. Freshly harvested fruits are reddish green in colour turns into full-red purple colour in a day or two. The fruits are harvested manually in spring and sun dried for preservation (Nair 1986). The adverse climatic conditions during the peak harvesting seasons greatly influence the shelf life of the fruits. It is estimated that, about 25 to 30 per cent of the fruits perish due to these reasons. The normal shelf life of the fresh fruit is about a week. Hence, these are cut into halves and sun dried. It takes around 6–8 days for complete drying. The ripe Kokum fruit is dark purple or red in color with a yellow tinge. It contains 3 to 8 large seeds embedded in a regular pattern like orange segments in the white pulpy material. The fruit shape varies, round, oblong, oval, fruits with pointed tips and it weighs around 21–85 g. Most of the existing plantations are raised by seed. Hence the yield varies from place to place depending upon orchard management practices.

All fruits on a kokum tree are not ready for harvesting at the time and hence periodical plucking is done. The number of pluckings varies from tree to tree. Generally 6 – 8 pluckings are required in high yielding plants.



Number of pluckings in Kokum is a constraint in harvesting. Fully ripe fruits are plucked by hand. Skilled persons climb on the tree and shake the branches. The ripe fruits which fall down are collected. It leads considerable loss of fruits. Approximately 35 – 40 per cent fruits are lost which include immature and broken fruits.

In majority cases, households and primary collectors harvest ripened fruits without causing much destruction to trees. The harvesting from tall plants of kokum is an important constraint. Harvesting time is extremely limited and coincides with the rainy season which is a great challenge to the Kokam growers/collectors.

Sustainable Harvesting Practices

Time and Age of Harvesting

In Kokum, flowering starts from October-November and continues upto February. Fruits are ready for harvest during the month of March to June. When the fruits turn from green to reddish in colour, they are plucked carefully by hand.

Kokam tree raised by seedlings starts fruiting after 7-8 years while grafted/ budded plants bear fruits after 4-5 years. Properly cared well grown kokum tree from 15 years onwards yields about 30 to 50 kg fruits per year.

The normal shelf-life of the fresh fruits is about 5 days. Hence sun drying is practiced for preservation. For sun drying, the fresh rinds are cut into halves and the fleshy portion containing the seeds is removed. The rind which constitutes about 50-55% of whole fruit is repeatedly soaked in the juice of the pulp during the sun drying. About 6-8 days are required for complete drying. The product so dried, constitutes the unsalted Kokam of commerce. A salted variety, where in common salt is used during soaking and drying of the rind is also marketed.

Post harvest method: Processing of Kokam fruit sector is very vital. Unlike other fruits, Kokum cannot be consumed as fresh fruit. Its utility starts only after processing. Green mature rind and red ripe rind are invariably used for processing of dry rind. Rind is also used as base material for preparing rind products like Kokum Syrup, Kokum Agal and Amsol (Wet rind). Kokum butter is extracted from seeds.

Seeds and rind are separated and dried under the sun. Dried rind is stored for future use by households; part of it is used for extracting syrup which is bottled and stored while remaining part is sold in the local market or to contractor. Seeds are stored and later oil (Kokum butter) is from extracted from seed kernels by boiling them with water. Under contract system, primary collectors at the village level harvest fruits from forests, separate rind from seeds, process- them by sun drying and sell them to contractor.

Ensuring natural regeneration of species: only healthy fruits to be collected and the raw and damaged ones should be discarded for regeneration.

It is necessary to build up skilled man power to undertake problems of management of kokum plantation and create training facilities for the benefit of farmers in harvest and post harvest management.

9. GAMBOGE OR BRINDAL BERRY (*Garcinia gummi-gutta*/*Garcinia cambogia*)



Garcinia cambogia, family Clusiaceae is a flowering evergreen tree, with drooping branches. The fruit is yellow, oval in shape and resembles small pumpkins. *Garcinia* is part of the same family as mangosteens; the fruit is harvested, dried and ground into a powder. *Garcinia* has garnered a lot of attention of late as a popular natural weight loss aid. The reason is that the rind of this pumpkin like fruit is rich in a substance called hydroxycitric acid / HCA.

This species has a restricted global distribution in the evergreen forests of Western Ghats ranging, from 400 m to 900 m. It is fairly common and abundant in the forests of western Sri Lanka from sea level to 600 m and in Malaysia also. In Kerala, it is very popular in the Central Travancore areas, where maximum diversity is seen. Field studies revealed that the var. *gummi-gutta* is cultivated all over the low lands and mid lands of Kerala ranging from sea shore to the high lands up to 600 m. It is found in semi-evergreen to evergreen forests. In India, it is commonly found in the evergreen and shola forests of Western Ghats, Karnataka and Kerala. The tree is very much adapted to both hilltops and plain lands, but its performance is best in riverbanks and valleys. It also grows well in dry or occasionally water logged or flooded soils.

Garcinia gummi-gutta is an evergreen, small or medium-sized dioecious tree, 5 –20 m tall, with a rounded crown and horizontal or drooping branches. Young branchlets are subterete and glabrous and the trunk and bark is reddish brown and lenticellate. Leaves are opposite decussate, petiolate, dark green, glabrous, elliptic to obovate. The polygamous flowers are in axillary or terminal clusters and the sepals are cream while the petals are pink in colour. The ovoid fruits are about 5 cm in diameter with 6 to 8 grooves. The fruit can be yellow, orange or red when ripe and has 6 to 8 seeds surrounded by a succulent aril.

Fruit is the main useful part. The color of the fruit is yellow or reddish or purple. Fully ripe fruit is too acidic or sour to eat fresh. The rind of the fruit has HCA, the biochemical with acclaimed with weight loss capacity. Fruit is simple and fleshy or berry. Fruit measures 3-4 cm in breadth and 4-6 cm in length. Summer is the fruiting



period. Unripe fruit is green from outside and white from inside. Ripe fruit is purple or red from outside and white from inside. There are many seeds within the fruit.

Chemical constituents: Studies have shown that the rind contains moisture (80.0 g/100 g), protein (1%), tannin (1.7%), pectin (0.9%), Total sugars (4.1%) and fat (1.4%). Garcinia leaves are reported to contain 75% moisture, 2.3 g of protein, 0.5 g of fat, 1.24 g fiber, 17.2 g of carbohydrates, 15.14 mg of iron, 250 mg of calcium, 10 mg of ascorbic acid and 18.10 mg of oxalic acid. The seed is very rich in stearic, oleic and stearic triglycerides. The plant also contains hydroxycitric acid lactone and citric, but in minor quantities. The phytochemical constituents present are citric acid lactone, Ascorbic acid, tartaric acid, malic acid, Garcinol, isogarcinol, cyanidin and Xanthone. The latex of *Garcinia cambogia* contains two polyisoprenylated benzophenone derivatives, camboginol (I) and cambogin (II). The major phytoconstituents in *Garcinia cambogia* is Hydroxycitric acid. This principal acid has been found to suppress the fatty acid synthesis, lipogenesis, food intake, and promotes glycogenesis, gluconeogenesis and induced weight loss.

Sustainable harvesting practices and Selection of plant/ tree for harvesting: For harvesting *Garcinia gummi-gutta*, it is important that only ripe fruits are picked, which are orange yellow in colour.

Tree start bearing fruits generally at the age of 10-12 years. Grafts start bearing from the third year onwards and will attain full bearing at the age of 12 to 15 years. Flowering occurs in January-March and fruits mature in July. Mature fruits, which are orange yellow in colour, drop off from the tree. Mature fruits are harvested manually before they fall.

The harvest season is between the second week of May and the end of the month. Once the rains start in the first week of June, even the plucked fruits start to decay.

Post harvest method: Usually the ripe fruit is halved or sectioned and spread in thin layers, dried in the sun for three to seven days to moisture level of about 15 to 20 percent and smoked. Commercially available rind is loaded with considerable amounts of common salt, which is added during drying. In Sri Lanka, the thick rind was cut into sections, dried in the sun and preserved for future use. This dried material along with salt is used for curing or Separated fruit rind is first sun dried and then either smoke-dried or oven-dried at 70-80°C. In order to increase the storage life and to impart softness, dried rind is mixed with common salt and coconut oil.

Ripe fruits of *Garcinia gummi-gutta* need to be harvested and dried to avoid damage. Once dried, the rind needs to be stored properly. Since it is very arduous to collect ripe fruits and dry them immediately using traditional drying methods (with the use of firewood), the community prefers to collect unripe fruits. This gives them time between collection and processing.

G. gummi-gutta fruits mature during the rainy season. It is essential that the fruit rinds (the economically important part) are processed within three days of collection; otherwise they rot and become useless, causing farmers to lose income. Traditionally, processing is done in makeshift processing units in which the fruit rinds are dried over an open fire in the forest or near or within homes. The rinds are spread over a metal mesh a metre above the flames, which create enough heat to dry the fruit. This processing technique consumes enormous quantities of firewood. Studies have shown that approximately 15-20 kg of firewood is required to obtain 1 kg of dried Garcinia rind in the traditional open-fire system.

Ensuring natural regeneration of species: only healthy fruits to be collected and the raw and damaged ones should be discarded for regeneration.

10. SOAPBERRY (*Sapindus laurifolia*)

Soapberry (*Sapindus laurifolia* Vahl.) commonly known as Reetha belongs to the Sapindaceae family. This species is native to south India, globally distributed in India, Sri Lanka and Myanmar. Within India, it is common in peninsular India. It is also cultivated on avenues or for ornamental purposes. It is distributed in the wetter habitats in the forest, such as on the banks of streams in semi-evergreen forests. It is distributed in the Western Ghats, South Canara and Mysore to Anamalai.

It is a medium-sized tree. The leaves are bipinnately compound and the leaflets have an acuminate leaf tip which is characteristic of this species. The flowers are dioecious and borne on the same inflorescence. The petals are softly woolly on the inner surface except the claw, scales are minute or absent. This species is chiefly known for its fruits, which are universally used as a substitute for soap. The root and bark are also said to be saponaceous. The fruits consist of three ferruginous-velvety drupes, almost completely combined, and are often unequal. The capsule of *S. laurifolia* has a detergent quality when bruised, forming suds if agitated in hot water. The fruit is used as soap and is also used by jewellers to wash silver due to its detergent activity. Soapberry fruits are also traded in local and urban markets. The local communities use this as soap for washing their hair, clothes, (especially wools and silks), linen, silver articles, etc. due to its mild action. The fruits are extensively collected during February and March.

Chemical Constituents

Fruits mainly contain saponin (11.5%) glucose (10%) & pectin, a while seeds give thick viscous oil. *Sapindus* fruit contains 34.3% seed and 65.7% pericarp. They contain Saponins like fraxin, aesculin, cyanogenetic compound, toxic substances and alkaloids. It also contains emarginatoside in aqueous extract of fruit, which on acid hydrolysis gives a sapogenin known as hederagenin, d-glucose, d-xylose and l-rhamnose. Pericarp of fruits contains cyclic sesquiterpene, oligoglycoside, trifolioside. Kernel contains 45% fixed oil. It contains palmitic 5.4%, oleic 55%, stearic 8.5%, linoleic 8.2%, arachidic 20.7% and behenic acid 2.1%. The fine kernel powder on extraction with ligroin gives 44.7% of dark yellow colored oil deposits small quantity of stearin on standing. The oil of contains 22% of glycerides of n-eicposaic acid and other acids like stearic, palmitic, lignoceric and oleic acids.

