

Study on Establishment of Bamboo Processing Plants in Amhara Regional State

A Thesis

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ABSTRACT

Bamboo is an ancient woody grass widely distributed in tropical, subtropical and mild temperate zones. There are about 1 200 species of bamboo in some 90 genera, of which two species namely highland and lowland bamboo are indigenous to Africa and widely distributed in Ethiopia. Ethiopia has more than 1 million hectares of bamboo which is 67% of African total. But compared to other bamboo growing countries Ethiopia is not getting equivalent economic advantage from the resource. Therefore, the aim of this paper is to show the benefit from the resource by developing the development and utilization model of bamboo and studying the establishment of processing plants for some selected products in Amhara regional state. These two Ethiopian bamboo species are found in Amhara region. But like any other regions the resource is not used as an input to processing plants that produce industrial and construction products. Some bamboo growing areas of the region are visited; data collected and the resource growing areas by zones and weredas are mapped. Domestic wood demand and supply is analyzed which shows huge gap between the demand and the available supply - demand by far exceeding supply. There is also increasing demand for bamboo and bamboo products in world market. General Model is developed to show the required integration between different parties to facilitate the development and utilization of the resource in Amhara region from cultivation to end market. In addition, cultivation, micro and small scale, and medium and large scale business models are developed with their corresponding components. Three products – bamboo flooring, bamboo mat and bamboo incense stick are selected for analysis for their technical and commercial viability. Required facilities are determined, project implementation plan is scheduled, and layout is developed for these three manufacturing lines. Finally detailed economic evaluation is made and shows - with the initial investment of Br. 41 million, the expected return will be Br. 94 million annually, with a payback period of less than a year. Projecting this result to national level, the country can get more than Br. 10 billion every year from the existing resource coverage. This figure could well be much higher if the cultivation and development efforts are made. The project is very attractive for investment and will help to improve the development and utilization of the resource. In addition the area of coverage and productivity of the resource should be improved, so that the country will entertain the maximum benefit out of this new sector.

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Generally I am happy to express my respect for the following, just to list some of them

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3. Agriculture Research Institute library workers
4. Amhara Region Bureau of Finance and Economic Development, GIS work team
5. Adal Industrial Plc
6. Awi Zone Office of Agriculture and Rural Development
7. Awi Zone Office of Trade and Industry

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LIST OF ABBREVIATIONS

AAU	Addis Ababa University
ACSI	Amhara Credit and Saving Institute
ANRS	Amhara National Regional State
ARARI	Amhara Regional Agricultural Research Institute
BDU	Bahir Dar University
BoARD	Bureau of Agriculture and Rural Development
BoFED	Bureau of Finance and Economic Development
BoTI	Bureau of Trade and Industry
CFC	Common fund for Commodities
CSA	Central Statistical Agency
DBE	Development Bank of Ethiopia
EABP	East African Bamboo Project
FAO	Food and Agriculture Organization
FEMSEDA	Federal Micro and Small Scale Enterprises Development Agency
FRA	Global Forest Resources Assessment
GIS	Geographic Information System
IMF	International Monetary Fund
INBAR	International Network for Bamboo and Rattan
MoTI	Ministry of Trade and Industry
ORDA	Organization for Rehabilitation and Development of Amhara Region
REMSEDA	Regional Micro and Small Scale Enterprises Development Agency
TVETA	Technical and Vocational Education Teaching Agency
UNIDO	United Nations Industrial Development Organization

1. INTRODUCTION

Ethiopia has the largest area of bamboo in Africa. Studies show that bamboo harvest in Ethiopia constitutes 67 percent of the total production in Africa. The country has nearly 1 million hectares of bamboo reserves, yet the production and consumption of bamboo and bamboo products is very limited, and value addition is minimal due to poor processing technology. Had the harvesting, production and processing of bamboo is well handled and managed, Ethiopia should have potential to generate an approximate of 9.5 billion birr every year. This is an indication that if the sector is exploited in reasonable amount, the potential will be very attractive to support the country's agriculture led economy together with Coffee, Horticulture, Leather and Hides, and others agricultural products.

Although bamboo is not an integral part of the economy of Ethiopia, it plays a very important role socially, economically and ecologically in areas where it occurs naturally and where it is planted. Bamboo culms in Awi Zone of the Amhara Region, for example, are used as construction material for housing, fences, and beehives in the villages. More importantly, a market for bamboo culms and bamboo products has developed in the past years. Many of the landless men buy bamboo from farmers and engage in producing mats, and furniture e.g. chairs, sofas, and baskets that they produce and sell along the roadside. For these households bamboo is the major source of income. But in addition to the traditional use of bamboo and bamboo products, attention should be towards the value adding process which will result in creating additional jobs to citizens and increased return from the sector. One way could be processing the bamboo to finished and semi finished products by introducing bamboo processing plants. These products may be used for industrial, household and construction purposes. Thus the aim of this paper will be developing models that show the utilization and development of bamboo in Amhara regional state and studying the feasibility of establishing bamboo processing plants in Amhara regional state.

2. OBJECTIVE OF THE THESIS

General Objective

The general objective of this paper is to study the opportunities and the expected challenges in introducing bamboo processing plant(s) in Amhara regional state. The paper will try to show the contribution of the sector in the national economy.

Specific objectives

The specific objectives of the research are:

- To help the region get another income generating opportunity of the relatively old but not exploited sector of agriculture.
- To show how it is helpful in creating more job opportunities for the people of the region.
- The study will be an example in showing what benefits can be obtained by adding values to the likes of Coffee and other agricultural products.

3. RESEARCH METHODOLOGY

1. Literature Survey:

Literatures are surveyed on relevant materials on bamboo plantation, harvesting, field management and production, post harvest management, bamboo processing and on viability study and business model developments and procedures. The literatures available are from electronic media, journals, and books. Secondary data are referred from previous related research studies, existing statistical data, etc. The sources of these literatures are from libraries like the university library, Agricultural Research Libraries (both the federal and regional), Ministry of trade and Industry library, Regional Micro and Small Enterprises Development Agency library (Bahir Dar) and Bureau of Agriculture and Rural Development library (Bahir Dar). Literature survey is done in the first two months of the thesis work.

2. Data collection from primary and secondary sources:

Data has been collected from primary sources by visiting sample areas of the region (The areas are selected for their potential of the resources and suitability of getting the required data for site selection). The area visited include Bahir Dar, Awi zone (Injibara, Tilili, Banja Shikudad woreda, Banja woreda, Kessa), and Sekela woreda of West Gojjam zone. There were some central data, in Bahir Dar, for all lowland and highland bamboo growing areas of the region and some rough estimation about the coverage of the resource in the region. In the field survey of Awi zone and west Gojjam zone, the plantations and some nurseries' have been observed and agricultural experts in each zone has been contacted. Some activities performed in marketing and small processing of the resource is also observed. Secondary data was collected from different sources like previous related research works, some statistical data, world bamboo resource reports, and regional forestry and bamboo resource studies. The areas visited and the duration in each is given in the following table.

Table 3. 1 Areas visited and time spent in each areas

Zones	Area Visited	Visited sites	Duration
Bahir Dar Special Zone	Bahir Dar	<ul style="list-style-type: none"> ▶ Bureau of agriculture and Rural Development ▶ Bureau of trade & Industry ▶ Bureau of Finance & Economic Development ▶ Regional Micro & Small Scale Enterprises Development Agency ▶ Amhara Region Agriculture Research Institute 	<p>March 02 - March 13, 2008</p> <p>March 20 - March 25, 2008</p>
		<ul style="list-style-type: none"> ▶ Agriculture and Rural Development Department ▶ Micro & Small Scale Enterprises Development Agency Department ▶ Injibara Preparatory School ▶ Highland Bamboo Nursery ▶ Different Wereda Offices 	<p>March 14 - March 17, 2008</p>
Awi Zone	Injibara	<ul style="list-style-type: none"> ▶ Banja Shikudad wereda agriculture & rural Development Office ▶ Plantations 	<p>March 18, 2008</p>
	Tilili	<ul style="list-style-type: none"> ▶ Sekela Wereda Agriculture & rural Development Office ▶ Plantations 	<p>March 19, 2008</p>
	Sekela	<ul style="list-style-type: none"> ▶ Plantation 	<p>March 20, 2008</p>
	Kessa		

3. Data analysis and synthesis:

After primary and secondary data are collected, the data are analyzed and synthesized in accordance with the objective of the paper. The analysis started after some data are available and progressed upto three weeks after the data collection is completed.

4. Model Development:

Models have been developed based on the need and capability of the resources like capital, manpower and raw materials availability. The models include micro, small, medium and large scaled enterprises with their detailed supply chains. Different market potentials and other stakeholders in each level have been included in the models. In addition some model products (three products) are analyzed for further feasibility study and their implementation, financial requirements and benefits of the processing plant has been included. this task is started together with the data analysis, and completed after three weeks the analysis is concluded.

4. Discussion, Recommendations and Conclusions

After the models are developed, they are discussed in some detail and the project analysis is made for representative products. Discussion of those models and the project analysis is accompanied by some conclusions and recommendations for implementations, future actions that need to be accomplished by different sectors in regional and country level, and some conclusions are also made. In addition some future research areas related to this paper are indicated - for further study. This portion of the thesis took five weeks.

4. EXPECTED RESULTS FROM THE THESIS

Positive results from this research will benefit both the region and the country. Individuals will be getting job opportunities. Cultivation of the plant will help in conserving natural environment by reducing erosion, land slip and the like, which are very common in the country and especially in the region. Generally this result will positively affect all the supply chain of bamboo and bamboo products; farmers, small business owners and potential owners, investors, craftsmen, etc. Bamboo has additional advantages such as providing a link between rural and urban communities, poverty reduction, environmental protection and community development. And the huge potential development may benefit the country's effort to join the middle income countries, and the effort to secure the Millennium Development Goals.

5. STATEMENT OF THE PROBLEM

Amhara region is one of the environmentally suitable regions in Ethiopia for the cultivation of bamboo. About 65 hectares (natural stand) and 2350 hectares (plantation) of land in Injibara and of Debresina/Wofwasha is covered with highland bamboo and 425,000 hectares (natural stand) of land in Metema/Dansha/Humera (Tigray/Amhara) is covered with low land bamboo. Both the highland and lowland bamboos are such a versatile type of resources that they can be used in many ways. Two different systems are in operation; bamboo from natural stands, and bamboo from plantations. Harvesting from plantations is carried out all-year-round when required by resource-poor homestead bamboo cultivators for whom it is a supplementary source of income. But it is poorly managed and exploited. Harvesting from natural stands is unregulated and is resulting in the severe depletion of the natural resources [12]. Harvesting practice uses primitive tools, resulting in damage to the stands and increased wastage. Only a small number of people are involved in cultivating and processing bamboo in Amhara region and generally in Ethiopia. The use of bamboo is restricted to the household level [7].

Generally the problems observed in developing and utilizing the resource in Ethiopia, and particularly in Amhara regional state include:

- The information available on distribution, extent and some characteristics of the resource contradict with one another. The variation in figures is very high, when comparing different sources.
- The marketing system in trading the resource is very traditional and some resources deteriorate due to poor storage and transportation.
- So far bamboo forest is not separately registered and reported annually, in country's periodic national forest inventories.
- The coverage is decreasing from time to time due to less attention given to the resource and lack of knowledge of its economic contribution. Resources are being cleared and put to fire for the purpose of farming crops.
- Lack of knowledge in planting, harvesting, collecting, storing and transporting the resource causes wastage of the resource in between.

- Non scientific harvesting cycle causes problems like very young culms are collected and some very old culms left on the farm for long period of time.
- Lack of training and awareness to the processing of bamboo make its application limited to some local furniture manufacturers, with relatively poor quality products.
- The wide industrial application of the resource is not well understood.

6. BAMBOO PLANTATION

6.1. THE GROWTH HABIT OF BAMBOO

The bamboo plant (Figure 6.1) is made up of an underground axis and above ground axis. The underground axis is comprised of rhizomes, roots, and buds. The above ground axis is comprised of stems, branches, and foliage. Buds on the rhizomes may develop into shoots that emerge from the ground. The new shoot elongates vertically into a main stem or *culm* until it attains its full height. The growth of a culm is completed in one growing season. In large bamboo species, new culms may grow to a height of more than 20 meters within 3 months [5].

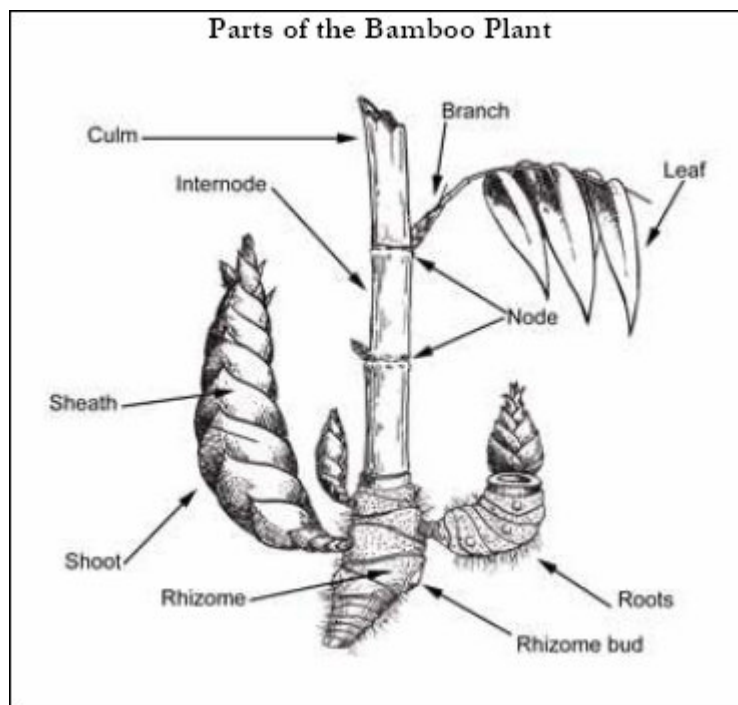


Figure 6. 1 Parts of the bamboo plant

6.2. TYPES OF PLANTATIONS

The term 'plantation' can mean different things and it is useful to explain the various senses of the term in relation to different bamboo plantation systems. This can at the same time help to illustrate various applications for bamboo in relation to forestry and farming. It is useful to distinguish, for instance, between homestead, commercial plantations, agroforestry, and forestry programs.

6.3. RAISING OF PLANTING MATERIALS

Growing bamboo starts with obtaining the materials for planting. Such materials may come in the form of seeds, wildings, offsets or cuttings that may be gathered from forests. Tissue-cultured plantlets provide other forms of planting materials. Such planting materials can be obtained and raised in the nursery as described in [Annex-E](#). The plantation method can be done with either of the following techniques:

- Propagation by seed
- Use of Wildings
- Vegetative Propagation
- Using Culm Cuttings
- Using Multiple Node Culm Cuttings
- Using Offsets
- Using Tissue Culture Plantlets

6.4. FIELD PLANTING AND ESTABLISHMENT

The following are the general procedure that can be followed in field planting and establishment.

- Selecting the Planting Site
- Plantation Layout
- Site and Ground Preparation
- Field Planting

6.5. PLANTATION MAINTENANCE AND HARVESTING

Proper maintenance and protection of the plantation is highly important. This involves replanting, plant protection, weeding, general tending and sustainable harvesting of culms (bamboo stems). See [Annex-E \[5\]](#).

6.6. POST-HARVEST TREATMENTS

Post harvesting is equally important activity that need to be considered in plantation to make sure that the product can reach healthy and with the desired quality to the next phase. And this may include the following post harvest protection activities:

Non-Chemical Methods

- Clump curing
- Smoking
- White-washing
- Plastering
- Soaking in water
- Simple construction method

Chemical Preservation Methods

Chemical preservation methods of bamboo generally provide more effective protection than non-chemical methods, but are not always economical. The following treatments are used. [See Annex-E.](#)

- Fumigation
- Steeping or sap displacement
- The open-tank treatment
- Butt treatment

7. LOGISTICS AND SUPPLY CHAIN MANAGEMENT

7.1. INTRODUCTION

All organizations move materials. Manufacturers build factories that collect raw materials from suppliers and deliver finished goods to customers; retail shops have regular deliveries from wholesalers; a television news service collects reports from around the world and delivers them to viewers; most of us live in towns and cities and eat food brought in from the country; when you order a book or DVD from a website, a courier delivers it to your door. Every time you buy, rent, lease, hire or borrow anything at all, someone has to make sure that all the parts are brought together and delivered to your door. Logistics is the function that is responsible for this movement. It is responsible for the transport and storage of materials on their journey between suppliers and customers.

7.2. DEFINITIONS

Supporting operations

Every organization delivers products to its customers. Traditionally we have described these products as either goods or services. Then manufacturers like Sony and Guinness make tangible goods, while AOL and Vodafone provide intangible services. In reality, this view is rather misleading, and every product is really a complex package that contains both goods and services. It is more accurate to describe products as lying on the spectrum shown in [Figure 7.1](#). At one end of this spectrum are products that are predominantly goods, such as cars and domestic appliances; at the other end are products that are predominantly services, such as insurance and education. In the middle are products with a more even balance, such as restaurant meals and hospitals.

At the heart of an organization are the operations that create and deliver the products. These operations take a variety of inputs and convert them into desired outputs, as shown in [Figure 7.2](#). The inputs include raw materials, components, people, equipment, information, money and other resources. Operations include manufacturing, serving, transporting, selling, training, and so on. The main outputs are goods and services. The products created by an organization are passed to its customers, giving the cycle shown in

Figure 7.3. This shows customers generating demands, with operations using resources to make products that satisfy them. Logistics moves materials around this cycle [13].

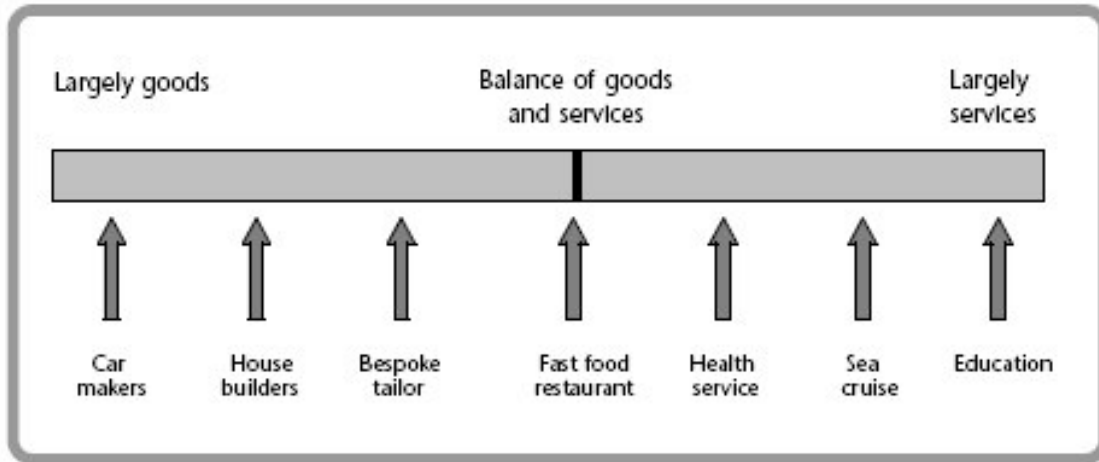


Figure 7. 1 Spectrum of products

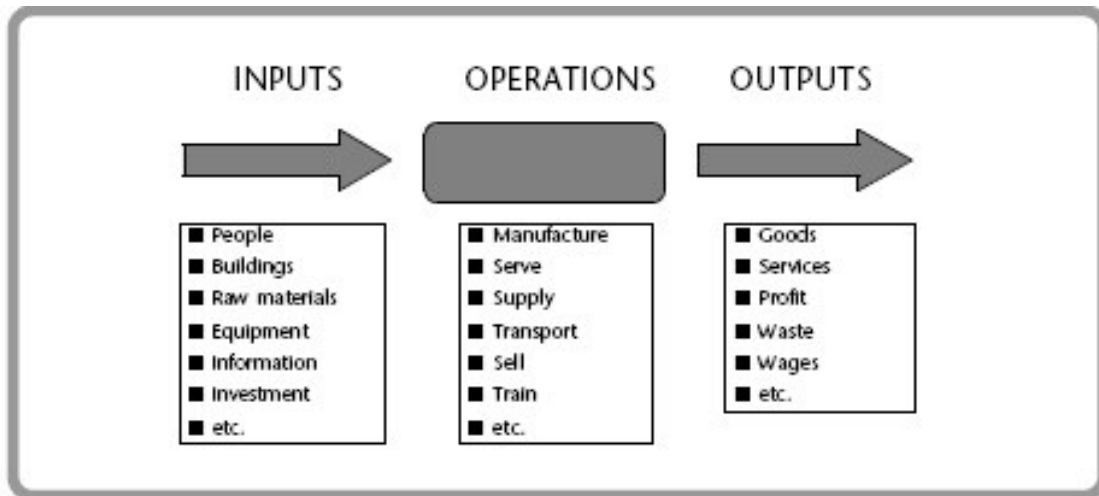


Figure 7. 2 Operations creating outputs

The operations are usually divided into a number of related parts, in the way that a hospital has an emergency room, surgical ward, purchasing department, heart unit, operating theatre and so on. So logistics also moves materials through the different parts of an organization, collecting from internal suppliers and delivering to internal customers (as shown in **Figure 7.4**). This leads to our basic definition.

LOGISTICS is the function responsible for the flow of materials from suppliers into an organization, through operations within the organization, and then out to customers.

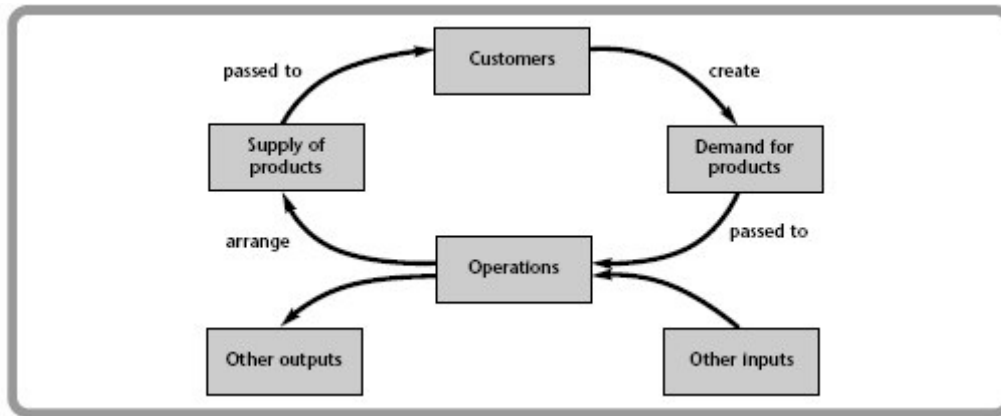


Figure 7.3 Cycle of supply and demand

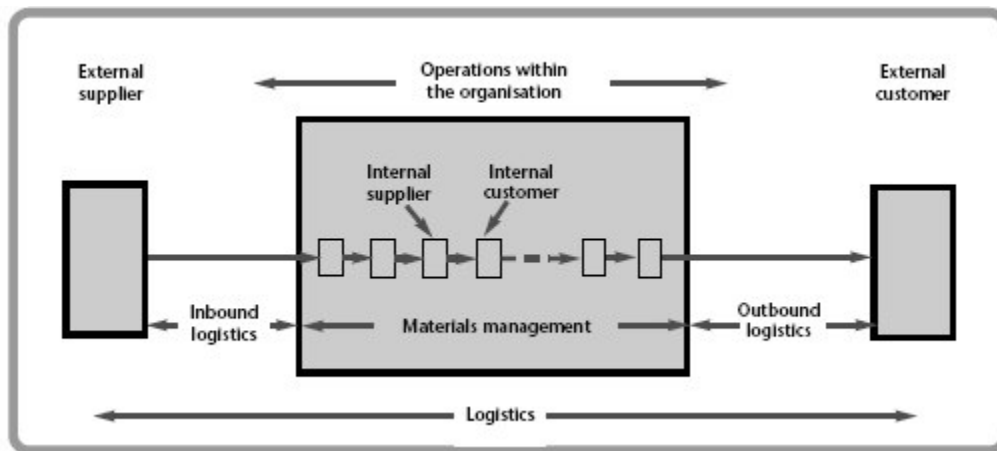


Figure 7.4 The role of logistics

Moving materials into the organization from suppliers is called inbound or inward logistics; moving materials out to customers is outbound or outward logistics; moving materials within the organization is materials management.

Materials

In these definitions we have talked about the movement of materials – but what exactly do we mean by materials?

MATERIALS are all the things that an organization moves to create its products.

These materials can be both tangible (such as raw materials) and intangible (such as information) [13].

7.3. THE SUPPLY CHAIN

So far, we have focused on the movement of materials through a single organization. In reality, organizations do not work in isolation, but each one acts as a customer when it buys materials from its own suppliers, and then it acts as a supplier when it delivers materials to its own customers. A wholesaler, for example, acts as a customer when buying goods from manufacturers, and then as a supplier when selling goods to retail shops. A component maker buys raw materials from its suppliers, assembles these into components, and passes the results to other manufacturers. Most products move through a series of organizations as they travel between original suppliers and final customers. A sheet of paper moves through several organizations before it reaches our desk (illustrated in [Figure 7.5](#)).

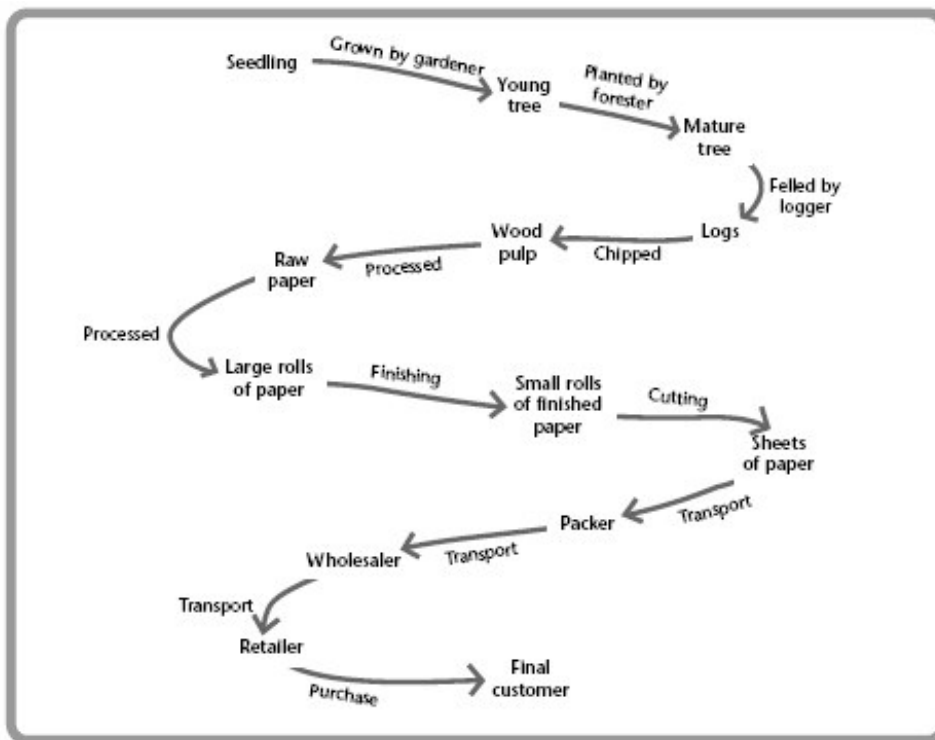


Figure 7.5 Outline of the supply chain for paper

People use different names for these chains of activities and organizations. When they emphasize the operations, they refer to the process; when they emphasize marketing, they call it a logistics channel; when they look at the value added, they call it a value chain, and when they see how customer demands are satisfied, they call it a demand chain.

A SUPPLY CHAIN consists of the series of activities and s that materials move through on their journey from initial suppliers to final customers [13].

Every product has its own unique supply chain, and these can be both long and complicated. The supply chain describes the total journey of materials as they move ‘from dirt to dirt’. Along this journey, materials may move through raw materials suppliers, manufacturers, finishing operations, logistics centers, warehouses, third party operators, transport companies, wholesalers, retailers, and a whole range of other operations. Sometimes, the supply chain goes beyond the final customer to add recycling and re-use of materials.

Structure of the supply chain

The simplest view of a supply chain has a single product moving through a series of s, each of which somehow adds value to the product. Taking one organization’s point of view, activities in front of it – moving materials inwards – are called upstream; those after the moving materials outwards – are called downstream.

