BAMBOO PRODUCTION AND PROPAGATION METHODS

Ben G. Bareja

TABLE OF CONTENTS

FOREWORD

I began to be intrigued with bamboo about 20 years ago. This propelled me into a vigorous search for information on the biology, uses, propagation, farm establishment, and everything having any relation to bamboo production. It was difficult at the time because of my provincial location and the absence of electronic communication. Nonetheless, the publications that I managed to acquire tremendously enhanced my awareness on the environmental and economic potentials of bamboo. In 1993, I authored a continuing program on greening and environmental enhancement which I proposed to my university employer for campus-wide adoption. This proposal included the establishment of a Bambusetum. But it was only in 1998, shortly after leave, that the bamboo collection plan was started. As I wrote this, I always had in my mind my sister's new farm in the province of Sarangani which is yet to be developed under my guidance. It is bounded by a river and a stream with a few clumps of naturally-growing bamboo belonging to four species. The practical advices and recommendations presented here, although specific to bamboo, will also find application in other agricultural crops and in any crop farming system.

BRIEF PROFILE AND USES OF BAMBOO

Bamboo or *kawayan* is a woody perennial belonging to the family of grasses, Gramineae (Poaceae), with unique qualities and versatile uses. The bamboo culm or pole is ideal as an inexpensive source of material for housing and construction, scaffolding, furniture, handicraft, banana props, fishpens, agricultural implements and carts, musical instruments, boat outrigger, pulp and paper manufacture, toys, industrial products such as bamboo tiles and plywood, and many more. It is commonly planted along river banks and

waterways to hold the soil in place and to check soil erosion. The young shoots (*dabong* or *tambo*) of certain species are ideal for food either fresh or canned. Harvesting of culms can be started in 3-5 years. This is a clear advantage even over fast growing trees because of quick return of investments.

Recently, the Philippine government launched the Engineered Bamboo or e-Bamboo Project which aims to supply at least 25 percent of the desk requirement of DepEd. At the forefront of the project are the Department of Environment and Natural Resources (DENR) and the Department of Trade and Industry (DTI) through the Cottage Industry Technology Center (CITC).

In 1997, there was an estimated total area of 3,040 hectares of private plantations of bamboo in the country with varying farm sizes up to 434 ha. Of these, 1,043 ha are located in Luzon while 312 ha are in Visayas. 1,685 ha are in Mindanao, most of which are located in Davao del Norte and planted to *laak* bamboo for banana props. Most large plantations are owned by corporate organizations.

RECOMMENDED BAMBOO SPECIES

There are more than 1,000 species of bamboo worldwide. In 1996, it was documented that there were 62 native and introduced species of bamboo in the Philippines with various growth habits including clump- and nonclump-forming, erect and climbing types. Twenty one (21) of these are endemic or native to the country. Thirteen (13) are climbers and 8 are erect. For farm establishment, agroforestry or engineered bamboo, the following species are highly recommended:

1. Giant bamboo or *apos* (*Dendrocalamus asper*);

2. *Botong*, *bolo, patong or buljuiawa* (*Gigantochloa levis* (Blanco) Merr.);

3.Thorny bamboo, spiny bamboo, *kawayan tinik, kawayan totoo* or *tamlang* (*Bambusa blumeana* Schultes).

4. Bayog (*Bambusa* sp. but formerly named *Dendrocalamus merrillianus*)

Other important species which are grown in private plantations are laak (*Sphaerobambos philippinensis*), kawayan-kiling or lunas (*Bambusa vulgaris*) and buho or bagakay (*Schizostachyum lumampao*).

Machiku (*Dendrocalamus latiflorus*), which is an introduced species, is internationally known for vegetable (shoot) production.

Two other introduced species, a mottled bamboo and the buddha's belly (*Bambusa ventricosa*) which has short, swollen internode, are gaining popularity for the *bahay kubo* and furniture-making industry.

PLANT PROPAGATION AND NURSERY MANAGEMENT

Asexual Propagation Methods

Bamboo can be propagated through sexual or asexual methods. Sexual method is with the use of seed, as in annual crops like rice, corn and beans. However, this method is unreliable and rarely known because seeds of bamboo are not available. In fact, only a few people are aware that bamboos produce seeds. It may take a century or even more for certain species to produce seeds, and the exact period for this to occur is impossible to predict.

