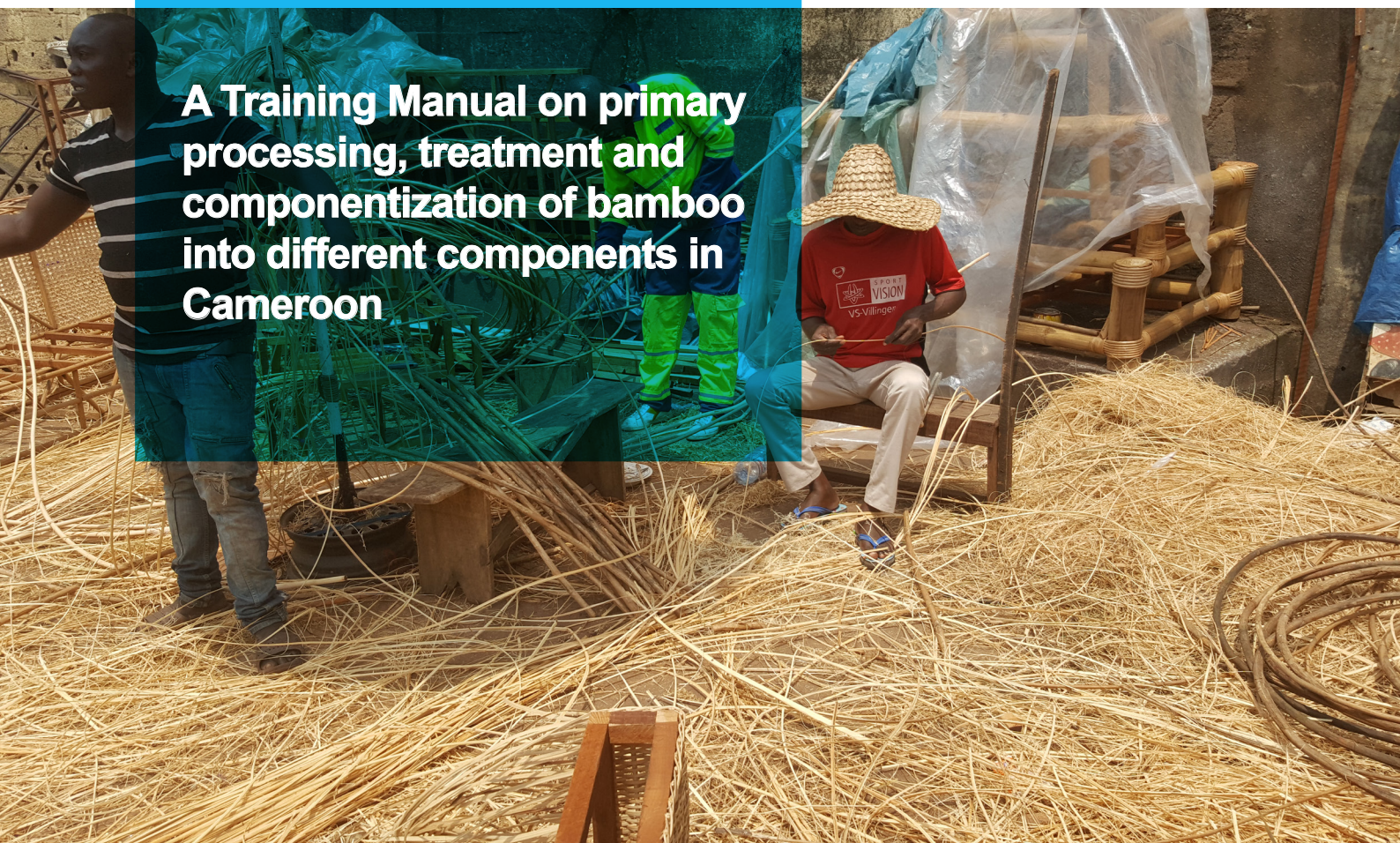




The Inter-Africa Bamboo Smallholder Farmers Livelihood Development Programme (Cameroon, Ghana, Madagascar and Ethiopia)

