



IMPLEMENTED BY GREEN INDIA MISSION UNDER ECOSYSTEM SERVICES IMPROVEMENT PROJECT



**Sustainable Harvesting Protocol
for NTFPs & Medicinal Plants**



**GREEN INDIA MISSION
MADHYA PRADESH FOREST DEPARTMENT**

ACKNOWLEDGMENT

This document is one of the most important deliverable of the Ecosystem Services Improvement Project being assisted by the World Bank Assisted and implemented by the Green India Mission of the State Forest Department of Madhya Pradesh. The sub-project is titled as “sustainable harvesting protocols, value addition & value chain development for non-timber forest products (NTFPs) in selected districts (Sehore, Betul and Hoshangabad) of Madhya Pradesh”.

The underlying idea behind this project is to reconcile the twin objectives of biodiversity conservation and enhanced livelihood of forest dwellers. This is a strategy for climate change mitigation, enhancement of forest cover, improvement of ecosystem services and livelihood opportunities for forest dependent communities.

Development of sustainable harvesting protocol for the most collected and traded species in the state has been the desired outcome of this project. This is the protocol of 25 most collected and traded NTFPs and Medicinal plants species of the State which has been prepared with inputs from the team of Society for Resource Planning, Development and Research, Bhopal. It has taken inputs from large number of stakeholder through 02 days training of gatherers, frontline forester, JFMC member, traders and also from the long experience of the research & development works of the team leader (Dr Ram Prasad).

Nevertheless, the information content in this has been contributed by our associates and partner in the organization as well as those of Madhya Pradesh Vigyan Sabha (MPVS), Bhopal. In particular I would like to take on record the assistance of Green India Mission (GIM) of M.P Forest Department with particular mention of Shri K. Raman, IFS, APCCF, Nodal Officer (GIM) and his dedicated team of consultants. From Madhya Pradesh Vigyan Sabha Shri S.R Azad and Dr U.S Sharma (Sr. Botanist Scientist) have also assisted in the compilation of this protocol. From Society (SRPDR) Dr Sushil Upadhyia, Ms Farha Naz Qureshi, Mr Pratyush Sharma and Varsha Dayma have continually worked to enrich this document.

A large number of field foresters and enlightened forest gatherers also assisted through their keen observation in providing material.

We acknowledge many others who have not being in particular mentioned but there is known mean. In the end we express our gratitude to Green India Mission for financial assistance from this project.

Date

20.09.2021



(Dr. Ram Prasad)



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FOREWORD

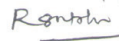
Madhya Pradesh Forest Department is one of the leading forest states known for its richness of bio diversity and productivity. The state boasts of its forest for a number of livelihoods providing bio diversity and a large dependence of tribal and landless laborer's. The population of Scheduled Tribals (ST) is 21.1% of the state population (15.31 million out of 72.62 million), according to the 2011 census and 18% of the tribal population of the country. In other words, the state of Madhya Pradesh is a home to one out of six tribal communities of the country and they derived sustained livelihood from its bio diversity rich forests. Integrity of forest eco-system encompassing large bio diversity is the lifeline of forest dwellers. Loss of this biodiversity would mean threat to livelihood and survival of the dependent communities.

The state Forest Department has been engaged in the restoration of the degraded forest ecosystem with the generous Grant in Aid from the World Bank for Ecosystem Service Improvement Program. The State has been implementing different components of the program aiming to forest restoration and ecosystem services. One of the components of Ecosystem Services Improvement Project is developing sustainable harvesting protocols, value addition and value chain development for NTFPs in the selected districts. The districts are *Sehore*, *Hoshangabad* and *North Betul* Forest Divisions which abound in prominent NTFP resources such as Mahua, Bael, Aonla, Achar, Satawar, Kalmegh, Nagarmotha, Safed Musli, Vaividang, Harra, Baheda and many others. They provide about 30% of the household income to the forest dependent communities. However, some of these species are gradually decreasing due to habitat degradation, and unsustainable harvesting. Active interest and engagement of rural communities in such a conservation program is an instrumental to address sustainability of these resources.

In order to educate and provide necessary information on the occurrence, importance and possibility for development of new products through processing and value addition, which is an important objective of ESIP project a sustainable harvesting protocol has been developed and is being published as a booklet in local language (Hindi) for use of NTFP gatherers and other stakeholders including forest field functionaries. The English version is meant for the Forestry researchers as a reference material.

I wish the literature produced on sustainable harvesting protocols will be helpful to senior forest officers to guide their field officers to persuade the communities, particularly the gatherers to follow responsible management and use sustainable practices so that the state continues to have the pride of place in the country in respect of richness of bio-diversity for the benefit of communities at large. The sustainability of these resources is vital for the Ecosystem Services Improvement Project. I would like to extend my appreciation to the efforts of project implementing agency (SRPDR) and Additional PCCF and Nodal officer *Green India Mission* in bringing out this useful publication.

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Preface

The National Mission for a Green India is one of the eight Mission under the National Action Plan on Climate Change (NAPCC). It recognizes that the climate change phenomenon will seriously affect and alter the distribution, type and quality of natural biological resources of the country. The NAPCC addresses the urgent and critical concerns of sustainable development and identifies the close linkage of the economy with its natural resource base. The Green India Mission puts the "greening" in the context of climate adaption and mitigation, aiming to enhance ecosystem services and provisioning services while addressing the livelihood issues of people living in and around forests. The Ecosystem Services Improvement Project (ESIP) with financial support from the GEF Trust Fund and administered by the World Bank is being implemented in the states of Madhya Pradesh. The project is designed to support Government of India's ambitious Green India Mission (GIM) and aims at increasing forest and tree cover, improvement in ecosystem services. The project also aims at enhancing forest-based livelihood opportunities of the stakeholders specially forests dwellers, small and marginal farmers living in fringe forest areas.

In forest areas about 30% of household income comes from Non timber forest products. NTFP resources, not only support basic livelihoods, but also can provide a strong incentive for involvement in forest conservation. The pressure on the resources is increasing due to recurring climatic change. Due to various reasons like overharvesting, premature collection, Climate change (extreme draught and flood situation) production of several NTFPs has gone down. Excessive demand by the herbal industries, forced premature product collection from various forest ranges through local villagers. Local people are engaged by traders and suppliers for collection of selected products. Due to destructive collection practices their regeneration going down and plants are coming under threat and many species progressing into the IUCN Red listing (RET- Rare, Endangered and Threatened). On the other hand, the loss of biodiversity is making the forest ecosystem degraded requiring serious attention for their restoration. Our shared goal is to empower forest-based communities to make use of and manage forest resources in a sustainable manner.

Realizing this situation, a consultancy project entitled "Sustainable Harvesting Protocols, Value Addition & Value Chain Development for Non-Timber Forest in selected districts (Sehore, Betul and Hoshangabad) of MP" was entrusted to MP Vigyan Sabha and SRPDR under World Bank funded Ecosystem Service Improvement Project.

It is in this context that the project has assigned the task of developing sustainable harvesting protocols, value addition and value chain development for NTFPs in the selected districts. I am happy to report that a publication containing details of 25 most commonly collected NTFP species from the state of Madhya Pradesh have been prepared in Hindi and English to cater to different stakeholders. Hopefully, it will be useful to the users to ensure compliance to sustainable harvesting protocols. The responsible management and user practices may appear putting restrictions on gatherers and thus may affect their annual collection but ultimately with their proposed involvement in developing new products through processing and value addition will compensate their short collection.

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Chapter 1

Background

In recent years NTFPs/medicinal plants are increasingly recognized as a source of significant livelihood opportunities for the rural poor and revenue for the state. The collection of NTFPs and medicinal plants provide sustainable sources of employment and cash income to the rural communities particularly the forest dwellers, landless poor and marginalized farmers, generating about 4 million person days of employment and which is expected to grow manifold as per the estimates made by Planning Commission, New Delhi (Annon, 2000). With a population about 1.3 billion and 147 million people living in 170,000 villages in the proximity of India's forest areas, majority of whom are poor, whose survival is critically dependent on forest resources. This high dependency on forest for their livelihood support is creating tremendous pressure on natural forests.

Also, the increasing preference for use of organic and natural products for medicines, food, fodder and shelter; dyes, chemicals and fragrance etc., have led to unsustainable extraction of resources from the forests. The last few decades have witnessed 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 healthcare systems. According to the Secretariat of the Convention on Biological Diversity (CBD), global trade of herbal products totaled an estimated US \$60000 million in the year 2002. 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.

Various reports suggest that 85% of the raw drugs used by Indian pharmacies come from wild resources. Approximately, 1.3 millions plants are found worldwide and about 55000 medicinal plant species are used globally by the industries to herbal industries for production of products and medicines for treating for different ailments. India has innumerable medicinal plant resources from which about 2000 plants are being used in the preparation of Ayurveda, Unani, Siddha, Homeopathy, modern medicines and other healthcare products. During corona pandemic (COVID19), the demand of medicinal plants increased manifold for increasing the immunity. Some of the Ayurvedic formulations have had large market in the first and second waves of pandemic during 2020 and 2021. Although, this demand might have tapered down after July 2021, nevertheless, the preference per the use of Ayurvedic drugs as may be observed in almost every household continues. Due to increasing demand of medicinal plants in markets have therefore, caused tremendous pressure on natural forest for extracting more and more plant resources, even unsustainably.

1.1 Perception of Sustainability at National & International Levels:

Several regional and global initiatives provide guidance to countries and stakeholders on sustainable use and sustainable management of biological resources and ecosystem goods and services. The Aichi biodiversity targets adopted in 2010 by the parties to CBD focus on sustainable use through goal B and target 7.

The National Biodiversity Strategies and Action Plans (NBSAPs) also recognize the need to focus on sustainable use of biological diversity. In 2007, under the aegis of IUCN, German Federal Agency for Nature Conservation (BfN), TRAFFIC International and WWF framed principles which are known as International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP). ISSC-MAP provide guidelines and tools to collectors, producers and decision makers for the planning and implementation of a sustainable resource management system based on the Good Agricultural and Collection Practices (GACP). Fair trade version 1.0, 2006 focused on relation between collectors and buying company, and introduced the concept of fair trade to the wild plant collection. In 2010, a comprehensive standard Fair wild standard (Version 2.0) was developed combining the guiding principles of ISSC-MAP and Fairwild Standards (Ver1.0, 2006) by including elements such as fair trade and certification. The University of Trans Disciplinary Health Sciences and Technology (TDU) formerly known as Foundation for Revitalisation of Local Health Traditions (FRLHT) was one of the members in the advisory board for drafting ISSC-MAP and field testing of the standard in 2007.

IUCN has exclusively formed a Specialist Group on Sustainable Use and Livelihoods to promote conservation and livelihoods through enhancing equitable and sustainable use of wild species and their associated ecosystems. Today, the most important issue is how to reconcile the twin objectives of biodiversity conservation and enhanced rural employment. The sustainable harvesting protocol therefore offers a good solution to manage the conflicting demands of conservation of biodiversity and livelihood of forest dwellers.



1.2 The Future for Non-timber Forest Products and Sustainable Forest Management

Non-timber forest products, whether foods, medicines, crafts, or cultural products, contribute to the livelihoods of people worldwide. These values are expected to increase as human populations increase, with associated greater market demand for NTFPs. However, many of these valuable species are already threatened by overuse and associated ecological impacts, and the lack of management and market integration. Within the country, most NTFPs are neither tracked nor monitored, which limits the potential for economic gains and social benefits from these products. As the market demands for NTFPs increase, the species from which they originate are likely to face greater pressures. To ensure the long-term sustainability of these resources and the harvest of products and to realize their economic potentials, much research and development is needed.

Integrating non-timber species into forest research and developing effective methods for inventory and monitoring is fundamental for their sustainable use, and for the health of forested ecosystems. Most studies on NTFPs have focused on harvest impacts or management at the population or species level, primarily on commercially important species. Although knowledge regarding the impacts that harvesting has on individual plants and populations is lacking it needs to be well researched and analyzed. It is urgently needed to improve management consideration, and attention of harvesting impacts at broader ecological scales. In addition, understanding the cultural importance and associated traditional and local knowledge regarding NTFPs is needed. In some cases, knowledge exists regarding how to harvest products with relatively little negative impact, but greater integration is needed to implement the appropriate and practical methods. Traditional and local ecological knowledge and management practices can provide fundamental information regarding the stewardship of NTFPs and the habitats and ecosystems in which they exist.

The future outlook for many non-timber species used as open access resources, which is applicable to India's most traded species is therefore not promising. The examples presented are applicable to many other ecologically, economically, and socio-culturally important NTFPs that are harvested for root-based products because about 32 % in herbal industries use root products as basic raw material. Each species harvested from natural forest shows significant population decline, including a loss of genetic diversity. Limiting harvest intensities or frequencies is necessary to allow for these typically slow-growing populations significant time to recover. However, research is needed to determine the length of time that is needed for populations to recover, and this will differ from species to species. Even with such restrictions, research indicates that some populations may never return to the pre-harvest levels. Enhanced regeneration efforts may be necessary to replenish depleted populations, as what occurs with replanting trees after timber harvest. According to an UNDP-NMPB supported study on supply and value chain analysis of NTFPs and medicinal plants in the state of Madhya Pradesh and Chhattisgarh (Prasad & Sharma, 2015) it has been observed that unsustainable extraction and use the resources are declining from 10-90% in different species. This way it is a high time to develop sustainable harvesting protocol and implement them through forest working plan.

The World Bank assisted Green India Mission (GIM) is committed to rigorously implement the protocol being develop by Society for Resource Planning Development and Research (SRPDR) in collaboration with Madhya Pradesh Vigyan Sabha (MPVS), Bhopal

1.3 Overview: Demands of NTFPs/Medicinal Plants by herbal industries:

As per estimate, 960 medicinal plant species are in trade. There are 193 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 are in high demand. As a result of the overwhelming demand of these NTFPs 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 demand for the certified products are increasing in European and American markets and India being one of the major exporters of NTFP to these market, 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 medicinal plants are still not given due recognition in Forest Working Plans in the country which is still timber oriented, as a result of which there is a threat for sustenance of the MADPs in view of the ever increasing demand in the national and international market, exploitative and unsustainable harvesting practices and discrepancies in the Management Plan.

Agro technology of threatened species is limited and commercial cultivation of even herbs will not increase, unless incentives such as buy back guarantees, venture capital funds, tax sops etc. are provided. This explains the



need for sustainable harvest of medicinal plants from the wild and substitution of the threatened species by options suggested in the pharmacopoeias. 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 used which is governed by the following factors:

1. Place from where the plants have been collected
2. Climate, soil, habitat of the area from which the plants have been procured
3. Appropriate time of collection

As the price paid to the gatherers tends to be very low, hence they apply destructive harvesting methods to increase their collection and income. A critical factor in wild harvesting is the lack of awareness, and proper monitoring and evaluation. 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 norms for collection of medicinally important plants. There are also restrictions on collection of some threatened medicinal plants species, collected from the wild sources. 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 medicinal plant existence. 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 medicinal plant species has been prepared.

1.4 Objectives of Sustainable Harvesting

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

- To ensure conservation and sustainable development of NTFPs/medicinal plants biodiversity through sustainable harvesting and management of natural resources.
- To ensure sustainable and remunerative returns to the gatherers of NTFPs and medicinal plants so as to effect reasonable increase their household income.
- To arrest the continuing decline of NTFP resources through Assisted Natural Regeneration (ANR) of struggling seedlings and saplings of most collected species in the natural forests.
- To reduce the drudgery to the women and children who constitute large percentage of gatherers.
- Capacity building of gatherers, frontline foresters and other community organization (WSHGs, JFMCs, BMCs, VDKs (Van-dhan Vikas Kendre Samities).
- To restore and development degraded ecosystem through the practice of sustainable management and development of biodiversity stocking in the natural forests harbouring most of the collected biodiversity.



Chapter 2

Concepts of Sustainability, Sustainable Forest Management and Sustainable Harvesting

2.1 Concept of Sustainability

Sustainability is the ability of the system to maintain a certain well defined level of performance over time and if required, to enhance the same in response to changing needs, either by itself or through linkages with other system without damaging the long term productivity of its resource base and essential ecological integrity of the system (Jodha, N.S., 1995). Sustainability is a complex concept. There are more than 60 definitions given by various authorities, however they all cover at least one of the following components:

- **Ecological Sustainability:** concern with the long-term health of the environment;
- **Social Sustainability:** apprehension about the welfare of future generations;
- **Economic Sustainability:** condemnation of rapid population growth and awareness over the possibility to maintain economic growth in the face of resource scarcity (Van Kooten and Bulte, 2000).

Despite the variety of ideas on sustainability and broad discussions on the perspectives of economic growth, general meaning of sustainable development supposes economic development to be within certain ecological limits. Though basic principle for sustainable development that focuses on non-declining per-capita human well being over time and presumes the ability of the society to live within the limits of the Earth has become dominant, the following separate sustainability concepts can be distinguished (Perman, Ma and Mc Gilvray, 1996):

- Sustainable state is one, in which utility or consumption is non-declining through time. The approach considers a Rawlsian ethical framework (equal utility allocation on each generation of people over time) as an appropriate one for developing principles of inter-temporal distributive justice. The Hartwick and Solow Rule consider the conditions to achieve this target.
- Sustainable state is one, in which resources are managed so as to maintain production opportunities for the future. This means that composite capital stock is non-declining over time. Substitution possibilities between natural and human-made capital are important in this respect.
- Sustainable state is one, in which the natural capital stock is non-declining through time. This approach presumes that natural capital is essential to production and is not substitutable.
- Sustainable state is one in which resources are managed so as to maintain a sustainable yield of resource services. That means that natural stock is held constant and delivers a constant flow of resource services over time. It is often used in biological models of renewable resource stocks.
- Sustainable state is one that satisfies minimum conditions of ecosystem stability and resilience through time. Humans are regarded as a part of the ecological system, sustainability of which is assessed in terms of the extent to which ecosystems' structure and properties can be maintained.

2.2 Defining Sustainable Forest Management

Apart from scientific debates, until recently, the issue of sustainable forestry was hardly given due attention on a policy level. At the first Ministerial Conference on the Protection of Forests in Europe held in Strasbourg in 1990, this topic was finally discussed. Sustainable Forestry was defined as a balanced management of forests, which takes into account their role as a life supporting system and their role in meeting the human needs of present and future generations without threatening forest capacity for renewal. The conference prepared six resolutions dealing with the issues that required increased international co-operation to promote the protection of forest resources worldwide.

In 1991, the IUCN, WWF and UNEP jointly published the first concrete document on joint actions in environmental field. It was the Caring for the Earth (1991) report, according to which the principles for sustainability include to "halt net deforestation, protect large areas of old forest and maintain a permanent state of modified forest". The document dedicates a chapter to the actions for development of sustainability on forested lands. Internationally, the creation and maintenance of markets for products of sustainably managed forests together with the assistance to lower income countries were identified as priority actions. The activities to enhance sustainable forestry include the expansion of wooded area, increase of the national capacity to manage forests



sustainably, the creation of a market for forest products from sustainably managed sources and more efficient use of timber (Hardashuk, Kopylova, Nizhnik et al., 1995).

By the time the UNCED conference in Brazil was held (1992), several countries had developed principles for sustainable forest use. The principles were discussed over at the Rio conference, and the debates resulted in a document, which reflected the first global consensus towards the problems with the forests. An agreement was reached on a set of principles for sustainable forest management. The Statement of Principles of Forests has become a guiding document aiming to contribute to the beneficial management, conservation and sustainable development of all types of forests.

International Tropical Timber Organization (ITTO, 1997) defines Sustainable Forest Management (SFM) as “The process of managing forest to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment”.

2.3 Sustainable Management of Non Timber Forest Products (NTFPs)

A sustainable system for exploiting non timber resources is defined as one in which fruits; nuts, latexes and other products can be harvested indefinitely from a limited area of forest with negligible impact on the species being exploited.

Harvesting of NTFPs, therefore, forms a key area of management in the tropical forests. Very little research is done in this area and hence data and information related to this area is lacking. Since this area is already much dented leading to the extinction of some of the valuable NTFPs, there is an urgent need to have some scientific basis of management of NTFP within a reasonable period of time to prevent further damage to these natural resources.

The establishment of sustainable harvesting techniques of NTFPs and medicinal plants has thus become a matter of great urgency. There is a great need to document and disseminate the sustainable harvesting techniques. Resource assessment is one requirement for the establishment and implementation of systems of sustainable harvesting.

Sustainable harvesting implies that only the part of current year’s products and services are extracted without causing damage to the plants are disturbing in any way the ecosystem functioning. In other words like bank interest the increment in case of trees and flowers, fruits, roots, stems, latex of current year should be partly extracted leaving some as future regenerative material and also for use by the wild animals who also act as a disseminators and thus ensure continuity of progeny.

2.4 Principal of Sustainable Harvesting:

The following are a set of principles that were developed using the above framework, complementing the already available guidelines and other frameworks.

The following set of principles have been developed by Arthur Selwyn Mark, Deepa G.B, and Jagannatha Rao (2018) jointly developed by MoEF&CC, Kerala State Council of Science & Technology and Kerala State Forest Research Institute, Peechi appears to be relevant and therefore being reproduced hereunder. (Principle 1 to 7)

Principle 1: Resource mapping, estimation and value analysis

This principle enables the local community to understand the availability of resources, potential quantity that can be harvested, their conditions in the wild and impacts of destructive harvesting. Further, it also provides for understanding the value of products harvested through value chain and the benefits realized by the different stakeholders involved and their roles and responsibilities in conservation of resources.

Principle 2: Participatory approach involving local community in conservation

Participatory approach integrates people of different socio-economic status; establish a need based and objective oriented local institution, thereby identifying roles and responsibilities, their dependency on the resource and their contribution towards conservation and sustainable use of wild resources. This principle enables the local community in the identification and selection of species and site for sustainable collection based on the criteria and, planning the methodology for sustainable harvesting by considering the traditional knowledge. The criteria for selection of species include: (a) species providing higher livelihood opportunities so that the local community takes responsibility in sustainable management of the resource; (b) highly traded species; (c) species with different parts harvested; (d) species collected only from wild; (e) endemic species.



Principle 3: Documentation, Assimilation and Application of Traditional Harvesting Knowledge

Documentation of indigenous knowledge related to phenology of the species, distribution, climate and productivity, animal interaction, regeneration, propagation, cultural and spiritual relevance, building local and species profile, medicinal values and traditional uses, harvesting patterns and processing. This principle helps the local people for documentation of traditional knowledge related to harvesting practices, ensuring customary rights of forest dwellers by involving them only without external labour forces, merging scientific information with traditional knowledge to develop good harvesting practices, and recognizing the association between community and the resources.

Principle 4: Development of Sustainable Harvesting Protocols, Tools and Field Implementation:

To evolve species specific and location specific sustainable harvesting practices/good collection practices/best practices by consulting traditional knowledge and academic knowledge, that will be implemented in the field by establishing institutional mechanisms.

This principle enables to develop species specific sustainable harvesting protocols (SHPs) and practices which are comprehensive and holistic that has ecological understanding of species, its collection, value addition and marketing.

4.1 Development of Sustainable Harvesting Protocols:

The components of SHP include species and location profile, distribution, phenology, morphology, threat status, medicinal uses, propagation technique, resource assessment, good collection practices and post harvesting technique. 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)?

4.2 Institutionalization:

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

4.2.2 Identification and registration of collectors: The CBO will ensure identification and registration of local collectors, undertake the capacity building, issue identity cards, organize collection, post harvesting interventions, marketing and benefit sharing.

4.2.3 Task Team: A multi stakeholder task team representing the intergeneration and gender equity, which undertakes resource assessment, implementation of sustainable harvesting techniques and monitor impacts of sustainable harvesting of resources. The activities of the task team are guided and monitored by the BMCs, JFMCs and/ or local forest management committees.

Principle 5: Training, Capacity Building and Dissemination

This principle describes various dissemination and capacity building programs for different stakeholder groups involved in the process. They are designed to develop and enhance the adaption of sustainable harvesting methodology. The importance of developing a communication strategy for different stakeholder groups engaged in the process is of critical importance. This enables sharing of information on methodology and its achievements to seek their Suggestions in order to reconsider the adaptive management strategy. Interpersonal communication is useful at the local community level where as other stakeholders can be effectively reached through group/mass communication.



Principle 6: Interventions for post harvesting techniques and market linkages

Post harvesting techniques such as drying, storage, value addition, labeling and branding fetch higher price in the market, also generate additional income and employment to the local people. Value added products linked directly to the herbal industries to ensure supply of quality raw material and provide health security.

Marketing is an important intervention for sustainably harvested produces, as this is the only available opportunity to generate economic incentive to the stakeholders that compensates for their involvement in the sustainable collection activities.

Need assessment for post-harvesting techniques has to be undertaken and species-specific protocols can be developed based on the market requirement. The economic value chain involves multiple actors from collection to the industry/ end product. To maximize the economic benefits to the grassroots level stakeholders (collectors), direct linkage with the industry is essential. As industry is the ultimate stakeholder of this sector, it can be engaged directly in the value chain to exercise the roles and responsibilities in conservation, resource augmentation, utilization and monitoring.

Principle 7: Linking trade, price and conservation principles and practices

It is to integrate stakeholders having different roles and responsibilities in the value chain of the resource collection, value addition and marketing. The idea is to directly link the primary stakeholders (collectors and village level institutions) from the resource base into marketing and trade of sustainably collected resources by assimilating possible value addition technologies at the local level to generate additional income and employment, thereby encouraging and enhancing the participation of stakeholders in conservation of resources. The capacity of the primary stakeholders is built on negotiation on price fixing and benefit sharing. Enhancement of skills of different stakeholders on the importance of sustainable harvesting, post harvesting techniques, marketing and certification improves the economic value chain and the economic incentives directly reaches the primary stakeholders and the dependent community. Certification of the sustainably harvested produces is one of the important aspects to fetch higher prices at national and international markets. Price fixing and benefit sharing is another crucial area in the trade of natural resources. Empowering the local dependent community on these issues will provide good economic benefits to them, thereby aiding in conservation of the resources. As the proverb 'Nature pays so it stays' goes, sustainable harvesting provides livelihood by offering additional employment and income, so conservation of resources is taken care for long term use by the current and future generations.