Asexual propagation is with the use of vegetative planting materials such as clump division, rhizome, offset, culm, culm cutting, branch cutting, marcotted culm and branch cutting and twig cutting. The protocols for *tissue culture* or micropropagation of some species of bamboo have been established but this method is beyond the means and expertise of ordinary farmers. The same is true for *airponics* which induces rooting without soil under oxygen-rich condition.

Propagation through asexual or vegetative means can be done anytime of the year provided that there is sufficient supply of water and the planting materials are protected against dessication and excess heat. The following methods are available to any conventional nurseryman and farmers:

a. Clump Division

This method will ensure maximum survival. It is preferred when there is a need for rapid production of planting materials or when the planting material is intended to be planted immediately in another site without undergoing the tedious and time-consuming process of producing potted, rooted seedlings.

This is ideal for clump-forming species which are difficult to propagate using culm and branch cutting like *buho* or *bagakay* (*Schizostzchyum* spp.). It is also widely applied in the propagation of ornamental species such as hedge bamboo (*Bambusa multiplex*) and dwarf buddha's belly (*Bambusa ventricosa*), especially when the mother plant is potted.

The procedures are easy and basically the same as those employed in dividing any tufted grass like lemon grass or tanglad (*Cymbopogon citratus*) into basal segments having several tillers. But in thick clumps of bamboo with fully grown culms, a digging bar

consisting of a G.I. pipe as handle with a piece of sharpened, flat truck spring welded at one end is needed to separate a segment of the clump. Immediately after separation from the mother clump, the planting material should be planted with the culms generally shortened or potted into appropriate containers.

This method will allow only a limited number of planting materials to be extracted from the mother clump. It will also affect the productive capacity of the remaining clump.

b. Basal Culm Division or Offset

This method consists of the production of planting materials using rhizomes and portion of the culm. It is commonly used in nonclump-forming or running bamboos but it can also be applied to clump-forming species with loose clumps where individual rhizomes or offsets can be conveniently separated from the mother clump. Most important erect bamboos in the Philippines are clump-forming types.

The procedure involves digging undergrown to expose the rhizome or basal parts of the culm and separating it by cutting through the point of attachment with the mother clump. Proper care should be exercised to prevent injury to the rhizome.

c. Culm

Culms with developed branches can be used as planting material either whole or cut into long segments with multiple number of nodes. This method is effective in bamboo species which can be easily propagated using culm cuttings such as giant bamboo, bayog, kawayan tinik, kawayan-kiling and botong.

Ideally, the culm should be 1-2 years old. The branches should first be removed with the use of a sharp bolo or pruning shear but the basal, swollen portions attached to the culm in each node are retained uninjured. It is important that these are retained because it is from these organs that shoots and roots of the new seedlings will develop.

Practical Method 1*: It is difficult to identify culms of certain ages, unless blanket harvesting is practiced or tagging is done. For practical application, harvest culms for propagation with detached leaf sheaths and with abundant fully developed branches.*

Practical Method 2: *Observe extra care in cutting down a leaning bamboo culm. The culm will likely drop suddenly without being disconnected at the uncut portion. The culm may split starting from the cut and thrust upward with tremendous force and hit you. To prevent this,* ***always make the first cut at the inner angle of slant.***

The best place to propagate the culm is along a sandy river bank at a time when there is no expectancy of floods for the next two months. This is to prevent the culm from floating and being carried downriver or be covered by thick debris. This propagation bed

has the advantage of keeping the culm moist without the necessity of supplying water manually. Otherwise, any flat portion of the farm which is not waterlogged can be utilized.

A furrow should first be dug on the sand bed or ground with a depth that will be sufficient to bury the culm with about 5 cm (2 in.) of soil cover at the top. If many culms are to be propagated, linear furrows are made which are parallel to each other. The entire culm, or long portion of a culm, is laid horizontally at the bottom of the furrow with the nodes at both sides (not bottom and top). Curbed culms will have to be straightened to fit into the furrows. Then the removed sand or soil is shoveled back into the furrow. The furrow should be kept moist but not waterlogged.

Practical Method 3: *To straighten a culm, remove a portion at the convex side (outside of a curve) with the use of a bolo then apply pressure.The same technique can be used to bend an otherwise straight culm.*

About 2 months from planting, or even earlier depending on the maturity of the branches, the culm will have shoots with sufficient number of roots developing from the basal nodes. The presence of roots can be ascertained by digging and exposing the buried basal portion of the shoot. Shoot emergence is not a reliable indicator of rooting.

