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SPECIFIC SEED TECHNOLOGIES AND NURSERY MANAGEMENT PRACTICES

FIELD CROPS

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- Food security is a primary concern of the government -- making available, and at affordable prices, food to sustain the population's requirements.

- The rice crisis of 1995 for example had a series of effects on the Philippine situation and has directly resulted in the double digit inflation in the economy by the end of the year. Certified seed stocks were sold as commercial rice.

- Long before the rice crisis, efforts had been focused on efficient productivity. Varieties were bred for better yield, insect and pest resistances, tolerance to environmental stresses and nutritional quality.

- Farmers are aware (or made aware) that using good quality improved varieties ensures increased production in a given hectare of cultivation.

- A good example of these varieties is the IPB-bred corn from the open-pollinated series to the hybrid varieties.

- Production wise, yield comparison per hectare basis to the national average of 1.3 tons shows that IPB Var 1 open pollinated has an average yield of 4-4.5 tons while a single cross hybrid 911 has a yield potential of 8.5 tons.

- Availability of good quality seeds is another concern of agricultural production. Good quality seeds ensure the reliability of cultivation and yield.

- Good production entails the availability in quantity, timeliness and guaranteed viability of seeds wherein distinctness, uniformity and stability of varieties are maintained.

- Farmers will grow crop varieties that ensure a margin of profit in their endeavors. Seed production practitioners, on the other hand, focus production of quality seeds bearing in mind that good qualities are intrinsic characteristics of the genetic make-up of the crop varieties.

SEED PRODUCTION PROGRAM

- Seed production is to the greatest extent a quality production.

- Seed production requires more care, equipment and storage facilities or it requires different types of resources and different categories.

- Some of the activities needed are the following:

    1. Research and plant breeding
    2. Certification, seed testing and control
    3. Seed multiplication/seed production
    4. Marketing

- Plant breeding or crop improvement is not a unilateral undertaking of the formal sector.

- It is a participatory endeavor from the existing farmers' practices, varieties/landraces to the formal evaluation, hybridization, selection, testing and release of the crop varieties.

- Farms utilization and public acceptance are included.

- Plant breeding starts with the available genetic diversity and/or the assembly of genetic variability to address breeding objectives such as market demands and utilization.

- Foremost is the knowledge and understanding of the breeding systems.

- Self pollinated crops such as rice, most legumes, tomatoes and eggplant, require emasculation of the female parent before hybridization.

- Cross pollinated crops, on the other hand, would require bagging of the female flowers (female parent) to prevent selfing as in corn or in cucurbits such as ampalaya and squash.

- Genetic markers are helpful in the selection process and in keeping the genetic integrity of the crop variety specially for varietal releases.

- Once the crop variety is ready for release, the crop variety is then ready for multiplication and the different seed classes/grades are produced. This is in the realm of the National Seed Industry Council (NSIC) and Bureau of Plant Industry (BPI) for laboratory testing and certification.

- The crop variety is then ready for multiplication and the different seed classes/grades are produced.

- The breeder has the sole right to produce the breeder seeds.

- Other institutions and entities involved in seed production will have at most three generations of seed multiplication from foundation, registered and certified seeds.

- Each generation of seed increase/multiplication derived from the breeder seeds will be the next lower seed class.

SEED PRODUCTION/MULTIPLICATION

The choice of production area depends on the following:

- history of the production site is useful that is to say the crops previously grown
- the availability of soil analysis data for the cultural management of the crop
- isolation requirements of the crop species from the neighbor farms
- cultural requirements of crops
- seed quality management

A. Seed Processing of Field Crops

- Seed processing is the entire process from harvesting of seeds through cleaning, drying, chemical treatment, storage and packaging.

- It is a critical chain in the seed industry wherein high yielding varieties are kept distinctly separated, selected, graded for good germination, protected from pests and diseases mechanical damage, gently handled under controlled temperature and moisture content, and chemically protected and packaged.

- Seed cleaning starts in the field. Prevention of other seed mixtures from weeds of previous crop is done by field inspection and those with mixture will not reach the processing plant such that harvest will be hard if not impossible to clean. If seed mixture is of the same species but other varieties occurs, the particular harvest is discarded.

  For example in corn: there are two types of residues in seed cleaning:

  - waste -- dust, sand, leaves, straws, cobpieces
  - rejects -- poorly developed kernels, cracked kernels and even oversized kernels

- It is normal and acceptable that rejects amount to 20-30 percent of the harvest during processing. The following steps are carried out in cleaning corn seeds:

  1. Dehusking
  2. Drying of cobs
  3. Shelling
  4. Fine cleaning
  5. Grading
  6. Sampling-guarantee
  7. Bagging/Tagging
  8. Storage/Delivery

B. Seed Storage

- The principal reason for storing seeds of economically valuable plants is to preserve the planting stocks of the highest possible quality from one planting season to another.

- High moisture content in the seed, high temperature and high relative humidity lower seed viability and favor insect and fungal growth (Figure 1)

- Seed-borne disease will reduce the amount and quality of yield; similarly at high temperature, the time duration of insect development from egg to adult is faster and therefore there is faster deterioration of stock seeds.

- For example in corn, based on the 1971 Society of Agricultural Engineers, the following interplaying factors should be considered: moisture content (MC), storage temperature (°C), and relative humidity (% RH).

Temperature (°C)	%RH	% max MC	Storage Time
30	50	12	9 months
20	60	13	9 months
30	45	10	3 years
20	50	12	3 years
10	60	12	5 years

C. Quality Control

- The farmers are guaranteed that their seeds are of highest quality with good germination and vigor

- Corn and palay are durable seeds unlike oil seeds (for example peanut, soybean) which are considered less durable.

- Measures of the development of deterioration process:

  a) germination capacity
  b) percent non-germinating seeds
  c) abnormal seedlings

- For vigor, the most common laboratory test is the Tetrazolium test where germinating seeds are categorized as viable and non-viable.

- In corn the acceptable germination for seed trade is a minimum of 85%. Figure 2 shows the relationship of seed germination and seed vigor.

IPB PRODUCTION GUIDE FOR CULTURAL MANAGEMENT OF CORN PRODUCTION (For Contract Growing)

1. Land Preparation

- Prepare land thoroughly by plowing 1-2 times followed by 2-3 times harrowing. When a tractor is used, plow soil 14-16 cm deep.

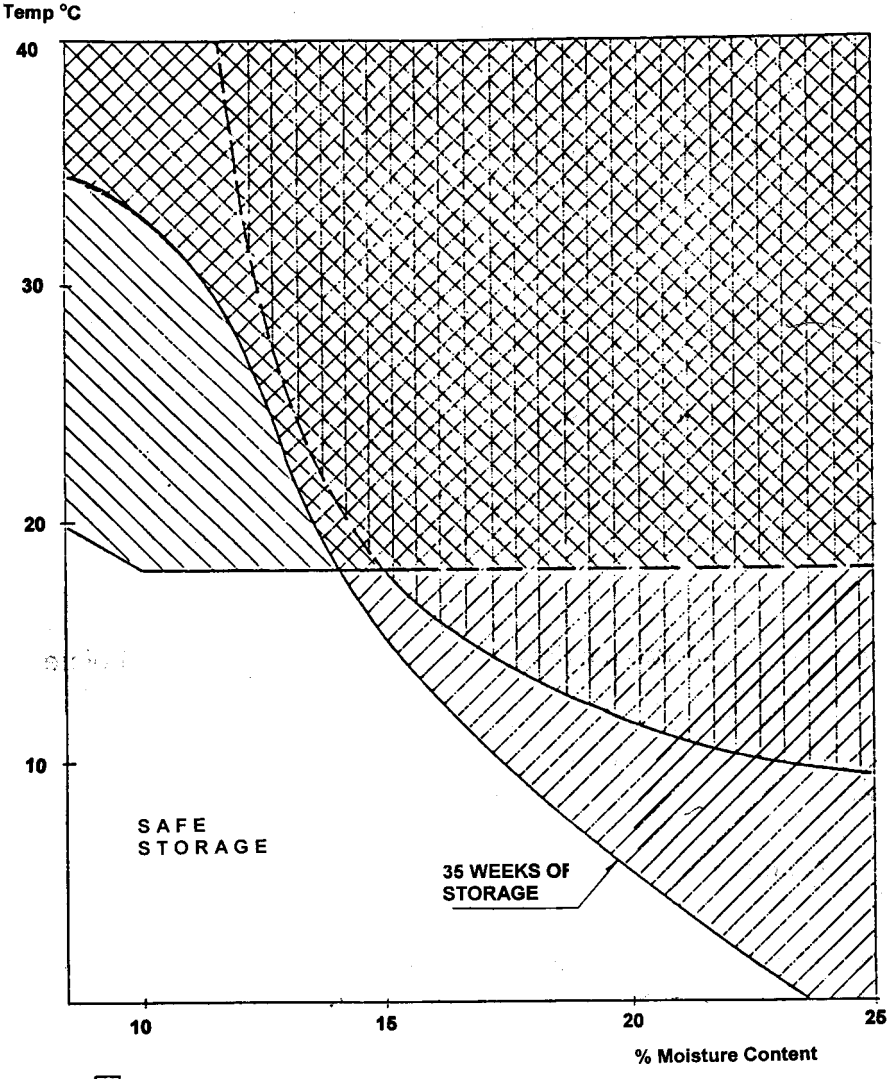
- Make furrows 8 cm deep spaced 75 cm apart one day before planting.