2.5 Towards sustainable management of NTFPs and Medicinal plants:

It is clear that in order to move towards a system of sustainable management of NTFPs and Medicinal plants, a number of aspects need to be addressed. Some of these summarized below:

- Better information on the current status and potential production of NTFPs and medicinal plants, both those that are cultivated from the wild, is required as a baseline from which to estimate trends in production. This is necessary before strategies for sustainable production can be developed.
- Supply chain information is currently poor and notoriously difficult to obtain given the non-transparent nature of trade. Collectors are generally not aware of the market prices of plants beyond the price paid by the local agent, and have no bargaining power. In fact, it appears that at each stage of the chain, the various actors involved have little knowledge of prices paid further long the chain. Improving the information may help the collectors to get a better share of the final prices of the plants, thereby increasing their stake in sustainable management.
- There is a potential for organization of collectors at the local level. Promising models for local organization of NTFP and medicinal plant collectors are already being developed and may serve to reduce the risk in business and degree of dependency upon traders to which collectors are currently vulnerable.
- The legal and administrative structure pertaining to NTFPs and medicinal plants can also play an important role in sustainable management. Regulatory Mechanisms that control the extent and nature of extraction can ensure that plants are sustainably harvested, while govt support prices (or other incentives) can help ensure a fair share for the primary collector/cultivators.
- Means of ensuring quality are of concerns to the industry and to consumers. There is a need for some system of quality control to be developed. Apart from ensuring the quality of raw material from correct botanical specifications, it is also necessary that the ingredient listed on ayurvedic products be actually used in the specified proportions.
- Another quality related aspects pertains to the preservation of the harvested raw material. Many species are harvested during the monsoon period and the moisture in the atmosphere makes harvested the raw material susceptible to fungal attacks. Currently there are practically no facilities or methods available fungal attack. The raw material either gets thrown away or, as is often the case, infected raw material is used in the final formulation. Any research undertaken on the preservation of the raw drug will hence go a long way in quality and waste control.



- The increasing involvement of casual untrained labour in the collection of NTFPs and medicinal plants from the wild is resulting in the use of unscientific harvest practices that are damaging to the plant as well as the environment. There is a need to not only impart scientific training to harvesters but also to educate them about the short term and long term advantages of following harvest practices that do not damage the plants in the long run.

2.6 Conservation Assessment and Management Plans (CAMP)

One method of rapid resource assessment is through CAMP (Conservation Assessment and Management Plans) process. CAMPs are intended to provide strategic guidance for application of intensive management and information collection techniques to threatened taxa. CAMPs provide a rational and comprehensive means of assessing priorities for intensive management within the context of the broader conservation needs of threatened taxa.

A CAMP workshop brings together 10- 40 experts (e.g., wild life managers, specialist group members, scientists from academic community and/or the private sector and captive managers) to evaluate the threat status of all taxa in a broad group (e.g. an order or family), country or geographic region to set conservation action and information gathering priorities. The CAMP process provides an opportunity to test the applicability of the New IUCN Red List Categories.

Four CAMP workshops conducted at Bangalore during 1995 to 1999 involved nearly 100 field botanists, including forest officials, trade experts and local healers and synthesized their perceptions of population reduction and fragmentation about each tax on.

A set of 8 criteria and 43 indicators were developed for sustainable forest management in India, through a process known as the “Bhopal-India Process”, which was adopted by MoEF&CC as National set of C&I. From the set of 8 criteria and 43 related indicators of the Bhopal India Process all the 8 criteria and 32 indicators can be applied exclusively to the sustainable management, development and use of NTFPs and medicinal plant resources.

2.7 Defining sustainable harvesting

A sustainable system for exploiting non- timber forest resources is defined, as one on which fruits, nuts, latexes and other products can be harvested indefinitely from a limited forest area with negligible impact in the species being exploited.

Sustainable harvest of a resource ensures an undiminished flow of benefits from the resource to its users over time in such a way that the harvest of NTFP does not have any deleterious effect on regeneration of target population or any other species in the community or on ecosystem structure and functioning. A broad definition of sustainability includes inter-generational equity, that is, maintenance of site values and opportunity for future options for use.

2.8 Types of unsustainable harvesting

1. Destructive Harvesting – e.g. uprooting the whole tree/plant or devoiding the tree from bark, cutting, lopping, debarking, tapping for gum/ resin, latex etc.
2. Premature Harvesting – plucking of fruits before maturing resulting in low regeneration.
3. Overharvesting – extracting more than the areas productivity.

The trees, shrubs, herbs and climbers yielding medicinal forest or seeds and found in natural forest are subjected to several problems; some of these problems are as follows:

2.9 Present system of collection and its impact on population viability:

1. 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 these products. So there is a competition among the collectors and also among the industries for the collection of maximum quantity of fruits; with the result that immature fruits are collected from the forest. Aonla fruit ripens during February but many times collection starts from October- November. Similarly, other fruits such as bael, 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.



2 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 tree unmindful of the damage being caused to the tree and the ecosystem. The damage is more pronounced in larger trees. In shrubs and herbs which can be handled from the ground, the damage is insignificant. In herbs and annuals, the tendency is to uproot the plant along with stem and branches.

3 New recruitments poor / absent:

In general, regeneration in forest is poor or absent in most forest types. The NTFPS and medicinal plants which occur in different forest types are no exception. New recruitments and younger plants 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 important as NTFPs 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. In case of Aonla (*Embolia officinalis*) often the unripe fruits are harvested in the month of September, even earlier also. Such fruits weigh less and thus, deprived the gatherers getting adequate collection and instead get poor returns from their collection. Even if harvesting is done after fruit ripening the gatherers start boiling the fruits in the local water streams in the forest and through the seed in the water after extracting the pulp. This way the regeneration becomes poor as the precious seeds are thrown in the water bodies. Even if some seeds germinate, the biotic pressures like fire and grazing kill the newly germinated seedlings. The result is no recruitment and no regeneration. The situation therefore, is very serious, and after few years when fruit yielding trees die there may not be any tree to take their place.

2.10 Determining sustainable harvesting limits

The conservation of commercially important forest resources in state owned natural tropical forests is a challenging task because these forests constitute a common property resource and local people have the right to free access to collect NTFPs. Owing to increased commercial utilization of forest resources, local user communities are encouraged to overexploit forest products, ignoring the traditional practices of sustainable harvesting of utilizable resources from natural forests. In the prevailing forest management system, extraction of NTFPs is not at all sustainable, either in ecological or economic terms. A participatory approach involving local forest dependant user community seem to be inevitable tool for sustainable management and in situ conservation of indigenous forest resources.

In theory, any harvesting plan should consider the availability of resources, the rate of use, and the renewal rate of the resources. Thus, only plans that promote harvest below the resource regeneration threshold and that do not modify the natural prevalence of the harvested species should be used (Lawes & Obiri, 2003).

Keeping this in mind, Madhya Pradesh State Forest Research Institute, Jabalpur, India, has taken the lead to determine the sustainable harvesting limits of over exploited NTFPs in natural forests, employing an integrated participatory approach in the tribal dominated forests of Madhya Pradesh.

The State Forest Research Institute (SFRI), Jabalpur has developed an index to determine the maximum percentage of harvesting at which maximum value of regeneration is recorded to determine the capacity of regeneration of selected medicinal plants after harvesting (Annual & Biannual).

$$\text{Regeneration Index} = \frac{\text{No. of plants regenerated}}{\text{No. of plants harvested}} \times 100$$

Extent of regeneration can be a good indicator of sustainable harvesting of NTFP.

Sustainability Index can be defined as $SI = \frac{N_h + N_r}{N_t}$

N_h = No. of plant harvested

N_r = No. of plant naturally regenerated

N_t = Total No. of plants before harvesting

For sustainability the value of SI should be > 1



On the basis of above index, harvesting limits was determined for Kalmegh. Different harvesting treatment plots with 20%, 40%, 60% and 80% levels of harvesting, was done for Kalmegh. The result of various levels of harvesting is as follows:

Sr. No.	Treatment Plots	Sustainability Index		
		Year 2005/06	Year 2006/07	Average
1.	T1 (20% harvesting)	3.54	1.91	2.723
2.	T2 (40% harvesting)	2.09	2.15	2.121
3.	T3 (60% harvesting)	1.95	2.24	2.094
4.	T4 (80% harvesting)	1.193	1.783	1.488

(Source: SFRI, Jabalpur Annual Research Report, 2007)

From the table it is clear that 80% harvesting as it gives maximum productivity for Kalmegh. Therefore, it was recommended that full protection should be observed for having maximum productivity of 80% harvesting and maintaining sustainability for Kalmegh.

2.11 Difficulties in sustainable harvesting

There are a variety of different ecological characteristics that can make sustainable harvesting a very difficult objective to achieve. The major problem areas are:

- the high diversity and low population density of plant species.
- the irregularity of flowering and fruiting.
- the importance of animals for pollination and seed dispersal.
- the high mortality and low success rate during seedling establishment.
- the sensitivity of population structure to changes in the level of natural regeneration.

In order to conserve valuable species of medicinal value and other NTFP yielding species, harvesting of plants and their products have to be sustainable. This manual, therefore, focuses on sustainable harvesting practices of various species of NTFPs and medicinal plants of ecological and economical importance. The NTFPs and medicinal plant species have been categorized on the basis of the parts used for medicinal purpose which are fruits, flowers, leaves, roots / rhizome, bark, stem, gum/ resin and all plant parts being medicinal.

2.12 Important indicators of sustainable harvesting

- Size class distribution of trees are important indicator of regeneration rate.
- Monitoring of seedling, sapling and adult tree densities help in appraising the sustainability of current harvest.
- While monitoring the size class distribution, if density drops below these values, the intensity of harvesting should be reduced.

2.13 Basic rules for sustainable wild collection

1. Plant species should be harvested under the best possible conditions avoiding wet soil, dew, rain or exceptionally high air humidity. Leaves, stems or flowers should always be gathered on a sunny day after the dew has evaporated off the plants but before the full heat of the day. For plants with volatile oils, such as mint and lemon balm, noon is a good time to harvest.
2. Rain water washes away some of the aromatic oils from many herbs, so after a rainstorm, harvesting should be done after 2-3 days after rains to let the plant's oil collect again.
3. The collectors should select harvest sites where the target plant could be readily found and the plant materials are likely to be of good quality and free of contamination from pollution and other negative environmental influences. Picking of herbs alongside highways or farm fields unless it is organic must be avoided.
4. If herb leaves are to be harvested, the harvested stems or branches must be hanged upside down in bunches for few days. This will bring the sap present in the stems or branches into the leaves.
5. The collectors must be provided with gloves in case of gum collection to ensure the protection of their hands and quality of the gum. After 3-4 uses the gloves must be discarded and new one should be used.
6. Helmet should also be provided to the collectors for the protection of the gatherers against falling of twigs, etc. in the forest.
7. Sharp cutting tools like chopper, sickle, secateur, scissor, hedge scissor must be used to avoid undue damage to the tree. With tender, non woody stemmed herbs, gathering of leaves, stems, or flowers can be accomplished easily with the help of scissors or sharp knife. Cutting tools must be cleaned and sharpened between two collections to reduce contamination.
8. Plant species listed under RET or on Appendix I of the Convention of International Trade in Endangered Species (CITES) or those which are not allowed to be harvested under State regulations due to concern about



- over harvest should not be harvested (e.g. *Taxus baccata* in Himalayas, *Sterculia urens* in Madhya Pradesh and Chhattisgarh).
9. Collection must be made from the abundant stands. Harvesting from stands where the plant is sparse or that are outside the species normal range should be avoided.
 10. During harvesting no other species growing in the collection area should as far as possible be mixed with the collected plant material.
 11. For harvest, only well grown and adult plants should be selected.
 12. Based on gatherer's perception and researches, the following retentions of different plant parts are recommended during collection:
 - For harvesting fruits, 25% have to be left for regeneration.
 - For harvesting seeds 30% must be left for regeneration.
 - During the harvest of flowers, 30% of flowers of each plant and 20% of the population must be left untouched.
 - In case of harvesting leaves, 70% of the plant leaves have to be left out.
 - Similarly, for harvesting roots or bulbs 80% of the plant population has to be left untouched.
 - For harvesting whole plant 50% of population should be left untouched.
 13. Leaves and roots of annual plants should be collected after flowering to ensure regeneration and better product quality unless otherwise recommended.
 14. For harvesting roots, a hole should be dug straight down and to one side of the roots. Gradually remove soil on one side of the hole towards the root. Then simply pull the root sideways into the hole. This method will damage the roots less than the common practice of digging down.
 15. For harvesting bark from trees or shrubs, the entire tree or shrub should not be girdled by removing the bark all the way around the tree, unless the tree has been or is to be removed for other purposes, e.g. , for timber harvest, or otherwise is to be destroyed.
 16. Whenever possible and acceptable for meeting quality standards the bark should be harvested from the branches rather than the tree trunk.
 17. As necessary and appropriate, use a dressing that will protect the exposed portion of the tree from invasion of the pathogen, rodents or insects that may cause further damage to the plant.
 18. For harvest that involves taking the entire plant (e.g. roots) the harvest should be limited in any population to leave a portion sufficient for regeneration of that population. Harvesting should be done only after the fruit has ripened and the seed has been released, if the species is seed propagated.
 19. While harvesting roots of perennial plants, some plants from each live stage should be left out. For species that regenerate from portions of roots or root crown a portion of the root should be left in the ground or the whole or divided crowns should be replanted, as appropriate (e.g. Satawar).
 20. For propagation by seeds, the seeds of collected species that reproduce sexually in a suitable environment should be planted.
 21. For asexual propagation, the whole or divided root crown, as appropriate, or other asexual propagation material should be prepared and planted in a suitable environment.
 22. The harvested material should not come under direct contact with the soil. It must be promptly collected and transported in dry clean conditions.
 23. During collection no other species growing in the collection area must be mixed with collected plant material.
 24. All containers used during harvesting must be clean and free of contamination from the previous plant material. When the containers are not in use, they must be kept under dry conditions free of pests and inaccessible to rodents, livestock and domestic animals.
 25. The freshly collected plant material should not be compacted as it would result in spoilage and undesirable quality changes and therefore, must be avoided.
 26. Freshly harvested plant material must be delivered to the processing facility as quickly as possible in order to prevent thermal degradation.
 27. Immediate post- harvest practices must stabilize the harvest to prevent degradation of the fresh material, which is particularly vulnerable due to naturally occurring moisture content of plants.
 28. Many harvested material, especially roots, need to be washed immediately after harvest to remove dirt and soil from the crop. Only potable water must be used for cleaning and the washed harvested material must be arranged to ensure adequate drying of the material.
 29. After harvesting the plant parts, their exposure should be limited to sunlight and they should be dried as soon as possible.
 30. During transportation of the harvest, the herbs should be protected from wind, dust or heat.



Chapter 3

Global Standards for Sustainable Harvesting on NTFPS

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 to sustainably harvest medicinal plants. Sustainable NTFP Harvesting Standards were developed in context of NTFP Certification primarily under three types of schemes (Mallet, 1999):

3.1 Sustainable Forest Management

- a) **Forest Stewardship Council (FSC)** – Smart Wood-Rainforest Alliances: By applying criteria that address ecological, social and economic issues since 1998, the FSC has permitted certification of NTFP management systems on a case to case basis. Smart-wood, rain forest alliance and others are involved in NTFP certification (Smartwood 2002). One issue on which all certification programmes can agree is that certification specific to NTFPs is still very recent and largely untested. However, the recent work of the FSC NTFP Working Group has gone a long way to refining certification for NTFPs. In another case, Smart-wood, an FSC-accredited certifier has developed a generic addendum to their criteria that will be used as the basis for all their future NTFP assessments. The NTFP Working Group of the FSC has been undertaking field trials and interpreting the FSC Principles and Criteria to make them more appropriate for the harvest of NTFPs (Smith, 2006; Mallet and Karmann, 2001). There are a set of 10 principles and 54 criteria under its system.
- b) **International Standards for Sustainable Collection of Medicinal and Aromatic Plants (IISC-MAP) Ver 1.0 2007:** WWF with IUCN under its TRAFIC network has developed an International Standards for Sustainable Collection of Medicinal and Aromatic Plants (IISC-MAP). The IISC-MAP has a set of 6 principle and 18 criteria indicators for sustainable collection of MAP resources. The project is implemented in the Himalaya Region (Nepal), Grater Mekong region (Cambodia), Tropical Amazon Region (Brazil), Southern Asia (India), South Africa South East Europe.

3.2 Organic Certification

- a) WHO – GACP (2002): The World Health Organization (WHO) has also developed a guideline for good collection practices (GCPs), which are being widely discussed for its implementation, by various NTFP producing nations (WHO, 2006; Karki and Rawat, 2004). WHO has prepared “Guidelines on Good Agriculture and Collection Practices” for medicinal plants during the year 2003- 2004. The guidelines apply at the time of collection of medicinal plants from forest and non- cultivated areas. It addresses various issues related to collection of medicinal plants, which help in conservation of species for long time survival. It also addresses the post management practices, such as product storage, product transport, processing issues or quality product issues. However specific guidelines for Good Agriculture and Collection Practices are to be developed for India. National Medicinal Plant Board has already prepared “Good Agriculture Practices for medicinal plants” under a project funded by WHO. NMPB has also implemented project for development of Good Harvesting/ Good Collection Practices of medicinal plants through various institutes. At present there is acute need to compile and correlate the information available in the form of guideline which could be implemented through stakeholders. Recently, National Medicinal Plant Board (2008) in India has also set up a committee involving experts and practitioners to develop India specific guidelines for Good Collection Practices other than the WHO standards for cultivated MAP resources.
- b) IMAFLORA, an organization in Brazil is assessing the possibility of certifying a forest region from which a wide range of medicinal plants are harvested, based on the individual management plans developed for each species.
- c) American Herbal Product Association: American Herbal Products Associations (AHPA) developed Good Agriculture and Collection Practices for Herbal Raw Materials to provide guidance to growers and collectors of herbs that are used in consumer products. In this article, guidance is provided on issues ranging from proper permits to plant identity and outlines on some long established harvest practices.
- d) WWF TRAFFIC INDIA has also developed General Guidelines for harvesting and Ayurvedic Medicinal Plants (AMPs).



3.3 Fair-Trade System

Under NTFP certification, fair trade certification promotes and assures benefit to the collectors. If try to redistribute some of the benefits back down in the production chain, to increase the profitability of NTFP collection to local people. Quality is major concern in this sector. The international “Good Collection Practices” are part of the certification process which assures the sustainability of the products in nature. In this reference “Good Manufacturing Practice” (GMP) requirement (under the Drugs and Cosmetic Act, 1940) to which also it tries to assure the products originate from sustainable and legal sources.

Table 1: Comparison among different sustainable NTFP / Medicinal Plants harvest standards

Criteria Organization	Emphasis	Weakness	Inference
ISSC MAP	Best practices in all the three strata viz. ecological, social and economic	The most comprehensive till date involving all the stakeholders but still the implementation agencies are not specified	Most relevant
FSC principles	Forest management units (FMUs) and Chain of custody (CoC)	Absence of policy environment in India	Await recommendation of certification committee
GACP, WHO Sanitation and handling of herbs	Little or no concern for ecology or sources	Largely applicable to cultivated MAPs and not the ones from wild	

(Source: Shanley et al., 2002)

In many countries, they don't have national standards for certification; in that case the criteria are developed by the accredited certifiers who take the responsibility of actual certification under FSC- endorsed national standard.

Apart from the above global standards there are also standards few standard developed by scientific organization and in India also there are work going on these standards. A few of them are mentioned below:

In a study conducted at FRLHT by Thomas et al. (2005) it was attempted to institutionalise such an adaptive management that would enhance or reduce subsequent harvest levels and methods based on observed impacts (on regeneration and stock), earlier harvest as well as pre harvest yield predictions. TO revive traditions through equitable benefit sharing, Gram Mooligai (i.e. village herbs) Company Ltd. (GMCL) was established with gatherers' group as share holders in Tamil Nadu state in Southern India. To earn more better price and sustain business demand, GMCL gatherers maximised not quantity but quality through thumb rules (do's and dont's) of sustainable harvesting practices: (a) appropriate habitat area, (b) maturity timing (c) less damaging methods (d) proper post harvest treatment (e) user (buyer, co- harvestor) agreements.

Jain (2004) in his article “Certifying Certification: Can Certification Secure a Sustainable Future for Medicinal Plants, Harvesters and Consumers in India?” expressed his concern on the fact that collection methods of the species are destructive as a result of which wild population is declining. TRAFFIC India research from 1998 to 2000 demonstrated that destructive and unsustainable collection, use and trade were the major threats to several important Indian medicinal plant species, despite various regulations in the country aimed at protecting plant resources.

Singh et al. (1997) in their book “Harvesting Herbs” recommended the harvesting of leaves, stems and flowers on a sunny day after the dew has evaporated off the plant, but before the full heat of the day has filled the garden. They also suggested harvesting of aromatic oil yielding plants such as mint and lemon grass just before noon so that the oil reaches the leaves by that time. They also suggested that for harvesting the herb leaves, the branch should be hanged upside down in bunches for few days so that the sap present in the stems or branches comes in the leaves.

A sustainable harvesting guideline was also developed jointly by NRCan, Canadian Forest Service, Federation and the PEI Dept. Agriculture and Forestry, April 2002 recommended shorter cuts in *Taxus canadensis* for taxane. This is because taxane content is higher in needles and small shoots than in large, woody branches and that the smaller branches can be utilized almost completely whereas other than the bark, larger woody material was



essentially waste from the extraction of taxane. Therefore, by harvesting smaller branches, less total biomass is required to yield a given amount of taxanes which is both better for the sustainability of the plants and more economical from the processing side.

Russo et al., in their paper Policy Guidelines for the Promotion of Sustainable Utilization of Non- Wood Forest Products stated that sustainable use of forest plant and animal species is receiving more attention now as a means of mitigating deforestation, hence maintaining forest cover and preserving biodiversity, while at the same time realising a sustainable income from it. NWFP are now widely acclaimed by many national and international conservation and development agencies as a panacea for forest conservation and rural income generation.

In a report prepared by Foundation for Revitalization of Local Health Tradition (FRLHT) for Andhra Pradesh Forest Department, a section exclusively on guidelines for harvesting, storage, drying and grading and structures, required for value addition and storage, has been provided in the report. It has been recommended in the report that in case of the crude drugs plant material should be collected in the appropriate season and time of the day. Harvesting of leaves should be done from plants during the flowering season when the plant is very active.

The sap movement and photosynthetic activity are at a maximum and leaves contain maximum of the active constituents. Collection of bark should be done in spring or early summer as cambium is very active in this season and since its cell walls are very thin bark gets separated very easily. Flowers should be harvested about the time of pollination in dry weather in the forenoon when the dew has disappeared and dried in shade. Roots and tubers are to be collected in autumn when the plant is inactive and the vegetative process has ceased and contain the maximum active constituents. Once the plant material is collected it is dried either in shade or in sun and stored. Impurities are then removed. Then the plant material is ready to be packed and transported as crude drugs to the end user companies.

The harvest of non-timber forest products (NTFPs) is coming under increasing scrutiny from certification programmes because of the key role that it plays in the sustainable management of community agriculture and forest resources worldwide. NTFPs are presenting many new challenges and opportunities in certification due to the wide range of management practices and difficulty in monitoring their harvest and processing.

Considering the importance of sustainable harvesting in the overall development of forests, Tropical Forestry Research Institute (TFRI), Jabalpur has initiated researchwork on sustainable harvesting of important MADP species e.g. *Andrographis paniculata* (Kalmegh), *Asparagus racemosus* (Satawar), *Phyllanthus emblica* (Aonla), *Rauvolfia serpentina* (Sarp Gandha), *Gymnema sylvestre* (Gudmar), *Tinospora cordifolia* (Giloe), *Terminalia arjuna* (Arjun), *Embelia tsjeriam-cottam* (Baividang), *Litsea chinensis* (Maida), *Curcuma angustifolia* (Tikhur), *Cyprus scariosus* (Nagarmotha), *Cymbopogon martini* (Palmarosa grass) and *Cymbopogon flexuosus* (Lemon grass). A report on Managing National Forests for Non-Timber Forest Products mentioned that until medicinal plants are recognized as a natural resource and managed as such, the conservation of these resources will be inadequate. These important components to the natural forest ecosystem play a critical role in the social, cultural, and economic make up of rural communities. Understanding the markets for these products is as essential as understanding the markets for any other natural resource that is extracted from public forests. Determining sustainable harvests levels and developing appropriate management strategies will remain elusive goals without a long-term commitment to monitor and track the markets.

In reality, the sustainable harvest of non-timber tropical forest resources requires quite a bit more than “blind faith” in the productive capacity of tropical plants. It requires careful selection of species, resources and sites. It requires controlled harvesting and periodic monitoring of the regeneration and growth of the species being exploited. More than anything, however, it requires a greater appreciation of the fact that ecology and forest management are the cornerstones of sustainable resource exploitation. There are ways to harvest non-timber products without damaging a tropical forest. Sustainable Harvesting is a very important aspect in sustaining the resource base either from wild or cultivated plants. Therefore, optimal methods of harvesting practices are necessary to be adopted or worked out in the absence of any foolproof system. This will cater to meet the following aspects also.

3.4 Standards for NTFP Certification by ICCF-IIFM

ICCF-IIFM has adopted a set of 4 principle and 16 criteria for development of National Standards for Sustainable Collection of MAPs adopted from IISC-MAP, 2007. A comparative analysis of the different certification schemes as applicable in India is given in Table: 2 Once these processes are concertized, it can be forwarded to International Certification Councils approval and accreditation of the standards so that the certifier can follow these standards for NTFP certification.

3.5 Voluntary Certification Scheme for Medicinal Plant Produce (VCSMPP) of Quality Council of India (QCI):-

In order to encourage Good Agricultural Practices (GAP) and Good Field Collection Practices (GFCP) in medicinal plants and enhance quality and safety of these plants, the National Medicinal Plants Board (NMPB), in



collaboration with the Quality Council of India (QCI), has launched a Voluntary Certification Scheme for Medicinal Plant Produce (VCSMPP).

3.5.1 Working Partnership with Quality Council of India and Society for Resource Planning, Development and Research (SRPDR):

- Quality Council of India and Society for Resource Planning, Development and Research (SRPDR) Bhopal have jointly organized a series of One Day Workshop to sensitize the gatherers, field foresters and JFMC members. One such workshop was held at Chada in Dindori District and three more at Chhindi (Chhindwara), Chhapara (Seoni) and Karhal (Sheopur) are listed for more workshops. This initiative is intended to take up Certification of medicinal plant cultivated areas as Good Agriculture Practices (GAP) and Good Field Collection Practices (GFCP). The latter one is planned in Sheopur Forest division. The area has been identified for certification of Salai gum tapping, Aonla, Satawar and some more naturally growing medicinal plants/ NTFPs.
- This is currently the most suitable option for forest department to get NTFP/medicinal plant rich areas, including the GIM landscape division certified under VCSMPP in collaboration with Quality Council of India (QCI). The organization (SRPDR) already a partner organization with QCI will always willing to assist in this matter. This will help to implement sustainable harvesting protocol and this way help the gatherers have access remunerative marketing channel.

3.5.2 Certification under FSC Standards:

The M.P forest Development Corporation has had taken the advantage of FSC certification of their plantation in Seoni-Barghat Teak plantation areas. This way some of the state's rich medicinal plants and NTFPs areas could be certified for conservation and larger market access of the products.



