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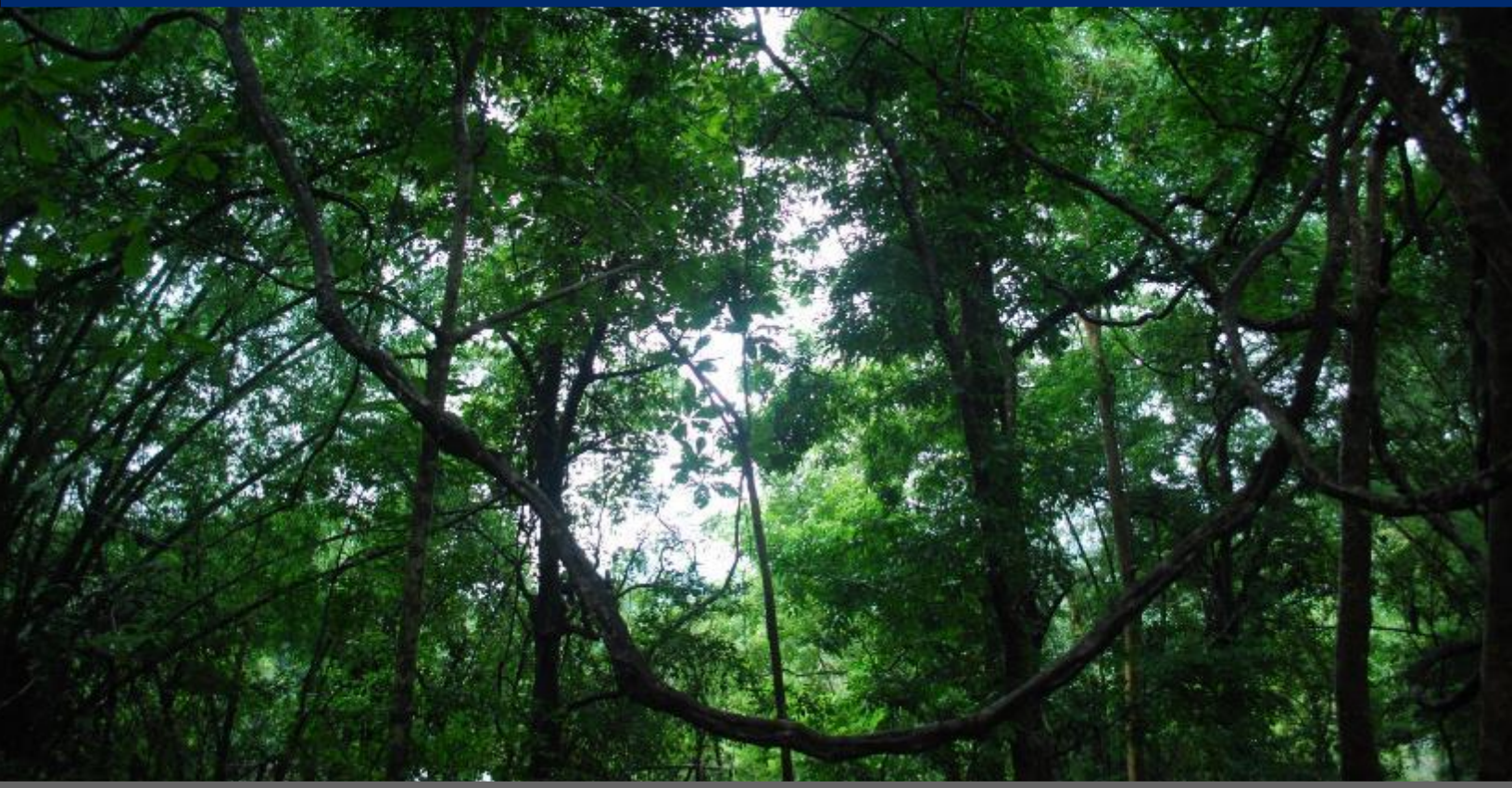
# Partnership for Land Use Science (Forest-PLUS) Program

## TRAINING REFERENCE MANUAL FOR SUSTAINABLE MANAGEMENT OF NON-TIMBER FOREST PRODUCTS IN SHIVAMOGGA



September 2016

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech ARD for Forest-PLUS Program, Contract No. AID-386-C-12-00002.

***Prepared by:***

Tetra Tech ARD for Forest-PLUS Program, Contract No. AID-386-C-12-00002
Tetra Tech ARD Contacts

Ben Caldwell, Chief of Party (Ben.Caldwell@tetratech.com)
Gina Green, Senior Technical Advisor/Manager (gina.green@tetratech.com)
Korinne Baccali, Deputy Project Manager (Korinne.Baccali@tetratech.com)

Tetra Tech ARD
P.O. Box 1397
Burlington, VT 05402
Tel 802-658-3890

# PARTNERSHIP FOR LAND USE SCIENCE (Forest-PLUS) PROGRAM

## TRAINING REFERENCE MANUAL FOR SUSTAINABLE MANAGEMENT OF NON-TIMBER FOREST PRODUCTS IN SHIVAMOGGA

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACF | Assistant Conservator of Forests |
| ANR | Aided Natural Regeneration |
| APCCF | Assistant Principal Chief Conservator of Forests |
| AR | Artificial Regeneration |
| CCF | Chief Conservator of Forests |
| FDA | Forest Development Agency |
| FAO | (UN) Food and Agricultural Organization |
| FRLHT | Foundation for Revitalization of Local Health Traditions |
| FYM | Farmyard manure |
| IBA | Indole-3-butyric acid |
| JFC | Joint Forest Committee |
| JFMC | Joint Forest Management Committee |
| JFPM | Joint Forest Planning and Management |
| $K_2O$ | Potassium oxide |
| LF | Large farmer |
| LL | Landless person |
| MP | Medicinal plant |
| NGO | Nongovernmental organization |
| NMPB | National Medicinal Plants Board |
| NTFP | Non-timber forest product |
| NWFP | Non-wood forest product |
| PFM | Participatory forest management |
| $P_2O_5$ | Phosphorus pentoxide |
| ppm | Parts per million |
| Rs | Rupees |
| SF | Small farmer |
| SFRI | State Forest Research Institute |
| TOT | Training-of-Trainers |
| VFC | Village Forest Committee |

# 1.0 INTRODUCTION

A training manual has been developed for the field functionaries of the Forest Department, non-timber forest products (NTFP) collectors, and representatives of joint forest management committees (JFMC). Deliberations, theories, and practical activities described in the module are based on various interventions by Forest-PLUS within the past 4 years. To develop this manual, several field exercises occurred, including situation analyses of existing value chains of three commercially important NTFP species, a survey to establish baselines for sustainable harvest levels, monitoring protocols, field demonstrations of sustainable harvesting techniques, establishment of institutional arrangements for value addition and marketing, etc. To improve regeneration and propagation of identified NTFPs, an assessment of existing nurseries occurred, and thereafter, improved nursery and propagation techniques were suggested. Guidance for developing this module derived from important suggestions and demands of different stakeholders during a 1-day, circle-level consultation organized in Shivamogga and attended by community representatives, circle-level forest staff members, NTFP contractors, and private nursery owners.

A draft of the training manual was presented to Assistant Principal Chief Conservator of Forests (APCCF) Training, and all tools, techniques, and methodologies conveyed in the modules were presented to the Chief Conservator of Forests (CCF) Shivamogga before trails were laid out in the field. As per their suggestions, effectiveness and efficiency of training topics were tested during 10 community-level trainings in the field involving community members and front-line staff members of the Forest Department. On the basis of feedback received from the participants, necessary modifications occurred.

This training manual includes the following five modules:

- NTFP: Introduction and basic tools and techniques for resource assessment
- Participatory Techniques for NTFP Monitoring
- Nursery propagation techniques for selected NTFP species
- Natural regeneration and augmentation techniques for NTFPs
- Principles of sustainable harvesting, good collection protocols with examples of sustainable collection of leaves of *Cinnamomum* species, fruits of *Sapindus emarginatus*, and resin of *Ailanthus triphysa*.

## 1.1 WHO CAN USE THIS MANUAL?

This manual can be used by frontline staff members (Block officers, Rangers, Assistant Conservators of Forests [ACF]) engaged in NTFP management, JFMC leaders, nursery managers, and non-governmental organization (NGO) staff members for training, developing nurseries, and strengthening institutional structure for NTFP value addition and marketing.

## 1.2 HOW CAN THIS MANUAL BE USED?

This manual has been designed for 2-day (16-hour) training. Before using this manual in the field, trainers must undergo a Training of Trainers (ToT). Participants in ToT should be working in the NTFP sector and have basic knowledge and idea of forestry and NTFP management. Trainers must learn how to mix theory with practical exercises and encourage involvement of trainees during discussions and exercises. Trainers must be familiar with NTFPs of the region, and should be able to explain to participants' botany and phenology of the species. Trainers should be good communicators and possess skills to effectively manage groups of varying educational and social background.

## 1.3 WHO IS THE TARGET AUDIENCE?

NTFP collectors, JFMC representatives, and frontline staff members constitute the key audience for this training manual. In addition, the module on establishing a baseline for resource monitoring will be useful to range-level officers. The module on nursery and propagation techniques could be useful to nursery managers and private nursery growers.

## 1.4 TRAINING SCHEDULE

Considering the diversity in education and social background of the audience, the following training schedule has been developed:

**TRAINING SCHEDULE**

| Day | Session | Duration |
|---|---|---|
| Day 1 | Inaugural session –<br>Participants registration, introduction, opening remarks, photo-session. | 1 hour (hr) |
| | Topic 1: NTFP – Introduction, importance of NTFPs for community, Trends and Emerging Issues in its Management<br><br>Basic tools and techniques for resource assessment<br><br>Group exercises and discussion; knowing community idea about NTFP<br><br>Documentary on “Biodiversity of Karnataka” | 2 hr |
| | Topic 2: Participatory resource monitoring<br><br>Documentary on “Participatory Resource Monitoring”<br><br>Group exercises and discussion | 2 hrs |
| | Topic 3: Nursery propagation techniques for selected NTFP species<br><br>Documentary on “Nursery Techniques of Selected NTFPs” | 2 hrs |
| **Day 2** | Recap of day 1 | 30 minutes |
| | Topic 4: Natural regeneration and augmentation techniques for NTFPs<br><br>Group exercises and discussion | 1 hrs |
| | Topic 5: Principles of sustainable harvesting, good collection protocols with examples of sustainable collections of leaves of *Cinnamomum* species, fruits of *Sapindus emarginatus*, and resin of *Ailanthus triphysa* | 2 hrs |
| | Group exercises and discussion | 1 hr |
| | Conclusion and valediction | |

# 2.0 NON-TIMBER FOREST PRODUCTS: AN INTRODUCTION

NTFPs are used within a complex socio-economic and ecological environment. Traditional forest-inhabiting communities might have used NTFPs/medicinal plants (MP) in a variety of ways, including as barter for other food items and for income generation. NTFPs have significant cultural values, and many have important medicinal values contributing to the community's health and well-being. The term NTFP is not a biological category. Rather, its significance is socio-cultural, and highlights the lesser documented relevance of biodiversity.

The term "non-timber forest products" (NTFP) encompasses all biological materials other than timber, extracted from forests for human use (Box 1). These include fruits, nuts, vegetables, medicinal plants, gums, resins, essences, barks, fibers (such as bamboo, rattans, and a host of other palms and grasses), fish, and game. The term "non-wood forest product" (NWFP) differs from the commonly used NTFP in that it excludes all wood parts.

In contrast, collection of NTFPs benefits the poorest of the poor, living on the edge of poverty, and the small income they receive provides a range of socio-economic benefits to these people. This should motivate them to conserve the key subsistence resources for the future (Lawrence, 2003).