Sustainable harvesting methods: Collect fully mature, well-ripened fallen fruits from the ground once in 2 days. Collection can also be done by shaking tree branches after noticing the maximum number of mature and ripe fruits.

Collect only 75-80 percent of fruits during peak season: Collection should only be done in the peak season (at the time when maximum quantity of ripe fruits is available). Do not collect fruits at initial stage of fruit ripening and also at the end of the season, in order to maintain availability of some fruits for regeneration and for wild animals.

Tools used for harvesting and processing: Hooked stick, gunny bags.

Time and age of harvesting: Collect fruit from February to March (during well-ripened/peak time): Timely collection of fruit is important because early collection may result in poor-quality (unripe) fruits.



Post harvest method: After collection, the leaves, twigs, and branches should be removed. Freshly harvested fruits should not be stored in sacks or heaps. Collected fruits should be dried well by spreading on a concrete floor or on bamboo mats under sunlight. Dried fruits should be packed in gunny bags and stored in well-aerated place to avoid fungal attack.

Packaging for transportation: Fruits should be stored in well aerated gunny bags.

Ensuring Natural Regeneration of Species

- Do not cut branches: Do not cut branches for collection of fruits; remove/cut the bunch of fruits only by pulling branches or climbing the tree.
- Collect the mature fruits during February-April as they fall from the trees. Dry them for 3 to 4 days and store in gunny bags.
- The raw and damaged fruit has to be left behind for its regeneration.

LEAVES YIELDING MEDICINAL PLANTS

The leaves of herbaceous plants should be collected before their flowering, unless otherwise specified. Where maturity of leaves does not limit the use of plants, collection should be done after flowering. Leaves should be collected anytime during the growing season, except that leaves of some deciduous species must be harvested in a particular season to maximize desired constituents. It should be collected before becoming pale and infested, blotched and curled leaves should be avoided. The proportion of discolored leaves in any leaf harvest must be limited to meet established specifications if any. Leaf material rich in essential oil must be handled carefully to avoid bruising of the leaves that could result in essential oil degradation.

1. GUDMAR (*Gymnema sylvestre* R. Br.)



Introduction

Gymnema sylvestre R. Br. (Madhunashini/Gudmar) is an important medicinal woody climber belonging to family Asclepiadaceae. It grows in the tropics of India, Asia, China, Indonesia, Japan, Malaysia, Srilanka, Vietnam and South Africa. In India, it is found growing in the forests of Madhya Pradesh, Chhattisgarh, Maharashtra, Orissa, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Kerala, Karnataka, Bihar and West Bengal. Due to its heavy demand in South East Asian countries it has become endangered and it is under cultivation in southern states of India, particularly in Tamil Nadu. Its leaves are simple, opposite, elliptic or ovate and hairy; the flowers are small, yellow and in umbellate cymes, the follicles are terete, lanceolate and upto 7.5 cm in length. Leaves and roots are useful part of the plant.

The plant is popularly known as Gudmar for its distinctive property of temporarily destroying the taste of sweetness due to the presence of a constituent, Gurmarin. Studies have revealed that the water extract of the leaves of inhibited absorption of glucose in the small intestine and suppressed the increase of blood sugar



value after administration of sucrose in rats. This climber is extensively used in most of the Indian systems of medicine as a remedy for rheumatism, cough, ulcer and pain in eyes. It is also useful in inflammations, dyspepsia, constipation, jaundice etc. Roots have been reported as a remedy for snakebite. It has a reputation in traditional medicine as a stomachic, a diuretic and as a remedy to control diabetes mellitus.

Gudmar is used in food additives against obesity and caries. Some researchers have suggested gymnemic acid as one possible constituent responsible for antidiabetic activity. This herb is ideally used in controlling blood sugar in a natural and effective way. The market demand for the drug is 150 tons annually. Fresh Gudmar leaves fetch Rs. 7-8 per kg and dried leaves fetches Rs. 24 per kg.

Sustainable Harvesting

As the prevailing harvesting practice is destructive one. There is an urgent need to develop a non-destructive harvesting practice for Gudmar. In this method selective harvest was done without harming the main plant. All the leaves were not harvested at a time. Only mature leaves (60%) were plucked by hand in the month of October. Young immature leaves (40%) were left on the plant. Second harvest was done in June. At this time also, only mature leaves were harvested. It was observed that the leaves left at the time of first harvest during October matured in June at the time of second harvest. This method did not affect the growth of plant. Sustainable harvesting of leaves should be done as per following points (Pandey and Yadav, 2010).

- Selective harvest should be done without harming the main plant.
- All the leaves should not be harvested at a time. Only mature leaves should be hand-plucked in the month of October and young immature leaves are left on the plant.
- Second harvest should be done in the month of June and again only mature leaves should be harvested.
- The crop can be cultivated for 10-15 years under good management.

2. MAHUL (*Bauhinia vahlii* L.)





Bauhinia vahlii (Mahul patta) belonging to family Leguminosae, is a gigantic climber that can grow upto 10-30 m long. It is one of the valuable climbers distributed in the dry deciduous forests of Chhattisgarh and Madhya Pradesh. It is otherwise known as camel's foot climber as the leaves are very much the size and shape of a camel's foot print. Leaves are compound, alternate, with leaf petiole and 11-15 nerved at the base, almost orbicular in shape and upto 45 cm long. Flowers are numerous, 2.5–8 cm long. This gigantic woody climber needs plenty of space for its growth. The flowering in Mahul patta occurs between April and June. The climber never becomes leafless and renews its leaf in May.

The leaf is mostly used locally by the grocery shops, petty hotels etc as plates and packing material. The plates made of Mahul leaf are largely being used during the community feasts. These plates are also commercialised due to its tenderness and capacity not to break easily. The plant has several other uses: its fibre is used for rope and bowstring, the seeds are roasted and eaten, and the plants plays important role in some rituals. During summer months when tribals are not engaged in any agricultural activities they harvest Mahul leaves. Yearly available quantity of Mahul patta in Chhattisgarh is 5260.00 MT.

Mahul leaves are available for collection around 9-10 months in a year, making it an almost year round livelihood option. After monsoon the newly flushed leaves are hand plucked, partially sun dried. The leaves are hand stitched by the tribal/rural women and cured under sun with utmost care to avoid fungal attack. The collectors harvest Mahul leaves by damaging plant to obtain maximum leaves. Such unsustainable harvesting method led depletion in the growing stock of leaves in the forests of Chhattisgarh. The species grows naturally in the forests. However, no efforts are made to regenerate it artificially.

Sustainable Harvesting Practices

Mahul leaves are available for collection around nine to ten months in a year, making it an almost year-round livelihood option. The production is less during summer and high during early winter. Though the availability of leaves in the forests is also high during the rainy season, the collection is low because of fear of attack by



various kinds of insects which breed on Mahul leaves. Mostly, the women and children of tribal/rural households collect the leaves from the forests.

Processing and Value Addition

After monsoon the newly flushed leaves are hand plucked, partially sun dried. The leaves are hand-stitched by the tribal/rural women and cured under sun with utmost care to avoid fungal attack. The leaf is mostly used locally by the grocery shops, petty hotels etc. as plates and packing material. The whole process of Mahul leaf plate making takes around 3-4 days and fetch per individual, i.e. one head load is around 10 chakis (leaf equivalent). Drying takes one day provided there is sun and the weather is not cloudy. Normally on the third day, stitching starts and one adult can stitch around 2 chakis a day. In a week, one family on an average can stitch 10 chakis of Mahul plates, which means an income of Rs. 100/week.

The stitched leaf plates are cut in to uniform size and packed as per market demand. For making buffet plates, they are machine pressed with cardboard at base. The shift to machine stitched plates has led to rise in the price obtained by the plate makers. Gracefully stitched pressed bio-degradable leaf buffet plates are a cheap hygienic and ecological substitute for thermocol and plastic plates.

3. TENDU (*Diospyros melanoxylon* Roxb.) Leaves

Introduction

Diospyros melanoxylon is endemic to Indian sub-continent. It is one of the most characteristic trees of the dry deciduous forests throughout India, covering the entire Indian peninsula the area of distribution extends up to Nepal in sub-Himalayan tracts including the Indian plain, Gangetic plain, Madhya Pradesh, Odisha, Maharashtra, Andhra Pradesh, western coast up to Malabar and Eastern coast up to Coromandel. Madhya Pradesh, Odisha, Maharashtra, Andhra Pradesh, Bihar, Rajasthan, Uttar Pradesh, Gujarat, Tamil Nadu and West Bengal are the main tendu leaf producing states in India. Leaves are used for making beedis. The leaf of tendu, which is used to roll beedis (Indian cigarettes), is one of the most socially and economically important NTFPs. Its collection provides employment to at least 75 lakh leaf pluckers, largely in central India (MFD 2012). Madhya Pradesh produces the largest volume of tendu leaf in the country, accounting for more than 25% of the national production. Tendu leaves is a nationalized NTFP therefore its trade is done by the state government only. The collection and trade of Tendu leaves is done through Madhya Pradesh Minor Forest Produce Federation (MPMFPPF) through cooperative societies formed at the village level for the purpose (Lal and Dave 1991). Tendu collection/harvest is labor-intensive and employs millions of tribals during the lean month of May, when they have very little else to earn. Tendu collection is major source of income to the tribal households in Madhya Pradesh and Chhattisgarh (MoPr, 2011). The production of Tendu leaves was found to be constant across the JFMCs in MP. However, increase in lantana shrubs has affected regeneration and spread of Tendu to some extent.

Prevalent/traditional Harvesting Practices

The traditional practice is to use pruning and fire, both of which are meant to 'injure' the tendu leaf plant and thereby stimulate the formation of new leaves that would be suitable for beedi-making (Hunter 1981). Pruning

also serves to maintain the plant as a shrub, rather than allowing it to grow naturally into a tree, so as to facilitate easy harvest by pluckers, especially by women and children. Tendu shrubs maintained in this manner form relatively monocultural patches on the edges of forests in the tendu leaf growing regions. Later on fire was banned by forest departments.

The tendu leaf collection process consists of plucking of leaves, making of bundles, and depositing the bundles at the phad (collection place). Entire households are involved in one or more of these activities. The main source of production of bidi leaves is from the bushes arising from the root suckers. However, the method of collection is unsustainable for the fact that generally the leaves, which are not suitable for the purpose, are also collected and optimum size leaves suitable for bidi making are later sorted to make bundles.

Pruning: Pruning of tendu bushes is carried out in February–March, roughly 45–60 days prior to the harvest season, so as to encourage growth of tender leaves. Funds for this activity are supposed to come from a Forest Development Fund created out of the profits from tendu sale.

Plucking: The tendu leaf harvest begins sometime in May when the phad (the place where the tendu leaf is collected and dried) is ‘opened’. Tendu leaf pluckers, often entire families, leave early in the morning for leaf collection and return home in the afternoon to sort and bundle the leaves (50 leaves per bundle) and submit them at the phad by the evening. The Phad Munshi (collection centre clerk), who is an employee of the PCS, receives and counts the bundles and enters the amount in the plucker’s card. Each PCS sets up several phads, one in each village or group of villages under its jurisdiction, for ease of collection.