Chapter 4

Techniques of Sustainable Harvesting of Medicinal Plants

4.1 Fruit yielding Medicinal Plants

Fruits should be harvested only when they are mature and ripe, unless specification requires collection of immature fruits. Only un-bruised 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.

4.1.1 *Aegle marmelos* (Bael)



1. Botanical characteristics: Bael is a medium sized tree upto 8 m height with a straight, sharp, axillary thorns and yellowish brown, shallowly furrowed, bluish grey, 4-8 mm thick, corky bark; leaves trifoliate, aromatic, alternate, leaflets ovate or lanceolate or ovate- lanceolate, crenate, pellucid- punctuate, laterals sessile, and terminal long petioled; flowers greenish white, sweet scented in axillary panicles; fruits globose and woody berry with yellowish rind; seeds numerous, oblong, compressed, embedded in orange brown sweet gummy pulp.

It flowers during May- July. Complete defoliation takes place in the following April during ripening of fruit. The new leaves and shoot takes place at the end of April and the flower buds appear almost simultaneously in May and fruit setting takes place in the third week of May. The fruits require about a year for ripening. By the end of October,



they attain almost half of their full size.

- **Common names:** Bilva, Holy fruit tree, Bel, Shirphal. Wood apple
- **Distribution:** The tree is a native of India and is found wild throughout the Indian Peninsula, in dry hilly places
- **Useful plant parts:** Fruits and bark
- **Active Constituent:** Alkaloids, carbohydrates, proteins and tannins
- **Propagation:** Seed
- **Regeneration Status:** Poor regeneration (Reason- harvest immature fruits rather than mature)

2. Importance: - Bael is a very good source of protein which is 5.12 per cent of the edible portion. Fresh half-ripe Bael fruit is mildly astringent and is used for dysentery and diarrhea. The pulp may be eaten or the decoction administered. Bael is said to cure without creating any tendency to constipation. Bael leaves, fruits and root can be used as tonic and coolant with antibiotic properties.

Yield- The average yield is 300-400 fruits per tree. The quality of fruits is greatly associated with the weight and size of the seed-sacs. The larger and heavier the seed sacs, the greater is the amount of mucilage and poorer the quality.

3. Prevalent harvesting practices:

Gatherers climb the tree and collect the unripe fruits with the help of sickle tied on a bamboo stick.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant/tree for harvesting

- The trees should be divided among the gatherers for collection of fruits
- Fruits should be collected only when it is matured
- For extraction of bark, middle aged to matured trees corresponding to GBH of 80 cm and above should be selected.

(ii) Characteristics of plant parts to be harvested (fruit colour, weight, fiber and pulp)

Fruits are deep green in color initially but gradually fade with the advancement of maturity and become yellowish on ripening. Harvesting at this stage is recommended.

The tree should be debarked only when it shows flaking. The color of the bark should be deep whitish brown for peeling.

(iii) Methods to be used for harvesting

The fruits on maturity start falling on the ground and must be collected. These are also collected by shaking the tree or collecting the fruits with the help of stick with a net attached to it. The fruits are harvested with a portion of the fruiting stalk as it makes handling of fruits easier. Also the stalk serves as a signal of ripening as it gets easily detachable only in ripe fruits.

The bark should be peeled with the help of a sharp knife in such a way that it does not injure the woody mass below. The tree should then be given rest till it heals. The next strip should be on the other side of the tree. The stripping should be done once in three years in one go in about 20 cm width.

(iv) Time and age of harvesting

The fruits of *Aegle marmelos* mature and set fruits after 5 years during the months of March- April. Therefore, fruits should only be harvested during these months and not before that when they are immature.

(v) Extent of harvesting

- Only 60–75% of the fruits should be harvested and the remaining should be left out for birds to help in dispersal of seeds.
- One incision of 20 cm width should be made covering half the girth of the tree. Second incision should be made covering the other half the next year. The tree should be given rest for a period of 2-3 years till it completely heals up.



(vi) Packaging for transportation

- The dried pulp should be packed in gunny bags for proper aeration.



(vii) Transport method and time (night, early morning)

The fruit being covered by hard shell can be transported any time as required.

(viii) Post harvest Method

The collected raw, half ripe and ripe fruits are first separated.

a. Processing of ripe fruits

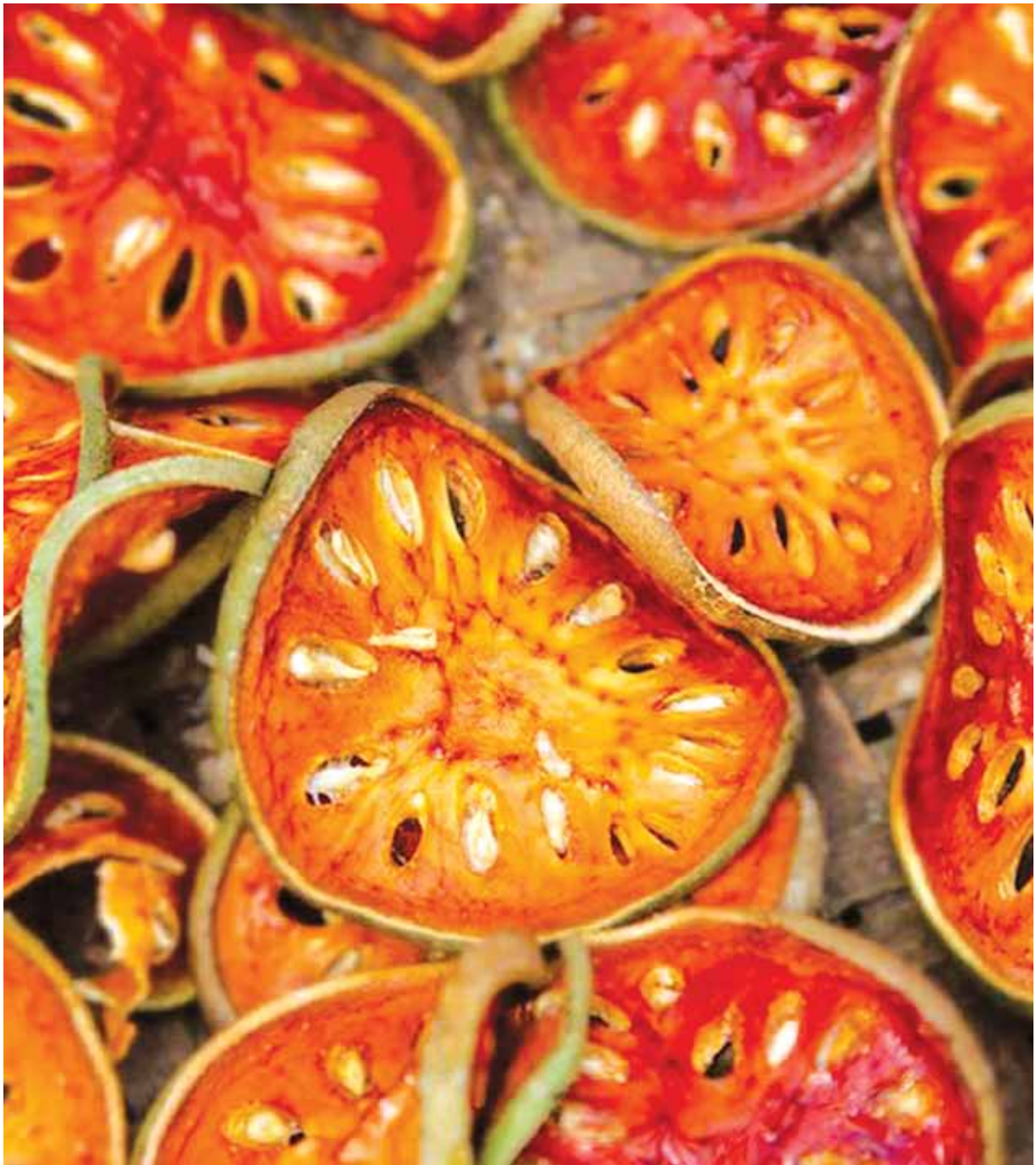
The fruits which are totally ripened are spread on a clean cloth or polythene sheet and dried in sun for 3-4 days. The epicarp of the fruits then gets separated from the pulp or gets cracked. The cracked epicarp on slight hammering gets separated from the pulp. The pulp is cut into four pieces and the seeds and white fibres in the pulp are removed. After 4-5 days of drying the sides of the pulp is changed for proper drying of both sides. After 15- 25 days the pulp gets completely dried.

b. Processing of unripe and half ripe fruits

The raw fruits and those which are half ripened are first boiled and then immersed in cold water repetitively. It is kept in boiled water for 5- 10 minutes. The fruits are then spread on a clean cloth and dried for 5- 6 hrs so that the epicarp cracks and gets separated from the pulp after slight hammering. After drying for 2-3days, the pulp is cut into 4 pieces. After 15- 20 days of drying the pulp gets completely dried and becomes light yellow to brown in color.

c. Storage

The completely dried pulp is then packed in gunny bags or cartons for proper aeration and stored in a dry place. The room temperature of the storage room should be 15- 25°C and not more than 8-10% moisture level.



The temperature and moisture of the storage room should be checked time to time. The pulp of light brown color is considered to be of good quality.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

- Only the healthy ones should be collected and the raw and damaged ones should be discarded for birds and for regeneration.

6. Ensuring natural regeneration of species

- Trees should be marked as seed bearer
- Natural seedling to be adopted and tended



- Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions

7. Processing possibilities:-

Bael being an indigenous fruit occupies an important place from medicinal point of views. Its nutritional and medicinal properties make this fruit one of the most valuable and a good source of nutrients and qualities to cure diarrhea, dysentery and other stomach ailments. This fruits have unlimited potential in its processed form. Bael can be processed to prepare jam, squash, nectar, toffee, slab, powder, ready-to serve (RTS), wine, etc.

➤ Value addition:-



- a) Bael Juice:- Bael juice is one such refreshing drink and also one of the oldest traditional drinks in India, which has Ayurvedic importance. It is a wonderful detox drink that cools us down, rejuvenates, cleanses, and nourishes the body with all the nutrients.



- b) Bael candy:- Bel has digestive and carminative properties which help to strengthen the digestive system and regulates bowel movement. It consists of carbohydrates, fats, protein, vitamin C and minerals like iron, phosphorus, carotene and thiamin. Bel cleanses the liver and strengthens liver functions.



- c) Bael Jam:- Bael Murabba - Indian Bael Jam 1Kg. Bael fruit is mildly astringent and used to cure dysentery, diarrhoea, hepatitis, tuberculosis, dyspepsia and good for heart and brain. The Bael fruit is one of the most nutritious fruits, rich in riboflavin.

➤ **Storage of Value Added Product:**

The storage life of the fruit will depend upon the stage of harvesting. Bael fruit can be stored for 10- 15 days at normal temperature, whereas fruit harvested at ripe stage can be stored for a week. The storage life of bael fruit could be increased from 2 weeks at 30 degree Celsius to 12 weeks at 9 degree Celsius and 85-90% relative humidity (Roy and Singh, 1979). The ripe bael fruit could be made available 2-3 months prior to schedule with the treatment ethrel (1000-1500ppm) and storing the fruits at 30 degree Celsius after harvesting in January. It takes 18-24 days for the fruit to be artificially ripened. Bael juice and jam is generally stored in plastic bottles and air tight glass jars respectively.

➤ **Utilization of processing waste of Bael:-**

Bael shell has very little use in present. Since this is important medicinal plant these sales could be dried and pulverized at waste material for making “Hawan Material”.

This material could be added with other similar leftover from the processing of other medicinal plants. For example in Sheopur Forest Division the Karhal, Vijaypur and Gouras are known to be center for processing of large number of medicinal plants. During the process they generate leftover which in this case may be termed, although wrongly as waste material but they are very precious for making Hawan material. They will clean the environment from pollutants.



4.1.2. *Buchnanian lanchan* (Achar)



1. Botanical characteristics: It is common in our forests mostly in eroded ravine lands. It avoids waterlogged areas, but occurs locally in clay soils. It is identified by dark grey crocodile bark with red blaze. It is a medium size tree, up to 40-50 ft. height with a straight trunk. A good species for afforesting bare hill slopes. It has poor coppicing capacity and produces root suckers sparingly. Flowers appear in pyramidal panicles of greenish while flowers in January - March. Fruits ripen from April to May and remain on the tree for quite a long time, drupe, globose (0.8 to 1.3 cms dia.), black when ripe. Stones hard, 2-valved; seeds biconvex, oily; the fruits and kernels are edible. Fruits can be collected from the tree in April-May and depulped to get the clean seed; the viability period is one year when stored in sealed tins.

- **Common Name:** Achar, Chironjee
- **Distribution:** The tree is natural wild growth in the tropical deciduous forests of Northern, Western and Central India, mostly in the States of Chhattisgarh, Jharkhand, Madhya Pradesh and in Varanasi and Mirzapur districts and Bundelkhand region of Uttar Pradesh.
- **Useful plant parts:** Kernel
- **Active Constituent:**
- **Propagation:** Seed
- **Regeneration:** Poor

Chironji is a vulnerable medicinal plant, is included in the Red Data Book published by International Union for Conservation of Nature and Natural Resources.

2. Importance:-

Chironji is a source of income for tribal people of Madhya Pradesh and other states. It is backbone of their economy. It is a multipurpose tree and very important plant for rural and tribal economy. It is used as a fuel, fodder, alternative host for Kusmi lac insect, and also used in cosmetic items and soaps. Seeds/ kernel are



nutritional, palatable and used as a substitute of almonds in confectionery. It is widely used by Indian tribes for treating various diseases.

Chironji a substitute of Almond plays a significant role in the rural livelihood of the District. One family collects about 50 kg Achar Guthli (seeds) in one season; out of this 20% is consumed and rest is sold. The villagers sell the Guthli, and the Chironji is extracted by breaking the Guthli; one kg of Guthli yields 200 gm Chironji. One tree yields about 20 kg Guthli, to the maximum of 50 kg in good season. The rates of Guthli per kg are Rs 25/- in May, Rs 50/- in rainy season, and Rs 70/- in October. The total collection of Guthli in the district is around 3000 quintals. Chironji is sold at the rate of 250/- per kg; 80% Chironji goes outside the district. Total contribution of the species to the rural livelihood of the district is to the extent of Rs 80 lakh per year.

3. Method of propagation: Seeds

4. Prevalent harvesting practices:

Unripe fruits are collected from the forests. The gatherers hack the branches or climb the tree and beat its branches with the help of a stick for the collection of fruits. This practice weakens the tree which ultimately results into its death.

5. Sustainable harvesting practices/ protocols

(i) Selection of tree for harvesting

Tree should be selected from the area where they are more in number. Fruits should not be collected from stands where only one tree exists.

(ii) Characteristics of plant parts to be harvested (bark colour)

The fruits of Achar turn red to light black on maturity should be harvested when they ripe and become black in colour.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

Before the collection of fruits the ground surrounding the tree should be cleaned. Gatherers should be assigned certain number of trees and they could be trained to collect black ripe fruits which are edible. The fruits, on ripening start falling on the ground. The fallen fruits are collected. The fruits can also be plucked with the help of stick.

(iv) Time and age of harvesting (period- season/ month)

The tree matures and sets fruit after 12 years. The fruits mature during the months of April- May and therefore should be harvested only during that period and not before that.

(v) Extent of harvesting- (quantity/ amount)

25% of the fruits should be left out to allow for natural regeneration.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

Gunny bags should be used for the transportation of the seeds.

(vii) Transport method and time (night, early morning)

Early morning is the best time for transportation of achar seeds to prevent drying from direct sunlight during transportation.

(viii) Post Harvest Methods

Primary processing of Achar includes cleaning, drying, grading and storage. The fruits of guthli are either broken ripe (when blackish) or unripe (when greenish). When broken in ripe form, it is dipped in water overnight and then



rubbed to remove the fruit pulp, washed and dried in sun. This guthli is called Dhulma and if it is in greenish form it is called kutma. In some areas, which are drier parts, seeds are dried with chilka (ie. Without the removal of fruit covering) and such guthli is called Pandi. Grading is done by immersing nuts in water. Good quality nuts sink to the bottom. Dhulma guthli fetches high price as compared to Kutma.

(ix) Storage- Storage of chironji is a problem as it tends to become rancid on storing. This is one of the prime reason for the rise in trade in guthli form and discarding of chironji produced from hard driven chakki. Chronji can best be stored without removal of its shell. It is best to store seeds in bags, in a dry place, in absence of moisture otherwise the seeds become black and become infected by fungus. Such seeds fail to fetch a good price. Chironji loses its palatability and deteriorates in quality of not properly stored.

(x) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Seeds should be stored in absence of moisture to maintain its quality.

5. Ensuring natural regeneration of species

- (i) For ensuring natural regeneration of species fruits on the top canopy should not be disturbed. Fruits fallen on the ground and damaged should also be left out for the birds which would also help in dispersal of seeds.
- (ii) Natural seedling to be adopted and tended
- (iii) Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions.

6. Processing possibilities

Although the kernel has more economic value, the fruits of chironji have potential to be processed into several value added products.

Value addition in chironji:-

Chironji Oil:- Chironji kernel contains about 52% oil (Kumar et al., 2012). The kernel is used for extraction of chironji oil. This extracted oil is used mostly in cosmetic manufacturing and substitute for olive and almond oils (Siddiqui et al., 2014). Sometimes this oil is also used by native people as edible oil.





4.1.3. *Emblica officinalis* (Aonla)



1. Botanical characteristics: A deciduous tree of small to medium size up to 8- 18 m meters in height with crooked trunk and spreading branches. Leaves simple, sub sessile; flower greenish yellow. Fruits nearly spherical pale yellow with 6 vertical furrows. Fruits are fleshy, about 2.24 cm in diameter and weigh about 5.68 grams. The stone of the fruit is six ribbed, splitting into three segments. Each contains usually two seeds: seeds 4–5 mm long, 2–3 mm wide. Each weighs about 572 mg.

- **Common Name:-** Amla, Aonla, Indian Goosberry

- **Distribution:-** It is found along hill slopes, on exposed slopes in dry deciduous forests above 800-1500m. Indian subcontinent, South and Southeast Asia. In India, it is found in Madhya Pradesh, Andaman & Nicobar Island, Assam, Manipur, Odisha, Rajasthan, Tamil Nadu, and Uttar Pradesh.

- **Useful plant parts:** Fruits

Active Constituent: Vitamin C

- **Method of Propagation:** Seeds

2. **Importance's:-** Amla is one of the most celebrated herbs in the Indian traditional medicine system, Ayurveda. It is traditionally used as a laxative, eye wash, appetite stimulant, restorative tonic, and to treat anorexia, indigestion, diarrhea, anemia, and jaundice. Aonla is used in the indigenous medicines (Aurvedic system) viz. trifla and chavanprash. Amla is becoming increasingly well known for its unusually high levels of Vitamin C which is resistant to storage and heat damage due to cooking. Fruits are commonly used for preserve (murabbas), pickles, candy, jelly and jam. Besides fruits, leaves, bark and even seeds are being used for various purposes.

5. Prevalent harvesting practices:

The gatherers lop the branches of the tree for the collection of fruits. Even the unripe fruits are harvested.



Sometimes the entire tree is cut for the collection of fruits.

6. Sustainable harvesting practices/ protocols

(i) Selection of plant/ tree for harvesting

- Since greater number of trees are available specific area should be assigned to each gatherers for collection of fruits.
- The selected matured trees should be marked in red.
- Certain areas should be marked for seed production only and should be fenced.
- Since de-pulping requires hard water boiling after which the seeds are damaged, the Seed Production Area (SPA) should be sufficient enough to produce adequate quantity of seeds not only for that area but for other areas as well.

(ii) Characteristics of plant parts to be harvested (fruit colour, weight, fiber and pulp)

The fruits on maturity become dull green in color. The diameters of matured fruits are 1.5 to 2.5 cm. It should be clean without any spot. Matured fruits are fleshy, about 2.24 cm in diameter and weigh about 5.68 grams.

(iii) Methods to be used for harvesting

- The trees or its branches should not be disturbed while harvesting fruits.
- Fruit should be collected by the help of bamboo with hook and net.
- The ground should be leaped with cow dung and mud or covered with gunny bags or black polythene sheets for easy citation of fallen fruits and also to avoid dust on the fruits.
- The fruits fallen on the covered ground should be collected.
- Ripe fruits on trees should be plucked with the help of sickle tied on a bamboo with a bag attached to it.
- The fruits after harvesting should be graded according to their sizes.

(iv) Time and age of harvesting

Emblica officinalis trees set fruits after four years and the fruits mature during the months of December- January. Therefore, fruits should only be harvested during these months and not before that. In order to comply with this, the collection period in each area should be notified rangewise or divisionwise as the case may be.

(v) Extent of harvesting

Only 60 – 75% of the fruits should be harvested and the remaining should be left out for birds to help in dispersal of seeds. In order to ensure this, the fruits on the uppermost branches should be left intact. 10- 15 fruits from each tree should be left out.

(vi) Packaging for transportation

The fruits should be packed in gunny bags or poly bags for proper aeration.

(vii) Transport method and time (night, early morning)

Transportation should be done in the evening or early morning to avoid moisture losses from the fruits.

(viii) Post Harvest methods

Fruits of Aonla are highly perishable in nature as the length of time between harvest and consumption is limited to a few days. Cold storage facilities are not generally available at the collection centers. The fruits must be stored in Zero Energy Cool chamber to enhance the shelf life of fruits by lowering down the temperature and maintaining high humidity inside the chamber.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Only the healthy ones should be collected and the raw ones should be left on trees. The damaged fruits should be discarded for birds and natural regeneration.

5. Regeneration status- Very Poor (Due to over-harvesting of this species density) Ensuring natural regeneration of species



1. Trees should be marked as seed bearer.
2. 10- 15 fruits from each tree should be left out.
3. Natural seedling to be adopted and tended.
4. Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions.

6. Processing possibilities

Aonla is used in the indigenous medicines (Aurvedic system) viz. trifla and chavanprash. Fruits are commonly used for preserve (murabbas), pickles, candy, jelly and jam. Besides fruits, leaves, bark and even seeds are being used for various purposes. Domestic consumers provide major market to Aonla.

Value addition:-

- **Amla Jam:** - Jam is a concentrated fruit product processing a fairly heavy body rich in natural fruit flavour. Pectin in fruit gives it a good set and high concentration of sugar facilitates its preservation.
- **Amla candies:-** Amla Candy is a good source of vitamin C, iron and minerals, it helps to boost immunity, regulates metabolism, helps in hyperacidity, eye ailments, skin diseases, anemia and blood-related disorders. Helps to improve the immune system of the body.
- **Amla juice:-** Amla juice is a great source of vitamin C, which is a water-soluble vitamin that acts as an antioxidant that may boost immune function.
- **Aonla Murraba:-** Aonla preserve is an extremely popular traditional product. It has the beneficial effect of purifying blood and also helps in reducing the cholesterol level and improving eyesight
- **Aonla dietary fibre enriched biscuits:-** Biscuits are amongst the lowest cost processed foods in the country. The fibre enriched biscuits may be helpful in curing the constipation and other ailments related to fast food habits. Moreover, it would also help in gainful utilization of aonla processing waste.





4.1.4. *Embelia ribes* (Vaividang)



1. Botanical characteristics: This climbing shrub, with brownish gray roots and hairy reddish rootlets. The stem is whitish gray, studded with lenticels, with a mature girth of 45-72 cms. Leaves are coriaceous, elliptic, lanceolate 6-14 cm long and 2-4 cms broad, alternating, acuminate entire, perfectly glabrous and petiole 1.0 cm - 0.8 cm margined. Midrib prominent, inflorescence panicles 15-60 cms in length, upper panicles often 7.5-10 cm pubescent. Flowers pentamerous, minute, white or yellow. Fruit- a berry, 2.4-4 mm obovate to subglobular tipped with style, smooth, succulent, in dry condition with wrinkles with loss of calyx.

- **Distribution:** *Embelia* grows in semi-evergreen and deciduous forests at an altitude of 1,500m found in central and lower Himalayas, Arunachal Pradesh, Assam, Bengal, Orissa, Andhra Pradesh and Madhya Pradesh throughout India.

- **Useful plant parts:** Fruits

Active constituent: Embelin

- **Method of propagation:** Propagation takes place by seeds. But the germination takes a long time, commencement being around 65 days after sowing. Therefore vegetative propagation is done by layering and rooting of stem cutting. Propagation by stem cutting is found to be reliable.

2. Importance: The fruits, leaves and roots are used to cure various diseases Embelin reported as aqueous extract of the fruits showed antibacterial and anti-fertility activities. It has the anti-bacterial and anti-protozoal properties. Also in abdominal disorders, lung diseases, constipation, indigestion, fungus infections, mouth ulcer, sore throat, pneumonia, heart disease and obesity, anti-fertility, analgesic, anti-inflammatory, antioxidant

3. Prevalent harvesting practices:

The branches containing the fruits are lopped and the fruits are collected in shed.



4. Sustainable harvesting practices/ protocols

(i) *Selection of plant for harvesting*

The shrub selected for harvesting should be of 1-2 m in height and should be free of diseases.

(ii) **Characteristics of plant parts to be harvested**

The fruits on maturity become red in colour.

(iii) **Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)**

Fruits should be plucked by hand and collected in a clean bamboo basket.

(iv) **Time and age of harvesting (period- season/ month)**

Harvesting should be done in the month of November and December when the plant has become 2 years old.

(v) **Extent of harvesting- (quantity/ amount)**

10% fruits should be left for regeneration.

(vi) **Packaging for transportation (Gunny bags, canisters, cartons)**

The fruits of *Embelia ribes* are packed in bamboo basket for transportation.

(vii) **Transport method and time (night, early morning)**

It is preferable to transport the fruits of this species in early morning or at night to avoid exposure from direct heat of the sun.

(viii) **Post Harvest Methods**

Winnowing should be done for removing impurities. Fruits should be dried in direct sunlight for 2-3 days. Fruits should be stored in neat and clean plastic bags to prevent moisture.

(ix) **Ways to avoid loss/ wastage (spread on the floor, overlapping)**

While collecting the fruits of *Embelia ribes*, care should be taken not to mix with other species to maintain its quality.

5. Regeneration status: It is considered to be vulnerable due to excessive harvesting.

Ensuring natural regeneration of species

- (i) Seed bearing plants should be marked.
- (ii) Young plants below 2 years of age should not be harvested.
- (iii) Natural seedling to be adopted and tended.
- (iv) Monitoring and Evaluation.

6. Processing Possibilities:-

Powder: - *Vividang* powder is used for suffers of piles and other ano-rectal disorders. It is also beneficial in managing obesity and benign tumors. It is also widely used against intestinal worm infestation.



FALSE BLACK PEPPER



4.1.5 *Terminalia bellerica* (Baheda)



1. Botanical characteristics: A handsome tree with characteristic bark, attaining a height upto 40 cm. found in deciduous forests throughout the greater part of India but not in the arid regions. Stems straight, frequently buttressed when large, leaves broadly elliptical, clustered towards the end of branches, flowers in solitary, simple, axillary spikes; fruits globular, obscurely 5 angled and ripen during November- February.