The culm is then dug up and the rooted shoots are separated by cutting or sawing the culm to the left and right of the rooted portion. Short segments of the culm are retained at both sides of the base of the shoot.

These seedlings can be directly planted in the field. However, to ensure maximum survival during outplanting, these should be potted into appropriate containers and given intensive nursery care.

Practical Method 4. *Culm propagation method is best applied along river banks to prevent the soil from caving in during floods. An entire culm can be propagated by burying on the ground, following the route of the river during the rainy season. Shoots will develop from closely spaced nodes. Without being disturbed by digging, each shoot will grow fast and produce more shoots. Within a short time and with less labor, you will have a thick hedge of bamboo protecting the river bank.*

d. Culm Cutting

A culm cutting is a segment of the culm having one or more buds or shortened branches. Culm cuttings are widely used to propagate various species of bamboo belonging to the genera *Bambusa* (e.g. kawayan-kiling, kawayan tinik and bayog), *Dendrocalamus* (e.g. giant bamboo) and *Gigantochloa* (e.g. botong).

Traditionally, farmers propagate kawayan-kiling and botong using culm cuttings with multiple number of nodes bearing buds. The lowermost nodes are inserted into the ground and after some time the exposed buds will sprout into branches.

This method is also appropriate in order to maximize utilization of mature culms which are harvested to be marketed or to be used for any specific purpose. After harvesting of the culm, the terminal portion which is normally discarded can be used as a source of starting materials for propagation.

For mass propagation, the use of single-node cuttings with whole culm is recommended. This method will maximize the production of planting materials from a single culm. The culm to be used should be one with detached leaf sheaths, with fully developed branches. Such branches have fully expanded leaves.

All branched portions can be used except those at the tip of the culm which are too thin, subject only to limitation that bigger portions of the culm will need big potting containers. To be able to use smaller pots, the use of single-node cuttings with split culm pretreated with rooting hormone can be an alternative.

To prepare single-node culm cuttings, the following steps are recommended:

1. Shorten the branches to 2 to 3 nodes from their points of attachment to the culm.

2. Cut the culm or saw about 2.5 cm (1 inch) below each node. It is important that only a short portion of the culm internode is retained below the base of the branch. An excessively long internode will prevent the branched node from being inserted into the potting container.

3. Where multiple number of branches emerge from a node in the culm, excess and small branches should be removed with the use of a pruning shear. Multiple branches will make insertion into the potting container difficult.

4.The final single-node culm cutting has a culm portion (internode) which is longer at the top and short at the bottom below the node, with one branch having 2-3 nodes.

As a rule, the prepared culm cuttings should be planted immediately. If delay cannot be prevented, they should be soaked in water to prevent drying up.

In planting, the culm cutting is inserted into the potting container (preferably a perforated plastic bag) with the branched node downward. The pot is then filled with sandy soil until the base of the branch is fully covered. It is essential that the base of the branch is completely covered with the potting medium because it is from this part that roots will emerge. As much as possible, the position of the cutting should be adjusted in a way that the culm slightly slants while the branch is more or less erect. The soil-filled bag is dropped several times to the ground to compact the soil slightly and to eliminate hollow spaces. More soil is added until a short distance (about 1.25 cm or half inch) below the top of the pot. This unfilled top portion of the pot will trap water before draining downward. Water is then poured in and allowed to fully permeate the potting medium.

The potted cuttings should be kept moist throughout the propagation period under shade and high humidity. These conditions are naturally present in some locations especially during the rainy season, otherwise the cuttings should be kept in a plastic tent

following the *kulob* or *bukot* system. For more convenience, it is recommended that a humid or non-mist *propagation chamber* be constructed, either movable or permanent.

The culm cuttings should have sufficient roots after about 2 months and ready for gradual hardening.

e. Branch Cutting

This method is ideal for thick-walled bamboo species such as *bayog*, giant bamboo and buddha's belly. In these species can be seen branches which produce plump, beak-like organs at their bases which later develop into new branches. Compared to other species, these branches have more swollen bases which progressively produce root initials as they mature. These branches can be easily separated from the culm with the use of a sharp bolo, chisel, hacksaw or crosscut saw, reduced to 2- to 3-node cuttings and inserted into the potting medium. Care is basically the same as in single-node culm cutting.