**A Training Manual on primary
processing, treatment and
componentization of bamboo
into different components in
Cameroon**



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PREFACE

Bamboo grows almost everywhere, even on soils with low fertility in tropical, subtropical and mid-temperate zones. Bamboo is a multipurpose plant that is currently used in our day to day life. It plays both direct and indirect roles in the livelihood of people around us. Bamboo influences livelihood directly via its socio-economic potential and indirectly through the role it plays in environmental protection. Bamboo has a great socio-economic impact on the sustainable development of many countries. Nowadays in Africa and particularly in Cameroon, experiences in bamboo products are still limited to bamboo furniture from handicraft even though the last 20 years has been a turning point in bamboo industrialized products. Indeed bamboo is now seen as a timber substitute. Its rapid growth rate and capacity for sustainable harvesting increases the demand for its products. Recent developments have created new employment opportunities in the bamboo handicraft sector (Bamboo farmers, bamboo collectors, bamboo culm sellers, bamboo culm transporters, bamboo processors, bamboo product sellers).

Bamboo has enormous potentials for socio-economic development; this gives place to the development of an international bamboo trade and market. It is exported worldwide as raw material, semi-finished and finished product. The bamboo sector can bring extra revenue to African countries via the development of some industries for bamboo processing into a variety of industrialized products. Bamboo is also used in the pharmaceutical domain for the production of drugs and cosmetic products. Its shoots are equally used in Asia as a vegetable (food). Bamboo positively impacts the environment. It can replace wood and as such reduces pressure on the demand for timber, thereby encouraging forest protection. Moreover, bamboo contributes to soil protection and has a great capacity to sequester carbon through its canopy and litter, hence reducing soil evaporation and erosion, limiting landslides and contributing to the restoration of soil fertility. Bamboo also purifies water and provides a source of energy. It can be used to produce both the wood fuel and charcoal for cooking and heating.

I. INTRODUCTION

Bamboo is not a tree, it is a grass plant from the family called Poaceae, having about 1,600 species worldwide. Bamboos grow in the tropical and subtropical regions of Asia, Africa, and Latin America. However, the growth rate is dependent on the soil type and climatic conditions, as well as species. Bamboo is considered as one of the fastest-growing plants on earth (with an average growth rate estimated at 26 cm per day). Like grass, bamboo reproduction is rapid. It can be done via vegetative and seed propagation. Bamboo culm height can reach up to 40 meters, with the diameter ranging from 1 mm to 30 cm. It is a sustainable and renewable natural resource which is used as construction material, for the manufacturing of furniture, textiles and as a food source. Given its numerous usages, bamboo provides an alternative to wood which could reduce pressure on our forest.

To further engage bamboo smallholders into industrial bamboo processing (**Module I: Bamboo primary processing**), it is necessary to demonstrate the importance of bamboo treatment before processing (**Module II: Bamboo treatment technics**) and its componentization (**Module III: componentization of bamboo into different components**).

Module I is designed to build the capacity of bamboo smallholders on bamboo harvesting and post-harvesting technics. Module II will illustrate bamboo non-chemical (traditional) and chemical treatment methods. **Module**

III provides information on the different bamboo components and usages.

1. The main objective of the training manual

This training manual aims to build the capacity of bamboo smallholders in order to further engage them in the bamboo processing industry in Cameroon.

2. Specific objectives of the training manual

1. To build the capacity of bamboo smallholder on bamboo harvesting and post-harvesting technics.
2. To engage bamboo smallholders into bamboo treatment methods.
3. To inform bamboo smallholders about the different bamboo components and usages.

3. Expected Outcome

1. The capacities of bamboo smallholders on bamboo harvesting and post-harvesting technics are improved.
2. Bamboo smallholders are engaged in bamboo treatment methods.
3. Bamboo smallholders are informed about the different bamboo components and usages

4. Target groups

This training manual targets Bamboo smallholders (Men and Youths) from different towns (Douala, Yaoundé, and Mbalmayo) in Cameroon where bamboo is being processed, who will serve as a source

of inspiration in their communities during and after the implementation of the project by contributing in the processing of quality bamboo products in Cameroon.