The upstream activities are divided into tiers of suppliers. A supplier that sends materials directly to the operations is a first tier supplier; one that send materials to a first tier supplier is a second tier supplier; one that sends materials to a second tier supplier is a third tier supplier, and so on back to the original sources. Customers are also divided into tiers. One that gets a product directly from the operations is a first tier customer; one that gets a product from a first tier customer is a second tier customer; one that get a product from a second tier customer is a third tier customer, and so on to final customers (see [Figure 7.6](#)).

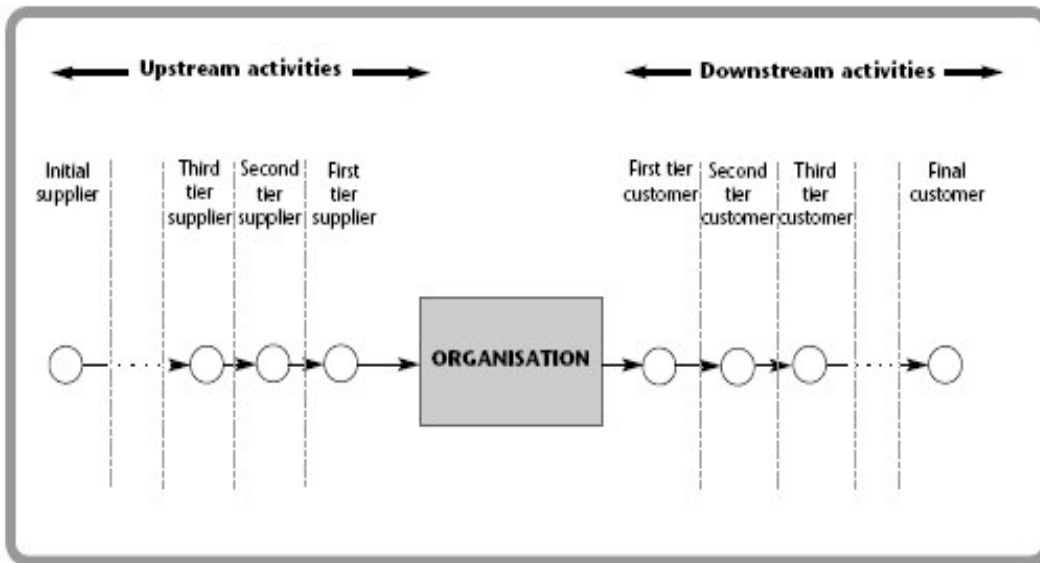


Figure 7. 6 Activities in a supply chain

In practice, most organizations get materials from many different suppliers, and sell products to many different customers. Then the supply chain converges as raw materials move in through the tiers of suppliers, and diverges as products move out through tiers of customers. A manufacturer might see sub-assembly providers as first tier suppliers, component makers as second tier suppliers, materials suppliers as third tier suppliers, and so on. It might see wholesalers as first tier customers, retailers as second tier customers, and end users as third tier customers (as illustrated in Figure 7.7).

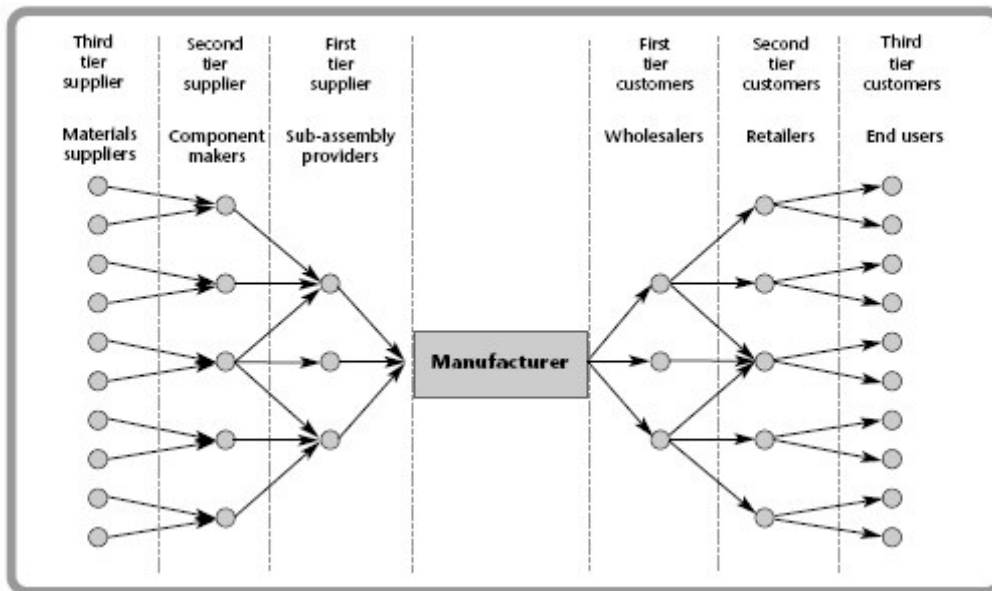


Figure 7. 7 Supply chain around a manufacturer

Supply chains diverge to meet demand from different types of customer. Manufacturers of car components, for example, sell some products to car assembly plants, some to wholesalers for garages doing repairs, some to retail shops for individual customers, and some directly to customers through websites. Then the supply chain divides into separate strands with the same product following alternative routes.

Benefits of supply chains

The following list suggests some other benefits of well-designed supply chains (where we use the terms ‘wholesaler’ and ‘retailer’ as a convenient label for intermediaries):

- Producers locate operations in the best locations, regardless of the locations of their customers.
- By concentrating operations in large facilities, producers can get economies of scale.
- Producers do not keep large stocks of finished goods, as these are held further down the supply chain nearer to customers.
- Wholesalers place large orders, and producers pass on lower unit costs in price discounts.
- Wholesalers keep stocks from many suppliers, giving retailers a choice of goods.
- Wholesalers are near to retailers and have short lead times.
- Retailers carry less stock as wholesalers provide reliable deliveries.
- Retailers can have small operations, giving a responsive service near to customers.
- Transport is simpler, with fewer, larger deliveries reducing costs.
- Organizations can develop expertise in specific types of operation.

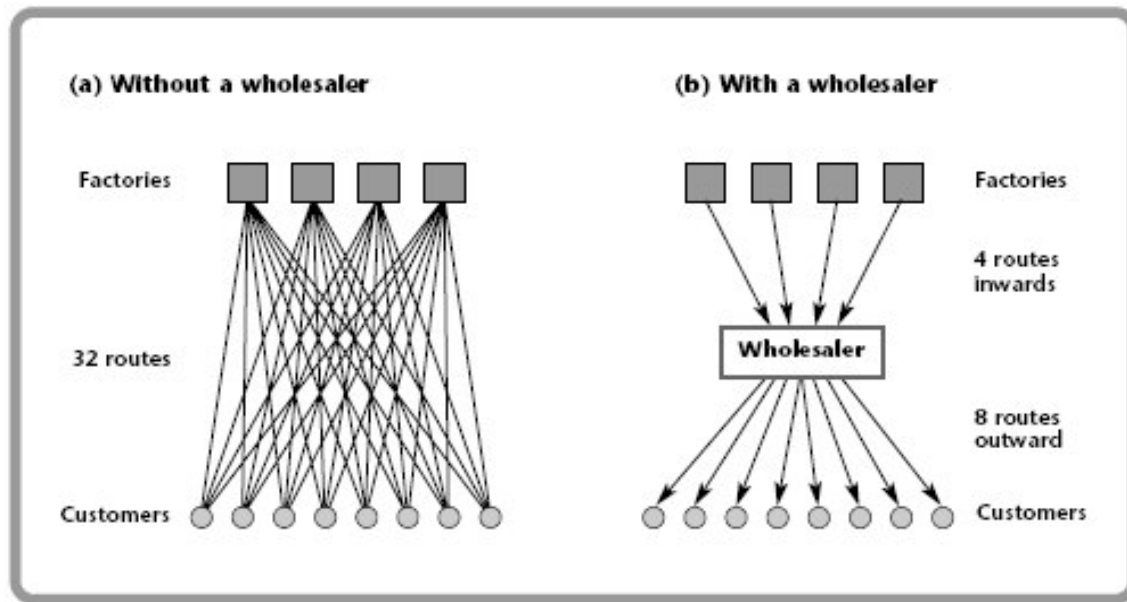


Figure 7. 8 Using intermediaries to simplify the supply chain

7.4. ACTIVITIES OF LOGISTICS

Separate activities

Logistics is responsible for the movement and storage of materials as they move through the supply chain. But what activities does this include? If you follow some materials moving through an, you can see that the following activities are normally included in logistics.

Procurement or purchasing: The flow of materials through an organization is usually initiated when procurement sends a purchase order to a supplier. This means that procurement finds suitable suppliers, negotiates terms and conditions, organizes delivery, arranges insurance and payment, and does everything needed to get materials into the organization. In the past, this has been seen as a largely clerical job centered on order processing. Now it is recognized as an important link with upstream activities, and is being given more attention.

Inward transport or traffic actually moves materials from suppliers to the organization's receiving area. This has to choose the type of transport (road, rail, air, and so on), find the best transport operator, design a route, make sure that all safety and legal requirements are met, get deliveries on time and at reasonable cost, and so on.

Receiving makes sure that materials delivered correspond to the order, acknowledges receipt, unloads delivery vehicles, inspects materials for damage, and sorts them.

Warehousing or stores moves materials into storage, and takes care of them until they are needed. Many materials need special care, such as frozen food, drugs, alcohol in bond, chemicals that emit fumes, animals, and dangerous goods. As well as making sure that materials can be available quickly when needed, warehousing also makes sure that they have the right conditions, treatment and packaging to keep them in good condition. We describe warehousing in more detail in Chapter 10.

Stock control sets the policies for inventory. It considers the materials to store, overall investment, customer service, stock levels, order sizes, order timing and so on.

Order picking finds and removes materials from stores. Typically materials for a customer order are located, identified, checked, removed from racks, consolidated into a single load, wrapped and moved to a departure area for loading onto delivery vehicles.

Materials handling moves materials through the operations within an . It moves materials from one operation to the next, and also moves materials picked from stores to the point where they are needed. The aim of materials handling is to give efficient movements, with short journeys, using appropriate equipment, with little damage, and using special packaging and handling where needed.

Outward transport takes materials from the departure area and delivers them to customers (with concerns that are similar to inward transport).

Physical distribution management is a general term for the activities that deliver finished goods to customers, including outward transport. It is often aligned with marketing and forms an important link with downstream activities.

Recycling, returns and waste disposal: Even when products have been delivered to customers, the work of logistics may not be finished. There might, for example, be problems with delivered materials – perhaps they were faulty, or too many were delivered, or they were the wrong type – and they have to be collected and brought back. Sometimes there are associated materials such as pallets, delivery boxes, cable reels and containers (the standard 20 foot long metal boxes that are used to move goods) which are returned to suppliers for reuse. Some materials are not reused, but are brought back for recycling, such as metals, glass, paper, plastics and oils. Finally there are materials that cannot be used again, but are brought back for safe disposal, such as dangerous

chemicals. Activities that return materials back to an organization are called reverse logistics or reverse distribution.

Location: Some of the logistics activities can be done in different locations. Stocks of finished goods, for example, can be held at the end of production, moved to nearby warehouses, put into stores nearer to customers, passed on to be managed by others, or a range of alternatives. Logistics has to find the best locations for these activities – or at least play a significant role in the decisions. It also considers related questions about the size and number of facilities. These are important decisions that affect the overall design of the supply chain.

Communication: Alongside the physical flow of materials is the associated flow of information.

This links all parts of the supply chain, passing information about products, customer demand, materials to be moved, timing, stock levels, availability, problems, costs, service levels, and so on. Coordinating the flow of information can be very difficult, and logistics managers often describe themselves as processing information rather than moving goods. Christopher supports this view by saying that, ‘Supply chain competitiveness is based upon the value-added exchange of information’. The Council of Logistics Management also highlights the combination of materials and information flow in their definition:

Logistics is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

Depending on the circumstances, many other activities can be included in logistics. Sometimes an organization might include sales forecasting, production scheduling, customer service management, overseas liaison, third party operations, and so on. The important point is not to draw arbitrary boundaries between functions, but to recognize that they must all work together to get an efficient flow of materials.

7.5. AIMS OF LOGISTICS

Logistics is responsible for the flow of materials through a supply chain. This function is also called **supply chain management**.

With our broad view, logistics managers have two main aims. The first is to move materials into, through, and out of their own organization as efficiently as possible. The second aim is to contribute to an efficient flow through the whole supply chain. Traditionally, managers concentrate on the first of these, focusing on those parts of the supply chain that they directly control. Hopefully, if each organization looks after its own logistics properly, materials will move efficiently through the whole chain, thus achieving the second aim. To some extent this is true. It is not, however, inevitable and organizations really need a more positive approach to co-operation. We will discuss this in the next chapter.

8. BUSINESS VIABILITY

8.1. BUSINESS MODEL

The term business model is used for a broad range of informal and formal descriptions that are used by enterprises to represent various aspects of its business, including its purpose, offerings, strategies, infrastructure, organizational structures, trading practices and operational processes and policies.

8.2. FEASIBILITY STUDY

A Business feasibility study can be defined as a controlled process for identifying problems and opportunities, determining objectives, describing situations, defining successful outcomes and assessing the range of costs and benefits associated with several alternatives for solving a problem. The business feasibility study is used to support the decision-making process based on a cost benefit analysis of the actual business or project viability. The feasibility study is conducted during the deliberation phase of a formal business plan. It is an analytical tool that includes recommendations and limitations, which are utilized to assist the decision-makers when determining if the business concept is viable [15].

8.2.1. THE IMPORTANCE OF A BUSINESS FEASIBILITY STUDY

It is estimated that only one in fifty business ideas are actually commercially viable. Therefore a business feasibility study is an important step in saving the utilization of scarce resources [15]. If a project is seen to be feasible from the results of the study, the next logical step is to proceed with the full business plan. The research and information uncovered in the feasibility study will support the business planning stage and reduce the research time. Hence, the cost of the business plan will also be reduced. A thorough viability analysis provides an abundance of information that is also necessary for the business plan. For example, a good market analysis is necessary in order to determine the business concept's feasibility. This information provides the basis for the market section of the business plan.

Finally, a feasibility study should contain clear supporting evidence for its recommendation. The strength of the recommendation can be weighed against the study ability to demonstrate the continuity that exists between the research analysis and the research proposed business model. Recommendations will be reliant on a mix of numerical data with qualitative, experience-based documentation. A business feasibility study is heavily dependent on the market research and analysis. A feasibility study provides the stakeholders with varying degrees of evidence that a business concept will in fact be viable.

8.2.2. BUSINESS FEASIBILITY STUDY AND DIMENSIONS OF BUSINESS VIABILITY

The business feasibility study findings will be assessed by potential investors and stakeholders regarding their credibility and depth of argument. The business feasibility study places the findings of the dimensions of business viability model assessment into a formal business report. It also aligns the findings with functional processes of an enterprise which an audience can easily understand. The dimension of business viability model is discussed in more detail in appendix H titled “dimension of business viability”. For the purpose of understanding the structure of business viability study the following represents the framework of the dimensions of viability [15]:

- Market viability
- Technical viability
- Business model viability
- Management model viability
- Economic and financial model viability
- Exit strategy viability

Business and market analysis will contribute considerably to the business feasibility study. Consideration should be given to using traditional business analysis techniques such as SWOT, Porter’s five forces and PEST. Although they may not provide information which is a perfect fit to the proposed business model, they will provide a strong starting point for future analysis.

9. WORLD BAMBOO RESOURCES

9.1. BAMBOO AS A PLANT

Bamboo belongs to the *Gramineae family* and has about 90 genera with over 1 200 species. Bamboo flowers rarely and in irregular cycles, which are not yet clearly understood. Thus taxonomists do not always agree on the identification of bamboo species and genera, but modern genetic analysis may shed new light on bamboo taxonomy [1].

Bamboo is naturally distributed in the tropical and subtropical belt between approximately 46⁰ north and 47⁰ south latitude, and is commonly found in Africa, Asia and Central and South America. Some species may also grow successfully in mild temperate zones in Europe and North America. Bamboo is an extremely diverse plant;, which easily adapts to different climatic and soil conditions. Dwarf bamboo species grow to only a few centimeters (cm), while medium-sized bamboo species may reach a few meters (m) and giant bamboo species grow to about 30 m, with a diameter of up to 30 cm. Bamboo stems are generally hard and vigorous, and the plant can survive and recover after severe calamities, catastrophes and damage. Young bamboo shoots were the first sign of new plant life after the nuclear bombing of Hiroshima and Nagasaki [1].

Bamboo shoots and culms grow from the dense root rhizome system. There are two main categories of rhizomes: monopodial and sympodial. Monopodial rhizomes grow horizontally, often at a surprising rate, and thus their nickname of 'runners'. The rhizome buds develop either upward, generating a culm, or horizontally, with a new tract of the rhizomal net. Monopodial bamboos generate an open clump with culms distant .from each other and can be invasive. They are usually found in temperate regions and include the genera *Phyllostachys* and *Pleioblastus*. Sympodialrhizomes are short and thick, and the culms above ground are close together in a compact clump, which expands evenly around its circumference. Their natural habitat is tropical regions and they are not invasive. The main genus is *Bambusa*.

9.2. BAMBOO AS A RESOURCE

Bamboo has received increasing attention over the last two decades for its economic and environmental values. In Africa, Asia and Latin America, it is closely associated with indigenous culture and knowledge and is widely used for housing, forestry, agroforestry, agricultural activities and utensils. In countries undergoing economic development, traditional bamboo culture gradually disappears. However, industrial development of bamboo is offering a new opportunity to younger generations to retain and continue developing cultural traditions related to the cultivation, harvesting and use of bamboo.

The physical and environmental properties of bamboo make it an exceptional economic resource for a wide range of uses and for poverty reduction. It grows quickly and can be harvested annually without depletion and deterioration of the soil. Bamboo can grow on marginal land, not suitable for agriculture or forestry, or as an agroforestry crop. It has a relatively light weight, because the culms are hollow, and unlike wood can be easily harvested and transported without specialized equipment or vehicles. It splits easily for weaving and is thus easy to handle also for women. Bamboo is often cultivated outside the forest on farms, where it is more easily managed. Processing normally does not require highly skilled labor or special qualifications and can be started by rural poor communities at a minimal cost. For the same reason, it could offer income-earning opportunities to handicapped people.

Bamboo use and trade have been growing rapidly in recent years. Bamboo is becoming popular as an excellent substitute for wood in producing pulp, paper, board and charcoal. It is widely used in construction, either in its natural form or as a reconstituted material (laminated boards and panels). In addition, bamboo shoots have become a popular vegetable, with Asian cuisine spreading quickly around the globe.

A systematic study prepared in the framework of the Global forest resources Assessment 2005 conducted an assessment on the availability, extent, ownership, etc, on world bamboo resources. A report format has provided to be submitted by participating

cases, additional data were obtained from remote sensing analyses. The information requested included bamboo resource composition, areas of monopodial and sympodial species and bamboo outside forest land. Although this study constitutes the most complete survey to date of bamboo resources at the global level, the data reflect both data availability and information gaps, the latter particularly in Africa and Latin America.

Figure 9.2 shows the share of world bamboo resources by continent. Asia remains the richest continent, with about 65 percent of total world bamboo resources [1].

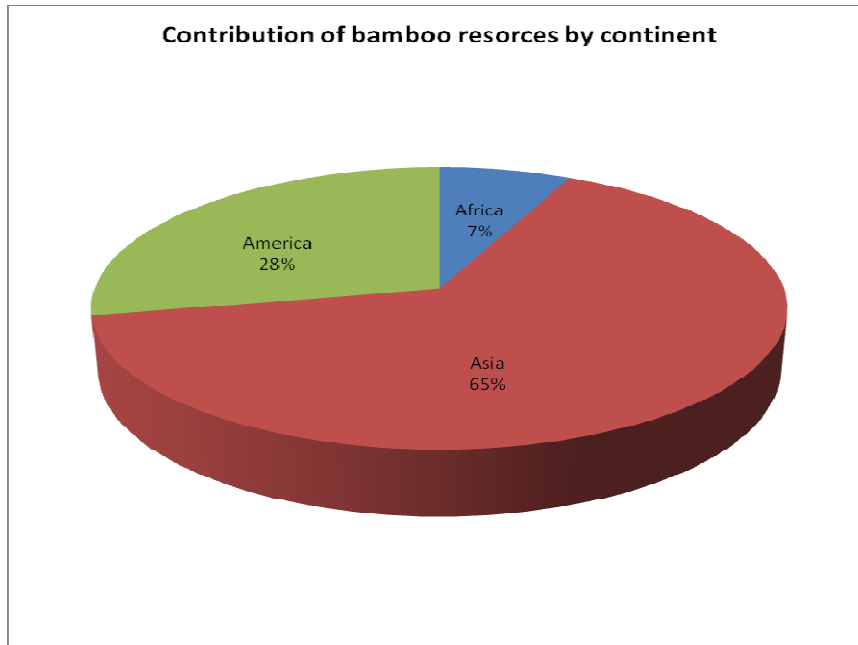


Figure 9.2 Distribution of the bamboo resources by countries

The table shows that bamboo may total more than 36 million hectares worldwide or an average of 3.2 percent of the total forest area in the reporting countries if bamboo outside forest land is included. Sixteen countries in Asia together reported a total of close to 24 million hectares of bamboo forest, constituting some 4.4 percent of the total forest area in the countries surveyed. Although the information gathered from Africa is partial, a total of over 2.7 million hectares of bamboo forest was reported by six countries (Ethiopia, Kenya, Nigeria, Uganda, the United Republic of Tanzania and Zimbabwe). In Latin America, at least ten countries have significant bamboo resources. Although precise assessments are still to be done, a total of over 10 million hectares is considered a realistic estimate for the region. Brazil, Chile, Colombia; Ecuador and Mexico have the richest bamboo resources.

Table 9.1 Distribution of the bamboo resources by countries

Country	Area of Bamboo(1000 ha)			Forest area(1000 ha)	Bamboo to forest area (%)
	1990	2000	2005	2005	
Bangladesh	90	86	83	871	9.5
Cambodia ^a	32	34	29	10447	0.3
China	3856	4869	5444	197290	2.8
India	10711	10863	11361	67701	16.8
Indonesia	2151	2104	2081	88495	2.4
Japan	149	153	154	24868	0.6
Lao People's Democratic Rep.	1612	1612	1612	16142	10
Malaysia	422	592	677	20890	3.2
Myanmar	963	895	859	32222	2.7
Pakistan	9	14	20	1902	1.1
Papua New Guinea	23	38	45	29437	0.2
Philippines	127	156	172	7162	2.4
Rep. of Korea	8	6	6	6265	0.1
Sri Lanka	3	3	3	1933	0.2
Thailand ^a	261	261	261	14520	1.8
Viet Nam ^a	813	813	813	12931	6.3
Total Asia	21230	22499	23620	533076	4.4
Ethiopia	849	849	849	13000	6.5
Kenya	124	124	124	3522	3.5
Nigeria	1590	1590	1590	11089	14.3
Uganda ^a	67	67	67	3627	1.8
United rep. of Tanzania	128	128	128	35257	0.4
Total Africa	2758	2758	2758	66495	4.1
Brazil		9300	9300	447698	2.1
Chile		900	900	16121	5.6
Ecuador		9	9	10853	0.1
Peru ^a		190	190	68742	0.3
Total Latin America		10399	10399	543414	1.9
Grand Total		35656	36777	1142985	3.2

^a Data on the extent of forest were obtained from sources other than national reports.

In Asia, the major bamboo producing countries are India (almost 11.4 million hectares) and China (over 5.4 million hectares), followed by Indonesia (2 million hectares) and the Lao People's Democratic Republic (1.6 million hectares). India accounts for roughly half

the total area of bamboo reported for Asia and, together with China, approximately 70 percent. Over the last 15 years, the bamboo area in Asia has increased by 10 percent, primarily due to large-scale planting of bamboo in China and, to a lesser extent, in India.

The total area of bamboo reported by the five African countries makes up over 2.7 million hectares. This equals 4.1 percent of their total forest area. Ethiopia reported 6.5 percent and Nigeria over 14 percent of bamboo in the forest cover. Nigeria may have overestimated the total area of bamboo due to a different methodological approach. It reported forest land with bamboo, but did not apply the reclassification method to calculate the pure bamboo area.

10. BAMBOO RESOURCES IN ETHIOPIA

10.1. BAMBOO RESOURCE AND DISTRIBUTION

Ethiopia is the second most populous country in Sub Saharan Africa facing threat of rapidly increasing population with the growth rate of 2.6 %. Its population was reported to be 64.3million in 2000 [18] and has been projected to reach 89.7 million in year 2015 [18].

Agriculture is back bone of the country's economy. It consists about 48% of the GDP; provides employment to 85% of the population; supplies raw material to 70% of the country's agro-based industries, and generate more than 90% of the country's foreign exchange earnings. The crop production sector accounts for 60% of the sector output.

Ethiopia has a total land area of about 111.2 million hectares of which the highland consists of 44% of the country's land mass and accounts for nearly 90% of the economic activity. Close to 66% of the land mass is estimated to be potentially useable for agricultural production (15% as cultivable land and 51% as grazing land) [18].

There are about 43 species of bamboo in Africa covering about 1.5 million hectares. Forty of these species are mainly distributed in Madagascar while the remaining three species are found in mainland Africa [12]. Ethiopia is one of the countries in Eastern Africa that possess considerable bamboo resources. There are two indigenous species of bamboo in Ethiopia i.e. the highland or African alpine bamboo (*Arundinaria alpina* K. Schumach.) and a monotypic genus, lowland bamboo (*Oxytenanthera abyssinica*. These species are found in some other African countries, but no where else outside the African continent. Information on bamboo resources in Ethiopia is very limited [1]. Bamboo forest is decreasing due to population growth, demand for land, migration and forest fires. Access to bamboo is becoming more difficult as authorities and users recognize the need to protect it from further decline. Management concepts and experience are lacking. In the 1960s, the total area of bamboo was estimated at 1.5 million hectares, including 1

million hectares of lowland bamboo. However, a study by private consultants in 1997 significantly reduced this estimate. The currently estimated total area of bamboo is 849 000 ha. The area of sympodial bamboo is 700 000 ha. About 481 000 ha were mapped and partly surveyed for the 1997 study. The total area of mapped monopodial bamboo is 148 626 ha, including 129 626 ha of naturally regenerated and 19 000 ha of planted bamboo. It is likely that the Ethiopian bamboo area has been shrinking since 1997.

Another study conducted by INBAR on the other hand grows naturally in the south, south-west, central and north-west highlands shows nearly similar results in the area coverage of bamboo in Ethiopia, and the data is well organized based on the regions and different bamboo growing zones (**Table 10.1**).

Lowland bamboo in Ethiopia grows only in the western part along major river valleys and in the lowlands bordering Sudan. It occurs between 1100-1700 meters above sea level.

The highland bamboo (*Arundinaria Alpina*) of Ethiopia at altitudes ranging from 2200 to 4000 meters above sea level.

Table 10. 1 Major Highland Bamboo Areas in Ethiopia[12]

No	Bamboo Area	Region	Natural Stand(Ha)	Plantation (Ha)	Total (Ha)	area
1	Injibara	Amhara	30	2350	2,380	
2	Agaro	Oromiya	-	1500	1,500	
3	Bale Mountains	Oromiya	56,851	-	56,851	
4	Shenen/Jibat	Oromiya	1,774	2561	4,335	
5	Gera	Oromiya	36,000	1250	37,250	
6	Bore/Hagereselam	Oromiya	-	2460	2,460	
7	Chencha/Arbaminch	South	2,460	3250	5,710	
8	Indibir/Jembero	South	-	1850	1,850	
9	Jima/Ameya	Oromiya/South	-	900	900	
10	Mizan Teferi/Kulish	South	-	1850	1850	
11	Debresina/Wofwasha	Amhara	35	-	35	
12	Wushwush/Bonga	South	-	1120	1120	
13	Bonga/Ameya	South	7,997	-	7997	
14	Masha	South	18,652	-	18652	
15	Munesa Shashemene	Oromia/South	4,183	-	4,183	
	TOTAL	-	127,982	19,091	147,073	

Table 10. 2 Major Lowland Bamboo Areas in Ethiopia [12]

No	Bamboo Area	Region	Natural Stand(Ha)	Plantation (Ha)	Total Area (Ha)
1	Hinde/North of Nekemte	<i>Amhara</i>	8,670	=	8,670
2	Asossa	Benshangul Gumuz	77,947	-	77,947
3	Bambasi	"	64,245	-	64,245
4	Begi	"	21,509	-	21,509
5	Nejo	Oromiya	27,612	-	27,612
6	<i>Dibate</i>	Benshangul Gumuz	14,200	-	14200
7	Guba	"	7,757	-	7,757
8	Kemashi	"	33,723	-	33,723
9	Pawe	"	53,830	-	53,830
10	Gimbi	Oromiya	29,125	-	29,125
11	Guten	Oromiya	6,044	-	6,044
12	Metema/Dansha/Humera	Tigray/Amhara	425,000	-	425,000
13	Didessa Valley	Oromiya	135,000	-	135,000
14	Dangur	Benshangul-Gumuz	27,350	-	27,350
15	Bulen	"	16,780	-	16,780
16	Galesa	"	10,870	-	10,870
	TOTAL		959,662	-	959,662

As per FRA 2005, forest ownership structure included three classes [1]:

1. Private -land owned by individuals, families, private cooperatives, corporations, industries, religious and educational institutions, pension or investment funds and other private institutions;
2. Public -land owned by the state (national, state and regional governments) or government-owned institutions or corporations or other public bodies including cities, municipalities, villages and communes; and
3. Other -land that is not classified as one of the two previous classes.