Comparatively, this method is more advantageous than culm cutting because the culm remains useful. However, not all branches are suitable for propagation at one time. For rapid and maximum production of rooted cuttings, only those with pronounced root initials at the bases should be used.

Kawayan-kiling can be propagated following this method. Branch cuttings can be used even without visible root initials.

f. Marcotting or Air Layering

Pre-rooted single-node culm cuttings can be produced by securing a sheet of thick plastic sheet around the culm including the basal portion of a branch and inserting a rooting medium (preferably a moist moss) in it. The steps involved are the same as in conventional marcotting except that there is no need for girdling or wounding. The top of the wrapping may also be allowed to remain open for convenience but frequent watering will be necessary which is difficult in the upper portions of the culm.

Marcotting is also applicable in producing pre-rooted branch cuttings. Just like the usual marcotting procedures, a transparent plastic sheet is wrapped around the base of the branch, a rooting medium is inserted, and both ends are tied. When roots are profuse and visible, the branch is separated from the culm, shortened to 2- to 3-node cutting, and potted.

Care of the potted cutting is the same as in other marcots. However, success in producing rooted cuttings will be further ensured if the cutting is raised under shade and high humidity as in single-node culm cutting and branch cutting.

g. Twig Cutting

In *bayog* and buddha's belly, a few secondary branches or twigs are frequently found with pronounced root initials. These can be detached and propagated directly following the methods for branch cutting or prerooted by marcotting.

h. Integrated Mass Propagation Technique

For mass propagation, methods using single-node cutting, branch cutting and marcotting can be applied simultaneously or sequentially in selected species such as those belonging to the genera Bambusa (e.g. *bayog*, *kawayan-kiling*, *kawayan tinik* and buddha's belly), Dendrocalamus (e.g. giant bamboo) and Gigantochloa (e.g. *botong*). The protocol can be used for mass propagation while preserving the culm intact for marketing or for any use.

For giant bamboo, bayog, and buddha's belly, branches with pronounced root initials can be harvested progressively until a few months prior to harvesting of the culm. Thereafter, all branches at the marketable portions of the culm are marcotted for the production of pre-rooted branch cuttings. Immediately after felling the culm, the following steps are recommended:

1. Shorten all the wrapped branches into 2-3 nodes and separate from the culm with the use of bolo, hacksaw or crosscut saw;

2. Sort the wrapped branch cuttings into two groups: rooted and unrooted;

3. Prepare single-node culm cuttings out of the terminal portion of the culm;

4. Plant the single-node culm cuttings in perforated plastic bags;

5. Arrange by group and provide with the necessary nursery care.

Hardening

Nursery grown seedlings should be hardened or conditioned before outplanting. This is an acclimatization process involving the gradual, intentional exposure of the plants to full sunlight and reduced watering. Properly hardened, the seedlings will have better chance of surviving in the field under harsh conditions.

BAMBOO FARM ESTABLISHMENT AND MANAGEMENT

Farm Plan Preparation

As in other plantation crops or any permanent crop which is planned to be established in an already available farm, it is essential that an overall Master Plan should be formulated first before starting with the actual development activities.

The farm plan serves as a blueprint of the step-by-step activities to be followed in developing and managing the farm. Without this plan, there is a possibility that future production will fail or become marginal due to constraints which have not been realized at the inception of the project. These constraints may include, among others, problems on accessibility to, from and within the farm, climatic and soil adaptability of the crop or crops, interplant competition, labor supply, water supply, and farm security against theft and astray animals. Worst, the farm owner himself may be forced to change plans and abandon what have already been accomplished simply because of lack of foresight. However, the farm plan should also consider contingencies and allow flexibility for revision under reasonable circumstances.

Just like in landscaping, it is necessary to conduct environmental scanning or on-farm evaluation prior to the making of a master plan. The evaluation is intended to collect data on the various properties of the farm including its physical features such as sources of water, location of rivers or streams, creeks and rockies, slope of the land and topography, as well as the general features of adjoining farms. The soil properties of the farm, the prevailing climate, and existing vegetation ought to be known. The adaptability of different plant species in the neighboring farms should also be noted. Everything that may have a potential effect on the immediate and long-term production of the farm has to be considered.

Lay-out Plan Preparation

Farm lay-out plan is the most important component of the overall farm plan. It is a drawing plan which is equivalent to a landscape design viewed from the top or a floor plan of a building, furnished with distances. It shows the boundaries, landmarks, creeks, and the locations of roads, buildings and structures, existing plants to be retained, plus the spots where plants will be planted.