- **Common name:** Bahera, Baheda, Bibhitaka, Aksha, Balela, Jaha, sagona, Beda, Tandi, Tani, Barro, Basal, Kalamai, Tadi.
- **Distribution:** It is large deciduous tree native to India. It is commonly found in plains and lower hills of Southeast Asia. In India, it is abundantly found in Madhya Pradesh, Chattisgarh, Uttar Pradesh and Maharashtra.
- **Useful plant parts-** Fruits **Active constituent:**
- **Method of Propagation:** Seeds

2. Importance- The fruit can be directly applied in a diverse range of conditions including throat and eye diseases, anti-HIV-1, and be used to cleanse the blood. baheda seed oil needs to be extracted and fruit needs to be converted into a paste so as to be utilized for application on swollen body parts. Fruit pieces need to be baked for consumption. Baheda fruit is powdered for it to be used as dressing for wounds and to arrest bleeding. The kernels can be put through the method of decoction (extraction by heating or boiling) and be readily consumed for boosting immunity and excessive thirst.



3. Prevalent harvesting practices

The gatherers either climbing on tree and shake its branches or lop the branches for collection of fruits. Sometimes even the entire tree is felled to ease collection of fruits.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant/ tree for harvesting

- The trees should be divided among the gatherers for collection of fruits.
- The matured trees should be marked in red to be harvested for the collection of fruits.

(ii) Characteristics of plant parts to be harvested (fruit colour, weight, fibre and pulp)

The fruit has five lengthwise ridges and is drupe-like in shape. The nut type fruits are picked while they are still unripe and green but mature. The seed of Harra (haritaki) fruit is oval in shape and abrasive in nature. It is covered by a firm and fleshy pulp.

(iii) Methods to be used for harvesting

The trees or its branches should not be disturbed while harvesting fruits. The area should be leaped with cow dung and mud or covered with gunny bags or black polythene sheets for easy citation of fallen fruits and also to avoid dust on the fruits. Only the fruits fallen on the covered ground should be collected.



(iv) Time and age of harvesting

The fruits of *Terminalia bellerica* mature during the months of November- February. Therefore, fruits should only be harvested during these months. In order to comply with this the time of harvesting should be notified range wise or division wise as the case may be.

(v) Extent of harvesting

Only 60 – 75% of the fruits should be harvested and the remaining should be left out for birds to help in dispersal of seeds and regeneration. In order to fulfill this criterion the fruits in the top most branches should be left undisturbed.

(vi) Packaging for transportation

The fruits should be packed in gunny bags for proper aeration.

(vii) Transport method and time (night, early morning)

Transportation should be done in the evening or early morning to avoid moisture losses from the fruits.

(viii) Post Harvest Method

The collected fruits are spread on the floor on a clean cloth and sundried for 10- 15 days. The outer cover is removed with the help of baton and is again dried for 4-5 days. It is then packed in gunny bags and stored in a raised platform with 10% moisture content and 25 0 temperatures.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Only the healthy ones should be collected and the raw and damaged ones should be discarded for regeneration and birds.

5. Ensuring natural regeneration of species

- Seed bearing trees should be marked.
- Young ones (below 50 cm girth) should not be harvested.
- Natural seedling to be adopted and tended.
- Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions.

6. Processing possibilities:-

A fruit of *Terminalia bellirica* (Baheda) is widely used in Ayurvedic formulations such as Triphala churna, Pathyadi churna, Phalatrikadi Kwatha churna, Avipattikara churna, and many more. Till now, more than 151 phytochemicals have been isolated from the fruit. The presences of diversified phytochemicals make the fruit a highly potent phytomedicines.





4.1.6 *Terminalia chebula* (Harra)



Ecological Status: *Terminalia chebula* 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. At the same time, it is known to promote tissue growth and health.

1. Botanical characteristics: Harra is a medium to large sized deciduous tree with a short clean trunk and a long expanding crown. The bark is dark brown, longitudinally fissured. The leaves are dark green, nearly opposite, shortly petioled, ovate oblong, obtuse or cordate at the base, when young clothed with glossy, silky hairs. The spikes are terminal. The flowers are small, white in colour. The fruit is a drupe and is oval, glabrous, irregularly and darkly grooved with five edges. Leaf fall occur in February- March and flowering in March- May along with new flushes.

- **Common name:** Harar, Harra, Hirda, Myrobalan and Haritaki

- **Distribution:** *Terminalia chebula* is found throughout South and Southeast Asia. In India, it is found in mostly in all states. Its habitat includes dry slopes up to 900 m in elevation.

- **Useful plant parts:** Fruits

Active constituent: chebulinic acid

- **Method of Propagation:** Seeds

2. Economic Importance:

The fruit also provides material for tanning leather and dyeing cloth. *Terminalia chebula* is a main ingredient in the Ayurvedic formulation Triphala which is used for kidney and liver dysfunctions. The dried fruit is also used in Ayurveda as a purported antitussive, cardiotoxic, homeostatic, diuretic, and laxative. There are various companies that use harar for making their various products like Himalaya, Dabur, Organic India, Kapiva, Baidyanath, etc. It is also grown as a shade tree also for cabinet work, furniture and interior fitting. This plant is also used as fodder. In some states of India and some countries from gulf like Arabic, Afghanistan and Pakistan, fruit jam is used as food



supplement.

3. Prevalent harvesting practices: The fruit bearing branches of the tree are lopped and fruits are collected from the lopped branches.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant/ tree for harvesting

- Tree selected for collection should be of 20-25 m in height.
- Tree must be free from any disease or infection.
- The tree should not have harmful climber.
- The trees should be divided among the gatherers for collection of fruits.
- The matured trees should be marked with red paint.

(ii) Characteristics of plant parts to be harvested (fruit colour, weight, fibre and pulp)

Fruits should be of 3 – 5 cm in length. Matured fruits are hard and have a pale yellow colour.

(iii) Methods to be used for harvesting

- The trees or its branches should not be disturbed while harvesting fruits.
- The fruits on maturity start falling on the ground and must be collected.
- Fruit should be collected by bamboo stick making fruits to fall on the ground.

(iv) Time of harvesting

- The fruits of *Terminalia chebula* mature during the months of November- March. Therefore, fruits should only be harvested during these months and not before that.
- Collection should be done in early morning and evening.
- The time of collection should be notified rangewise or divisionwise to the collectors.

(v) Extent of harvesting

- Only 60–75% of the fruits should be harvested and the remaining should be left out for birds to help in dispersal of seeds. 50-100 fruits on every tree should be left out.
- Good quality fruits should only be collected and the damaged ones should be left out.
- Fruits on the uppermost branches should be left undisturbed.

(v) Packaging for transportation

- The fruits should be packed in gunny bags for proper aeration.

(vi) Transport method and time (night, early morning)

- Transportation should be done in the evening or early morning to avoid moisture losses from the fruits.

(vii) Post Harvest Methods

Fruits are spread on a clean cloth and dried in shade. After drying for 30- 40 days the fruits dry completely. The fruit are then graded based on the physical characteristics. When the fruits have completely dried it is then crushed in roller crusher to separate the seeds. The fruits can be stored in gunny bags for one year but fresh seeds germinate quicker.

(viii) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Only the healthy fruits should be collected and the raw and damaged ones should be discarded for birds and natural regeneration.



5 .Regeneration status: Poor (excessive harvest)

Ensuring natural regeneration of species

- i. Trees should be marked seed bearer.
- ii. Young ones (below 40 cm girth) should not be harvested.
- iii. Natural seedling to be adopted and tended.
- iv. Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions.

7. Processing possibilities:

T. chebula has been also employed as co-ingredient in Ayurvedic formula named 'Triphala'. In Indian system of medicine (ISM) it is widely mentioned as Rasayana drug. Tree plants, such as *Embllica officinalis*, *T. chebula*, *T. bellerica* are used in preparation of triphala and utilized in ratio of 1:1:1, according to Ayurvedic Formulations of India (AFI). This formulation is useful as detoxifying agent of colon, purgative in chronic constipation, to help in digestion and as a body rejuvenator.

The plant has been proved to exhibit many medicinal and pharmacological activities, for instance anti-diabetic, antimicrobial, antioxidant, anti-mutagenic, anti-proliferative, anti-inflammatory, cardio-protective and wound healing. In present review, recent advances in medicinal properties of *T. chebula* are discussed.





4.1.7 *Madhuca longifolia* (Mahua)



One of the few trees that may not need deliberate conservation efforts due to its assimilation in cultural identity. In the tribal belt the center of the village is usually adorned with a huge Mahua tree, beneath which all the village meetings are held. Regeneration is plentiful. The tree is rarely cut due to its economic importance and religious taboos threatening wrath of the spirits upon cutting the trees.

1. Botanical characteristics:

Mahua is one of the most important trees of Central India. The Mahua trees have large spreading root system, though many of them are superficial. Wood is hard to very hard with large sapwood. Hardwood is reddish brown in color. It is large and deciduous trees with a short Bole and rounded crown. *Madhuca longifolia* is a deciduous tree with a large, spreading, rounded crown that can grow 16 meters or more tall. The short bole can be 80cm in diameter.

- **Common Name:** Mahua, mahwa, mohwa, mohwra, honey tree, butter tree.

- **Distribution:** Mahua is a large deciduous tree growing widely under dry tropical and sub tropical climatic conditions. *Madhuca Longifolia* distributed in Andhra Pradesh, Gujarat, Madhya Pradesh, Odisha, Chhatisgadh, Jharkhand, Bihar, and Uttar Pradesh.

- **Propagation:** Seed

- **Useful Part:** Flower and seed

Active constituent:

2. Importance: A multipurpose tree that is very important to the local economy, supplying a range of foods, medicines and other commodities. Mahua has a special status among NTFPs as it is linked to the tribal livelihood systems in different ways. Mahua flowers and seeds, which have medicinal and nutritional properties, are collected and dried. It is also an important source of seasonal income. Its flowers are used to brew country liquor which is very popular in the tribal areas of the country.



Traditional Medicine Importance:-

1. The flowers are used as tonic, analgesic and diuretic, traditionally used as cooling agent, tonic, aphrodisiac, astringent, demulcent and for the treatment of helminths, acute and chronic tonsillitis, pharyngitis as well as bronchitis.
2. The bark is used for rheumatism, chronic bronchitis, diabetes mellitus, decoction for rheumatism, bleeding and spongy gums. It is a good remedy for itch, swelling, fractures and snake-bite poisoning, internally employed in diabetes mellitus, fruits are astringent and largely employed as a lotion in chronic ulcer, in acute and chronic tonsillitis and pharyngitis.
3. Madhuca longifolia leaves are expectorant and also used for chronic bronchitis, Cushing's disease, verminosis, gastropathy, dipsia, bronchitis, consumption, dermatopathy, rheumatism, cephalgia and hemorrhoids.
4. The seeds fat has emulscent property, used in skin disease, rheumatism, headache, laxative, piles and sometimes as galactagogue.

3. Prevalent Harvesting Practices:

Traditional/Common Practice- Mahua flowers are hand-picked from the forest floor, which is sometimes bushy and inaccessible. Therefore, for the convenience of collection, the forest floors are set on fire so that the floor becomes charred and the white flowers are clearly visible. But if the fire is not controlled it can become a forest fire which destroys much biodiversity.

Post Harvest Treatment- Due to lack of knowledge of proper techniques, the collectors resort to traditional methods and do not grade flowers based on quality parameters. Also drying is done under unhygienic conditions and the flowers are often not thoroughly dried, which results in accumulation of moisture such that the quality of the whole collection deteriorates and collectors don't get remunerative price.

Storage: Almost 30% of all the Mahua collected is spoiled due to lack of proper storage facilities.



4. Sustainable harvesting practices/ protocols

(i) Selection of plant for harvesting

The tree matures and starts bearing 8 to 15 years, and fruits up to 60 years. Mahua is found abundant in forest of Central India. Tree should be equally divide among collectors.

(ii) Methods to be used for harvesting

The fresh flowers fall on the ground early in the morning and are picked up with hands by primary collectors. At times, a long bamboo stick with an anchoring arrangement is used to pluck the flowers from the tree by shaking the branches (Bakhara et al., 2016). The floor below tree has grass and fallen leaves that needs to be cleared off before collection. Generally, people put fire to clean floor below the tree (Chandel et al., 2018). A lot of time is spent on the collection of flowers because Mahua flowers are collected manually one by one from the ground The fresh flowers fall on the ground early in the morning and are picked up with hands by primary collectors. At times, a long bamboo stick with an anchoring arrangement is used to pluck the flowers from the tree by shaking the branches (Bakhara et al., 2016). The floor below tree has grass and fallen leaves that needs to be cleared off before collection. Generally, people put fire to clean floor below the tree (Chandel et al., 2018). A lot of time is spent on the collection of flowers because Mahua flowers are collected manually one by one from the ground Using net with the help of poles under the tree is a best practice for collecting mahua flower. Its protect from dust and foreign materials.



Install the nets under the tree on a platform to collect the falling flowers. As this flowering period is of 10-20 days, the installed nets can catch the falling flowers and villagers can later collect these from the net instead of handpicking from the ground, which is undeniably less tedious. The flowers collected in nets are cleaner than those handpicked from the ground, and certainly, have more value to be used to make various food items.

(iii) Time of harvesting

Flower- The corollas fall on the ground in showers during March and April, Mahua fruits ripen in May-June when they fall from the tree.

(iv) Storage

The flowers after transportation are usually dried in sunlight (≈ 40 to 43 °C) for 5 to 7 days. The dried flowers are packed in gunny bags (Fig 3c) and stored in dark ventilated rooms (Fig 3d). Mahua has a hygroscopic tendency and gathers moisture, especially during the monsoon, when moisture percolates from earthen floors and roofs. Almost 30 % of all the mahua flowers collected from the forests are spoiled either by insects or microbes due to lack of proper storage facilities. The flowers after transportation are usually dried in sunlight (≈ 40 to 43 °C) for 5 to 7 days. The dried flowers are packed in gunny bags (Fig 3c) and stored in dark ventilated rooms (Fig 3d). Mahua has a hygroscopic tendency and gathers moisture, especially during the monsoon, when moisture percolates from earthen floors and roofs. Almost 30 % of all the mahua flowers collected from the forests are spoiled either by insects or microbes due to lack of proper storage facilities.

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(v) Packaging for transportation (Gunny bags, canisters, cartons)

After collection, the flowers are packed in baskets, bags and in gunny bags. The collected flowers are transported through bicycle and carts to their homes. As per the prevalent practice, it is transported in gunny bags and also in the bamboo baskets. Villagers sometimes use both for transportation. These flowers are either used for home consumption or sold in Market.

(vi) Transport method and time (night, early morning)

Seeds can be transported any time as per convenience.

(vii) Post harvest methods

After collection the flowers were dried in sun on ground for 3 to 4 days then dried flowers are stored in jute bags. For longer period it should be stored in tight containers.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

The quantity collected by villagers was at the rate of average 2 local baskets (about 40 kg) of fresh flower daily in a season. When these flowers are dried in sun it yields about 300 gm of dry flower per kg of fresh flower. It is also observed that only 60% flowers are collected and rest 40% go waste due to various reasons, i.e. eating by cattle's.

Solar Dryer/Tunnel: Using Solar Dryer is efficient tools for mahua flower drying, it is maintain the quality and protect from unhygienic and foreign matters.



4. Regeneration Status:- Fairly Good

Seeds germination is fairly high. The seedling can be uprooted and planted nursery, poly-bags or directly in field bunds or in plantation after attaining the height of 60cm to 1m.

In the absence of planned plantation programme the old tree are gradually losing vigor. It is necessary to nurture young ones and plant regularly in other suitable places.

Ensuring natural regeneration of species

- (i) Young plants should not be harvested.
- (ii) Natural seedling to be adopted and tended.

5. Processing Possibilities:

Mahua flowers are well known for their high reducing sugar and nutrient content. Flowers of the plant are edible. The corolla commonly called as Mahua flowers is a rich source of sugar containing appreciable amount of vitamins and minerals. The flowers are also used in preparation of distilled liquor, portable spirits, vinegar and feed for livestock.

Value addition:-

They are edible and used as a sweetener in preparation of many local dishes like halwa, kheer, puri and burfi in the mahua production belt of India.

Germination percentage is high in fresh seeds (80-100%). Seeds have no dormancy and do not need any treatment for better germination.



Mahua Jam



Mahua Laddoo



Mahua Candy



Mahua Biscuit



Mahua Oil



Mahua Cake



Mahua drink



4.1.8 *Holarrhena Pubescens* (Indrajao)



1. Botanical Characteristics:-

Indrajao is a deciduous shrub or a small tree, growing up to 3 ms high. Short stem has pale bark and several branches. Oppositely arranges, ovate, obtusely acuminate leaves are 10-20 cm long. Leaf stalks are very short. White flowers appear in corymb-like cymes, 5-15 cm across, at the end of branches. Flowers have five white petals 2-3 cm long which turn creamish yellow as they age. The flowers are beautiful with oblong petals which are rounded at the tip, and remind one of frangipani.

H. pubescens is a deciduous tree, with oblong and elliptic leaves. Flowers are white, fragrant corymbose cymes. The corolla is lobed and oblong. Fruits are slender, terete follicles, with white spots. Seeds are glabrous and linear-oblong. Its flowering season is from April–July, and fruiting is from August–October

- Common Name:

- **Distribution:** Indrajao is native to Africa, Indian Subcontinent to Indo-China. It is also found in the Himalayas up to altitudes of 1500 m.

- **Useful Part:** Seeds and Bark **Active Constituent:**

- **Method of Propagation:-** Seed

2. Importance: *Holarrhena pubescens* is an important medicinal plant of the Apocynaceae family that is widely distributed over the Indian subcontinent. The plant is extensively used in Ayurveda and other traditional medicinal systems without obvious adverse effects.

It has economic importance due to the extensive use of seeds as an anti-diabetic. It is widely used in Indian medicine for treating diseases viz. diarrhea, amoebic dysentery, liver disorders, irritable bowel syndrome, and bleeding piles. The plant is astringent and bitter in taste. It is used traditionally to treat several diseases.



5. Prevalent Harvesting Practices:

Present harvesting methods of medicinal plants from forests involve mostly destructive practices. Destructive methods of harvest include stripping of tree completely for its bark or cutting it to facilitate harvest. The medicinal plants in which bark is useful part are under more threat as the bark from the trees is extracted by making blazes in the tree trunk. The only possible way to meet this increasing demand is by harvesting the bark in such a way that it should not affect the health and growth of trees. It is therefore desirable to standardize the sustainable harvesting practices through scientific experimentation.

6. Sustainable Harvesting Practices:

Sustainable Harvesting Practices:-

Systems for sustainable bark harvesting largely depend on the response of the target species to bark stripping. The volume of bark that could be harvested under different harvest prescriptions and scenarios would largely depend on the growing stock and growth of the target species, bark characteristics (especially bark thickness), and the rate of bark re-growth after harvesting. Different forest and woodland species react differently to bark stripping, both in terms of wound closure and susceptibility to insect and fungal attack. 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.

Bark Harvesting

Three methods of bark harvesting were studied.

- Method I: Tree girth was divided into four equal parts and the bark was extracted from one part.
- Method II: Tree girth was divided into three equal parts and the bark was extracted from one part.
- Method III: Strip bark harvesting conducted by removing longitudinal alternate/opposite strip on the main trunk of the tree.

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. Good collection practices are necessary for the long term survival of wild populations and their habitats. Medicinal plant materials need to be collected in a proper season to ensure the best possible quality of both the starting material as well as the finished product. It is necessary that the harvesting practices employed should be non-destructive.

In India, the demand of *Holarrhena antidysenterica* is 1000-2000 MT annually. Excessive bark harvest affects availability of *H. antidysenterica* (Kutaj) population in the forest areas of central India. The species has decreased alarmingly due to illegal logging and unsustainable harvest of bark. Keeping the view in to consideration a study was conducted for sustainable harvesting of *H. antidysenterica* (Kutaj) bark in Tropical Forest Research Institute, Jabalpur, M. P.

7. Regeneration Status:

Importance/Medicinal uses:

It is a medicinal plant in Ayurveda. It is one of the best drugs for Diarrhoea. In chronic diarrhoea & to check blood coming from stool, it should be given with Isobgol, castor oil or Indrayav.

According to Ayurveda, the bark is useful in treatment of piles, skin diseases and biliousness. The bark is used externally in case of skin troubles. The bark is mostly mixed with cow urine and applies it in affected parts.

In treatment of urinary troubles, the bark is given with cow milk. The fresh juice of bark is considered good to check the diarrhoea. In Bleeding piles Decoction of Kutaj bark with sunthi checks mucus & blood. Application of this herb is useful in Rh. Arthritis & Oestioarthritis.



This is a valuable medicinal tree species, e.g. the bark, flowers and seeds are used by traditional healers, rural communities and pharmaceutical companies for remedies of conditions such as astringent, dietary, dysentery and gastric problems (Troup, 1986; Baul, 2006). Although propagation by seeds is possible, seeds of *H. pubescens* are not abundant and germination from seed is uncertain and time consuming, because local people harvest the entire tree or cut the large branches to address their fuel or fodder needs without regard to the ecological and medicinal values

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This is a valuable medicinal tree species e.g the bark, flower and seeds are used by traditional healers, rural communities and Pharmaceutical companies for remedies of condition such as astringent, dietary, dysentery and gastric problems. Although propagation by seed is possible, seeds of *Indrajao* are not abundant and germination from seed is uncertain and time consuming because local people harvest the entire tree or cut the large branches to address their fuel and fodders.

Holarrhena antidysenterica Linn (Family Apocynaceae) is one such plant, popularly known as “Indrajav,” distributed throughout India upto an altitude of 4,000 ft. In Indian traditional medicine, the plant has been considered a popular remedy for the treatment of dysentery, diarrhea, and intestinal worms. This tree is popular for its numerous medicinal properties and seeds and bark of this tree have been used in Ayurveda since long time. Bark of *Holarrhena antidysenterica* Linn is used in Ayurveda as an anti-microbial, anti-inflammatory and analgesics. Other useful parts used as medicine are root and leaf. The bark and the roots have been found to be an excellent remedy for both acute and chronic dysentery especially in cases where there is excessive blood with mucus and colic pain associated with stools.

8. Processing Possibilities:-

Indrayava (*Holarrhena antidysenterica* seed) has been used in bleeding piles, diarrhea, eczema, fever and colic as per Ayurveda. The folklore use of Indrayava for curing diabetes is reported as taking 10 grams of Indrayava soaked overnight in 80 ml of water and then drinking the liquid.





4.1.9. *Annona squamosa* (Sitaphal)



1. Botanical Distribution:- CUSTARD apple (*Annona squamosa*) can be called as a delicacy of dry region due to its very sweet delicate pulp. It is a deciduous or semi-deciduous tall woody shrub of about 5-6 meters height having irregularly spreading branches. The fruits are rich in carbohydrate mainly in the form of sugars (23.5%), protein (1.6%), calcium (17mg/100g), phosphorus (47mg/100g) and iron (1.5mg/100g).

The naturally-grown custard apple plants may be seen frequently in patches in the forest. Owing to its seed propagation in wild form, its adaptability has reached to the maximum in marginal areas as well as its native place. Since, there is fast genetic erosion in custard apple genotypes due to rapid deforestation, industrialization, animal grazing, uncontrolled urbanization and increasing population pressure in these areas, its collection and conservation has become most important as ex-situ conservation.

Common Name: Sugar Apple, Sitaphal, Custard apple

Distributions:- Custard apple growing regions in India include Assam, Bihar, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, and Uttar Pradesh, Andhra Pradesh, Telangana and Tamil Nadu.

Plants part: Fruit

2. Importance: Custard apples contain anti-oxidants like Vitamin C, which helps to fight free radicalism our body. It is also high in potassium and magnesium that protects our heart from cardiac disease. Not only that, it also controls our blood pressure. Custard apples contain Vitamin A, which keeps your skin and hair healthy.

3. Sustainable Harvesting: Custard apple is a seasonal fruit and should only be harvested when it reaches complete maturity. The fruit maturity is known by the change in color of the fruit from green to a different shade. Another indication of maturity in custard apples is known by the display of inner pulp. The fruit should never be picked when it is green in color because later it would develop into inferior quality. The fruits are harvested in late spring or winter (September to October) and it is estimated that a mature tree can produce 30-50 kg of fruits annually.



After the harvest, short twigs that bore flowers and fruits are shed completely.

Time of harvest: The season of harvest is from September to October.

4. Post-harvest handling: The fruits do not withstand cold storage as well as handling after ripening. Firm but mature fruits can be kept at 6 deg.cent. Temperature for about a week but such fruits lose aroma and attractiveness and also develop some sapid taste.



5. Storage: The fruits should be stored at a temperature of 15 to 20°C with a relative humidity of about 85 to 90%. The storage area should have low oxygen and ethylene tension with only 10% CO₂ to extend the shelf life of the fruits. Storing the fruits in cold storage or handling, the completely ripened fruits is not advisable because the fruits cannot withstand these practices.

6. Propagation: The annonas are commonly propagated by seed

Regeneration Status:

7. Processing Possibilities:

- **Cold Storage & Marketing:** The frozen pulp is stored in the deep freezers which are later on shifted to the rented cold room. The pulp can be kept preserved for two at the temperature of -18 degrees centigrade for 2 years.
- **Value addition:-** Custard Apple Pulp is mostly used in preparing custard apple ice cream, sitafal shake, and sitafal ice-cream in states of Rajasthan, Gujarat, and Madhya Pradesh.
- **Packaging:-** The pulp is packaged in the corrugated boxes and transported in the refrigerated vehicle or insulated boxes above the distance of 200 km to keep it frozen.





4.1.10. *Mucuna pruriens* (kaunch)



1. Botanical Characteristics

An erect, annual, 60-125 cm tall, stem robust, branching, cylindrical below, 4 angled upwards, containing a large pith, leaves broadly lanceolate, 5 nerved, sub sessile; flowers greenish yellow, in large panicles, capsules egg shaped, many sided, 6 mm in diameter, sharp pointed, seeds smooth, many angled.

The flowering occurs from July-October. *Mucuna pruriens* seeds are black in color and known as *Mucuna Beans*. The species name “pruriens” derived from Latin word, which means “ITCHING SENSATION

- **Common Name:** - *Mucuna pruriens* is commonly known as Velvet Bean, Cowhage, Kauch and Atmagupta
- **Distribution:-** It is widely found in many state of India. It is also known as “KIWACH” in hindi. This is a medicinal plant and used in traditional Ayurvedic India Medicine
- **Useful plant parts:** Whole plant
- **Method of propagation:** Seeds

2. Importance:

The legume family (Fabaceae) is the third largest among flowering plants, consisting of approximately 650 genera and 20,000 species and is the second most important plant source of human and animal nutrition.