II. METHODOLOGY

The methodology used will be participatory and will involve the participants taking full responsibility. Depending on the different modules, interactive presentations will be given. Participants will work either individually or in groups by answering oral/written questions in a workshop designed from their real-life experiences, specially oriented to their knowledge on bamboo processing. Many activities will be based on participants' experiences using questionnaires and discussions. In some cases, there will be collective reflections (brainstorming session) and comments on possible case studies. In addition to these, a practical phase will enable participants to learn how to treat bamboo traditionally and process bamboo into products such as chairs, stools, cups, and musical instruments in groups.

1. Tools needed

Didactic support: printed documents (ToR, training manual, PowerPoint presentation).

Tools: Flip chart, post it, markers, conference paper, digital camera, video projec-

tor, laptop, Dictaphone, saw, cutlass, knife, hand saw, angle scale, measure tape, measure ruler, mallet, hammer, cutting plier, half-round file, chisels, files, marking tool, nose Plier, handheld bamboo splitter, planners, Bench vice, hot air gun, handheld grinder, Vernier Caliper, brushes, power drill and work table.

2. Content of the training manual

This training manual is focused on three (3) modules organized as follow:

1. Module I: Bamboo primary processing.

- Bamboo harvesting technics;
- Bamboo post-harvesting technics;

2. Module II: Bamboo treatment technics.

- Non-chemical /traditional bamboo treatment;
- Chemical bamboo treatment;
- Bamboo culm storage;

3. Module III: componentization of bamboo into different components.

- Bamboo components
- Bamboo handicrafts processing

3. Evaluation of the training

At the end of the training, evaluation forms will be distributed to participants. This evaluation

will be focused on the training organization (strengths and weaknesses), the logistics, the working conditions, the relevance of different modules, the interests of participants, the animation style and the suggestions of participants. These sheets will be analyzed and used to improve each module to better meet the expectations expressed.

III. MODULE I: BAMBOO PRIMARY PROCESSING

1. Bamboo harvesting technics

1. Bamboo culm selection for harvesting

Bamboo selection is very important both for bamboo sustainable management and the production of good quality bamboo products. Bamboo can grow to full length in less than 2 years, the reason why it is considered as the fastest-growing plant on earth and records growth rates of up to one meter per day for some species. Attaining its full length does not mean it can be harvested and used because at this stage, the inside of the bamboo fibers has not fully developed. Three main criteria can be used to identify and select a mature bamboo. The main criteria for selecting bamboo are culm size, culm age, and culm Colour.

- Bamboo culm size varies from one species to another. Young bamboo (1 to 3 years old) is shiny, smooth and has a **bright green** Colour. At this stage, it is not ready to be used.
- 3 to 5-year-old Bamboo has a **dark green** Colour with white spots or powder on the culm indicating the beginning of lichens. This is the sign that bamboo is mature and can be harvested.
- Bamboo from 5 to 7 years old and even more is susceptible to animal attacks and starts to die. In this case, old bamboo will start to **lose its dark green Colour** turning brown with lichens and developing cracks that can be observed on the culm.