**Box 1: "NWFP"**

According to the Food and Agriculture Organization (FAO) (1999), non-wood forest products (NWFP) consist of goods of biological origin other than wood, derived from forests other than wooded land and trees outside forests. The three terms encompassed by the term "non-wood forest products" (NWFP) are:

- ***Non-wood****:* Excluded are all woody raw materials such as timber, chips, charcoal, and fuel wood, as well as small woods such as tools, household equipment, and carvings.
- ***Forest****:* Derivation must be from forests or other wooded lands, or trees outside forests. "Forest" refers to a natural ecosystem in which trees could be a significant component. However, forest products are derived not only from trees, but from all plants, fungi, and animals (including fish) for which the forest ecosystem provides habitat.
- ***Products:*** Products must be tangible and physical objects of biological origin, such as plants, animals, and their products

## 2.1 NTFPS AND THEIR IMPORTANCE

Historically, people have valued forests *not for wood alone* but for a wide range of other products derived from them. Recognition of the role of NTFPs has increased in the contexts of employment generation, food, health, livelihood, and other essential socio- cultural needs of any people, more so traditional peoples. Large numbers of rural poor, and even urban poor, with access to wild areas rely on a variety of forest products for their own use, as raw materials of cottage industry, or as a source of livelihood (income). Many NTFPs like *Phyllanthus emblica*, cinnamon, rubber, cocoa, etc., have over time become products of large-scale plantations.

Collection of NTFPs usually has affected the forest ecosystem less than timber extraction, and can provide an array of socio-economic benefits (particularly through community action), and

therefore can become an important component of forest and ecosystem management (Brown et. al 2002). NTFPs are important to three main categories of people:

- Rural populations who have traditionally used them for livelihood, social, and cultural purposes
- Urban consumers, who purchase them for medicinal, cosmetic, and “nutraceutical” uses
- Traders and product processors for value addition and sale.

## 2.2 CURRENT TRENDS AND EMERGING ISSUES IN NTFP MANAGEMENT

The disheartening scenario of NTFPs in India arises from a multiplicity of factors affecting given areas—environmental, social, economic, and political operative. People and agencies attempting to protect and conserve natural resources must understand these contributory factors to formulate a proper conservation strategy.

**BOX 2: MAJOR ISSUES IN NTFP MANAGEMENT**

- Destruction of natural habitats: This involves large-scale diversion of natural habitats and complete removal of forest areas for different developmental activities.
- Increasing demand and overharvesting of the source: Increase in demand for NTFPs/MPs and derivatives prompts removal beyond the potential harvest from the wild, thereby subjecting the resource base to severe stress, leading to depletion and extinction.
- Insufficient understanding/knowledge about NTFPs/MPs: This is lack of comprehensive and exhaustive information on various aspects of populations, reproductive biology/ecology, propagation methods, and other aspects of NTFPs/MPs.
- Improper collection and export norms for NTFPs/MPs: Absence of appropriate criteria specifying quantity to be collected, season/time and frequency of collection of NTFPs/MPs, and handling are of concern. Many NTFPs/MPs in raw/processed forms are among the commodities exported from the country.
- Inherent features of the plant: Certain inherent features of some plants render them easily vulnerable to extinction.

**TABLE 1: KNOWING COMMUNITY UNDERSTANDING ABOUT NTFP – GROUP EXERCISE**

| Objective | Knowing the community's idea |
|---|---|
| Group size | 10-12 members in a group (if many VFCs are present, club them together) |
| Location | Class room |
| Time required | 20 minutes |
| Materials required | Writing material, flip chart, board, pen/pencil/chalks |
| Convener | Resource person/expert |
| Activities | Following questions to be answered by the community:<br>1. How do you define NTFP in your region?<br>2. What are the components included in the definition of NTFP/MP in your region?<br>3. What economic plant species occur in your region?<br>4. What products do they produce?<br>5. How they are different from timber products? |
| Expected outcome | Improved understanding and clarity of the concept of NTFPs |

## 2.3 ASSESSING VALUE CHAINS OF NTFPS

A holistic view of NTFP market chain valuation can provide insight into links between NTFP-based activities and their contribution to livelihoods, and therefore understanding of the importance of NTFPs to populations. This in turn can guide development, governance, and management of value chains. Knowing the "real" value of NTFP market chains is important to address governance issues in market chains. Governance arrangements in a market chain have critical implications for how values are determined and benefits are distributed in market chains (Jensen, A., 2009). Variables that play large roles in determining how global value chains are governed and change include complexity of transactions, ability of actors to codify transactions, capabilities in the supply base, access to information and exchange methods, market structure, transparency and entry barriers to markets—at individual, household, and community levels. Understanding how these variables interact and the power plays in chains can help those active in NTFP market chains improve their position, income generation, and resource management. This understanding can aid regulators and development organizations by indicating the range of values of NTFP markets, and by providing a systemized method for analyzing these indicators and their impacts.

Governance within global value chains has been identified as an important determinant of how value is controlled and distributed along a value chain, and ultimately affects livelihoods (Marshall et al., 2003; Velde et al. 2004; Kusters, Achdiawan et al., 2006; Schreckenberg et al., 2006; Belcher and Schreckenberg, 2007). Level and type of governance affect costs; highly governed but also competitive chains have been shown to be very successful in reducing production costs, increasing quality, and increasing production speed; such chains also are sources of information on how to improve skills and production flows. Particular determinants include how access to a market is governed to determine how, where, and when actors participate in a value chain, how and where funnels for technical assistance enter the chain, and who and which stages of value chains are promoted for policy initiatives (Ingram, V. and G. Bongers. 2009).

The impact of value chains on poverty and marginalization can be assessed by examining the level of integration of people and areas into global value chains, and trading relationships. Poverty may be exacerbated if “normal functioning” of chains where the poor or chronic poor are involved (usually in initial production or processing stages) are left ‘’unchecked’’ to market and social forces. This is especially the case for chains driven by retailers and branded manufacturers. Where value chains are less clearly driven by northern-based actors, integration in even “normal” circuits of value chains can substantially and positively impact poverty. Conditions of inclusion in and/or exclusion from value chains are generally more important than inclusion and exclusion per se (*IDS Bulletin* 32.3, 2001)

## 2.4 RESOURCE ASSESSMENT OF NTFPS

Periodic assessment of NTFP resources is an essential prerequisite for working out details of sustainable management. This involves examination of constituents of commercially useful resources and effects of their exploitation on the resource base. The aim is to assess potential of NTFPs at present and in the future through quantification in the wild, combined with market or product surveys. A multi-stakeholder approach will help bring together expertise to develop and standardize appropriate procedures and protocols for NTFP assessment.

VFCs should develop an understanding of the species and quantity of NTFPs collected for different purposes.

VFCs should have the list of NTFPs collected from the management area. Information should include details such as plant parts collected by the local community from forest and non-forest areas, locations of collection, number of families dependent on the species, quantities collected, and end-uses, as far as possible.

Participatory assessment of resources (species collected, that is, roots, leaves, fruits, gum, flowers, etc.):

- For different uses such as medicine, food, cosmetics, industrial use, etc.
- From forest areas and non-forest areas (agricultural lands, waste lands, revenue forests, etc.)
- For commercial and own use.

Processing and value addition will increase economic incentives for local communities and provide more employment.

**TABLE 2: AVAILABILITY OF NTFP AT VFC LEVEL – GROUP EXERCISE**

| Objective | Understanding on availability of NTFPs at VFC level |
|---|---|
| Group size | People from one VFC in a group |
| Location | Class room |
| Time required | 30 minutes |
| Materials required | Writing material, flip chart, board, pen/pencil/chalks |
| Convener | Resource person |
| Activities | 1. Ask from where it is collected and purpose of collection<br>2. Discuss marketing and value addition programs<br>3. Write the name of the NTFPs and their uses in the VFC area |
| Expected outcome | Number of NTFPs collected for different purposes at VFC level |

## 2.5 QUANTIFICATION OF AVAILABILITY OF NTFPS/MPS

The first step is to assess population size, availability, and extractable quantity of NTFPs. Information on species-wise abundance, distribution, and reproductive biology is very important. It is essential to document the quantity of NTFPs collected location-wise, as well as frequency and method of collection, and details of actual collectors. The percentage of NTFP collected from an area for own use and sale, combined with demand for the products in the market, determines the pressure on and extent of threat to a species. Experienced collectors are generally aware of destructive practices and are able to develop thumb rules for sustainable collection. Use the format for assessment indicated in Table 4.

**TABLE 3: NTFP QUANTIFICATION METHOD FOR COMMUNITY**

| Objective | NTFPs resource quantification and assessment |
|---|---|
| Group size | 10-12 members in a group (if many VFCs are present, club them together) |
| Location | Classroom and outdoor |
| Time required | 5 minutes in the class room + 30 minutes in the field + 10 minutes for sharing from each group |
| Materials required | Writing material, pen/pencil |
| Convener | Resource person/expert |
| Activities | 1. Ask people in the group to discuss and fill Table 4.<br>2. After completing the Table, ask group members to discuss the current resource status of NTFPs in their VFC area.<br>3. Ask the group to categorize the species according to their local conservation status as threatened, vulnerable, near extinct, abundant, etc. |
| Expected outcome | The information will increase understanding of availability, population, and conservation status of each NTFP resource. |

**TABLE 4: FORMAT FOR CAPTURING DETAILS ABOUT NTFPS' COLLECTION**

| NTFPs/MPs | No. of people involved | Collection period (months) | Quantity collected (kilograms [kg]) | Subsistence (%) | Sale (%) | Income (Rupees [Rs]) |
|---|---|---|---|---|---|---|
| NTFPs | | | | | | |
| 1. | | | | | | |
| 2. | | | | | | |
| 3 | | | | | | |

## 2.6 PARTICIPATORY TECHNIQUES FOR NTFP MONITORING

Harvesting qualitatively and quantitatively affects vegetation patterns, as well as growth and development of particular species in natural forests. Any such intervention, whether natural or manmade, must be monitored. Methodologies should be designed for monitoring changes; mitigation options should be developed for recovering the natural statuses of species, as well as biodiversity associated with these. Also required are institutional mechanisms for regular monitoring—implemented via provision of necessary training and monetary support.

Before embarking on monitoring, it is important to identify the following key factors in sustainable harvesting of selected NTFPs:

- Sustainable forest development: Forest development must be consistent with conservation that not only meets the needs of the present but also will satisfy future needs and aspirations of the community. Forests provide products needed for sustenance such as fuel wood, fodder, NTFPs, and small timber; forests also yield non-tangible environmental benefits.
- Monitoring should thus meet criteria associated with healthy forests, people's perception and participation, environmental indicators, and economic viability.
- Sustained and effective participation of the local community is important. A goal of any participatory monitoring should include assessments of current extent and effectiveness of participation, and development of strategies to promote sustained participation of the community in monitoring.

### 2.6.1 Objectives of participatory NTFP monitoring

The primary objective is to promote scientific management of the forest and NTFPs by local communities, followed by sustainable utilization of resources to generate livelihood and resource security. Other objectives include:

- Enabling the local community to monitor the forest, vegetation, and ecological, social, and economic issues of NTFP management at the VFC level
- Building institutional structures within the VFC and capacity within the local community to equip scientific monitoring

- Facilitating adaptive management of selected NTFPs to increase biodiversity and flow of products, and demonstrate benefits in order to motivate and sustain interest of the local community.

### 2.6.2 Approach to participatory NTFP monitoring

This is a tool for adaptive forest management. VFCs can measure impacts of sustainable harvesting as an important activity. Thus, monitoring every year or once every 2 years may be mandated, depending on type of forest and human resources available. Monitoring could occur at two levels: the village community level, with minimal observations, and the Forest Department level, with more emphasis on size class distribution, changes in numbers of individuals within species, regenerative capacity, etc.

### 2.6.3 Monitoring of institutional, social, ecological, and economic issues

- ***Institutional issues:*** Institutional issues pertaining to monitoring include (1) structures and functions of VFC, forest divisions, and state and national level institutions; (2) membership of various institutions, particularly the VFC; (3) effectiveness of participation of local communities and Forest Department; (4) factors contributing to participation of communities; (5) role of Forest Department, NGOs, and other institutions; and (6) capacity, activities, and impacts of institutional building.
- ***Social issues:*** Social issues pertaining to monitoring could include (1) impacts of collection of NTFPs on different social groups in the village; (2) factors contributing to effective participation of women, landless people, and artisans; (3) development of leadership and generation of awareness; (4) sharing of costs (of protection) and benefits among different social groups; and (5) impact on quality of life.
- ***Ecological and silvicultural issues:*** Ecological and silvicultural issues in monitoring studies could include (1) forest regeneration model or the approach adopted; (2) biodiversity status; (3) species of community, species actually planted; (4) silvicultural practices adopted; (5) rate of growth and biomass production; (6) NTFP species' regeneration; (7) sustainability of regeneration; (8) grazing and harvesting practices adopted and impacts on sustained production; (9) species choice and silvicultural practices to be adopted for sustaining flow of forest products, and (10) impacts on soil and water resources of the village.
- ***Economic issues***: Economic issues could include (1) investment and operational costs; (2) opportunity cost to communities for participation; (3) economic values of different products (grass, fuel wood, NTFP, timber); (4) cost-benefit analysis; (5) economic indicators to promote community participation; and (6) cost-effectiveness of afforestation.