Mucuna pruriens in natural habitat (southwest India) with pods, ripened and dried seeds.

Mucuna pruriens (Fabaceae) is an established herbal drug used for the management of male infertility, nervous disorders, and also as an aphrodisiac. It has been shown that its seeds are potentially of substantial medicinal importance.

All parts of *Mucuna* plant are reported to possess useful phytochemicals of high medicinal value of human and veterinary importance and also constitute as an important raw material in Ayurvedic and folk medicines. *Mucuna* seeds constitute as a good source of several alkaloids, antioxidants, antitumor and antibacterial compounds. Seeds are the major source of L-DOPA, which serve as a potential drug in providing symptomatic relief for Parkinson's disease.

Mucuna Pruriens has many traditional uses in numerous diseases. Seeds are used for Parkinson's disease in Ayurvedic system. It is widely used for dysentery, diarrhea, snakebite, cancer, diabetes, dysmenorrhea, delirium, gout, sterility, gonorrhea, muscular pain, rheumatic disorder, impotence, tuberculosis, cough and sexual debility. It is also used as blood purifier, diuretic, nerve tonic, uterine stimulant, emmenagogue and aphrodisiac in India. It has been used for intestinal gas, impotence, edema, Parkinson's disease and worms in Brazil. Ground and roasted seeds of *Mucuna Pruriens* have been as coffee in Central America. These seeds are also used in constipation, general debility, sterility and gonorrhea.

Leaves are useful in inflammation, cephalalgia, helminthiasis, general debility and ulcers. Roots are bitter in taste. It is diuretic, anthelmintic, emmenagogue, purgative, stimulant, emollient, thermogenic and tonic. In Ayurvedic system, it is used in neuropathy, ulcers, nephropathy, constipation, dropsy, delirium, amenorrhea, dysmenorrhea, strangury, elephantiasis and fever.

The natural regeneration of plant takes place by seeds, when the seeds become biologically mature having high potentiality of viability during November (Bhattarai, 1996). The viability of seeds is very low if seeds are collected before November.

3. Prevalent Harvesting Practices

Collection is done manually without using any instruments. Whole plant is pulled out.

4. Sustainable Harvesting Practices/Protocols

(i) Selection of plant for harvesting

Stands where the plant is scarce should be left undisturbed. Harvesting should be done from the areas where the frequency of the plant is very high. The plants should be matured and free of diseases.

(ii) Characteristics of plant parts to be harvested

The plant should be harvested when the seed is setting. The plants are collected when the capsules are fully formed for further propagation.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

The crop matures in about 140 days after sowing. Mature pods are harvested to collect seeds from the pods. At the time of harvesting the pods turn to grayish-brown in colour indicating maturity for picking. Normally 3-7 seeds are found in a pod and 5-6 pods per inflorescence are generally available. Thus, about 25-30 bunches can be harvested per plant. Normally 100 seeds weigh 90-110 gm.

(iv) Time and age of harvesting (period- season/ month)

Pods should be harvested after 140 days after sowing when the plant is well developed, after the plant has flowered and produced pods. The seeds harvested from the mature fruits are viable for more than two years, recording viability of more than 90%. The germination percentage declines after 2 to 3 years of storage.



(v) Extent of harvesting

Pods should be harvested from the stands where the frequency of the species is higher. Stands where the species is scarce should be left undisturbed. About 30% of the matured plants should be left un-harvested where the frequency is higher.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

The dried plants tied up in a slip of bamboo into flattish bundles each 1 m long and up to a kg in weight.

(v) Transport method and time (night, early morning)

(vi) Post harvest method

The whole plant should be dried in shade. Then small dried bundles of Chiraita is collected into big bundles and sold to the local traders.

(vii) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Chiraita is mostly collected from government forest, which has no control over collection. Who comes to collect first, will collect more and earns more money. Thus, there is always competition for collection and collectors collect before seed dispersal. Seeds are only the medium for the propagation of this plant, so care should be taken to collect the plants after seed dispersal to ensure future regeneration.

5. Regeneration Status:

Ensuring natural regeneration of species

- (i) Seed bearing plants should be marked.
- (ii) Young ones (below 60 cm height) should not be harvested.
- (iii) Natural seedling to be adopted and tended.

(iv) Monitoring and Evaluation- The areas where the frequency of this species is less should be marked and the gatherers should be prevented to collect Chirayita from this area. A small committee should be formed to monitor the compliance of the condition.

6. Processing Possibility

Value addition

***Mucania pruriens* powder**





4.1.11. *Celastrus paniculatus* (Malkangani)



1. Botanical Characteristics

Celastrus paniculatus is a deciduous woody liana also known as Malkangani, Jyotishmati, Black oil plant, climbing staff tree, intellect tree etc. is a large, woody climbing shrub, up to 10 m. in height, distributed almost all over India, up to an altitude of 1800 m. and also found in the middle and south Andmans. In southern Rajasthan, Calastrus paniculatus is found naturally in some forest area of Madhya Pradesh. But its density is very low.

Botanical Description:

Celastrus paniculatus is a large liana (woody climber), height up to 18m with stem diameter up to 23cm. Stem woody, bark brown and thin. Branchlets hairless, with many distinct minute white dots called lenticels; leaves simple, alternate, ovate to oblong-elliptic, about 5-15x2-8 cm; apex acute, acuminate or obtuse; base round, shortly acuminate, margin toothed with rounded teeth, hairless; lateral nerves 5-8 pairs, slender; leaf stalks about 3 cm long; flowers unisexual in terminal pyramidal panicles, about 6mm across, yellowish or greenish white, collected in terminal paniculate cymes; panicles 5-30cm long, pendulous. Capsules sub-globose, 1.0-1.5 cm in diameter, smooth, yellow when mature, transversely wrinkled, dehiscent by three valves; seeds 3-6, ellipsoid or ovoid, about 6x3 mm, yellowish brown enclosed in crimson-red aril; flowering is from November to February and fruiting is from March onward.



- **Common Name:** Malkangani, Jyotishmati
- **Distribution:** The genus is distributed in the sub-Himalayan tract from the Jhelum eastward, up to 6000 ft., the species is extensively distributed in Andhra Pradesh, Bombay, Bihar, Orissa, Madhya Pradesh, Gujarat, Western Ghats, Uttar Pradesh, Kerala, Tamil Nadu, Karnataka, Jammu Kashmir and Himachal Pradesh.

- **Useful part:-** Leaves and Seeds
- **Propagation:-** Seed

2. Importance: According to Ayurveda, leaves are emmenagogue whereas seeds are acrid, bitter, hot, appetizer, laxative, emetic, aphrodisiac, powerful brain tonic, cause burning sensation. Oil enriches blood and cures abdominal complains. According on Unani system of medicine, seeds are bitter, expectorant, brain and liver tonic, cure joint-pains, paralysis and weakness. Oil stomachic, tonic, good for cough and asthma; used in leprosy, cures headache and leucoderma.

3. Prevalent Harvesting Practices:- The villagers generally collect mixed lot of raw and ripe fruits. For the experiment only ripe fruits were collected. The seed of *Celastrus paniculatus* Linn. was used as drying material for applied treatments. This experiment was done in the months of September-October.



Collection: Mature fruits of Malkangani are collected from the forest areas in the months of November-December

4. Sustainable Harvesting and Processing: Seeds of Malkangani are separated from its fruits by removing petals manually or by rubbing lightly on the surface of jute bag/ rough surface. Seeds were washed in water to remove the outer pulpy layer on the seeds and dried in shade, sun and hot air at 40°C for 24 hrs. Time of drying was kept constant to observe the effect. Seeds dried by all methods were evaluated separately for oil content.

Malkangani is an Ayurvedic herb that is most well known for its benefits to the nervous system. Traditionally, this herb is called 'brain clearer' and is believed to be helpful in improving intelligence. Malkangani is also considered to be beneficial in the management of rheumatism, asthma, leprosy, gout and many other health conditions.

5. Regeneration: - Poor (one among the RET medicinal plants, shows poor germination under natural conditions) Naturally, *C. paniculatus* is propagated through seeds. Indiscriminate collection of this plant from the wild has posed a serious threat to its existence in the wild, especially when the plants are harvested well before seed set. Moreover, propagation either by seed or vegetative is rather difficult. However, the viability and germination



(11.5 %) of the seeds are poor. Dormancy in freshly harvested seeds of *Celastrus* spp. was primarily related to the inhibitory influence of hard seed coat.

For raising seedlings in nurseries, seeds are the important means of propagation, but it has been experienced that seed germination and speed of germination is not only erratic but also low and takes more time to complete, which results in prolong germination, irregular seedling growth etc. To enhance seed germination there is usually a back-up with hormonal treatment, such hormones includes GA3 and kinetin.

6. Processing Possibilities:-

Value addition-

Malkangni oil is used mostly for tropical application as massage oil for muscular, joint problems and for minor injuries. Mature fruits of Malkangni are collected usually in the month of October-November whereas the oil is extracted preferably during summer season. The seeds separated can be stored for about 2 years after collection. Seeds are separated from seed coat and steamed in an assembly of a metal pot with narrow opening a basket of bamboo that fits perfectly on the opening of this metal pot and a lid. The metal pot is filled with water and heated on fire. A bamboo basket containing seeds is placed and covered with lid. The seeds are steamed for about 45 min till it is properly cooked. The seeds are then taken in a cloth and squeezed/pressed hard between wooden plates. Red colored oil flows out, which can be stored for one year. From one kg of Malkangni seeds, as much as 300 gm of oil can be extracted. The cake that remains behind in the cloth is used to treat patients with paralysis. It is supposed to prevent pre-mature graying of hair.

7. **Packaging-** Oil can be packaged in attractive small bottles for better values.



4.2 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.

Thumb rules for harvesting of leaves

1. Always leave some leaves on the plant to recuperate. The proportion of leaves to be harvested should be determined and should be left so that the growth and reproduction are not negatively affected.
2. The leaves should be harvested after the seeds have been produced when possible.
3. When possible, the leaves should be harvested during the season when growth and leaf production is highest.
4. When environmental conditions are stressful for the plants leaf harvesting should be postponed or should be harvested in less quantity.
5. If the leaf size is decreasing the rate of harvest should be lowered as it indicated stressful conditions.
6. If seed production is decreasing the rate of harvest should be lowered.
7. If the plant size in a population appears to be decreasing, even if vegetative sprouting is increasing (i.e. the population is becoming dense), the rate of harvest should be lowered.
8. The rate of harvest should be decreased if there is heavy pressure from grazing, fire or other incidents that may negatively affect the plants.
9. Some plants and some areas should be left un-harvested to allow them to recuperate and to be available to other organisms that may depend on them. The harvest areas should be rotated over years.
10. Whether the leaves are short lived or long leaves should be observed. For long lived leaves, harvest should be done sparingly and the ways to increase the number of plants should be looked upon. Thick leaves often the sclerophyllous, may be indicators of long life span.
11. The conditions in which the plant grows best should be determined and the population should be managed to optimize these conditions.



4.2.1. *Gymnema sylvestris* (Gudmar)



Ecological Status: CG-VU; MP- VU

The plant is stomachic, stimulant and diuretic. The leaves of the plant when chewed, possess a remarkable property of paralyzing, for few hours, the sense of taste for sweet and bitter substance; acid taste is not affected while salt taste is very slightly affected if at all, influenced.

1. Botanical characteristics:

Gymnema sylvestris is a woody perennial climber with small yellowish flowers and simple opposite, ovate-elliptic hairy leaves. It is found in various deciduous forests of India.

G. sylvestre is a perennial, slow growing, medicinal plant with stem up to 8 meter length. Stem of *G. sylvestre* is cylindrical, light brown with small hairs. It is a large woody climber which can grow an altitude of 100-1000 m. Leaves are 2-6 cm long and 1-4 cm wide with green color, simple, usually ovate or elliptic (1.25–2.0 inch × 0.5–1.25 inch), petiolate, rounded to cordate base, margin entire, glabrous, opposite with acute apex, reticulate venation, pubescent on both the surfaces. Leaves have a characteristic odour, slightly bitter taste and astringency. Flowers are small, yellow colored and arranged in umbellate cymes inflorescence. Follicles are fusiform, lanceolate up to three inch long. Pedicels are long; Calyx-lobes are long, ovate, obtuse and pubescent. Corolla is pale yellow campanulate, valvate, corona single, with five fleshy scales.



Scales are adnate to throat of corolla tube between lobes; Anther is connective produced into a membranous tip, pollinia two, erect, carpels two, unilocular; locules many ovuled.

- **Common name:** Gurmar, Madhunasini, Merasingi
- **Distribution:** The species occurs in all tropical zones of India and is a common climbing plant in central and southern India.
- **Useful plant parts:** Leaves **Active Constituent:** Gymnemic Acid
- **Method of propagation:** *Gymnema sylvestris* is propagated through seeds as well as by stem cuttings. Seeds are reported to have short viability.

2. Importance:

Gudmar (Gurmar) powder is very beneficial for health. It is useful in the management of diabetes due to its antioxidant and anti-inflammatory properties. It helps to manage infections (generally tooth infections) by preventing the growth of bacteria because of its antimicrobial and antibiotic properties.

The herbal extract is used in dietary supplements since it reduces body weight, blood cholesterol, and triglyceride levels and holds great prospects in dietary as well as pharmacological applications.



3. Prevalent Harvesting Practices:

Normally, the collectors harvest the leaves by using a non-destructive method i.e. by cutting the whole vine and then collecting the leaves. Due to widespread prevalence of such unsustainable harvesting practice, the availability of Gudmar is decreasing day by day. The gatherers uproot the whole plant and then collect the leaves.

4. Sustainable Harvesting Practices/Protocols

(i) Selection of plant for harvesting

The leaves should be collected from plants which are mature and disease free and should be collected from the area where it is abundant.

(ii) Characteristics of plant parts to be harvested

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

The leaves should be collected by hand plucking in the months of December and January. The roots should be collected in the months of May- June by cutting the upper portion of the roots instead of uprooting the entire plant for regeneration for the left over portion of roots below the soil.

(iv) Time and age of harvesting (period- season/ month)

Leaves are usually collected during October- December and are cleaned and dried in shade. The roots are collected during summer.

(v) Extent of harvesting- (quantity/ amount)

While harvesting leaves 70% of the leaves have to be left out and while harvesting roots 80% of the roots have to be left untouched.

(vi) Packaging for transportation (Gunny bags, canisters, cartons)

The dried leaves and roots should be packed in polybags to protect from moisture.

(vii) Transport method and time (night, early morning)



The dried leaves and roots can be transported preferably at night or in the early morning.

(viii) Post harvest methods

The leaves are cleaned and dried in shade for 2 days and then collected in poly bags to protect from moisture. The roots are cleaned, washed, cut into pieces and then dried.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Only the healthy and matured ones should be harvested. Immature ones should be left untouched.

4. Regeneration Status:- Endangered species (Due to its enormous requirement in the medicine preparation, this plant has been over exploited from the nature) Ensuring natural regeneration of species.

- (i) Young plants should not be harvested.
- (ii) Natural seedling to be adopted and tended.
- (iii) Monitoring and Evaluation.

5. Processing Possibilities:-

Value Added Product:

- **Gudmar dried leaves:-** Dried leaves and extracts have been used to treat eye diseases, allergies, constipation, cough, dental caries, obesity, stomach ailments, and viral infections.
- **Gudmar powder:-** Powder used as a destroyer of glycosuria, and is believed to neutralize the excess sugar present in the body

Storage of Value Added Product: Dried leaves need to be packed in polythene bags. The moisture content of the dry leaves should be less than 8% to prevent deterioration.

Yield: About 1250 kg of dry-weight leaves can be obtained per hectare every three months.



4.3 Root/Rhizome yielding medicinal plants

Roots should be dug out with almost 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.



4.3.1 *Asparagus racemosus* (Shatavar)



Ecological Status: CG-NT; MP- NT

1. Botanical characteristics: It is an armed climbing under shrub with woody erected stems with re-curved or rarely straight spines young stems very delicate, brittle and smooth; leaves reduced to chaffy scales and spines; cladodes triquetrous curved in tufts or 2-6; flowers white, fragrant, in simple or branched racemes on the naked nodes of the main shoots or in the axil of the thorns; fruits globular or obscurely 3 lobed, pulpy berries, purplish black when ripe, seeds with hard and brittle taste. The tuberous succulent roots are 30 cm to a meter or more in length, fascicled at the stem base, smooth, tapering at both ends.

- **Common name:** Satamuli, Satavar, Abhiru.

- **Distribution:** Shatavar is common throughout the tropical and subtropical regions, particularly central India. It is also found up to an altitude of 1500 m in subtropical Himalayas. By nature, the plant is xerophytic and prefers the semi-arid to subtropical, cool environment.

- **Useful plant parts:** Tuberous roots

- **Active constituent:** Shatavarin I-IV, a polycyclic alkaloid and Asparagamine- A.



- **Method of propagation:** Rhizome

2. Importance:

Shatavari or Satmuli is a very important medicinal plant, which is used, in many (allopathically) incurable diseases in Ayurveda and also in Himalayan traditional medicine system. Traditionally this plant is used as a reproductive tonic. It is also used traditionally for treating gonorrhoea, piles, diabetes, increasing lactation, anthelmintic (pertaining to a substance capable of destroying or eliminating parasitic worms, esp. human intestinal helminthes), rheumatism, cough, diarrhoea, dysentery, gastric troubles and headache.

The tubers are anti-diarrhoeic, diuretic, nutritive, tonic, aphrodisiac, appetizer and alterative. They are also reported to increase lactation. In addition, the plant is considered slightly sweet, and is useful in the diseases of blood, kidney, liver, scalding urine, rheumatism, gleet, and gonorrhoea.

3. Prevalent harvesting practices:

- The tuberous roots are collected by uprooting the plant completely. The tubers attached to the plant including the rhizome (disc) are then cut giving them no chance to rejuvenate
- After unearthing the roots it is never paced back as a result of which the roots remain open and exposed to sunlight leading to the death of plants within few days
- The tuber collection is done throughout the year. On an average, a family collects satawar tuber for around 40 days a year whenever the stock is available. Such intensive harvesting reduces the number of plants sharply
- There is no restriction on the time of harvesting. Similarly plants of all age group are harvested which puts a question mark on the future production capacity.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant/tree for harvesting

Mature Asparagus plant, more than 3 years old, were selected for harvesting of the tuberous roots. The plant can be identified by observing the thickness (not less than 5 cm) of the climber at the collar region. Plant bearing flowers and fruits were avoided for selection in order to facilitate their multiplication phenomenon for maintaining the plant population.

(ii) Characteristics of plant parts to be harvested

For harvesting the roots of Asparagus plant, mature plant with 5 cm diameter at the collar region should be selected. Flowers and fruits bearing plant should be avoided for harvesting roots.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

Implements used for harvesting

Axe: used for cleaning the unwanted plant found around the Asparagus to create working space

Pick axe: for digging the soil covering the tuberous roots

Hoe: to remove the loose dug out soil from the plant before harvesting and to replace it again after the roots is cut.

Hand cultivator: to separate the webs of tuberous roots lying in the soil

Secateur: used for pruning of tuberous roots close to the disc (rhizome) of the plant

Harvesting Operation:

- To create working space around the climber, unwanted plants were removed by cutting them at the ground level. The area of around 1 m periphery of the plant is cleaned.
- Soil is dug out from the collar region to the climber without disturbing the disc of the plant. Length and depth of digging depended upon the spread of tuberous root. Due care must be taken to protect the roots from cutting by pick axe
- Tuberous roots of more than 15 cm in length should be selected for cutting.
- Selected roots must be cut carefully from the disc using sharp secateurs without disturbing the disc of the plant. Dead and rotten tubers must be removed from the disc to check further infection to other tubers and to maintain the fresh tuber production capacity of the climber.



- After cutting the tubers from the plant the dugout soil must be put back in place to cover the remaining tubers for facilitating further survival and continuous production of tubers for future harvesting.

(iv) Time and age of harvesting (period- season/ month)

The roots of more than 3 years of age should be harvested in March- May, before the onset of monsoon.

(v) Extent of harvesting- (quantity/ amount)

Harvesting of tubers should be limited for 80% of the total number of tubers. 20% of the tubers must be left out at the disc for further survival of the plant.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

The Asparagus roots are dried and packed in Poythene bags and then kept in gunny bags to protect from moisture.

(vii) Transport method and time (night, early morning)

It can be transported at anytime of the day through trucks if quantity is large for supplying the pharmaceutical companies. For small quantities it is transported in bullock cart.

(viii) Post Harvest Methods

The roots are peeled and dried in sun for 4-5 days. Plastic bags and sell before the onset of monsoon. The whiter it is, the more prices it will fetch. On becoming reddish it fetches low price.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

- Immature plants less than 3 years old should not be harvested
- Harvesting should be done after ripening of Asparagus fruit
- Only 80% tubers more than 15 cm long should be harvested
- Soil digging should be restricted to the spread of tuberous roots only and no extra soil must be disturbed
- Rhizome should be kept intact

6. Regeneration Status: Poor (due to over exploitation and using traditional unharvesting practices)

Ensuring natural regeneration of species

- Young ones (below 3 years old) should not be harvested
- Monitoring and Evaluation- Developing Village level Satawar Committed for monitoring the sustainable extraction of Satawar.

7. Processing possibilities:

Roots of satavari need to be cleaned, washed and dried in cabinet dryer at 50°C. Dried roots then need to be ground to fine powder in a hammer mill, packed in LDPE bags and stored at room temperature.

- Dried Roots
- Root powder



Storage of Value Added Product: Dried roots or ground root powder need to be packed in LDPE bags and stored at room temperature.



4.3.2. *Chlorophytum borivilianum* (Safed Musli)



1. Botanical characteristics:

Chlorophytum borivilianum

(family: Liliaceae) is one of the highest valued medicinal plants found in an Indian forest. Out of 200 species of

Safed musli (*Chlorophytum borivilianum*) is an eminent medicinal plant of India and considered as a 'white gold' or 'divya aushad' in Indian systems of medicine. It is one of the highest valued medicinal plants found in an Indian forest. *Chlorophytum borivilianum* (Safed Musli) is an annual herb with tubers, crown, leaf and flowers as different parts. Mainly its tuberous roots are used in ayurvedic medicines. It is a herb with sub-erect leaves and tuberous root system. It can grow upto a maximum height of 1.5 ft. Tubers can grow upto a depth of 10". Safed Musli is a tiny annual herb that grows well in tropical and sub-tropical climates with altitudes upto 1500 meters. Its seeds are black in colour and triangular in shape. Two seeds are present in single locule. The flowers are small, usually white, produced on sparse panicles up to 120 cm long; in some species the panicle also bears plantlets, which take root on touching the ground.



- **Common Name:** Safed Musli
- **Distribution:** In India, Borivilianum is distributed mainly in Southern Rajasthan, Northern Gujarat and Western Madhya Pradesh.
- **Useful plant parts:** Tuberous roots
- **Active constituents:** Glycosides, saponins, saponinins, steroids, Asparagin vitamins and carbohydrates.
- **Method of propagation:** Musli is a tuberous plant and propagates only through the root. Sexual vegetative reproduction is very rare and takes 18 months to mature.

2. Importance:- It is largely used as ethnic medicine by local healers of indigenous communities of India. Safed musli was originally grown in thick forests of India, is a promising medicinal plant with great economic potential. The appreciation of medicinal value of safed musli tubers has been made in ancient Indian medicine literature right from the 11th century AD. Traditionally, Chlorophytum borivilianum is well known for treating male impotency in India. The multi therapeutic and nutritional importance of Chlorophytum borivilianum is attributed to the rich source of phytochemicals particularly saponins. Recently, Chlorophytum borivilianum has gained a well established domestic (Indian) and international market for being the herbal alternative of “Viagra” without any side effects. Under the trade name ‘Nai Chetna’, the state government of Gujarat, India, has launched a novel potency drug from Chlorophytum borivilianum. Modern pharmacological studies of Chlorophytum borivilianum have demonstrated a wide range of pharmacological activities, most importantly aphrodisiac, immunomodulatory and anticancer activities. The plant is cultivated in different parts of India on a small scale at present. Safed musli is being promoted as a sexual enhancement herb and has historically been used as an aphrodisiac herb.

Due to high economic value, Chlorophytum borivilianum has also encountered a problem of adulteration with closely resembling medicinally inferior species. The studies available on toxicity, safety and quality of Chlorophytum borivilianum are inadequate for providing information on commercial utilization.

3. Prevalent harvesting practices:

Due to intense competition among the collectors, the roots of safed musli are harvested before maturity. In order to collect more roots the collectors dug the roots up from the soil without following any scientific harvesting technique and damage the root disc which helps in regeneration of the roots. No care is taken to replace back the root disc into the soil.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant/tree for harvesting

The roots of Safed Musli should be uprooted only after seeding is over to allow for natural regeneration.

(ii) Characteristics of plant parts to be harvested (bark colour)

The leaves, on maturity, turns yellowish in colour which indicates that the root of Safed Musli has become matured and the seeds have shed for regeneration.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

At first the soil of 1 feet radius from the roots of Safed musli should be removed and the roots should be detached from the ground. The roots of Musli occur in cluster and in between the roots the root disc is present. The roots should be separated from the root disc. The disc should be replaced in the pit and covered with the dugout soil.

(iv) Time and age of harvesting (period- season/ month)

The roots of Safed Musli are harvested in the months of October- November after seeding has occurred to ensure natural regeneration.

(v) Extent of harvesting- (quantity/ amount)

Only the roots should be harvested leaving the root disc in the soil for natural regeneration.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

The roots should be graded according to the thickness of the roots before packing. The totally dried roots should be



packed in polythene sheets at low temperature and then brought to the market.

In future the most suitable technique for packaging would be to vacuum pack the roots in aluminum foil. This way it could be stored for 2-3 months.

(vii) Transport method and time (night, early morning)

The roots of Safed Musli should preferably be transported at early morning to prevent drying from Sun's heat.

(viii) Post harvest methods

a. Storage

For storing the roots for use as planting material, the roots along with its crown should be placed in a perforated plastic bag in 200- 300 C and 50- 65% humidity. The plastic bag should be covered with sand.

Another method of storing the roots of Safed Musli is digging a pit of 1 m deep on a clean and sloping land. The pit should be covered with a thin layer of sand with the roots of musli along with the disc on top of it. The moisture content of the pit is maintained at 70- 80%.

b. Processing

The roots are then kept in a basket and the basket is placed in a stream of flowing water to wash away the soil on the roots. After washing the soil it is heaped for 2-3 days and sun dried. Solar drier or tunnel drier could also be used to complete the drying process within few hours.

The roots are kept in heaps for 7-8 days during which water must be sprinkled over it once daily. After 7-8 days the upper layer of the roots gets loosened which can then be easily removed by hand. It is again spread over thin sheet of cloth and dried in the sun for 2-3 hours. On drying the weight of the roots is reduced by 75- 80%.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

The roots should not be stored in a cold storage as it becomes susceptible to fungal attack affecting its terminative capacity. The roots should not be rubbed over stone as it removes the upper layer along with some quantity of pulp which degrades the quality of roots. It would be easier to peel the upper layer of the roots with knife.