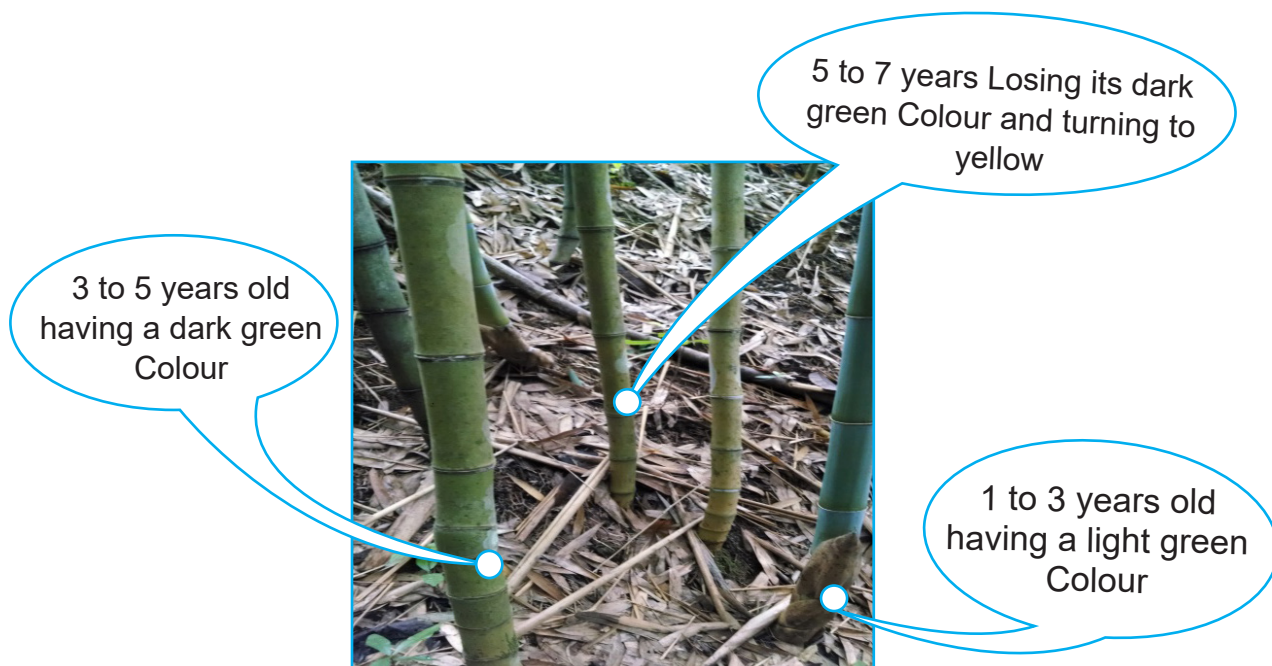


Photo: Yushina alpine different growing stage

2. Bamboo culm harvesting

Harvesting should not be done during the rainy season because during this period bamboos grow well and have high moisture and starch content which makes them susceptible to fungal and insect attacks. Again, when harvesting mature bamboo, we need to take care not to damage new bamboo shoots and plants that emerge during the rainy season as this will hinder regeneration. Therefore, the dry season is the best period to harvest bamboo.

Also, when harvesting bamboo, we need to take into consideration that new culms are produced towards the periphery of the clump as observed in the case of clumping species. Therefore harvesting of mature bamboo culms should be done from the centre to the periphery of the clump. Furthermore, when harvesting *Bambusa vulgaris* for example, we need to harvest only 70% of all mature culms in the given clump, not 100% to ensure natural regeneration.

Mature bamboos are between 3-5 years old, these bamboo age group should be selected for harvesting because at this age

range, they shrink less when drying and its starch and sugar contents are lower, so there is less chance for insect infestation. Mature bamboos are between 3-5 years old, these bamboo age group should be selected for harvesting because at this age range, they shrink less when drying and its starch and sugar contents are lower, so there is less chance for insect infestation. Culms should be cut as low as possible (height), between the first or second node above the ground using a saw or cutlass, leaving only one internode above the ground.



Photo 2: Bamboo harvesting

2. Bamboo post-harvesting techniques

Bamboo moisture content is more than that of wood with similar density. Freshly harvested bamboo when drying contracts and shrinks, this could reduce its diameter and wall thickness. After harvesting all bamboo culms needed, we have to keep the harvested bamboo with all its branches and leaves vertically leaning against another bamboo tree or timber species found on the site with the base part on a stone or other material to avoid direct contact with soil at the harvesting site for at least 3 days for the first drying process. This enables the bamboo culm to lose its humidity progressively through natural ventilation and transpiration via the leaves. This process (Post-harvest bamboo drying via transpiration) reduces the quantities of starch found in bamboo culms thereby reducing the risk of bamboo being infected by fungal.