Post-harvest processing: The contractor (who has been awarded the contract for that particular lot) sends specialized labourers to dry and pack the leaves in the phad, after which the packed bags are taken to godowns (often owned by the MP MFP Federation (MPMFPEFED), Bhopal but rented to the contractors) and eventually sold in the market after being sorted and graded.

Payment to leaf pluckers: Payment for the collected leaves is made in two phases. A ‘collection wage’ is announced by MFP Federation (MPMFPEFED), Bhopal before the starting of the plucking season. The second part of the payment, formally called an ‘incentive wage’ but colloquially referred to as bonus is made much later, typically 14–18 months later.

Sustainable Harvesting Practices

- Pruning of tendu bushes is carried out in February–March, roughly 45–60 days prior to the harvest season, so as to encourage growth of tender leaves.
- Collection should be done from healthy and vigorously growing bushes arising from the root suckers as the bigger trees are not capable of producing trade quality leaves for wrapping bidis as the later are stiff and brittle.
- Leaves should have large size (at least the size of palm), thin, with no tomentum and practically no prominence of secondary nerves.
- Careful hand plucking of leaves with desirable traits.
- Only undamaged and disease free leaves should be collected.



- All diseased and damaged leaves should be removed before drying.
- Leaves are plucked in a very short period before the onset of monsoons during the months of April to June. The most appropriate time of harvesting is onset of summer rather than peak summers. During late April to early May rejuvenated pruned plants/bushy growth through root suckers bear profuse and thin leaves suitable for bidi making (Singh, 2010).
- All good leaves from the pruned tree/bush should not be plucked at one go leaving 1/3 for plant growth from photosynthetic activity and rejuvenation of the bush.
- After plucking leaves are stored, spread on the ground in a layer for drying in the sun, which is completed in nearly 8 days and the tied in bundles of 50 to 100 leaves, (locally called gaddies).

Post Harvest Processing

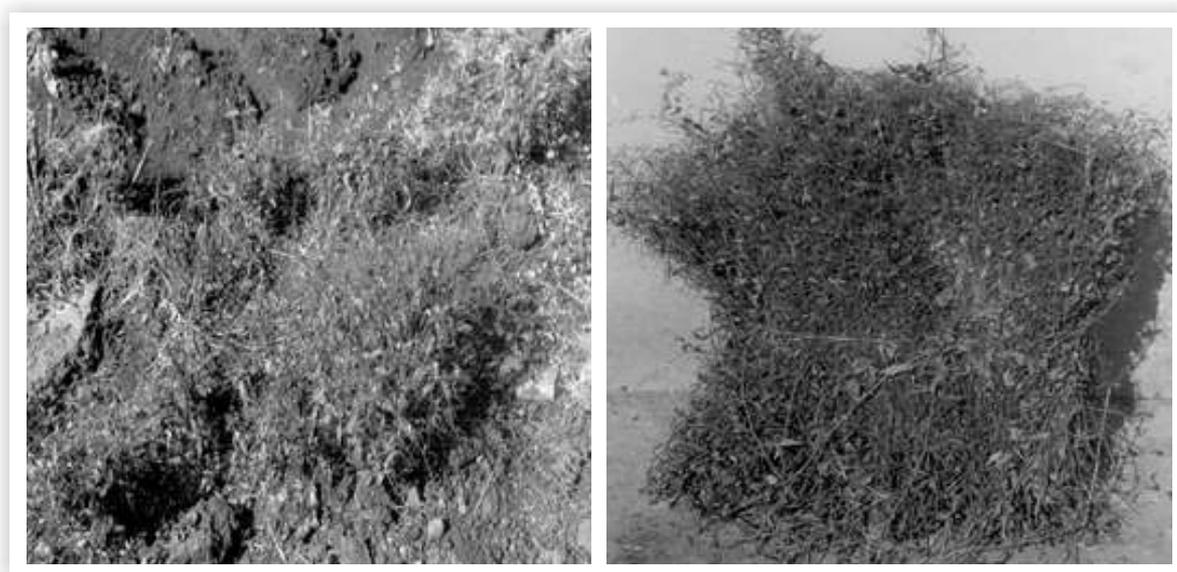
Though bamboo shoot is an ideal vegetable for healthy diet but it contains potential toxic compound i.e. cyanogenic glycosides (Taxiphyllin),

- Gunny bags containing 100 Gaddies are transported through vehicle (tractor/trucks etc.) for temporary storage (godams) before final movement to bidi factories.
- The dried leaves are sprinkled with water to soften them and then filled tightly in jute bags and exposed to direct sunlight for 2 days.
- While drying the leaves, care should be taken that these do not become excessively brittle and should retain good colour as much as possible.
- Leaves should be stored in proper storage free from insects.

WHOLE PLANT NTFPs

When collecting whole herbaceous plants, or the entire aerial parts of herbaceous plants, harvesting should be done prior to any visual decline in any of the plant parts. This is typically at the stage at which flowers are emerging.

1. KALMEGH (*Andrographis paniculata* Wallich ex Nees)



Introduction

Andrographis paniculata Wallich ex Nees (Kalmegh), commonly known as king of bitters belongs to family Acanthaceae. The genus *Andrographis* contains about 40 species distributed in different parts of tropical Asia and widely distributed in plains throughout India and Sri Lanka. About 19 species are reported to be available in India, out of which two viz. *Andrographis paniculata* and *Andrographis alata* have medicinal properties. Grows mainly as under shrub in tropical, moist deciduous forest and found in the states of M.P., Chhattisgarh, Odisha, Maharashtra, Assam, Bihar, West Bengal, U.P., Tamil Nadu, Karnataka and Kerala in India, southwards through Thailand and Peninsular Malaysia to Indonesia.

Kalmegh is a bitter annual herb is erect, branched, 60-100 cm in height, having quadrangular branches, simple opposite leaves, short petioled, elliptic to lanceolate narrowed at both ends, glabrous. Inflorescence is racemes, paniculate, divaricate. Flowers are small, white with purplish blotches in terminal or axillary pedicels manifesting distant, usually pubescent; calyx are five partite glandular pubescent; corolla are bilabiate, hairy outside the lower lip deeply three lobed, deflexed upper oblong slightly 2 fid, stamen are two, filaments hairy anthers are two celled connate deep purple, ovary and base of style subglabrous or very sparsely hairy. Fruits are linear compressed capsule 1.5 to 0.5 cm in length, when young slightly glandular, hairy when mature, glabrous. Seeds are about 08-10 in number on retacula, subquadrate, robose without hair, brownish or creamy yellow.



Kalmegh has been used for centuries in Asia for the treatment of various ailments. It is found in the Indian Pharmacopoeia and is being prominently used in at least 26 Ayurvedic formulas. The juice extracted from fresh and dried leaves of Kalmegh are the official drugs in Indian Pharmacopoeia. It is reported to possess astringent, anodyne, tonic and alexipharmic properties and is useful in dysentery, cholera, diabetes, influenza, bronchitis, piles, liver disorder, jaundice, hepatomegaly, skin disorder, fever, wounds, leprosy, sore throat, tonsillitis, osteodynea, menstrual disorder, hypertension and worm infestation. Panchang (stem, leaf, flowers, seed and root) of the plant is used in various formulation of Indian system of medicine. The plant is bitter acrid, cooling, laxative, antipyretic, anti-inflammatory, expectorant, digestive and stomachic. Andrographolide has been shown to inhibit human, breast, liver and prostate cancer cells. Andrographolide showed anticancer activity on diverse cancer cells representing different types of human cancers. Unlike cytotoxic anticancer drug cisplatin, andrographolide is rapidly metabolized when taken orally. The herb is used primarily for liver complaints and to reduce fevers in the traditional medicine of India and China. A large variety of Indian herbal patent medicines are available in which *A. paniculata* is a prominent ingredient. Kalmegh is an anti-insect crop of the rainy Season. Its crop doesn't affect from any kind of insects. From the cultivation of Kalmegh, farmer earns a lot of money than the other crops. Usually the output is about 40 quintal Kalmegh dry plants from one hectare, which can be sold easily at Rs. 1000/- to Rs. 1500/- per quintal. In this way farmer spends Rs. 15,000/- on the cultivation and earns Rs. 40,000/-. This means he gets a pure profit of Rs. 25,000/- to Rs. 30,000/- per hectare (NMPB, 2004). The demand of drug is 330 tons annually.

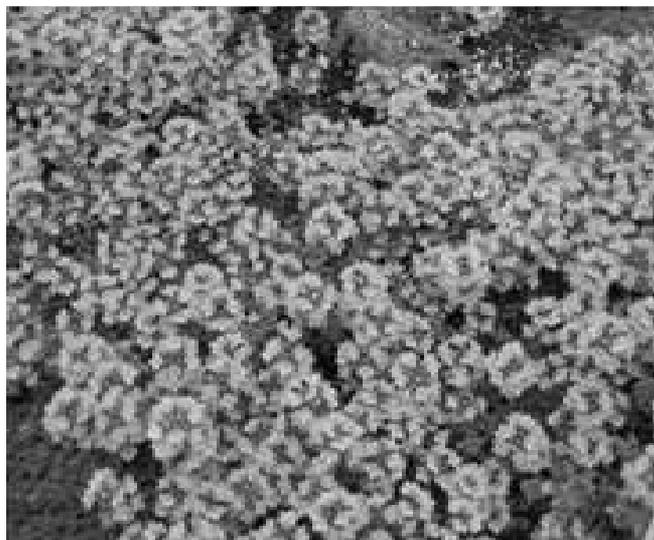
Phytochemistry: The whole herb is the source of several diterpenoids of which the bitter, colourless and crystalline lactone andrographolide is very important which is distributed all over the plants in different proportions. The other main diterpenoids are deoxyandrographolide, neoandrographolide, 14-deoxy11,12-didehydroandrographide and isoandrographolide. Kalmegh contains bitter principle andrographolide, a bicyclic diterpenoid lactone and Kalmeghin (upto 2.5%). Both growing region and seasonal changes have a strong impact on formation of the diterpene lactones. The highest concentration of the active components is found in leaves just before the plant blooms. The leaves contain the maximum active principle content while in the stem it is in lesser amount.

Sustainable Harvesting

Kalmegh was commonly available in the forests of Madhya Pradesh and freely collected by the villagers. However, due to increase in demand and destructive harvesting practices, today this has become scarce commodity in the forests. Considering the problem, Pandey and Kori (2011) developed non-destructive harvesting method for sustainable development of Kalmegh. Followings are some recommendations for harvesting of Kalmegh.

- Cut method (sustainable harvesting practice) is superior and has an edge over the destructive harvesting method since it improves natural regeneration of the herb. This harvesting practice proves to be a tool for sustainable development of Kalmegh.
- Sustainable harvesting technique will be very useful in the forest areas where the Kalmegh was available earlier but due to destructive harvesting the population has decreased.
- By non-destructive harvesting technique root stock of Kalmegh can be preserved in the forest areas.