2. Planting

- Normally, the recommended distance between rows is 75 cm.

- The spacing between hills, however, varies. When hills are spaced 25 cm, maintain one plant in each hill and two plants when hills are spaced 50 cm apart.

- In any case, maintain a plant density of 53,333 plants per hectare. If the area for planting is relatively flat, orient the row in the East-West direction so that plant can maximize the light energy.



RELATIONS BETWEEN STORAGE TEMPERATURE, MOISTURE CONTENT, INSECT ACTIVITY, FUNGUS ACTIVITY AND GERMINATION IN WHEAT

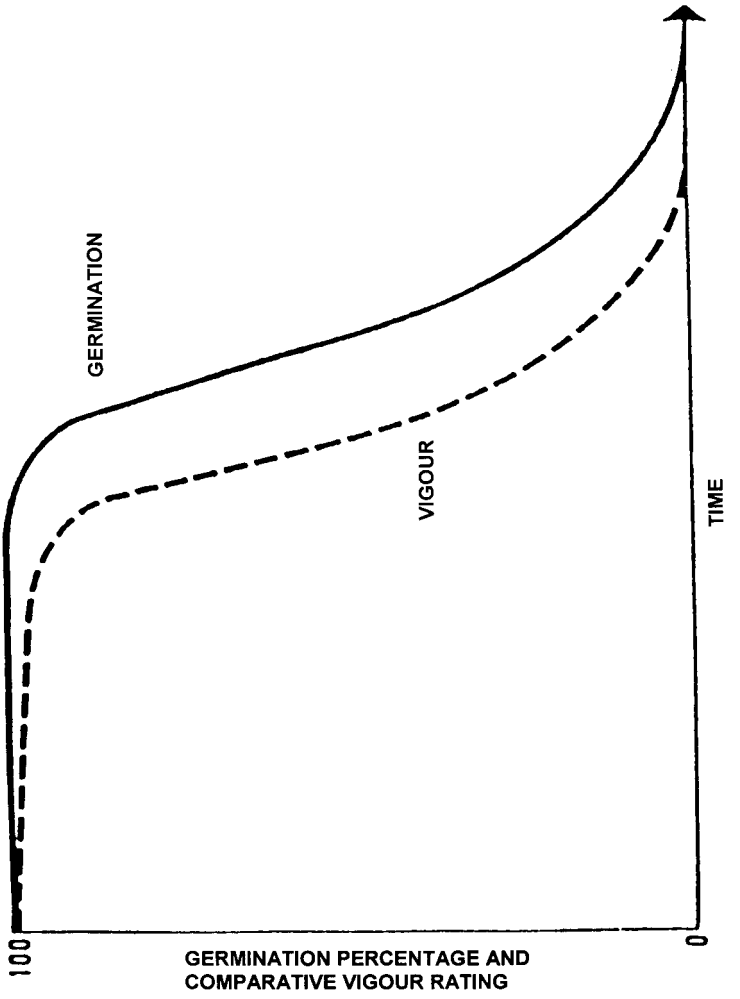


FIGURE 2. **The loss of vigour and germination of seed as a function of time**

- For a sloppy area, arrange rows perpendicular to the slope to minimize soil erosion.

- You need about 15 kg of good quality seeds to plant a hectare following the recommended distance of planting.

3. Fertilization

- The rate of fertilizer should be based on the results of soil nutrient analysis.

- Without soil analysis, use of 6 bags of complete (14-14-14) fertilizer per hectare as basal application in furrows and cover the fertilizer with a thin layer of soil about 2 cm thick.

- Twenty five to 30 days after planting, sidedress with 4 bags ammonium sulfate or 2 bags of urea.

- Cover the fertilizer immediately by shallow hilling-up.

4. Thinning

- Thin seedlings to one or two plants per hill depending on the chosen planting distance 20 days after planting.

5. Weed Control

- Do shallow cultivation/off barring and spot weeding to effectively control weeds right after thinning.

6. Insect Pest and Disease Control

- The most destructive insect pest is corn borer and the most devastating disease is downy mildew.

- Corn borer heavily infests plants more during the rainy season than in the dry season.

- Follow the Integrated Pest Management approach to corn borer which is a combination of several control and preventive measures such as sanitation, use of tolerant varieties, biological agents and insecticides.

- At flowering stage, detassel 75% of the plants by removing the tassels of plans in three rows in every four rows.

- Prevent downy mildew by treating the seeds with fungicides (such as Apron) before planting, by using resistant varieties and by practicing sanitation like roguing out infected plants.

7. Harvesting

- For grain production, pick and dehusk the ears right in the field.

- Dry the ears for 2-3 days until moisture content allows convenient shelling.

- Dry the shelled grains further to 14% moisture content to avoid mold formation and for better grain storage.

SEED STANDARDS FOR HYBRID CORN

I. General Requirements for Hybrid Corn Seed Production

The general requirements for corn seed production as adopted by the Seed Certifying Agency are basic and are observed together with the following specific standards.

III. Land Requirements

There are no requirements as to previous crop. However, the field must be relatively free from volunteer plants.

IIII. Field Inspection

Official seed inspectors are required to conduct at least three field inspection besides those during detasselling, as follows:

1. At planting time, to make sure that male and female rows are properly placed and in a correct ratio.

2. During the vegetative stage, to determine whether to do rouging of off-types, diseased plants and volunteer plants (if any), cultivation, weed control and application of fertilizers.

3. At flowering time, rouging of female; off-types should be done followed by detasseling. For single crosses only 0.25% undetasseled is allowed. For three way crosses, 0.5% undetasseled (shedding) is allowed.

4. At harvest time, to see that the ears of the seed parents are properly guarded against mixture with the harvest from the pollen rows.

IV. Field Standards

A. Production Area -- The area intended for hybrid corn seed production should be at least one hectare.

B. Isolation -- A specific seed production field must have proper isolation.

- Time isolation -- 20 days before or after planting of any corn planted nearby.

- Distance isolation -- Isolation requirement should be included.

C. Detasselling -- Field inspection should be furnished with guide on detasselling process depending on the variety at flowering stage but before pollen shedding.

- At least four samples of 100 plants each are necessary before any decision can be reached as to whether a hybrid corn seed production field is rejected or approved. The inspector continues to take samples if a determination number is not yet reached. If tassel shedding exceeds minimum standard add at least two more sampling.

V. Seed Standards

Factors	Single Cross %	Double Cross %	3 way Cross %
Pure seed (min.)	98	98	98
Inert matter (max.)	2	2	2
Other varieties	2 seeds/500g	5 seeds/ 500 g	for consultation
Other crop seed (max.)	0	0.5	-
Weed seed (max.)	0	0	-
Germination (min.)	85	85	85
Moisture content (max.)	14	14	14

SEED STANDARDS FOR INBRED LINES OF CORN

I. Land Requirements

There are no requirements as to the previous crop.

II. Field Inspection

At least four inspections shall be made by the inspector of the certifying agency before and during the pollination period.

III. Field Standards

A field which contains, at any one inspection, more than one-tenth of 1.0% of definitely off-types or more than 2.0% of doubtful type of plants that have shed or are shedding pollen when 5.0% or more of the plants in the fields have receptive silks shall not be certified.

IV. Seed Standards

Factors	Inbred (Fb,) (%)
Pure seed (min.)	98
Inert matter (max.)	2
Weed seed (max.)	0
Other varieties (max.)	0
Other crop seed (max.)	0
Germination (min.)	85
Moisture content (max.)	14

IPB PRODUCTION GUIDE FOR CULTURAL MANAGEMENT OF MUNGBEAN

1. Land Preparation

- Good tilth is necessary for uniform germination and for the rapid establishment of the mungbean seedlings. One plowing and at least one harrowing of four passing when using tractor-drawn implements while two plowings and at least two harrowings with one harrowing of four passing after plowing when using draft animals may be required.

- Furrows are made 50 cm and 75 cm apart for the dry and wet seasons, respectively.

- Planting after rice harvesting without land preparation can also be done. However, the ricefield must be weed free.