When coming back to collect the harvested bamboo, the culm branches should be re-



Photo 3: bamboo drying via transpiration

Photo source: bellobamboo.com

moved cautiously without damaging the culm using a knife or cutlass. Also, the culm could be cut using a saw or cutlass to facilitate its transportation to the working area for treatment, storing and processing.

IV. MODULE II: BAMBOO TREATMENT TECHNIQS

Bamboo is a plant which contains starch/sugar, which is a source of food for some living organisms like fungi and insects. Therefore, harvested bamboo culms are highly exposed to fungi and insect attacks. To reduce or control insect and fungi infestation risk, harvested bamboo culms (between 3 – 5 years old) should be treated before processing. This will considerably increase the quality and durability of the processed bamboo products. If not treated before pro-

cessing, the products made out of these harvested bamboos will not last long. Bamboo can be treated traditionally (with no chemicals) and chemically depending on the type of bamboo culm harvested (*Bambusa vulgaris*, *Bambusa vitata*, *Yushina alpine*, *Phyllostachys aurea*), on the bamboo culm status (it is split or whole cane, dry or green), its future application, quantity to be treated and the time available.



Photo 4: *healthy and infested bamboo culm*

1. Non-chemical / traditional bamboo treatment

These are ancient bamboo treatment methods, widely used for centuries by bamboo smallholder farmers in countries where bamboo grows. There are numerous traditional bamboo treatment methods. However, we will look at commonly used methods such as soaking in water or leaching treatment method, bleach and hot air injection treatment method and drying by smoking treatment method.

1. Soaking in water or leaching treatment method

This is a traditional bamboo treatment method commonly used by Asian and Latin American bamboo smallholder farmers. It is the immersing of bamboo culms in a tank (with an outlet for draining) full of water or running water (streams, rivers) to leach starch in bamboo culms. This reduces the starch content in bamboo culms, which makes them less susceptible to insects and fungi attacks and increases its durability.

The following steps are applied when using this bamboo treatment method:

- Bamboo culms after the 3 days drying



Photo 5: *Soaking bamboo in water or leaching* Photo source: bellobamboo.com

at the harvested site, are transported to the treatment area.

- These culms are cut using a saw according to the processing outcome.
- Fill the tank with clean water (if not, use running water).
- Bamboo culm nodes should be punctured (Making a longitudinal hole in the culm) before horizontally immersing them into the water. This is to ease the running of water *through the bamboo culm*.
- Make sure bamboo culms are immersed

completely in the tank or running water by using a load.

- When immersing in a tank with stagnant water, change the water weekly to prevent bacteria propagation and bad odours.
- Bamboo culms should remain soaked in the water for at least 3-4 weeks and pay attention not to exceed 3 months. This could negatively affect the epidermis (skin) of the bamboo having as consequence a decrease in the physical and mechanical properties of the bamboo.
- After about 3-4 weeks, the bamboo culms are pulled from the tank and stacked vertically for bleaching for at least 3 days according to the sunshine intensity.
- These bamboo culms are often rotated twice per day to avoid cracks on culms during periods of intensive sunlight.
- Bamboo culms are ready to be stored for future processing.

This method is recommended for bamboo use in craft making and mat processing. However, bamboo leaching does not guarantee long term bamboo culm protection. This method is efficient to remove starch from the culm and enhance permeability for future treatments.

2. Bleach and hot air injection treatment method

Bleaching is a traditional treatment method frequently used by many bamboo smallholders. It is the drying of bamboo culms in an open space vertically standing. This method enables bamboo culms to lose its chlorophyll (green colour) and to turn into a golden yellow colour. After bamboo bleaching, hot air is injected into the punctured nodes of the bamboo culms. This will make the bamboo culms look more attractive for processing and will also reduce insect and fungi attacks due to less starch content.