4. Regeneration status: Poor (The increased commercial exploitation of *Chlorophytum borivilianum* and low productivity of this endangered plant has raised the concern over its conservation)

Ensuring natural regeneration of species

- Plants with green leaves should not be harvested as it indicates that the roots are still immature and seeds are not shed for regeneration.
- Natural seedling to be adopted and tended
- Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions

6. Processing Possibilities:

Value addition:-

- **Dried Musli Root:**
- **Root Powder:**





4.3.3. *Cyprus rotundus* (Nagarmotha)



Figure 1: *Cyprus rotundus*

1. Botanical characteristics

Cyprus rotundus is a pestiferous perennial weed with dark green glabrous culm, 0.5- 2 ft high, arising from a system of underground tubers. The plant has an elaborate underground system consisting of tubers, rhizomes and roots. The tubers are white and succulent when young and hard and black when mature. It thrives on all kinds of soil under varying climatic conditions.

- **Common Name:** Motha or Nutgrass
- **Distribution:** It is extensively distributed due to its ability to adapt wide range of soil types, temperatures, soil, pH, altitudes and moisture soil. This plant grows in small clumps up to 100cm high. It is native of India.
- **Useful plant parts:** Roots
- **Active constituent:** cyperene
- **Method of propagation:** Propagate through both tubers and rhizomes

2. Importance:- *Cyprus rotundus* L (Cyperaceae) is one of the highly valuable, potent, multipurpose medicinal herb used in traditional medicine for treatment of several human ailments. According to the Ayurveda, root is pungent, acrid, cooling, astringent, appetizer, stomachic, anthelmintic and useful in treatment of leprosy, thirst, fever, blood diseases, biliousness, dysentery, pruritis, pain, vomiting, epilepsy, ophthalmia, erysipelas etc. Accord-



ing to the Unani system of medicine, the root is diuretic, emmenagogue, diaphoretic, anthelmintic, vulnerary and useful for ulcers and sores, fevers, dyspepsia, urinary concretions etc. Useful in checking soil erosion. The tuber yields an essential oil (0.5-0.9%), which is used in perfumery and incense.

Rhizome extract of *C. rotundus* is found to improve lactation and also relieve inflammation, itching and milk duct clogs.

3. Prevalent harvesting practices:

The whole root of the plant is dug out.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant for harvesting

Around 30-40 cm high plants should be selected for collection of roots.

(ii) Characteristics of plant parts to be harvested

The leaves of the plant, on maturity, become yellowish in colour. The roots collected should be of 5-7.5 cm long and finger thickness.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

The roots should be collected by sharp and medium size instrument. A portion of root should be left underground so that it germinates into a new plant in the coming monsoon.

(iv) Time and age of harvesting (period- season/ month)

The roots should be collected from December- January

(v) Extent of harvesting

The entire immature, rotten, disease and damaged roots should be left at collection site. 1/3 of the total mature roots should be left at site for regeneration.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

(vii) Transport method and time (night, early morning)

(viii) Post harvest method

The roots so collected should be kept in dry place. Roots should be washed with clean water 4 days 5 times and the sand and dust must be removed. The clean roots should be dried in shade for 2-3 days storage. The roots so collected should be stored in clean gunny bags. The place selected for storage should be free from rodents and termites.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

While removing tubers there should not be any damage to the tubers.

5. Ensuring natural regeneration of species

- (i) Seed bearing plants should be marked**
- (ii) 80% of the roots should not be harvested for regeneration**
- (iii) Natural seedling to be adopted and tended**
- (iii) Monitoring and Evaluation**



9. Processing Possibilities:

The dried tuberous roots need to be collected, dried in sun and used in traditional medicine. Essential oil needs to be extracted by steam distillation. The roots need to be supported on a cage/ perforated grid below which water needs to be boiled. The water below the grid is to be heated which produces saturated and wet steam which will rise through the roots vaporizing the essential oil with it.

Value Added Product:

- Dried Nagarmotha & Nagarmotha powder (To treat many types of disturbances caused by vitiation of pitta. Traditionally used to quench hard throat of summers, fevers, solar dermatitis, etc.)
- Nagarmotha oil (The essential oil (0.5-0.9%) from the tuber is used in perfumery, soap making and insect repellent cream)

Storage of Value Added Product: Dried roots should be stored in airy containers, jute bags or perforated bags at room temperature under moisture free conditions. Nagarmotha oil maybe stored in air-tight glass jars.





4.4 Gum yielding medicinal plants

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.

General methods of blazing and tools to be used for gum tapping

1. Long sharp cut blazes are best as they give pure resin/gum and the bark heals faster. Irregular cuts add impurities to the resin.
2. Sharp knives or chisel can be used to make blazes.
3. Instead of letting the gum or resin solidify on the bark, it is better to fix a collection trough e.g. coconut shell, hollow bamboo etc.
4. Long cuts are better as they provide more area for exudation and heal faster. Square and round cuts take longer time to heal as the distance between the two walls are more.
5. If in the same tree more than one blaze is made, they should be staggered for optimum exudation.



4.4.1. *Boswellia serrata* (Salai)



Ecological Status: CG-VU; MP- VU

Salai gum or Indian olibanum is the gum-resin obtained from the species of *Boswellia* of which *Boswellia serrata* Roxb. occurs in India. *Boswellia serrata*, more commonly known as frankincense, has been used as a medicine for millennia.

Salai extract remains an important aspect of the oldest medical teaching in the world: the Indian Ayurveda.

1. Botanical characteristics:

Boswellia serrata is a moderate size to large deciduous tree with a light spreading crown and somewhat drooping branches. It usually has short bole of 3.6- 4.5 m in length. Ordinarily it attains a girth of 1.2- 1.8 m and a height of 9-15 m. Bark is very thin, grayish- green peeling off in papery flakes. Blaze flushed with lighter and darker pink, exuding small drops of resin. Leaves alternate, exstipulate, imparipinnate. Flowers white crowded towards end of branch but not terminal.

The leaves turn yellowish to light brown in December and commence to fall in quantity. During the season the trees are recognizable from a distance by the light brown colour of their foliage. By the end of January to the end of April, the trees are leafless and remain so till the new leaves appear in May- June. The racemes appear at the ends of branches from end of January to March or April when the tree is leafless or nearly so; sometimes flower appear before the old leaf fall or after the fresh leaf sprout. The drupe ripens in the month of May-June.



- **Common Name:** Frankincense, Salai, luban, salga, shallaki, guggal, kungli kundrikam , morada

- **Distribution:** The tree occurs mainly in Madhya Pradesh, Andhra Pradesh, Odisha, Rajasthan and Gujarat and to a lesser extent in Maharashtra, Uttar Pradesh and in other dry and tropical regions of the country.

- **Useful plant parts:** Gum

Active constituent: Boswellic acids

- **Method of Propagation:** Seed

2. Importance:

- Salai gum resin is traditionally used as incense because of its very unique fragrance.
- It is widely used in ayurvedic formulations for treating asthma and arthritis. Boswellia has been shown to be as effective and, in many cases, better than drugs like Phenylbutazone and other anti-inflammatory drugs.
- It is used in indigenous medicine for rheumatism, nervous disease as a diaphoretic, astringent and as an ingredient in certain ointments.
- It is also used for lighting fires.

3. Prevalent harvesting practices:

Blazes are made by de-barking the stem with the help of sickle shaper, semi- circular sharp edged iron blade locally called as “schilchy”.

The height of tapping is 5-6 m above ground level. The debarking is done by circular scaling upto 10 cm of bark upto a depth of 0.25 cm of tree trunk. As the collection season advances, the scaling of bark continues upwards and finally the total height of debarked portion of stem extends upto 40- 45 cm. For the fresh renewing of tapping, they are debarked usually 2.5- 3 cm above the upper tapping limit with the help of “Schilchy”. At the commencement of the season the tapping is renewed after nearly 50- 60 days after which fresh debarking is done.

As the collection season advances, this frequency is increased to almost weekly for cleaning the oleoresin duct for continuous secretion of gum.

The oozing oleoresin from the tree trunk is collected in the small bell shaped metallic pot called “Dhati” which is rubbed against the blazed gum secreting area of the tree. Gum collection is stopped from mid June to October for recovery of its wounds and regeneration of Salai tree.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant/tree for harvesting

Salai trees, between the age group of 35- 60 years, yield maximum gum due to highly active resin secretion glands. Trees falling outside this age have less active resin secretion glands and hence, produce less gum.

(ii) Characteristics of plant parts to be harvested (bark colour)

Only middle aged, healthy Salai tree of 61 cm. girth and above should be tapped.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

- Only healthy Salai tree of 61 cm girth and above should be tapped, the blazes being confined to the main stem between 0.6 cm above the ground level and the point of first main branching.
- The initial blaze should not exceed a width of 10.16 cm and a depth of 0.6 cm and a minimum period of two weeks should elapse before it is freshened.
- Freshening should not be done more than twice a week and the initial scrapping should not exceed 2.54 cm at each freshening.
- Over mature salai tree of over 91 cm girth should be tapped to death before felling. Such tapping should start 5 years before final felling.
- The tapping season is prescribed to be 60 days in the year commencing in July with freshening upto September or early October, with tapping commencing again in November. The peak yields are obtained in July, December and February while in August, November and April the yields are normal. In the remaining months the yields are lowest.



Another method of gum tapping has been prescribed by MFP branch of FRI, Dehradun which is as follows:

- The bark of the tree which is about 1 cm thick, containing maximum number of resin canals, are connected to those in the wood. Hence blazing should be confined to bark only and that to upto a depth not exceeding 0.6 cm.
- Tapping should be confined to trees of and above 90 cm girth at breast height.
- The season of tapping should be from October- November to end of May, depending upon the locality as the oleoresin obtained during the rains is darker in colour and inferior in quality. It should be stopped before monsoon.
- Blaze is made on trees at 15 cm above the ground level with an adze. One blaze is made on the tree upto 90 cm girth, with an additional blaze for every 50 cm increase in girth. The size of the blaze should be limited to 30 cm vertical length x 20 cm width x 0.6 cm thickness.
- The oleoresin starts oozing out soon after the blaze is made. The first collection is done after a month when freshening is also done. Thereafter freshening should be done fortnightly. At every freshening 1.6 cm of bark is removed on the upper side. In the season 20 cm of bark is removed during the freshening. The spacing between the blazes at the end of 1 year of freshening may vary from 28.8- 62.5 cm.
- For continuous tapping, the bole is divided into 3 zones, each one being tapped for one year. Thus, three zones would be covered in three years. For making another horizontal row of blazes in subsequent years 5 cm of space may be left above the blazed portion. The blazes of the subsequent year's horizontal rows should be alternating or staggering with previous year's blazes i.e. the previous and the fresh blazes will not be in the same longitudinal row.

Bhargava, 1951 had prescribed the minimum girth of 61 cm for undertaking resin tapping. As against this, FRI, Dehradun (year) had prescribed minimum girth of 90 cm or above for tapping. When Bhargava had prescribed the minimum girth of tree, there were large number of trees of this species which were well distributed, particularly in dry deciduous forest. It was this impression that salai occurs abundantly in the forest. The idea of News Print Paper Mill in Nepal in Nepanagar (Khandwa district of Madhya Pradesh) was planned in 1960s. In less than a decade later, the resource depletion and lack of natural regeneration prompted the State Forest Department to undertake plantation of *Boswellia serrata*.

A separate plantation division for the purpose was created and a special Working Plan was prepared to meet the raw material requirement of Nepa Paper Mills. All these efforts of regenerating *Boswellia serrata* naturally and by plantations did not succeed. Today, the paper mill is importing raw material as far as from Assam and also using other alternative raw materials.

This case is to illustrate that our knowledge for utilization of this species is only skin deep. *Boswellia serrata* is a precipitate of dry deciduous forest eco system. Therefore, it is advisable to use this species with care and caution. Abundance of resources also prompted foresters to be only spectator for reckless tapping which led to death of large number of trees. This was also considered uneconomical timber species and was therefore, extensively harvested to cater to the demand of making orange packing cases. This also resulted in depleting the Salai trees in the natural forests.

Wise men are those in Chambal areas in Madhya Pradesh (eg. Sheopur Forest Division) where communities have informally distributed group of *Boswellia* trees and tapped them by most scientific methods. They inherit this informal legacy and even give part of their possession to their daughters as a token of dowry. These practices have helped them to keep the trees in good health and productivity. These practices have been recognized by successive forest working plans of Sheopur division.

(iv) Time and age of harvesting (period- season/ month)

The yield of resin from Salai tree is maximum during the period between Octobers to February, due to favourable temperature for gum secretion. During this period the ducts continue to secrete resin and their passage is not blocked up due to drying of gum as it starts happening in the following months of dry summer.

(v) Extent of harvesting- (quantity/ amount)

Blazes should not be more than 0.6 cm deep and only one zone should be tapped in a year.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)



The gum is kept in polybags to protect from moisture.

(vii) Transport method and time (night, early morning)

Like other resin and gums it is preferable to transport at night to avoid exposure to excessive heat during the day time. This will help in avoiding wastage and maintaining quality.

(viii) Post harvesting methods (aerated, spread)

It is dried in shade and packed in basket made of *Nyctanthus arbotristis* (Harshringar) which is widely distributed and grows as weed. This species is harvested for preparing baskets used for local storage of gums. Lantana, another weed can also be used for storage of gums. This is also an eco friendly approach. In areas where both the species are not found bamboo basket could be prepared for storage of gums and can be transported in trucks.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Since oleoresin ducts are found just below the bark of Salai tree, for the collection of gum, scaling of bark without damaging the trunk is required. If some damage is done to the secretion glands, the healing phase will prolong which would bring down the quantity of gum secreted.

5. Regeneration Status: Poor (due to un-regulated and un-scientific tapping)

Ensuring natural regeneration of species

- Young ones (below 80 cm girth) should not be harvested
- Natural seedling to be adopted and tended
- Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions

Yield: Average annual yield of salai gum per tree is estimated to be about 1 kg, though a well grown tree yields upto 2 to 2.5 kg of gum resin in a year

6. Processing Possibilities:

Salai gum is collected in a semi-solid state. After collection, the bark and other impurities are removed manually. The crude gum-resin is allowed to remain in a bamboo basket for upto a month during which the fluid portion, locally known as ras, flows out. The as forms about 8 to 10 percent of the raw material and is used in paints and varnishes. Remaining semi-solid to solid part is the gum resin, which is dried thoroughly and sometimes treated with soapstone powders to make it brittle. It is then broken into small pieces by wooden mallet or chopper. During this process, bark and other impurities are again removed manually. The gum-resin is then graded according to its colour and impurities.





4.4.2. *Commiphora wightii* (Guggal)



1. Botanical characteristics: It is a shrub or small tree, reaching a maximum height of 4 m, with thin papery bark. The branches are thorny. The leaves are simple or trifoliate, the leaflets ovate, 1-5 cm long, 0.5-2.5 cm broad, irregularly toothed. It is gynodioecious, with some plants bearing bisexual and male flowers, and others with female flowers. The individual flowers are red to pink, with four small petals.

- **Common Name:** Indian bdellium-tree, gugal, guggul, gugul, or mukul myrrh tree

- **Distribution:** Guggal is a spiny shrub or small tree with many branches, usually growing two or three meters high, that is native to India, Arabia and Pakistan. It is found in the arid, rocky tracts of Rajasthan, Gujarat, Madhya Pradesh and Karnataka in India.

- **Useful plant parts:** Gum

- **Active constituent:** Guggulsterol

- **Method of Propagation:** Stem cutting

2. Importance: *Commiphora wightii* (Arnott) Bhandari is an important medicinal plant of herbal heritage of India. It provides oleo gum resin which is extracted from the bark through a process called tapping. Sushruta Samhita



(600 B.C.), a well-known Ayurvedic medical text, describes the usefulness of oleo gum resin in the treatment of a number of ailments, including obesity and disorders of lipid metabolism. Unfortunately the plant *Commiphora wightii* has become endangered because of its slow growing nature, poor seed setting, and lack of cultivation, poor seed germination rate and excessive and unscientific tapping for its gum resin by the pharmaceutical industries and religious purposes.

3. Prevalent harvesting practices:

- The stem and branches of tree is blazed at different places in the months September- June
- Deep blazes (3 inches deep) 1-2 inches in length are made on the stem and branches of the tree
- Gum oozing is maximum in the morning and evening and takes place for 15- 20 days
- Around 0.5- 1.5 kg of gum is extracted from a single tree
- The tree becomes susceptible to fungal attack
- The same tree is continuously blazed for 2-4 consecutive years as a result of which the stem becomes weak and falls down under strong wind
- Due to unscientific method of extracting gum the traders are reluctant to purchase the gum and therefore, very little price is paid for the gum to the collectors

4. Sustainable harvesting practices/ protocols

(i) Selection of tree for harvesting

It is advisable to select trees which are fairly well grown and are uniformly distributed in the area. The experience shows that 8- 10 years old trees are good for gum tapping. However, since the tree is of small to medium size, each tree should not have more than one blaze in a year. After the scars have been healed, then only second blaze should be made opposite to the first one. This way, each tree may have 4 blazes in 4 years after which a rest of 2 years is recommended

(ii) Characteristics of plant parts to be harvested (bark colour)

Dark brown colour of the bark is indicative of maturity of the bark which should be selected for harvesting.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)



- The ground area within 1 m radius of the selected tree is cleared to allow the gum tapper to stand at ease.
- The tree trunk is also cleaned of debris and loose barks using a piece of cloth.
- The tree is lopped and the lopped branches are cut into 1-2 cm pieces with the help of cutting pliers during mid January to mid February.
- The pieces are then dried in the sun.
- These pieces are then powdered and with the help of solvent extraction method the gum is extracted
- The gum oozed out from the cut surface of the attached branches is also collected.
- The gum extracted through this process is translucent, shiny and golden in colour.
- This process should be repeated after every two years.

(iv) Time and age of harvesting (period- season/ month)

Guggal plants typically begin yielding resin after 5 years. But 8- 10 years old trees are good for tapping gum. The tree must be tapped for resin from November to January.

(v) Extent of harvesting- (quantity/ amount)

Each tree should be blazed only once a year. Second blaze should be made only after the first one is healed up.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

It is packed in basket made of *Nyctanthus arbotristis* (Harshringar) which is widely distributed and grows as weed. This species is harvested for preparing baskets used for local storage of gums. Lantana, another weed can also be used for storage of gums. This is also an eco friendly approach. In areas where both the species are not found bamboo basket could be prepared for storage of gums and can be transported in trucks.

(vii) Transport method and time (night, early morning)

The gum should preferably be transported at night to avoid exposure to excessive heat during the day time. This will help in avoiding wastage and maintaining quality of the gum.

(viii) Post Harvest Methods

The extracted gum is dried in the sun stored in polythene line bags with 15- 250 temperatures and 8- 10% moisture.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

Deep blazes (3 inches) should not be made to avoid exposure of the cambium layer for prevention of fungal attack and destruction of entire tree. Infected tree should not be used for tapping.

5. Regeneration Status: Poor (due to overexploitation)

Ensuring natural regeneration of species

- (i) Seed bearing trees should be marked
- (ii) Young ones (below 80 cm girth) should not be harvested
- (iii) Natural seedling to be adopted and tended
- (iv) Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions

6. Processing possibilities:-

- The exuded resin is allowed to dry on the tree before it is collected. Collected resin is cleaned by sieving and hand picking to remove foreign matter, and packed in sacks for transfer to points of sale, either nationally or internationally. The collected gum is graded according to its purity.
- The extract of gum guggul, called guggulipid, guggulipid, or guggulipid, has been used in Unani and Ayurvedic medicine, for nearly 3,000 years in India. The gum contains minerals, resin, volatile oils, sterols, ferulates, flavones, sterones, and other chemical constituents.
- Guggul is useful in weight management as it helps to improve metabolism and reduce Ama (toxic remains in the body due to improper digestion) by increasing the digestive fire.



- It also helps to reduce swelling, pain and stiffness in joints in case of osteoarthritis as well as rheumatoid arthritis due to its anti-inflammatory and anti-arthritis properties.
 - Guggul might also be helpful in managing blood cholesterol levels by lowering total cholesterol, low-density lipoprotein (LDL or bad cholesterol) and triglyceride levels.
 - Guggul can be taken in the form of powder, tablet or capsule to help reduce the production of sebum which inhibits the growth of acne-causing bacteria due to its anti-bacterial property.
 - Paste of Guggul mixed in warm water on the joints helps to reduce joint pain.
 - Guggul should always be chewed well before swallowing in order to get the maximum benefits
- Guggul is also known as “Pura” which means “wards off disease”. It is used as a source of commercial “Gum guggul”. The major bioactive component of Guggul is oleo-gum-resin (a mixture of an oil and yellowish or brownish fluid secreted from the plant stem or bark). It is this oleo-gum resin that is said to have therapeutic benefits.

Packing & Storage:- After collection, the oleo-gum resin is stored in airtight plastic container or corrugated box with polyethylene liners. Guggul gum is stored in dry and cool places.

Guggul powder:- Guggul is a very effective herb for controlling obesity & cholesterol. It possesses strong purifying and rejuvenating properties. It is also useful in arthritis, effective in blood circulation etc.





4.4.3. *Sterculia urens* (Kullu)



Figure 2: *Sterculia urens*

1. Botanical characteristics: Very common in all forests. It is always conspicuous especially in hot season from the light coloured, almost white smooth bark. It grows in sandstone, quartzite (not on laterite) rock. It prefers ferruginous and rocky soil but avoids loam or heavier soils. It is a drought resistant species. Flowers in crowded, erect, pyramidal panicles appear in December to March. The follicles ripen in April-May and shed the seeds. Fruits of 4 to 5 sessile radiating follicles are covered outside with stiff, stinging bristles; orange to bright red when ripe. Seeds are 3 to 6 in each follicle, 6 mm long, oblong, dark brown and shining.

- **Common name:** Gum-karaya, Gulu, Kadaya, Karaya, Katera, Katilo, Kullo.
- **Distribution:** *Sterculia urens* is indigenous to India having a wide distribution. It is abundantly found in the dry deciduous forests in Madhya Pradesh and Chhattisgarh.

- **Useful plant parts:** Gum **Active constituent:**
- **Method of Propagation:** Seed

2. Importance: *Sterculia urens* has been vastly used in pharmacy, health care, food, cosmetics, waste management, paper-textile, composite fiber, and leather industries, for a long period of time. Gum exudate of this tree is of high market value, therefore, in the name of its exudate, plant is commonly known as 'Karaya Gum' tree. Polymers of karaya gum are ideal choice over synthetic ones because of its natural availability, cost effectiveness, non-hazardous nature, easy recovery, and physicochemical properties. Moreover, the tree is widely used in tribal populations for



its indigenous remedies against various ailments like oligospermia, leucorrhoea, constipation, body swelling, throat infection, wound healing, etc. Biochemical analysis authenticates photo physical, photochemical as well as pharmacological uses, and validates ethno-botanical applications by tribal communities up to some extent.

3. Prevalent Harvesting Practices:

- The stem and branches of tree is blazed at different places in the months September- June
- Deep blazes are made on the stem and branches
- Due to these unscientific technique of blazing tree, it becomes susceptible to fungal attack
- The same tree is continuously blazed for 2-4 consecutive years as a result of which the stem becomes weak and falls down in strong wind
- Due to unscientific method of harvesting gum the traders are reluctant to purchase the gum and therefore very little price is paid for the gum to the collectors

5. Sustainable harvesting practices/ protocols

(i) Selection of plant/tree for harvesting

8 years old tree with 90 cm or more girth at waist height- (a tree whose trunk matches the entire arms-reach of a normal individual) is considered for gum tapping.

(ii) Characteristics of plant parts to be harvested (bark colour)

Healthy tree should be selected for tapping gum. The diameter of the selected tree should not be less than 90 cm.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

- The ground area within 1 m radius of the selected tree is cleared to allow the gum tapper to stand at ease.
- The tree trunk is also cleaned of debris and loose barks using a piece of cloth.
- At waist height on the tree trunk, a 12- 15 cm horizontal incision is made using a sharp sickle. The ends of the incision is joined by another, higher crescent shaped incision on the trunk.
- The two incisions should be deepened with the help of sickle so that each incision is about 3 cm deep. The bark between the incisions should not be removed.
- The bark bounded by the incisions should be beaten using a small mallet or the blunt end of the sickle till it becomes soft and pulpy and should be left for a fortnight.
- After a fortnight the beaten bark between the incisions that would have dried and died, is removed. The blaze is then exposed. A thin layer of live bark from top crescent is removed to initiate gum flow. The blaze then becomes ready for tapping.
- The area in and around the blaze is cleaned with cloth and a small polythene sheet is attached to face the blaze using thorns.
- The gum starts oozing out in the form of large irregular drops and drips on the polythene sheets. The polythene sheet is left on the tree for 48 hours.
- On the 3rd day remove thorns from lower end of polythene attached to the blaze with the help of sickle and bamboo basket hanging from elbow by coir rope handle. The polythene is held in one hand with gum collected on it.
- The thorns are now removed from the upper end of the polythene. Now holding the sickle in the left hand the gum stream is cut to disconnect the gum collected on the polythene sheet from the flows oozing from the trunk. The polythene with its gum is carefully placed in the bamboo basket.
- A new clean polythene sheet is attached to the blaze. If the gum flow has ceased, the crescent shaped incision is freshened by slicing a thin layer from it using the sickle.
- The gum tapping step 9-11 every 3rd day, till the blaze is too high on the trunk for the tapper to reach easily. Then is the time to start preparing a new blaze.
- The new blaze should be made diametrically opposite the first blaze. The same steps are repeated on that side for





another 3 years. Then a third blaze may be made on one side between the two. Similarly the fourth blaze would be made on the side opposite to the 3rd blaze on the trunk.

- After a tree has been tapped for 12 consecutive years in this way, the wound from the first blaze should have healed up completely and the trunk on that side would be ready for tapping again.

(iv) Time and age of harvesting (period- season/ month)

The gum tapping is done in hot season from October- June during which, gum oozing is maximum

(v) Extent of harvesting- (quantity/ amount)

Only one blaze per tree should be made at a time.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

It is packed in basket made of *Nyctanthus arbotristis* (Harshringar) which is widely distributed and grows as weed. This species is harvested for preparing baskets used for local storage of gums. Lantana, another weed can also be used for storage of gums. This is also an eco friendly approach. In areas where both the species are not found bamboo basket could be prepared for storage of gums and can be transported in trucks.

(vii) Transport method and time (night, early morning)

It is preferable to transport at night to avoid exposure to excessive heat during the day time. This will help in avoiding wastage and maintaining quality of the gum.