2. Planting

- Mungbean can be grown during the wet (May to June) and the dry (October to November) seasons. Where rainfall irrigation is available, especially at the critical flowering and pod development stages, December until February planting is also suggested.

- Seeds are drilled at the rate of 25-30 seeds per linear meter. This will give an appropriate population of 300,000-400,000 per hectare and requires 20-25 kg of seeds per hectare.

3. Inoculation

- A 100-gram inoculant is enough to treat 6 kg of mungbean seeds. Effective inoculants are available in various offices at the Bureau of Plant Industry, Bureau of Soils, and Biotech, UPLB.

- To inoculate, add a little water to the seeds and mix until the seeds are coated with the inoculant. Treatment must be done just before planting and avoid direct exposure of the treated seeds to sunlight. Specific directions in using commercial culture are found on the label of each container.

4. Fertilization

- The general recommended rate for mungbean fertilization is 30-30-30 kg/ha NPK equivalent to 4 bags of complete fertilizer (14-14-14) at planting time. However, this will vary depending on the natural fertility of the soil and the season of the year.

- Sidedressing can also be done within the first week of crop emergence.

5. Irrigation

- Frequency of irrigation is largely influenced by the prevailing climate and the soil structure. Wet season planting in general does not required any irrigation.

- Soils with light texture need more irrigation due to the lower water holding capacity in comparison to the heavy soils.

- During the dry season, irrigation at flowering stage and during the pod filling stage is very necessary.

6. Weed control

- The field should be kept weed free for at least 2 weeks before seedling emergence.

- Handweeding or off-barring during the first week from crop emergence followed by hilling-up in the third to fourth week before the plants close in should be done.

- Occasional spot weeding should be done to remove fast-growing weeds.

7. Insect Control

- During the seedling stage, mungbean is more prone to beanfly damage. Aphids, leafhoppers, stink bugs and all sorts of defoliators are also serious during the seedling stage and throughout the duration of the crop.

- At flowering up to the pod development stage, pod borer is the important pest which may cause flower drop, thus, reducing pod setting. Developing pods may also fail to produce sound kernel due to pod borer damage.

- Frequent pest surveillance and timely application of insecticides are necessary to minimize pest damage.

8. Disease control

- The serious diseases of mungbean are those caused by soil-borne pathogens as well as fungal leaf diseases such as Cercospora leafspot (CLS) and powdery mildew.

- CLS is more severe during the wet season. The first visible symptom is the appearance of water-soaked spots on the leaves which later on turn reddish brown with small gray centers. These spots will coalesce causing large dead areas on the leaves which may cause drying of the entire leaves.

- Powdery mildew is favored by high relative humidity and cool temperature, hence, this is serious during the November-December plantings. The early symptom is the occurrence of a white powdery spot on the upper surface of the leaves which when fully developed could occupy the whole leaf surface.

- Damping-off is caused by several soil-borne fungi. This is favored by humid atmosphere and wet soil. If infected before emergence, the seeds may rot or the sprouts decay in the soil after emergence.

- Adequate control by sound cultural practices (time of planting and removal of alternate hose) and/or use of recommended chemicals are recommended to produce good quality seeds.

9. Rouging

- It is suggested that rouging is done at least three times before harvest considering the distinct morphological characteristics of the variety.

- The first rouging should be done at seedling stage preferably three to five days from emergence, second rouging at early pod development, and last rouging at least five days before harvest.

- It is also important that all plants that are heavily infected with diseases especially those that show virus symptom should be removed during rouging.

10. Harvesting

- Harvest mungbean plants by hand as soon as 75% of the pods are fully dried.

- The first harvest can be done in 60-65 days from crop emergence depending on the variety and season of planting. Second harvest should be done 10-15 days after the first priming.

- If soil moisture is available, it is possible to allow the crop to produce mature pods up to the third harvest. This could be achieved by supplemental N fertilizer and adequate insect control after the first priming.

11. Drying and Threshing

- Pods are first dried in the sun then threshed by using a mechanical thresher or by beating the pods inside the jute sack with a wooden stick.

- Care must be observed in order that the seeds are not damaged during threshing and drying.

- If machine is used for threshing, it is advisable that the machine should be operated at the lowest speed possible that could efficiently thresh the plant.

- The seeds are dried further (2-3 days) preferably to about 10-12% moisture for long storage.

12. Storage

- As soon as the seed moisture content reaches 12% or lower, the seeds should be properly cleaned by removing impurities, off-types and damaged seeds.

- The purified seeds are then properly bagged preferably in sacks with plastic lining and stored in well ventilated or air-conditioned room.

- If recommended by the seed analyst, the seeds should be treated with insecticide-fungicide mixture before bagging.

VEGETABLE SEED PRODUCTION

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- Vegetable seed production in the country is gaining considerable momentum.

- Only few foreign and local seed companies are mainly engaged in vegetable seed production.

- Unfortunately, seed supply can not meet the demand, hence, importation of seeds is resorted to.

- It is a big challenge to local seed technologists to initiate moves to make the country self-sufficient in vegetable seeds.

SEED PRODUCTION

- Available technologies for seed production are very similar to those applied for fresh market production.

- Cultural management practices for fresh market production are the ones followed for seed production.

- Planting distance, fertilizer and water management, and control of pests and diseases are very similar in both fresh market and seed production.

- This present situation may be attributed to the lack of available cultural management practices developed specifically for vegetable seed production.

- Although there are similarities in cultural management practices in both fresh market and seed production, it could be stated that there are some basic differences between the two.

- The following are some cultural management practices which are mainly observed in vegetable seed production but not for fresh market production.

1. Observance of Isolation Distance

- Isolation distance must be strictly observed.

- Isolation distance is imperative to maintain the genetic purity and avoid contamination especially in cross-pollinated crop like crucifers and cucurbits.

- For self-pollinated cropslike solanaceous and legumes, isolation distance may be less but, nevertheless, it is still observed in seed production to prevent admixtures during harvest especially when planting two cultivars of the same crop.

- The following are isolation distances for some vegetable crops being adapted by Vegetable Crops Division, Department of Horticulture, UPLB.

Table 1. Isolation distance for different vegetable crops being adopted by the Vegetable Crops Division, Department of Horticulture, UPLB.

Crop	MINIMUM ISOLATION (m)	
	Stock Seed	Commercial Seed
Solanaceous		
• tomato	25	10
• sweet pepper	50	25
• eggplant	100	50
Legumes	25	10
Cucurbits	400	200
Crucifers	1000	800
Malvaceae	50	25

2. Need for Pollinators

- Pollinators are needed for seed setting to increase yield.

- Pollinators must be introduced in the field in case natural pollinators are not sufficient.

- At least 1-2 beehives must be present per hectare for seed production of crucifers to insure sufficient pollination.

- In case pollinators are present in a seed production field, spraying to control pests and diseases must also be limited so as not to harm the pollinators.

- Most pollinators are active from 6 to 10 o'clock in the morning so spraying must not be done during this time.

- Precaution must be observed in order that pesticide residues would not be too toxic to affect the pollinators after spraying.

3. Conduct of Field Inspection and Rouging

- A seed lot contaminated with other crop, cultivar or noxious weed seeds will result in the lowering of seed quality.

- Field inspection and rouging should be conducted regularly during the entire crop growing period to insure quality of produce.

- Plants of other crops and cultivars, noxious weeds, off-type plants, and plants infected with seed-borne diseases must be removed and disposed off properly.

- The following are the recommended stages for rouging.

a) Early vegetative stage -- Characteristics of leaves, stew, growth habit and others must conform with the cultivar description.

b) Late vegetative stage -- Some characteristics must be observed as in number 1.

c) Flowering stage -- Time of flowering and flower color should conform with the cultivar description. At flowering stage, most of the plant characteristics are expressed, hence this may be considered as the best time to do rouging.

d) Fruiting stage -- Fruit shape, color and size must conform with the cultivar description.

e) Harvesting stage -- Prior to seed extraction all off-type, malformed and diseased fruits must be removed.

4. Harvesting at Seed Physiological Maturity

- Seeds must be harvested at the time of physiological maturity which is theoretically the best time to harvest the seed.

- At seed physiological maturity, all the assimilates needed have been translocated to the seed, hence this is also the point of maximum dry weight.

- At the point of physiological maturity, the seed is at its highest vigor level, hence also at its highest quality level.

- Seed physiological maturity is entirely different from fruit maturity, and various crops will have different visual indicators of physiological maturity.

SEED PROCESSING AND HANDLING

- Seed processing refers to all the activities after harvest, involved in preparing the seed for storage and marketing.

- The concern for proper handling does not end at harvesting but will continue up to the post-harvest aspects for seed is a biological entity whose viability must be maintained to insure that quality will not deteriorate until it is ready for planting.