Approximately 2 percent of bamboo area is classified as private forests, which normally lie on lower altitudes up to 1 800 m. Naturally regenerated bamboo stands are located above 2 000 m and belong to regional governments.

Growing stock is a major indicator of the extent of bamboo resources. Information on growing stock is also needed to estimate bamboo biomass and carbon content. Growing stock is normally measured in culms (for monopodial species), clumps (for sympodial species) and weight (for both types of species). Coefficients exist for the different species to convert number of culms and clumps to fresh and dry weight.

Table 10. 3 Growing stock of bamboo resources [1]

Country	1990			2000			2005		
	Stock (million tonnes)	Area (1 000 ha)	Average (tonnes/ha)	Stock (million tonnes)	Area (1 000 ha)	Average (tonnes/ha)	Stock (million tonnes)	Area (1 000 ha)	Average (tonnes/ha)
Bangladesh	1	90	11	1	86	12	1	83	12
China	96	3 856	25	144	4 869	30	164	5 444	30
India	115	10 711	11	117	10 863	11	122	11 361	11
Indonesia	13	2 151	6	11	2 104	5	10	2 081	5
Malaysia	7	422	17	10	592	17	11	677	17
Myanmar	18	963	19	18	895	21	18	859	21
Pakistan	0.09	9	10	0.14	14	10	0.21	20	11
Philippines	6	127	48	6	156	39	6	172	35
Total Asia	257	18 329	14	307	19 579	15	332	20 697	16
Ethiopia	21	849	25	21	849	25	21	849	25
Kenya	1	124	5	1	124	5	1	124	5
Nigeria	27	1 590	17	27	1 590	17	27	1 590	17
Uganda	3	67	37	3	67	37	3	67	37
United Republic of Tanzania	5	128	35	5	128	35	5	128	35
Total Africa	57	2 758	21	57	2 758	21	57	2 758	21
Total	314	21 087	15	364	22 337	16	389	23 455	17

Study on Establishment of Bamboo Processing Plants in Amhara Regional State

In case of Ethiopia, growing stock was calculated based on the reported average growing stock of the monopodial species (51 tones per hectare) and sympodial species (19 tones per hectare). Total stock is over 20 million tones, while average growing stock is 24.6 tones per hectare. The report also specifies that the average annual increment of unmanaged, naturally regenerated bamboo forests in Ethiopia is 8-10 tones per hectare of oven-dry weight [1].

11. BAMBOO IN AMHARA REGION

11.1. WHY AMHARA REGION?

The population of Amhara Region is projected to be 20 million in July 1, 2008, based on the 1994 Census data [14]. Amhara region is selected for the study. There are some reasons to select Amhara regional state in favor of others. But this can be considered as a model and extended for other bamboo growing regions by making some modifications, depending on the nature, infrastructure, and some other factors in the region considered.

The following are some of the reasons that favor the study to be in Amhara region:

1. Environmental Factors:

Most of the area in Amhara region is suitable for growing bamboo, some suitable for lowland bamboo and some others are for highland bamboo. From the eleven zones in the region, there are four highland bamboo plantations reported and there are two zones reported some coverage of areas with lowland bamboo. But there the experts in the region strongly believe that the zones will be much more than this number if proper extension services for the plantation and management of bamboo are programmed.

2. Plantation Experience:

There is historical and very long plantation experience of bamboo in some zones of the region. For instance, Awi and Sekela zones are well known to integrate the resource with their day to day life. In these zones planting bamboo and using it as a source of income has very long history. The farmers are well aware for the local value of the resource. Highland bamboo in these zones is used for almost every equipment used in homes, including agricultural equipments, furniture, fencing, day to day applications and as construction materials. Therefore there is high experience with the farmers, like propagation, harvesting, collection, and marketing the resource.

3. Environmental Protection:

Ethiopian highlands are highly facing a problem of land erosion, land slip and other environmental degradation. Amhara is one of those mountainous regions in Ethiopia.

Bamboo is excellent in protecting the above environmental problems. Amhara region contributes 50% of the total erosion level in the country []. Planting bamboo, then, will help to recover the environment in addition to the expected economic and cultural advantage.

4. Infrastructures:

The available resources (especially the highland ones) are at very good location and are near to potential market such as Bahir Dar and Addis Ababa. Road access to almost all resource bases is good (for instance in Awi zone most of the growing areas are not that far from the main road connecting Bahir Dar and Addis Ababa, which is good quality asphalted road). Some facilities such as water, electricity and telecommunication are there in most of the bamboo growing areas in the region.

11.2. BAMBOO RESOURCE IN AMHARA REGION

The quality of data on the availability and extent of bamboo in Ethiopia is relatively poor; this is also observed in Amhara regional state. The data are very inaccurate and inconsistent. Some studies estimate the resource to cover very large area and some others the estimated amount is exaggerated and the previous coverage does not exist now. The se ones estimate the coverage is very low. But all researchers, data and regional experts all agree on the huge potential of the region for cultivation of both lowland and highland bamboo in the region.

There are two types of bamboo species in the region: highland bamboo (in Amharic, Kerkeha) and the lowland bamboo (in Amharic, Shimel). Different environment and ecological conditions support different zones to have the access for growing these two different bamboo species. As their names indicate lowland bamboo can grow in low land areas of the region with an altitude of less than 1800 meters above sea level, and the highland ones grow in the highland altitude (more than 1800 meters above sea level) of the regions.

11.2.1. HIGHLAND BAMBOO

In recent survey by regional bureau of agricultural and rural development, it is found that five of the eleven zones in Amhara region reported the presence of highland bamboo resource.

In Awi zone, the resource is better integrated with the day to day life of many households and is the only source of income for many farmers and other urban dwellers. In this zone it is well recognized by farmers and it is common to see small plantations in most of the houses. In addition, some local furniture and other agricultural equipments are mostly made of highland bamboo. Some farmers also have experienced the nutritious value of bamboo as a food but mostly for its medical purposes.

The following table summarizes the zones and Woredas in the zones that grow the resource in the Amhara Region according to the report from Amhara Region Bureau of agriculture and rural Development [8].

Table 11. 1 Main highland bamboo growing areas in Amhara region

Zones	Woredas
Awi	<ul style="list-style-type: none">- Guagusa Shikudad- Injibara town Adm.- Fagita Lekoma- Ankesha
West Gojjam	<ul style="list-style-type: none">- Sekela- Dega Damot- Quarit
East Gojjam	<ul style="list-style-type: none">- Sinan- Bibugni
South Gondor	<ul style="list-style-type: none">- Farta- Estie
North Shoa	<ul style="list-style-type: none">- Tarma Ber (Debre Sina)

All these areas growing the resource are mapped and put as ANNEX A. The original map is obtained from GIS team of ANRS BoFED.

11.2.2. LOWLAND BAMBOO

The second type of indigenous bamboo is lowland bamboo. It grows in three zones of the region. There is a huge estimated potential of lowland bamboo. But there is a lack of awareness in its economic value and is being cleared and put in fire for farming. The current level of lowland bamboo resource is expected to be much less than the reported amount, due to the above reasons and the action of resettlement of farmers from less productive areas to these areas as pointed out by the experts from the regional bureau of Agriculture and Rural Development.

In lowland bamboo growing areas the resource is used for construction (fencing, housing), furniture (chairs and tables), and mostly is used as walking sticks in many parts of the country. Low land bamboo is mostly recognized for its industrial use as raw material for pulp and paper [4, 8, 9, 10].

The following table summarizes the zones and woredas that report to the availability of low land bamboo.

Table 11. 2 Main lowland bamboo growing areas in Amhara region

Zones	Woredas
Awi	<ul style="list-style-type: none">- Jawi- Guagusa- Ankesha
North Gondor	<ul style="list-style-type: none">- Quara- Metema- West and Tach Armachiho- Adiarkay

All these areas growing the resource are mapped and put as ANNEX - A.

Provided that more effort is made to support the plantation and management of bamboo through better extension service programmes, it is believed by regional experts in the region, that the coverage of the resource would be expanded to other zones of the region [8].

11.3. ACTIVITIES PERFORMED SO FAR

1. East African Bamboo Project:

Recently, East African Bamboo Project (EABP) is working on development of bamboo in East Africa (Ethiopia and Kenya). This project aims at developing the plantation and utilization of bamboo resource in these two east African countries. The project works in cooperation with UNIDO and many stake holders; Ministry of Trade and Industry (Ethiopia and Kenya), Ministry of Agriculture (Ethiopia), and Ministry of Environment and Natural Resources (Kenya).

2. Introduction of New Species to Ethiopia:

Ten new species of bamboo has been brought by East African Bamboo Project from Asia and are being introduced to Ethiopian ecology [4]. This is with the aim of diversifying the existing two indigenous species and to increase the coverage of bamboo resource in some areas that are not ecologically suitable for these two indigenous species. There are three nurseries established in Ethiopia. One of these is found in Injibara (at a distance of about 8 km from the town, near Lake Zengena). In this nursery there are five new species imported from abroad and two indigenous species growing from seed, which is collected from Southern region of Ethiopia. The nursery is under the EABP, and the fund require is obtained from CFC (Common Fund for Commodities), with a technical support of United Nations Industrial Development Organization (UNIDO), and under the supervision of International Network for Bamboo and Rattan (INBAR). The condition of the nursery in Injibara is not that well managed. There is no proper follow up in the area.

3. Adal Industrial PLC:

Adal Industrial PLC is established in September 2006, at a distance of 26km to eastern part of Addis Ababa (road from Addis to Debrezeit). With 80% female employees the industry creates employment opportunity for 120 employees. It is organized to process bamboo. There are different products that are made from bamboo in the industry. These products include:

- Bamboo Flooring
- Bamboo Blinding/Curtain/
- Incense Sticks
- Tooth Picks

4. Testing two Ethiopian indigenous bamboo species:

The mechanical and physical properties of the two Ethiopian indigenous bamboo species were sent to China, by Dr. Seyoum Kelemework, and the result presented in Beijing [4], China on January 16, 2008. The aim was to identify whether the industrial applications are possible and to identify the types of products that can be made from these local bamboo species.

The result discussed shows that the Ethiopian indigenous bamboo species are good in industrial applications. The industrial products include, laminated bamboo lumber, bamboo ply board, bamboo floor, bamboo mat, incense sticks, oriented strand boards, and bamboo medium density fiber board (MDF) [4].

12. BAMBOO MARKET AND SUPPLY

12.1. BAMBOO PRODUCT

Forest resources are experiencing increasing pressure due to the growing world population and improving living standards [1]. Bamboo is the most important non-wood forest product and in India is known as the 'poor man's timber'. In China, it is the valuable raw material for the booming bamboo industry.

During the last 15-20 years, bamboo has developed as an exceptionally valuable and often superior substitute for wood. Bamboo-based panels and boards are hard and durable and may successfully substitute for hardwood products. Bamboo may replace wood in many industrial applications and thereby contribute to the saving and restoration of the world's forests.

Bamboo is a major construction material in many countries, particularly in rural areas. It can be used for almost all parts of houses, including posts, roofs, walls, floors, beams, trusses and fences. People also use bamboo to produce mats, baskets, tools, handles, hats, traditional toys, musical instruments and furniture. In the food sector, bamboo shoots are becoming more popular. Bamboo has a tremendous potential for economic and environmental development and international trade.

Bamboo raw materials

Bamboo is a non-durable resource. Its use in exposed conditions requires prior treatment, while its use can be further enhanced through the application of modern engineering techniques. Bamboo can be processed into modern products (engineered bamboo) that may successfully compete with wood products in price and performance. Use of bamboo in composite panels and boards overcomes differences in quality related to the culms and allows the production of homogeneous products. Engineered bamboo may well replace wood, steel and concrete in many uses.

Bamboo charcoal

Bamboo charcoal is traditionally used as a substitute for wood charcoal or mineral coal. It can serve as a fuel, absorbent and conductor. The calorific value of bamboo charcoal is almost half that of oil of the same weight. Activated bamboo charcoal can be used for cleaning the environment, absorbing excess moisture and producing medicines. The absorption capacity of bamboo charcoal is six times that of wood charcoal of the same weight. China is a leader in its production. At present, Japan, the Republic of Korea and Taiwan Province of China are the main consumers, but its importation is rapidly expanding in Europe and North America. There are three main reasons contributing to the success of bamboo charcoal in international trade:

1. Bamboo grows faster and has a shorter rotation compared with tree species;
2. The calorific value and absorption properties of bamboo- charcoal are similar to or better than those of wood charcoal; and
3. It is cheaper and easier to produce.

Bamboo housing

There are three main types of bamboo housing:

1. Traditional houses, which use bamboo culms as a primary building material;
2. Traditional bahareque bamboo houses, in which a bamboo frame is plastered with cement or clay; and
3. Modern prefabricated houses made of bamboo .laminated boards, veneers: and panels.

Experts estimate that over one billion people live in traditional bamboo houses. These buildings are usually cheaper than wooden houses, light, strong and earthquake resistant, unlike brick or cement constructions. New types of prefabricated houses made of engineered bamboo have certain advantages. They can be packed flat and transported

long distances at a reasonable cost. They are better designed and environmentally friendly. Bamboo materials are widely available and can be cultivated at a low cost. In addition, bamboo is being employed in construction as a substitute to reinforcing iron [3].

Bamboo pulp, paper and cloth

Several bamboo-producing countries, such as China and India, use bamboo in pulp; paper and more recently cloth. Bamboo paper has practically the same quality as paper made from wood. Its brightness and optical properties remain stable, while those of paper made from wood may deteriorate over time. The morphological characteristics of bamboo fibers yield paper with a high tear index, similar to that of hardwood paper. The tensile stiffness is somewhat lower compared with softwood paper. The strain strength is between that of hardwood and softwood papers. The quality of bamboo paper may be improved by refining the pulp [1, 2].

Bamboo panels

Bamboo fiber is longer than wood fiber, which gives bamboo some technological advantages. The panels are widely used in modern construction as structural elements or as forms for concrete moldings. They are also used for flooring, roofing, partitions, doors and window frames. Bamboo panels have some advantages over wooden boards due to their rigidity and durability. Various types of bamboo veneers, panels and boards can be broadly classified as follows: veneers, strip boards, mat boards, fiber boards, particle boards; medium density boards, combinations of these, and combinations of these with wood and other ligno-cellulose materials and inorganic substances.



Bamboo flooring

Bamboo flooring is a quality product that can be used widely and has a large, global consumer market. It has certain advantages over wooden floors due to its smoothness, brightness, stability, high resistance, insulation qualities and flexibility. Bamboo flooring has a soft natural luster and maintains the natural gloss and elegance of bamboo fiber. This flooring is attractive to the demanding markets in Europe, Japan and North America. The estimated annual production of bamboo flooring in China was 17.5 million m² in 2004. Exports account for some 65 percent of total production.



Horizontal Natural



Carbonized



Horizontal Carbonized



Natural



Vertical Natural



Tiger



Vertical Carbonized



Outdoor decking

Bamboo weaving products and crafts

Bamboo crafts and woven mats are traditional products in China, India; Malaysia, the Philippines and Thailand. The technique has been known for several thousand years. These diverse products have become an indispensable part of daily life, literature and art. There are nearly 20 categories of woven bamboo products in Asia, including fruit baskets, trays, bottles, jars, boxes, cases, bowls, fans, screens, curtains, cushions, lampshades and lanterns.

Bamboo fuel

Through pyrolysis, bamboo can be converted into three valuable products: bamboo charcoal, oil and gas. Changing the pyrolysis parameters can change the product shares depending on the purpose and market conditions. Bamboo extracts contain valuable elements and can be used in pharmaceuticals, creams and beverages. Bamboo gas can be used as a substitute for petroleum. Bamboo charcoal is an excellent fuel for cooking and barbecuing. Activated charcoal is used as a deodorant, purifier, disinfectant, medicine, agricultural chemical and absorbent of pollution and excessive moisture [1, 2].

Bamboo shoots

About 200 species of bamboo can provide edible and palatable bamboo shoots. Fresh bamboo shoots are delicious and healthy, with high fiber content. Bamboo vegetables can be found in Chinese grocery stores and restaurants worldwide. After cooking the shoots are still crisp, because cooking does not destroy their texture. Cooked bamboo shoots can be stored in containers and shipped worldwide.



Bamboo Furniture

Traditional bamboo furniture uses natural round or split bamboo. A new type of 'pack-flat' 'knock-down' furniture uses glue-laminated bamboo panels. Unlike the traditional design, this furniture may be shipped in compact flat packs, to be assembled on the spot. The new design overcomes many of the problems of traditional bamboo furniture, such as high labor and transportation costs, low productivity, instability, varying quality and susceptibility to insects and fungi. At the same time, it retains the distinct physical, mechanical, chemical, environmental and aesthetic features of bamboo.

Export of laminated bamboo furniture is growing rapidly. However, trade statistics currently do not capture the value, owing to the absence of a special code for bamboo furniture. It is usually classified as wooden furniture.

Bamboo and culture

Bamboo is an important resource, which was discovered, adopted and developed by humans in ancient times. The first scripts were written in China on strips of bamboo more than 6 000 years ago, during the Neolithic period. Bamboo pens, brushes and musical instruments were invented 3 000 years ago. The first paper was produced from bamboo in China in the ninth century. Bamboo culture is an essential part of human history and civilization, especially in Asia.

Bamboo and the environment

Bamboo protects steep slopes, soils and water ways, prevents soil erosion, provides carbon sequestration and brings many other ecosystem benefits.

12.2. BAMBOO MARKET

12.2.1. DOMESTIC MARKET

Wood is one of the earth's most valuable resources and it conforms to the most varied requirements. It is easily worked with tools and machines and it has a very strength to weight ratio. Despite its strength it is so elastic that steam can be used to make it into complex shapes. Wood is resistant to mild chemicals and it does not corrode [16]. Due to the growing world population the consumption wood and wood products is increasing. Therefore there is scarce of the resource in the market, and the world is finding some fast growing plants like the bamboo grass. Then, the demand for bamboo and bamboo products is increasing.

Bamboo can substitute 'almost all' wood and wood products. That means wood production which take long period and very high cost can be replaced by using fast growing grass – bamboo.

Therefore some data are available for demand of wood and wood products in Ethiopia, which are helpful in defining the demand of bamboo and its derivatives.

In Ethiopia, information regarding utilization of forest and forest products are scarce and are ill-managed. Even though figures are not precise, it is estimated that about 24 million m³ of wood is produced annually, of which 10% is used for industrial and building purposes and the rest for the fuel wood and charcoal. The estimated demand for fuel wood consumption varies from 49 to 64 million m³ [11]. The estimated demand of industrial wood in the whole country for year 2000 is 400,000m³ per annum and is projected to be 1.6 million m³ per year for year 2014. And the annual demand for construction wood is estimated to be 2.1 million m³ per year by year 2000 and is anticipated to be 4.2 million m³ per year by 2014. Fuel demand estimation is made based on the consumption per capita and is found to be 1m³/year for rural households and 0.94 m³/year for urban dwellers.

Table 12. 1 Production and Demand for wood in Ethiopia

Item	Year 2000	Year 2014
Annual Production	24 million m³	24million m³
Annual Demand for Fuel wood	49-64 million m ³	85 million m ³
Industrial Wood Demand	400,000 m ³	1.6 million m ³
Construction Wood	2.4 million m ³	4.2 million m ³
Total Wood Demand	51.8-66.8 million m³	89 million m³

Table 12. 2 Local wood based industries and their capacities, August 2000

S.No.	Industry	Amount (in numbers)	Capacity/annum
1	Stationary Saw Mills	> 38	---
2	Ply Wood	2	2900m ³
3	Particle Board	2	5600 m ³
4	Fiber Board	1	4000 m ³
5	Mobile Saw Mills	6	45000 m ³
6	Pulp and Paper Mills	2	9500 metric tones

Table 12. 3 Production of major manufactured wood articles, 2003/2004 – 2005/2006

Product's Name	Unit	2003/2004	2004/2005	2005/2006
Timber	m ³	7 219	11 996	9 311
Plywood	m ³	-	8 722	357
Particle Board	m ³	7 950	1 300	2 079
Paper	Tons	8 411	6 167	5 485
Boxing Paper	Tons	4 274	4 453	5 950

Major sources of forest products are:

1. Natural forests
2. Plantations and

3. Trees outside forests such as trees around homestead, trees along the road side, trees on farm and import of forest products.

There is increasing per capita demand of wood and wood products in the global and local markets, due to the increasing quality of life globally. In addition there is high growth rate of Ethiopian population which is expected to have 89.7 million in 2015. Therefore, there will be very huge demand for wood and wood products, in which the pressure will be expected to be very high on the existing decreasing natural stand forests. Bamboo can be used to share this pressure since it is fast growing and can be a substitute to almost all wood products.

12.2.2. FOREIGN MARKET

According to INBAR's trade database, the annual export of bamboo in 2000 was valued at about US\$2.5 billion (Table 12.3). China, Indonesia and Viet Nam were the major bamboo producers and exporters in Asia. The total value of exports of raw bamboo is about US\$89 million. China exported some US\$25 million worth of raw bamboo, roughly a third of the world total. It was followed by Indonesia (US\$10.6 million, 12 percent) and Viet Nam (US\$7.7 million, 8.6 percent). Singapore and Hong Kong were important bamboo and rattan processing centers and exporters. There was a US\$18.6 million trade of bamboo raw materials in Singapore, which accounted for over 20.9 percent of world trade. Hong Kong's annual trade value was US\$4.69 million, which accounted for 5.3 percent of the world total.

Table 12. 4 Export of bamboo products in 2000 (million US\$)

	Africa	Asia	Europe	North and Central America	Oceania	South America	Total
Bamboo products	29	1554	739	120	8	5	2455
Market share	1.2	63.3	30.0	4.9	0.4	0.2	100

The main importers together make up some 80 percent of the world bamboo import trade (Table 12.5). The European Union, Hong Kong, Japan and the United States were the major markets for bamboo products, collectively accounting for 71 percent of the total market share.

Table 12.5 Main importers of bamboo products in 2000 (million US\$)

	US A	U K	Netherlan ds	Germa ny	Franc e	Japa n	Hon g Kon g	Other s	Tota l
Bambo o import	899	12 5	106	169	169	349	163	475	2 455
Marke t share %	36. 6	5	4.3	6.9	6.9	14.2	6.6	19.3	100. 0

According to Chinese customs statistics, the total trade value of nine bamboo commodities (identified by country-specific, eight-digit codes) was over US\$517 million in 2002 (Table 12.6). This is 9.4 percent more than the average for the previous four years, 1998–2001.

Table 12.6 Bamboo export value in China 1998–2002 (1 000 US\$)

Product Code	Products	Average 1998 - 2001	2002
07099010	Bamboo shoots, fresh or chilled	4874	4957
07119031	Bamboo shoots, in brine	6376	7346
07129010	Bamboo shoots, dried	10469	11359
14011000	Bamboo, used primarily for plaiting	26486	25665
20059030	Boiled bamboo shoots in airtight containers	123406	116989
46012090	Mats, matting and screens made of bamboo	20204	41424
46021030	Basketwork, wickerwork and other articles of bamboo	103916	138199
94015000	Seats of cane, osier, bamboo or similar materials	19999	21157
94038010	Other furniture of cane, osier, bamboo or similar materials	34007	33627
Total		473149	517719

Source: Customs General Administration of China, 2003.

The awareness to the economic value of bamboo is increasing in the global market. It is substituting many wood species products and some countries like China and India are making the resource sustainable source of national income. The trading of bamboo is increasing from year after year.

13. BAMBOO DEVELOPMENT MODEL FOR AMHARA REGIONAL STATE

13.1. IMPORTANCE OF DEVELOPING THE MODELS

The development and utilization of bamboo in Ethiopia is very poor. When compared with other bamboo growing countries, Ethiopia is not benefiting from the resource; rather it is being damaged. The importance of developing the model is to show the integrated effort in developing and utilizing the bamboo resource in Amhara regional state and make the resource play its role in the development of the nation. The model will try to show how the integration will have an impact on the economy of the country by creating high number of employment opportunities, import substitutions and export opportunities. For the country to have sustainable development there should be some new and competent sources of economic development areas that can insure job opportunities to the increasing population of the nation, keep ecosystem and species in the country, and that can solve the urban challenges. Bamboo is well proved to play its part in creating job to many citizens, earning huge amount of income from export and local trading, protecting the ecosystem and helping many small and large processing industries to emerge.

The model tries to define all the stakeholders that can contribute their part in every phase of development and utilization of the resource in Amhara National Regional State. In addition the point where each stakeholder plays its part is also shown in the model.

13.2. COMPONENTS OF THE MODELS

The business development model is organized into two general parts. The first one is the actual task and businesses that should be done and the second ones are the parts that play their role in enabling those businesses. This includes the following basic components.

1. Cultivation (Plantation):

In the development model plantation is the first one is plantation of the resource in some selected areas in the region. In cultivation of the resource there will be some parties that need to work together.

2. Micro and Small Scale Enterprises:

Bamboo can generate many job and business opportunities that can be run with small amount of financial requirement. Handicrafts can be organized with some hand tools and equipments with in the range of 20,000 Birr. Some small scale businesses may be also created with some additional number of employees and start up capital.

3. Medium and Large Scale Enterprises:

Some processing industries of bamboo will give considerable amount of income and import substitution, in addition to exports, by producing industrial products. Ethiopian local species of bamboo are tested for their suitability of some industrial products, like, bamboo ply board, bamboo particle board. In addition the lowland bamboo is good for production of pulp and paper.

4. Licensing:

To enable the business process permission and licensing businesses is very important. There are some legal institutions in the region that need to play their part. Depending on the phase in the model the involving parties will be different.

5. Nurseries and Tissue Culture Centers:

When we think of plantation of bamboo in commercial level, it is required to think of nurseries and tissue culture developing centers to be integrated with the cultivation.

6. Sources of fund:

There are local and international organizations that are working in the region. The agricultural development is being supported by these organizations. Some organizations like CFC (Common Fund for Commodities) and UNIDO are already working on the development of bamboo resource in Ethiopia.

7. Technical Support:

There are also some organizations that can give technical support to the development and utilization of bamboo in Ethiopia. For instance, FAO (Forest and Agricultural Organization), put the development of bamboo as a strategy of insuring sustainable development in developing countries. INBAR and EABP are also providing technical support in plantation and utilization of the resource in some African countries, including Ethiopia.

8. Market

There are different market opportunities in each different level of the business model. There is expected high demand gap in the local market and the importance of bamboo in the world market is increasing, due to the increasing pressure of wood products due to the increasing population and improved quality of life.