(viii) Post Harvest Method

- 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. The 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 and 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 on the basis of colour and amount of impurities.
- The dried gum should be stored in clean and air tight polythene bags ready for the market.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

6. Regeneration Status:

Ensuring natural regeneration of species

- Young ones (below 80 cm girth) should not be harvested.
- Natural seedling to be adopted and tended.
- Monitoring and Evaluation- A small committee of stakeholders should be formed to monitor compliance of the above prescriptions.

Gum collected by the villagers is delivered to the agents appointed by the trading corporation at rates fixed according to quality of gum. It is then packed in gunny bags and transported to towns. The gum often contains many impurities like tree bark etc.

At the grading centre the big lumps are broken into small pieces of about 1 to 3 cm in diameter. The broken pieces are then graded manually in five different grades, which are registered with the Indian Agmark Organisation, and which are based mainly on criteria of viscosity, colour and free from external bark, sand etc.

Gum is further purified by size reduction and removal of pieces of bark by air flotation methods. Other mechanical methods are used to remove sand, dirt and other types of foreign matter. Gum karaya is also granulated and powdered for obtaining a homogenous dispersion. Granulated or crystal gum karaya are usually processed so that the particle size is between 6 and 30 mesh. These granulated gum karayas are used principally as bulk laxatives.



7.Processing Possibilities:

Currently, the gum is used in a variety of products including cosmetics, hair sprays and lotions to provide bulk. Gum Karaya also used for constipation, liverticular disease and as laxative. Also used to osmotic aids through gum which is from powder, paste, ring, disk, a sheet board advantageous only the other adhesive plasters and cements specially immediately after postsurgical core of skin /sensitive skins or in soothing to skin, less likely to produce softness, darker support microbial growth.

Sores and Wound: It found that the application of powdered Gum Karaya stimulated granulation and healed the resistant bed sores in few patients. Gum Karaya powder packed in to open wounds increased the Normal granulation tissue and also resulted in good epidermal in growth. Gum Karaya is also used in dentine adhesive, medical adhesive tapes for the treatment of stomatities and also used in preparation of pressure-sensitive masking tapes, medical ellies, and pastes. The gum is also used to treat throat infections.





4.4.4. *Vachellia nilotica* (Babul Gum)



1. Botanical Characteristics:- The genus *Acacia* belongs to family *Mimosaceae*. *Acacia* is a medium to large tree, native to West Asia, which can reach a height of 10 m, with an average of 4-7 m in height. The crown is somewhat flattened or rounded, with a moderate density.

The branches have a tendency to droop downwards if the crown is roundish. The bark is blackish grey or dark brown in mature trees and deeply grooved, with longitudinal fissures. The young branches are smooth and grey to brown in colour. The young twigs are covered in short hairs. Paired, slender, straight spines grow from a single base and sometimes curve backwards, are up to 80 mm long and whitish but often reddish brown in colour.

- The leaves are twice compound, i.e. they consist of 5-11 feather-like pairs of pinnae; each pinna is further divided into 7-25 pairs of small, elliptic leaflets that can be bottle to bright green in colour.
- Flowers are bright yellow, numerous, in fluffy globular heads 1.2 cm diameter, usually in clusters of 2 to 6, on individual pubescent axillary stalks 1.5 to 2 cm long.
- Babul tree is a very good source of gum which is popularly known as Indian gum Arabic.
- **Common name-** *Acacia nilotica* is commonly known as babul, kikar or Indian gum Arabic tree has been recognized worldwide as a multipurpose tree.
- **Distribution:-** Babul (*Acacia nilotica* L.) trees are found abundantly in Madhya Pradesh on field bund particularly in plain region and are the source of fuel wood and timbers for making furniture's, construction of houses



and agricultural tools. However, due to overexploitation, the biodiversity of this tree over the entire state is in question.

- **Useful Part:-** Gum **Active Constituent:-**

- **Propagation:-** Seed

2. Importance: It provides timber, fuel, shade, food, fodder, honey, dye, gum and fences. It also impacts the environment through soil reclamation, soil enrichment, protection against fire and wind, and as a haven for biodiversity and ornament. It is widely used in ethno-medicine. Its bark and branches are excellent for gums. These are used to strengthen gums and stop gingivitis and whiten teeth.

The gum Arabic is used in printing, dyeing, paints and is marketed as Amravati gum in India. Acacia Nilotica is quite a hit in the tanning industry, as the byproduct from felling the bark has high levels of tannin.

The foliage and the pods dropped during the dry season can be a fundamental source of nutrients in periods of feed scarcity.

Gum is widely used as industrial, food and medicinal purposes. This article briefly reviews the botany, distribution, ecology and environment, improved techniques of gum extraction, its uses and properties.

Medicinal Uses: The leaves, bark, gum and pods of *A. nilotica* are used for medicinal purposes. The tender growing tops and leaves are used as a douche in cases of gonorrhoea, dropsy and leucorrhoea. Pulp of leaves, decoction of bark and the gum are prescribed in diarrhoea, dysentery and diabetes. A paste made of the burnt leaves with coconut oil makes a very efficacious ointment in cases of itch. The leaves and the gum are used for gargling for relaxing sore throat and spongy gums. Decoction of leaves is also used as wash for bleeding ulcers and wounds.

3. Sustainable Harvesting

- **Period of harvesting/collection:** Collection of gum Arabic takes place at intervals during the dry season from November to May. During the rainy season no gum is formed since the trees are in full bloom.
- Gum tapping is not very popular among gatherers. Due to lack of technical knowledge, farmers are not exploiting this valuable product in a sustainable way.
- **Method of harvesting/tapping:** The gum exudes from the cracks on the bark of the tree under difficult conditions such as heat, dryness, wounds, and diseases. The gum flows naturally from the bark of the trees in the form of a thick and rather frothy liquid, and speedily concretes in the sun into tears.
- To accelerate exudation and to improve and regulate gum production, Acacia trees are tapped by means of incisions (60 cm x 5 cm) made in their branches some weeks ahead of time. Usually mature trees, 4.5- 6 m high and 5-25 years old, are tapped by making incisions in the branches and stripping away bark. The gum starts to collect in the wound within 3-8 weeks, but this depends on the weather conditions.
- Gum droplets are about 0.75 -3 cm in diameter, and they gradually dry and harden on exposure to the atmosphere. These gum tears are manually collected.

Storage: - Just after harvest, the gum is delivered to cleaning sheds for the removal of impurities sand, and pieces of bark. There after it is sorted to different grades based on color and per cent of impurities. Sorted and cleaned gum arabic is usually traded as tears that are approximately 2.5 to 5 cm in size packed in 100 kg jute bags.

4. Regeneration:- Fairly Good

5. Processing and Value Addition:

Food:- Confectioneries, Dairy Products, Bakery products, Beverages, Flavour emulsifier, Diabetic and dietetic product.



6. Transportation and Storage:

The crude gum arabic is stored and exported either in burlap or jute sacks. The graded gum is packed in heavy duty bags of about 80 kg each. The US regulations require that only new, unused jute sacks are used. Semi-processed and processed kibbled variety, granules and powdered gum arabic is exported in drums, polyethylene lined multi-wall paper bags or polyethylene lined cardboard boxes. Gum arabic, when stored in cool (21 -24°C) and dry place, has an unlimited shelf life.



4.4.5. *Anogeissus latifolia* (Dhawda)



1. Botanical characteristics: Dhawda is a large tree growing in the plains and dry mountains of India up to a height of 20-25 m above mean sea level. It is also known as Axlewood (*Anogeissus latifolia*). Exudate is released from the tree, which is used for calico printing.

Axlewood (*Anogeissus latifolia*) is a small to medium-sized tree up to 20-36 m tall, with a straight and cylindrical bole up to 80-100 cm in diameter. Its wide leaves (that give it the name *latifolia*) are opposite or sub-opposite, simple with grayish-yellow or whitish hairs below. The fruit is a 2-winged pseudo-achene, packed into a dense head with a single seed.

- **Common Name:** Axlewood
- **Distribution:** The tree grows extensively all over the country, more commonly in the dry deciduous forests in the Western Ghats and dry plateaus of Vindhya, Satpura and Western Ghats range of mountains, extending in Maharashtra, M.P. Chhattisgarh, Bihar and Orissa. It is a large erect deciduous tree that may grow up to a height of 25 meters, with a smooth light colored bark. Sometimes the bark has whitish grey depressions caused by exfoliation of bark.
- **Useful Part:** Gum ghatti



2. Importance: *Anogeissus latifolia* timber gives a heavy hardwood, good charcoal and firewood. It provides a gum that is a good substitute for gum arabic. Its leaves give tannins used for tanning and dyeing. *Anogeissus latifolia* is used as fodder for cattle, buffaloes and other ruminants. In certain areas of the subtropical forest of the Himalayan foothills of India, *Anogeissus latifolia* is the most important fodder, fuel and timber tree, and excessive lopping of leaves and cutting of saplings and branches for firewood may cause poor regeneration. In these regions, *Anogeissus latifolia* may be a major fodder tree for buffaloes in pastoralist communities.

The leaves are also fed on by the *Antheraea paphia* moth which produce the tassar silk (Tussah), a form of silk of commercial importance. The outer trunk has pale yellow color.

The exudation process happens very slowly over a period of days and depending on the size or age of the tree the exuded gum nodules can range from 5g to 50g in weight.

The emulsification mechanism in gum ghatti is similar to that of gum Arabic, where the protein is responsible for the surface activity by acting as the strong anchor point at the oil water interface.

This is why gum ghatti can emulsify 20% medium oil at much lower concentration compared to Gum Arabic. The emulsification performance and stability of gum ghatti, which is completely soluble, is compared with standard gum arabic at a range of concentrations. The interfacial rheology of gum ghatti is superior to that of gum Arabic at the same concentration due to the high protein content and possibly the conformation in solution. Gum Ghatti has an age old reputation of being a very good medicinal product as well as having excellent qualities for the food industry.

3. Sustainable harvesting/tapping:- The trees are not usually tapped for gum. The gum oozes out naturally from the bark through injuries and wounds mostly in summers and is collected manually. In some places artificial incisions are made in the bark to increase the gum yield. These incisions are made carefully so as not to permanently injure or kill the tree.

- **Period of harvesting/collection:** Maximum quantity of the gum is collected during the summer months i.e. from March to mid of June. During this time, as the weather gets warmer, the yield increases. Normally the largest crop is picked in the month of April and afterwards.

Yield:- A tree on an average yields around 1-2 kg of gum in a year. Gum yield depends upon the locality, size and vigour of the tree and method of tapping. There are reports in which a more professional method of tapping resulted into the yield of as much as 3 kg per tree per year, the tree being mature with girth of 90-120 cm.



4. Properties

- Gum ghatti is a moderately viscous gum lying intermediate between gum arabic and gum karaya. It forms viscous solutions at concentrations of about 5% or higher and exhibits typical non-Newtonian behaviour.
- The emulsifying properties of gum ghatti are excellent and considered to be better than gum arabic and thus used in more difficult-to handle systems.
- Gum ghatti solutions are sensitive to alkali. Viscosity increases sharply with pH upto a maximum at about pH of 8.0 and above that the solutions tend to become stringy.
- Gum ghatti is approved for food use and is in the GRAS list under the Food, Drug and Cosmetic Act, U.S.A. It is non toxic and is not metabolized in human.

5. Post harvesting: Harvesting and grading of gum ghatti are done by methods similar to those used for gum karaya. The exudates are handpicked by the locals, mostly tribal and laid to dry in the sun for several days. At the processing centers, gum with bark and gum without bark are sorted. The barks are handpicked and removed from gum. The gums with bark are also fed to processing machine where barks are detached from the gum. The finer crushed particles are screened and removed. The gum is then hand-sorted into various grades according to color and amount of impurity.



6. Processing possibilities:-

- Ghatti tears are further processed mainly by grinding in which the gum is pulverized to fine powder. However, various other mesh separations are made as per the demands of the separation. Some work has been done on spray drying the soluble fraction to obtain powdered gum ghatti.
- Gum Ghatti is used in sweets, flavours, beverages, printing, hair fixers, wine, petroleum industry etc. Gum Ghatti has an age old reputation of being a very good medicinal product as well as having excellent qualities for the food industry.
- It is used in laddoos, which helps in repairing the damage to body after pregnancy helps in strengthening the bones and joints helps in cell and tissue repair keeps body warm during winters.
- Grading of the gum crumbs into a transparent lot fetch better price (20-30% more) than mixed one.



7. Storage and handling:

Graded gum ghatti is usually packed in burlap bags of 50 kg capacity for storage and transportation purposes. Warehousing in a cool, dry place is recommended for extended storage. If the gum becomes damp, it tends to agglomerate and form lumps.



4.5 Stem yielding medicinal plants

4.5.1 *Tinospora cordifolia* (Giloe)



Figure: *Tinospora cordifolia*

Tinospora cordifolia, is a large, glabrous, deciduous shrub belonging to the family Menispermaceae. It is distributed throughout tropical Indian subcontinent and China, ascending to an altitude of 300 m. 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.

1. Botanical characteristics

The stem of *Tinospora cordifolia* is succulent with long filiform fleshy aerial roots from the branches. The bark is creamy white to grey, deeply left spirally, the space in between being spotted with large rosette like lenticels. The leaves are membranous and cordate. The flowers are small and yellow or greenish yellow. In auxiliary and terminal racemes or racemose panicles, the male flowers are clustered and female are usually solitary. The drupes are ovoid, glossy, succulent, red and pea sized. The seeds are curved. Fruits are fleshy and single seeded. Flowers grow during the summer and fruits during the winter.

The stem part of the plant is used for medicinal purpose and it is the main ingredient of various formulations in different traditional system of Indian medicines or Ayurvedic, Siddhu & Unani (ASU) system of medicines.

- **Common Name:** Guduchi, Moonseed, Giloy



- **Distribution:** The species is endemic to India and is common throughout tropical and subtropical zones at an altitude of 600 m. It is distributed in Arunachal Pradesh, Assam, Bihar, Delhi, Gujarat, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Sikkim, Tamil Nadu, Uttar Pradesh, and West Bengal.

- **Useful plant parts:** Stem

- **Active constituent:** cordifolioside A, magnoflorine, tinocordiside

- **Method of propagation:** Propagated through stem cuttings

2. Importance:-

T. cordifolia one of the most important herbs in Ayurveda has remarkable affect in memory impairment and learning enhancement (Mutalik and Mutalik, 2011). It stimulates the immune system by synthesizing acetylcholine, which has significant role in the enhancement of cognitive functions. Role of aqueous extract of T. cordifolia roots for improving memory has been mentioned in TCM as well as in western and Ayurvedic herbal medicine.

3. Prevalent harvesting practices: The entire plant is uprooted for the collection of stem.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant for harvesting

The matured plants whose leaves are shed in the months of February- March are selected for harvesting.

(ii) Characteristics of plant parts to be harvested

Matured Tinospora stem is 3-4 inches in diameter and is brownish in colour.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

When the leaves start shedding in the months of March- April, the stem is cut leaving 1 foot above the ground with the help of a sharp instrument. The stem is then cut into sizes of 3-4 inches long. The stem is sold in the market in the name of Giloe or Guduchi. The left over portion of the stem attached to the ground again germinates into a new plant.

(iv) Time and age of harvesting (period- season/ month)

The stem is harvested in the month of April when all the leaves of the plant is shed.

(v) Extent of harvesting

The stem is harvested leaving 1 foot of the stem above the ground so that it germinates into a new plant in the coming monsoon.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)

The cut and dried stem are packed in clean and moisture free polythene bags.

(vii) Transport method and time (night, early morning)

(viii) Post harvest method

The cut stems are then dried in shade. These are then graded according to the thickness of the stem. These are then packed in clean and moisture free polythene bags and stored.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)



5. Regeneration status:

Ensuring natural regeneration of species

- (i) Seed bearing plants should be marked.
- (ii) Young ones (less than 3 inches in diameter) should not be harvested.
- (iii) Natural seedling to be adopted and tended.
- (iv) Monitoring and Evaluation.

6. Processing possibilities:-

- Giloye Dried Stem
- Giloye Powder
- Giloye Juice





4.6. Whole Plant Medicinal

Whole plant harvest is done basically to extract the chemical components in the aerial parts such as leaves, stems, etc. Generally harvesters prefer to collect larger quantity of biomass, and they do not wait until the plants complete fruiting and seed dispersal. However, when this happens, plant resources will eventually be exhausted and the harvester will be deprived of income.

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. However, if the harvesters wait until this point, many plant species would have exhausted their resources through the process of producing fruits and dispersing the seeds and the leaves may have turned yellow or withered. The plant often loses its biomass and therefore all of the preferred properties important for the raw drug trade.

As the whole plant harvesting practice does not provide opportunities for the plant to produce fruit and seeds, the regeneration will be affected locally. Therefore the other option would be to leave some proportion of the plant in the whole population un-harvested so that they set fruits and take care of regeneration. Those plants selected to be left un-harvested should be healthy ones, as the seeds from the healthy plants can help guarantee the healthy populations in the future. In case of climber plants, the entire plants should not be harvested. Leaving a part of the plant that is large enough to produce fruits is important so that it will have chance of setting seeds and can help ensure the sustenance of the population.



4.6.1 *Andrographis paniculata* (Kalmegh)



Andrographis paniculata is traditionally known as kalmegh. The plant is widely used in Ayurvedic and Homeopathic systems of medicine. The plant grows in waste grounds and prefers moist habitat. The herb is bitter in taste and has weak odor. The whole plant may be used in medicine. In India, Kalmegh extract is used for blood purification.

1. Botanical characteristics:

Andrographis paniculata is an erect annual herb, chiefly found in the plains throughout India from Himachal Pradesh to Assam and Mizoram and all over South India. Stem dark green, 0.3- 1.0 m in height, 2-6 mm in diameter, quadrangular with longitudinal furrows and wings on the angles of younger parts, slightly enlarged at the nodes; leaves glabrous, upto 8.0 cm long and 2.5 cm broad, lanceolate, pinnate; flowers small in axillary and terminal racemes or panicles; capsules linear- oblong, acute at both ends, 1.9 cm X 0.3 cm; seeds numerous and yellowish brown in colour. The plant flowers during August- November and the whole plant starts maturing during February- March.

Because of its well-known medicinal properties, it is also cultivated - quite easily, because it grows in all types of soil. Moreover, it grows in soil types where almost no other plant can be cultivated, particularly "serpentine soil," which is relatively high in aluminum, copper and zinc. Such hardiness helps account for its wide distribution.



- **Common Name:** Creat or green chiretta, Kalmegh

- **Distribution:** It is widely distributed throughout plains of India from Uttar Pradesh to Assam, Madhya Pradesh, Tamil Nadu and Kerala.

- **Useful plant parts:** Whole plant Active Constituent: Andrographolite

- **Method of propagation:** Seeds

2. Importance:

Since ancient times, Kariyat is used as a wonder drug in traditional Siddha and Ayurvedic systems of medicine as well as in tribal medicine in India and some other countries for multiple clinical applications. The therapeutic value of Kalmegh is due to its mechanism of action which is perhaps by enzyme induction. The plant extracts exhibits antityphoid and antifungal activities.

The whole herb is bitter in taste and is source of several diterpenoids of which a bitter water soluble lactone “andrographolide” is important. It is useful in burning sensation, chronic fever, malaria and intermittent fever, inflammation, cough, bronchitis, skin diseases, intestinal worm, dyspepsia, flatulence, colic, diarrhoea, dysentery, haemorrhoids and vitiated condition of pitta.

3. Prevalent harvesting practices:

Since the entire plant is used for medicinal purpose for the cultivate done, the entire plant is uprooted. For wild collection the common practice is to cut the plant with the help of sickle at a height of 10- 15 cm above the ground.

4. Sustainable harvesting practices/ protocols

(i) Selection of plant for harvesting

Normally well grown plants of 60- 100 cm in height should be selected for harvesting. Plants with mature pods should be left for regeneration. Fruits bearing plants should be harvested. The young ones should be left to have ramifications of roots for further regeneration. Some old plants should also be left for dissemination of seeds.

(ii) Characteristics of plant parts to be harvested (bark colour)

Dark green plants indicate that they are still growing and therefore, dull green to brown plants with solid stem may indicate the stage of maturity. Fruits bearing plants should be harvested. Local gatherers can also indicate best stage for harvesting.

(iii) Methods to be used for harvesting (especially designed sickle, basket, hand plucking, not breaking branches)

Harvesting should be done by sickle at a height of 4-5 cm from ground.

(iv) Time and age of harvesting (period- season/ month)

Harvesting should be done in the month of November. It is desirable that Forest Department or other state authorities should educate gatherers about the maturity period before which harvesting should not be done. JFM committees and Gram Sabha could also be involved in prescribing regulatory mechanism and its compliance for sustained production and maximum benefit to gatherers and consumers.

(v) Extent of harvesting- (quantity/ amount)

Minimum 30% plant should be left, selected from amongst the most vigorously growing and well distributed should be left out as future germ plasm. It may be desirable to guide the JFM committees to earmark certain patches on rotation basis to act as germplasm bank. In Dhamtari Forest Division, this type of deferred harvesting planned and implemented by JFM committees have given good results. Harvesting should be done in one cycle a year.

(vi) Packaging for transportation (Gunny bags, canasters, cartons)



The material should be collected and stored under shade. Once the material has turned into brown to black it can be stored in gunny bags for long haul. For transporting small quantities of harvest to small distance, paper packing boxes (cartons) with perforation all around can also be used.

(vii) Transport method and time (night, early morning)

The harvested material should preferable be transported at night or early morning to avoid moisture loss.

(viii) Post harvesting method

The whole plant material should be cut into pieces of 4-5 cm and dried in shade taking due care of contamination from physical impurities and other flora and fauna. It should be stored in aerated place with wooden platform to ensure aerated condition. It should be stored in single, not with any other spp.

(ix) Ways to avoid loss/ wastage (spread on the floor, overlapping)

The material should not be transported in very dry form as it is liable to break into smaller pieces and become dust. It is therefore reliable to transport the material during night. To avoid wastage, the material properly packed without allowing too much drying should be preferred

5. Regeneration Status: Poor (overexploitation and harvest before seed dispersal).

Ensuring natural regeneration of species

- i. 30% of the plants should be left out for seeding and natural regeneration.
- ii. Young plants should not be harvested.
- iii. Natural seedling to be adopted and tended.
- iv. Monitoring and Evaluation- Only single round of collection in the forest would be permitted so that the plants left over or regeneration purposes do not run the chance of being collected in the second round. It would be ensured through decisions taken by the community on where to go for collection in a particular period and monitored through collection records maintained by internal inspector. A small committee of stakeholders should be formed to monitor compliance of the above prescriptions.

6. Processing Possibility:-

- Dried Kalmegh
- Kalmegh Powder



Storage of Value Added Product: After harvest, the plants need to be cleaned and dried in hot air oven at 46 degree Celsius to 50 degree Celsius for 8 hours or until properly dried. The dried plants need to be stored in airless plastic bags and kept in clean cool place (but not more than a year).



4.6.2. *Withania somnifera* (Ashwagandha)



1. Botanical Characteristics

- It is a dense, hairy, erect, grayish-tomatoes herb or under-shrub, grows up to a height of 1.5 meter.
- It's all parts are covered with whitish, stellate trichomes.
- Branching is extensive; leaves are simple, alternate or sub-opposite, ovate, entire, basis cunate, 10 cm long.
- The roots are stout, long tuberous, fleshy, whitish-brown.



- **Common name:-** Withania somnifera, known commonly as Ashwagandha, Indian ginseng, poison gooseberry, or winter cherry is an annual evergreen shrub in the Solanaceae or nightshade family that grows in India.

- **Distribution:-** Ashwagandha is native to the Indian subcontinent, specifically the drier areas of India, Pakistan, and Sri Lanka. It also grows in parts of Africa, and it can grow in temperate climates, including Western North Carolina, where Gaia Herbs is located.

- **Part used:-** Roots, leaves, bark and seeds.

- **Active constituents:-** The main active constituents of Ashwagandha plant are alkaloids and steroidal lactones. The important chemical constituents (Withanolides) are present in roots, leaf and berries.

2. Importance:-

Ashwagandha is considered to be one of the best rejuvenating agents in Ayurveda. Its roots, seeds and leaves are used in Ayurvedic and Unani medicines. Ashwagandha **root** drug finds an important place in treatment of rheumatic pain, inflammation of joints, nervous disorders and epilepsy. Dried roots are used as tonic for hiccup, cold, cough, female disorders, as a sedative, in care of senile debility, ulcers, etc. **Leaves** are applied for carbuncles, inflammation and swellings. Leaf juice is useful in conjunctivitis. **Bark** decoction is taken for asthma and applied locally to bed sores. Ashwagandha and its extracts are used in preparation of herbal tea, powders, tablets and syrups.

- The drug is rejuvenating agent; mainly used in Ayurvedic and Unani preparations.
- The plant has anti-tumor, anti-inflammatory, anti-bacterial, fungicidal, anthelmintic, anti-convulsant, anti-stress, immunomodulatory and anti-pyretic properties.
- It is also used in insomnia, weakness, ulcers and painful swellings as aphrodisiac and in leucoderma.
- The paste prepared out of its leaves is used for curing inflammation of tubercular glands and that of its roots for curing skin diseases, bronchitis, ulcer and dyspepsia and eye diseases.
- The fruits and seeds of Ashwagandha are diuretic in nature.
- The leaves are reported to contain anthelmintic and febrifuge properties.
- An infusion of the bark is given for asthma.

3. **Prevalent Harvesting Practices:-** For root collection, the whole plant is pulled out.

4. Sustainable Harvesting

- a. Selection of plant of harvest:** The plants start flowering and bearing fruits from December onwards.
- b. Characteristics of plant part to be harvested:** The maturity of crop is judged by drying out of leaves and yellow red berries. The entire plant is uprooted for roots which are separated from aerial parts by cutting the stem 1-2 cm above the crown.
- c. Method to be used for harvesting:-**
The roots are then either cut transversely into small pieces (7 to 10 cm) or dried as it is in the sun. About 650-800 kg roots can be obtained from 1 ha on drying it comes to 350-435 kg.
There should be moisture in soil at the time of digging. Roots are dug out or ploughed using power tiller or a country plough. The tap root should be carefully pulled out not damaging even the small lateral roots. Berries are hand plucked separately. They are dried and crushed to take out the seeds.
- d. Time and age of harvesting:-** The crop is ready for harvest in January-March at 150 to 180 days after sowing.
- e. Packaging for transportation:-** Ashwagandha is harvested and dried preferably under the sun. Most preferable drying could be in shade after spreading it on tarpaulin. Alternatively, it could be dried put in trays under solar tunnel. This maintenance the color and chemical content. The dried material should be loosely packaged in gunny bags with good perforation for aeration. Every lot should be labeled with details about the origin, weight and other details.
- f. Regeneration Status:-** Poor (over exploitation)

5. Post-harvest: Primary processing

The dried roots, entire or transversely cut into smaller pieces, has to be further water washed, cleaned, trimmed and



graded. The roots are beaten with a club, which removes adhering soil and breaks off the thin, brittle lateral rootlets. Lateral branches, root crown and stem remains on roots are carefully trimmed with the help of knife.