In monocropping in which only a single crop is to be grown, a simple planting lay-out can be prepared showing the boundaries of the farm, the locations of hills (the specific spot on the ground where a plant will be planted), the plant-to-plant spacing, and distances from the outermost hills to the boundaries. The planting lay-out plan is a simple planting guide which is part only of a more comprehensive, overall farm lay-out. With this, the total number of planting materials to be procured can be determined with precision. The

population density will also serve as basis in the estimation of farm inputs and in projecting yields.

For big, erect species of bamboo like giant bamboo, botong, kawayan tinik, bayog and buddha's belly under monocropping, the planting distance range from 7 m x 7 m to 10 m x 10 m. For medium sized clump-forming bamboos like *laak* and *buho* (*bagakay*), planting can be done at 4 m x 5 m spacing. However, the size of the farm, ease in harvesting, preemptive protection against fire, and accessibility to transport vehicles should be considered. In large farms, roads and firebreaks need to be provided. Personal observations also revealed that at 7 m x 7 m spacing, the unpruned thorny thickets surrounding the clumps of *kawayan tinik* tend to overlap, making inter-plant passage difficult. In such spacing, regular cleaning of the clumps should become part of farm management.

The estimated population density (PD) for a square or rectangular system of planting can be calculated with the use of the following formula:

$$PD = \frac{A}{d_r \times d_h}$$

where: PD = population density; A = farm area (m^2); d_r = row distance (m); and d_h = hill distance (m).

Thus assuming that bamboo will be grown as sole crop in a farm which has an area of 1 hectare (10,000 m^2) following a rectangular pattern with a spacing of 10 m x 8 m, the total population density will be 125. This is a mere estimate and may not be the same as the actual population based on the planting lay-out.

Fixed plant-to-plant spacing may not be applicable in lands with irregular terrain. For erosion control in sloping lands, it is recommended that contour lines be located by using an A-Frame which is an essential tool in the Sloping Agricultural Land Technology (SALT) developed by the Baptist Rural Life Center at Bansalan, Davao del Sur. Viewed from the side, an imaginary line that will traverse the points of each contour line will be more or less horizontal, as if a plastic hose filled with water was used by a carpenter in locating two points of the same elevation. The contour line will serve as a guide in the placement of seedlings during outplanting.

Practical Method 5. *With only a bolo and string, you can make an A-Frame right in the farm. Just collect 3 straight, sturdy bamboo or wooden poles. Two of these are about 2 meters or 6 feet long and intended to be used as legs of the A-Frame. One is about 1 meter long or one-half of the length of the legs, to be used as crossbar or connector of the two legs.*

There is no need to measure exactly the lengths of the poles. It is sufficient that the two legs are relatively long and the crossbar is approximately one-half as long as the legs.

When the A-Frame is finished, you can decide if its size will be convenient to use. If not, you can discard it and make another one with longer or shorter poles.

To construct the A-Frame, tie the legs at one end. Tie one end of the crossbar to the middle of one leg and the other end to the second leg. Then tie one end of a string to the top of the frame (the portion in which the two legs are connected) and tie a piece of stone to the other end just below the crossbar to serve as plumb bob (*tonton*)*.*

To calibrate the A-Frame, stand it upright over flat ground. Mark the crossbar where it is in touch with the weighted string. Reverse the A-Frame so that each leg is exactly on the same spot previously occupied by the other. Again mark the crossbar. The midpoint of these two marks is your reference point in using the A-Frame to find the contour lines in your farm. When the string crosses this reference point, it means that the two legs of the A-Frame stand on spots at more or less same elevation.

An online, illustrated guide on the construction, calibration and use of an A-Frame is available at PCARRD in this URL: **http://www.min.pcarrd.dost.gov.ph/cin/AFIN/A-frame.htm**.

Clearing

To facilitate lay-out and in preparing for planting in farms with tall shrubs, slashing should be done. This operation will also include the removal of large weeds and unwanted vegetation from the area. Depending on the existing vegetation, the slope of the land, the cropping system to be adopted, and the planned timetable of planting, the area may be completely cleared and plowed, strip cleared or spot cleared.

Field Lay-out

This commences the execution of the farm lay-out or of the planting lay-out plan in preparation for planting and the construction of farm structures. It can be done gradually section by section, or fully cover the whole farm depending on the availability of labor, tools and materials for the succeeding operations which may include planting or construction.