Because monitoring has to be a dynamic and continuous process, establishment of institutional mechanisms for participatory NTFP monitoring at the village level is necessary to enable the local community to monitor statuses of resources over a period of time. Ideal institutions are Joint Forest Management Committees (VFCs) initiated under the Joint Forest Planning and Management (JFPM) program in Karnataka. Suggestion is to create teams under VFCs to

ensure monitoring, and to involve them in planning and managing resources based on the monitoring process.

### 2.6.4 Strategy for participatory NTFP monitoring

The rationale for developing monitoring systems through participatory means is that it enables active involvement of local institutions and communities in proper management of forests. The Forest Department and local NGOs (if any) are expected to facilitate the process.

Any design for use of biological elements must incorporate a system sustainable in several senses—biologically, ecologically, economically—and socially appropriate. **The basic idea behind monitoring is that NTFP resources should be managed well and utilized sustainably**. Sustainable use has been defined as use of components of diversity in a way and at a rate that does not lead to long-term decline of biological diversity, thereby maintaining potential to meet the needs and aspirations of present and future generations.

The central strategy of this monitoring is a focus on participatory, scientific, and adaptive management of forests via development of participatory steps and uses of local knowledge and understanding of resource management.

### 2.6.5 Generation of baseline information and monitoring of NTFP resources

The prerequisite for monitoring of resources for longer periods is generation of baseline data/information. Data acquired regarding ecological, social, personal, and economic parameters during the first year can be considered baseline information, to which monitoring data of subsequent years will be added to increase understanding of changes that lead to improvement.

It is vital to always compare changes to original conditions; the purpose of generating baseline data under monitoring is to provide direction for changes anticipated in adaptive management of forests and NTFPs.

Local NGOs (if any, otherwise Joint Forest Committees [JFC]) may have to educate local communities about the purpose of gathering baseline data, and convince them to do so. Assumedly, over the long term, local communities will realize that this information is useful for monitoring progress.

A factor to keep in mind while establishing a baseline scenario is that local NGOs (if any, otherwise JFMCs) can take the lead in acquisition of such information, with the help of local communities and the Forest Department. It is essential to record data on proper documents through field investigation. All relevant information should be gathered, as this may have current or future implications. Documentation and sharing of this information with VFCs and the Forest Department is essential to verify its validity and usefulness in future applications.

### 2.6.6 Development of human resources for NTFP monitoring

***Sensitization of the village community***

The resource person, with active involvement of local staff of the Forest Department, can brief the community about the aim and importance of NTFP monitoring, methodology to be adopted, and expected results of analysis of data. Every aspect of monitoring activity should be explained to the community, with provision of examples for better understanding.

***Training of community members***

VFCs require training on techniques applied in NTFP monitoring. Simple parameters have to be selected for the purpose. Normally, villagers can identify almost all trees, shrubs, and herbs in their forests by local names. They are also knowledgeable about the economic importance of species, their usefulness, etc. However, villagers require (1) minimal training in and demonstration of recording these parameters, and (2) instruction in simple analysis. **A team of at least 10 members, composed of representatives from different stakeholder groups and approved by the VFC, can be trained for an intensive monitoring process.**

***Field methods for monitoring***

Standard ecological methods, and social and economic index method, can be adopted for studying various ecological, social-personal, and economic parameters. For example, for ecological monitoring, measurements of tree girth, height, regeneration status, etc., can be recorded. The number of quadrates and replicates can be based on the type of vegetation sampled.

***Relevance of data and analysis***

Success and performance of natural protection and plantations are important in this context. Various factors influence performance, such as protection, grazing, and fire—changes of which must be recorded (in terms of number of species, density, etc.) to understand growth and development of plantations. This information could help in adoption of suitable management strategies, considering local needs and environment. Regarding socio-economic data, generation of baseline data will indicate performance/progress of social and economic development among VFC members and the village as a whole by reference to the socio-economic index.

**TABLE 5: DIFFERENT STEPS OF PARTICIPATORY NTFP MONITORING PROCESS AT VFC LEVEL**

| Stage | Step | Objective/output | By whom |
|---|---|---|---|
| Pre-monitoring stage | Select VFC | A selected VFC for monitoring | Resource persons and Forest Department |
| **Stage I:** Constitution of monitoring team | VFC meeting | To explain the purpose and process of participatory NTFP monitoring at VFC level<br>To prepare adaptive management plan for selected NTFPs | Resource persons and Forest Department |
| | Stakeholder group meeting | To select representatives for the team | VFC and Forest Department |
| | Participatory forest management (PFM) team meeting | To train for monitoring process<br>To monitor, document, and analyze | Resource persons and monitoring team |
| **Stage II:** Generation of baseline data/information | Forest, vegetation, and ecology related | To understand vegetation status<br>To prepare forest management plan | Monitoring team and VFC |

| Stage | Step | Objective/output | By whom |
|---|---|---|---|
| **Stage III:** Monitoring of parameters | Field measurements | To arrive at quantity and quality of data | Monitoring team |
| | Recording | To use for present and future reference | Monitoring team and VFC |
| | Analysis | Interpretation of data | Monitoring team and VFC |
| **Stage IV:** Decision making process and adaptive management | Team meeting | To prepare inputs for decision making process | Monitoring team |
| | VFC meeting | To discuss and consider inputs for adaptive management of forest | Monitoring team, VFC, Forest Department, and Resource persons |

### 2.6.7 Quantification technique for NTFPs

***Transact walk***

The transact walk can be carried out by VFC and Forest Department staff members to determine the present status of the forest/NTFPs. During the transact walk, different plant species, water storage structures, paths, plantations, cultural properties, etc., will be identified. The important NTFP species will also identified.

**TABLE 6: OBSERVATIONS DURING TRANSACT WALK**

| Issues for monitoring | Observations in the field |
|---|---|
| Landscape and land use pattern | |
| Forest patches and vegetation status | |
| List of trees/NTFPs | |
| List of NTFP shrubs and herbs | |
| Animals and birds | |
| Water bodies, tanks, and rivers | |
| Watershed area, check dams, etc. | |

***Trend analysis map (NTFP species present in previous and current status)***

Assess the condition of NTFPs in the village by reference to trend data:

**Name of the forest patch:**

**Approximate area:**

**Local name of the patch:**

**TABLE 7: HISTORY AND CURRENT CONDITION**

| 25 years ago | 10 years ago | Current status |
|---|---|---|
| | | |

***Quadrant sample technique***

During the transact walk, the NTFP collection area will be identified for laying out quadrates, to measure biophysical and biodiversity parameters of selected NTFPs.

**Technique of sampling:** Plot will be selected where selected NTFPs are collected

**Technique:** Quadrate technique

**a:**

25 x 25 meters (m): Matured trees

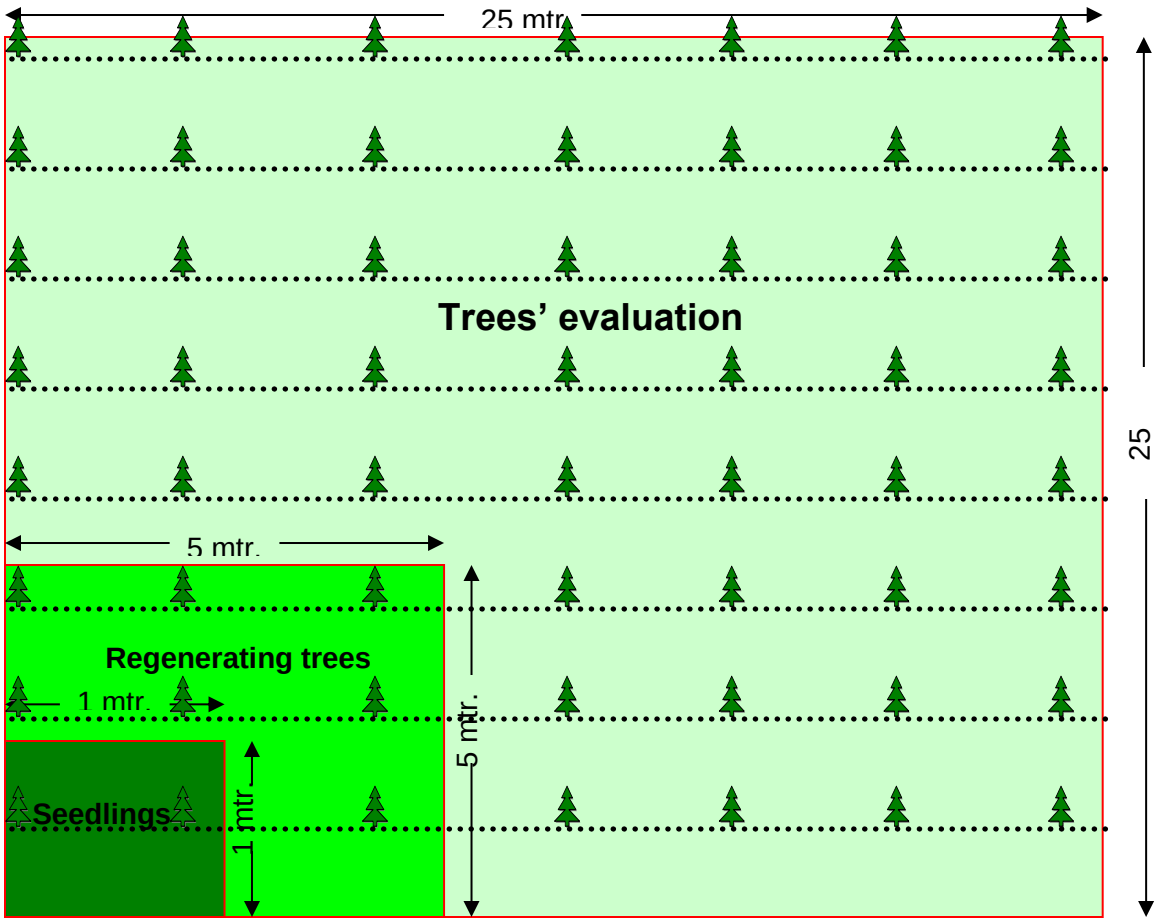
5 x 5 m: Regenerating trees

1 x 1 m: Seedlings

**PHOTOGRAPH 1: ENUMERATION OF SEEDLINGS IN 1 X 1M QUADRATE**

**PHOTOGRAPH 2: MEASURING THE GIRTH OF THE TREE IN QUADRATE OF 25 X 25M, AND PERMANENT MARKING OF THE TREE FOR LONG-TERM MONITORING**

**FIGURE 1: MODEL OF QUADRATE SAMPLING TECHNIQUE**



Measure height and girth of each tree in girth class exceeding 10 centimeters (cm).

**TABLE 8: ENUMERATION OF SELECTED NTFP SPECIES, WHERE SI IS THE SPECIES IDENTIFICATION NUMBER**

| Sl. number | Name of selected NTFPs | Height (m) | Girth (cm) | Remarks |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |

**TABLE 9: ENUMERATION OF ASSOCIATED SPECIES**

| Sl. number | Name of species | Remarks |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |

**TABLE 10: REGENERATION OF SELECTED NTFP SPECIES**

| Sl. number | Name of species | Number in each quadrate | Remarks |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

### *Quantification of data*

**TABLE 11: QUANTIFICATION OF MATURE NTFP TREE SPECIES**

| Sl. number | Name of species | Height (m) | | | Girth (cm) | | |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Avg. | Max. | Min. | Avg. |
| 1. | | | | | | | |
| 2. | | | | | | | |
| 3. | | | | | | | |

**TABLE 12: QUANTIFICATION OF REGENERATING NTFP TREES**

| Sl. number | Name of species | Number |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |

**TABLE 13: QUANTIFICATION OF SEEDLINGS OF SELECTED NTFPS**

| Sl. number | Name of species | Number |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |

## 2.7 ACQUIRING BIOPHYSICAL AND BIODIVERSITY INFORMATION REGARDING NTFP SPECIES

### 2.7.1 Indicators for biophysical and biodiversity information

- Species diversity and density—across plots for NTFP species
- Species survival and growth rate
- Current use of resource and its economic value
- Demand and supply status of forest resources with future projects
- Regeneration status
- Biodiversity associated with selected NTFP species.