- Proper post-harvest handling must be given due consideration in order to maintain high seed quality.

- Post-harvest activities involve drying, threshing, cleaning, upgrading, treating, packaging and storing.

A. Seed Drying

- When seeds are harvested at physiological maturity, seed moisture content is very high.

- it is imperative to dry the seed to reduce the moisture at a safe level.

- In seed drying, the initial moisture content must be given due consideration in order to avoid thermal injury.

Table 2. Recommended drying temperature for vegetable seeds, National Seed Foundation, Institute of Plant Breeding, UPLB

Initial Moisture Content	Recommended Drying Temperature
> 18%	32-35°C
10-18%	35-38°C
<10%	38-40°C

B. Seed Threshing/Shelling

- Threshing or shelling is primarily done to separate the seeds from the pods.

- Moisture content should be within the range of 16 - 18% to avoid mechanical injury.

- Seeds should not be harvested when they are too wet or too dry.

- If seeds are too wet, the seeds are very soft and are susceptible to mechanical injury.

- If they are too dry, their seed coats become brittle and are susceptible to mechanical damage

C. Seed Cleaning and Upgrading

- After threshing, there are still a lot of contaminants present in the seed lot.

- Examples of these contaminants are chaff, broken seed, weed seeds and immature seeds. These must be removed.

- In order to separate the seeds from the contaminants, physical differences between the seed and contaminant must be present in order for a cleaning or upgrading machine to function.

- The differences in the following physical properties are taken advantage of in order to separate the good seeds from the contaminants.

    1. Size -- Length, width, thickness
    2. Shape or degree of roundness
    3. Color
    4. Texture
    5. Weight
    6. Affinity
    7. Electrostatic charge
    8. Resiliency

D. Seed Treating

- In order to protect the seeds from storage pests and diseases, seeds should be treated with chemical insecticides and fungicides.

- Chemicals may either be sprayed or applied in slurry or powder form.

- In case of the spray or slurry method, it is recommended that treated seeds be dried further to avoid increase in moisture content.

E. Packaging and Storage

- In order to facilitate handling of seeds, it is recommended that seeds be placed in packages for easier handling than in bulk.

- In the choice of packaging material, the primary consideration should be its moisture proof container to avoid the reabsorption of moisture which might cause seed deterioration.

Table 3. List of different packaging materials and their respective properties, UPLB Seed Technology Programme

Material/Resistance	Water Vapor	Gas transmission	Water
Kraft paper	0	0	2
Glassine paper	0	0	2
Polyvinyl chloride (PVC)	2	5	10
Polyethelene (PE)	7	3	10
PE coated paper	7	3	6
Aluminum foil	10	10	10

Properties are graded from 0 to 10, where 10 is the highest and 0 signifies that the property is non-existent.

- In seed storage, temperature, relative humidity and seed moisture content must be controlled in order to prolong the viability.

- In general the lower the temperature, relative humidity and seed moisture content the better for seed storage.

Table 4. Recommended storage conditions for vegetable seeds, UPLB Seed Technology Programme

Storage Time	MINIMAL SAFE STORAGE		
	Temperature, °C	Relative Humidity, %	Moisture Content, %
Short term (1-9 months)	30 20	50 60	12 13
Intermediate (18 months)	30 20 10	40 50 60	10 11 12
Long term (3-5 years) (5-15 years)	 10 0-5	 45 30-40	 <10 <10

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FRUIT TREES

Flordeliza B. Javier

- Germination of seeds is one particular process in plants considered basic in its perpetuation.

- Avocado, chico, carambola, citrus, durian, guava, jackfruit, lanzones, mango, mabolo, papaya, rambutan, santol, tamarind, tiesa are among the perennial crops integrated with agroforestry having high value and promise. The economic parts are basically the fruits.

- These crops produce seeds that respond to temperature and moisture affecting the germination process in a different manner compared with the so-called conventional seeds. Handling and processing of this group of seeds are considered specialized horticultural techniques in seed or sexual propagation.

- Growing of seedlings for rootstocks and/or seedling trees of these crops require special procedures and practices.

- The package of technology on the aspect of propagation and nursery management in fruit crops production had been standardized very recently. The target is to produce quality seedlings particularly for rootstocks.

SOURCING AND PROCUREMENT OF SEEDS

- Seeds are sourced/taken from mature/ripe fruits.

- Origin and species/cultivar of the fruits of specific crops should preferably be known.

- Avoid over-ripe/rotting fruits as source of seeds.

HANDLING AND PREPARATION OF SEEDS

- Seeds are extracted from fruits preferably after harvest.
- Mucilage or pulp/fleshy tissues adhering to the seeds are removed.
- Seedcoats are removed in some seed species.
- Cleaning seeds by washing with tap water is also done.
- Briefly air-drying seeds is also recommended.

PREPARATION OF SEEDBED/GERMINATION BED

- For construction of new seedbed, materials (concrete slab, bamboo, wood) are provided for to elevate the bed row.
- The medium used is sand (river) or soil and sand mixture.
- The medium used is sterilized prior to using the seedbeds.
- Length of holding material for the bed and volume of the medium depend on the size and volume of operation.
- Cultivation and medium turning, re-sterilization are practiced before sowing in the case of permanent and routinely used seedbeds.

SOWING OF SEEDS

- Seeds are sown in the proper position for big seeds.
- Shallow sowing of seeds is also recommended just allowing the whole seed to be covered with the medium.
- Mulching is adopted in dry-hot months to conserve water.

WATERING

- Seedbeds are watered regularly keeping enough water always available to the seeds.

PREPARATION OF INDIVIDUAL CONTAINERS FOR TRANSPLANTING

- Black plastic (polyethylene) bags measuring 8" x 12" or 7" x 11" are recommended.
- Holes (4 each side) are provided using a puncher.
- Medium rich in organic matter is used.
- Ordinary soil is mixed with compost (animal manure or plant residue) and sand usually in 1:1:1 by volume.
- The medium is placed in containers corners folded inside preferably 3/4 full.
- Tapping the container on the ground surface is done for full packing.

TRANSPLANTING

- Seedlings are transplanted when the first pair of leaves have attained maturity.
- Dig seedlings individually taking care not to break the roots.
- Individual potting is usually done for container-grown system of growing seedlings.
- Trimming of leaves (1/2 distal portion towards tip) is usually done for broad-leaf fruit crop species.

WATERING AND CARE OF TRANSPLANTS

- Regular watering of seedlings is required.
- New transplants are kept under shade for about 2-3 weeks.
- Partial shading before complete sunlight exposure is practiced for further seedling growing.
- Growing of seedlings (from seed) to graftable stage requires 6 months to one year depending on species.

TREE CROPS

Jose O. Sargento

- The country is seriously involved in undertaking massive rehabilitation and revegetation of large tracts of open and unproductive lands to ensure sustained supply of goods and services for its people and maintain a sound and pleasant environment.

- Toward this end, the government through the Department of Environment and Natural Resources (DENR) has recently prepared a Master Plan of Forestry Development covering a 25-year period (1991-2015).

- Embodied in this plan is a plantation development program which has targeted the following planting areas through various programs/strategies: 305,000 ha for contract reforestation under the FLMA program, 104,00 ha under the IFP/TLS/TPSA program, 116,000 ha under the community-based forest management program, and 39,000 ha under the agroforestry program (DENR,1990)

- Under the agroforestry program DENR (1990) has also estimated that about 15,000 ha of agroforestry farms shall be established every year from 1996 until the year 2015. Hence, establishment of these plantations will require millions of quality plantable seedlings of various forest and horticultural species.

SOWING TECHNIQUES

- Sowing of seeds is one of the major operations in raising quality seedlings.

- Seedlings could be raised as : (a) bareroot stock, and (b) potted (containerized) stock.

- Barerooted stock are seedlings raised in an open bed from which plants are lifted and planted with roots bare of soil.

- Potted stock, on the other hand, are seedlings raised in individual containers (pots) which are taken to the planting site with a ball of soil around the roots.

A. SOWING METHODS AND MEDIA

- Seeds can be sown in seedbox, or seedbed, or directly in containers, depending on the size and germination capacity of the seeds.

1. Direct sowing, by dibble method, in individual containers/pots for seeds with germination of 50% or better.

♦ One seed per pot for over 75% germination.

♦ Two seeds per pot for 50-75% germination. If both seeds germinate, one can be transplanted into another container. Example: pines, *Moluccan sau*

2. Fine and small seeds can be sown by broadcast method in seedbox filled with a mixture of fine sand and soil. Fine seed could be mixed with filler such as fine sand for even distribution of seeds in germination medium. Example : bagrass, kaatoan bangkal, *Acacia mangium*

3. Medium and large seeds can be sown in seedbed in lines or drills along the length of the bed.

B. Depth of Sowing

- Generally, seeds are sown to a depth equal to their average diameter.