1. General Model

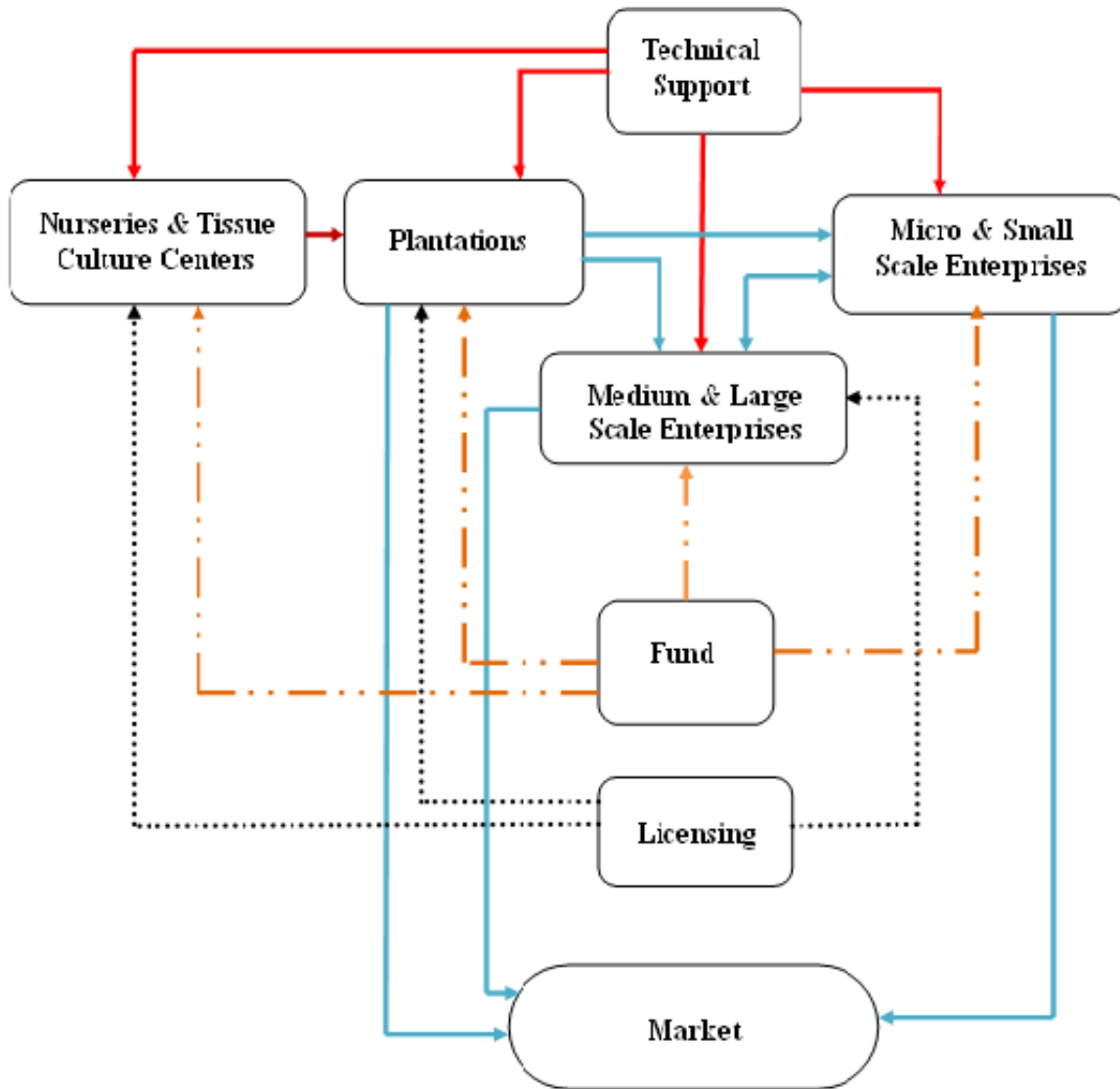


Figure 13.1 General bamboo development and utilization model

The above figure shows the general model of developing and utilization of bamboo resource in Amhara regional state. Different parties are shown different roles in different stages of the development model. Integration is the key to get the maximum benefit from the development of the resource.

2. Cultivation

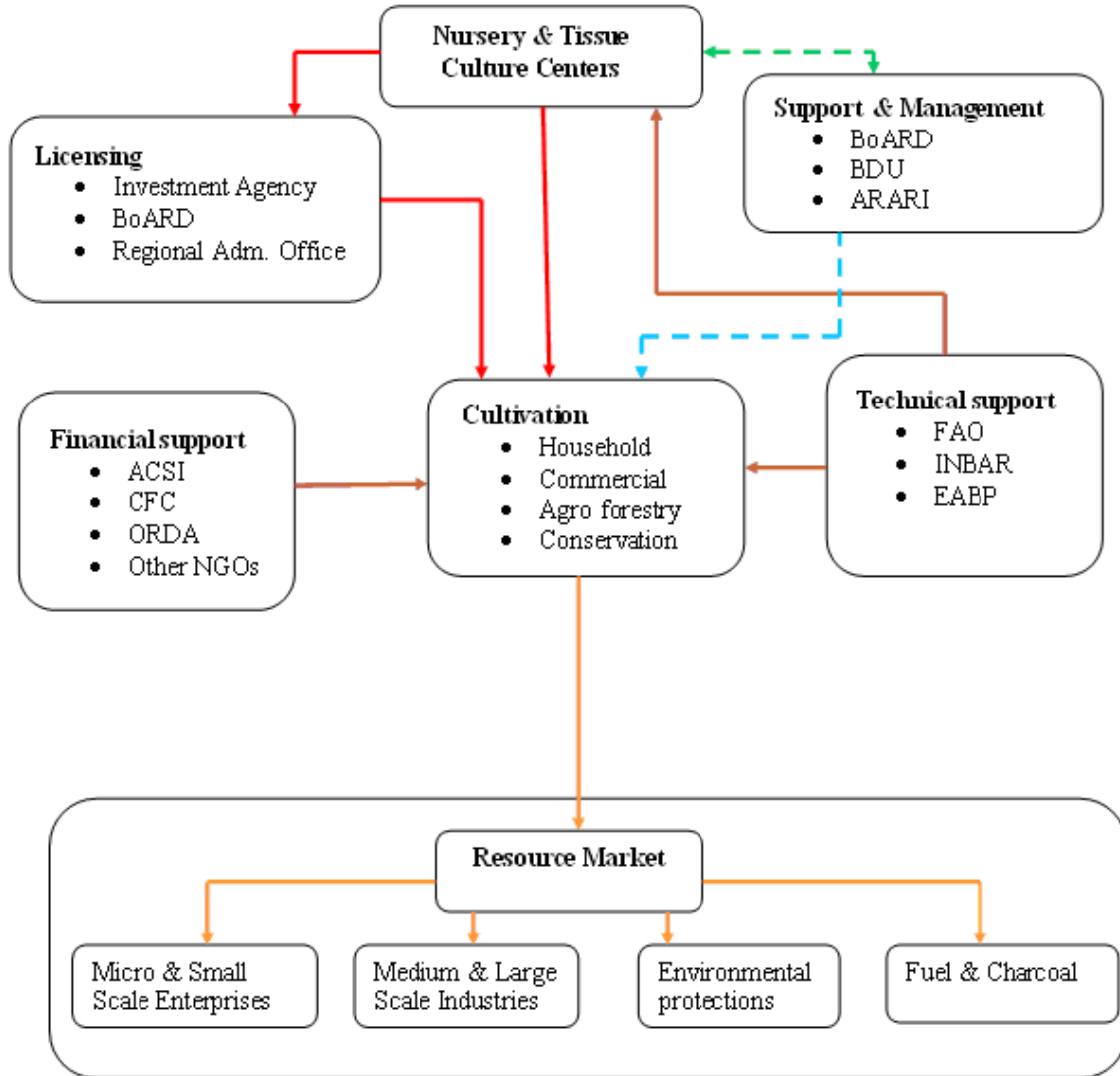


Figure 13. 2 Bamboo plantation model

Figure 13.2 shows different plantations that may be included and the parties that are required to implement the model effectively. Some governmental and non governmental organizations working in the region may be contacted their effort may be organized to get maximum possible benefit of the plantation.

3. Micro and Small Scale Enterprises

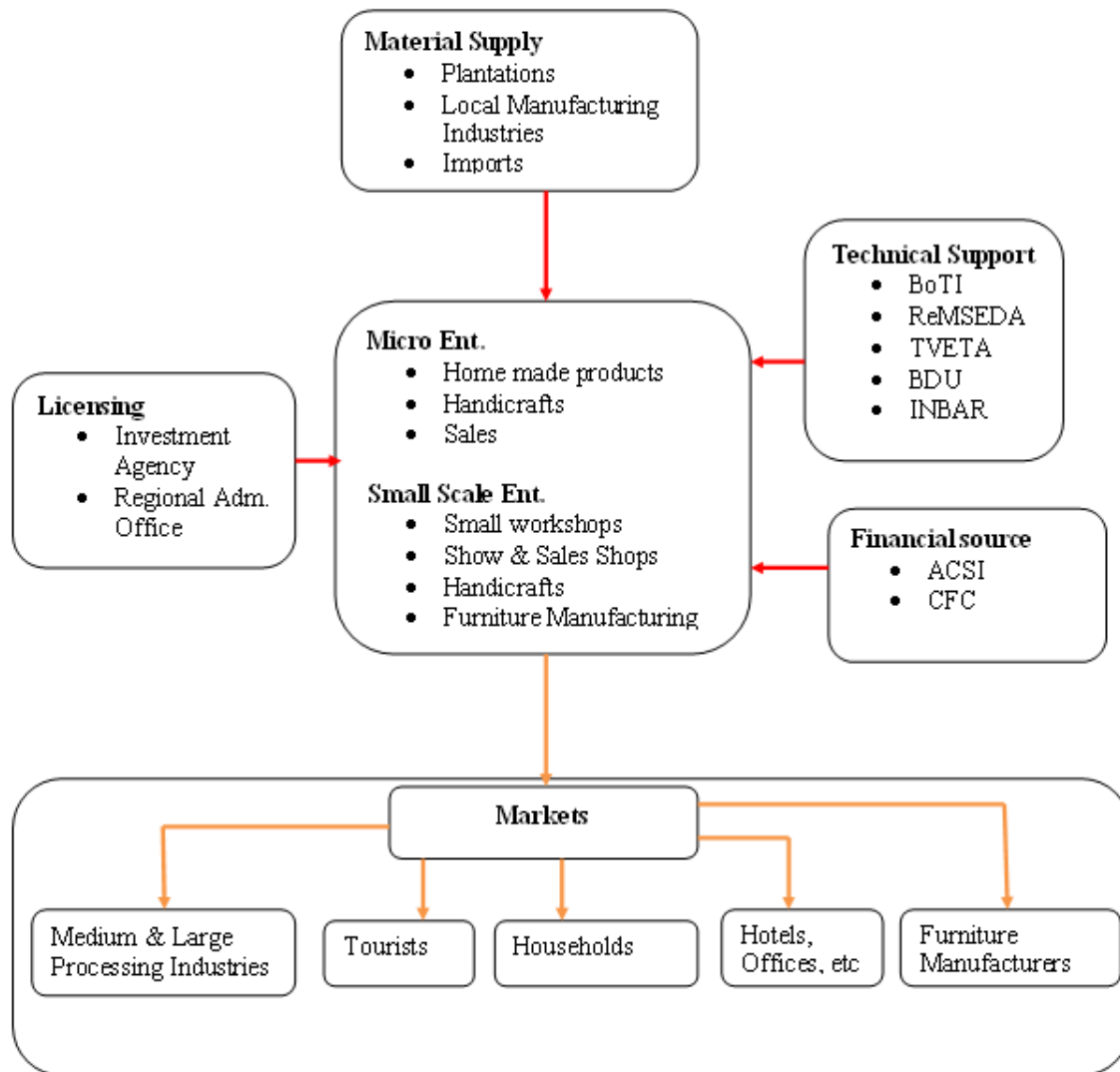


Figure 13. 3 Model for micro and small scale enterprises development

The above figure shows how the integration help in creating job and income opportunities in micro and small scale levels from the development of bamboo. Micro enterprises are businesses that may need a capital of less than Br. 20,000 and mostly require less than ten employees. And small scale enterprises are classified with their capital requirement of between Br. 20,000 and Br. 500.000. Different organizations are indicated that are working on enhancing the capability of micro and small scale enterprises in the region.

4. Medium and Large Scale Enterprises

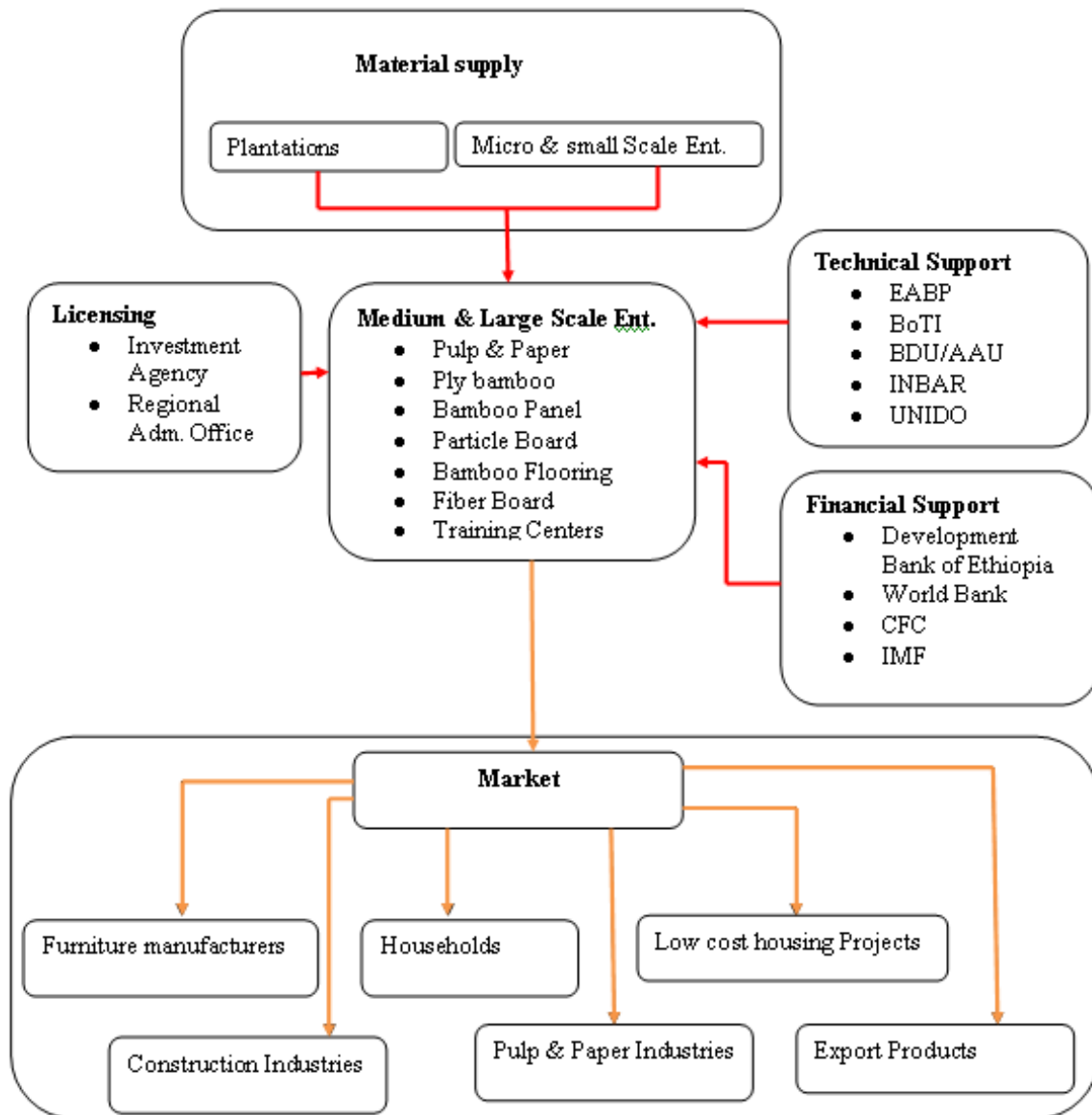


Figure 13. 4 Model for medium and large scale enterprises development

Figure 13.4 shows the development model for the processing of bamboo resource in medium and large scale business level. The business definition based on Ethiopian context is demanding a capital of more than Br. 500,000. Different industrial and construction products may be processed and give very huge return for the country.

We will consider some sample products and see how they are worth to invest on them, in the next section of the paper.

14. FEASIBILITY STUDY ON SOME REPRESENTATIVE PRODUCTS OF BAMBOO

There are three types of products selected for their economic advantage, technology availability and market demand. These products are bamboo mat, bamboo flooring and bamboo incense sticks. These products are highly demanded in the international market and their demand is showing increasing pattern from time to time. The manufacturing process needs some simple facilities that can be imported from countries like England, India, Taiwan and china. The skilled labor requirement can be fulfilled with the available manpower in the country with only some weeks training. Generally the investment cost of these facilities is small relative to their daily processing capacity. The manufacturing process of these products is shown below.

14.1. MANUFACTURING PROCESS

The manufacturing process of the three selected products is given in the next three pages. **Figure 14.1** shows the manufacturing steps of manufacturing bamboo mat, **Figure 14.2** indicates the manufacturing steps of bamboo floor manufacturing line and **Figure 14.3** shows the steps required in bamboo incense sticks manufacturing. The basic raw material required is good Ethiopian highland bamboo. Some additional raw materials to be used are lacquering, gluing and varnishing chemicals.

The layout of the processing plant, showing the arrangement of manufacturing facilities position of offices, raw material stores, finished good stores, parking areas etc, is prepared and is shown as an **Annex – C**.

1. Bamboo Mat Manufacturing Process:

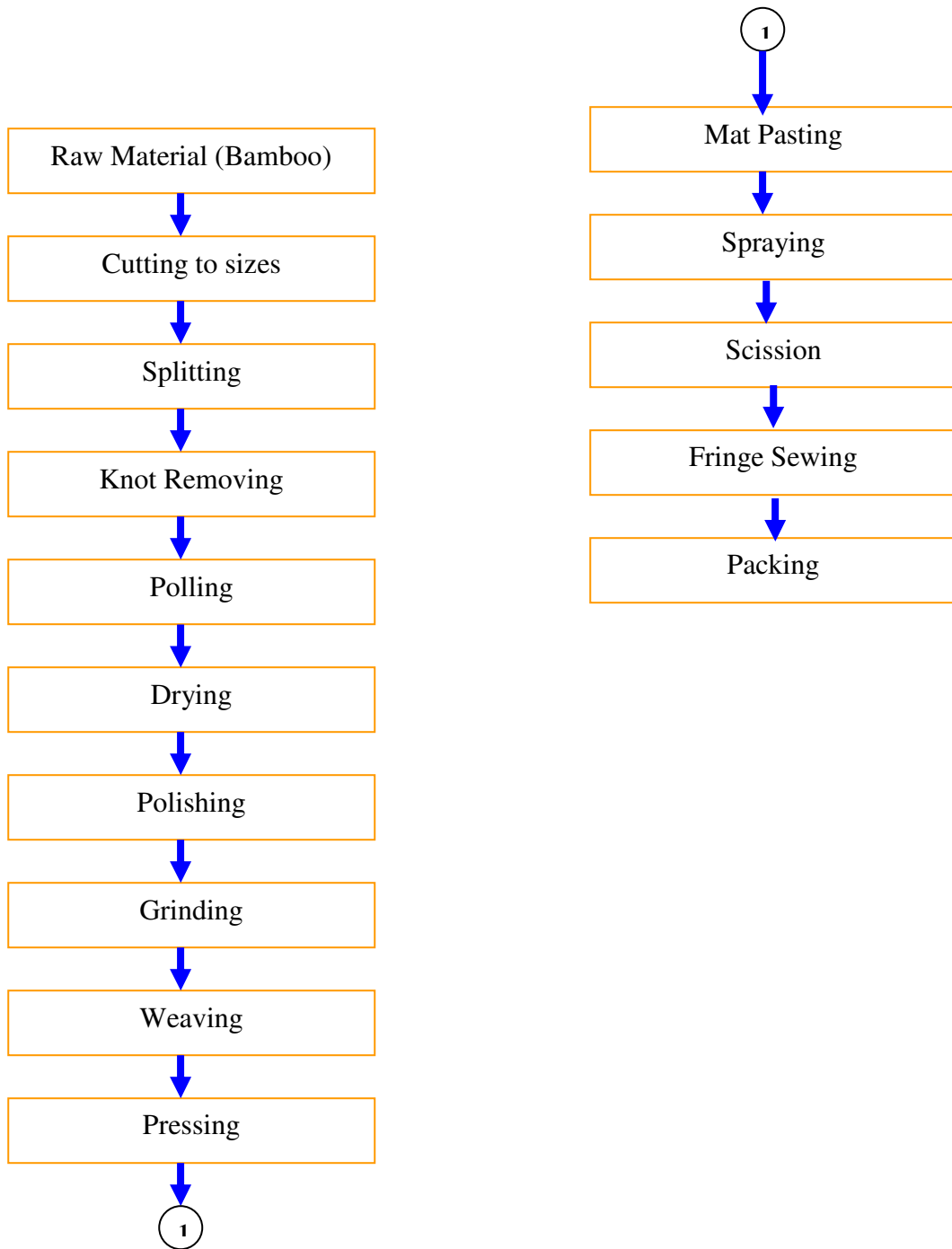


Figure 14. 1 Manufacturing process for bamboo mat

2. Bamboo Floor Manufacturing Process:

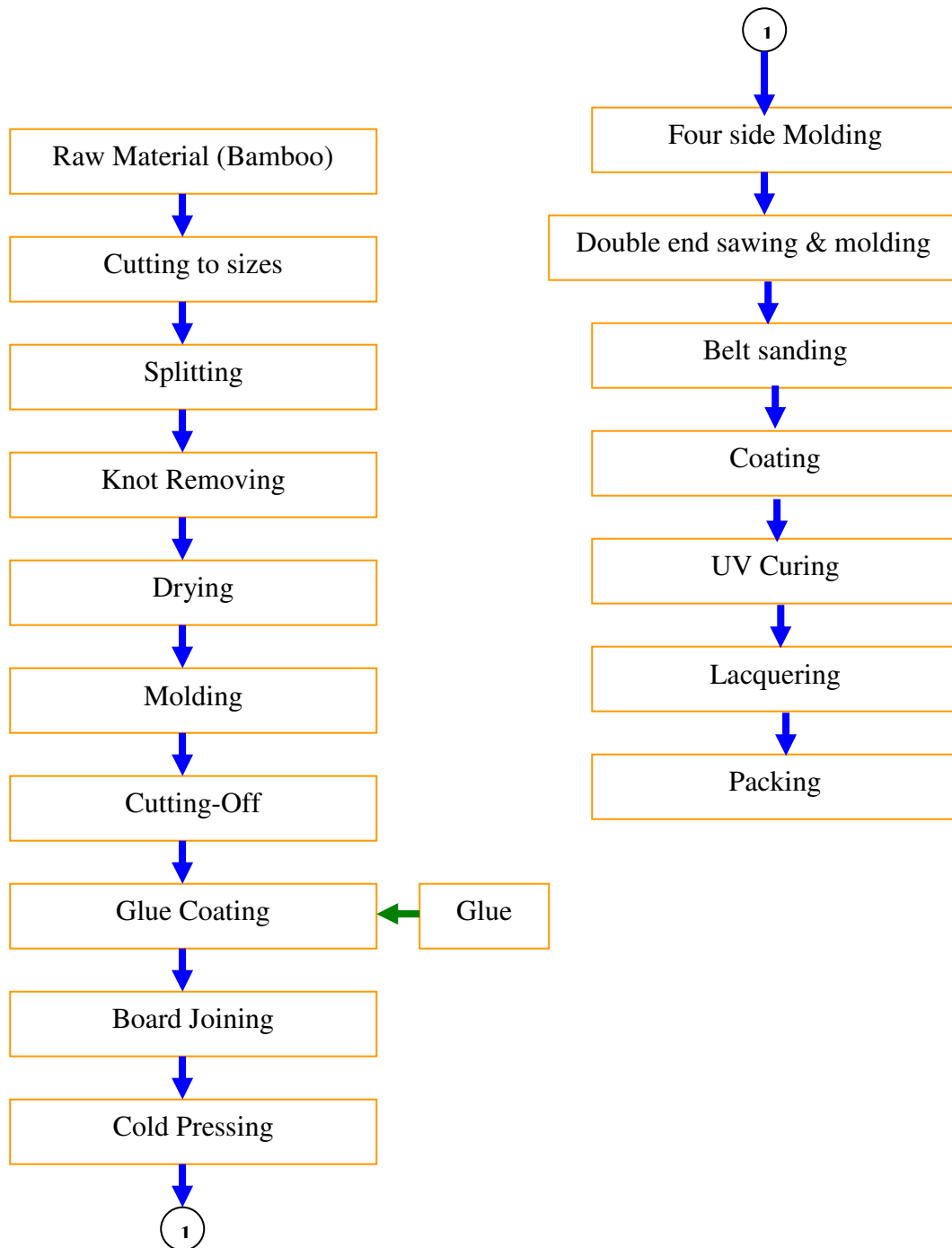


Figure 14. 2 Manufacturing process for bamboo flooring

3. Bamboo Incense Manufacturing Process:

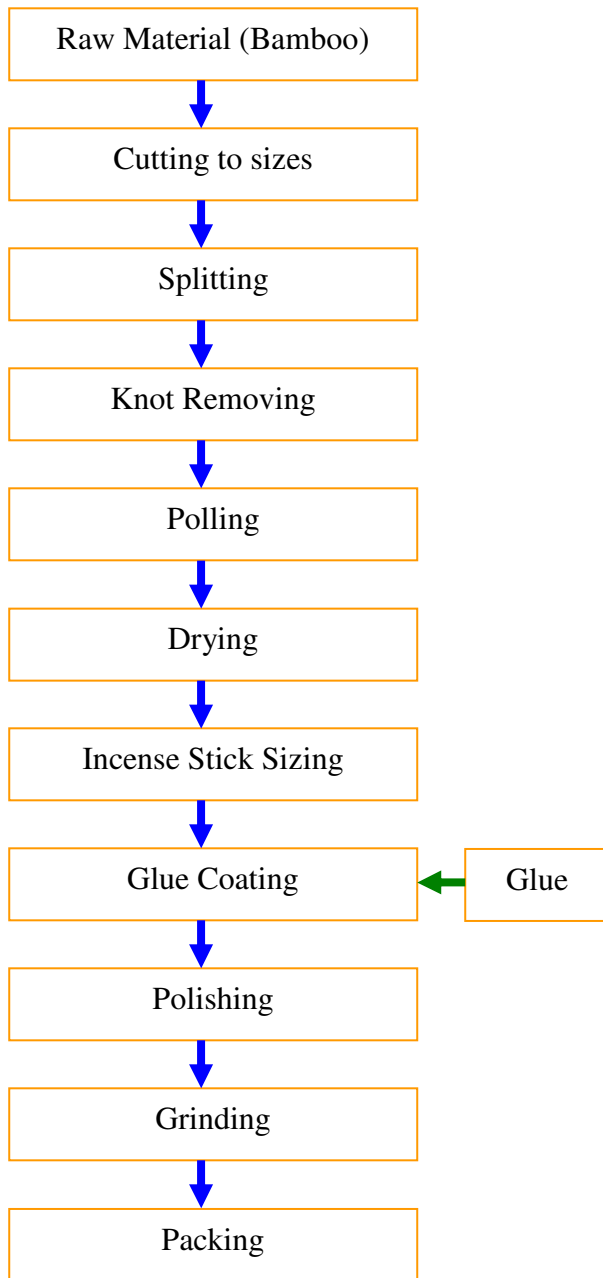


Figure 14. 3 Manufacturing process for bamboo incense sticks

14.2. MANUFACTURING MACHINERIES

To manufacture the three different products, we need different machineries. These machineries should be arranged based on the above manufacturing process. Among these are the following machines.

The detailed specification of all the required manufacturing machines are organized and put as an **Annex - B**.

1. Bamboo Mat Manufacturing Machines

The table below shows the required machines used in bamboo mat manufacturing lines with their required quantity, unit cost and the total purchasing cost.

Table 14. 1 Machines required for mat manufacturing line

S.N.	Machine	Quantity	Unit Price(Birr)	Sub total (Br)
1	Bamboo Sawing Machines	8	38391	307128
2	Bamboo splitting Machine	9	65512	589608
3	Knob splitting Machine	1	45000	45000
4	Polling Machines	1	45000	45000
5	Polishing Machine	1	67500	67500
6	Drying Machine	1	72600	72600
7	Auto High Speed Cutter Grinder	2	66500	133000
8	Weaving Machine	7	112000	784000
9	Pressing Table	2	147250	294500
10	Bamboo Pasting Machine	1	71000	71000
11	Auto Sprayer	1	80000	80000
12	Scission Machine	8	39000	312000
13	Sewing Fringe	2	51400	102800
			Total Cost	2904136

2. Bamboo Flooring Manufacturing Machines

The table below shows the required machines used in bamboo floor manufacturing lines with their required quantity, unit cost and the total purchasing cost.