### 2.7.2 Indicators for conservation and maintenance of selected NTFPs and biodiversity

- Growth of trees, flowering, and fruiting
- Improved species richness and density
- Improved harvest methods
- Natural regeneration status
- Rainfall
- Extent of weeds, pests, diseases, grazing, fire, etc.
- Availability of food to animals and birds
- Change in number of trees planted on private lands
- Community composting
- Improvement of family economic conditions and quality of life
- Continuous availability of NTFP produce
- Increased employment opportunities
- Increase in availability of NTFPs for sustenance and sale.

## 2.8 FORMAT FOR COLLECTION OF BASELINE DATA/INFORMATION

**TABLE 14: FOREST TYPES INFORMATION**

| Forest class | Area (hectares [ha]) | Plantation, if any |
|---|---|---|
| Reserved forest | | |
| Protected forest | | |
| Area under JFPM | | |
| Area under Forest Development Agency (FDA) | | |

**TABLE 15: AFFORESTATION UNDER DIFFERENT LANDS**

| Scheme and model of the plantation | Year | Area | Species |
|---|---|---|---|
| Enrichment plantation | | | |
| Natural protection | | | |
| Fuel wood plantation | | | |
| NTFP plantation | | | |
| Multipurpose plantation | | | |

**TABLE 16: COLLECTION OF NTFP RESOURCES IN THE VILLAGE**

| Resource/stakeholder group | Number of families collecting | Quantity gathered (per family) | Frequency | Season of collection |
|---|---|---|---|---|
| NTFPs<br>1. LF<br>2. SF<br>3. LL<br>4. Women & children | | | | |

*Notes:*

LF Large farmers
SF Small farmers
LL Landless people

**TABLE 17: NTFP RESOURCE NEEDS MET (% COLLECTION TO MEET VILLAGE NEEDS)**

| | Forests | Agricultural lands | Plantations | Buy from market |
|---|---|---|---|---|
| NTFPs<br>1.<br>2.<br>3.<br>4.<br>5. | | | | |

**TABLE 18: NTFP RESOURCE BASE**

| | Area | Dominant species |
|---|---|---|
| Natural forest (area) | | |
| Plantation I (area) | | |
| Plantation II (area) | | |
| Plantation IIII (area) | | |

**TABLE 19: STATUS OF NTFP RESOURCES (NATURAL FORESTS AND PLANTATIONS)**

| | | Dominant species | NTFPs extracted | | | |
|---|---|---|---|---|---|---|
| Density of forest | Area | | NTFP 1 | NTFP 2 | NTFP 3 | NTFP 4 |
| **Natural forest** | | | | | | |
| Dense forest | | | | | | |
| Moderately dense | | | | | | |
| Open forest | | | | | | |
| Degraded forest | | | | | | |
| **Plantations** | | | | | | |
| Plantation 1 | | | | | | |
| Plantation 2 | | | | | | |
| Plantation 3 | | | | | | |
| Plantation 4 | | | | | | |

# 3.0 NURSERY PROPAGATION TECHNIQUES FOR SELECTED NTFP SPECIES

Raising plantations or farming NTFP species will require a good nursery of quality seedlings. Nurseries provide not only seedlings but are also a good source of income and can generate employment directly or indirectly for those involved. When considering augmentation of NTFP resources, the basic need is centralized nurseries to provide quality planting materials.

## 3.1 SITE CHARACTERISTICS FOR NURSERY

A reasonably centralized nursery has its own advantages. Ideally, a nursery should be set up close to the plantation site, which will greatly reduce the cost of transportation. The site should have an assured water source, so that a proper irrigation facility could be arranged. Because the seedlings are to be distributed from the central nursery, transport and communication facilities must be organized, and access to the nursery must be kept in mind. Seedlings do well in proper sunlight and moisture regimes. Hence, the land to be selected should be exposed to sufficient sunlight. The soil should preferably be sandy loam; areas with rocks and boulders are to be avoided. The site has to be well drained and adequately protected from grazing and browsing cattle and wild animals such as wild boars, deer, rabbits, etc. Availability of manpower for working will be an added advantage.

### 3.1.1 Preparation of nursery beds

After selection, the site should be properly fenced. Nursery beds can be properly laid out. Usually the beds encompass 10 x 1.2 m, but this need not be a rigid criterion. On slopes, the size could differ—as small as 2 x 1.2 m or 5 x 1.2 m. In a nursery will be two types of beds. In fact, most nurseries visited by us do not maintain these sizes and have their own dimensions considering their land and net house size and slope: (1) open bed or exposed beds that have only side protection of bamboo splits or bricks; and (2) shaded beds that have an overhead shade of thatch, netlon, agro-shade, or plastic sheet in addition. These shades are given at a height of 1.5 m, and slant to 1.2 m for draining down water. Similarly, several beds can have a common shade or they can be in a greenhouse/net house. These were the cases wherever we visited.

### 3.1.2 Management of germination beds

Depending on their functions, nursery beds are either germination/mother beds or seedling beds. Mother beds are shaded beds where seeds are sown for preparing seedlings. In these beds, soil is to be properly sieved, and no pebbles or stones should be left. Sand should be preponderant in the bed mixture. These beds could receive a dressing of fungicide like Dithane/Indofil, etc., and pesticides, if required. Alternatively, these beds can be treated with organic neem-based pesticides or fungicides. Currently, several commercial preparations are available in the market for raising organically produced seedlings. Soil in the beds should be properly worked out and mixed.

### 3.1.3 Sowing techniques in beds

In these beds, seeds could be either broadcasted or sown in lines. Line sowing has several advantages—for easy pricking out, weeding, manuring, etc. Line sowing occurs in shallow furrows of 0.5-2 cm or even up to 5 cm so as to burrow the seeds, which obviously depends on the size of the seeds. The furrows are then closed. Broadcasting involves very small seeds, and after sowing, a thin layer of soil is spread over.

### 3.1.4 Mulching and watering

After sowing, the usual practice is to mulch with a thin layer of thatch. This is more important for open beds. In the sown beds, regular adequate watering is necessary— usually two times a day during non-rainy seasons. However, watering should be to the minimum and as per requirement only. Overwatering should be avoided.

### 3.1.5 Germination period

Depending on seed dormancy and viability, germination will occur within 5 to 60 days, or even within 150 days or more. Seeds of *Sapindus*, etc., take months to germinate. They have very long dormancy (Bisht and Ahlawat, 1999).

***Pricking out***

After germination in mother beds, the seedlings can be transplanted/pricked out to polythene bags of required size depending on the size of seeds. The usual sizes, in inches, are 4 x 5, 5 x 7, 7 x 9, etc.

Pricking out occurs at the three-leaf stage or when seedlings attain a reasonable size of 1-5 cm. Sometimes it is possible to prick out only at the five-leaf stage.

Large-sized seeds can also be directly sown to poly bags or seedlings can be raised in seedling beds. Seeds like *Mesua ferrea, Terminalia chebula, Vateria* sp., *Canarium strictum,* etc., can also be sown this way, avoiding the mother bed stage.

Transplanted seedlings are kept in shade beds or in open beds. These are regularly watered; pest and disease incidence is monitored and controlled.

### 3.1.6 Advantages of planting tall seedlings

Though ideally, 1-year old seedlings are maintained in nurseries and used for raising plantations, they can be kept for over 2 years. In recent times, root trainer nurseries have also become popular (Bisht et al. 2001). To avoid damage by cattle and other animals, use of tall seedlings on plantations is generally preferred. In these cases, even 2- or 3-year-old seedlings are used. This type of planting is applied widely in landscaping and avenue plantations. To maintain seedlings in beds for long durations without root penetration to deep soils, special treatments will be required.

## 3.2 VEGETATIVE PROPAGATION

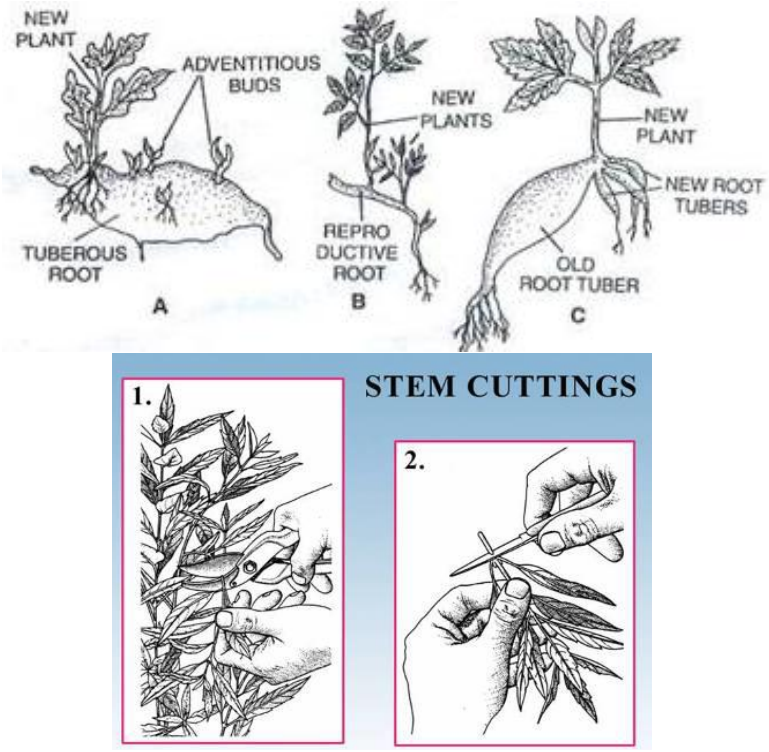
Aside from raising seedlings via seeds, they can also be raised by application of vegetative methods. This is particularly important when seeds are not available or have extremely short viability. Vegetative propagation has advantages over seed because seedlings can be produced nearly throughout the year; they are true to plant type, with characteristics of the mother plant. They produce fruits early, as the cuttings are physiologically mature. They are hardier than

seed-raised seedlings. Different methods of vegetative propagation are branch/stem cutting, root suckers, tiller splitting, rhizome cutting, tuber, rhizome, bulb, leaf, etc. Methods of grafting or layering can also be tried.

### 3.2.1 Rhizomes, tubers, and bulbs

Plants like *Dioscorea*, *Costus*, *Alpinia*, *Gloriosa,* turmeric, etc., can be propagated by use of freshly collected rhizomes or tubers. Regarding *Ginger*, *Dioscorea*, and similar plants, propagation materials and use can also be split or cut. These can also be used directly at planting sites without need to go through the nursery stage.