C. Time of Sowing

1. Sowing should be properly timed. Failure to do so could result in undersized or oversized seedlings during planting time.

2. Seeds with short viability period like dipterocarps and mahogany, if possible, should be sown immediately after collection.

3. Generally, the right time for sowing seeds for each species depends on:

    - date of planting out in the field
    - time needed to raise the stock
    - desired size of planting stock (see Table 1)
    - rate of growth of seedlings.

D. Care after Sowing

1. Mulching -- covering the newly sown seeds with thin layer of decomposable materials for the protection of the seed until it germinates.

2. Watering

- By sprinkling, with a fine spray, seeds sown in containers and seedbeds.

- By capillary method for fine seeds sown in seedboxes.

3. Protective shelter (shading) – use locally available materials such as bamboo slats, talahib stalks.

4. Control of damping-off

- To prevent damping-off, use sterilized soil and clean water or water with fungicide (Captan) for watering, and avoid dense seed-sowing.

- To control damping-off, use fungicide following instructions accompanying the chemical (e.g., Terrazole) purchased.

5. Weeding

- Start weeding as early as when the leaves of the favored plants can be definitely identified. Note that weed is a plant out of place.

6. Pricking-out (thinning)

- Prickout or remove young seedlings from their overcrowded condition in seedbox or seedbed to give the seedling adequate space for growth and development.

- Good quality pricked-out seedlings are transplanted either in pots or in transplant beds.

TRANSPLANTING

A. Definition

- Transplanting is the transfer of seedlings from the seedboxes or seedbeds to containers or transplant beds.

- Transplanting into pots/containers is called potting or containerization.

B. Purpose

1. To give each seedling adequate space to grow and develop.

2. To produce hardy plant with numerous fibrous roots and stocky top (crown).

C. Techniques

1. Hole or dibble method -- in pots or beds using a dibble or pointed stick.

2. Trench or furrow method -- in beds using trowel or transplant hoe.

D. Condition of Seedling for Transplanting

1. When seedlings are large enough to handle, at least the first lateral roots appear and stem becomes woody or lignified;

2. When seedling can be adequately maintained by watering and shading.

TENDING

- This involves the care, protection and conditioning treatments of young plants until they are ready for field planting.

- Activities include watering, shading, weeding, fertilizer application, root pruning, conditioning (hardening off), and protection from pests and diseases.

A. Watering

1. Purpose: To maintain sufficient moisture in the root zone to enable the seedlings to make the desired growth.

2. Frequency of watering and amount of water to be applied depend on:

- Species, stage of growth, characteristics and size of the seedling stock, and density of stocking

- Physical condition of the soil

- Weather conditions

- Technical measures applied like shading, mulching, and cultivation which reduce transpiration of the seedlings and evaporation of soil moisture.

3. Correct watering cannot be done by rule, e.g. twice a day, daily. It can only be learned by experience.

4. Method of watering (Irrigation)

- Overhead sprinkling -- sprinkling, spraying

- Surface irrigation -- flooding for depressed beds; for raised beds, furrow irrigation, i.e. flooding between the rows of seedlings or between the raised beds.

B. Shading

1. Purpose/Benefits

- Prevents young seedlings from damage caused by direct sunlight and heat.
- Reduces the evaporation of soil moisture and the transpiration through the leaves.
- Lessens frequency of watering.
- Acts as a buffer during heavy rain.
- Provides shade for workers and their continuous access to seedlings.

2. Types of Shade

- Natural shade -- represented by trees growing in the nursery. Evergreen leaves are preferable, e.g. agoho, *Moluccan sau.*
- Artificial shade -- provided by shading devices placed over the plants such as palm leaves, bamboo, wooden slats, plastic or polyethylene sheets, netting, etc.

C. Weeding

1. Weeding is the removal of weeds. A weed is a "plant growing where it is not wanted." Unwanted plants compete with tree seedlings for light, nutrients, and soil moisture.

2. Methods of weeding

- Mechanical -- by hand, with tools or machine

- Chemical -- use of herbicides or weedkillers by knapsack sprayer or machine-pulled sprayer

3. Time of weeding

- Remove all weeds as early as they could be distinguished from the favored plants.

D. Fertilizer Application (Nutrition)

1. Plant nutrients are chemical elements that are taken up with the soil water by roots and serve as promoters of various vital life processes in the plant organism like photosynthesis, cell division, flowering, fruiting, etc.

2. Forest nurseries generally use compost, fertilizers and, recently, biofertilizers (mycorrhiza)

a) Compost is well decomposed organic matter of all kinds (grasses, forest litters, farm manure, vegetable remains, etc.)

b) Commercial fertilizer (mixed and complete) are generally easy and convenient to apply because different compositions have been prepared and dosage of application determined to suit the nutrient requirements of crops/seedlings being raised. Examples of application of commercial fertilizers to seedlings of some important forest tree species are shown below:

- Bagrass: 6 to 7 grams of Supergrow (10-2-0) or Bestgrow (12-12-12) per seedling 2 months after transplanting.

- Mahogany and yemane: 4 to 5 grams of Urea (45-0-0) and ammonium sulfate (21-0-0) almost 3 months after transplanting.

- Benguet pine, Mindoro pine, and Caribean pine: 0.2 grams of NPK (11-14-14) fertilizer per seedling.

- Teak: 100 mg of granulated fertilizer is added to each polybag/seedling about 7 weeks after transplanting until time of planting.

c) Mycorrhizal Technologies

- Mycorrhiza is a symbiotic association between a fungus and the root of plants.

- All trees grown in the uplands form mycorrhizal association.

- Mycorrhiza is considered a biofertilizer because of its ability to facilitate absorption of nutrients from the soil for increased growth of plants.

- The different mycorrhizal technologies available for reforestation/agroforestation are summarized in Table 2.

E. Root pruning

1. Root pruning is the removal of the lower part of the root system particularly the tap root.

2. The main purpose of root pruning is to prevent the growth of a long tap root and induce the formation of many lateral roots.

3. Beneficial effects of root pruning

- Hardens the seedlings.

- Retards shoot growth.
- Favors the development of plant with a balanced top-root ratio.
- Eases the lifting of planting stock.
- Stimulates root ramification and the development of a compact and fibrous root system.

4. Methods of root pruning

- Potted stock -- by lifting the potted seedlings and cutting the roots found outside the pots using pruning shears or sharp knives.
- Barerooted stock in beds -- by underground root pruning using sharp tools like spade, bolo, or knife, or wrenching/pruning machine.

F. Conditioning (Hardening-Off)

1. Conditioning is the "treatment" given to seedlings while in the nursery by subjecting them to a little "rougher" condition in order to accustom them to the more adverse conditions obtaining in the planting site. This could be done by modifying any or a combination of the tending techniques described. This treatment makes the seedlings "hardier" against unfavorable environmental conditions.

2. Methods/techniques

- Gradual reduction of frequency of watering and amount of water supplied.

- Reduction of frequency of fertilization and amount of fertilizer supplied.
- Skillful regulation of light by gradual removal of shade.
- Root pruning/wrenching.
- Topping or cutting back of shoots.
- Occasionally, spacing.

3. Generally, conditioning is undertaken 4 to 6 weeks prior to dispatch of seedlings.

G. Protection from Pests and Diseases

1. Control of Seedling Diseases

- Diseases of Leaves and Shoots (e.g. leaf spot, blight causes by rust, mildew) -- Use copper fungicides or some of the new organic fungicides such as Terbam, Maneb, Captan, Difolatan.
- Needle browning of pines caused by a pathogen, *Cercospora* species -- Remove all diseased seedlings, and use fungicide Daconil/Bravo (75% ai). About 36 grams in 10 liters of water is sufficient for 5 beds (about 37,500 seedlings), applied with a knapsack sprayer.
- Root rot in pines -- generally occurs as a result of over-watering. Reduce watering and spray fungicides such as Benlate (75% ai). About 40 grams in 10 liters of water is sufficient for 5 beds (37,500 seedlings).

2. Control of Seedling Pests

- Various species of insects attack nursery plants. Insecticides can be used to control them. These are conveniently applied using knapsack sprayer. The type and rate of application of insecticides however vary depending on the pest and the plant species being attacked.

- Example -- In ANZAP (Philippines) termites and crickets attacked *Eucalyptus camaldulensis* and *Pinus caribaea*. To control termites, Dieldrix (30% ai) is applied at 0.04 ml/m_2 in a solution of 1 ml per liter of water. On the other hand, crickets can be controlled by applying Endrin (19.5% ai) at 15 ml in 10 liters of water which is sufficient for 5 beds (37,500 potted seedlings).