Table 14. 2 Machines required for bamboo flooring manufacturing line

S.N.	Machine	Quantity	Unit Price (Birr)	Sub total (Birr)
1	Bamboo Sawing Table	10	38391	383910
2	Bamboo Splitting Machine	12	65512	786144
3	Knob Splitting Machine	1	45000	45000
4	Drying Machine	1	72600	72600
5	Open side Auto four sides molder	2	62750	125500
6	Automatic Cut-off Saw	4	39000	156000
7	Roll Coater Glue Spreader	2	59420	118840
8	High Frequency Board Joining Machine	2	133000	266000
9	Hydraulic Cold Press	3	147200	441600
10	Four Side Molder	2	92900	185800
11	Auto Six Spindle Double End Miter Saw with Molding Head Machine	2	80000	160000
12	Light Duty Series Wide Belt Sander	3	88350	265050
13	Reversible Roller Coater	3	76700	230100
14	UV Curing Machine	3	65600	196800
15	Lacquered Pan and Wide Belt Sander	4	88350	353400
			Total Cost	3786744

3. Bamboo Incense Sticks Manufacturing Machines

The table below shows the required machines used in bamboo incense sticks manufacturing lines with their required quantity, unit cost and the total purchasing cost.

Table 14. 3 Machines require for incense sticks manufacturing line

S.N.	Machine	Quantity	Unit Price(Birr)	Sub total
1	Bamboo Sawing Table	5	38391	191955
2	Bamboo Splitting Machine	6	65512	393072
3	Knob Splitting Machine	1	45000	45000
4	Polling Table	1	45000	45000
5	Drying Machine	1	72600	72600
6	Incense Stick Sizing Machine	2	142000	284000
7	Polishing Machine	1	67500	67500
8	Auto High Speed Cutter Grinder	2	66500	133000
			Total Cost	1232127

The equipments that are to be used in moving materials from receiving to stores, from stores to production areas, with in the production area, from production area to finished goods store and from store to shipping areas are also included in the estimation of cost and the total cost for materials handling is Br. 1,000,000. The material handling facilities include one forklift, conveyors, push carts, etc.

14.3. RAW MATERIALS REQUIRED

For the production of bamboo floor, bamboo mat, and bamboo incense sticks, the basic raw material required is good quality bamboo. The Ethiopian highland bamboo is taken to be the raw material for our consideration. The highland bamboo responded good results for different tests for its physical and mechanical properties and can be used for the manufacturing of these products. In addition to the basic raw material- bamboo, glue, varnishing chemicals and lacquering chemicals are required.

14.4. PROJECT SCHEDULING

Activities to realize the project

For the project to be implemented it will be necessary to consider all the activities required, their estimated duration, and their precedence relationship. The following table shows the activities required, their duration and their precedence relationship.

Table 14. 4 Project activities, duration and precedence relationships

Activity Name	Description	Duration (Days)	Precedence
A	Licensing and registration	10	-
B	Acquisition of land	20	A
C	Land Development	40	B
D	Building	190	C
E	Electrification	10	D
F	Purchasing machines and equipments	100	B
G	Machine installation and plant erection	30	E,F
H	Commissioning	5	G

The activity durations consider their implementation based on calendar days. Then the total completion of the project will take nearly one year. The detailed project schedule is shown in **Annex - D**.

Organization Structure and Manpower Requirement

The manufacturing process focuses on one product family and all the three products use the same raw material – highland bamboo. Therefore it will be reasonable to organize the organization into functional departments. The organizational structure is designed to be flat for better organization and smooth flow of work, since the orders from top level management and information from lower level of management to the top can reach with shorter time and cost.

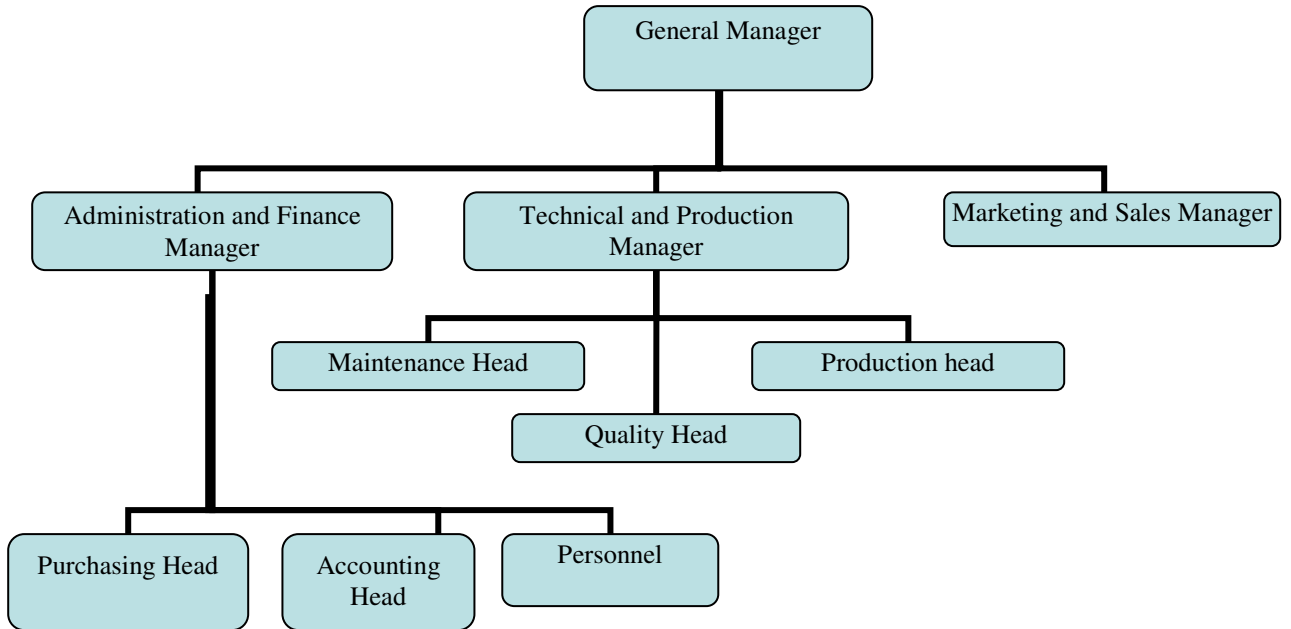


Figure 14. 4 Organizational structure

14.4. COMPONENTS OF CAPITAL COST OF THE PROJECT

a. Land

Area selected for this investment is Injibara (Capital of Awi zone) for the following advantages:

1. The raw material is very well distributed around the town (including the town plantation and the potential). It is economically advantageous to get the raw material (bamboo) with relatively lower cost of raw material and lower cost of transportation.
2. The area has well established infrastructures such as telephone, water, electricity, road and internet.
3. It is only at a distance of 122 km from Bahir Dar, the capital of the region and has International Air Port which started international flight recently. This international flight may be used to export products to foreign market, help to import some supportive raw materials (Lacquering chemicals, Glue, and varnishing chemicals), and to import machineries, equipments, and spare parts.
4. It is also near to the potential local market, Addis Ababa. The town is located at a distance of km and the entire road is connected with good quality of asphalted road, and the road journey will take nine to ten hours.

Injibara is the administrative center of the Awi Zone in the Amhara Region. Injibara is located at 10°57'N, 36°56'E, at an elevation of 2560 meters above sea level, in Banja Woreda. Injibara is situated in a predominantly mountainous location. The hills and valleys receive high amounts of rain, especially in the rainy season. This high rainfall permits farmers to grow multiple crops a year. With this rainy weather comes hail, however, which is a major problem for the local farmers.

Based on figures from the Central Statistical Agency in 2006, the old town Injibara has an estimated total population of 1364, of whom 649 were males and 715 were females. The figures for modern Injibara (Kosober) are 2,317 (male), 2,532 (female) and 4,849 (total).

Proposed land size = 14,400m²

Cost of leasing land = Br 1.21/m²

Cost of land = area*cost/m²

= 14400x1.21x40 (modality of lease price payment is with in 40 years and the right on the land will last for 80 years)

= Br.696,960

Investment permit cost = 600Br

Registration and working permit fee = Br. 550

Total investment permit and certificate fee = **Br. 1150**

Total cost of land = **Br. 698,110**

b. Land development charge

The land will need some development before any other construction is commenced, and it can be reasonably approximated to cost **Br. 50,000**

c. Building

i. Main building, Office & Administrative Blocks:

The cost of building, for the offices, administrative blocks and main building will be done at the same rate.

Built up area = Area of main building + Area of Offices + Area of
Administrative blocks

= 3680 sq.m

Cost of construction at the rate of Birr 3500/ sq.m.

Cost= 3680x3500 = **Br. 12,880,000**

ii. Store Room:

Built up area= 1520sq.m.

Cost of construction at the rate of birr 1800/ sq.m

Cost = 1520x 1800= **Br.2,736,000**

iii. Other Amenities:

Toilet block, guard house, power house, and fence = **Br.110,000**

The total investment required for building is sum i+ii+iii = **Br. 15,726,000**

d. Plant & machineries

All machineries required for the processing plant are to be imported from abroad (the valuation is done based on the value of machineries to be imported from England, Taiwan, China and India). The cost is assumed to cover the shipping of all the facilities to the port of Djibouti. After the port land and rail transport modes may be used.

The total purchasing cost of the machineries is **Br 8,923,007**. This figure includes the total cost of material handling equipments used in the processing plant.

The following data custom duty charges and clearance charges are based on custom data of 2005, and some adjustments are made for the transporting charge.

Custom duty on machines (15%) = **Br.1,338,451**

Clearing charge (1.5%) = **Br. 133,845**

Total investment on plant and machinery and equipments is
= **Br. 10,076,600**

e. Transportation & erection charges

Road transportation charge = Br. 1.45/km/Quintal

Distance of the site (Injibara) measured from the port of Djibouti = 1430km

Weight of machines = 213000kg = 3130 Quintals

Transportation cost = $1.45 \times 1430 \times 3130$ = **Br. 4,416,600**

Assuming the erection can be done by local experts and is estimated to cost (the cost will include consulting from structural engineers, preparing special foundations and physical erection of facilities) will be **Br. 150,000**

Total cost of erection and transport = **Br. 4,500,600**

f. Electrical

Cost of electric motors, starters, switches, cables & other electrical items

$$= \text{Br. } \underline{\underline{850,000}}$$

g. Contingencies

The following assumptions are made for the provision of contingency based on the level of uncertainties and variations expected. More numbers assumed for more uncertain investments.

- 0% contingency on land =0
- 5% contingency on land development = Br. 500
- 5% contingency on building = Br. 786,300
- 15% contingency on imported machinery = Br. 1,511,490
- 5% contingency on transport and erection = Br. 225,000
- 5% contingency on electrical = Br. 42,500

$$\begin{aligned} \text{Total required contingency} &= 500+786300+1511490+225000+42500 \\ &= \text{Br. } \underline{\underline{2,565,800}} \end{aligned}$$

h. Miscellaneous fixed assets

- Office furniture = 500,000
- Office equipments =220,000
- Electric board = 10000

$$\text{Total miscellaneous cost} = \text{Br. } \underline{\underline{720,000}}$$

$$\begin{aligned} \text{The total fixed asset cost} &= 698110+50000+15726000+10076600+ \\ &\quad 4,500,600+850,000+2,565,800+720,000 \\ &= \text{Br. } \underline{\underline{35,137,110}} \end{aligned}$$

$$\text{The total fixed asset cost} = \text{Br. } \underline{\underline{35,135,110}}$$

i. Preliminary and preoperative expense

- i. For the calculation of preoperative expenses the following logical assumptions are made.

Service charge on term loan 0.65%

Commitment charge on term loan = 0.8%

Rate of investment on term loan = 7.5%

Assume term loan of 60% on fixed assets

Term loan = $0.6 \times 35,137,110 = \underline{\text{Br. 21,082,270}}$

Service charge = $0.65/100 \times 35,137,110 = \underline{\text{Br. 228,390}}$

- ii. Commitment charge on term loan 1.00%

Commitment charge = $0.01 \times 35,137,110 = \underline{\text{Br. 351,370}}$

- iii. Rate of interest on term loan 7.5% per annum

Assuming the interest during implementation period (12 months) & the loan is uniformly distributed throughout the year

Interest = $0.075 \times 21,082,270 \times 1/2 \times 12/12 = \underline{\text{Br. 790,585}}$

- iv. Insurance premium on fixed assets

Insurance premium on fixed assets at 0.75% per annum except land
= $(35,137,110 - 698,110) \times 0.75/100 = \underline{\text{Br 258,300}}$

Other start up cost birr = **Br. 50,000**

Total pre-operative expense = $228,390 + 351,370 + 790,585 + 258,300 + 50,000$
= **Br. 1,678,645**

j. Working Capital Margin

Considering the nature of the manufacturing process and the machines and equipments being employed we can reasonably assume the utilization of our capacity as follows:

Table 14. 5 Assumed capacity utilization

Year	I	II	III	IV	V
Capacity utilization	70%	80%	80%	80%	80%

At this stage, the working capital requirement for the first year of operation with an assumed 70% utilization is calculated.

To get the working capital for each month let us find the raw material & other expenses:

2. Raw Material & Consumables

For the manufacturing of bamboo flooring, bamboo mat and bamboo incense sticks the raw material used is selected to be Ethiopian highland bamboo. In addition some chemicals are used in the process these chemicals are glue, varnishes and lacquering chemicals.

Average daily production of the three products is calculated by adding the daily capacity of the three manufacturing lines.

Line 1: Bamboo floor manufacturing line capacity = 5 tons/day

Line 2: Bamboo mat production line capacity = 4 tons/day

Line 3: Bamboo incense sticks manufacturing line capacity = 2 tons/day

The total average daily capacity of the plant will be 11 tons/day.

Assuming 9 % wastage of raw material we can calculate the daily requirement for bamboo and other consumables.

Therefore the daily demand of raw material = 12 tons of bamboo per day.

The production is to be done in one shift.

But the for the first year 70% utilization is used, hence

Output/day = $0.7 \times 11 \text{ tons/day} = \mathbf{7.7 \text{ tons/day}}$

Raw material/day = $12 \times 0.70 = \mathbf{8.4 \text{ tons/day}}$

Output per month assuming 25 working days (300 working days in a year)

$= 7.7 \times 25 = \mathbf{169.4 \text{ tons/month}}$

Raw material requirement for 1 month = $12 \times 25 = \mathbf{300 \text{ tons}}$

The cost of raw material for one month requirement can be calculated by changing the number of culms into tonnage, since the raw material is bought in number of culms.

One matured Ethiopian highland bamboo weigh in average 8.7kgs. Therefore there are 1149 culms in one ton.

Thus we need 1149×12 culms/day = **13788 culms/day**. And for 70% utilization of the first year, we need **9652 culms/day**.

The average cost of one culm, including transport is Br 7.50, and adding unit cost of consumable chemicals to it the cost will reach up to Br 10.00.

Therefore the daily raw materials cost will be calculated for 70% capacity utilization as:

$$= 9652 \text{ culms/day} \times \text{Br } 10/\text{culm} = \text{Br } 96520/\text{day and}$$

$$= \text{Br } \underline{\underline{2,413,000/\text{month}}}$$

2. Expense

a. Direct expense:

i. Power

Connected power = 520HP = 388kilowatts

Monthly consumption = $388 \times 8 \times 25 = 77600$ KWH

For the first year operation (70%utilization)

Consumption = $0.7 \times 77600 = 54320$ KWH

Power charge = 0.3349Birr/KWH (for industrial use)

Power charge = $0.3349 \times 54320 = \underline{\underline{\text{Br. } 19,000/\text{month}}}$

ii. Water

Water is required for the process of manufacturing and for other services.

Average monthly requirement = 4000m^3

For the first year with utilization of 70% = 2800m^3

Water charge = $\text{Br. } 5.5/\text{m}^3$

Monthly water charge = $7000 \times 5.5 = \underline{\underline{\text{Br. } 15,400}}$

iii. Wages & salary

The following personnel and wages and salaries are required for the first year of operation. The assumption for wages and salaries are made based on current market value of workers. The number of workers is determined based on the designed capacity of the plant and the workers may be classified as administrative workers and

production workers. There are 117 machines in the plant and there are some other facilities that need workers like moving materials from one place to another and operating material handling equipments. Therefore we need 145 workers for operating machines and material handling tasks, of which 90 are skilled workers.

Table 14. 6 Manpower requirement

No	Title	No. of person	Salary/month	Total salary
1.	General manger	1	8000	8000
2.	Production in charge	6	2500	15000
3	Administrative Staff	35	2200	77000
3.	Skilled/Semiskilled personnel	90	1500	135000
4.	Unskilled workers	55	750	41250
5.	For non regular workers			10,000
	Total	187		<u>286,250</u>

Monthly salary of the administrative staff = 77000+8000 = **Br. 85,000**

Monthly salary to direct workers = **Br.201,250**

iv. Repair & maintenance

- a. Repair & maintenance for building for the first year= 0.5% of the cost per year

Repairing of buildings cost/month = $(0.5/100 \times 15726000)/12 =$ **Br. 6552**

- b. Repair & maintenance for plant machinery for the first year = 4% of the cost per year

= $(4/100 \times 10076600)/12 =$ **Br. 33600**

Total maintenance cost = **Br. 40152/month**

v. Depreciation

The following depreciation rate is assumed for the calculation:

- Office & Administrative building = 4%
- Factory building = 4%
- Plant & machineries = 8%
- Office equipments = 7%

Depreciation = $0.04 \times 15726000 + 0.08 \times 10076600 + 0.07 \times 720000 = \text{Br. 8,740,720}$

Depreciation per month = **Br. 728,393/month**

The total direct expense per month

= $19,000 + 15,400 + 201,250 + 40,152 + 728,393$

= **Br. 1,004,200/month**

b. *Overheads:*

i. Administrative overheads

From the manpower planning we can see that the salary to administrative staff per month = $8,000 + 77,000$

= **Br. 85,000 /month**

ii. Selling overhead

Packing expense = 0.3% sales turnover

Selling & advertisement expenses = 1% of sales turnover

Selling overhead = 1.3% of sales turnover

Now let's calculate the daily sales of the processing plant. The Ethiopian highland bamboo productivity is 1149 culms/hectare. The daily raw material required is 8.4 tons for the first year (9652 culms/day), and the output per day for the 70% utilization of first year is 7.7 tons/day (8847 culms/day).

Thus this output can be changed into appropriate unit that can be directly used in the market selling unit, m².

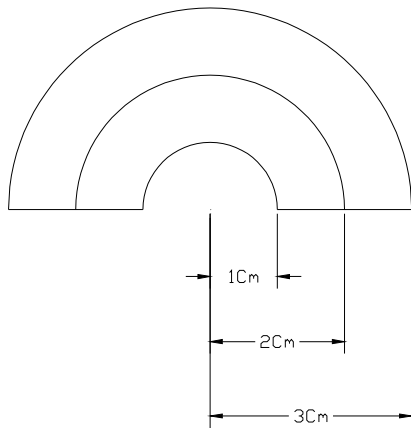


Figure 14. 5 Cross –sectional dimension of Ethiopian highland bamboo

The cross sectional dimension shows the mean diameter of the Ethiopian highland bamboo is 4 cm.

Perimeter of one culm = π *Diameter = π *0.04m = 0.12m

The average length of the culm is considered to be 6m. Therefore the total daily out put of the system will be = (Perimeter of the culm)*(Length of the culm)*

$$\begin{aligned} & \text{(Number of culms used per day (daily output))} \\ & = 0.12\text{m} * 6\text{m} * 8847 \\ & = \mathbf{6370\text{m}^2} \end{aligned}$$

The minimum current selling price of products is USD 20/m². There fore it will be logical to take the price to be set at USD 10/m².

Thus, Sales turnover per month for the first year of operation at 70% utilization and

$$\text{for 25 working days in a month} = 25 \times 10 \times 6370 = \mathbf{USD 1,592,500}$$

$$= \mathbf{Br. 15,144,675^*}$$

(* Taking 1USD = 9.51 Birr)

$$\text{Packing expense} = 0.3/100 \times 15,144,675 = \mathbf{Br. 45434/month}$$

$$\text{Selling\& advertisement expenses} = 1/100 \times 15,144,675 = \mathbf{Br.151,450/month}$$

$$\text{Selling overhead} = 1.3/100 \times 15,144,675 = \mathbf{Br. 196,880/month}$$

$$\text{Total overhead} = \mathbf{Br. 393,762}$$

$$\text{Monthly Expense} = 85,000 + 393,762 = \mathbf{Br. 478,762}$$

To get the working capital let us calculate the total assets since working capital is 25% of the total assets. To calculate the total asset, the following assumptions have been made.

Current assets

- Raw material - 2 month
- Work in progress - 5 days
- Stock of finished goods - 2 month
- Debtors - 2 month

Current liabilities

- Suppliers credit for raw material - 0

Total current assets

i. Raw Materials for two months

$$\begin{aligned} &= \text{Cost of raw materials for two months} \\ &= 2 \times 2,143,000 = \mathbf{Br. 4,286,000} \end{aligned}$$

ii. Work in progress for 5 days

$$\begin{aligned} &= \text{Cost of raw material for 5 days + expense for 5 days} \\ &= 5/25 \times 2,143,000 + 5/30 \times 1,004,200 = \mathbf{Br. 595,970} \end{aligned}$$

iii. Stock of finished goods for two months

$$\begin{aligned} &= \text{Cost of material for 2 month + Expense for 2 month} \\ &= 2 \times 2,143,000 + 2 \times 1,004,200 = \mathbf{Br. 6,294,400} \end{aligned}$$

iv. Debtors for two months

$$\begin{aligned} &= \text{Cost of material for 2 month + Expense for 2 month} \\ &= 2 \times 2,143,000 + 2 \times 1,004,200 = \mathbf{Br. 6,294,400} \end{aligned}$$

$$\begin{aligned} \text{Hence total current assets} &= 4,286,000 + 595,970 + 6,294,400 + 6,294,400 \\ &= \mathbf{Br. 17,470,770} \end{aligned}$$

$$\begin{aligned} \text{Working capital margin at 25\% of total current assets} &= 25/100 \times 17,470,770 \\ &= \mathbf{Br. 4,367,692} \end{aligned}$$

Cost of the Project

Table 14. 7 Cost of the project

Item	Cost (Birr)
a. Land	698110
b. Land development	50000
c. Building	15076600
d. Plant and machinery	10076600
e. Transportation and erection	4500600
f. Electrical	850000
g. Contingency	2565800
h. Miscellaneous assets	720000
i. Preliminary and pre operative expense	1678645
j. Working capital margin	4367692
Total	40584047

Hence the maximum permissible bank finance

$$\begin{aligned} &= \text{Total current assets} - 25\% \text{ of the total current assets} - \text{current liabilities} \\ &= 17,470,770 - 4,367,692 - 0 \\ &= \underline{\mathbf{Br. 12,229,540}} \end{aligned}$$

Profit before Tax & Interest

Gross profit before tax = Sales - Raw material cost – Expense - Overheads

$$\begin{aligned} &= 15,144,675 \times 12 - 2,143,000 \times 12 - 1,004,200 \times 12 - 498,762 \times 12 \\ &= \underline{\mathbf{Br. 137,984,556/year}} \end{aligned}$$

Financial charges

- a. Interest on term loan

Assuming 11% rate per annum to be cleared in 7 years where for the first year is excluded, interest on term loan will be calculated to be:

$$= 0.11 \times 21,082,270 = \underline{\mathbf{Br. 2,319,050}}$$

b. Interest on working capital loan

Assuming loan from bank for working capital is taken, the interest on working capital loan will be:

$$= 0.11 \times 4,367,692 = \text{Br. } \underline{\underline{480,450}}$$

Profit after financial charge = $137,984,556 - 2,319,050 - 480,050$

$$= \text{Br. } \underline{\underline{135,425,056}}$$

Preliminary expense written off = Br.1,678,645

Profit before tax = **Br. 133,746,411**

Assuming 30% income tax rate

Provision for tax = $0.30 \times 133,746,411 = \text{Br. } 40,123,923$

Profit after tax = $133,746,411 - 40,123,923 = \text{Br. } \underline{\underline{93,622,488}}$

Dividened = 10% of the profit after tax = 9,322,488

Retained profit = Profit after tax - Dividend

$$= \text{Br. } \underline{\underline{84,260,239}}$$

Net cash accrual = Retained profit + Depreciation + Preoperative expense

$$= 84,260,239 + 728,762 \times 12 + 1,678,645 = \text{Br. } \underline{\underline{94,679,660}}$$

Cost of Production & Profitability Estimate for Five Years

General Assumptions

For the production and profitability of the processing plant for the first five years of production can be evaluated by having the following reasonable general assumptions.

- An increase of 10% in the wages and salaries payable every year
- An increase of 5% on repair & maintenance
- An increase of 10% in factory supervision and administrative expense
- Term loan payment = nil for the first year of operation
- Term loan payment for the next years (excluding the first year) will be Br. **3,011,753** each year
- Assuming dividend at the rate of 10% from second year of operation on wards and which will increase by 2% each year and zero for the first year of operation

The table below revises the cost of production and profitability estimate for the first five years of operation.

Table 14. 8 Cost of production & profitability estimate for five years

Item no	Description	Year I	Year II	Year III	Year IV	Year V
	Capacity utilization	0.7	0.8	0.8	0.8	0.8
		18173610		20769840	20769840	20769840
A.	Sales realization	0	207698400	0	0	0
B.	Cost of production					
	Raw material	25716000	29389714	29389714	29389714	29389714
	Power	228000	260571	260571	260571	260571
	Water	184800	211200	211200	211200	211200
	Wages & salaries	2415000	2656500	2922150	3214365	3535802
	Repair & maintenance	481824	505915.2	531210.96	557771.50 8	585660.08 3
	Depreciation	8740776	1297680	1297680	1297680	1297680
	Sub total B	37766400	34321581	34612527	34931302	35280627
C.	Adm. & selling overhead					
	Administrative expense	1020000	1122000	1234200	1357620	1493382
	Selling expense	4725144	5400165	5400165	5400165	5400165
	Sub total C	5745144	6522165	6634365	6757785	6893547
D	Gross profit before tax (A-B-C)	13822455 6	166854655	16645150 9	16600931 3	16552422 6
E.	Financial charges					
	Interest on term loan	2319050	1792000	1792000	1792000	1792000
	Interest on working capital	480450	316513	316513	316513	316513
	Sub total E	2799500	2108513	2108513	2108513	2108513
G.	Profit after interest(D-E)	13542505 6	164746142	16434299 6	16390080 0	16341571 3
F.	Preliminary expense written off	1678645	0	0	0	0
H.	Profit/loss before tax	13374641 1	164746142	16434299 6	16390080 0	16341571 3
I.	Provision of tax (30% of income tax)	40123923	49423842.4 5	49302898. 7	49170240. 1	49024713. 9
J.	Profit/loss after tax	93622488	115322299	11504009 7	11473056 0	11439099 9
K.	Dividend	9362249	11532230	13804812	16062278	18302559. 9
L.	Retained profit	84260239	103790069	10123528 5	98668282	96088439
M.	Depreciation	8740776	1297680	1297680	1297680	1297680
N.	Preliminary expense written off	1678645	0	0	0	0
O	Net cash accrual	94679660	105087749	10253296	99965962	97386119

	(L+M+N)			5		
P	Term loan repayment	nil	3011753	3011753	3011753	3011753

IRR Calculation

The IRR uses the NPV equation as its starting point:

$$NPV = 0 = \frac{\text{initial investment}}{(1+IRR)^0} + \frac{\text{Cash flow Year 1}}{(1+IRR)^1} + \dots + \frac{\text{Cash flow Year n}}{(1+IRR)^n}$$

Initial investment = **Br. 40,584,047**

$$40584047 = \frac{94679660}{(1+IRR)} + \frac{105087749}{(1+IRR)^2} + \frac{102532965}{(1+IRR)^3} + \frac{99965962}{(1+IRR)^4} + \frac{97386119}{(1+IRR)^5}$$

Solving for the value of IRR in the above equation we can find, **IRR = 225%**.

Since the IRR value of the project is very high, it will be worth to invest in it. The investment will be returned with in less than a year.

This project will create job opportunities to more than 187 citizens, and the total Ethiopian highland bamboo may create jobs for a total of 4000 citizens. This number will be very high if all the supply chain is considered and the plantation, micro and small businesses are also considered. The resource required to run the planned capacity of this processing plant is the existing plantation of 2380 hectares of highland bamboo in Awi zone.

In addition, if all existing resource is utilized and value addition is made by processing the same, the country will get more than Br. 10 billion annually.