**FIGURE 2: VEGETATIVE PROPAGATION THROUGH ROOTS/TUBERS/RHIZOMES/BULBS (BELOW) AND STEM CUTTINGS (BOTTOM)**



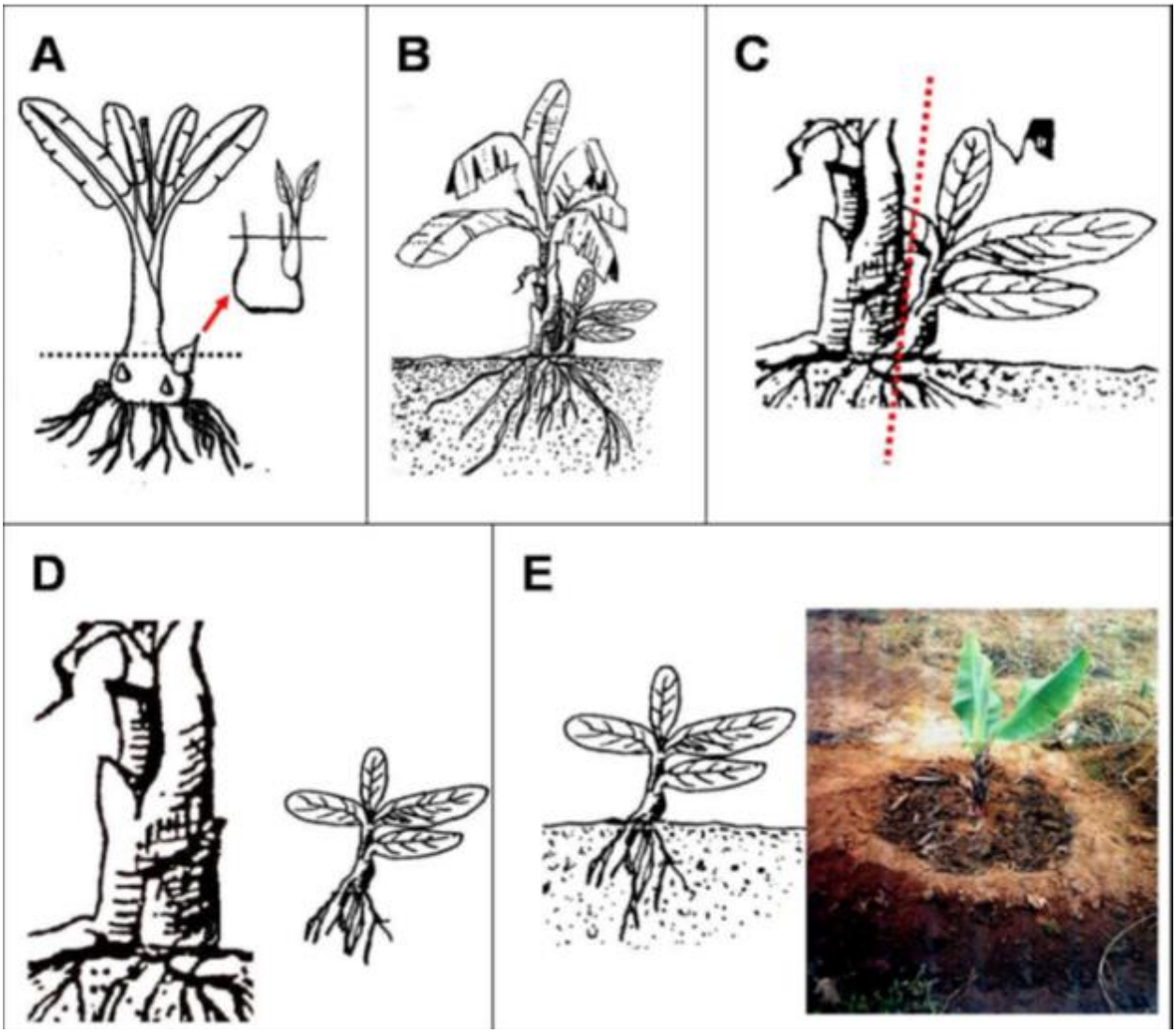

### 3.2.2 Branch cuttings

This method of propagation is widely practiced in cases of *Piper* spp., *Rauvolfia*, *Hibiscus*, *Adathoda, Tinospora,* etc., where 1-year old branches are selected and cut into 10- to 20-cm-long pieces with more than one node. The base of the cutting is given a coating of rooting hormones or is dipped in hormonal solution and then planted slightly slanting, preferably in sand beds. They are profusely watered. Rooted cuttings can be transplanted to poly bags or can be used as naked seedlings. Sprouting will be observed within 1 to 3 weeks. Rooting, however, will occur after 30 to 90 days.

### 3.2.3 Suckers and slips

Some plants like banana, *Piper mullesua, Acorus calamus, Aloe*, *Centella, Bacopa,* etc., produce suckers/stolons or slips that can be separated/extracted and used as seedlings for planting.

**FIGURE 3: VEGETATIVE PROPAGATION THROUGH SUCKERS**




A-C: The sucker grows from the bud around the true stem, called rhizome, which is a horizontal underground stem

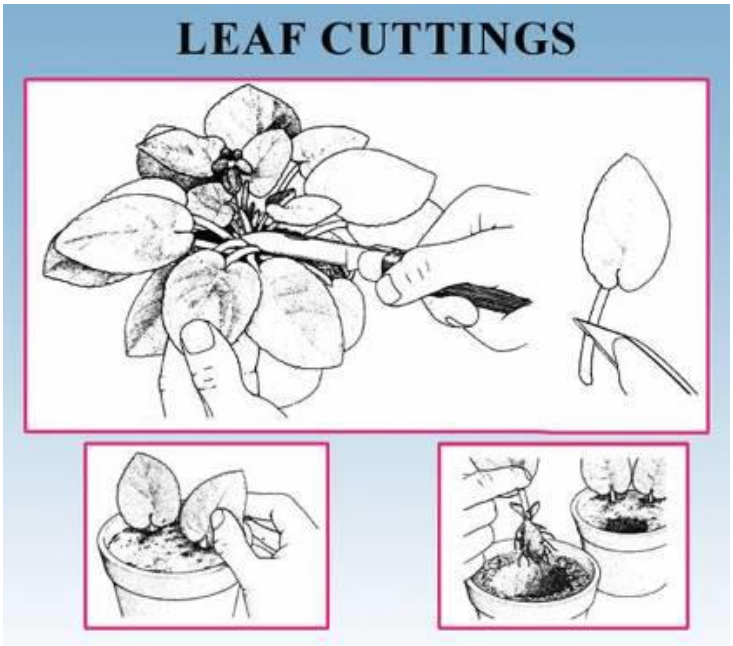
D: The sucker is separated from the main plant along with its roots.

E: The separated sucker is planted in the soil and is a regenerated plant.

### 3.2.4 Propagation though leaves

Leaves of *Kalanchoe* (*Bryophyllum*) produce seedlings once in touch with soil, which can also be considered an easy method of propagation.

**FIGURE 4: VEGETATIVE PROPAGATION THROUGH LEAVES**




Leaves are cut from the mother plant and planted in soil. After rooting occurs, remove and plant separately.

### 3.2.5 Layering and grafting

These methods, popular in horticulture, can also be applied for quality seedling productions in cases of medicinal plants. *Embelia ribes, Cinnamomum* spp, *sapindus* etc., can also be propagated this way.

**FIGURE 5: STEPS IN SIMPLE GRAFTING**

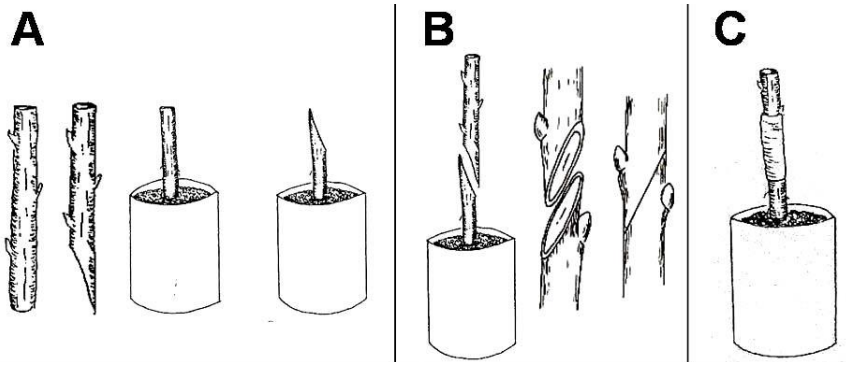
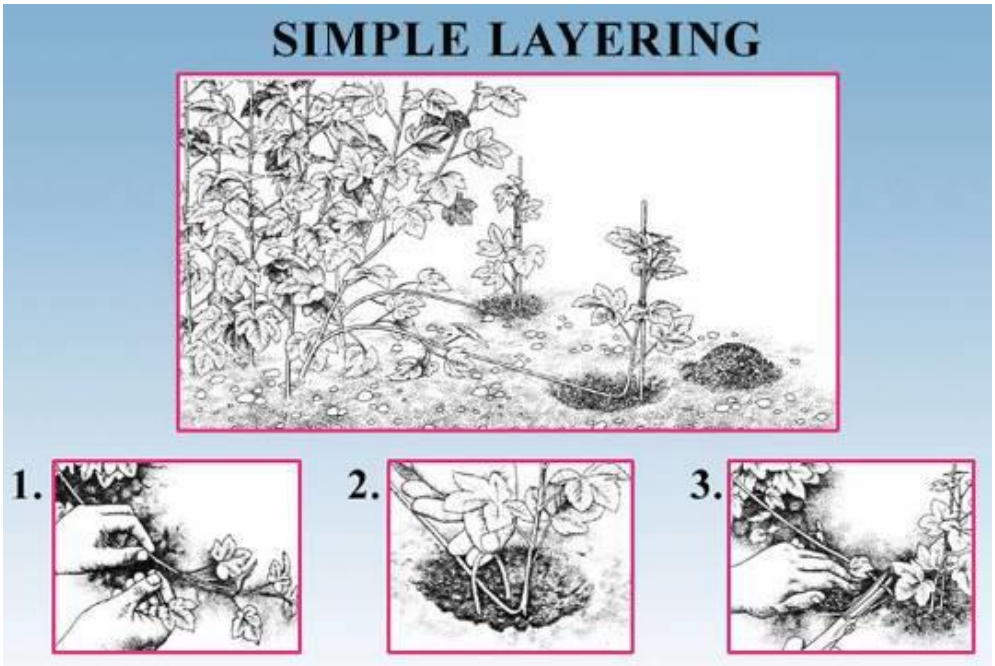


**FIGURE 6: VEGETATIVE PROPAGATION THROUGH LAYERING**




1. Select part of the branch.
2. The part is covered with soil.
3. After rooting occurs, that portion is cut and planted as a new plant.

### 3.2.6 Wild seedlings/wildings

Plants like *Cinnamomum*, *Rudraksh*, and similar seeds are difficult to germinate in nursery beds, although profuse germination occurs in wild habitats. Seedlings of these, otherwise wasted in forests, can also be collected at a very young stage and used to raise nursery stock.

## 3.3 SEED MANAGEMENT

Because seeds are the basic material and foundation for a good nursery and for quality planting material, efforts should occur to collect the best seeds from the best plants. While collecting seeds, one should keep in mind their maturity, season for collection, and method of collection. After collection, they could either be sown directly or stored for later use depending on the viability and dormancy of the seed.

The process of seed management involves the following factors:

- **Viability: "**Viability" of seeds, in common terms, is their ability to germinate and to produce seedlings which, in fact, tend to lose viability with time. Some seeds like *Vateria*, *Shorea*, etc., cannot be stored and are to be sown immediately after collection for good germination, as these seeds lose viability soon after maturity and collection.
- **Dormancy: "**Dormancy," on the other hand, is the seeds' character to germinate after a time gap. In fact, this helps the species tide over adverse periods in nature—seeds germinate during favorable seasons. Depending on the species, the seeds may have

dormancy of a few days to several months. *Rudraksh* or *Sapindus* (*Ritha)* have dormancy of over a year. Seeds maintain dormancy usually through mechanical means, like hard coat or physiological factors.

- **Seed cleaning:** In any case, after collection of fruits, the seeds are to be extracted and used for sowing directly or after undergoing proper pre-treatment. If they are to be stored, the seeds are dried to the desired level of moisture content after cleaning. Cleaning ensures removal of foreign particles and dirt and insects. They can even be graded at this stage. Standard practices like winnowing, sieving, or sorting can be selected for this purpose based on the size of the seed. Seed cleaning machines are available in the market these days. Some seeds are to be cleaned by washing or composting to remove the fruit wall.
- **Pre-treatments:** It is essential to break the dormancy to induce germination at our will. This is usually practiced through different pre-treatments that include mechanical means, water treatments, acid treatment, etc. In water treatment, the seeds are kept under cold water for a specific period—for instance, overnight, a day, or more—depending on hardness of the seed coat. Hot water is often used in place of cold water if duration is to be much reduced. Notably, treatment of all seeds in this manner is not possible.

Acid treatments of specific seeds by use of hydrochloric acid, sulfuric acid, or nitric acid are also practiced. This method involves dipping seeds in acid for brief periods, taking them out, and washing them with tap water thoroughly before sowing them.

In mechanical treatments, the seeds are scarified and the coat is mechanically punctured so that penetration of water is possible. This could occur manually or through mechanical scarifies.

Standard practices suitable for the selected species have been shortlisted after detailed discussions with nursery managers, field forest officers, and collectors of the selected species. They have shared the necessary information based on their practical experience, presented in the next section of this report, conveying specific profiles of species and nursery technology.