SEEDLING STOCK QUALITY

- Good quality seedlings have better chance for survival and early growth in the planting site.

- Quality of seedling stock could be determined by grading/culling.

- Morphological grading/culling of seedling stock could be based on seedling size (height and root collar diameter), age, health and vigor, stem and crown form, root system, and top-root ratio.

- A good example of workable grading system for seedlings of forest tree species has been developed and applied in PICOP (Appendix A).

- Examples of desired sizes and ages of plantable seedling stock of some forest tree species are shown in Table 1.

DISPATCH

- Preparation of planting stock for dispatch varies depending on the type of planting stock. i.e., bareroot or potted.

- Generally, this is conducted during the planting season.

a. Bareroot or Stumped Stock

i. To facilitate lifting of seedlings and with less injury to rootlets, seedbeds/transplantbeds are watered and appropriate tools are used.

ii. After lifting, long tap roots of seedlings are pruned while some leaves of broadleaved species are trimmed.

iii. Seedlings are tied in bundles, root system soaked in a moisture-retention medium like sticky mud, and wrapped with moist materials like fresh banana sheath or wet gunny sack.

b. Potted Stock

i. After lifting, long tap root and other roots found outside the pot/container are pruned and some leaves of broadleaved species are trimmed.

ii. Seedlings are then placed in containers like basket or box which could be conveniently handled and transported by field workers.

iii. Before leaving the nursery, seedlings are given good watering.

WILDLING STOCK CULTURE

- Wildlings are seedlings growing naturally under the forest canopy.

- These could be used as substitute for nursery-grown stock (i.e., seedlings).

- However, their survival in the planting site is generally low if they are outplanted without passing through a hardening (conditioning) process.

- Hence, they are lifted and transported in the nursery, taken care of and subjected to hardening/conditioning treatments to increase their chance of survival in the field.

- Some of the forest tree species that could be planted as wildlings are narra, mahogany, molave, yemane, raintree, lumbang and palosanto.

CONCLUDING REMARKS

- Each forest tree species has specific growth requirements. This requirement becomes complex when the plants are mixed with other plant species as in the case of agroforestry farms.

- Hence, a nursery and plantation person should have intimate knowledge and adequate skills in raising each species in order to ensure a successful plantation development program.

- Additional research is needed for many more forest tree species particularly indigenous ones in order to tap their economic and ecological potentials.

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APPENDIX A: Examples of morphological grading system of plantable seedlings at PICOP nurseries (Tagudar, 1976)

1. Bagrass

Grade	Description
A1	Healthy and vigorous, dominants; 35 cm and up; 8-9 weeks old or younger; thickness of stem at ground level 1/2 cm and up; long internodes almost all ___ cm and up; large and abundant leaves
A2	Same as A1 except that seedlings under this grade have height range from 30 to 35 cm, stem thickness 2/5 cm to 1/2 cm and internodes 3 to 5 cm
B1	Healthy and vigorous; all dominants; 25-30 cm., 8-9 weeks old or younger; thickness of stem at ground level 2/5 to 1/2 cm, internodes 3-5 cm
B2	Same as B1 except that seedlings have height range from 20 to 25 cm, slightly thinner stem and shorter internodes
C	Healthy and of good form; all intermediates 15-20 cm tall; not yet plantable but salvageable
D	All suppressed; malformed and sickly (regardless of health), considered culls, all must be condemned and thrown out

2. Moluccan sau

A1	Healthy and vigorous; all dominants; 25 cm and up; 6-7 weeks old or younger; thickness of stem at ground level 2/5 cm and up to internodes 5 cm and up; large and abundant leaves
A2	Same as A1 except that seedlings under this grade have height range from 20 to 25 cm, stem thickness 1/5 cm, internodes 2 - 4 cm
B	Healthy and vigorous; all co-dominants; 15-20 cm and up; 6-7 weeks old or younger; thickness of stem at ground level 1/5 - 2/5 cm, internodes 1-1/2 - 4 cm
C	Healthy and of good form; all intermediate 5-10 cm tall; not yet plantable but salvageable
D	All suppressed; malformed sickly (regardless of height), considered culls, all must be condemned and thrown out

3. Pine species

A1	Healthy and vigorous; all dominants; 25 cm and up; 4-5 months old or younger; thickness of stem at ground level 1/2 cm and up; abundant needles and spreading branches
A2	Same as A1 except that seedlings under this grade has solitary stem with no side branches; thickness of stem 2/5 cm to 1/2 cm
B	Healthy and vigorous; all co-dominants 20-25 cm and up 4-5 months old or younger; 2/5 cm to 1/2 cm abundant needles and spreading branches
C	Healthy and of good form; all intermediates 15-20 cm tall not yet plantable but salvageable
D	All suppressed; malformed and sickly (regardless or health), considered culls, all must be condemned and thrown out

Only the As and Bs are sent out for planting and are planted in separate blocks. The Cs are retained in the nursery for rehabilitation. The Ds are thrown out.

Table 1. Nursery growing period, plantable size, and type of planting stock of some forest tree species in the Philippines. (Sargento, 1989)

SPECIES	NURSERY GROWING PERIOD in germination bed (week)	NURSERY GROWING PERIOD in pots/ transplant bed (month)	PLANTABLE SIZE (Morphological Grade) Height (cm)	PLANTABLE SIZE (Morphological Grade) Stem dia. at root collar (cm)	TYPE OF PLANTING STOCK
1. Agoho	6 - 8	12-18	20-30		potted
2. Alnus	1 - 2	5-6	20-30		potted
3. Bagras	2 - 4	1.5-2	25-35	0.5 & up	potted
4. Benguet pine	2 - 4	7-8	15-20		potted
5. Caribbean pine	2 - 4	9-12	25-30		potted
6. Dipterocarp spp. (white lauan, bagtikan, etc.)	1 - 4	11-12	25-30		potted
7. Giant ipil-ipil	5 - 6		15-30		potted
8. Gubas	3 - 6	1-2	15-30		potted
9. Kaatoan bangkal	8 -10	3-4	15-30		potted
10. Mahogany	2 - 4	5-6	20-30	0.5 & up	potted
		11-12	75-100		bareroot
11. Mangium	1 - 1	2-2.5	20-25		potted
12. Mindoro pine	2 - 4	1-2	10-15		potted
13. Moluccan sau	1 - 2	1-2	10-15		potted
14. Narra	2 - 4	5-6	20-30	0.5 & up	potted
		11-12	75-100		bareroot
15. Red river gum	2 - 4	3-4	30-40	0.5 & up	potted
16. Teak	3 - 6	12-14	100-150	2-4	stump cuttings
17. Yemane	8 -10	5-6	20-30		potted
		12-14	100-150	2-4	stump cutting

Table 2. Different mycorrhizal technologies for reforestation. (PCARRD, 1992)

Mycorrhizal Type	Mycorrhizal Technology	Manner of Application	Tree Species
Ectomycorrhiza:	1. Mycorrhizal soil	Mixed with potting soil (5-10% by volume)	Pines
	2. MYCOGROE Tablets	1 tablet per plant in the nursery	Pines, agoho, Eucalyptus, Dipterocarps
Endomycorrhiza	MYKOVAM 1	1-2 per plant in the nursery	narra, yemane, mahogany, ipil-ipil, Acacias, falcata, etc.

NON-TIMBER FOREST CROPS

Jose O. Sargento

- Non-timber forest crops include trees and shrubs which produce bast fibers, or fruits/seeds and juice/sap for food and beverages. They also include erect and climbing palms, ferns, vines, and grasses.

- In recent years, proper attention has been paid to the importance of the non-timber forest products, especially in their local context where they may be considerably more valuable than the timber (wood) obtained from the forest.

- The continued destruction of our remaining forests has drastically and adversely affected the supply of raw materials of the non-timber forest crops for our flourishing industries. To help remedy the situation, establishment of plantations of commercially important non-timber forest crops is imperative.

I. ERECT BAMBOOS

Description and Habitat

- Bamboos are perennial giant grasses that belong to the family Graminae.

- They have woody stems or culms arising from rhizomes.

- Culms are cylindrical with a series of nodes and internodes.

- Thickness of the culm wall varies. Some culms have thin walls, while others are nearly solid inside.

- Bamboos also vary in stem diameter and height.

- Bamboo grows in a wide range of site conditions both in the tropical and temperate areas with elevation ranging from about sea level to about 3,200 meters above sea level.

- Most species of bamboo grow in areas with an annual temperature ranging from 8°C to 36°C.

- Bamboo grows best in clay-loam soils derived from river alluvium or from underlying rocks.

- A soil pH ranging from about 5 to 6.5 is most suitable for growing bamboos.