15. CONCLUSIONS AND RECOMMENDATIONS

15.1. CONCLUSIONS

From this paper we can conclude that,

- 1) Ethiopia has the largest bamboo resource in Africa, which constitutes more than 67% of the total 1.5 million hectares of African resource. Even though the resource exists in large extent in Ethiopia, the utilization and development of the resource is poor. Currently the application is limited only to some household level, low quality, and low priced products. Hence the resource is wasted due to poor utilization and low attention to the economic, environmental and social value of the resource.
- 2) The market of bamboo is increasing from time to time in the global market and the transaction reaches its high value, and is also expected to increase from time to time.
- 3) There are two types of indigenous species of bamboo in Ethiopia, namely highland bamboo and lowland bamboo. The mechanical and physical properties of these indigenous species respond well to many industrial and construction products. The Ethiopian highland bamboo is good for products including, bamboo flooring, bamboo panels, ply bamboo, bamboo mats, and incense sticks. Therefore it is technically feasible to produce some of these products.
- 4) The developed bamboo development and utilization models show how the contributing parties can be integrated. Bamboo can be effectively utilized when the plantation is well integrated with micro and small scale industries, medium and large scale processing industries and finally with the customer by creating effective and optimal supply chain.
- 5) The commercial evaluation of some representative products (bamboo flooring, bamboo mat and incense sticks) shows positive result. The processing plant is designed to process all these three products, and the processing plant will base on

- the existing plantations of 2380 hectares of the highland bamboo resources around the town, and may not need to have its own plantation.
- 6) The processing plant is reasonably located at Injibara town of Awi zone in Amhara Regional State. The site is situated with proximity to the raw material and availability of all the facilities to reach local and international markets.
 - 7) The investment requirement for this representative project is about Br. 41 million and the expected annual return is Br. 94 million is expected in its first five years of operation. Therefore the pay back period is less than a year and it will have an IRR value of 225%.
 - 8) Based on the analysis, Ethiopia can get more than Br.10 billion annually from the processing of existing plantation of the highland bamboo resource. This figure could be much higher if new commercial cultivation is considered.

15.2. RECOMMENDATIONS

It is logical to think that Ethiopia is not getting the deserved benefit of having large bamboo resource coverage. And to improve this, existing traditional way of utilizing the resource should be improved and generally the following recommendations are made for implementation.

- 1) Bamboo resource should be properly mapped and separately included in the forest inventory so that some further tasks could be simple and complete.
- 2) There should be better utilization of the resource to entertain the complete advantage of the resource.
- 3) There should be better integration and coordination of different stakeholders in the development and utilization of the resource. All parties (sponsors, technical assistants, government offices, non governmental organizations) should play their part in the proper utilization of the resource.
- 4) There should be some tissue culture centers to encourage mass plantation of the resource for commercial purposes.
- 5) Some effort is required to implement some processing plants in the country, so that the country will benefit from this untapped sector.
- 6) This effort can be extended in the value addition to other agricultural products so that the export income of the nation will be maximized, and create more job opportunities to citizens in the process.

16. FUTURE RESEARCH AREAS

This thesis tries to address some of the many issues that can be done with bamboo resource in Ethiopia. But there are many other interesting future expected areas that can be done in recent years. And the following may be included.

1. Integration of bamboo resource with low cost housing projects:

There is increasing pressure on shortage and increasing cost of construction materials. Therefore it will be helpful to integrate bamboo with other construction materials, for their advantage of low cost and attractive nature. Experiences of many Asian and some Latin American countries may help.

2. Paper and pulp processing:

There are some preliminary studies on the technical feasibility of lowland bamboo to be used as a raw material for pulp and paper industries. The quality of pulp and paper made of bamboo is better than hard wood pulp and papers and equivalent to that of soft wood pulp and paper products.

3. Bamboo fuel and extracts

Through pyrolysis, bamboo can be converted into three valuable products: bamboo charcoal, oil and gas. Changing the pyrolysis parameters can change the product shares depending on the purpose and market conditions. Bamboo extracts contain valuable elements and can be used in pharmaceuticals, creams and beverages. Bamboo gas can be used as a substitute for petroleum. Bamboo charcoal is an excellent fuel for cooking and barbequing. Activated charcoal is used as a deodorant, purifier, disinfectant, medicine, agricultural chemical and absorbent of pollution and excessive moisture.

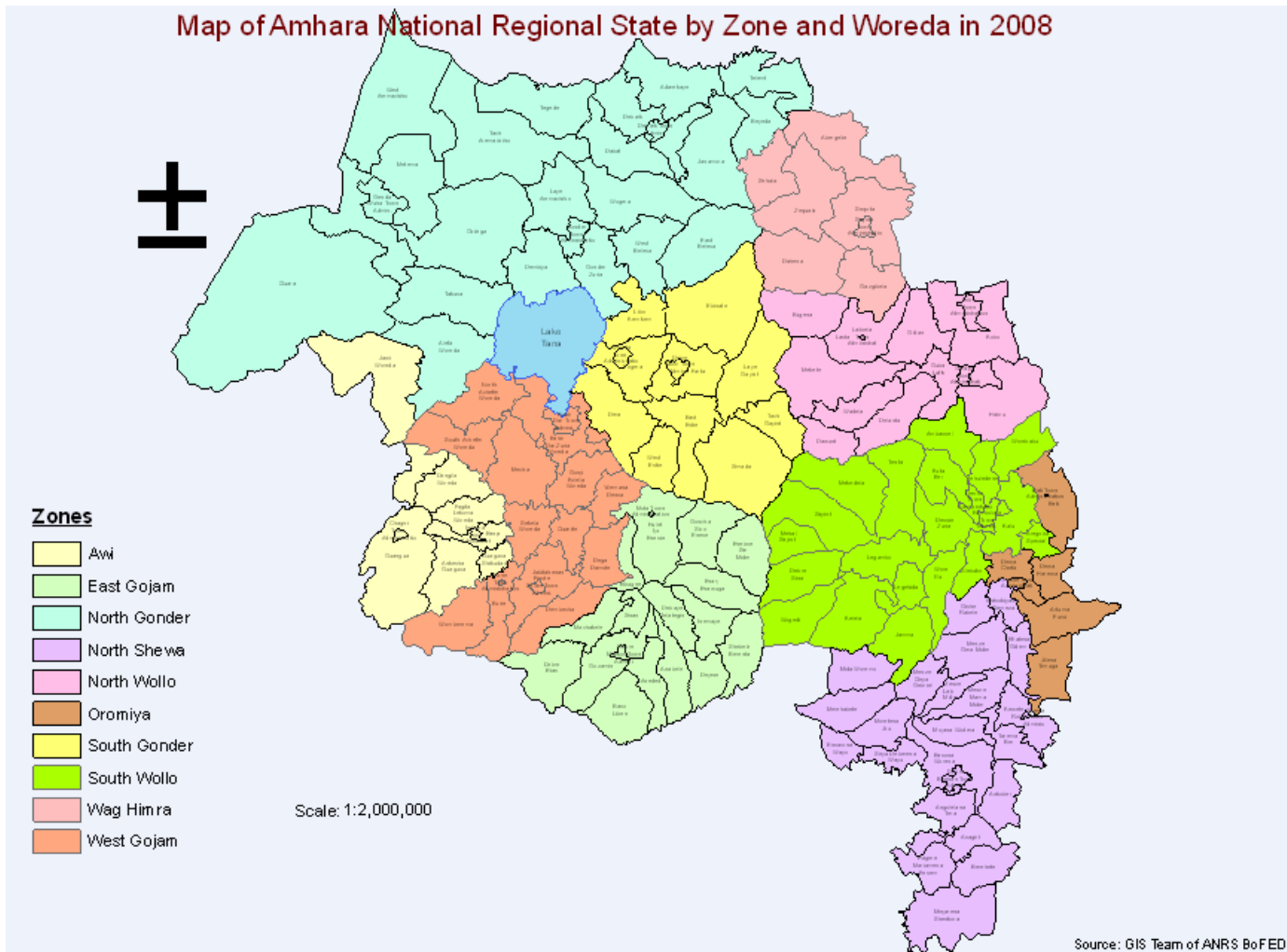
REFERENCES

1. Maxim Loboviskov, "**World Bamboo Resources, A Thematic study prepared in the framework of the Global Forest resources assessment-2005**", Rome, 2007
2. Eastern Africa Bamboo Project, "**Priority to the millennium grass – Bamboo, for its superior products**", Ethiopia
3. Francis E, Brink, "**Bamboo Reinforced Concrete Construction**", US Naval Civil Engineering Laboratory, Port Huenema, California, Feb, 1966
4. Seyoum Kelemework, "**Anatomical Characteristics of Ethiopian Lowland Bamboo**", International Center for Bamboo and Rattan, Jan 16, 2008, Beijing, China
5. Bernard Kigomo, "**Guidelines for Growing Bamboo (Based on Guidelines Establishment and Managing plantation of Bamboo in Kenya**", March 2007
6. The Yankee Group Inc, "**Western Juniper Harvest Systems Trial (Final Report)**", Oregon, December 2001.
7. UNIDO, "**Bamboo Market Study in Ethiopia, prepared for UNIDO, Technical Report**", 20 Jan 2007
8. Minda Teshome, ANRS, Bureau of Agriculture & Rural Development, "**Regional Bamboo Resource Potential and Development Program**", 2008, Bahir Dar (unpublished)
9. Agricultural Research Center, "**Fiber and Paper Making Characteristics of Bamboo**", Technical Report Bulletin No. 1361, US Department of Agriculture , Washington DC, August 1966
10. Minda Teshome, "**Bamboo Development Strategy for Amhara Region, submitted to regional Micro and Small Trade and Industry Enterprise Promotion Agency**," December 2007, Bahir Dar (unpublished)
11. Million Bekele, "**Data Collection and Analysis for Sustainable Forest Management in ACP Countries linking national and International efforts**", August 2000, Addis Ababa

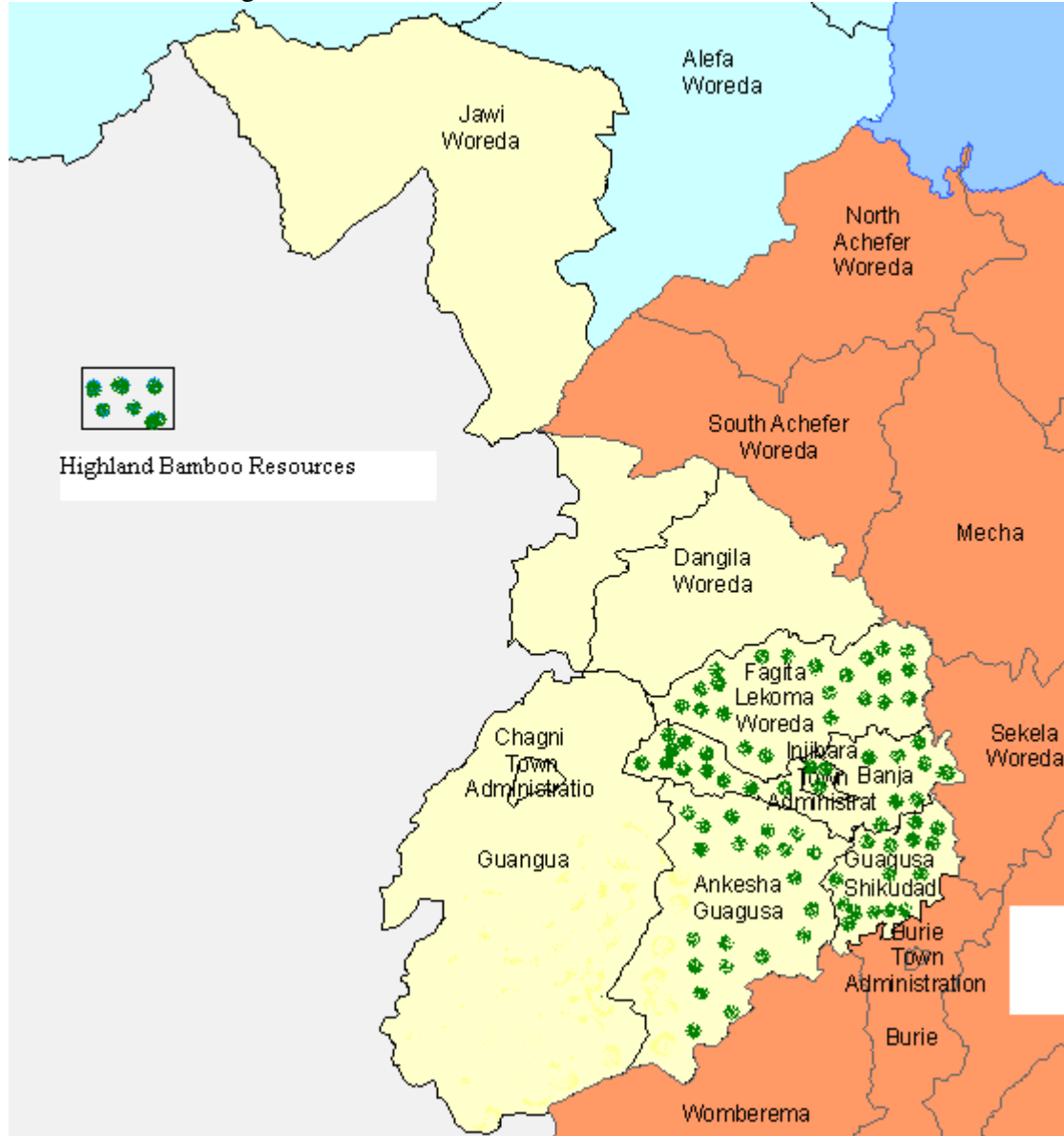
12. Ensermu Kelbessa, "**A socio-Economic Case study of the Bamboo Sector in Ethiopia: An Analysis of the Production to Customption System**", March 2000, Addis Ababa
13. Donald Waters, "**Logistics: An Introduction to Supply Chain Management**", Palgrave MacMillan, 2003
14. FDRE, Central Statistical Agency, "**Statistical Abstract 2007**", January 2008, Addis Ababa
15. Thompson, A, "**Business Feasibility Study: Dimensions of Business Viability**", Perth, Best Entrepreneur, 2003
16. FAO, "**Wood Preservation Manual**", Rome, 1986
17. N, Imboden, "**A Management Approach to Project Appraisal and Evaluation**", Paris, 1978
18. Amlaku Asres, "**An Economic Evaluation of Soil Conservation in Amhara Region**", University of Jordan, August 2002

ANNEX – A: Regional Map and Bamboo Resource Distribution

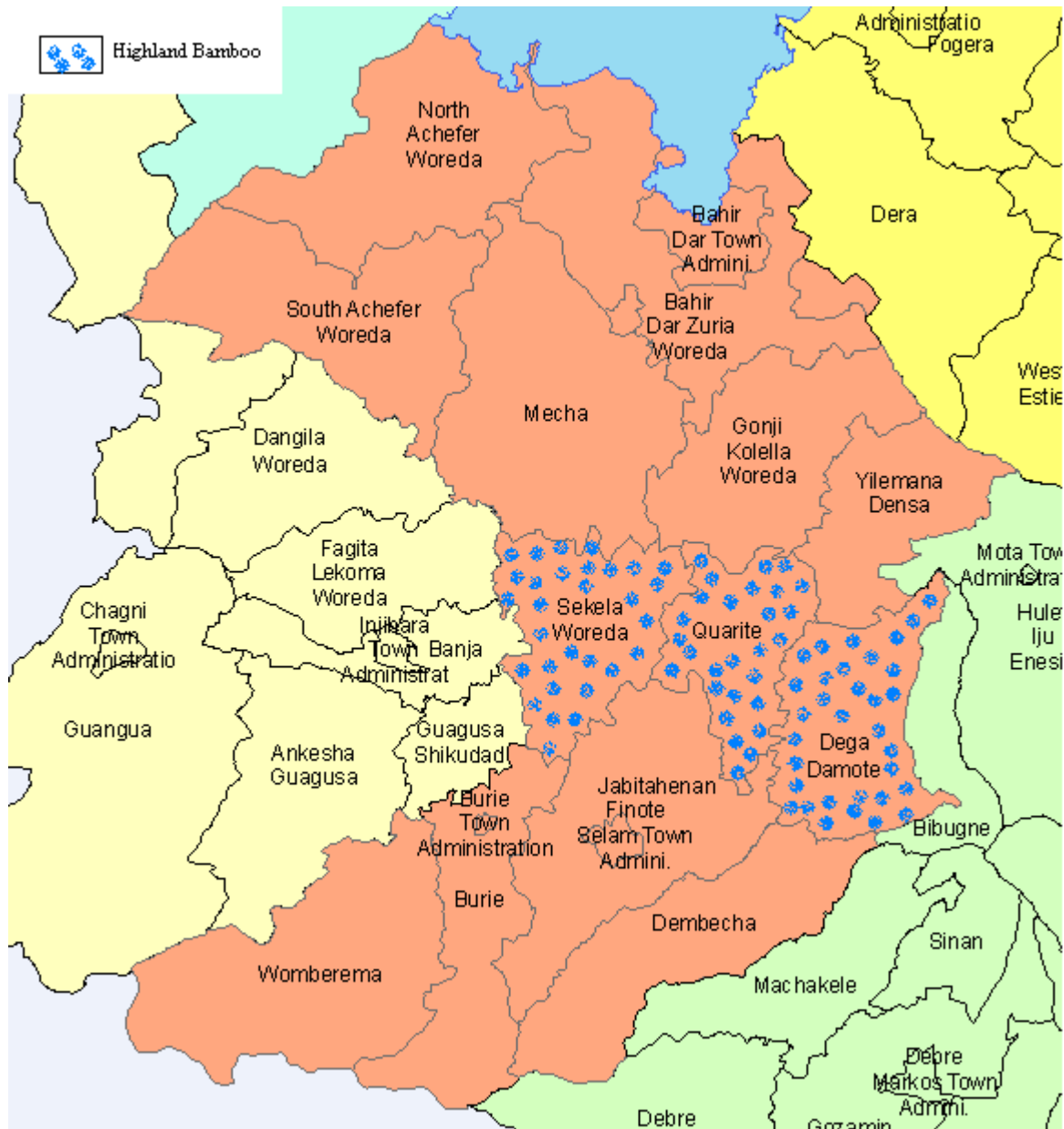
ANNEX – A 1: Map of Amhara Regional State by Zones and Woredas, 2008



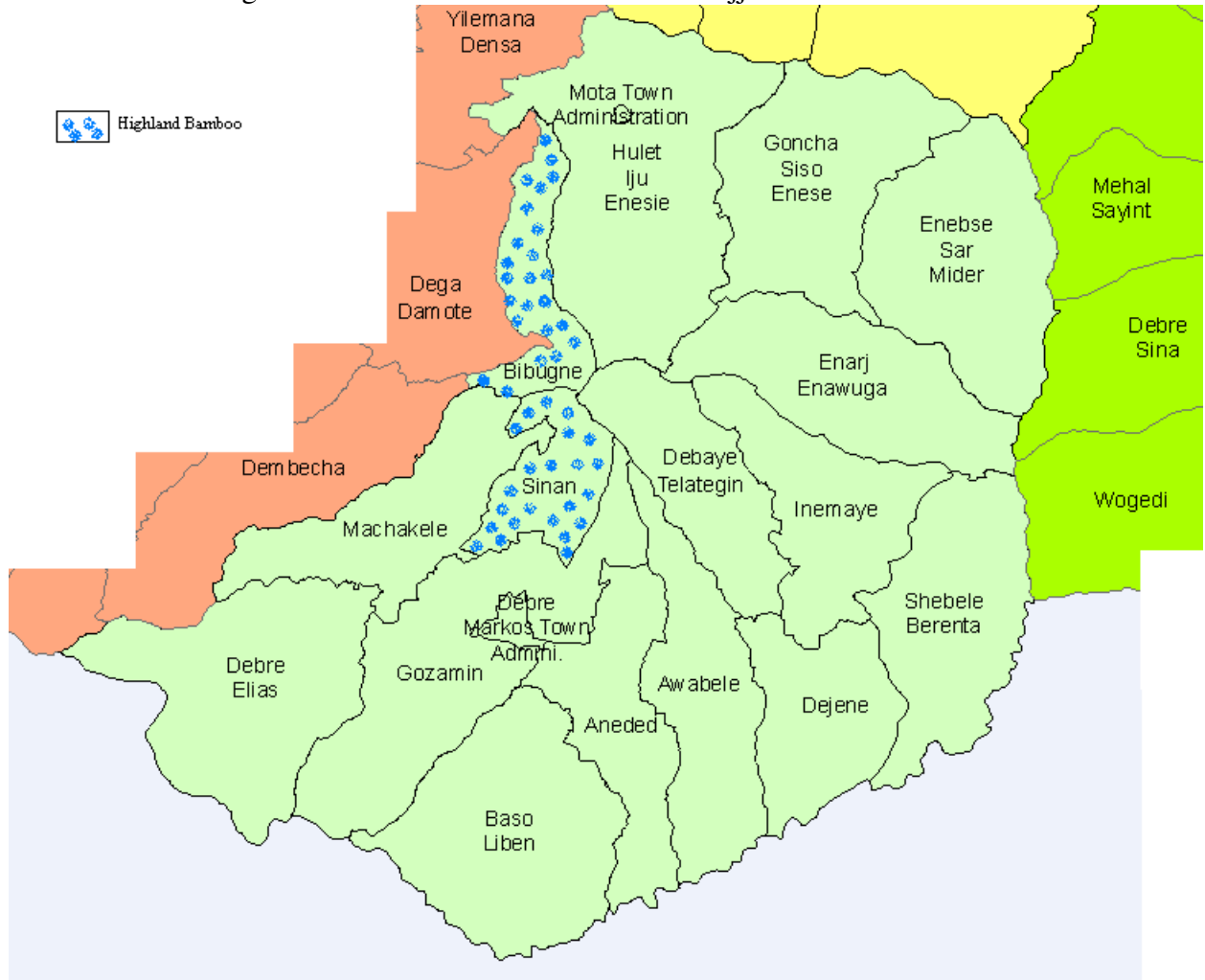
ANNEX – A 2: Highland Bamboo Distribution in Awi Zone



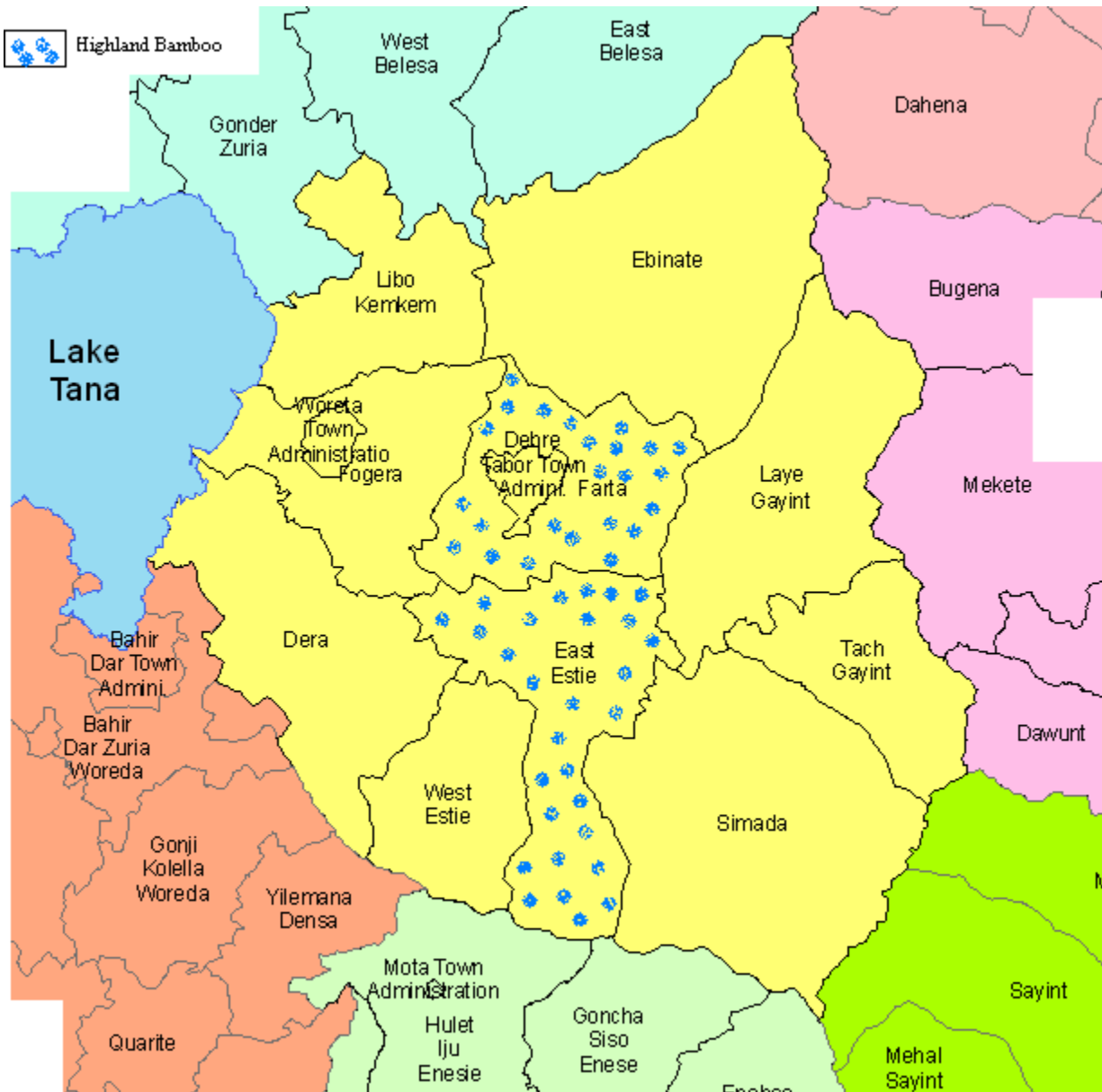
ANNEX – A 3: Highland Bamboo Distribution in West Gojjam Zone



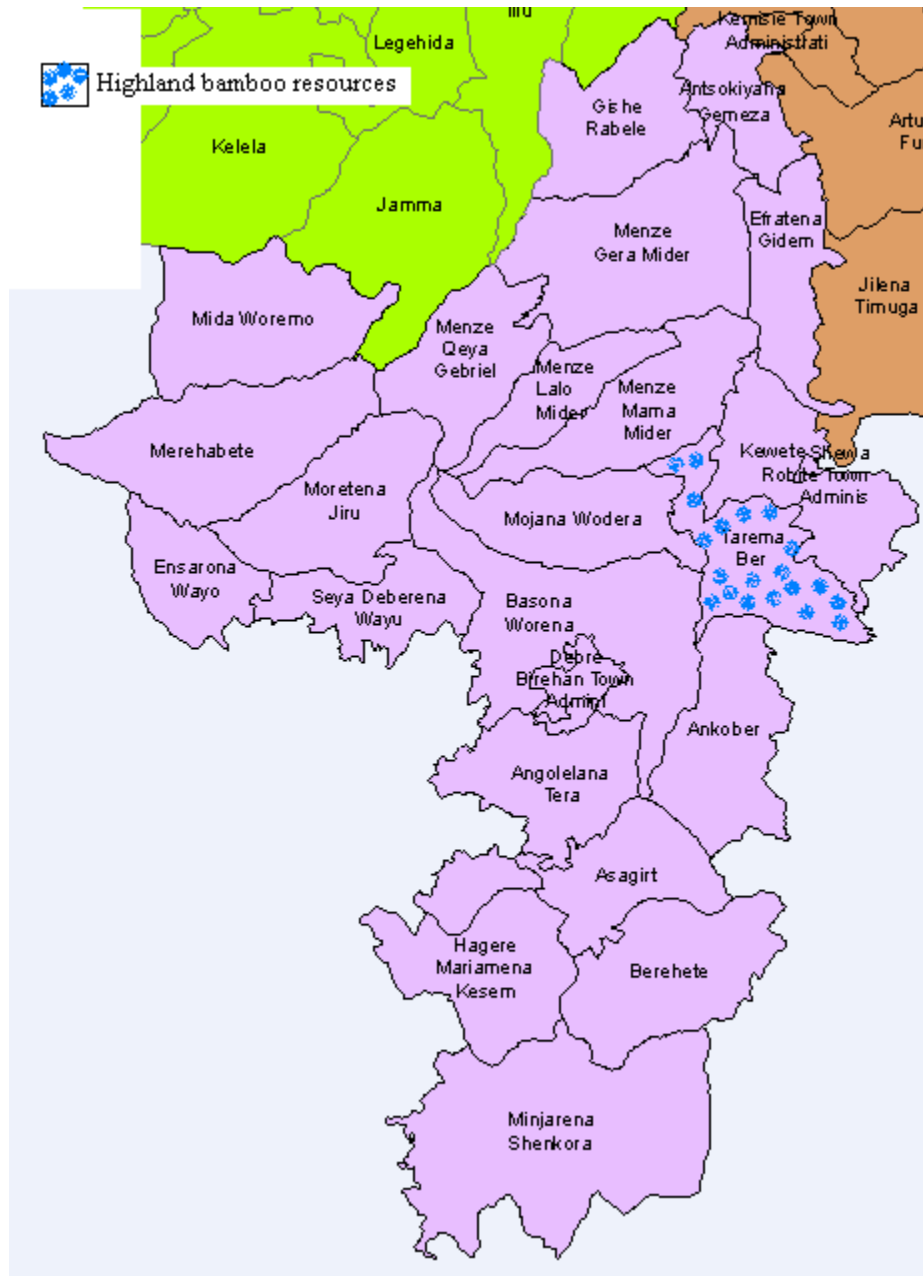
ANNEX – A 4: Highland Bamboo Distribution in East Gojjam Zone