Photo 6: Bamboo Bleaching

The following steps are applied when using this bamboo treatment method:

- Bamboo culms after the 3 days drying at the harvested site, are transported to the treatment area.
- Wash bamboo culms with clean water.
- Bamboo culms should be left to dry under the sun for at least 1 week depending on the amount of sunlight at the given period.
- These bamboo culms are often rotated twice per day to avoid cracks on culm during intensive sunlight.
- Bleached bamboo culm nodes should be punctured before injecting hot air into the culms in order to rapidly reduce the humidity left after the bleaching process.
- Bamboo culms are ready to be stored for future processing.

3. Drying by smoking treatment method

Drying bamboo by smoking is one of the oldest treatment methods used by bamboo smallholders in Asian countries. Here, bamboo is placed on a source of heat usually fire. The heating of bamboo will reduce water and starch content, thereby decreasing bamboo moisture content. This protects the bamboo from fungi and insect attacks. The following steps are applied when using this bamboo treatment method:

- Freshly harvested bamboo is trans-

ported to the treatment area

- Bamboo culms should be placed on a fire source, frequently turn/rotate to avoid cracks on culms due to heat intensity.
- Bamboo passed on the fire (smoking) is clean with a dry clean tissue
- Bamboo culms are ready to be stored for future processing.



Photo 7: *Drying bamboo by smoking*

2. Chemical bamboo treatment

Although traditionally treated bamboo reduces insects and fungi attacks compared to the freshly cut culms, these methods do not, however, provide complete satisfaction in the long term. Chemical bamboo treatments are more efficient preservatives used on bamboo culms to protect bamboo products from degradation for many years.

There are a number of methods, however, we will look at commonly used methods such as the soaking treatment method, the pressure tank (“Boucherie”) treatment method and the boiling treatment method using chemicals such as boric acid and borax/sodium borate.



Photo 8: *Borax and boric acid*



1. Soaking treatment method

Boric acid and borax/sodium borate are chemicals that can be used for the treatment of bamboo. A mixture of boric acid and borax results in the formation of disodium octaborate. Borax or sodium borate is a colourless and powdery mineral, which is easily soluble in water. They are insect repellent and environmentally acceptable preservatives compared to other preservatives such as chromate copper arsenate and ammoniacal copper arsenate. The soaking treatment method is the immersing of bamboo culms in a tank (with an outlet for draining) full of water and chemicals to load them with salt. This leaches starch and sugar content in bamboo culms, thereby making them less susceptible to insects and fungi attacks and increases its durability. The following steps are applied when using this bamboo treatment method:

- Bamboo culm after 3 days drying at the harvested site, are transported to the treatment area.
- Wash bamboo culms with clean water.
- Fill the tank with clean water and add the chemicals, then mix up the water to get a solution.
- Bamboo culm nodes should be punctured (Making a longitudinal hole in the culm) before horizontally immersing them into the water solution. This is to ease the flow of water through the bamboo culm.
- Make sure bamboo culms are immerse completely by using a load.
- Bamboo culms should remain soaked in the water solution for at least 1 week.
- After about one week, the bamboo culms are pulled from the tank and stacked vertically to further encourage salt diffusion (the water evaporates leaving the salts inside the bamboo), aired and

sun-dried for at least 3 days according to the sunshine intensity.

- These bamboo culms are often rotated twice per day to avoid cracks on culm during periods of intensive sunlight.
- Bamboo culms are ready to be stored for future processing.

2. Pressure tank (“Boucherie”) treatment method

Boucherie bamboo treatment method is a mixture of boric acid and borax added to water in a pressure tank. This method is the pumping of chemicals using pressure into bamboo culms to quickly and uniformly dry bamboo. The main aim of the boucherie treatment method is to force the preservative into the bamboo tissue.