Economic Importance

- Bamboo is a highly versatile and cheap raw material very much suited to low cost housing, furniture and handicraft manufacture, fishpen industry, banana industry, pulp and paper manufacture, musical instruments and ornamental artifacts.

- Bamboo shoots are cooked as food.

- As a reforestation species, bamboo helps control erosion, stabilizes river banks, and beautifies the landscape.

- Not all bamboo species (both erect and climbing types), however, could be used for all the above purposes. Some of them have limited but special uses (Table 1).

Table 1. Some bamboo species growing well in the Philippines and their economic importance (PCARRD, 1984; Virtucio, 1991).

SPECIES	ECONOMIC IMPORTANCE									
	A	B	C	D	E	F	G	H	I	J
Anos (*Schizostachyum lima*)						x	x			x
Bayog (*Dendrocalamus merrillianus*)	x	x	x		x		x	x	x	x
Bikal (*Schizostachyum diffusum*)		x					x			
Bolo (*Gigantochloa levis*)	x	x	x	x	x			x	x	x
Buho (*Schizostachyum lumampao*)	x	x		x		x	x			x
Botong (*Dendrocalamus latiflorus*)		x							x	
Giant bamboo (*Gigantochloa aspera*)	x	x	x			x	x		x	
India bamboo (*Bambusa arundinaceae*)							x			x
Kawayan-china (*Bambusa multiplex*)							x			x
Kawayan-kiling (*Bambusa vulgaris*)	x		x				x	x		x
Kawayan-tinik (*Bambusa Blumeana*)	x	x	x	x	x		x	x	x	x
Kayali (*Gigantochloa atter*)				x						
Laek (*Shaerabambos philippinesis*)				x						x
Pole-vault bamboo (*Phyllostachys nigra*)							x			x
Spineless India bamboo (*Bambusa tulda*)							x			x
Utod (*Yushania nitakayamensis*)						x				
Yellow bamboo (*Bambusa vulgaris* var. *striata*							x	x	x	x

Economic Importance:

A - Housing and other construction
B - Handicraft industry
C - Furniture industry
D - Fishing industry
E - Banana Industry
F - Musical instruments
G - Pulp and paper industry
H - Food preparation
i - Deformed or structure bamboos
J - Erosion control and landscape beautification

Propagation Methods

- Bamboos can be propagated using either the reproductive (sexual) or vegetative (asexual) method.
- The reproductive method uses seeds.
- The most commonly used vegetative methods include clump division (offset planting), culm cuttings and branch cuttings.

↳ *Reproductive Method (Propagation by Seed)*

- The reproductive method is not practical in most bamboo species because of prolonged flowering cycle.
- If ever they flower at all, a large number of seeds normally have very, very low viability.
- Seeds are sown immediately in seedbox containing top soil.
- Germinated seedlings that are about 2 months old, are transferred into plastic bags containing top soil.
- Seedlings are maintained in the nursery until they reach plantable size of 30-50 cm tall, with 2 to 3 new shoots produced and have green leaves and fresh scales or hair on their leaf sheathes.

↳ *Vegetative Method*

1. Clump Division (Offset Planting)

- This involves separating clump portions (one-half or smaller) and transplanting such clump fractions in another area.

- Common and practical method of clump division is by single-clump offset planting.

- 1-year-old culms with rhizome are severed from the clump when the lateral buds of the rhizomes are still dormant or before they have pushed more than 5 cm.

- In producing offsets, care should be observed so as not to injure the buds or "eyes".

- This method assures better survival than other methods and has the advantage of developing plantations faster and reaching maturity earlier.

- The method is laborious, time-consuming, depletes the clump source, and entails expensive transport.

- The method is applied to *Bambusa, Dendrocalamus,* and *Schizostachyum* species.

2. Branch Cuttings

- This involves cutting of three-node cuttings from basal and middle portions of primary branch which developed rhizomes and aerial roots from 1- to 2-year-old culms.
- Cuttings are rooted in plastic bag containing a 1:1 mixture of sterilized and sieved forest soil and riversand.
- With regular watering, the branch cuttings are expected to produce roots and sprouts within a 90-day period.
- Branch cuttings are the cheapest available and practical method of propagation.
- Cuttings are convenient and easy to handle for field planting.
- The method is applicable to giant bamboo, striated bamboo, kawayan kiling, kawayan tinik, bayog and boho.

3. Culm Cuttings

- This method is the most common and practical method of mass-producing planting stock
- The specific steps involved are as follows:

a) Select 1½-to 2½-year-old culms from a good clump.

b) Remove the selected culms from the mother clump.

c) Use saw or sharp bolo to cut the culm into 1- or 2-node cuttings.

d) Place immediately the 1- or 2- node cuttings in a vertical or inclined position in a polyethylene bag containing top soil with the lower node well covered with soil.

e) Water potted cuttings daily in a shaded area during the first month with the top portion of the culm cavity always filled with water to prevent desiccation.

f) Three weeks after potting, apply 10 g of complete fertilizer (14-14-14) to provide adequate nutrients to the propagules.

g) After about 1 month in a shaded area, transfer the potted cuttings with sprouted buds to an open area to harden before outplanting. One week before outplanting, watering should be discontinued. The potted cuttings are plantable in the field once they have stayed in the nursery for about 4 months.

4. Pre-rooted and Pre-rhizomed Branches

- Regularly debudding the rhizome and severing the newlyemerged culm from the clump enhance development of aerial roots and rhizomes at some branch bases.

- Branches which are already pre-rooted and pre-rhizomed are cut and used as propagules.

- This method can facilitate propagation of bamboos

- Branches are light, easily available, cheap and easy to handle both in the nursery and in the field.

- This method has been tried in kawayan-kiling.

II. RATTANS

Description and Habitat

- Rattans are spiny climbing palms that grow abundantly at low to medium altitudes in the forest of South and Southeast Asia, the Pacific, and West Africa.

- They also thrive in thickets or in open country.

- The ASEAN region, particularly in Indonesia, Malaysia and the Philippines has the most number of rattan which consists of 12 recognized genera consisting of about 600 species.

- Not all rattans are useful. Only few species are commercially exploited and cultivated.

- In the Philippines, the most commonly used are palasan (*Calamus merrillii),* limuran *(C. ornatus* var. *philippinensis*), sika (*C. caesius*) and ditaan (*Daemonorops mollis)*

Economic Importance

- Poles/canes are useful in the manufacture of furniture, handicraft items, fish traps, twines, hats, walking sticks, baskets and mat-making, among many other items.

- Shoots and fruits of some species are edible.

- Sap from rattan fruits is used as dye and medicine (for treating rheumatism, asthma, diarrhea, snake bites, and intestinal disorders).

Propagation

- Rattans could be grown successfully by using seedlings, wildlings and tissue-cultured clones.

- The use of tissue-cultured clones is still new. Initial success was observed in palasan, limuran and ditaan in the Philippines (Garcia and Sanchez, 1990 and Sargento and Sanchez, 1990).

1. Seedlings

a) Seeds are extracted from ripe fruit by manual crushing or smashing the fruits in water to separate the seeds from the scales.

b) To hasten seed germination, each seed's hilar cover is removed by using a sharp pointed object, or by placing the seeds in moist gunny sack under room temperature for 3-5 days.

c) Seeds are sown in boxes lined with moist sterilized gunny sack and covered with same materials.

d) Germinants are potted in polyethylene bags containing 1:1 river sand and top soil, or 1:2 humus and top soil.

e) Complete fertilizer (14-14-14) may be applied at a rate of 4-5 g per seedling to enhance growth.

f) Seedling should be maintained in a shaded area with about 50-60% transmitted light.

g) Seedlings are ready for outplanting after 8 to 12 months in the nursery, or when they have produced 4 to 5 expanded leaves.

2. Wildlings

Wildlings are young plants naturally growing on the forest floor.

a) Wildlings with 2-3 expanded leaves should be collected during the rainy seasons.

b) Wildlings are transferred to polyethylene bags containing a 1:1 top soil and compost.

c) Potted wildlings are maintained in a shaded area with about 50-60% transmitted light for 2 to 4 months before outplanting.

3. Tissue-Culture Clones

The procedure in propagating rattans by tissue culture are as follows (Garcia and Sanchez., 1990):

a) Cabbage tissues from either sucker or wildling of rattan are used for meristem culture.

b) These are subjected to sterilization/decontamination, inoculation, culture and maintenance procedures.

c) Cultured leaflets and roots are transferred from culture vessels to polybags containing a mixture of sieved forest topsoil and compost.

d) These are maintained in the nursery for 3 to 5 months for acclimatization prior to outplanting.