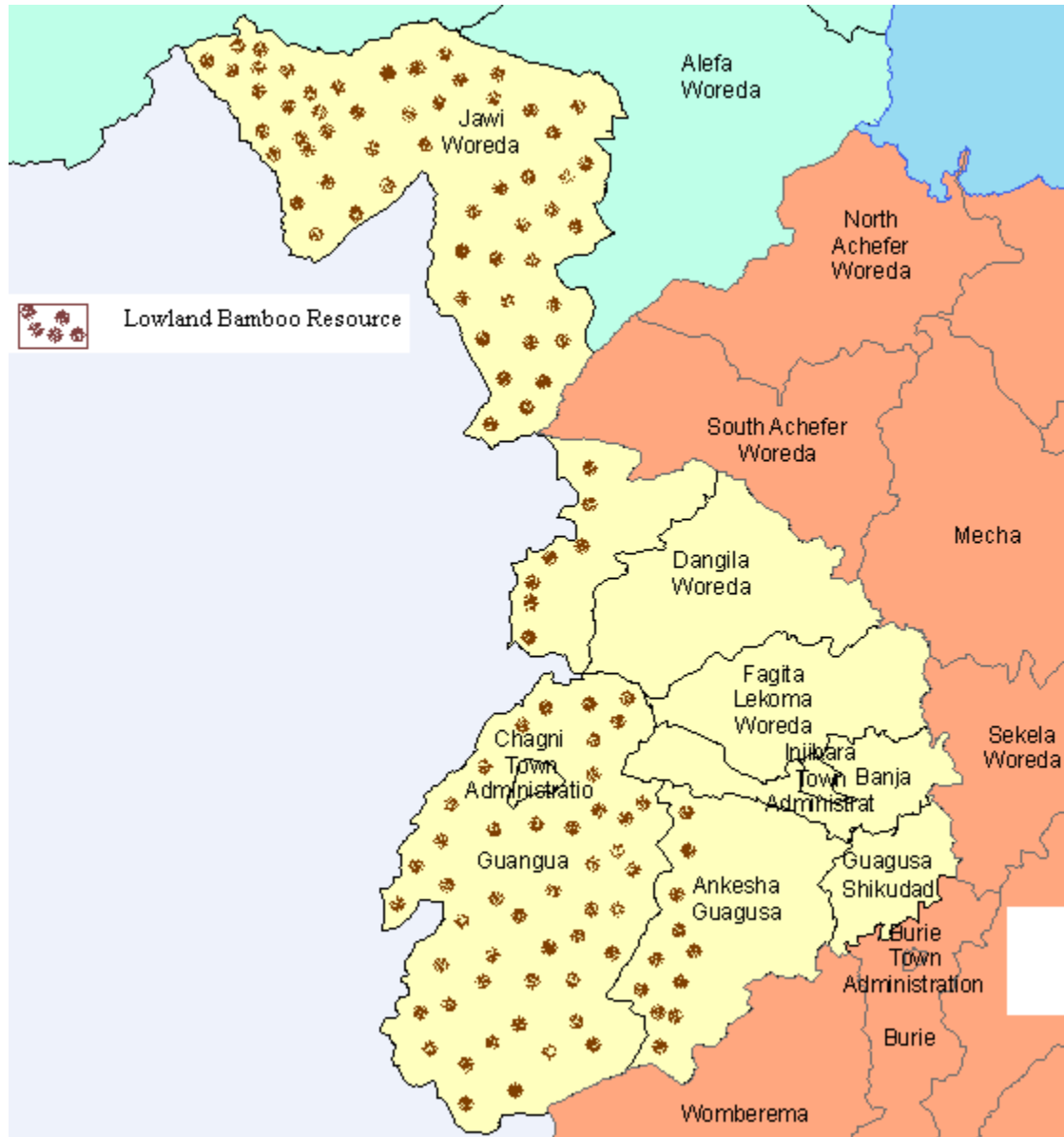
ANNEX – A 5: Highland Bamboo Distribution in South Gondor Zone



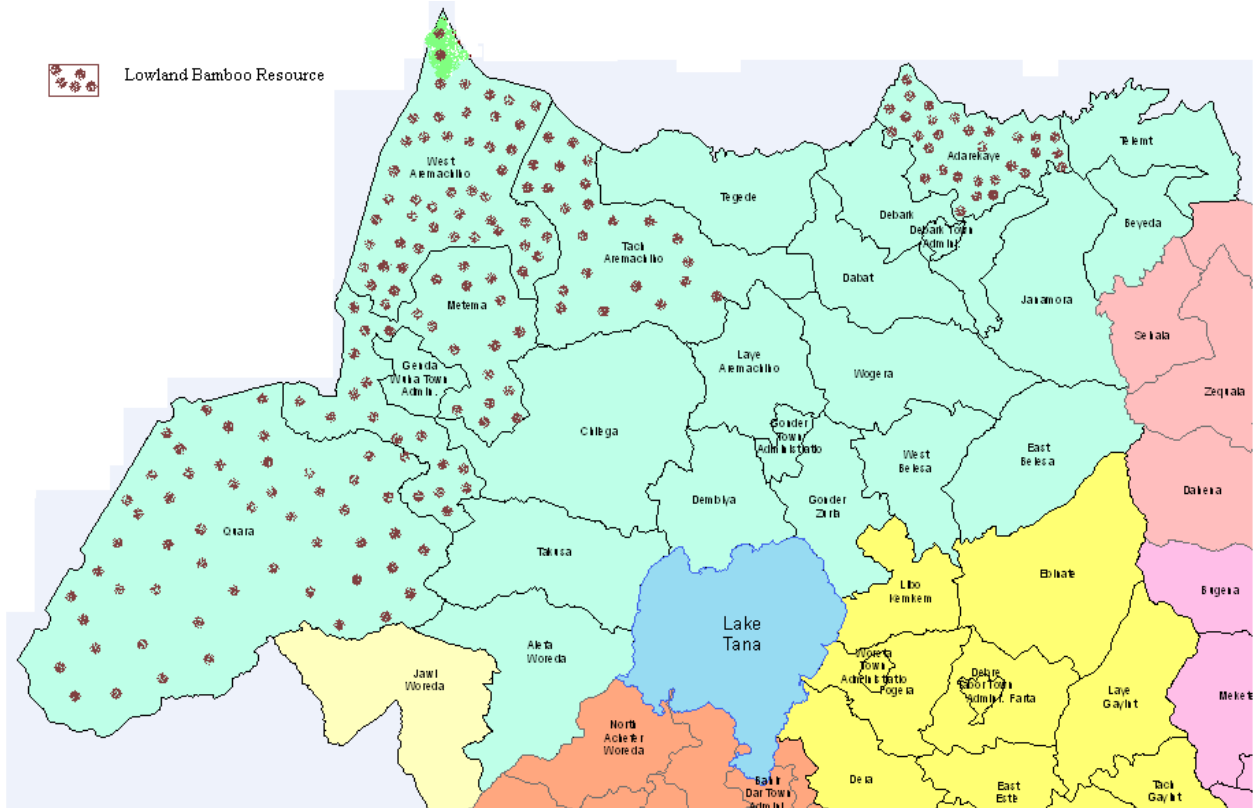
ANNEX – A 6: Highland Bamboo Distribution in North Shewa Zone



ANNEX – A 7: Lowland Bamboo Distribution in Awi Zone



ANNEX – A 8: Lowland Bamboo Distribution in North Gondor Zone



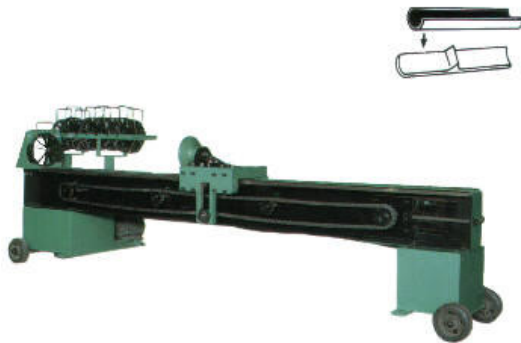
ANNEX – B: Detail Specification of Bamboo Processing Machines

1. ORIGINAL BAMBOO SAWING TABLE



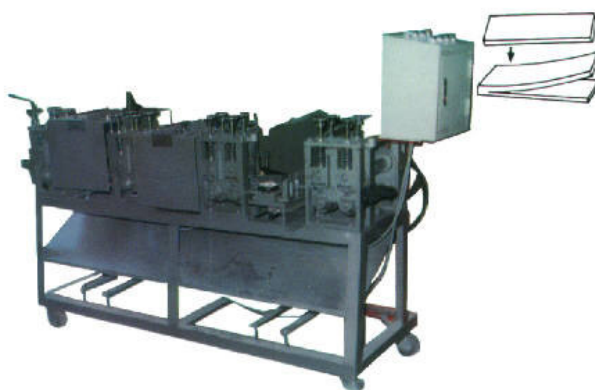
MODEL	PC-W101
Motor Power	2HP
Spindle Speed	1032R.P.M.
Productivity	120 pcs/hr
N.W.	85kg
G.W.	145kg
Machine Size (LxWxH)	100X70X155cm
Packing Size (LxWxH)	110X80X165m

2. SPLITTING MACHINE



MODEL	PC-W102
Motor Power	3-5HP
Spindle Speed	368R.P.M.
Productivity	103 pcs/hr
N.W.	580kg
G.W.	750kg
Machine Size (LxWxH)	410x100x120cm
Packing Size (LxWxH)	420x110x138cm

3. KNOB SPLITTING MACHINE



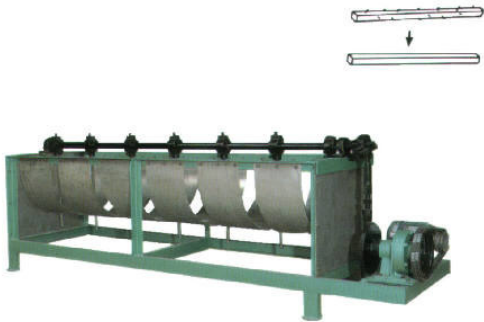
MODEL	PC-W103
Motor Power	5-8HP
Spindle Speed	553R.P.M.
Productivity	253 ft/sec
N.W.	360kg
G.W.	480kg
Machine Size (LxWxH)	180X70X135cm
Packing Size (LxWxH)	190X80X145cm

4. POLLING TABLE (4-CUTTER TYPE)



MODEL	PC-W106-1
Motor Power	3,3,2HP
Spindle Speed	4013 RPM
Productivity	135-405 ft/sec
N.W.	460kg
G.W.	620kg
Machine Size (LxWxH)	110x100x100cm
Packing Size (LxWxH)	120x110x110cm

5.1. POLISHING MACHINE (MAT LICED)



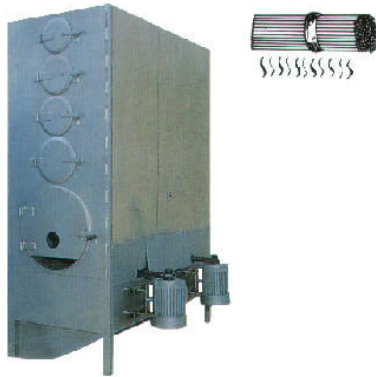
MODEL	PC-W109-1
Motor Power	2.5M
Spindle Speed	76 R.P.M.
Productivity	8000 pcs
N.W.	230kg
G.W.	310kg
Machine Size (LxWxH)	270x76x89cm
Packing Size (LxWxH)	280x86x107cm

5.2. POLISHING MACHINE (INCENSE STICK)



MODEL	PC-W110
Motor Power	1HP
Spindle Speed	368 RPM
Productivity	90kg
N.W.	230kg
G.W.	345kg
Machine Size (LxWxH)	380x64x120cm
Packing Size (LxWxH)	390x74x138cm

6. DRYING MACHINE



MODEL	PC-W107
Motor Power	3,3HP
Productivity	150000 pcs
N.W.	1500kg
G.W.	1620kg
Machine Size (LxWxH)	105x250x220cm
Packing Size (LxWxH)	115x260x230m

7. AUTO HIGH-CUTTER GRINDER



MODEL	PC-Q311
Motor Power	1HP
Productivity	3400R.P.M.
N.W.	305kg
G.W.	350kg
Machine Size (LxWxH)	85x75x135cm
Packing Size (LxWxH)	90x80x145m

8. WEAVING MACHINE



MODEL	PC-W112-2
Motor Power	1/2,1/4HP
Specifications	212cm
Productivity (8hr)	50-160M
N.W.	1000kg
Machine Size (LxWxH)	2757x1333x1454
Packing Size (LxWxH)	2850x1550x1670

9. PRESSING TABLE



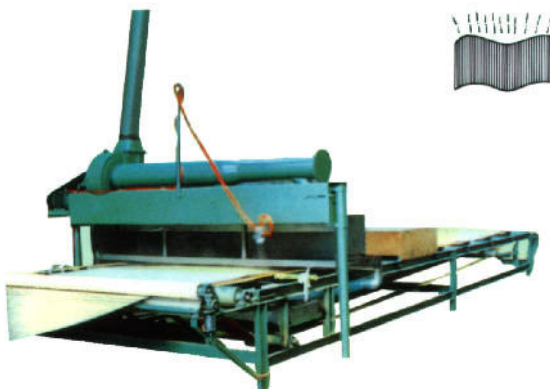
MODEL	PC-W113-1
Motor Power	7 1/2HP
Specifications	212cm
Productivity	700-1100M
N.W.	18000kg
Machine Size (LxWxH)	3212x1061x3000
Packing Size (LxWxH)	open container

10. BAMBOO MAT PASTING MACHINE



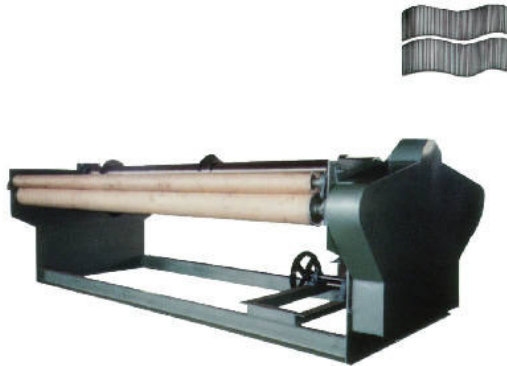
MODEL	PC-W115-1
Motor Power	1HP
Specifications	212cm
Productivity	1800-2500M
N.W.	1800kg
Machine Size (LxWxH)	2879x758x1515
Packing Size (LxWxH)	2820x1000x1760

11. AUTO SPRAYER



MODEL	PC-W114-1
Motor Power	3,1/2,1,1,30HP
Specifications	212cm
Produce Capacity (Daily)	200-300Y
N.W.	1850kg
G.W.	1900kg
Machine Size (LxWxH)	10605x2273x2575
Packing Size (LxWxH)	A 3850x 900x1500

12. SCISSION MACHINE



MODEL	PC-W116
Motor Power	1/2HP
Capacity Per Min	100-150 pcs
Productivity	120 pcs/hr
N.W.	500kg
G.W.	550kg
Machine Size (L x W x H)	252x130x80cm
Packing Size (L x W x H)	262x140x90cm

13. OPEN SIDE AUTO FOUR SIDES MOULDER



MODEL	PC-C601
Moulding capacity	180x75mm
Working capacity for plane	150mm
Lower spindle power	3HP
Front vert. spindle power	
Front upper spindle power	5HP
Rear upper spindle power	
Left vert. spindle power	2HP
Right vert. spindle power	2HP
Feeding power	1HP
Machine size	2400x1200x1200 mm
Measurement	2460x1260x1450 mm
N.W./G.W.	1100/1400 kgs

14. AUTOMATIC CUT-OFF SAW



MODEL	PC-B901
Saw blade speed	3630/3050 RPM
Saw blade size	1"x18"x3.4mmx120T
Cycle speed	81 cuts per minute
Working air pressure	4-5 kg/cm
Table height from floor	890mm
Table surface area	660x700mm
Dust outlet diameter	4"
Motor	7.5HP (10HP optional)
Net Weight	350kgs
Gross weight	410kgs
Packing measure ment	950x850x1350mm

15. ROLL COATER GLUE SPREADER



16. HIGH-FREQUENCY BOARD JOINING MACHINES



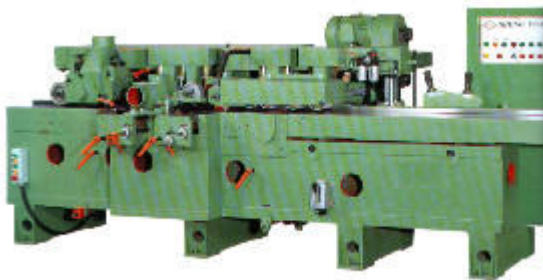
MODEL	PC-K091
Mains voltage	220-380V
Input power	10KVA
HF output	6KW
Oscillating frequency	5-8MHZ 13.56MHZ
Rectifier	Silicon diode
Press	Pneumatic/Hydraulic
Max capacity	650x1000x65
Belt conveyor	Motorized
Control	Electronic
Dimensions	1500x4000x1600

17. HYD. COLD PRESSES



MODEL	PC-K003
Platen size (mm)	2500x1250
Daylight (mm)	1000
Total thrust (Ton)	50
Hyd. cyl.	125x2
Stroke (mm)	500
Pressure (kg/cm)	1.6
Hyd. power (HP)	5
Machine size (mm)	3300x1400x2400

18. FOUR SIDE MOULDER

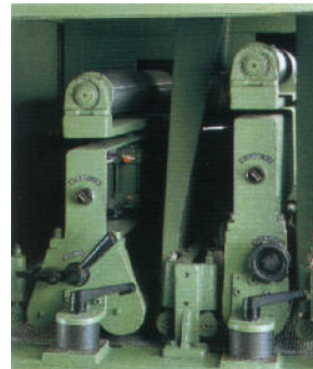


MODEL	PC-C611	
Max. working width	200mm	
Max. working height	125mm	
Upper spindle motor	10HP	
Lower spindle motor	7.5HP	
R-Vertical spindle	7.5HP	
L-Vertical spindle	7.5HP	
Feeding motor	5HP	
Up & down motor	1HP	
Spindle speed	6000RPM	
Spindle diameter	40mm	
Feeding speed	6-25M/min	
Max. cutter dia.	First bottom spindle	160mm
	R-vertical spindle	180mm
	L-vertical spindle	180mm
	Top spindle	180mm
	Rear bottom spindle	-
Packing size	2800x1500x1650mm	
N.W.	2000 kgs	
G.W.	2500 kgs	

19. AUTOMATIC DOUBLE END MITER SAW WITH MOULDING HEAD MACHINE



MODEL	PC-B421
Number of rails	2
Width of cut (mm)	280-1200
Length of cut (mm)	540
Sawblade dia. (optional)	10"-12"(Φ25.4mm)
Sawblade motor	2HPx4,3HPx2
Molding spindle dia (mm)	25.4or30
Length of cutter (mm)	80or100
Molding spindle motor and speed	3HPx2,7000RPM
Sawblade speed	3300-3600RPM
Sawblade and molding spindle tilt	360
Packing size (mm)	2250x1100x1500
N.W. (kgs)	1100
G.W. (kgs)	1170



MODEL	BKM-25DA
Max. working width	24"
Max. working thickness	5"
Main motor (standard)	10,7½HP
Main motor (optional)	15,10HP
Feed motor	2HP
Table hoist motor	½HP
Variable feeding speed (m/min)	6-25
Sanding belt size	25" x48"

20. REVERSIBLE ROLLER COATER



MODEL	PC-M013
Eff. coating width (mm)	600
Workpiece thickness (mm)	1-35
Min. workpiece coating length (mm)	300
Feeding speed (m/min)	15-40
Feeding power (HP)	2
No. of roller	2
Machine size (mm)	1340x1240x1250
Measurement (mm)	1440x1340x1550
N.W. (kgs)	500
G.W. (kgs)	620

21. INCENSE STICK SIZING MACHINE



MODEL	PC-W108
Motor Power	1HP
Spindle Speed	2293 RPM
Productivity	12 pcs/sec
N.W.	110kg
G.W.	165kg
Machine Size (LxWxH)	213x77x110cm
Packing Size (LxWxH)	223x87x128cm

22. UV CURING MACHINE

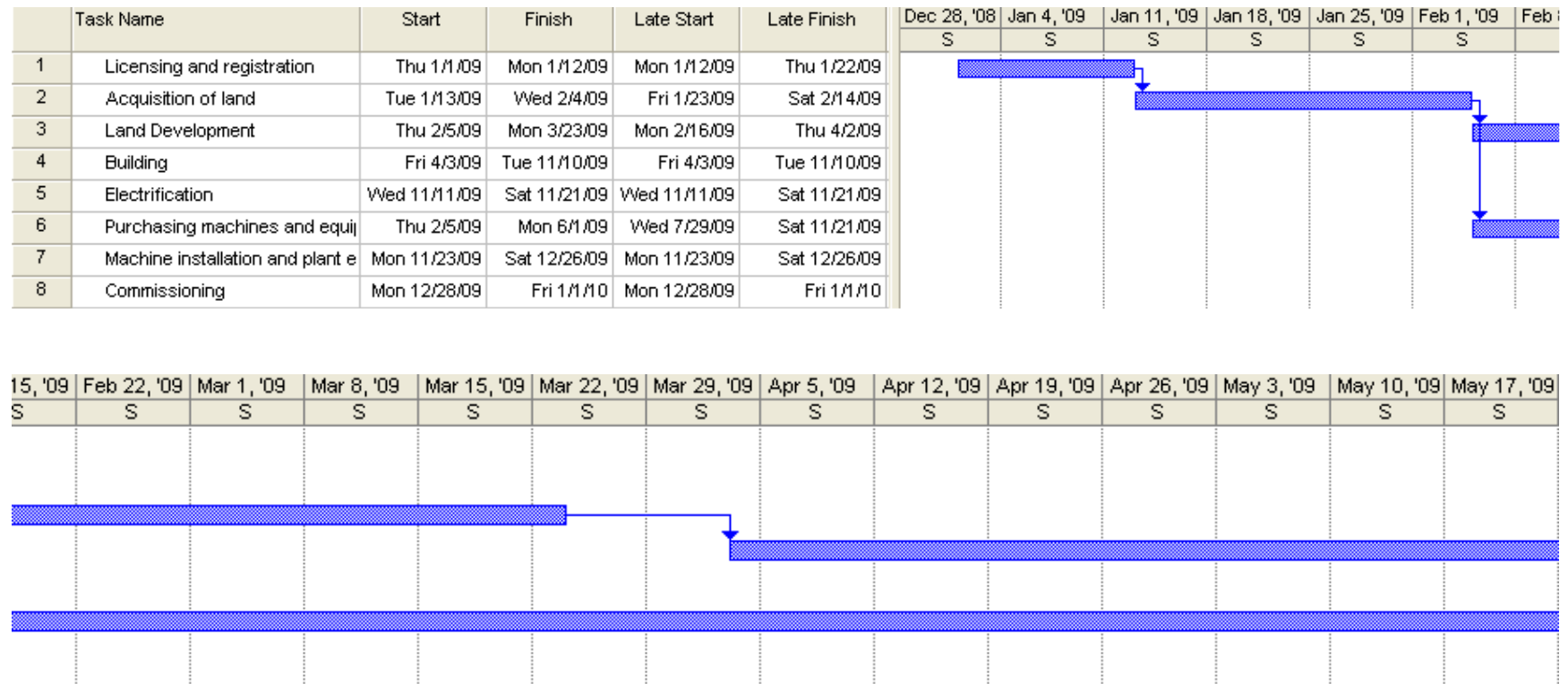


MODEL	PC-M401
Eff. irradiant width (mm)	300
No. of UV lamp (kw/pcs)	2.5/2
Feeding speed (m/min)	0-30
Power	7KVA/220V 3Φ
Suitable workpiece profile	Flat workpiece
Machine size (mm)	2000x600x1700
Measurement (mm)	2080x680x1900
N.W. (kgs)	250
G.W. (kgs)	325

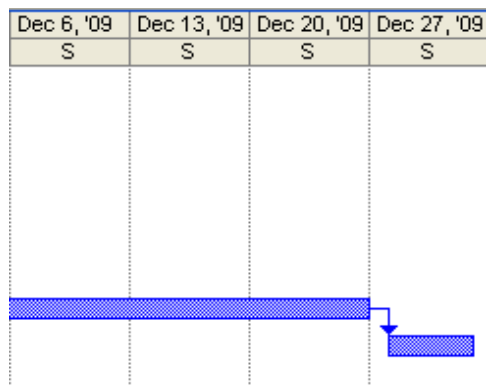
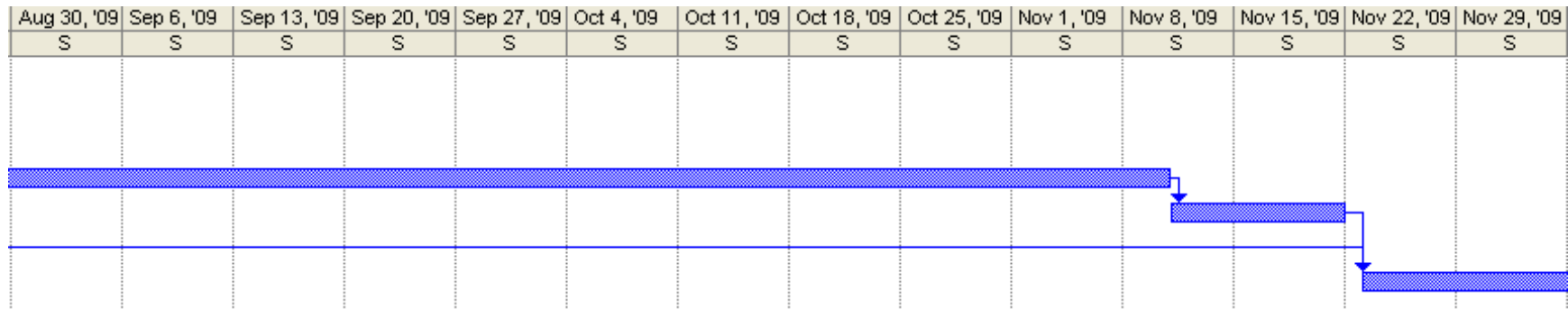
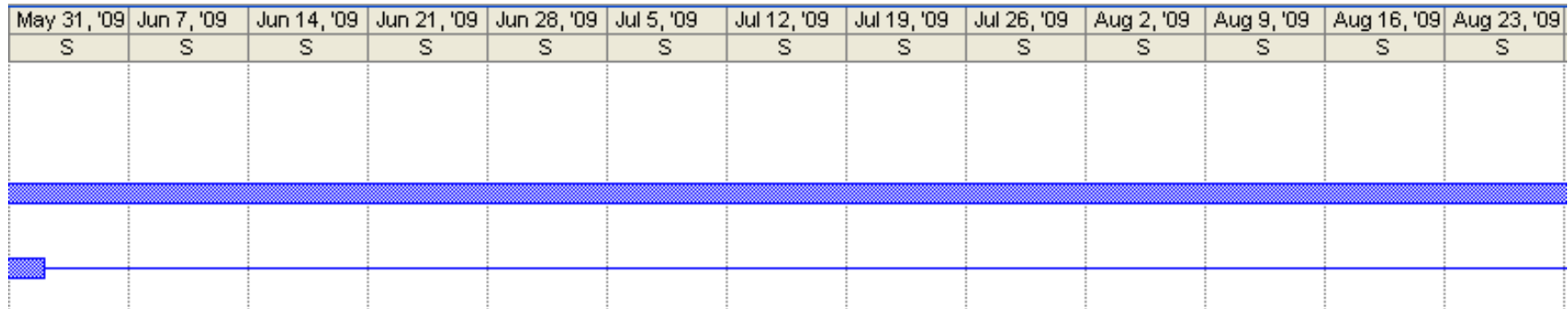


MODEL	BKM-25B
Max. working width	24"
Max. working thickness	5"
Main motor (standard)	5HP
Main motor (optional)	7½HP
Feed motor	1HP
Table hoist motor	¼HP
Variable feeding speed (m/min)	6-25
Sanding belt size	25"x48"
Working pressure (kg/cm)	5
Net weight (kgs)	620
Gross weight (kgs)	770
Machine size (LxWxH) cm	139x120x160
Packing size (LxWxH) cm	148x130x179

ANNEX – D: Scheduling Implementation Plan



Study on Establishment of Bamboo Processing Plants in Amhara Regional State



ANNEX – E: Bamboo Plantation Guidelines

E1. THE GROWTH HABIT OF BAMBOO

The bamboo plant (**Figure E1**) is made up of an underground axis and above ground axis. The underground axis is comprised of rhizomes, roots, and buds. The above ground axis is comprised of stems, branches, and foliage. Buds on the rhizomes may develop into shoots that emerge from the ground. The new shoot elongates vertically into a main stem or *culm* until it attains its full height. The growth of a culm is completed in one growing season. In large bamboo species, new culms may grow to a height of more than 20 meters within 3 months.