2. BANAJWAIN (*Thymus serpyllum* Linn.)



This species is globally distributed from Africa to Asia. In India, it is found in the Himalayas of Jammu & Kashmir, Himachal Pradesh, & Uttarakhand between an altitude ranges of 1500-4500 m. It is also grown in the gardens of western India. Among the countries producing Thyme oil, Spain, stand first followed by France, Morocco and the Mediterranean countries. The bulk of the world demand for thyme oil is met by Spain and Turkey.

This is a perennial & evergreen herb of 10-25cm height and is commercially important for its pleasant aromatic oil. Leaves small, elliptic or oblong-ovate or lanceolate, 6-15 mm. long, glandular; flowers polygamous in whorls, males larger; nutlets smooth. The flowers are small, purplish or bluish to all most white, unite in spikes at the tip of branches and have a bilabiate tube like calyx and bilabiate, tubular corolla with a 3-lobed lower lip. The fruits is nutlet brown, 4 sectioned, smooth and is found in the remains of the calyx.

Whole plant is being used to get essential oil. The yield of essential oil from fresh plants is 0.27 % and from the dried plants up to 0.60 %. The oil yield content from plant cultivated at Chakrata (6000 ft.) varies from 0.47 % to 0.53 % and the major oil component is Thymol ranges from 45.8 % to 48.4 %.

Prevalent/traditional Harvesting Practices

The prevalent harvesting practice is destructive as whole plants are dug-out from natural habitat without considering the age and time of harvesting.

Sustainable Harvesting Practices

- For extracting the oil, fresh herb is collected, on dry days, at the initiation of flowering stage. To maximize essential oil yield, only one harvesting per year should be taken, when 50% of flowers have bloomed.
- The leaves and flowers which are used for culinary and medicinal purposes are harvested five months after sowing or planting.



- The leaves and flowers are plucked from the plants or shoots of about 15 cm are cut off from the plants.
- During harvesting lower portion of the stem, along with any yellow or brown leaves, should be rejected.
- Sun drying of thyme is not recommended, as it often results in rapid decrease of product quality.
- The yield is comparatively low during the first year. However, the plants become woody which necessitates their replanting after three or four years.
- Only shoot portion along with flowers should be harvested while root portion should not be uprooted.

Post Harvest Method

- The harvested crop should be dried in the shade or in dryer immediately after harvest.
- Harvested crop/essential oil should be stored in airtight containers to prevent the loss of flavor.
- The dry leaves are curled, brownish-green in colour, usually not longer 6-7 mm.
- The dry shoots may also be powdered and packed.
- Sun drying of thyme is not recommended, as it often results in rapid decrease of product quality.
- Transportation should be done in the evening or early morning to avoid moisture losses.

Ensuring Natural Regeneration of Species

- Only shoot portion along with flowers should be harvested whereas root portion not be uprooted.
- Most thyme farmers do not harvest during the first year of plant establishment. They can get good yields from the second year until the sixth year. After six years, commercial thyme growers plow and destroy the plants so as to rotate the crop or plant new seedlings.
- If the plants are cut very short, they will be unprotected against the frost and may not survive.

STEM YIELDING NTFPs /MEDICINAL PLANTS

1. GILOE (*Tinospora cordifolia* Thunb. Miers)

Introduction

Tinospora cordifolia Thunb. Miers belonging to family Menispermaceae, is a succulent climbing shrub distributed throughout India. It is commonly known as Amrata, Gurich or Gurbel. In Hindi, the plant is commonly known as Giloe, which is a Hindu mythological term that refers to the heavenly elixir that have saved celestial beings from old age and kept them eternally young. It grows naturally to an altitude of approximately 1000 m in Assam, Bengal and throughout peninsular India. It is abundantly available in the crude drug market of Katni (M.P.), Dhamtari (C.G.), Delhi and Mumbai.

T. cordifolia is a perennial, large, glabrous, deciduous climbing shrub. The stems are rather succulent with long fleshy aerial roots from the branches. The bark is creamy white to grey, the space in between being spotted with large rosette like lenticels. The leaves are simple alternate, membranous and cordate to ovate, shortly acuminate at apex. The flowers are unisexual, small and yellow or greenish yellow. In auxiliary and terminal racemes or racemose panicles, the male flowers are clustered and female are usually solitary. Stamens in male flowers are six, in female flowers carpals are three with six staminodes. Fruits are fleshy and single seeded. The fruits are drupes, ovoid, glossy, succulent, red and pea sized. The seeds are curved. Flowers commen during summer and fruits during the winter. The plants shed their leaves during winter season.

Giloe is used as a constituent of several pharmaceutical preparations which are used in general debility, dyspepsia, fevers and urinary diseases. The bitter principles present in the drug shows antiperiodic, antispasmodic, anti-inflammatory and antipyretic properties. The leaves are beaten with honey and applied to ulcers. Dried and powdered fruit, mixed with ghee or honey, is used as a tonic and also in the treatment of



jaundice and rheumatism. The root is powerful emetic and used for visceral obstructions; its watery extract is used in leprosy. A decoction of the leaves is used for the treatment of gout and young leaves bruised in milk are used as a liniment.

T. cordifolia is also widely used in Indian ayurvedic medicine for treating diabetes mellitus. Oral administration of an aqueous *T. cordifolia* root extract to alloxan diabetic rats caused a significant reduction in blood glucose and brain lipids. Though the aqueous extract at a dose of 400 mg/kg could elicit significant anti-hyperglycemic effect in different animal models, its effect was equivalent to only one unit/kg of insulin. There is a huge market for the roots, extract of Giloe in medicinal use. The annual consumption of the crude drug mostly by Ayurvedic pharmaceuticals/ herbal drug manufactures is estimated to be 4000 tons annually. In addition some of the herbal drug dealers are directly buying this drug from the local drug collectors of their region.

Sustainable Harvesting

Due to increase in demand and destructive harvesting practices, this species has become scarce commodity in the forests. Keeping above into consideration experiments were conducted for developing non-destructive harvesting practices. Non-destructive harvesting practice for Giloe was developed by Pradhan et al., (2013). Sustainable harvesting should be done as following:

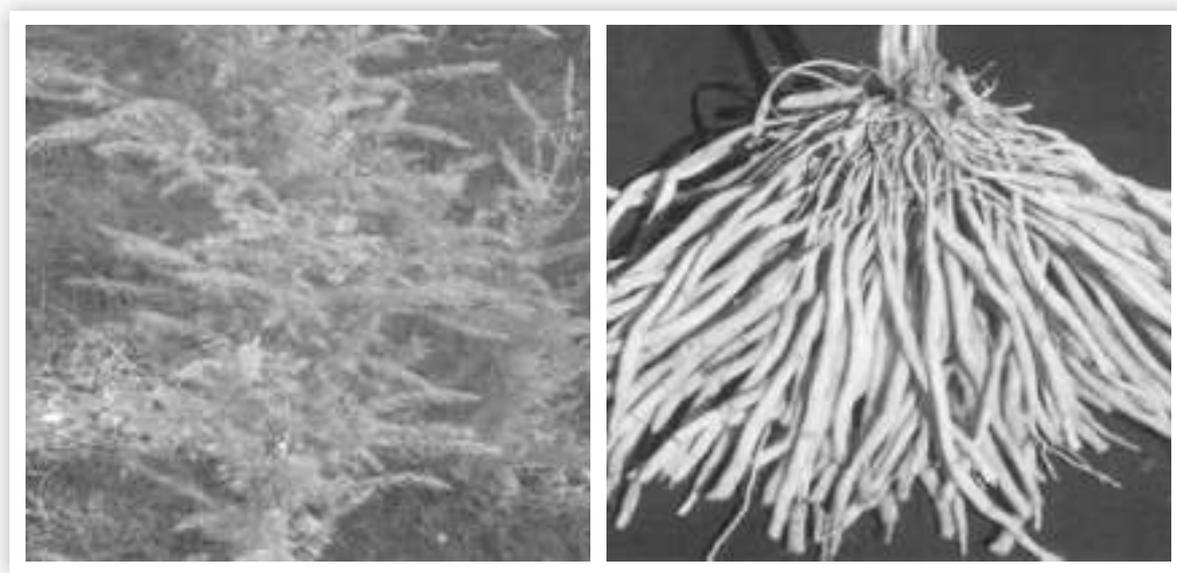
- Giloe stem should be harvested from two year old plants 15 cm above the ground level and cut into small pieces and dried into sun.
- It is recommended to cut Giloe stem into small pieces for better and efficient drying.
- Harvesting should be done in the month of December.

ROOT/RHIZOME YIELDING NTFPs / MEDICINAL PLANTS

Roots should be dug out with utmost care. The roots of annual plants must be dug when the plants are well developed, but generally before flowering. Roots of perennials should be harvested late in the fall or early in the spring. Collect biennial roots in either the fall of the first year or spring of the second year. The root material that is rich in essential oils should be handled carefully to prevent bruising of the epidermis, where the oils typically reside, which could result in essential oil degradation. Injured roots must be separated. Herbs after seeding must be uprooted so that the seeds that have fallen on the ground can regenerate the next year.

For some high value medicinal plants e.g., *Asparagus racemosus* (Satawar), *Chlorophytum borivilianum* (Safed Musli) and *Rauvolfia serpentina* (Sarpagadha) in which roots are useful parts are under threat as almost all collectors followed destructive collection practices. The process of depletion was such that above medicinal plants were vulnerable to local extinction because of the reckless collection practices.

1. SATAVAR (*Asparagus racemosus* Wild.)



Asparagus racemosus Wild. belonging to family Asparagaceae (Liliaceae), is commonly called Satavari, Satavar or Satmul. The plant is found wild in tropical and subtropical India including Andaman and Nicobar Islands. It is distributed from mean sea level upto 1500m in the Himalayas from Kashmir eastwards. The crop is cultivated in Kerala, Tamil Nadu, Andhra Pradesh and northern states in India. However, most of the requirement of the industry is met through wild collections from forests. The plant is a spinous, with tuberous, short rootstock bearing numerous succulent tuberous roots (30–100 cm long and 1–2 cm thick) that are silvery white or ash coloured. These dried roots are the part that finds use in various medicinal preparations. The stem is woody, climbing, whitish grey or brown coloured with small spines. The plant flowers during February–March leaving a mild fragrance in its surrounding and by the end of April, fruits can be seen with attractive red berries.



The roots of the plant contain four saponins viz., shatavarin I to IV recognized for broad biological activity. Satavar is recommended in Ayurvedic texts for prevention and treatment of gastric ulcers, dyspepsia and as a galactagogue. Due to its multiple uses, the demand for *Asparagus racemosus* is constantly on the rise, however the supply is rather erratic and inadequate. Destructive harvesting combined with habitat destruction in the form of deforestation adds to the magnitude of the problem. All of this has resulted in the drastic shrinkage of its population. It is estimated that in India, more than 500 tones of Satavar roots are needed every year for various medicinal preparations.

Present Harvesting Practices

Generally harvesters harvest entire plants from to area to maximize the amount of collected tubers. Removing all roots from all the plants does not leave any scope for regeneration. Very often people uproot entire plant (whole plant) without leaving any root in the ground for regeneration. There were several examples of such reckless collection practices, which have accelerated the degradation of high-value NTFPs.