III. ANAHAW OR FAN PALM

Description and Habitat

- Fan palm or anahaw (*Livistona rotundifolia* (Lam) Mart.) is an erect palm 15 to 20 m tall and about 25 cm in diameter.
- Its native habitat is South and Southeast Asia.
- Typically, it occurs beneath the canopy of dipterocarp and mixed forest species.
- With proper care, it will live for about 50 years.
- Its ability to grow in shade may aid in its establishment in brushy or forested areas.
- It is usually found at low to medium altitudes -- the leaves are smaller at higher altitudes.

Economic Importance

- Leaves are used as thatch, or made into raincoats, hats, fans, containers for boiling water or rice, etc.
- Buds and shoots are edible.
- Nuts are eaten when young and green.
- Mature trunk is used for house parts, fishpens, poles, fuel, and split into strips for flooring.
- Planted as ornamental, both indoors and outdoors, as well as for watershed protection purposes.

Propagation

- Fan palm is propagated from seeds.
- To hasten germination, the hilar cover of the seeds is removed and then the seeds are stored in damp jute sack treated with fungicide.
- Seeds are sown in beds.
- Germination takes place in 2 to 3 days.
- Germinants are transplanted into pots filled with garden soil.
- Seedinngs are ready for outplanting once they have attained about 20 cm long leaf, or 2 to 3 expanded leaves.
- When using bareroot wildlings as planting material, they are carefully dug, mudpuddled and taken directly to the planting site.
- Preferably, they should be cultured and hardened in the nursery prior to outplanting.

IV. BURI PALM

Description and Habitat

- Buri or buri palm (*Corypha utan Lamk.*) is an erect palm, with straight trunk, constricted below the crown, attaining 20 m in height and 70 to 100 cm in diameter.
- The plant lives up to more than 30 years during which large quantities of starch are collected in the trunk.

- It then flowers and bears fruits once, then dies.
- This is one of the limitations of buri, that is, seed is produced only once, just before the tree dies.
- Buri occurs on flat or gently sloping land at low and medium altitudes, and it is most abundant in secondary forest.
- It is reported to grow well on soil even with a pH of 4.65 (acidic).
- Following fires in which its leaves are burned off, it may resprout if the growing bud is not killed.

Economic Importance

Leaves

- Soft leafbuds are eaten raw (salad) or cooked.
- Bud yields sap for beverage (tuba) and for making vinegar, syrup and muscovado sugar.
- Unexpanded leaves are used as cropping fibers and strips from unexpanded leaves are made into hats, mats, bags, and baskets.
- Petiole yields buntal fibers used for making Lucban hats
- Mature leaves are good for thatch.
- Midribs are raw materials for furniture and for making brooms, and woven into high quality hats and cigarette cases.

Fruits

- Fruits are cooked as sweet meat.
- Seeds are used for rosary beads, playing marbles and buttons.

Trunk

- Edible starch is extracted from the young trunk (ubod).
- Mature mainstems are used for flooring, panelling stairs, bridge construction, and culverts.

Note: Buri palm is also planted as ornamental and for soil erosion control purposes

Propagation

- The only known means of reproducing buri is by seeds.
- There are about 490 seeds/kg.
- Seeds should be collected from the trees, cleaned, dried, and stored in dry, airtight containers.
- Viability is maintained for several months.
- In nature, germination can take 1 to 2 years.
- Removal of the hard fibrous seed cover shortens germination time to 1 month.

- Seeds sown in sterilized garden soil germinate in 8 months with 70% germination.

- They are transplanted in polyethylene bags filled with garden soil.

- They are maintained at the nursery until the seedlings have 2 fronds, which means they are already plantable.

- Wildlings with 2 fronds can be transplanted with 90% survival if they are watered daily and placed in partially shaded area between lifting and outplanting.

V. KAONG OR SUGAR PALM

Description and Habitat

- Kaong or sugar palm [*Arenga pinnata* (Wurmb) Merr.] is an erect palm reaching a height of 15 m and a diameter of 40 cm.

- It is widely distributed at low and medium altitudes, in ravines along streams and areas under semi-cultivation.

- It is occasionally found in virgin forest, even in an altitude of about 1,200m.

Economic Importance

- Mature plants of kaong are even found in agricultural plantations yielding various kinds of raw materials of commercial importance.

- Kaong yields sugar, starch, fermented drink, alcohol, thatching materials, midribs for making brooms and fibers that are used in industrial work and cottage industries.

Propagation

- Except planting of bareroot wildlings, there is no known cultural treatment so far applied to kaong.

VI. SALAGO

Description and Habitat

- Salago (*Wikstroemia spp.*) is a forest shrub of medium size which can attain a height of 3 meters.

- It grows in thickets in primary and secondary forests at low and medium elevations.

- It is known to thrive even in poor soil but for best yield it prefers well-drained soil.

- It is drought tolerant and can easily establish with the least nutrient requirement.

- It can grow and tolerate partial shading as it has shown good growth when planted under coconut plantation.

Economic Importance

- The fibrous material in the bark of salago is an excellent raw material for the manufacture of security and onion skin paper while the short fiber in the stem is used for the manufacture of high-grade papers.

- This fiber also a promising raw material for the manufacture of currency paper, bank notes, paper checks, bond paper for legal documents, certificates, insurance policies, and stencil papers.

- The fibers are likewise used for making ropes, fishlines, nets, clotheslines, sacks, strings, cordage and textile fabrics, cords, strainers, mosquito nets, bags, wallets and hats (Lapis 1991, PCARRD 1988).

Propagation

- Salago can be propagated by seeds and vegetative means; the most common method is by seeds.
- Seeds are collected manually. Ripe fruits are usually yellowish to reddish.
- To extract the seeds, the fruits are macerated until the seeds are separated from the pulp.
- Dry the seed under the sun for two to four hours.
- Seeds are soaked in water overnight before sowing.
- Seeds may be sown in germinating medium composed of 1:1 mixture of river sand and top soil.
- To minimize damping-off, germination medium should be sterilized by pouring hot water.
- Germination occurs from 7 to 15 days after sowing.
- The germinated seedlings are potted on individual plastic bags when the first pair of leaves appear, about 20 days after germination.
- The ideal potting medium is a 1:1 mixture of river sand and top soil.

- Hardening procedures involve reduced watering and gradual exposure to full sunlight two months before outplanting

- Seedlings are ready for outplanting 4-6 months after transplanting (UPLBFI-RRDF-DENR, 1991).

VII. NITO

Description and Habitat

- Nito (*Lygodium circinatum*) is a slender, cluster forming and climbing fern.

- The climbing part is actually the leaf which is of indefinite growth and length.

- Nito thrives well in friable and well-drained soil.

- It grows in altitude ranging from about sea level up to 630 meters above sea level.

- It grows in both open and partially shaded areas, over shrubs and climbs into trees.

- It is most abundant in uncultivated coconut stands, cogonal areas, second-growth and virgin forests.

Economic Importance

- The splints prepared from nito are used in the manufacture of baskets, hats and fancy boxes.

- Nito splints combined with buri make various fancy articles like cigarette cases.

- The shoot of nito has medicinal uses.

- When chewed and applied to wound caused by a bite of venomous insects or reptiles, it neutralizes the poison.

- Nito is used as a substitute for *Helmintostachys zeylanica* in cases where a protective medicine is desired after child birth (PCARRD, 1988; Piñol, 1991).

Propagation

- Nito could be propagated either by spores, rhizomes, or tissue culture (Dr. M.U. Garcia, personal communication).

VIII. TIKOG

Description and Habitat

- Tikog (*Fimbristilys globulosa*) is a member of the grass family whose stalk reaches a height of about 1 meter in average sites and 3 meters in excellent sites.

- It occurs abundantly at low altitudes in settled areas and in wet and swampy areas.

- In some areas, it grows in association with rice.

- The plant is moisture-loving, but can nevertheless thrive for more than 6 months of continuous drought.

- The conditions in Samar, Leyte, and Bukidnon appear favorable for growing tikog (PCARRD, 1988; Piñol, 1988).

Economic Importance

- The stalks of tikog either whole or split are used in the manufacture of mats.
- Tikog mat weaving has become an industry in itself in Samar and Leyte, playing an important role in the region's economy.
- Tikog is also used for making hats, bags, slippers, tobacco cases, cushions and similar products.

Propagation

- Tikog could be propagated by suckers which are directly planted on the ground like rice (palay) farming.
- No nursery practices needed.

CONCLUDING REMARKS

- Non-timber forest crops provide various products of subsistence value as well as raw materials for cottage industries, large-scale commercialization, and export.
- Because of their varied economic importance and suitability for integration into an agroforestry system, propagation and cultivation of non-timber forest crops could help solve the problems of land degradation and poverty in the countryside particularly the uplands.
- However, more research works have yet to be accomplished on propagation techniques for most of the non-timber forest crops in order to ensure rapid mass propagation and production of planting materials to meet the increasing demand and maximize their economic potentials.

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