## 3.4 NURSERY AND PROPAGATION TECHNIQUES OF SELECTED SPECIES

### 3.4.1 Habit and habitat of *Sapindus emarginatus*

**Botanical name:** *Sapindus emarginatus*

**Family:** SAPINDACEAE

**Local name:** English – Soap nut; Hindi —– Reetha; Kannada – Kukatekayi, Antuwala

**Habit:** Tree

**Plant Description:**

A medium-sized to large deciduous tree with a globose crown and fine leathery foliage, usually reaching a height of 12-20 m and a

**PHOTOGRAPH 3: SAPINDUS EMARGINATUS**

girth of 1.8 m. It is native of China and Japan, and is cultivated throughout North India (up to 1,500 m) and in Assam (indigenous). The fruits are used as shampoo and also have medicinal properties. Fruits are drupe, globose fleshy, one seeded, 1.8-2.0 cm across and 0.8-1.2 cm in diameter, black and loose in dry fruit. Ripened fruits are collected from the forest floor/ground under the tree, and dried in shade for 3 to 4 days. Gentle cracking of pericarp releases the seeds. Seeds are very hard and orthodox, and hence can be stored for about 1 year or more. The plant is cultivated in homesteads in India for fruit pulp to be used as soap to wash hair and valuable clothes. Leaves are used as fodder for cattle.

**Nursery and Propagation Techniques *Sapindus emarginatus*:**

Propagation is through seeds.

- **Seed collection**: The ripe fruits turn pinkish and are with smooth hard pericarp. These are collected from trees by pruning the branches, plucking them from branches, or (ideally) collected them from the ground below the fruiting trees. The seeds are ready for collection by winter time. The collected fruits are brought to a seed storage facility and de-husked, or the hard cover of the fruits is removed, to expose the seeds. In fact, gentle cracking of the pericarp will release the seeds. Usually, one seed can be obtained from each fruit. Rarely, two seeds could also be present. The extracted seeds are dried for 3 to 4 days and stored for sowing purposes.
- **Seed viability**: The seeds are viable for a comparatively longer period of 12 months or more. For raising nursery seedling stock of this species, because the seeds are dormant, they must be pre-treated to break the dormancy.
- **Seed treatment**: For this, the seeds are slightly scarified near the micropylar end and subjected to warm water or boiling water treatment (ideal). The seed germinates easily, taking about 1 to 2 months. To ensure higher percentage of germination, the seed is soaked in lukewarm water for 24 hours and then sown.


- **Raising in nurseries:** After seed treatment, the seeds are sown directly in already prepared 60 x 60 cm pits at 5 x 5 m spacing, in polythene bags filled with clayey loam soil mixed with farmyard manure (FYM), or in similarly prepared nursery beds. If sown in nursery beds/germination beds, they can be line sown in approximately 3-cm furrows and covered with sand mixed with soil. The bed requires constant watering.
- **Germination period:** One to 2 months.

- **Pricking out:** Seedlings are pricked out when they attain a height of 7-10 cm. If seeds are sown directly in poly bags or fields, it is useful to sow more than one seed in the pots. After germination, extra seedlings, if any, can be removed and used for raising stock of seedlings. This will ensure adequate plant density. One-year-old seedlings or those even more aged can be used on plantations.

**TABLE 20: SUMMARY OF SEED PROPAGATION TECHNIQUES OF *SAPINDUS EMARGINATUS***

| | |
|---|---|
| **Seed collection period** | November to December |
| **Number of seeds/kg.** | 470 |
| **Seed viability** | 12 months |
| **Pre-sowing treatment** | Scarification on top of seed near micropyle is required to enhance germination |
| **Germination period** | 25-45 days |
| **Germination percentage** | 74 |
| **Seedlings obtained/kilogram (kg) seeds** | 345 |

### 3.4.2 Habit and habitat of *Ailanthus triphysa*

**Botanical Profile:**

**Botanical name:** *Ailanthus triphysa (*Dennst.*)* Alston

**Synonyms:** *Ailanthus malabarica* DC

**Family:** SIMAROUBACEAE

**Local name:** English – White palle, Maharukh; Hindi – Gugguldhup; Kannada –Halmaddi, Guggul Dhupa

**Trade name:** Maharuk, Whitesiris, White palle

**Habit:** Tree

**PHOTOGRAPH 4: AILANTHUS TIPHYSA**

**Plant Description:**

*Ailanthus triphysa*, the tree of heaven, is a densely foliaceous, deciduous tree up to 25 m tall with whitish bark. The stem is straight and cylindrical; bark is smooth in young trees and rough, glandular, and greyish brown in older trees with conspicuous leaf scars.

***Nursery and propagation techniques for Ailanthus triphysa:***

*Ailanthus triphysa* can be propagated both by seed germination and vegetatively via stem cuttings.

**Propagation by seeds:** *Ailanthus* trees flower in February-March, and the fruit, a reddish-brown samara, ripens in March-April—the ideal time for seed collection. The seeds can be stored only for a few months. Alternate wetting and drying improves seed germination. The procedure involves soaking the entire quantity of seeds in cold (room temperature) water in the evening and draining the water next morning, followed by drying the seeds under shade during the day. The cycle is repeated for 2 to 3 days.

**Nursery practices:** Raised beds of 10 x 1 m are formed. Preferably, sand, soil, and FYM (1:1:1 ratio) must form the top layer of the beds. Sowing occurs after the bed is watered. Usually, sowing proceeds via broadcast method (or dibbling) in November-December for June planting, and March-April for October-November planting. After sowing, a thin layer of soil is sprinkled on the beds to cover the seeds. The beds are also mulched with green leaves to reduce evaporation losses, and are dusted with Carbaryl 10 percent to prevent insect attack. Seed rate is 1 kg per bed. After sowing, watering occurs by use of a fine rose-can twice a day for 10-15 days, and once a day afterwards. The nursery beds also must be weeded as and when necessary.

- **Pricking out:** Germination takes place about 8-10 days after planting, and the seedlings attain a height of 10-15 cm within 6 weeks. They are then pricked out into polythene bags containing 1:1:1 mixture of sand, soil, and FYM.
- **Planting practices**: Containerized stock (commonly in poly bags, but also in root trainers) is planted in pits (15-20 cm cube) at 2 x 2 m spacing with onset of rains, in the case of monospecific woodlots. To suit requirements of intercropping, the row-to-row spacing can be altered. *Ailanthus* is ideal for planting in the homestead or farm boundaries either in single or staggered paired rows at spacing of 2.5 x 2.5 m.

  Two to three weedings may be necessary during the initial years to keep the plantation weed-free. Fertilizers may be applied @ 30-40 grams (g) nitrogen, 15-20 g phosphorus pentoxide ($P_2O_5$), and 15-20 g potassium oxide ($K_2O$) per year per sapling from the second year to the fifth year, and thereafter once in 3 years, for a pure plantation.

  If too many lateral branches are produced, pruning may be practiced. The trees can be felled/harvested over a period of 8 to 10 years.

- **Pests in nursery:** The two major pests are shoot webber *(Alteva fabriciella)* and defoliator *(Eligma narcissus)*. Shoot webber is economically more important because it will damage the terminal shoot and can result in epicormic shoot formation. Epicormic shoots lie dormant beneath the bark, their growth suppressed by hormones from active shoots higher up the plant. Under certain conditions, they develop into active shoots, such as when damage occurs to higher parts of the plant, or light levels are increased following removal of nearby plants. Epicormic buds and shoots occur in many woody species. These can be controlled by application of Quinalphos at 0.05 percent.
- **Pests in young plantations:** The above two are the major pests in young plantations also, but control measures may not be cost effective. If required, 0.1 percent Quinalphos can be applied by use of a rocker sprayer. Shoot webber affects seed production. Usually, control measures are not adopted, but any insecticide recommended by the nursery can be used.

**Propagation by stem cuttings:** The semi-hardwood branch cuttings of 10-15 inches in length and 3-4 inches in girth are treated with fungicide @ 2.5 g/1 liter (L) of water for a few minutes to

avoid fungal infection. The branch cuttings are treated with indole-3-butyric acid (IBA). Ideal concentration for inducing maximum rooting of *Ailanthus triphysa* is 3500 parts per million (ppm) of IBA. For rooting, average temperature of 30-35 degrees Celsius (°C) and relative humidity of 80-85 percent are to be maintained. After 35 days, prominent roots will be formed. After 60 days, root formation is complete and ready for transplantation.

### 3.4.3 Habit and habitat of *Cinnamomum malabatrum*

**Botanical Profile:**

**Botanical name:** *Cinnamomum malabatrum* (Nees)

**Family:** LAURACEAE

**Local name:** Kannada –Pinga Dalchinni

**Habit:** Tree

**Plant Description:**

**PHOTOGRAPH 5: CINNAMOMUM MALBATRUM**

Medium-sized tree. Bark smooth reddish-brown outside, dull red inside. Branchlets and leaves are yellow-tomentose when young. Leaves opposite and sub-opposite, apex acute, sub-coriaceous, glabrous, glossy, and tomentose. Petiole 1.5 cm long; leaf blade ovate-lanceolate, or elliptic-oblong, acute or obtuse at apex, rounded to acute at base and glaucous beneath. Flowers bisexual, greenish-yellow in terminal and axillary panicles. Berry oblong, fruiting pedicels short, smooth, glabrous, seated on a fleshy cup-shaped disc.

**Distribution:** Endemic to Western Ghats of Karnataka, Kerala, and Tamil Nadu. Fairly common tree in evergreen forests of Western Ghats at low elevations up to 500 m altitude.

**Agro-climatic requirement:** This comes up well from sea level to elevation of about 500 m. It grows in areas receiving mean annual rainfall of 2,000-4,000 millimeters (mm). Mean annual temperature in the regions of its natural presence is about 27 °C. It grows well in sandy soils and on lateritic soils.

Nursery and propagation techniques ***Cinnamomum malabatrum*:**

It can be propagated both from seeds and via vegetative means.

***Seed propagation:***

- **Seed collection:** The tree bears flowers between January-February, and fruiting is observed during March-April. Fully ripened fruits are either picked up from the tree or the fallen ones are collected and heaped in a shady place until the outer pulp rots and turns black. The fruits are crushed mildly to expose fleshy portions, then mixed with wood ash and allowed to dry for 3 days. Seeds are removed from the fruits, washed free of pulp, and sown immediately.
- **Seed viability:** Seeds are viable for only a short period of time.

- **Seed sowing:** Fresh seeds must be sown on raised beds with overhead shade, or in polythene bags containing a mixture of sand, well-rotted cattle manure, and soil in 2:1:1 proportion.
- **Germination:** In nursery beds, seeds are sown at 5 cm spacing. They germinate over a period of 15-20 days, and the percentage of germinated seeds varies from 60-70, possibly reaching 80 percent. Seedlings are retained in the nursery for 150 days.

***Vegetative propagation:***

1. Through root suckers (it is a shoot that grows from a bud at the base of a tree or shrub or from adventitious buds in its roots): Root suckers arising naturally around a mature tree are separated and planted in polythene bags.
2. Through cuttings: This can be propagated through cuttings of young three-leaved shoots and also by layering shoots.

***Transplanting and aftercare***

The seedlings can be transplanted to polythene bags at the four-leaved stage, or when 6 months old, and kept in the shade. They are transplanted to the field after 12 months. Planting occurs in 60 x 60 x 60 cm pits at spacing of 3 x 3 m. Mulching is required to prevent exposure to sun. Regular watering of plants during dry months is essential in the early years.

# 4.0 NATURAL REGENERATION AND AUGMENTATION TECHNIQUES FOR NTFPS

## 4.1 INTRODUCTION TO REGENERATION AND PLANTATION OF NTFPS

In the field, natural regeneration occurs through seeds. Though in nature regeneration occurs continuously, this could be enhanced or improved by providing suitable conditions and through external interventions.

Conditions favoring/affecting regeneration are:

- Seed production and dispersal
- Soil conditions
- Light conditions
- Genetic factors
- Nature of undergrowth and biotic factors
- Climatic factors.

## 4.2 FORMAT FOR RECORDING REGENERATION STATUS OF NTFPS

Table 21 lists steps to be followed for natural regeneration of a 1-ha plot for the selected NTFP species. Forest Department officials in collaboration with JFMCs can record observations within identified natural regeneration areas. This information will help in maintaining successful regeneration plots, as well as monitoring growth and development of the species.