To execute the planting lay-out plan efficiently in planting systems in which plants are arranged in linear pattern, the following tools will be needed:

1. Bolo- to clear a strip, collect and sharpen stakes;

2. Stakes- to mark hills or planting spots;

3. Mallet or substitute- to sink the stakes into the ground;

4. Measuring tape- to measure distances;

5. Nylon rope or string- to align the hills in a straight pattern; and

6. Big carpenter's square (*esquala*), triangular ruler or protractor- to arrange rows and columns of plants perpendicularly or at right angle.

Practical Method 6*: **Two points make a straight line**. By sinking the base of a straight stake to the ground at the center of a hill and another one in the next hill, you can locate the line of a row of hills. Someone will have to remain at the first stake to "telescope" through the two stakes and direct another person to place a stake farther forward in line with the direction of the two original guide stakes. Two guide stakes at the tipmost hills can also be used to position the hills in a straight line between these two stakes. This practical technique is also called "mata-mata." "Mata" means eye.*

Practical Method 7: *If the prescribed tools are not available, you can arrange rows and columns approximately at right angles by using any of the following materials provided that one corner is intact with lengthwise and crosswise edges: plywood, plain sheet, corrugated G.I. sheet, bond paper, any writing paper. The angle at each corner of these materials is perpendicular or 90 degrees.*

Practical Method 8: ***3:4:5 will make a right-angled triangle*****.** *Even if all the usual tools and substitutes in determining right angle are not available, you can still proceed with your planned lay-out by making your own right triangle right in your farm. To do this, first cut a stick, say about 10 cm or 4 inches long. The length of this stick will determine the final size of your triangle.*

Using this stick as a measuring tool, cut a straight stick, branch or stem with a length equivalent to 3 measuring sticks, another which is 4 lengths, and the third being 5 lengths. Thus assuming that your measuring stick is exactly 10 cm, you now have 3 separate sticks having lengths of 30 cm (3 x 10 cm), 40 cm (4 x 10 cm), and 50 cm (5 x 10 cm) or with a ratio of 30:40:50.This is just the same as 3:4:5. Simply connect these 3 sticks on the ground, and you now have your right triangle.

Holing and Pre-planting Preparation

Digging of planting holes should commence soon after clearing and field lay-out while the weeds have not regrown and the stakes marking the hills have not been displaced.

To provide ample space with loosened and amended soil for maximum growth of the bamboo seedlings, it is best to dig large holes. Generally, the size of holes should be 50 cm x 50 cm x 50 cm or with 50-cm diameter from side to side and 50 cm deep. The topsoil that will be removed from the hole is reserved for refilling.

To ensure supply of essential nutrients for the developing seedling, it is recommended that 5-10 kg of compost will be deposited at the bottom of the hole and covered with sufficient thickness of topsoil. If compost is not available, dried manure or

leaves of any leguminous plant like *ipil-ipil (Leucaena* sp.*)*, *madre de cacao (Gliricidia sepium)*, *acacia* (*Albizia saman*), *kamachili* (*Pithecellobium dulce*) or any leguminous covercrop can be used, singly or mixed.

Planting

The hardened seedlings should be planted at the onset of the rainy season to take advantage of available water supply, reduced light intensity, and cool temperature. This is especially necessary in the absence of irrigation. In holes with compost, planting can be done immediately.

But in holes with undecomposed manure or leaves, planting is best delayed for at least 15 days in order to allow initial decomposition of the applied organic materials and to prevent possible injury to the seedlings. During these first days, decomposition process is thermophilic which means that high amount of heat is generated. To be on the safe side, experiment with a few seedlings.

If the potting medium is firm enough and held tightly by the roots of the seedling, the potting container (plastic bag) can be removed without danger that the soil will crumble. If not, only the bottom of the plastic bag is removed and one side is cut. This will be pulled upward later. The potted seedling is laid at the bottom of the hole and topsoil is shoveled in up to the top of the potting medium.

In areas which are prone to flooding, the top of the potting medium should be in the same elevation with the surface of the land. To prevent waterlogging, the base of the seedling is elevated by mounding. But in areas where rainfall is scarce and waterlogging is not a problem, a slight depression surrounding the seedling is left after firming the shoveled-in soil. This depression will trap water. Apply water immediately after planting to minimize transplanting shock.