Asparagus roots are sold for Rs. 90 to Rs.120 per kg and are in high demand because of their medicinal value. This had led to competition among local people and outsiders to collect as much as possible. This partly explains why, people were harvesting (uprooting) whole Asparagus plants. Present harvesting practices are unsustainable and have resulted in depletion of the plant resource base.

Sustainable Harvesting Practices

The sustainable practice for Asparagus is to leave two or three roots in the ground while harvesting them.

- First harvesting should be done after 1.5-2 years of transplanting, which continues for 10-15 years.
- Whole rhizomes should not be extracted at a time, 3-4 tubers should be left in the ground for regeneration.
- When the roots of Satawar (*Asparagus racemosus*) are harvested (dug out), the big and small roots are separated. Only bigger mature roots are collected and washed with water, dried and stored.
- Few smaller roots (3-5) along with the disc are remaining in the soil. These very roots sprout again in the next season.
- Alternatively 100% tubers may be harvested from 75% percent plants available in the area. 25 % population should be left intact for natural regeneration.
- Roots of Satavar should be collected in the month of April-May.
- The roots should be cleaned and peeled off with the help of sharp knife immediately after collection/harvesting. It is observed that in case the roots are not peeled off within a few days, it is difficult to remove the skin as such.
- After removing the skin, a thread present in mid of roots should be removed than it is cut transversely into small pieces and dried in shade.

2. SARPAGANDHA (*Rauvolfia serpentina* Benth. Ex Kurz.)



Introduction

Rauvolfia serpentina Benth. Ex Kurz. (Hindi: Sarpagandha) belonging to family Apocynaceae, is one of the most important medicinal plant of India. Sarpagandha is widely distributed in the foot hills of Himalayan range, up to the elevation of 1300-1400m, lower hills of Himachal Pradesh, Uttaranchal, Uttar Pradesh, Jammu & Kashmir and almost throughout the country. Rauvolfia is an erect perennial under shrub, found growing in moist damp and shady places of regenerated forests. The leaves are in whorls of three, elliptic, lanceolate or abovate acute or acuminate, dark green above and pale green below. Flowers are white or pinkish in many flowered cymes. It is also declared as a rare medicinal plant species.

There is a great demand of Sarpagandha in the international market for the alkaloids as well as the raw drug. The world requirement of dried Sarpagandha roots is around 20,000 tons/annum and in India the demand is 700 tons annually. The consumption of the raw drug is substantial in the indigenous drug market. Presently, average Sarpagandha market price is Rs. 500/kg.

Due to its increasing commercial demand and price in international markets, over harvesting, premature harvesting, destructive harvesting and irrational collection practices have been taking place in India. It has contributed to rapid depletion of the species from its natural habitats. In India, *Rauvolfia serpentina* has been categorized as an endangered species, based on the IUCN Red Data Book (IUCN 2001) and critically endangered in CAMP 2001 Report. It is also enlisted in CITES Appendix II. Poor seed viability, low seed germination rate, low vegetative propagation rate, overexploitation and loss of habitat are the major causes of decline of this species from its natural habitat.



Major Chemical Constituents

The major alkaloids present in roots and root bark are reserpine, serpoterpene, ajmaline, ajmalicine, serpentine, serpentinine, serpaajmaline, yohimbine (Rastogi & Mehrotra 1993), rescinnamine, deserpidine, coryanthine, reserpiline, alstonine (Sipahimalani 2002), arginine, lycine, serine, aspartic acid, glutamic acid, thereonin, alanine, praline, valine, tyrosine, phenylalanine, iso-leucine, cystine, histadine, asparagines, glutamines, glycine, tryptophane and aminobutyric (Hussain et al. 1992), ophioxilin, phytosterol, oleic acid (Sharma 2004), chandrine, papavarine, corynanthine, raunatine, rauvolfinine, sarpagine (Joshi 2006).

Medicinal Uses

The root, which is the most important useful part of the plant, is bitter, acrid, pungent and antihelminthic. The roots are the main source of drug for insanity, lowering blood pressure, mental disorder and hypertension. The decoction of root is employed in labor to increase uterine contraction and useful in bowels, insomnia, epilepsy, diarrhoea and dysentery. Roots are also given with the combination of other medicinal plants to cure cholera, colic and fever. More than 17 types of alkaloids are found in *R. serpentina* roots, out of them seserpine and serpentine are most useful.

Harvesting technique: Roots are collected from 2-3 years old plants. 30 months duration crop produce maximum root yield. However, for commercial purpose 15-18 months crop duration is feasible. Root collection is better when leaves are matured and ready to shed in winter season. At this stage the roots contain maximum concentration of total alkaloids. At harvest time root may be found go up to 40 cm deep in soil (NMPB 2004). Light irrigation is done for easy digging. Roots are dig up along with thin side roots, cleared and washed thoroughly and cut into 12-15 cm pieces for drying and storage. Care should be taken not to keep the root bark intact.

Sustainable Harvesting

Roots should be collected only from the matured plants. Tender and small roots should be left and covered by soil for regeneration (Pandey and Mandal, 2010). At least 20% plants should be reserved at site for sustainable production. 4-5 years rotational harvesting cycle should be adopted for sustainable production.

Normally Sarpagandha roots are harvested by digging out the roots from the field. While in non-destructive harvesting method, two small roots having at least two nodes were left in the soil for regeneration. Sustainable harvesting of Sarpagandha should be done as per following points.

- For sustainable harvesting 20% plants should be harvested.
- For commercial cultivation the crop should be harvested after 18 months of planting and can be harvested till 30 months.
- This method is found to be very useful in *in-situ* conservation areas.
- Some plants were also harvested after 24 and 30 months after plantation.

3. NAGARMOTHA (*Cyperus scariosus* R. Br.)

Introduction

Cyperus scariosus R. Br. (Nagarmotha) commonly known in India as Nagarmustaka belongs to family Cyperaceae. It has a large genus of about 600 species, distributed throughout all continents in both tropical and temperate regions. *Cyperus* is distributed in Asia, Indian Subcontinent, Indo-China, Malaysia, Bangladesh and Myanmar. It is found in damp places in Bengal, Uttar Pradesh, Odisha, Madhya Pradesh, Chhattisgarh and eastern and southern parts of India. It grows in medium black soil and marshy lands. Marshy land and hot climatic conditions are best suitable for its luxurious growth. They are annual or perennial plants, mostly aquatic and growing in still or slow-moving water up to 0.5 m deep. The species vary greatly in size, with small species only 5 cm tall, while others can reach 5 m in height.

The Nagarmotha plant produces deep brown tubers with aromatic odour. Flowering occurs in the month of July and seed setting in the month of October-November. Its oil is obtained by steam distillation of fresh and dried tubers (rhizomes) and is used as hair tonics and as fixatives in perfumes. It forms good substitute for patchouli oil in soaps and other perfumes. A decoction of the tubers is used for washing hairs, treating gonorrhea and syphilis. It is also given in general weakness and diarrhea. The regeneration in Nagarmotha occurs mainly through underground rhizomes and once established in the soil, the plant spreads rapidly, unless otherwise removed completely or washed off in floods. Natural regeneration in Nagarmotha is a major problem as villagers harvest all the materials available in forest. Nagarmotha oil is used in various cosmetic industries and pharmaceutical industries. Its market price of is Rs. 22-30/kg.

Sustainable Harvesting

Sustainable harvesting can be done to regulate harvesting limits. Harvesting should be done throughout the areas keeping at least 10-15% plants spread over the areas to facilitate better growth and multiplication and ensure sustainability. 90% harvesting intensity treatment showed almost double increase in multiplication rate which is the most important indicative parameter of natural regeneration and multiplication than its nearest treatment of 80% (Rani Abha et al., 2009). Sustainable harvesting should be done as per following guidelines:

- It is recommended that while harvesting Nagarmotha complete removal of the plants should be avoided.
- Harvesting should be done throughout the areas keeping at least 10-15% plants spread over the areas to facilitate better growth and multiplication and ensure sustainability.
- The roots of Nagarmotha (*Cyperus rotundus*) are dug out in October –January. Only black mature roots should be harvested leaving immature red roots in the soil, they sprout again in the next rainy season to produce another plant, thus ensuring sustainability.
- Harvesting should be done at proper maturity stage.



4. JEEVAK (*Crepidium acuminatum* syn *Malaxis acuminata*)



Jeevak (*Microstylis wallichii* syn *Malaxis acuminata*) is a highly exploited medicinal terrestrial orchid. The orchid belongs to the Epidendoideae sub-family of Orchidaceae. It is a sympodial orchid growing on humus or half rotten leaf litters of the moist forest floor of temperate and sub-tropical region of the Himalayas between 1800m to 2300m MSL. The orchid is a critically endangered species because of its extensive use in Ayurvedic preparations like Astawarga, Jivinya verga, Madura verga and also in Chyvanprash as a health tonic, blood purifier, and aphrodisiac and also as an antioxidant

Phenological Characteristics: Jeevak is an erect, tuberous, small, terrestrial orchid, about 20–25 cm high. The stem tends to be pseudo-bulbous at the base. New plants arise from the rootstock and the mother plant decays as the daughter plants grow. Leaves are simple, three or five in number, and sheathing at the base. Flowers are minute, pale yellowish-green in colour, tinged with purple, and borne in terminal racemes. Flowers bloom in mid-May and the plant remains in full bloom till October. Fruiting is completed in October–November, after which it enters into dormant stage

Useful plant parts- The main part of the plant applied in folk and Ayurvedic medicine is the pseudo bulb.

Major Chemical contents- Major phyto-constituents present in Pseudobulbs are carbohydrates (23%–28%), proteins (30–42 mg/g), total sugars (29–32 mg/g), and phenols (1.2–2.1 mg/g).

Prevalent/traditional Harvesting Practices

In Uttarakhand, it grows well in Oak-Deodar forest areas. The local people only collect the plants from forest areas without considering the harvesting limit of the species. This unscientific collection of the plant without

focused conservation lead to the depletion of the plant density in natural habitat of the Himalayan region. In Uttarakhand, its collection from the wild has been banned because of its dwindling presence (Singh et al; 2005). However, illegal exploitation of the orchid continues and the resource may vanish unless right steps are taken up immediately. Collectors take out the whole plant mass and do not seem to leave even the small bulbs for future growth thus endangering its survival in the wild. Unsustainable harvest of wild populations of this orchid for pharmaceutical and nutraceuticals purpose has been a major threat to causing the rarity of this species (Hinsley et al. 2017).

Sustainable Harvesting Practices

- Only mature and big size pseudobulbs (length more than 5 cm and diameter more than 1 cm) should be harvested in the month of October every year.
- The results indicated that only 11.04 % pseudobulbs from one kg harvested pseudobulbs are big in size and can be used for commercial /market purpose, 26.65 % of pseudobulbs being middle size can be used for vegetative multiplication whereas 59.31 % of pseudobulbs should being small should be left for regeneration purposes.
- Medium sized pseudobulbs (having average length and diameter of 3.59 cm and 0.79 cm) should be used for vegetative propagation. While remaining small pseudobulbs (having average length and diameter was 2.89 cm and 0.48 cm) should be left for natural regeneration at the time of harvesting in wild.
- To maintain sustainability only 60% plants should be harvested leaving 40 % for natural regeneration.
- The pseudobulbs should be collected/harvested in winter (October to November) when the floral and leave part is shedding and plant in going in dormant stage.