- **Grading:** The entire product is then carefully sorted into four grades based on the thickness and uniformity of the pieces.
- **A-Grade:** Root pieces up to 7 cm in length, solid, with 1.0-1.5 cm diameter; they should be brittle and pure white on the inside.
- **B-Grade:** Root pieces up to 5 cm in length, solid, with a diameter of less than 1 cm, the roots should be brittle and white on the inside.
- **C-Grade:** Root pieces up to 3-4 cm in length, side branches solid, with a diameter of 1 cm or less.
- **Lower Grade:** Small root pieces, semi-solid, very thin or very thick, chopped and yellowish on the inside.

6. Processing Possibility: Herbal inclusion not only gives medicinal qualities but can also give new flavor to the product. Ashwagandha is a valued herb in ayurveda medicine and such was used and cultivated for centuries in India. It possess therapeutic value against a large number of ailments such as mental diseases, asthma, inflammation, arthritis rheumatism, tuberculosis, infections, fever, male sexual disorders and variety of other diseases including cancer.

Value addition:- value added products from Ashwagandha include root powder, capsules, root extract, herbal beer etc. in addition to the traditional drug made from this plant. Health drinks, herbal tea, functional foods, nutraceuticals and cosmeceuticals are some of the value added products on which enterprises can be setup.

Three types of value added products viz. ashwagandha sweet n salty biscuit, ashwagandha churan ball, and ashwagandha beverage were prepared by the incorporation of ashwagandha root powder, ashwagandha leaf powder and ashwagandha root+leaf powder. Ashwagandha biscuit was ranked higher in acceptability than ashwagandha churan ball and the beverage was liked the least. The products prepared by the incorporation of ashwagandha leaf powder and ashwagandha root+leaf powder were not acceptable in comparison to the products prepared by the incorporation of Ashwagandha root powder. This might be due to the bitterness of leaves. The changes in the sensory attributes of the products differed slightly during 30 storage period.

Ashwagandha laddoo:- The demand of functional food is increasing day by day. Laddu is round shape product that is placed in sweet's category. There is several type of material that is used for preparation of laddu. Nutritional and medicinal qualities of laddu can be enriched by addition of ingredients such as medicinal plant extract or powder





4.6.3. *Gloriosa superba* (Kalihari)



1. Botanical characteristics:- *Gloriosa superba* is a striking climber with unusual and beautiful, red and yellow, flame-like flowers in summer; it is suitable for shade or sun, and is easy to grow.

It is an herbaceous, climbing perennial, growing between 3.5 to 6 m in length, usually trained at 1.5 m above the ground level. The vines are tall, semi hard stemmed with tuberous roots that support themselves by means of cirrhoues tips. Leaves are sessile, alternate; flowers bright, solitary, at first greenish later becoming yellow and finally scarlet; fruit capsules containing many seeds.

- **Common names:** Malabar glory lily, Karihari, Visalya & Superb lily.
- **Distribution:** Throughout India, upto 1800m. in low forest.
- **Part used:** Root, Tuber and leaves.
- **Major constituents:** Rhizomes and seeds contain colchicine, isoperlolyrine and related tropolane alkaloids. Air dried rhizomes contain β - sitosterol and its glucoside, 2-hydroxy 6-methoxy benzoic acid.
- **Propagation:** It can be grown by seeds and tubers but plants are best raised from tubers.

2. Importance:-

The plant has been used in the Indian system of medicine since time immemorial. Its rhizomes are reported to have been used as a tonic, anti-periodic, anti- helminthic and also against snake bites and scorpion stings. It is used in



local applications against parasitic skin diseases and as a cataplasm in urological pains. The drug is sometimes used for promoting labour pains and conversely also as an abortifacient. It is considered useful in colic, chronic ulcers, piles and gonorrhoea.

The medicinal properties of the plant are due to presence of alkaloids chiefly colchicine and gloriosine. It is used in the treatment of gout, a common disorder in the temperate parts of the world. The colchicine content varies from 0.15 to 0.3% in the rhizomes and 0.7 % to 0.9% in the seeds. The discovery of high colchicine content in seeds led to surge in demand in domestic and international markets.

3. Prevalent Harvesting Practices:-

4. Sustainable harvesting practices:-

- a. **Selection of Plant of harvest:** The fruits are harvested after 170-180 days of planting. The tubers are harvested after 5-6 years of plantation, collect only mature one and left the smaller for regeneration. Cut into small pieces and dried in shade.
- b. **Characteristics of plant part to be harvested:** It is typical geophytes whose aerial stems die down in the dry season and the tuber is dormant during this period, only sprouting with the rains. Two or more tubers develop during each growing season. The tuber contains mainly starch, which increases gradually until the tuber is full grown. Colchicine content in tubers increases simultaneously.
The rhizomes, which are, buried beneath the soil again sprouts and the plant cycle continues with the advent of monsoon. The rhizomes are finally harvested after 5-6 years of plantation, cut into small pieces and dried in shade.
- c. **Method to be used:** Mature tubers of gloriosa superb are dug out manually.
- d. **Time and age of harvesting:** The crop flowers during September – October and matures in 170 - 180 days after planting. A single plant produces 75 - 100 flowers and a single fruit contains 70 - 100 seeds. The right stage of harvest is when the capsule starts turning light green from dark green and skin of the fruit shows shrunken appearance and becomes light in weight. At this stage, when pressed the pod gives a cracking sound.
- e. **Post harvesting method:** The whole husk with seeds intact is dried in shade for 3-4 days by spreading them uniformly over any clean, dry floor or any platform specially erected for the purpose. After this, seeds and pericarp are separated manually by beating with wooden stick to remove seeds and pericarp. The seeds are then spread thinly over the drying yard under open sun and dried for 2-3 days until it dries uniformly.
- f. **Packaging for transportation:** After Dried seeds should be stored in Jute Bags and kept in the shade.
- g. **Regeneration status:** Poor (over exploitation , only collect from natural forest area).





5. Processing possibilities: The export of herbs and value-added extracts of medicinal herbs are gradually increasing over the years.

1. Kalihari root powder pack (lep) is applied over the affected part of the scalp. It helps eradicating fungal infection and stimulates the growth of new hairs.

2. Kalhari oil

3. Kalihari paste is prepared using Kalihari roots powder and water. All ingredients are mixed and heated until the oil remains with residues underneath. Then oil is strained out and residues are discarded. This oil is known as Kalihari oil. It is used externally as antiseptic and pain reliever.





4.6.4. *Acorus calamus* (Bach)



Acorus calamus is commonly known as sweet flag in India. The leaves of *Acorus calamus* have a lemony scent as well as the roots have a sweet fragrance. *Acorus calamus* has long been known for its medicinal value, and has been cultivated in Asia for this reason.

1. Botanical Characteristics: - *Acorus calamus* has a single prominent mid-vein and then on both sides slightly raised secondary veins (with a diameter less than half the midvein) and many, fine tertiary veins. The leaves are between 0.7 and 1.7 cm wide, with average of 1 cm. The sympodial leaf of *Acorus calamus* is somewhat shorter than the vegetative leaves. The margin is curly-edged or undulate. The spadix, at the time of expansion, can reach a length between 4.9 and 8.9 cm. The flowers are longer too; between 3 and 4 mm. *Acorus calamus* is infertile and shows an abortive ovary with a shriveled appearance.

Hardy perennial herb of marshy places, to 6 feet tall, aromatic, rhizome stout, pinkish; leaves to 3/4 inch wide, with a prominent midrib; spadix stout, to 4 inches long. The genus *Acorus* is considered to be the most primitive extant monocot.

- **Common name:** Bach Sweet Flag/Vacha.

- **Distribution:** Sweet flag grows in India, central Asia, southern Russia and Siberia, Europe and North America. Habitats include edges of small lakes, ponds and rivers, marshes, swamps, and wetlands.



- **Part Used:** Rhizome or root

- **Active composition:** Calamus contain asarone

- **Propagation:** This plant is propagated through roots/rhizomes and seeds. Roots of 5-6 cm, firm, and free from any damage or infection is used.

2. Importance:-

Acorus calamus is the most popular known medicinal plant which is used for many Ayurveda drugs in India. It is a tall perennial wetland monocot with scented leaves and rhizomes which have been used medicinally. The leaves have sword shape and are yellowish green in color. Plant size is big i.e. 2m tall. Flowers are cylindrical in shape and are greenish brown in color. The rhizomes of the plant is used to cure various diseases such as sedative, stomachic, aromatic, insecticidal, anti-inflammatory, aphrodisiac, antipyretic, insecticidal, carminative and many other diseases.

The plant is useful in bronchitis and remittent fever. It is a simple and useful remedy for flatulence, colic or dyspepsia and a pleasant adjunct to tonic or purgative medicines. The powdered roots are used as a vermifuge. The rootstock and leaves are used in the preparation of perfume and hair powder. It is used as a remedy for chronic diarrhoea. The rhizome is also used as an appetite stimulator, useful in the treatment of epilepsy, hysteria and memory loss. The dried rhizome of the plant constitutes the drug called, 'calamus of commerce'. In high doses, the plant is hallucinogenic. It is used for flavoring liquors.



Calamus is a herb used for the appetite and as an aid to the digestion. It is used for fevers, stomach cramps and cholera. The rhizomes were used for toothache and powdered rhizome for congestion. The rhizome part is also used to treat several diseases like asthma and bronchitis.

3. Prevalent Harvesting Practices:-

4. Sustainable Harvesting/Management:

Flag root is a very important and sacred medicine to forest gatherers, and should be treated with respect. Special care must be taken when harvesting, because wet areas are particularly vulnerable to disturbance and compaction. Harvest in extreme moderation-harvesting rhizomes can kill a plant, and only very small amounts of are needed. Replant small rootlets to promote plant regeneration.

Plant starts yielding by 6-8 months after sowing. Harvesting is done when the lower leaves dry and turns yellow in color as it indicates its maturity. Before harvesting the field should be partially dried so that digging will be easier.

5. Post-harvest

After harvesting, cleaning is done. After cleaning rhizomes are cut unto 5-7.5 cm of size. Then rhizomes are air dried and are beaten and rubbed. The rubbing is done 2-3 times. After rubbing, packing is done for transportation. The useful products are made by processing such as extract, oil, powder etc.

6. Regeneration Status: Poor (habitat degraded and overexploitation).

7. Processing Possibility:-

The scented leaves and rhizomes of sweet flag have been traditionally used as a medicine and the dried and powdered rhizome has a spicy flavor and is used as a substitute for ginger, cinnamon and nutmeg for its odor. The rhizome may be dried for used in decoction, distilled for oil or used for fresh tinctures, liquid extracts, paste and powders.

Value addition Essential oil content: - The dried rhizomes and matured leaves (at the time of harvesting) contain 1.85% and 0.1% of calamus oil, respectively.





Chapter 5

Management of Medicinal Plants for Sustainable Harvesting

5.1 Medicinal Plant Conservation Areas (MPCAs) and Medicinal Plant Development Areas (MPDAs)

In a project coordinated by Foundation for Revitalization of Local Health Tradition (FRLHT), supported by DANIDA, implemented over a period of eleven years (1993- 2004) in three South Indian States- Karnataka, Kerala and Tamil Nadu- by State Forest Departments (SFDs) of these states and a network of local NGOs, medicinal plants were conserved in their natural habitat through MPCAs and MPDAs.

The MPCAs were located in the buffer zones wherever possible in National Parks and Wildlife Sanctuaries, as these areas already enjoy a high degree of legal protection. Elsewhere these MPCAs were located in the Reserve Forests to have the benefit of legal protection to these forests. Participation of local communities especially of those who were directly dependant for their livelihoods upon the selected sites for MPCAs, formed an integral part of the approach for effective management of MPCAs and alternate means to income generation were incorporated into this adaptive model. Forests

MPDAs were developed in degraded forest areas in the vicinity of MPCAs and providing economic benefits to the local communities. This approach was a natural outcome of the efforts to involve communities in the management of the MPCAs, when it was realised that the communities needed to be compensated for the benefits forgone by them in the process of protection of MPCAs. Major thrust of this component was to augment native populations of the important medicinal plant species of MPDAs through intensive plantation and management of these species. The areas were managed and the usufructs were shared under the JFM guidelines in practice at the time.

5.1.1 Community Based Monitoring of MAP

A community based monitoring approach that takes the four interlinked scales viz. 1. The landscape level; 2. Community and ecosystem level; 3. The plant population level and 4. The genetic level, into account can play an important role in ensuring long term conservation of susceptible MAP and other culturally and economically important wild resources, as well as of local livelihoods. It is often the case that different stakeholders involved in MAP harvest (harvesters, traders, managers, biologists, etc.) monitor resources in their own ways. Effective community based monitoring, however, can allow for information flow among the different stakeholders and in this way lead to MAP resource conservation and sustainable use.

Types of monitoring usually practised by different stakeholders

Stakeholders	Type of monitoring usually practised
Harvesters	Maturity time for harvest, viability of harvest (worth time/ effort)
Traders	Yields, markets, trade routes, selection of harvest groups
Forest managers	Yields, as well as weeds, fire, parasites
Scientists	Regeneration, population dynamics, productivity, harvesting methods; usually in protected areas and results are not shared or implemented.

Types of protocols that are used in community-monitoring of NTFP

- Use of PRA (Participatory Resource Assessment), interviews or discussion groups to document traditional knowledge, local activities that relate to harvest, and perspectives on trends in harvest and current harvest methods.
- Use of local indicators of resource condition and production such as visual estimates of production, size, colour, etc.



- Monitoring of harvest methods, such as rating proportion of harmful harvesting.
- Monitoring at the level of trade cooperative or at the market: colour, size, weight of plants harvested- i.e. a fundamental role of traders for monitoring.
- Use of plots or transects that allow for visual estimates and/ or counts of annual production and regeneration levels.
- Recording of predictive signs such as flower production to plan appropriate harvest levels.
- Annual rating of disturbance factors perceived to affect (increase or decrease) resources such as fire or grazing.
- Annual rating of habitat health including perceptions of habitat health, including perceptions of abundances of other animals and plants.
- Annual community mapping of NTFP resources, indicating which forest areas have high and low MAP production for the curring year and local estimates of production (using local methods).
- Pre and post harvest meetings to discuss monitoring outcomes and plan accordingly.
- Local experimentation on harvest level.

Case Studies

Experience of harvesters from South India

The Irulas do a lot of herbal medicinal plant collection and harvest very carefully, keeping even the hairs covered so that nothing gets mixed with the medicinal plant. They make sure that people who are ill and menstruating women should not collect. They don't harvest what has fallen on the ground because there needs to be regeneration. They harvest seeds and leave some of the flowers and tubers, for the same reason. They know that they have the right to collect NTFP and don't face problems with the Forest Department and district administration in this regard.

SHGs have allocation for collection based on needs. There are other income opportunities for them such as nurseries, etc. Neither do they have the need to overharvest, not to enter the mainstream of commercialized medicinal plant production, wherein the medicinal plants have pesticide residues even in them.

The Irulas even have license for preparing tribal medicines; they have a facility for preparing and processing the plants in hygienic conditions. They even help the regeneration to the extent that if there are too many saplings under an adult tree, they will transplant some of them.

Indrani, with ITWWS- NGO, Chengalpet, Tamil Nadu, South India.

Lakshmi, a specialize midwife at ITWWS, Chengalpet, Tamil Nadu said that they maintain a register of what is collected, how much is collected, when to collect and how to maintain the quality of collection. She also said that they use improved method of harvesting e.g. applying a paste of soil to a bark extraction wound to prevent fungal infection. They are thus well aware of the improved harvesting techniques.



Chapter 6

Medicinal and Aromatic Plants in Working Plan & Micro Management Plan

6.1 Incorporating NTFPs/Medicinal Plants in Working Plan:

Medicinal and aromatic plants provide livelihoods to millions of rural people who are fully or partially dependent on these plants as a source of income (Shukla and Srivastava, 1993). Medicinal and aromatic Plant serves as a potential means of employment and income generation to all those involved in the chain from the stage of collection to the various agencies connected with market and trade for meeting local and industrial needs but no efforts have been made to develop crude management prescriptions for these NTFPS in the working plans which were addicted to catering the timber production requirement. Management of forest so far has been timber centered. The management plans or working plans are prepared keeping in view the requirements of timber tree species. Other species yielding non-timber forest products (NTFP) are generally ignored in the management. There are no or very few prescriptions relating to the management of medicinal plants. The working plan code issued by the Government of India does not include provision to prescribe management of medicinal plants. Several plant products required in large quantity have been harvested unsuitably resulting in loss of species. Several medicinal plant species once found abundantly have now become rare and some of them have become locally extinct. Notable examples are Sarp Gandha (*Rouvolfia serpentina*) from Madhya Pradesh and Chhattisgarh, Aswagandha (*Withania somnifera*) from Western Madhya Pradesh, Safed Musli (*Chlorophytum borivillianum*) from Central Madhya Pradesh and *Dioscorea* spp. in several states; once abundant have now become almost rare in these areas. MADPs species have preferences for different ecosystem and have varied preferences for light conditions indicating different silvicultural treatments. Time has come to identify such areas in the Forest Division for regulating the extraction of valuable germplasms from forests.

If MADPs are not protected and managed properly, the day is not far, when many species will become extinct and the forest already much impoverished will further lose its biodiversity value. Forests Working Plan Officers are therefore required to be oriented for identifying MADPs hot spots in working plan areas and prescribing sustainable silvi-cultural treatments.

It is, therefore, necessary that management of MADPs be included in the working plan of the area. But there are certain limitations within the working plan which needs to be taken care.

6.2 Preparation of NTFP based Micro Management Plan of JFMC areas:-

With the growing preference for use of organic/natural products for food, medicine, cosmetics, and many other formulation the market demand for medicinal plants/NTFPs has increased manifold in the past few decades.

The Pandemic situation like COVID-19 has also discovered the Importance of these natural products to boost immunity against the Pandemic. Climate change impact have also increased pressure on forest gathering as in the event of agriculture crop failures the poor and particularly the forest dwellers have to depend on forest resources for their sustained livelihood. The pressure on forest have often tended to be destructive and unsustainable extraction to increase the collection and household income. All these factors are contributing to the depletion of resources. According to the study by Prasad and Sharma (2015) the decline of resources of important collected species varies from 10-90% in some cases.

Joint Forest Management (JFM) provided a new initiative to join hands with local forest dependent committees to conserve and manage the resources for mutual benefits of forest biodiversity as well as livelihood of the communities. The **Forest Working Plans** are often prepared with timber production in focus. Although NTFP/medicinal plants have been now placed with similar importance in the Working Plan it has not been possible to field implement the strategy for conservation and management of NTFPs/Medicinal plants. The management buys for timber are still very strong and is likely to continue this way only even in future. As discussed above the NTFPs/medicinal plants continue of great importance for their livelihood and therefore it is essential to have a Micro-Management Plan for JFM areas so that they continue to extend their support for forest conservation and management *quid-pro-quo*.



In case of NTFPs/medicinal plants the State Government have permitted its collection and transport without any restriction. As a result anyone could enter the forest and collect and transport any amount of NTFPs/Medicinal plants without paying any fees as a result it is presently not possible to regulate the collection and extraction. This has been one of the most critical factors responsible for implementation of sustainable harvesting protocol.

It is therefore necessary for a well developed Micro-management Plan for each JFMC areas. This will have the involvement of the JFMCs and other community institution in the conservation, sustainable extraction and equitable distribution of benefits. Their capacity building to undertake different conservation, sustainable harvesting and processing to develop new products will have long lasting effect on the resources and socio-economic status of gatherers. The Micro Plan will be prepared with Full Corporation and involvement of JFMCs, primary NTFP gatherers cooperative society members under the technical guidance of local forest officers. This way there will be a genuine and sincere participation.

Objectives:

1. To ensure conservation and development of NTFP resources through scientifically managed and sustainably harvested.
2. To conserve and restore the rare , threatened and distressed species of NTFPs and Medicinal plants through different restoration methods (sowing & planting), adoption and nurturing through Assisted Natural Regeneration methods.
3. To ensure sustained supply of resources for the present and future generation through sustainable management and conservation of resources.
4. To create awareness among stakeholders about need for conservation, restoration and development of declining resources due to climate change impacts.
5. To encourage good field collection practices.
6. To encourage through capacity building for post harvest operation, grading, packaging, safe and secured storage so as to deliver quality material available to processing unit and end units.
7. To encourage and impart bargaining skill.
8. To help them develop NTFP based cottage industry for employment generation.
9. To undertake skill development programme of the local villagers.

Resource Assessment: The area under the control JFMCs should be assest for the availability of important NTFPs/ Medicinal plants in it. A typical example of a Moist Sal Forest in Dindori Forest Division was assesst for Micro Plan preparation. Similar, assessment may be done for other area to be treated under Micro management plan. The information on resource availability is being reproduced in Table 02.

Table 02: The availability of Medicinal plant /NTFPs in the sample plot of JFMC areas

Sr. No.	Species	Common Name	Collection period	Use practices
1	<i>Ceropegia bulbosa</i>	Dochi kanda	December-January	Self use
2	<i>Pueraria tuberosa</i>	Birar kanda	December-January	Self use
3	<i>Dioscorea daemona</i>	Bechadi	January	Sell/self use
4	<i>Chlorophytium tuberosum</i>	Safed musli	December-January	Sell
5	<i>Woodfordia fruticosa</i>	Dhawai phool	May- June	Sell
6	<i>Terminalia chebula</i>	Harra	November- December	Sell
7	<i>Terminalia belerica</i>	Baheda	November- December	Sell
8	<i>Emblica officinalis</i>	Aonla	November- December	Sell/self use
9	<i>Buchanania lanzan</i>	Chironjee	April-May	Sell/self use
10	<i>Celastrus paniculata</i>	Malkangni	October-November	Sell
11	<i>Embelica tsjeriam cottam</i>	Vaividang	September-October	Sell/self use
12	<i>Centrantherum anthelmnticum</i>	Van jeera	October-December	Sell



Table 03: Common species regeneration technique, harvesting time

Sr. No.	Species		Regeneration technique	Harvesting period	Germination percentage	Plant percentage
	Botanical Name	Common name				
1	<i>Emblica officinalis</i>	Aonla	Plant	Nov-Jan	80-90	60-70
2	<i>Aegle marmelos</i>	Bael	Plant	April-May	35-40	20-25
3	<i>Buchanania lanzan</i>	Chironjee	Plant	April-May	30-70	15
4	<i>Terminalia chebula</i>	Harra	Plant	Nov-March	40-60	15
5	<i>Terminalia bellerica</i>	Baheda	Plant	Nov-Feb	70-80	55
6	<i>Asparagus racemosus</i>	Satawar	Seed/plant	Oct-April	70-80	40-50
7	<i>Acorus calamus</i>	Bach	Tuber	Feb-March	60-70	30
8	<i>Gloriosa superb</i>	Kalhari	Seed	Oct-Jan	70-80	20-25
9	<i>Celastrus paniculata</i>	Malkangni	Seed	October-Jan	70-80	30
10	<i>Embelia tsjeriam cottam</i>	Vaividang	Seed	Sept	70-80	20-30
11	<i>Chlorophytum tuberosum</i>	Safed musli	Plant/tuber	Sept-Oct	60-70	20-30
12	<i>Costus speciosus</i>	Kewkand	Tuber	Sept-Oct	70-80	20-30
13	<i>Ceropegia bulbosa</i>	Dochi kanda	Tuber	Sept-Oct	70-80	20-30
14	<i>Dioscorea daemona</i>	Bechadi	Tuber	Sept-Oct	70-80	20-30
15	<i>Pueraria tuberosa</i>	Birar kanda	Tuber	Sept-Oct	70-80	20-30
16	<i>Oroxylum indicum</i>	Shionak	Plant	Dec-March	60-70	20-30



References

Annon. (1999). Annual Report (1998- 99). Ministry of Environment and Forests, Government of India, New Delhi, India. <http://envfor.nic.in/repot/9899/chap1.html> Retrieved 4 July 2003.

Annon. (2000). Generic Guidelines for Assessing Forest Management. (March 2000 version). SmartWood, Richmond, Vermont, USA.

Annon. (2002). Action Plan for Conservation, Cultivation and Sustainable Utilisation of Medicinal and Aromatic Plants in Uttaranchal, Part 1. Herbal Research and Development Institute and Forest Department, Uttaranchal, India. Unpublished Report.

Annon. (2003). Environment Information System- Medicinal plants of Concern (Overview). Foundation for Revitalisation of Local Health Traditions, Bangalore, India. <http://envis.frlht.org.in/overview.htm> Retrieved 4 July 2003.

MoEF (Ministry of Environment and Forests), Government of India (2002). India Climate -friendly Development. TERI, for MoEF, Government of India. pp45. <http://envfor.nic.in/cc/cop8/moefbk.pdf>, Retrieved 10 October 2003. World Bank (1996). India Ecodevelopment Project. (Project document). Global Environment Facility, World Bank, Washington.

planningcommission.nic.in (Retrieved 11 January, 2008)

Jain, P. (2004). Certifying Certification: Can Certification Secure A Sustainable Future For Medicinal Plants, Harvesters and Consumers In India? TRAFFIC Online Report Series No. 9.

Nautiyal, A.R.; Nautiyal, M.C. and Purohit, A.N. (eds). 1997. Harvesting Herbs- 2000. Bishen Singh Mahendra Singh, Dehradun.

http://www.canyew.org/sustainable_guidelines.htm (Retrieved June15, 2008)

Russo, L. Messrs P. Vantome and S. Walter. Policy guidelines for the Promotion of A Sustainable Utilization of Non Wood Forest Products. Harvesting of non wood forest products.

<http://www.fao.org> (Retrieved June 15, 2008)

Raju G. and Sastry, M.S. (2006). Report on Guidelines for Harvesting, Storage, Drying and Grading & Structures required for Value Addition and Storage. Prepared by FRLHT for Andhra Pradesh Forest Department.

Mallet, P. and Karmann, M. Certification of NTFPs: an Emerging Field. ETRN News 32: NTFPs.

Managing National Forests for Non-Timber Forest Products. A Case Study Analysis of Different Management Approaches. Chapter 5.

Charles M. Peters Sustainable Harvest of Non-timber Plant Resources in Tropical Moist Forest: An Ecological Primer.

Suresh, J.; Hemalatha P. and Selvi R. BIODIVERSITY AND CONSERVATION OF MEDICINAL PLANTS. Horticultural College & Research Institute, TNAU Periyakulam East – 625 604

http://www.nbaindia.org/docs/ncb_jan_06_16.pdf- 23 June, 2008.

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

Report on International Workshop on Ecological Monitoring- Processes, Proceedings and Protocols. Auroville, Tamil Nadu. 28- 30 November, 2005.





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