Replanting

Replanting of missing hills should be done immediately upon detection of dead seedlings. Further delay will mean a waste of time and may intervene with the other farming operations. The opportunity offered by the rainy season for maximum survival of the seedlings may also lapse. Worst, the advanced growth of the established plants will likely suppress the growth of newly planted seedlings.

Watering

Sufficient water should be supplied to the plants especially at seedling stage, in sandy soils, and during drought or dry season.

Weeding

The growth of weeds should be suppressed to minimize competition for water, nutrients and light. Depending on such factors as erosion control in sloping lands, enhancement of visibility, conservation of soil water, growing of cash crops or intercrops and livestock integration, weed control may be blanket, strip, or restricted to the immediate peripheries of the seedlings (spot weeding).

Mulching

Mulching is the operation which consists of the laying or placing of any material, either organic or inorganic, natural or synthetic, on the ground mainly to minimize loss of water from the soil through evaporation, to suppress weed growth, to control erosion, and to regulate soil temperature. In bamboo, it should be started immediately after planting by collecting cut foliage, leaves or straws of weeds within the farm and piling these, as compactly as possible, at the bases of the seedlings. The thicker, the better. When decomposed, these will become organic fertilizers.

After several years when the plants are fully grown, the leaves of bamboo will accumulate over the ground and weed growth will become minimal. Mulching may no longer be a part of farm operations.

Covercropping

Covercrops are plants grown or maintained for purposes like those of mulches, with the addition that they are live. They may also be called groundcovers, equivalent to those in landscaping minus the aesthetic consideration. In South Cotabato, Philippines, the most common and naturally-growing covercrop is the carabao grass (*Paspalum conjugatum*).

Mainly because of their additional advantage of having the ability to enrich the nitrogen fertility of the soil, leguminous, vine-like species of plants are commonly used as covercrops in coconut and in other plantation crops. These plants have growth habit similar to Lima bean or patani (*Phaseolus lunatus*) and hyacinth bean or bataw (*Lablab purpureus*) which can also be used if seeds for planting are available.

For rapid establishment of groundcover, prevention of soil erosion and enhancement of soil fertility in farms in which annual intercrops are not to be grown, the following leguminous covercrops are recommended:

1. Calopo or *munggo-munggo* (*Calopogonium muconoides*)- adapted to open sun;

2. Centro (*Centrosema pubescens*)- adapted to partial sun or partial shade;

3. Siratro (*Macroptilium atropurpureum*)- adapted to open sun.

These plants are also recommended as protein-rich sources of forage for livestock animals. Seeds are plentiful and can be harvested from naturally growing plants during summer (March to April). On the disadvantage side, these plants, especially calopo, have trichomes on their leaves which may cause allergy. These plants are also twining or climbing and so regular slashing should be included in the cultural practices.

Crop Protection

Bamboo is resistant to insect pests and diseases. With available forage in the farm, it is also less favored by grazing animals. However, to ensure that the plants will not be injured by astray animals, each should be provided with a tree guard or the whole plantation is fenced. The fence will also exclude intruders who may be tempted to harvest young shoots.

As protection from fire especially during dry months, strips of land can be made into firebreaks by plowing to get rid of combustible vegetation.

Fertilization

Although bamboo can survive in poor soils, it is advantageous to apply fertilizer for optimum growth. Fertilizer application at the rate of 200-300 gm per plant starts after planting and every 3-4 months thereafter. As the clumps become thicker, the rate of fertilizer should also be increased progressively. The application of fertilizer can be scheduled at the start and at the end of the rainy season in areas having pronounced dry and rainy seasons.

Organic fertilizers such as compost and manures may also be used in combination with or as a substitute to synthetic fertilizers.

Pruning

The lower branches of the culms should be removed to enhance farm visibility, promote air movement and facilitate ease in fertilization and harvesting. Partial pruning of the thorny thicket surrounding the clumps of *kawayan tinik* is also recommended to allow passage between clumps especially when planted with narrow spacing. Sufficient thicket should be retained to hold the culms erect.

Thinning

Thinning or removal of dead, damaged and defective culms is done 3 years after planting. This will promote visibility and provide more space for the growth of new shoots. In large clumps, removal of young shoots with narrow diameter is recommended. These will develop into small culms but will likely become hindrances during harvesting.