Post Harvest Method

- The harvested pseudobulbs should be packed in gunny bags for proper aeration.
- Transportation should be done in the evening or early morning to avoid moisture losses from the pseudobulbs.
- For Marketing- The Pseudobulbs should be cleaned, washed, dried in shade, and stored in cool and dry place.
- For Propagation- Storage of harvested tubers should be done by burying them in sand/soil. Pseudobulbs can also be stored in pots or brick chambers filled with sand or inside the pits made on the sloping walls of terraces.

Ensuring Natural Regeneration of Species

- The large and middle size pseudobulbs should be harvested for marketing and vegetative propagation purpose and small pseudo bulbs can be retained in forest area for regeneration purpose.
- The orchid should be harvested at maturity when upper part of the plant is shedding and in dormant stage.
- 40 % plants should be left for natural regeneration.



FLOWER YIELDING MEDICINAL PLANTS

In general, flowers must be harvested (or if specified, flowering tops) when they have just opened or shortly enough afterwards to avoid any faded or brown blossoms. The flower buds must be collected before the buds open and at early morning. The departure of insects must be encouraged by shaking the material and then by allowing it to sit for some time. Flowers must be handled carefully to prevent degradation as these are generally more delicate than other plant materials. The flowers rich in essential oils must be handled carefully to prevent bruising that could result in essential oil degradation. Some healthy flowers, particularly in top canopy could be left out to bear fruits and seeds for dispersal.

1. DHAWAI (*Woodfordia fruticosa*)

Species Description

Woodfordia fruticosa (Linn.) Kurz (Family Lythraceae), commonly called as Fire-Flame Bush, Dhavai and Dhatki. It is a much branched, beautiful shrub (1-3 m high) with fluted stems and long spreading branches. The plant is abundantly present throughout India, ascending up to an altitude of about 1500 m, and also in a majority of the countries of South East and Far East Asia like Malaysia, Indonesia, Sri Lanka, China, Japan and Pakistan as well as Tropical Africa. In India, it is widely found in the forests of Madhya Pradesh, Chhattisgarh, Odisha and Jharkhand. In some places it is also cultivated as an ornamental shrub in gardens for its flowers which are borne during the summer season. It is the plant of tropical and subtropical regions with a long history of medicinal use.

The original Sanskrit name Agnijwala or Tamra-pushpi appears to be derived from the bright red colour of the flower and the bark. The bark of the plant, characteristically cinnamon-brown coloured and smooth, peels off in fibres and the young shoots are terete, often clothed with fine white pubescence. The leaves are 1.5-13 x 0.8-4 cm, opposite or sub-opposite, decussate, sometimes in whorls of 3, sessile. Flowers are brilliant red.

Medicinal Uses

In India, Dhawai is a much used medicinal plant in Ayurvedic and Unani systems of medicines. The plant possesses many medicinal properties. Flowers are the most effective fermentation agent, used in Ayurvedic medicines. The dried flowers are reported to be used for the treatment of haemorrhoids, dysentery, diarrhoea, liver diseases, piles, disorders of mucous membranes, leucorrhoea, menorrhagia, ulcers, wounds, burning sensations, skin diseases, fever, headache, herpes, etc. Dhawai is exploited particularly, in perfume, leather and textile industry and believed to be superior for woolen and silk fabrics. The dye was extracted from the fresh floral parts of plant collected from wild. We can get different shades of colour using different mordants. This colour dye has no side effect on skin and it has no harmful effect on environment also. The process is economically viable as the raw materials are available at low cost and so cost of production is also very low. The flowers, which contain much of tannin, are flame coloured and yield red/pink/brown/flame coloured shades of dye (depending upon the fabric used) in large amounts, therefore, utilized throughout India for dyeing silk and fabrics on a commercial scale. Many tribes of Arunachal Pradesh have been using this plant species traditionally in combination with other plants for extraction and preparation of dyes utilizing indigenous processes.

Although all parts of this plant possess valuable medicinal properties, there is a heavy demand for the flowers, both in domestic and international markets specialized in the preparation of herbal medicines. The flower is pungent, acrid, cooling, toxic, sedative and anthelmintic, and is useful in thirst, dysentery, leprosy, erysipelas, blood diseases, leucorrhoea, menorrhagia and toothache. It is considered as 'Kapha' (mucilage type body secretion) and 'Pitta' (energy-dependent metabolic activity) suppressant in the Ayurvedic concepts of medicine. Many marketed drugs comprise flowers, fruits, leaves and buds mixed with pedicels and thinner twigs of the plant.

The flowers are used in the preparation of Ayurvedic fermented drugs called "Aristhas" (hot extraction followed by month-long slow fermentation) and "Asavas" (cold percolation followed by month-long slow fermentation). Aristhas are believed to be general health tonics in nature, having overall health stimulating properties via ameliorating and/or delaying one or other systemic disorders. Of the 18 aristhas mentioned in the Indian Ministry of Health & Family Welfare's monograph (CCRIMH, 1978), 17 have been found to contain *W. fruticosa*. Tribal people in the Chhattisgarh use fresh flowers to stop bleeding in emergency cuts, but they prefer to employ dried flower powder to heal wounds more efficiently. It is also one of the ingredients of a preparation used to increase fertility in women. Flowers used for the ayurvedic preparation "Kutajarista" for Sprue, dysentery, diarrhoea, "Lukol" for the leucorrhoea DUB (dysfunctional uterine bleeding) and symptoms of pelvic inflammatory disease. Oil based flower extract has always been recommended for open wounds. The dried flowers powder sprinkled over ulcers and wounds to diminish discharge and promote granulation. They are also used as tonic in disorders of mucous membranes, hemorrhoids and in derangement of the liver. An Ayurvedic medicine called "Balarishta", a drug of 'Asava' and 'Aristha' group, contains *W. fruticosa* flowers as one of the major constituents and is used in burning sensation in stomach (Agnimandya), weakness (Daurbalya) and rheumatic diseases (Vataja roga). A popular crude drug (Sidowaya or Sidawayah) of Indonesia and Malaysia mainly contains dried flowers of *Woodfordia fruticosa*. It has been used as an astringent to treat dysentery and sprue and also for the treatment of bowel complaints, rheumatism, dysuria and hematuria in many southeast Asian countries. Water decoction of the fresh flowers, either alone or in combination with ginger (*Zingiber officinale*) or intrajua (*Wrightia tinctoria*), is used for the treatment of dysentery. Oral use of powdered bark in managing diarrhea is well known. Successful treatment of otorrhoea by dried powdered flowers in tribal areas of Chhattisgarh is reported to be popular. Management of female-specific disorders like leucorrhoea and dysmenorrhoea with flower-based preparations is very popular among these tribes. However, many of these tribal therapies are not supported by systematic ethnobotanical and ethnopharmacological research.

Chemical Constituents

The extracts of *W. fruticosa* flowers showed the presence of carbohydrates, gums, flavonoids, sterols and phenolic compounds/tannins. A series of publications have appeared on the structural characterization of the secondary metabolites of the plant. The compounds identified are predominantly phenolics, particularly hydrolysable tannins and flavonoids. The following chemical constituents are found in different part of the *Woodfordia fruticosa*. Octacosanol and sitosterol, steroid sapogenin hecogenin and meso-inositol from the flowers, lupeol, betulin, betulinic acid, oleanolic acid and ursolic acid from the leaves. The phenolic constituents include gallic acid in leaves and stems. A large number of new and known hydrolysable tannins have been isolated from the flowers.



Harvesting of Flowers

Flowers are the most useful part of the plant. Villagers/tribals harvest flowers from the forest. Often they cut branches of the bush for harvest which is the main reason for depletion of the population.

Do's and Don'ts

Branches should not be cut for collection/harvesting of flowers.

Entire flowers should not be harvested from shrub.

About 20% flowers should be left intact with shrubs to facilitate natural regeneration.

Harvesting time depends on the climatic conditions of the area; flowers should be harvested during February-April at full blooming stage.

GUM/RESIN YIELDING NTFPs

Flow of gum is more in hot weather. Therefore, tapping should be done between October- June. The stem of the tree should be divided into three zones and each zone should be tapped in one year. The blazes of the subsequent year should be alternating or staggering with the previous years of blazes i.e. old and fresh blaze should not be in the same longitudinal row. After 3 years of tapping, sufficient rest should be given to the tree to rejuvenate from the injury.

1. SALAI (*Boswellia serrata* Roxb.)



Introduction

Boswellia serrata Roxb. (Family - Burseraceae), also called Indian frankincense, is a moderate to large branching tree. *Boswellia serrata* has been an important tree species in central India. It is a moderate-sized to large, deciduous tree with a light, spreading crown and somewhat drooping branches. It usually has a short bole, 3-5 m in height, sometimes can be more taller, if grown in a fully stocked forest. Ordinarily, it attains a girth of 1.2-1.8 m and a height of 9-15 m. Bark is very thin, greyish-green, ashy or reddish in colour with a chlorophyll layer beneath the thin outer layer, which peels off in thin, papery flakes.

The tree is native to India, North Africa and the Middle East. It is distributed throughout India. In India, it occurs in the states of Madhya Pradesh, Jharkhand, Andhra Pradesh, Odisha, Gujarat, Punjab, Assam, Rajasthan, and Karnataka. Because of overharvesting of gum-resin in Madhya Pradesh, a ban was enacted in 1969 but was later lifted in 2003 (Brendler et al., 2018). The species is vulnerable in Chhattisgarh, where gum-resin is harvested by the local communities for medicinal purposes. The trees are most often found growing out of



rocks and hillsides and dry river beds, wherever rich soil deposits of limestone are found. The species is best known for its non-timber forest product, olibanum. In addition, it has numerous environmental, socio-economic, traditional and industrial uses. However, the species is declining at an alarming rate and thus needs priority in conservation. *Boswellia serrata* produces gum-resin that is popularly called Indian frankincense or Indian olibanum. The gum-resin from *B. serrata* is medicinal and is popular among Unani, Ayurveda, and western medicinal practices. It is extensively used in Ayurvedic medicine. The Sushruta Samhita and Charak Samhita describe the anti-rheumatic activity of various types of gugguls (oleo gum resins), especially the *Boswellia serrata*, these resins have been used medicinally for over a thousand years.

Boswellia serrata resin is described as having bitter and sweet flavors, with astringent, demulcent, expectorant, antiseptic and anti-inflammatory properties. It is a powerful wound healer and very effective in the treatment of painful joint diseases with inflammation and reduced mobility. It improves blood supply to the affected areas, shrinks inflamed tissue, reduces pain, and enhances repair of local blood vessels damaged by proliferating inflammation. These effects are attributed to chemical compounds known as Boswellic acids, which are now used in contemporary medicine as anti-arthritis and anti-inflammatory pharmacological agents. Demand for the resins is very difficult to quantify accurately. They are often aggregated as other natural gums, resins and balsams. There is also a great deal of unofficial trading across the borders of producing countries.