**TABLE 21: RECORDING NATURAL REGENERATION FOR NTFPS**

| Activities | Name of species |
|---|---|
| Survey for selected species and its regeneration | |
| Site information, location (latitude and longitude) | |
| Habitat analysis | |
| Soil condition | |
| Light condition | |
| Inherent characters | |
| Seed production and dispersal | |
| Climatic factors | |
| Manipulation of ground vegetation and biotic influence | |
| Assisting regeneration | |
| Thinning | |
| Pollarding | |
| Pruning and lopping | |
| Augmentation of seeding and planting | |
| Maintenance and tending | |

## 4.3 FACTORS AFFECTING REGENERATION AND PLANTATION OF NTFPS

### 4.3.1 Seed production and dispersal

Seeds are the prerequisite for regeneration—new plant production is based on quality seeds capable of germination. If seed production is reduced, regeneration is also naturally impacted by reduced seedling production. In addition, regeneration also depends on seed dispersal, as only seeds lodged under favorable conditions can grow into full trees. Thus, if a seed is very heavy, it will fall to the ground, lie below the tree in total shade, and may not have ample opportunity to germinate and survive. If seeds are winged and dispersed by wind, they could get blown away to extreme locations. This would certainly result in deposition of seeds in good locations, germination, and robust growth. So also with animal-dispersed seeds, which also get adapted and pre-treated in a way, resulting in enhanced germination with adequate manure that helps establishment of the seedlings.

### 4.3.2 Soil conditions for seed production

Seeds fall on soil, germinate, and establish themselves by anchoring to the soil. Roots penetrate deeply, and this determines chances of survival. Every species requires a specific set of soil conditions, absence of which could threaten survival of the species (see Box 3).

**BOX 3: SPECIES-LEVEL INTERVENTIONS FOR IMPROVING SOIL CONDITION**

- **For *Ailanthus triphysa***

  Regeneration of *Ailanthus* trees occurs in open canopy areas and is always restricted to particular patches. It is very important to identify such patches with good natural regeneration, either by seeds or by coppices, to undertake soil treatment. In identified patches, regenerating plants can be covered with leaf litter mulch for softening the soil and increasing moisture content in the soil, especially after rains.

- **For *Cinnamomum* spp.**

  First, identify the regenerating plants of *Cinnamomum* around PLUS (+) trees. During rainy season, to avoid water logging conditions, the soil can be loosened; during summer, leaf litter mulch can be provided to avoid water evaporation and maintain moisture content in the soil.

- **For *Sapindus emarginatus***

  Regenerating plants in the identified + tree area be identified. To maintain moisture content of soil during summer season, mulching with leaf litter should occur.

Usually the soil should be porous, well drained, well aerated, and not too acidic or basic. Under these conditions, remedial measures can be taken to ensure optimum growth. Some interventions suggested for soil enhancement are loosening the soil around the regenerated plant and mulching with leaf litter. This will enable retention of water and moisture, provide better survival conditions, and establish the plant.

### 4.3.3 Light conditions for regeneration

Light is the next aspect that contributes to regeneration (Box 4). In the wild, plants differ in light requirements. Some species are strong light demanders while some are partial light-requiring ones. Yet others are shade-tolerant and prefer to grow in shade. Therefore, if a shade-tolerant species is grown in the open where it is exposed to strong light, it may well perish. Similarly, if a strong light demander is grown in complete shade, chances are that it will die. Light also affects soil, with more radiation tending to dry soil faster and render it unsuitable for growth of seedlings.

**BOX 4: SPECIES-LEVEL INTERVENTIONS ADDRESSING LIGHT CONDITIONS**

- **For *Ailanthus triphysa***

  *Ailanthus* is a light demanding species. Therefore, this grows in the open canopy area very well. To facilitate proper sunlight, pruning/lopping of branch operations can be undertaken depending on canopy cover. Further, thinning operations can also occur if mature and regenerating plants are denser.

- **For *Cinnamomum* spp.**

  *Cinnamomum* trees prefer shady areas. Ensure a proper canopy for regenerating plants outside the forest area. Otherwise, the seedlings will not be established if exposed to sunlight. Suggestion is to move regenerating seedlings to canopy area or provide temporary shade for growth and development of regenerating plants.

- **For *Sapindus emarginatus***

  *Sapindus* is also a light demanding species. Seedlings have great difficulty surviving in good canopy areas. Ideally, artificial regeneration of species in open areas should occur because survival rate in good canopy area is much less, and pruning, lopping of branches, or thinning cannot be done as it grows along with other associated species.

### 4.3.4 Effect of wind on regeneration

Wind on newly planted or growing seedlings desiccates or dries them through enhanced transpiration. Wind is another condition affecting regeneration, primarily through seed dispersal. Small-sized seeds are most affected by wind, traveling via wind currents and depositing in

**BOX 5: SPECIES-LEVEL INTERVENTIONS INVOLVING COLLECTION OF SEEDS WITH RESPECT TO WIND CONDITIONS**

- **For *Ailanthus triphysa***

  Seeds of *Ailanthus* are light-weight and easily carried by wind. The seed sets during windy season (May-July). Therefore, regeneration is affected by wind. To collect viable seeds for artificial regeneration, suggestion is to cover the + trees with nets and collect the seeds.

- **For Cinnamomum spp. and Sapindus emarginatus**

  Both *Cinnamomum* and *Sapindus* seeds are conventional seeds not much affected by wind.

places where they may or may not establish. Such regeneration will not ensure proper survival rate and development of regenerating plants. Seeds of *Ailanthus triphysa* could reach far off places. This will warrant understanding of wind direction, velocity, and season so that one can decide whether to make use of conditions at the site (see Box 5 above).

### 4.3.5 Inherent characters of species

Regeneration could also be affected by the plants' inherent qualities resulting from their genetic makeup. Thus, plants get adapted with qualities such as leaf fall, deep penetrating roots, xerophytic characteristics, thorns, and many qualities that deter survival.

**BOX 6: SPECIES-LEVEL INTERVENTIONS FOR INHERENT CHARACTERS**

- *Ailanthus* species is a very fast growing and soft wood. The root system does not penetrate deep into soil. To ensure proper survival of regenerating trees, soil conservation measures are necessary along with mulching with leaf litter to provide nutrients to growing stocks.
- *Cinnamomum* is a slow growing species. It requires supply of adequate nutrients by mulching with leaf litter. Water logging conditions must be avoided during rainy seasons by implementing soil and water conservation measures.
- *Sapindus* is a moderately growing species prone to browsing by animals in open areas, as well as in homesteads. Thus it needs protection from animals (physical fencing) and provision of nutrients via leaf litter mulching.

### 4.3.6 Nature of undergrowth and biotic factors

Also very important in regeneration of plants under wild conditions is the tendency of many species of ground flora to dominate the land and obstruct regeneration. Often, they block light required for germination and growth of the selected species. Sometimes the growing plants attract browsing and grazing animals, which could threaten newly growing seedlings. Many species of ground flora also grow so luxuriantly that they may compete with and outgrow the desired species. Thus, study of ground flora and plants in different canopy levels is necessary to determine appropriate measures (e.g., weeding and canopy clearing) to manage regeneration. Provision of adequate fencing to the plot may be necessary to prevent/minimize animal intrusion and resulting damage in order to foster regeneration.

**BOX 7: WEEDS AND BIOTIC FACTORS**

*Ailanthus* species regenerate in open areas, not much covered by ground flora. However, weeds dominate during winter season. Moreover, weeds grow as regenerating trees grow up and extend canopy cover. It is necessary to undertake weeding operations during winter season and close the area by fencing to protect regenerating plants from grazing.

### 4.3.7 Climatic Factors

Water and temperature are important deciding factors in success of regeneration. The study area where *Cinnamomum* grows receives heavy to medium rainfall (2000-6000 mm) and has moderate temperatures (average of 15$^{o}$C). Thus, any effort to promote large-scale regeneration warrants a simulation of similar climatic factors. *Ailanthus* and *sapindus*, on the other hand, regenerate well comparatively within areas in the district that receive less rainfall and have moderate temperatures. During summer, regenerating plants will suffer from water stress. Therefore, water and soil conservation measures must occur to improve survival of the seedlings. Further, to enhance regeneration in areas that receive heavy rainfall, proper drainage systems should be established to avoid water logging conditions.

## 4.4 SILVICULTURAL OPERATIONS

Interventions such as lopping and pruning are needed to maintain good growth of the selected plants in high-density regenerating areas. Lopping of branches of adjoining plants will open up space for growth of the regenerating plants. Similarly, pruning of branches is also practiced for regenerating plants, as well as for associated plants.

**BOX 8: SPECIES-LEVEL SILVICULTURAL INTERVENTIONS**

In the field in Megaravalli and Nagara range, good regeneration of *Ailanthus* with different age and girth size was observed. More than 2,000 regenerating plants were observed within 1 ha. This is a high-density regenerating area where maintaining a good survival rate and good growth of plants is difficult. Therefore, thinning out the inferior and weak seedlings is necessary. In this place, regeneration also occurs via stool coppicing, essentially from cut trees' bases from the stumps. More than one coppice may be present, and if so, cutting unwanted ones and retaining only better ones is necessary to maintain higher growth.

Regarding *Sapindus*, pollarding could be attempted to generate more branches and enhance seed production. This species is observed under cultivation more in homesteads, so suggestion is to use well-grown, nursery-raised seedlings for planting.

Regarding *Cinnamomum*, observed growing in high forests, assisted regeneration will involve manipulation of different levels of canopy, treatment of ground vegetation, soil working, slash disposal, direct seedling, and protection.

*Cinnamomum* grows under shade and in evergreen forests; regeneration is poor. Under these conditions, suggestion is to augment the species by adapting the Aided Natural Regeneration (ANR) model, according to which 200 plants per ha can be planted by maintaining 10 x 10 m spacing. To undertake this, a tunnel is opened up below existing trees, and seedlings are planted at specific intervals at appropriate spacing. This method includes a specification for weeding and tending to enhance regeneration.

## 4.5 PLANTATION MODELS AND MODELS PRACTICED IN THE FORESTRY SECTOR

Plantations are usually taken up through government programs. "Plantation," in fact, is synonymous with "artificial regeneration" in forestry parlance whereby forest crop is raised

artificially either by sowing or through planting. This is superior to natural regeneration, resulting in production of a uniform crop easy to manage. For raising plantations, first, land is prepared by clearing weeds and bushes. The area is fenced and protected from encroachment and intruding animals that would damage seedlings by grazing, browsing, or trampling.

The prepared land is further divided into blocks, and ranging and pitting ensue. Ranging proceeds by use of appropriate spacing. Usually, in forestry, planting occurs within 1 x 1 m or 2 x 2 m areas. After periodic intervals, appropriate thinning occurs following silvicultural practices. Ultimately, this forest crop will be maintained within areas of 4 x 4 m or 5 x 5 m.

Weeding and tending occur four times during the first year of plantation; subsequently, three times in the second year, two times in the third year, and thereafter, once every year.

During dry months, planted seedlings receive mulch for retention of moisture.

Usually, plantations occur within open lands. For *Sapindus* and *Ailanthus*, open land plantations are recommended because these are light-demanding species. Regarding *Cinnamomum,* seedlings can be planted in partially shaded areas because the chance of seedling survival in open conditions is not good.

***Plantation models practiced in the forestry sector***

Plantation models practiced for forestry species are as follows:

- **Artificial Regeneration (AR):** In this model, in open forests, 1,100 seedlings are planted to enhance AR of selected species. *Ailanthus triphysa* can be regenerated through this model. After successful regeneration, silviculture operations must occur to maintain the optimum number of plants per ha. Suggestion is to thin 50 percent of the population after 10 years of plantation, and to thin 25 percent of the existing population in the 15$^{th}$ year of plantation. Ideally, 375 trees per ha can be maintained. If density is greater, or a problem develops affecting growth and development of the trees, further suggestion is to thin 25 percent of the existing population.
- **Aided Natural Regeneration (ANR):** This model can be applied either under open forest conditions or within degraded forests. In the ANR model, 200 plants per ha are planted along with/without associate species. *Sapindus* and *Cinnamomum* can be regenerated by use of this model—*Sapindus* can be planted under open forest conditions and within degraded forests; *Cinnamomum* plantation can be undertaken only within areas of less canopy.
- **Mixed plantation of trees with NTFP and medicinal values:** In this model, selected species can be planted along with other species that are naturally compatible. A total of 1,100 plants including associated species can be planted per ha. Decision making as to choice and proportions of seedlings of selected species must include local communities based on local conditions/requirements. This model is ideal for all the three selected NTFP species—*Ailanthus triphysa*, *Cinnamomum* spp. and *Sapindus emarginatus*. However, *Cinnamomum* spp. can be planted within areas with less canopy.