Roguing

Roguing or the removal of off-types is essential in buddha's belly (*Bambusa ventricosa*) which is prone to interspecific transformation. This phenomenon also occurs, though very rare, in kawayan tinik and yellow bamboo (*Bambusa vulgaris* var. striata).

In bhudda's belly, it is expected that shoots belonging to bayog (*Bambusa* sp.) will grow within the clump. Left unchecked, bayog will invade the clump and, ultimately, it will consist purely of bayog culms.

To preserve the specific identity of the clump, off-types should be removed immediately. But mere culm cutting will not completely eliminate the off-type. The rhizome from where the off-type culm originated should be removed.

Cash Crop Intercropping

It is wasteful to allow the interrow spaces to become idle. To maximize land utilization, it is recommended that early-maturing cash crops should be intercropped during the early years before harvesting of the mature culms. Cash crops may consist of annual (e.g. corn) or perennial crops (e.g. banana). They will become sources of revenue while waiting for the bamboo plants to mature.

In mango plantations, corn intercrops tend to improve the growth of the mango trees.

Harvesting

Mature culms of desirable sizes are ready for harvest at 3-5 years after planting. Based on observable traits, the following indexes are generally used in identifying a mature culm:

1. Leaf sheaths are naturally detached from the culm;

2. The bark of the culm has a glossy texture; and

3. The bark of the culm approaches bronze-like or yellowish color.

Harvesting is preferably done during dry months. This timing of harvesting is traditionally practiced by farmers to prevent or minimize attack on the culm by post beetle (*bokbok*). Scientifically, this is attributed to low starch content of the culm. Harvesting during the dry season (summer) is also beneficial because shoots rarely grow during this period. Thus damage to new shoots is prevented or minimized. Also, the removal of culms will promote the growth of new shoots, in time for the incoming rainy season.

The cut should be made as close as possible to the base. However, leaving some portion of the culm in young clumps will be beneficial to the entire clump.

The following methods of harvesting are practiced:

1. Selective method- only mature culms or culms of certain ages are harvested. This is recommended for the harvesting of quality culms.

2. Divided Clump method- the clump is divided into two halves. One-half portion is harvested in the first year and the other half in the succeeding year, leaving only the youngest culms and shoot. This means that many culms are about one-year old during harvest. Although many culms may not be fully mature, they are preserved by sea water if used in the making of fishpens (*bonsod*).

To be able to harvest more mature culms, this method can be modified by increasing the number of clump divisions to 3. Harvesting in each division will be every two years.

3. Clear cut or Blanket method- all the culms in a clump are cut except those which are very young. Harvest interval maybe yearly or any period depending on the quality of culms desired.

REFERENCES

AFSICH. 1993. Agroforestry species in the Philippines: common names, seed sources, and growth requirements. Agroforestry Seeds Circular No. 3 Supplement (March 1993). UPLB, College, Laguna, Phils.: Agroforestry Seed Information Clearinghouse Project.

Mabaquiao, P.S. 2010. Engineered bamboo project a promising industry. PIA Daily News Reader (03/09/2010). Retrieved April 28, 2010 from http://pia.gov.ph/?m=12&sec=reader&rp=1&fi=p100309.htm&no=10&date=03/09/2010.

Monton, R. and B.G. Bareja. 1999. The effect of alpha naphthalene acetic acid (ANAA) on the rooting of bayog bamboo. MSU, Gen. Santos City. (unpub. undergrad. thesis).

PCARRD. 2003. How to construct the A-Frame. Philippine Council on Agriculture, Forestry and Natural Resources Research and Development. Los Banos, Laguna. Retrieved May 4, 2010 from http://www.min.pcarrd.dost.gov.ph/cin/AFIN/A-frame.htm,

Pinos, A. and B.G. Bareja. 2000. Propagation of different bamboo species using branch cutting with and without alpha naphthalene acetic acid. MSU, Gen. Santos City. (unpub. undergrad. thesis).

Rivera, M.N. undated. Philippine national report on bamboo and rattan. Retrieved April 27, 2010 from http://www.inbar.int/documents/country%20report/Philippine.htm.

Rizaldo, A. and B.G. Bareja. 2000. Propagation of giant bamboo using branch cutting with different rooting media. MSU, Gen. Santos City. (unpub. undergrad. thesis).

Roxas, C. A. undated. Bamboo research in the Philippines. Retrieved April 27, 2010 from http://www2.bioversityinternational.org/publications/Web_version/572/ch30.hm.