The resins are sorted and graded according to size, colour and state of cleanliness before being bagged for export. The larger, paler lumps used for chewing are more highly valued than the smaller, darker coloured pieces and the powder and siftings. Myrrh is usually only classified as cleaned or uncleaned. It is more susceptible to quality variation than olibanum because of the mixture of species that often exists in export shipments. Pieces of good quality selected myrrh should be slightly sticky on breaking, rather than crystalline, indicating high oil content. It is important to use high quality material for production of essential oil. There are no international standards for the distilled oils. Quality is judged on aroma as perceived by the prospective buyer.

Sustainable Harvesting

The method of harvesting or tapping of *Boswellia* varies according to species and the customs of the region. A scrap is made in the bark of the tree resulting in a milky gum-like substance exuding from the cut area. Sustainable harvesting is used to protect trees from cut injuries. Scrapping should not be done in the tree having girth less than 60 cm. Harvesting of Salai should be done as per following points (Pandey and Yadav, 2010).

- Scrapping should be done upward direction of the tree up to approachable height.
- Blaze/scrap should not be deeper than 0.6 to 1.0 cm.
- After a spell of tapping from 3-4 years, the trees should be rested.
- Average annual yield of a tree is about 2-3 kilograms.
- The gum should be stored for about 12 weeks to harden to the required consistency. The best quality resin is pale in color, the lower quality gum is a darker amber or reddish color.

2. GUGGAL (*Commiphora wightii* (Arnott) Bhandari)

Commiphora wightii commonly known as Guggal, is a medicinally important species of the family burseraceae. "Guggul-gum" oleo-resin is the exudate of *Commiphora wightii*. Guggul has very high demand in national and international herbal industries. This plant is exploited for tapping gum by the tribal in an unscientific manner, causing high mortality and decline in its population density. It is a threatened species that is endemic to western India, is tapped to extract medicinally important oleo-gum-resin (guggul). In addition to this, slow growing nature, poor seed setting, germination and regeneration and lack of cultivation practices also contributed in its population decline. Presently, this important medicinal plant is categorized as critically endangered species by IUCN's Red list (IUCN, 2010).

The shrub is found in rocky and open hilly areas or rough terrain and sandy tracts in warm and semiarid to arid areas. In India, its distribution is restricted to Rajasthan, Gujarat, Madhya Pradesh, Karnataka and Kalat division of Andhra Pradesh (Soni, 2010). Rajasthan is having largest area covering guggal population but density is very poor. Highest density of guggal is reported in Sawai Madhopur (~ 74 plants ha⁻¹) and Jhunjhunu (~ 69 plants ha⁻¹) districts of Rajasthan.

It is much-branched, dioecious, up to 6 m tall with brown coloured, spine scented knotty, crooked and spirally ascending branches ending in sharp spines. Bark shiny, ash to yellowish white coming off in rough flakes exposing the greenish under bark, which also peels off in thin papery rolls. Leaves small, sessile, rhomboid-(ob) ovate, 1-3 leaflets, highly aromatic, leathery, shining green on top and greyish below with irregularly toothed edges. Flowers are small, unisexual, sessile, brownish red, occurring singly or in groups of 2-3, 8-10 lobed disc and an oblong-ovoid ovary; stamen 8-10. Fruits are ovoid green berry like drupe, reddish, 6-8 mm in diameter. Seed generally contain an under developed embryo.

Chemical Constituents

The gum resin contains 3.2% gum and 19.5% mineral matter chiefly consisting of silicon dioxide, magnesium, calcium, iron, and aluminum. It also contains about 1.5% essential oil, which contains 6.5% myrcene and 11% dilynene. A number of steroids have also been isolated from guggul like Z-guggul sterone and E-guggulsterol I, II, and III. It is a well known for its valuable active principle found in its oleo-gum-resin (guggulsterone E and Z), which are used in drugs preparation for lowering the cholesterol level in human body.

Prevalent/traditional Harvesting Practices

It is reported that gum tapping is mainly done by the tribals. They make incisions on the stem and apply a paste which invariably contains oleo-gum-resin (guggul) along with urine of horse or wild ass and copper sulphate (Bhat et al., 1989). This method is known to produce 3-4 times more gum compared to normal tapping but it results in death of the tree. As attributed by Soni (2008) death of the tree is due to copper toxicity. Deep incision made by the local communities is also thought to be injurious for the tree. Bhatt et al. (1989) developed an improved tapping method using 'Mitchie Gollidge knife' and application of ethephon. They claimed an increase of 22 times in oleogum-resin production by this method over traditional one. In addition, the plants remained healthy. Conflicting reports do exist about the optimum time for tapping. Atal et al. (1975) reported that tapping season for guggul was between November and December (cold season) and collection can be



made till May-June (hot season). Bhatt et al. (1989) reported that the favourable period to obtain higher guggul yield is April to May.

It oozes out sometimes naturally as well as on injury. The gum-oleo-resin is located in the gum-oleo-resin ducts scattered throughout the bark. The flow of gum is more during winter, that is, December to February. The traditional unscientific methods of making several deep incisions in stem and applying of a paste containing guggul gum and copper sulphate though increases the gum yield but leads to high mortality of plants (Atal et al., 1975; Soni and Swarnkar, 2006; Kasera and Prakash, 2005; Mandal et al., 2011). In past, many researchers worked on improvement of oleo-gum resin harvesting practices (Thomas et al., 2010). Bhatt et al. (1989) treated 27 plants with 100, 200 and 400 mg concentrations of ethephon in three different ways. They reported maximum 880 g cumulative gum yield in three successive years with 400 mg ethephon applied through roots, which is equivalent to 32.6 g of gum harvested per plant each year. Arya et al. (2013) conducted tapping experiment by giving three semi-circular cuts (half of the stem or branch girth) and used three concentrations (150, 300 and 450 mg) of ethephon.

Previously reported harvesting methods using ethephon and bacterium treatments as gum enhancer yielded 35.8 g plant⁻¹ and 49.4 g plant⁻¹ gum respectively, but these lead 42% and 100% mortality. In the study carried out by AFRI, Jodhpur gum yield has increased with increase in branch girth size and inflicting 8 cm horizontal cut in three branches of average girth size 19.90 ± 0.35 cm yielded 4.22 ± 0.33 g plant⁻¹ guggul gum without any mortality (Saini et al., 2018).

Sustainable Harvesting Practices

The plant should be allowed to grow for at least five to six years before commencing extraction of oleo-gum resin. Naturally growing healthy plants of more than six years should be selected for tapping gum.

The oleo-gum resin is tapped during winter, from November–February, by making a 7–10-cm long incision in the main stem near the base. Plants start gum oozing immediately after the cut and continue upto a week. Gum yield increased with increase in collar/branch girth size.

Cut of 4 cm yields maximum gum across all the orientations. Gum yield increased with increase in cut size, whereas horizontal cuts were found best for gum harvesting.

Maximum gum yield is obtained in November and it was minimum in July. If we divide the year into three seasons, average gum yield is highest during winter season followed by summer season and lowest in rainy season.

The cut part is completely covered with resin in about a month's time. The exuded gum secreted is collected every week up to one month after which further exudation of gum stops. Total gum oozed out is collected after seven days in zip lock polybags and air dried at room temperature for 25 days before weighing.

The method developed by AFRI, Jodhpur (7 cm horizontal cut) on main stem or thick branches yield gum without any mortality. The yield has increased with increase in branch girth size. The method yielded comparatively less guggul gum but without any mortality.

Post-harvest management After collection, the oleo-gum resin is stored in airtight plastic containers.

3. BLACK DAMMAR OR DHOOPA (*Canarium strictum*)





Canarium strictum Roxb. is an indigenous and endemic plant species of Eastern and Western Ghats. It is a Red-listed medicinal evergreen tree species known for its aromatic resin (Black Dammar or Dhoopa). It occurs in the tropical moist evergreen and moist mixed deciduous forests, and is commercially harvested for dammar, throughout South and South East Asia. Due to its overexploitation and the loss of habitat, it has been enlisted as an endangered species. Habitat fragmentation and landscape changes, pollinator limitation and seed dispersal limitation have adversely affected *Canarium* population in its natural habitat.

Canarium strictum is a large tree with a spherical crown and a clear trunk 30-35m long (Fig.1). It is found in both Eastern and Western Ghats. Leaves are compound (3-9 pairs), imparipinnate, increasing in size towards apex. It is reported to be polygamous with some trees having more male flowers than female. Flowers are arranged, in shortly branched axillary panicles, about 1 cm long, yellow to dull white, shortly stalked and mildly fragrant. Flowering occurs from February to April and fruits start maturing from November to January. Phenology is observed to vary with locations. Fruits are drupe, 2.5 to 5.0 cm long, pointed at ends, mesocarp fleshy, stone hard, aromatic and seeds trigonous, usually 3-celled with three seeds. The ripen fruits/drupes are collected by lopping the small branches, the fleshy mesocarp is removed with a sharp knife, and seeds are dried under proper shade.

Black dammar, the resin obtained from *Canarium strictum*, is one of many important NTFP that are used, harvested, and sold by indigenous (adivasi) communities throughout the Western Ghats. It contains b-pinene, a-terpinene and g-terpinene as major chemical constituents.

Prevalent/traditional Harvesting Practices

Harvesting is practiced following age old traditions. Tools like sharp axes and curved knives are generally used. In some places, it is a practice to set a low intensity fire at the base of the tree by using dry leaf litter, and burning the bark before incisions are made on the tree. Very rarely, the collectors collect resin without harming the tree (Kannan, 1992; Augustine and Krishnan, 2006).

Three broad resin-harvest strategies were identified: collection from natural fissures, tapping using incisions, and tapping using incisions and fire, each practiced in a different region. However, within each strategy there was large variation in tapping frequency and timing, tenure practices, and resin quality. The loss of tree tenure in some areas has led to a higher frequency of tapping and to the production of lower quality, lower value resin. Factors driving changes in both tenure and tapping strategies include rising commercial demand and value, pressure from outside harvesters, changes in livelihood strategies, and habitat destruction. Tapping leads to elevated mortality of *C. strictum* adults, with fire tapping have a greater negative impact than tapping with no fire (Varghese and Ticktin 2008).

Sustainable Harvesting Practices

- Trees could be tapped only after they reach 100 cm girth at breast height.
- Collect resin which naturally oozes out from the tree. When left undisturbed, the tree generates resin, which can be collected in blocks. The bark could also be lightly tapped and left undisturbed. Resin collects beneath the bark.

- Collection can be done throughout the year without harming the tree. If small incisions are made to induce resin flow, then it is best to avoid the monsoon season for collection.
- Natural fissures allow 2-3 kg collection per week. However, when incisions or light fire is made, the collection reduces to 1-2 kg and the tree is damaged.
- Over harvest should be avoided.

Post Harvest Method

- The resin is sun dried and packed in air tight containers free from moisture.
- The resin can be transported once collected..
- Properly dried and stored resin has a long shelf life.