# 5.0 HARVESTING TECHNIQUES, PRINCIPLES, PROTOCOLS, AND GOOD PRACTICES– DESTRUCTIVE OR "BUSINESS-AS-USUAL" COLLECTION OF NTFPS

Destructive collection practices are major causes of depletion of plant resources within the wild. Some reasons for destructive collection are lack of awareness of good collection practices, growing industrial demand for resources within the wild, weak guidelines and monitoring mechanisms for wild resource collection and management, competition among local collectors, and unavailability of better price/incentive for primary collectors.

## 5.1 DESTRUCTIVE COLLECTION OR "BUSINESS AS USUAL" OF *CINNAMOMUM MALABATRUM*

- Collectors from distant areas or a local collector collects the leaf by cutting branches. Collectors cut twigs of all sizes (from 2 to more than 25 cm), which are easily accessible; sometimes they lop main branches and chop trees to save time and labor.
- Leaves are collected from all trees irrespective of age, size, and height.

**Note**: At present, collection of *Cinnamomum* is banned by the Forest Department. But due to unscientific collection practices of earlier collectors, many trees have encountered problems and are dying at early ages.

For the group exercise to understand the current/business-as-usual harvesting pattern of the local community, refer to Tables 22 and 23.

**PHOTOGRAPH 6: DESTRUCTIVE HARVESTING OF CINNAMOMUM LEAVES**

## 5.2 DESTRUCTIVE COLLECTION OR "BUSINESS AS USUAL" OF *SAPINDUS EMARGINATUS*

- Generally, the community collects the fruits by cutting the branches in the wild—because of competition among the community members, they collect the fruits by cutting branches (sometimes shaking the branches) during ripening or before ripening at once, without leaving any fruits for regeneration.
- Mature and immature fruits are collected at once because competition among local collectors precludes them from avoiding collection of immature fruits.

For the group exercise to understand the local community's current/business-as-usual harvesting pattern, refer to Tables 22 and 23.

**PHOTOGRAPH 7: UNSUSTAINABLY HARVESTED FRUITS OF SAPINDUS AND DRIED ON THE FLOOR**

## 5.3 DESTRUCTIVE COLLECTION OR "BUSINESS AS USUAL" OF *AILANTHUS TRIPHYSA*

- Collectors from distant areas or a local collector collects resin by tapping the tree—on both sides of the trunk, the tapper removes the bark over more than a 1-foot width and 6-foot length along with wood. In some cases, up to 8 feet in length and 2.5 feet in width has been removed, leaving 2 to 3 inches of bark on one side of the stem above 0.5 foot from the ground. However, collectors claim that they remove the bark above 3 feet from ground level, removing 0.5 foot width x 3-foot length x 1-inch depth in the first year by using an axe; within the next 2 years, only length will be increased up to 3 feet. After 3 years of tapping from the same side, next-year tapping will occur on the opposite side of the trunk.
- Collection season lasts for 9 months, occurring throughout the year except during the 3 months of heavy rainy season. This system affects the trees' strength and encourages pest attack because of the short time available to the trees before the monsoon arrives for recovery from the wounds.

**Note**: Due to commercial tapping of *Ailanthus* via deep cuts at the base of the bole by use of an axe, many trees' boles have been damaged near breast height. These methods often lead to death of tapped trees. Because of crude tapping methods and over-exploitation, the population of *Ailanthus* trees has declined.

For the group exercise to understand the local community's current/business-as-usual harvesting pattern, refer to Tables 22 and 23.

**PHOTOGRAPH 8: DESTRUCTIVE TAPPING AND HARVESTING OF RESIN OF *AILANTHUS***

**TABLE 22: ASSESSING PATTERNS AND METHODS OF COLLECTING SELECTED NTFPS – GROUP EXERCISE**

| Objective | To understand the local community's current/business-as-usual pattern of harvesting NTFP species |
|---|---|
| Group size | 10-12 members in a group (if many VFCs are present, club them together) |
| Location | Class room |
| Time required | 1 hour |
| Materials required | Writing material, pen/pencil |
| Convener | Resource person/expert |
| Activities | 1. Prepare the list of selected NTFP collection methods and patterns (Table 23)<br>2. Participatory discussion on nature of collection and its impact on ecology, economics, and social dependence |
| Expected outcome | Understanding current methods and practices of collecting selected NTFPs/MPs, and impacts of these within the VFC area |

**TABLE 23: DETAILS ON METHODS OF COLLECTING SELECTED NTFPS IN THE VFC AREA (GIVE ☑ MARK)**

| NTFPs/ MPs | Over-collection | Repeated collection | Untimely collection | Immature produce collection | Collection of substitutes | Natural disturbances |
|---|---|---|---|---|---|---|
| **1.** | | | | | | |
| **2.** | | | | | | |
| **3.** | | | | | | |

# 6.0 SUSTAINABLE COLLECTION OF SELECTED NTFPS

## 6.1 PRINCIPLES OF SUSTAINABLE HARVESTING

Good collection practices, or sustainable collection practices, involve extraction of NTFPs or wild resources from the forest area without damaging reproduction or associates of these resources. Applying sustainable collection practices in the wild is significant in conserving a resource and also fulfills needs of forest dependents and other stakeholders who directly or indirectly receive benefits of NTFPs.

Development of good collection practices through participatory steps requires merger of both traditional and modern knowledge. This enables implementation of collection regimes and monitoring by local communities. Development of this process has included specification of steps embodying participatory and biometric protocols for implementation of a methodology for sustainable collection of NTFPs. These participatory steps are (1) enumeration of species, (2) estimation of yield/assessment of resources, and (3) a market survey.

Traditional methods of collecting NTFPs were sustainable, but increasing commercial demand has led to gradual replacement of these by unsustainable collection methods. The traditional knowledge has been documented and merged with scientific information to develop good, sustainable collection methodology. The following sections address good practices for collecting *Cinnamomum* spp., *Ailanthus* resin, and *Sapindus* fruits.

## 6.2 SUSTAINABLE COLLECTION OF *CINNAMOMUM MALABATRUM* LEAVES

- **Assess resources before proceeding to collect leaves:** Because the leaves are collected from the tree, damage could be tremendous. To avoid this, knowledge of resource availability or quantity of leaves available from a tree is essential.
- **Select mature trees (approximately more than 8-10 years old) for collection:** Collection of leaves can begin when a tree attains height of at least 5-6 feet (4 to 5 years) by trimming small twigs, which will help maintain the height of the tree with more branches. Actual collection can begin by cutting small branches after the tree is 8 or 10 years old.
- **Collection can occur every year from vigorous trees and in alternate years from old and weak ones:** Complete lopping of big branches every year damages the tree.
- **Selective harvesting/cutting small branches (twigs):** Branches of less than thumb thickness should be cut, 80-90 percent leaves can be collected without cutting and damaging the big branches. Branches should not be allowed to grow very tall; they should be maintained from young age/small size of tree.
- **Mother tree should be maintained for reproduction at ratio of 20:1:** Because more leaves are collected by cutting branches, chances to produce seeds from those trees

decrease precipitously. To avoid this problem, it is crucial not to cut branches of (not collect leaves from) 1 out of 20 trees to maintain seed production.

- **Collect leaves from February to March (before flowering/during budding):** Timely collection of leaves is important because early and late collection may result in poor quality of leaves or essential oil.
- **Tools used for harvesting and processing:** Sickle/cutter, tarpaulin for drying, and gunny bags.

**PHOTOGRAPH 8: SUSTAINABLE HARVESTING OF LEAVES OF *CINNAMOMUM*, PLUCKING THE LEAVES DIRECTLY FROM TREE (L) AND FROM SMALL TWIGS (R)**

### 6.2.1 Processing/value addition:

- Collect matured leaves.
- Dry them on tarpaulin or cement floor.
- Put in gunny bags and store in well-aerated place to avoid fungal attack.

### 6.2.2 Quality parameters for collection and trade:

- Collection should occur when leaves become dark green and thick.
- After collection, remove the twigs and branches.
- Do not store fresh leaves in a bundle/bag for a long time.
- Do not dry directly on ground (soil) and in sunlight.
- Storage/shelf life details: Depends on dried material and storage place; fresh leaves cannot be kept for a long time.

## 6.3 SUSTAINABLE COLLECTION OF *SAPINDUS EMARGINATUS* FRUITS

- **Assess resources before collecting fruits:** Because fruits are collected, adverse effect on reproduction of species is high. To avoid this issue, knowledge of resource availability or quantity of fruits available from a tree is essential.

- **Collection can occur every year from good fruit-bearing tree**: Collect fully mature, well-ripened fallen fruits from the ground once in 2 days. Collection can also occur by shaking tree branches after noticing the maximum number of mature and ripe fruits.
- **Collect only 75-80 percent of fruits during peak season:** Collection should occur only in the peak season (at the time when maximum quantity of ripe fruits is available). Do not collect fruits at initial stage of fruit ripening and also at the end of the season, in order to maintain availability of some fruits for regeneration and for wild animals.
- **Do not cut branches:** Do not cut branches for collection of fruits—remove/cut the bunch of fruits only by pulling branches or climbing the tree.
- **Collect fruit from February to March (during well-ripened/peak time):** Timely collection of fruit is important because early collection may result in poor-quality (unripe) fruits.
- **Tools used for harvesting and processing:** Hooked stick, gunny bags.

### 6.3.1 Processing/value addition:

- Collect well-matured fruits.
- Dry them on concrete floor or on bamboo mats.
- Put in gunny bags and store in well-aerated place to avoid fungal attack.

### 6.3.2 Quality parameters for collection and trade:

- Collection should occur when fruits ripen.
- After collection, remove the leaves, twigs, and branches.
- Do not store fresh fruits in a sack or heaps.
- Dry well by spreading on a concrete floor or on bamboo mats under sunlight.
- Storage/shelf life details: Depends on dried material and storage place; fresh fruits cannot be kept for a long time.

**PHOTOGRAPH 10: DRYING OF SUSTAINABLY HARVESTED *SAPINDUS* FRUITS**

## 6.4 SUSTAINABLE COLLECTION OF RESIN OF *AILANTHUS TRIPHYSA*

- **Assess resources before collecting resin:** Collection of resin injures the main trunk of a tree. This damage may lead to death of the tree within a short time because of destructiveness of the tapping method. Therefore, understanding availability of resources or of trees is essential before initiation of resin extraction.
- **Select healthy and mature trees for tapping:** Collection of resin can occur when trees attain girth of >90 cm.
- **Remove the bark (tap) in very small size—Method 1:** Remove the bark over an area less than 0.5 foot in width and 1 foot in length above 3 feet from ground level on one side of the tree trunk without damaging the wood (cambium). During the next 2 years, remove the bark over 1-foot length in each year, and increase up to 3 feet in length; do not increase width. After 3 years of tapping on the same side, next-year tapping can occur on the opposite side of the tree.

  **Method 2—Rill method (Fish bone):** Make 2-inch-wide channels in fish bone shape of 1.5 to 2 feet length above 2.5 feet from ground level. Fix a small vessel to collect the resin at the base of the channel. Collection season is November- May.
- **Collect the resin or tap the resin during November to May:** Do not tap during the rainy season.
- **Tools used for harvesting and processing**: Axe; bark remover; modified triangle-shaped, sharp-edged equipment.

**PHOTOGRAPH 11: IMPROVED METHOD OF TAPPING AND SUSTAINABLE COLLECTION OF RESIN OF *AILANTHUS***

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**U.S. Agency for International Development/India**
**American Embassy**
**Shantipath, Chanakyapuri**
**New Delhi 110 021**
**Tel: +91-11-2419-8000**
**Fax: +91-11-2419-8612**
**www.usaid.gov/in**