Photo 8: Bamboo boucherie treatment
Photo source: INBAR

The following steps are applied when using this bamboo treatment method:

- Freshly harvested bamboo culms are used.
- Bamboo culm edge is cut at the node using a saw to ease the connection to the pressure tank and to avoid slipping due to pressure during the treatment.
- Mix up boric acid and borax with water in a container (1.5kg boric acid and 1.5kg borax is sufficient for 30 litres of water), to get a water solution.

- Add the water solution into the pressure tank.
- Connect the pressure tank to bamboo culms, pump the tank to 30 – 35psi pressure and maintain the given pressure.
- Pump the solution into bamboo culms using the pressure for at least 1 hour.
- A container or barge should be placed under bamboo culms to collect the solution at the end of the treatment.
- Bamboo culms are ready to be stored (20 to 30 days) for future processing.

This method is advantageous because it is mostly used to treat large quantities of bamboo, it is portable (can be used directly on the bamboo farm) and takes less amount of chemicals (boric acid and borax) for bamboo treatment.

3. Boiling treatment method

Boiling treatment method is not commonly used by bamboo smallholder farmers. It consists of boiling bamboo culms in a drum with a mixture of boric acid and borax added to water to get a solution. The solution penetrates into bamboo culms by capillary action during boiling. The following steps are applied when using this bamboo treatment method:

- Bamboo culm after the 3 days drying at the harvested site, are transported to the treatment area.
- Wash bamboo culms with clean water.
- Fill the drum with clean water and add the chemicals, then mix up the water to get a solution.
- Place the filled drum on fire.
- Add bamboo culms cut according to the length of the drum vertically.

- Boil bamboos for 3 to 4 hours.
- Bamboo culms should be left to dry under the sun for at least 3 days depending on the amount of sunlight at the given period.
- Bamboo culms are ready to be stored for future processing.

3. Bamboo culm storage

After bamboos have been treated, bamboo culms should be stored for at least 2 weeks (better dry) before processing in a ventilated shelter and not in a closed area. When storing, bamboo is usually stacked either vertically or horizontally. Vertical stacking gives less chance to fungal infection and it is best for storing small quantities of bamboo. Horizontal stacking works better for large quantities of bamboo culms. In this case, we need to stack bamboo on large platforms and place a thick plastic sheet under stacks to prevent fungal infections. The bamboo culms should be stacked based on their size, diameter, and quality.