Ensuring Natural Regeneration of Species

- Do not damage the tree with fire.
- Male and female trees being separate, it is better to harvest resin from male trees. Destruction of female trees would affect fruit and seed production which would upset the ecological balance as the fruits are eaten by hornbills and bats.
- Seed bearing trees should be marked
- Naturally regenerated seedlings are available in large numbers. These wildings may be collected and introduced into newer areas.
- Monitoring and Evaluation- The JFMC members should be sensitized on the need for the sustainable harvest of the species.



4. KARAYA GUM (*Sterculia urens*)

Sterculia urens or Karaya (Kullu) tree is a native of dry deciduous forests in tropical climates. It is usually found in tropical dry rocky hills and plateau. It is always noticeable from its smooth greenish-gray bark or white stem peeling off in large papery exfoliation, especially in the hot season, and the gaunt white stem with stiff spreading branches. *S. urens* is indigenous to India having a wide distribution. It is abundantly found in the dry deciduous forests in Madhya Pradesh and Chhattisgarh, which in earlier contributed about 50% of gum production in the country and the remaining came from Andhra Pradesh, Rajasthan, Gujarat, Odisha, Maharashtra, Karnataka and Tamilnadu. It is a medium- to large-sized (of 30-40 m height and up to 135 cm girth), deciduous, much branched, gum-yielding tree.

Karaya gum is the dried exudate from the tree *S. urens*. It is also known as Gum Kullu, Katiera in the trade. Karaya gum is an important raw material in the textile cosmetic, food, pharmaceutical and other industries. Gum Karaya is collected as exudates from the natural wounds or from the cuts made artificially (tapping) on the stem and the branches of *S. urens* (Anonymous, 1973). The gum ducts normally occur in the pith and cortex of young stem of *S. urens*. Gum karaya is vital for tribal economy and its trade value is substantial, there is a pressing need to develop a scientific and sustainable tapping method to increase the yield and ensure the survival of the tapped trees.

Gum Karaya belongs to the tragacanth group of gums that swell to jelly-like masses in water but are not actually soluble in it. Chemically speaking gums are plant polysaccharides or their derivatives, which disperse in water to form viscous mixtures (Gautami and Bhat, 1992). About 70% of the country's katira production is exported to the United States, Germany and other countries of the developed world and the remaining (30%) is consumed within the country. Kullu gum is commonly used as a substitute for gum tragacanth; in some of its properties, e.g., viscosity, it is in fact superior to the latter and has the added attraction of being less costly.

Traditional Harvesting Practices

Traditionally trees are tapped by blazing, stripping of the bark or making deep cuts in the base of the tree with axe. The commercial tapping of Gum karaya is done by blazing, peeling, or by making deep cuts at the base of the bole using an axe or a sickle. These tapping methods are brutal and injurious to the plants, often leading to their death. Several institutions have explored methods of tapping the gum tree to maximise gum yields (both qualitatively and quantitatively) without killing the precious tree resource. Two of the improved methods of kullu tapping, one adopted by the Damoh and Jabalpur Forest Departments and another evolved by the Forest Research Institute (FRI) Dehradun (FRI, 1972). One of the recent interventions done by GCC and Kovel Foundation for sustainable harvest of gum Karaya.

Sustainable Harvesting

GCC, in collaboration with Kovel Foundation, Visakhapatnam (Andhra Pradesh) conducted regular work on development of scientific tapping of gum Karaya (Anonymous, 2008). They also supplied tool kits consisting of the following items:

- Improved sickle for blazing the gum tree
- Five inches stainless steel forceps for removing bark and other matter from the gum
- Small polythene liners for gum collection
- Bamboo basket for transporting the gum from tree to home
- Material for a one mt. height wooden platform for drying the gum.
- Bamboo mat to cover wooden platform
- One sq. metre polythene liners to place over the bamboo mat for drying the gum

Tribals, both men and women are involved in the pre- and post-harvesting of gum karaya. Men conduct most of the gum blazing while women manage processing (drying, grading and storage). Tribal men and women who undertake gum collection start early in the morning, carrying their food and water. They walk three to 10 kilometers based on the geographical location of gum trees in the area. They have an informal understanding about the sharing of gum trees in the forest i.e. whoever cuts the tree first "owns" it in subsequent years. They blaze the gum tree and leave it for 20 days to ensure regeneration of the blazed portion. On the 20th day, they cut the blazed area at a thickness similar to onion peel at the upper portion. When women accompany their husbands, they carry baskets for gum collection. They visit to the gum trees on alternate days and make fresh blazes on gum trees, wherever needed. Gum collection trips are made three times a week (Mishra, 2005; Bhattacharya et al, 2003). The gum pickers were trained in gum harvest and post-harvest processing also. As a result of scientific interventions, gum karaya's quality and purchase prices have risen substantially.

Procedure

- Select a *S. urens* tree 90 cm or more girth at waist height - (a tree whose trunk matches the entire arms-reach of a normal individual is considered suitable for gum tapping).
- Clean and clear the ground area within 1m radius of the selected tree to allow the gum tapper to stand at ease; also clean the tree trunk of debris and loose bark using leaves or a piece of cloth.
- At waist height on the tree trunk, make a 12-15 cm horizontal incision using a sharp sickle. Join the ends of this incision by another, higher, crescent shaped incision on the trunk.
- Deepen the two incisions with the sickle, so that each incision is about 3 cm deep. Do not remove the bark between the incisions.
- Beat the bark bounded by the incisions, using a mallet or the blunt end of the sickle/axe, till the bark becomes soft and pulpy. Leave the tree for 14 days.
- Return to the tree after a fortnight and using hands and/or sickle, remove the beaten bark portion between the incisions that will have dried and died by now. This exposes the blaze. Peel off a thin layer of live bark from the top crescent portion to initiate gum flow. The blaze is now ready for tapping.



- Clean the area in and around the blaze using a piece of cloth and attach a small polythene sheet to the face of the blaze using thorns. The gum oozing from the crescent incision in the form of large, irregular tears should drip on this polythene. Leave the polythene on the tree for at least 48 hours.
- Return on the 3rd day with the sickle and a bamboo basket hanging from the elbow by a coir rope handle. Remove thorns from lower end of the polythene attached to the blaze and hold the polythene (with the gum collected on it) carefully in one hand. Now remove the thorns from the upper end of the polythene too. Holding the sickle in the more deft hand cut the gum stream to disconnect the gum collected on the polythene from the flows oozing from the trunk. Carefully place the polythene with its gum in the bamboo basket. Attach a new, clean polythene sheet to the blaze. If the gum flow has ceased, freshen the crescent-shaped incision by slicing a very thin layer from it, using the sickle.
- Repeat the gum tapping step no. 8 every 3rd day, till the blaze is too high on the trunk for the tapper to reach easily. Then it is time to start preparing a new blaze. Usually, it takes 3 years for a blaze to travel that far. Only one blaze should be made per tree, at a time.
- The new blaze should be made diametrically opposite the first blaze. Steps 2 to 9 are repeated on that side for another 3 years. Then a third blaze may be made on one side between the first two. Similarly, the fourth blaze would be made on the side opposite to the 3rd blaze on the trunk. After a Karaya tree has been tapped for 12 years continuously in this way, the wound from the first blaze should have healed completely and the trunk on that side be ready for tapping again.
- The gum-bearing polythene sheets are inverted and emptied on to a larger polythene sheet that has been spread over a bamboo-mat on a raised platform. This platform should be at least of waist height and constructed in an open, dust-free and sunny space to allow the gum to dry quickly. Pieces of bark, leaves or other extraneous material should be removed from the semi-solid gum using a pair of forceps. The gum pellets are sun dried until they become brittle.
- The dried gum is then sorted into grades (four) on the basis of colour and amount of visible impurities.
- The dried gum should be stored in clean and airtight polythene bags ready for the market.

Precautions: Gum Karaya has to be protected from dust, sweat and moisture, especially before it has dried completely. Hence, the following precautionary measures should be adopted:

- The blaze, the tree and its surroundings should be kept clean to prevent attack by white ants or infestation by other insects and fungus.
- The depth of the vertical cuts should not exceed 3 cm, otherwise the heartwood of Kullu tree will be damaged.
- Care should be taken not to handle the gum with bare or unclean hands.
- The drying platform should be high enough to be out of reach of small children.
- The specified implements should not be used for any household or other commercial use.
- During the rains, a shallow incision (> 15cm in length) should be made above the blaze and a polythene

sheet (larger than the one on which gum collection is on) fixed along it using a rope or thorns. This polythene protects the blaze, the oozing gum and the smaller square of polythene below from rain. Additionally, 2 shallow vertical cuts can be made at a distance, but parallel to the blaze walls to keep the stem flow off the face of the blaze.

- In order to prevent collection of water in the blaze during the rains, the first horizontal incision of the blaze can be slanted outwards. It has been reported that the red-barked trees give higher yields than the white barked ones; also trees on hill slopes are supposed to yield more gum than others.

A new method has also been developed in which trees are tapped to increase gum yield by making incisions in the bark or treating with stress hormone ethylene or ethylene-releasing compounds such as ethephon (2-chloroethylphosphonic acid). The gum yield increase with increase in concentration of ethephon (Nair 2004). Some new scientific methods of gum Karaya tapping has been developed by Kuruwanshi et al., 2017).

Period of harvesting/collection: The best quality gum is collected during April, May and June i.e. in summer. During this time, as the weather gets warmer the yield increases. The gum collected during the monsoons has low viscosity. In September, after the monsoon, the collection cycle is repeated.

Storage: Gum karaya tends to agglomerate or form lumps when exposed to wet and humid conditions. Therefore, handling recommendations include storage in sealed polythene lined containers. For extended storage, materials should be warehoused in a cool, dry place.

Quality control: There are at least five Indian grades of Karaya: HPS (Hand Picked Selected) Superior No.1 and No.2 (Fair Average Quality) and Siftings. The first four grades are the main export grades. The main quality criteria at the sorting stage are colour and foreign matter although even after grading the quality of consignments is often variable. The higher grades should be cleaner and paler than the lower ones, which may be dark brown in colour and have bits of bark present. A BIS specification (IS 12408:1988) exists for food grade gum Karaya.



6 WAY FORWARD

Collection/harvest and trade of NTFPs including medicinal plants from the wild provides livelihood opportunity for millions of rural dwellers but it has also brought ecological vulnerability. There is need to follow sustainable harvesting practices to ensure sustainability of resources. A robust system for traceability and ensuring chain of command for wild collected products will not only check illegal wild collection but will also guarantee better remuneration to the harvesters for their products in national and international markets. In this scenario, there is need to implement market-based tools such as certification for conservation, sustainability and equitable trade of the MAPs from the wild. These initiatives may enhance investment in education, health and food security which could play key role in building resilience among rural communities to fight against biodiversity loss and climatic vulnerability. There is a complex regulatory mechanism for trade in wild collected/cultivated MAPs which varies from State to State. This has led to a variety of interpretations and there is a need for improved harmonisation among various stakeholders for a national policy/strategy on conservation while promoting fair trade in MAPs to achieve Sustainable Developmental Goals 2030.

INSTITUTIONALIZATION

Field implementation of sustainable collection methods requires the participation of the local community. Enabling the local community-based organizations to involve in planning, field execution of sustainable harvesting and monitoring socioeconomic and ecological impacts of harvesting, thereby reconsider the Decision-Making Matrix (DMM) under adaptive management strategy.

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