Figure E1 **Parts of the bamboo plant**

The bamboo culm is cylindrical and is divided into sections by diaphragms or nodes. The section between two nodes is called an internode. Internodes are hollow in most bamboos, but solid in some species. The new culm is protected by sheaths that are attached to each node. The culm gradually develops branches and leaves. As the culm matures, it lignifies and becomes harder and stronger. The bamboo culm does not get thicker each year. Unlike trees, bamboos do not have any secondary growth. Rather, as the rhizome system develops and matures, new and larger shoots emerge annually until the maximum size of the species has been reached. The life of a culm varies from species to species. Usually a culm is fully mature after 3 or 4 years. As mature

culms grow older, they deteriorate and eventually die and rot. The life of the bamboo plant is however sustained by the new shoots and culms.

Silvicultural management of bamboo is heavily based on its growth habit, particularly the way the underground rhizome develops leading to the formation of culms. Effective management involves systematic but selective cutting of mature culms, thereby harvesting a crop that is valuable and useful. The removal of mature culms also maintains the vigour of the plant and allows for the continuous generation of new shoots.

Two main systems of rhizome formation are predominant in bamboos, namely clump forming rhizomes and running or creeping rhizomes. Clump forming bamboos have rhizomes that exhibit a sympodial branching pattern. Running bamboos, on the other hand, have rhizomes with a monopodial branching pattern.

In sympodial branching, each branch or axis, becomes dominant. In the case of bamboos with sympodial rhizomes, each new rhizome turns upward and develops into a culm. On the other hand, bamboos with monopodial rhizomes have a single, dominant subterranean stem, or axis that develops secondary stems that either extend laterally or turn upward to become culms. The lateral extension of the monopodial bamboos may exceed hundreds of meters.

E2. TYPES OF PLANTATIONS

The term ‘plantation’ can mean different things and it is useful to explain the various senses of the term in relation to different bamboo plantation systems. This can at the same time help to illustrate various applications for bamboo in relation to forestry and farming. It is useful to distinguish, for instance, between homestead, commercial plantations, agroforestry, and forestry programs.

Homestead Farms

A homestead farm is a small property with a dwelling house where a family resides and adjoining land where cash crops and trees are planted. Planting bamboo clumps in a homestead can foster self-sufficiency of woody materials as well as fiber for producing domestic implements such as baskets and mats. It is common to see this kind of plantation in Amhara region. In Awi-zone it is considered as alternative income source in addition to their primary source.

Commercial Plantations

Bamboo can be planted as a commercial crop in areas of farms of just a few hectares to large estates of thousands of hectares. Plantations have a well defined structure and a selection of crops that are cultivated mainly for generating economic gain. A bamboo plantation need not be a monoculture; on the contrary, it is advisable to have an assortment of bamboo species in the plantation.

Agro forestry

The term ‘agroforestry’ broadly refers to land use systems and agrarian practices that involve the cultivation of woody species in combination or rotation with agricultural crops and/or animals on the same land management unit. Agroforestry systems are driven by economic and ecological goals. The aim is to generate a sustainable use of land for the benefit of livelihood and the environment. The use of bamboo in agroforestry systems involves intercropping of cash crops and the planting of hardwood trees. In this way cash crops can generate income in the short term, bamboo can generate income in the medium term, while the trees can generate high value in the long term. The use of numerous species with different rotations has a beneficial impact on the soil. Knowledge, careful selection and good management of species are needed to maximize the production and positive environmental effects while avoiding the shortcomings of monoculture plantations.

Conservation Programmes

Bamboos can be integrated in forestry programs, primarily as fast growing woody species that can generate a green canopy in a short period of time. In forest environments, bamboo provides many environmental benefits, especially in relation to erosion control and protection of soil.

E3. RAISING OF PLANTING MATERIALS

Growing bamboo starts with obtaining the materials for planting. Such materials may come in the form of seeds, wildings, offsets or cuttings that may be gathered from forests. Tissue-cultured plantlets provide other forms of planting materials. Such planting materials can be obtained and raised in the nursery as described below.

Propagation by seed

Bamboos generate seeds when they flower. For many tropical bamboos, flowering intervals range from 40 to 80 years. There are two types of flowering in bamboos, gregarious flowering and sporadic flowering. When gregarious flowering occurs, the clumps of an entire species flower,

produce seed, and then die. Although large quantities of seed are produced during gregarious flowering, they are viable only for a short period, sometimes only for a few days or months. Sporadic flowering occurs in many species, including *Yushania alpina*, *Dendrocalamus giganteus*, *Dendrocalamus strictus*, *Dendrocalamus hamiltonii*, *Bambusa tulda*, and *Guadua angustifolia*, among many others. In this type of flowering, seeds are produced but the clumps generally survive. What triggers the flowering of bamboo is not yet scientifically understood and the onset of flowering is therefore not predictable.

Because of the long flowering intervals of bamboo, seeds are very seldom available and not always a viable method for large scale propagation. If seeds of a certain bamboo species become available, it is highly advisable to buy only from reputable vendors or specialized organizations that can guarantee the provenance and viability of the seeds.

Use of Wildings

Apart from raised seedlings, wildings of bamboo from indigenous forest stands can be collected and used for raising a bamboo plantation.

Young clusters of bamboo wildings can be scooped using a spade and taken to the nursery for individual pricking into polyethylene tubes. Care should be taken to avoid disturbing intact small wildings which resemble a mass of grass in the field. Small wildings of bamboo that are pricked into tubes and kept under shade generally establish well. This method can raise many seedlings.

Once in the nursery and under shade, watering can be done regularly using a fine rose-can. Most likely establishment would be poor due to disturbance of the rooting system during the uprooting from the forest.

Vegetative Propagation

When seeds or wildings are not available, bamboos can be propagated vegetatively. This offers a better source of planting material. Offsets (rhizome with attached section of stem) are commonly used but their extraction is laborious and time consuming, and it is difficult to collect large quantities of planting materials.

During extraction, damage may also occur to the roots, buds and rhizomes of mother clumps. Offsets are bulky and also difficult to transport. Only small annual planting programmes may therefore be possible when using offset materials.

Use of culm cuttings is a viable alternative and has several advantages. Multiplication of several clumping species is possible by this method. When outplanted, vegetative materials raised from cuttings develop to clumps much faster than offsets and even seedlings. The local species of

bamboo, *Yushania alpina* and *Oxytenanthera abyssinica*, have however proved difficult to propagate in this manner.

Using Culm Cuttings

- Good cuttings are obtained from 2 to 3 years old culms of healthy clumps.
- Double node or triple node cuttings are then prepared from the cut culms. The cuttings should be made leaving a space of 5-7 cm away from the nodes. A sharp cutting knife is necessary. For bamboos with thin walls the use of a saw is recommended to avoid splitting of the cut ends.
- The best culm cuttings are generally those that are obtained from the lower and thicker part of the culm, which has the vigor to generate roots and shoots. Successful rooting and shooting is generally harder to achieve with cuttings from the upper and thinner part of the culm.
- It is essential that the cuttings have either buds on the culm nodes or buds on the culm branches. All branches and leaves of the cutting should be cut off down to the first or second branch node.
- The cuttings should then be buried 6 – 10 cm horizontally on a raised nursery bed prepared with a light soil and sand mixture (Figure E2). For some species, there is a higher rate of success when a section of the branch with a bud is left emerging vertically from the ground. Buds at the nodes or branches should always be placed on the sideways or facing upwards and never downwards. Under warm or hot propagation conditions, buds facing downwards will normally not grow.

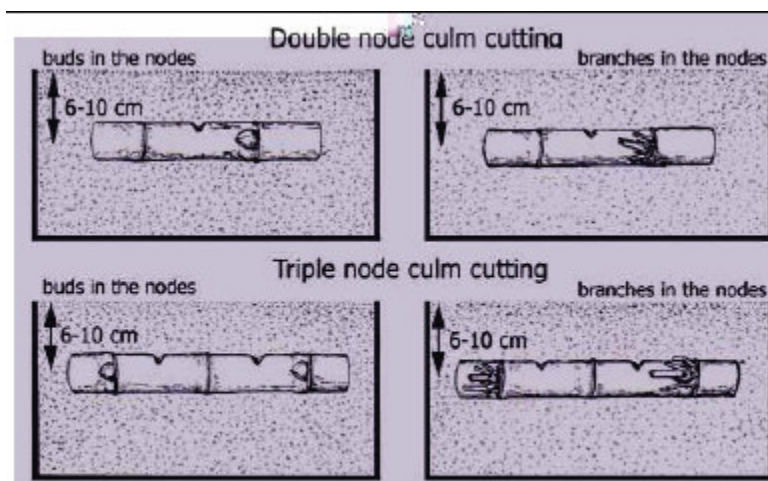


Figure E2 Planting depth

- Remember that for many species, the propagation success rate by culm cuttings can be difficult or very low. As for the local species, *Yushania alpina* and *Oxytenanthera abyssinica*, the success rate is extremely low.
- For many species, the rate of rooting and sprouting of cuttings can be enhanced by some form of treatment. For these, an opening of about 2 cm in length and 1 cm in width is made in the centre of the internodes (Figure E3).



Figure E3 Culm enhancing treatment

- The most recommended treatment for root induction is the use of 1-Naphthalene acetic acid (NAA). This is prepared by dissolving 10 g of NAA in 250 ml of ethyl alcohol (95 %) in a container and stirring the solution gently. The solution is poured into a clean container and water added to make up 100 litres. Stir thoroughly to mix. The final concentration will be 100 mg/l of water or equivalent 100 parts per million (ppm). This quantity of solution is sufficient to treat 1000 cuttings. Small volumes can be prepared by use of equivalent amount of NAA.
- Pour about 100 ml of the solution into the culm cavity through the opening using a wash bottle or any other convenient apparatus to avoid spillage (Figure E4). Note that culm cuttings should be treated with NAA as soon as possible (preferably the same day). If this is not possible due to distance from the extraction site, the cuttings may be preserved by keeping them in moist sawdust, but for no longer than 3 days.



Figure E4 Pouring Solutions into culm

- Close the hole by wrapping and tying it with a polythene strip, ensuring that the wrapper is tight to prevent the solution from leaking (Figure E5).



Figure E5 Wrapping the hole

- The cuttings are then transferred into a raised 1-m wide nursery bed filled with a mixture of soil and sand. The cuttings should be placed horizontally across the nursery bed, with the opening facing upwards (Figure E6). One week prior to planting, the nursery bed is drenched with an effective insecticide (e.g. Aldrin or any other) and a fungicide to prevent termite and fungal attack respectively.

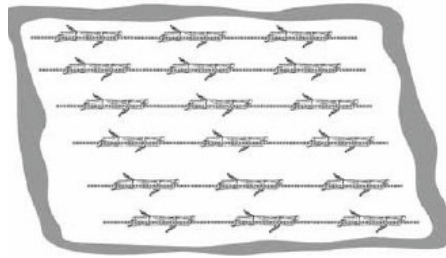


Figure E6 Plantation arrangement

Using Multiple Node Culm Cuttings

- Using the same preparation methods described above, culms cuttings of more than three nodes maybe used for propagation. This is especially successful with species that are easy to propagate. The preparation and arrangements in the propagation beds would be as illustrated in Figure E6 only that the culm cuttings are continuous. In preparing these long cuttings, great care has to be taken to avoid damaging the buds. These multiple node culm cuttings are then buried 6-10 cm below ground and incubated for a length of time to facilitate shoot and root development.
- In cold climatic conditions, roof cover with polythene sheets on top and sides improve the temperature and humidity levels, giving better results for the multiple node cuttings. Furthermore, covering the top soil during the incubation period with polythene sheet reduces evaporation and the frequency of watering the buried culms.

Using Offsets

At the onset of the rainy season and just before the emergence of new shoots, offsets can be obtained from bamboo stands as outlined below:

- Dig out about 30-60 cm below ground for a rhizome of one to two years old culm (for the indigenous bamboo). This can be recognized by the dark green colour and smooth downy stems.
- Once a rhizome is exposed, cut back the aerial culm to 60 cm in length and cut the rhizome off from the parent clump. Avoid injuring the junction of the culm and rhizome and the underground dormant buds at the base of the culm (Figure E7).

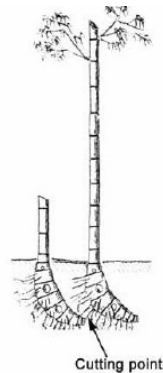


Figure E7 Point of separation of offset

- Extracted offsets should be transported to the planting site without any delay (preferably the same day or the next) and planted immediately.

Using Tissue Culture Plantlets

Tissue culture (TC) is an essential method of propagating certain plant species on a large scale. Commercial TC production is done in laboratories that need to produce and sell mass quantities of plants in order to be economically viable.

Presently, only a few commercial tissue culture labs around the world produce bamboos. A very important step prior to TC is the selection of elite mother plants with desired characteristics. When bamboos are micropropagated from the tissue of a mature plant, the result will be a clone of the mother plant. On the other hand, when seeds or the tissue of young plants are used as propagules, the properties of the resultant clones will not be predictable.

TC bamboo plantlets are small and generally more vigorous than bamboos propagated by more traditional methods. They can be grown to a size of up to 50 cm and planted into the field. Alternatively, they can be further subdivided by means of rhizome division. Mass propagation of small tissue culture plants is easily achieved and much less labour intensive than propagating large cuttings. Each TC plant can be multiplied into 4 to 6 plants within a year. This allows for a rapid development of nurseries stocks. When effective nursery management techniques are applied, an investment of, for example, 10,000 young TC plants supplied in the form of rooted

plugs can be easily multiplied by division of small plants to produce 40,000 to 60,000 planting materials in one year.

Bamboo produced by TC may be widely used to develop large scale industrial plantations for timber, biomass, or pulp and paper. Cloning bamboo plants with superior traits opens opportunities for achieving a better quality crop, either in culms or in high quality edible shoots.

There are two indigenous species of bamboo in Ethiopia, *Oxytenanthera abyssinica* and *Yushania alpine*. They can both be propagated by using rhizome offset, which is labor intensive, or by using seeds that can be found from natural sources in Ethiopia, Sudan, and other countries.

E4. NURSERY TECHNIQUES AND MANAGEMENT

Nursery Layout

Growing plants in a nursery becomes more efficient when the nursery is well organized in straight rows and blocks that are separated by paths. Each block or section should be clearly demarcated and small signboards on the ground should indicate the botanical name of the plants in each location.



Figure E8 Bamboo nursery

Since different species of young bamboos are not easily identifiable or distinguishable from each other, it is advisable to label or tag each and every plant. This obviously implies extra costs but it reduces the risk of mixing up species in the nursery. It also facilitates the sales and distribution of plants and allows planters to distinguish the young plants when they are eventually taken to the field for planting.

Labeling

When labeling the plants, it is advisable to use a coding system that not only refers to the species, but also to the provenance of the mother plant.



Figure E9 Labeling

Separation of Seedlings

When propagating by seed, it is advisable to place the seedlings of a particular species in a separate nursery block or location. Seedlings should be separated from plants of the same species that were vegetatively propagated. The reason for this is that it is hard to tell if the seeds really are of the species. Seed suppliers make mistakes and sometimes packets of seeds are marked incorrectly. All precautions should therefore be taken to prevent mixing up plants and to allow for a clear identification of plants in the nursery at any time.

Weeding

Weeding in the nursery is essential for the health and vigor of the young plants. Competition from weeds should be minimized.

Shading

Whatever planting stock is used (seedlings, wildings, offsets, or cuttings) shade must initially be provided to protect them from direct sunlight. The shade, mostly of thatch or any other material could be removed during the onset of cool weather.



Figure E10 Shading

Watering

Water is needed by young seedlings and cuttings in beds or polythene tubes. During cold weather, watering may be done once per day. In the dry season, watering should be done twice a day. As a rule, plants in the nursery should be watered regularly.

Treatments

After one month, it is recommended that sprouts from cuttings are treated with some effective fungicide (e.g., Copper Sulphate) to avoid fungal attack. If necessary, farmyard manure may be applied to increase the vigor of the sprouts.

Mass Production (Proliferation) of Seedlings

Growth of bamboo is supported by the development of a system of rhizomes. Establishment of planting materials depend very much on how well the rhizome system of a planting material is developed.

Development of the rhizome system starts early in seedlings and buried cuttings, and at some stage in the nursery and can be separated into several individual shoots. Proliferation is the method of separating developed system of rhizome in young nursery materials into many individuals. Such individuals are transplanted into polyethylene tubes that give them ‘new’ vigour of growth.

Where procurement of bamboo seed is difficult, available seedlings in the nursery are maintained through proliferation (mass production) while still carrying out annual planting programmes. Each seedling with sufficient stems can be cut down the middle and multiplied by 2 (Figure E11). Cuttings are also proliferated through initial separation of sprouted and rooted nodes (Figure E12) done by cutting at the middle. There are transplanted into separate containers and further proliferation can then be undertaken in the same way as seedlings.



Figure E11 Seedling Division

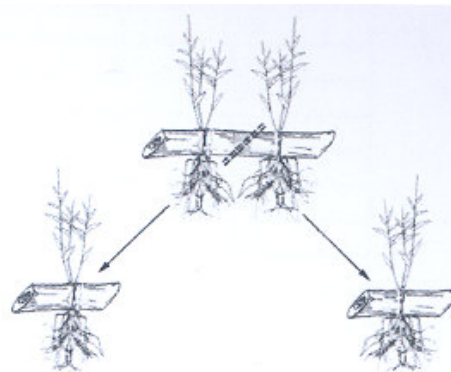


Figure E12 Separation of culm Cuttings

E5. FIELD PLANTING AND ESTABLISHMENT

Selecting the Planting Site

Site selection for various species of bamboo is important in order to enhance management, field operations and healthy growth. The selected area of planting should be one that is not prone to grazing and fire. The planting area should be selected and demarcated early, preferably 2 – 3 months prior to the onset of rainfall in the year of planting. Bamboo prefers loamy and sandy loamy soils, but what is more critical is good drainage since the crop cannot withstand water logging. Sloping land is thus preferable.

Species such as *Dendrocalamus strictus* and *Oxytenanthera abyssinica* are draught resistance and withstand areas having annual rainfall of less than 800 mm. For reasonably good growth most bamboos require annual rainfall of more than 1000 mm.

Plantation Layout

It is important to plan the field layout so that harvesting and hauling of culms is facilitated when the clumps have matured. Planning the field layout in north-south rows is advisable to have an even distribution of sunlight in the plantation. Planting in lines and rows makes management of the plantation easier. The direction of rows and lines should however be planned with full consideration of the characteristics of the terrain. This is especially important when intercropping is to be done in slopes or hillsides. When furrows are ploughed for cash crops between the bamboos, they should be done across the slope, following the contour of the land, and never in an uphill-downhill direction. Furrowing across the slope will prevent the water runoff and thereby control erosion.

A well planned field layout is essential to facilitate the management and enhance the yield of a bamboo plantation. Field layout should take into account the habit and size of the bamboos, such that small species are spaced more closely and large species are afforded wider spaces. A spacing of 4.5m x 4.5m to 5m x 5m may be sufficient for many bamboos. For larger species, spacing should be widened and plants per hectare should be reduced, especially when the objective of the plantation is to harvest bamboo timber. Spacing of up to 10 x 10m (100 clumps/ha) are suitable for large bamboos; wider spacing will allow the clumps to reach their full potential.

When determining the spacing of plants, it is advisable to provide extra space between rows. The spacing of plants in-line may be reduced while the spacing between-lines can be increased. The aim is to have easy access and mobility between rows of clumps so that felled culms can easily be stacked and hauled to the farm gate.

The following table (Table E1) shows spacing that may be considered for small, medium, to large bamboos.

Table E1 Plant spacing for plantation

Plant spacing (m) and plants per hectare		
In line	Between Lines	Plants Per hectare
4	5	500
4	6	417
5	6	333
5	7	286
6	7	238
6	8	208
7	8	179
7	9	159
8	9	139
8	10	125
9	10	111
10	10	100

If the main purpose of the plantation is to cultivate edible shoots, the spacing can be reduced significantly. Since most of the new shoots will be harvested, only a few shoots are left to grow into mature culms. A well maintained bamboo clump that is thinned down to about 15-20 culms of various ages will vigorously direct the plant's energy towards the production of new shoots. Thinning the clump also implies that it will require less space than it otherwise would.

Site and Ground Preparation

The preparation of the plantation site should only begin after a plantation layout has been clearly planned and defined.

The planting site must be cleared of bush, grasses and other unwanted vegetation. Clean cultivation may also be carried out especially where intercropping of bamboo with other crops is to be done.

After ground clearing, planting spots are dug at spacing suitable for the species to be planted, in accordance with the plantation layout and design. The size of the planting holes will depend on the type of planting material as well as on rainfall and climatic conditions of the planting site. As a rule, larger and deeper planting holes are always better and allow for easier establishment of newly planted bamboos. Usually holes of 60 cm diameter and 60 cm depth should be dug around each stake in areas of medium to high rainfall. Well rooted seedlings or TC bamboos may be

planted in small holes of 30 cm diameter and 30 cm depth. Wider planting holes of up to 1 meter in diameter allow for improved micro-catchment and are preferred in areas where annual rainfall is less than 1000 mm. In all cases the holes must be refilled with soil up to 10 cm below the ground surface. Where necessary mix up to 2 kg phosphoric fertilizer or organic manure in the top soil of each pit. Filling should be completed one month before the rainy season.

Field Planting

- Seedlings should be transported at the onset of the rainy season to ensure good survival. The rains also keep the soil moist enough to provide them with enough water.
- Planting of container or potted transplants from the nursery should be done immediately at the start of the rainy season.
- For offsets removed from the forest, planting must be done the same day with a maximum delay of one night.
- When planting, the potting material (plastic or tin containers, polyethylene bags, etc.) should be removed before placing the seedling in the planting hole.
- The rhizome portion of the offset should be placed 10-20 cm below the ground level and covered with soil.
- After placing the plant (either seedling or offset) in the hole, cover with soil and always lightly press the soil around the plant.

E6. PLANTATION MAINTENANCE AND HARVESTING

Proper maintenance and protection of the plantation is highly important. This involves replanting, plant protection, weeding, general tending and sustainable harvesting of culms (bamboo stems).

Harvesting

The clumping habit enables the plant to regenerate naturally after harvesting: Harvesting of bamboo is therefore through selection rather than clear felling.

The planted area should normally be ready for first harvesting in about six to eight years. Thereafter, cutting of mature stems can be done at intervals of four or more years.

The cutting cycles and methods of extraction of stems from a bamboo clump entail an important management system of the entire bamboo plantation. Success or failure of sustainability of crop production will therefore depend on how best stem extractions are carried out.

Cutting Cycles and Methods of Cutting

After the first cutting in a plantation, subsequent selective extraction of bamboo stems should be done at intervals of 4 years. This cycle of cutting is considered suitable for a number of clumping bamboo species.

Unless properly managed, clumping bamboos tend to become congested, resulting in deterioration both in quality and in quantity. It is difficult to extract bamboo from congested clumps. If left untended, clumps of some species become extremely congested.

Congestion should never be allowed to occur in a clump. Clump congestion decreases the productivity of the clump and the quality of the bamboo culms.

Cutting Rules

The following bamboo cutting rules are to be followed for a well established bamboo area.

- Culms growing on the periphery of the clump should not be cut. Cutting should be restricted to the oldest culms in the centre of the clump.
- All dead and dry culms should be cut and removed.
- All broken, live stems, less than 2.5 m in length, should be removed except in clumps containing less than 10 culms. In the latter case, even shorter broken culms may be retained for support of new culms.
- Heavily congested clumps may not be salvaged to productive state and should be clear-felled.
- Current year's and one-year old culms should never be cut unless in cases where they are curved and twining around other culms or are infested by disease or insects.
- The number of older culms retained should not be less than the number of current year's culms.
- Rhizomes should not be dug out.
- In order to avoid future congestion, all clumps should be worked, even though they may not produce usable or saleable material.
- Culms should be cut between 15 and 45 cm from the ground, but not below the first prominent node above the ground.
- Cutting should be made with a sharp tool-bill-hook, a sharp panga or saw so that the stump is not split.
- All cutting debris should be collected and removed away from the clump.
- Lopping of bamboos should be prohibited.

- No cutting of culms should be done during the growing season, i.e. during the rains. Culm cutting should be done only during the dry seasons.
- In case of sporadic or gregarious flowering, all flowered clumps which have shed their seeds should be clear felled.
- The areas under bamboo should be strictly fire-protected.

It is necessary that sharp implements, are used in order to avoid splitting of stumps and the cut culms. A long sharp knife or preferably a curved saw may be used

E7. POST-HARVEST TREATMENTS

Methods for Protecting Bamboo

Bamboo poles are susceptible to decay and attack by fungi or insects especially powder post beetles. Such attacks give bamboo low natural durability. One way to extend the life of bamboo under use is through preservation treatments. Processing and construction methods may also minimize attack by fungi and insect.



Figure 6. 2 Bamboo Protection after harvesting

When bamboo culms have been preserved, and particularly when they will be used for construction or for value added products, it is strongly advisable to store them in an elevated and covered area to protect them so that their quality can be maintained.

Techniques used to increase the durability of bamboo include non-chemical and chemical methods. The most useful and economical methods are listed below.

Non-Chemical Methods

Clump curing: culms are cut at the bottom, but are left standing on the clump for some time with branches and leaves still on. Because the assimilation of the leaves still goes on, the starch content in the culm is reduced and as a result, the durability against infestation by borers is increased. This treatment does not influence attack by termites or fungi.

Smoking: culms are stored above fireplaces inside houses for some time so that the smoke blackens the culm.

Due to heating, the starch within the stem cells may be destroyed. In Japan, the bamboo materials are kept in a heating chamber at 120 -150° C for 20 minutes. The treatment is effective against insect attacks.

White-washing: bamboo culms and bamboo mats for housing construction are often painted with slaked lime (white wash). This delays water absorption, leading to a higher resistance against fungi.

Plastering: cow dung is mixed either with lime or with mortar and plastered onto the surface of bamboo. This is a common method used in the construction of bamboo houses.

Soaking in water: Freshly cut, green, culms are put into stagnant or running water or mud for several weeks.

Subsequently, the bamboo is dried in shade. During the soaking period, starch is reduced and the method therefore improves the resistance against borers which are usually attracted by the high amount of starch in bamboo culms.

Simple construction method: In constructions using bamboo, the upright culms that provide structural support should be elevated on stones, cement, or concrete blocks, and never directly on the bare ground or soil. This will reduce the risk of rotting and insect attack. Painting the culms with water repellent formulations helps to reduce mould.

Chemical Preservation Methods

Chemical preservation methods of bamboo generally provide more effective protection than non-chemical methods, but are not always economical. The following treatments are used.

Fumigation: application of methyl bromide or some other chemical to bamboo for insect control.

Steeping or sap displacement: green bamboo culms are allowed to stand vertically in a container of preservative solution till adequate chemical is picked up. At times, the culm may be freshly cut with branches and leaves on.

The open-tank treatment: culms prepared to size are soaked in a solution of a water soluble preservative for several days. The solution gets into the culm by diffusion through the ends and partly through the sides.

Where a big drum is not available-due to cost limitation, a trough in the ground can be used as follows:

- Dig a pit measuring 4 to 5 m long, 60 cm wide and 1 m deep. Line the pit with plastic sheet, holding it firm with posts or stones at the surface of the ground.
- This pit will serve as the container of the chemical solution and as the dipping tank for the cut bamboo poles.
- The poles are left in the preservative for several days.
- It is always advisable for the workers to wear gloves, waterproof aprons, and protective masks as precautionary measures.

Butt treatment: the bottom part of green bamboo or dried bamboo is immersed in a container of preservative, for example, an old oil drum. The culms are left for about one week. The open-tank and the butt methods are effective, economical and more popular.

Using these methods, 10% Copper sulphate solution extends the service life in the ground extensively. For out-of-ground contact poles or strips, treatment with 10% boric acid will give extended service life.