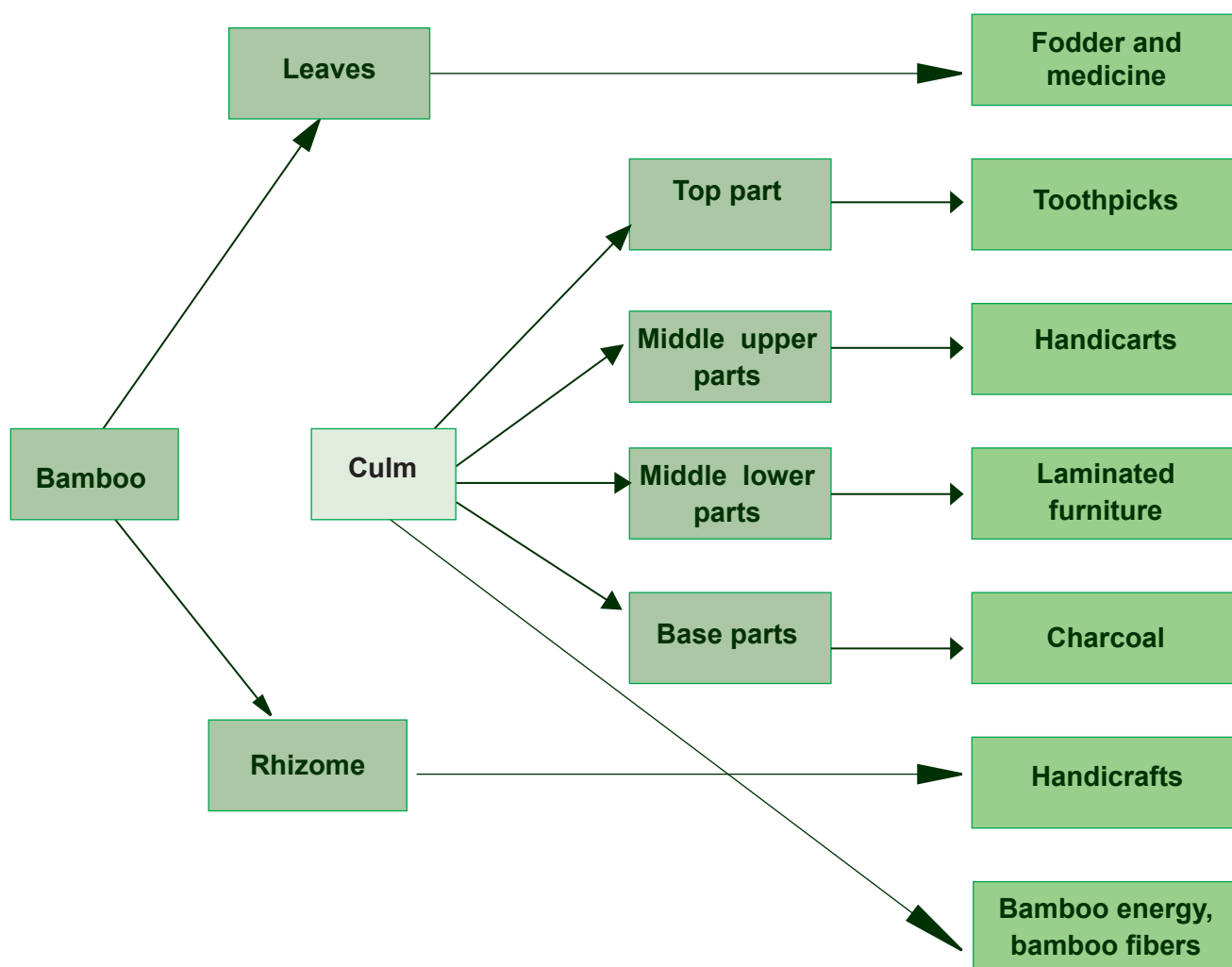


Photo 9: *Bamboo vertical storing (photo source: INBAR)*

V. MODULE III: COMPONENTIZATION OF BAMBOO INTO DIFFERENT COMPONENT

1. Bamboo components

Bamboo is divided into 3 main components, which are bamboo leaves, bamboo culm and bamboo rhizome. All the part of a bamboo culm is useful as illustrated below.



2. Bamboo handicrafts processing

Various bamboo species are used according to the products to be processed. For practical reasons, some bamboo craftworks such as chairs, stools, cups and musical instrument will be processed by participants after treating bamboo traditionally.

1. Bamboo stool

- Processing steps:
- Cut treated bamboo culm according to the length need,
- Bend two identical pieces of the treated bamboo to make the stool frame,
- Scrape out the bamboo culm skin after bending,
- Mark points on bamboo for drilling and drill,
- Cut six identical cross pieces for the seat assembly,
- Reduce the diameter at the end for each to fit tightly into the drilled hole,
- Assemble the seat frame,
- Make 4 legs, mark and drill a hole through each,
- Fix the leg member on the seat frame,
- Fix the tie member between the legs with an adhesive and nail,

2. Bamboo Chair

Processing steps:

- Cut treated bamboo culm according to the length needed,
- Prepare the frame of the chair,

- Make the back rest unit and front leg unit of the chair,
- Make the seat unit of the chair,
- Assemble the chair,

3. Bamboo cups

- Processing steps:
- Cut Bamboo culm at two node edge (an internode),
- Cut the internode into two equalled parts,
- Cut 2 – 3 cm of the bamboo culm and split into 2 equalled parts,
- Fix the 2 – 3 cm split parts using an adhesive on the cut internode.

4. Bamboo musical instruments (Flute)

Processing steps:

- Cut treated bamboo culm according to the length needed,
- drill holes in the bamboo culm piece,
- sharpen one edge.



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