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VOCATIONAL GUIDE

IN

APPROVED CACAO CULTURAL PRACTICES

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PREFACE

Cacao was first introduced into the Philippines from Mexico in 1670. Since that time, cacao has been produced here, but not on a commercial scale which would support an export industry. Since 1954, the Philippines has imported approximately four to five million pesos worth of cacao and cacao products annually. Efficient production of cacao will help to uplift the economy of the country by saving the dollars spent for importing this commodity and furnishing an income for the local growers. A cacao plantation which is properly managed will earn a very high return or profit on the investment. The Philippine National Bank estimates this return to reach as high as 30.7 percent. There is presently a world-wide and local shortage of cacao and it will be many years before production can adequately cope with the demand. This ensures a very favorable local market and/or dollar export commodity.

The soil and climate in many areas of the Philippines are ideal for profitable cacao production. It is a crop which lends itself to farm-home backyard, as well as large scale production, since no particular problems are encountered in caring for and preparing the beans for market. Production of cacao will not compete, for land, with the production of the staple food crops. Cacao grows well on hilly land where cultivated staple food crops should not be planted. Thus marginal and non-farmable land is used for food production and to earn a high rate of profit.

Cacao products are wholesome, nutritious foods well liked by

nearly all Filipinos. Processing plants have been constructed in the Philippines with which to process the locally grown crop. In addition to the advantages mentioned, production of cacao will foster and encourage local industry.

This guide will be useful to the teachers in the agricultural schools in preparing lesson materials for teaching the students; to the students and farmers as a source of information about cacao production and processing; and to other government agricultural agencies in the preparation of materials for demonstrating approved methods of cacao production and processing.

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RAISING CACAO AS A CASH CROP

A. Climate

1. Cacao grows best where:

   a. The temperature ranges from 70° to 90°F.

   b. Rainfall is evenly distributed throughout the year or there is only a short dry period.

   c. There is minimum fluctuation in the soil moisture, atmospheric temperature and humidity.

   d. Cacao trees are not subjected to sudden or pronounced desication.

   e. Typhoons are not common, because they adversely affect production.

2. Ample shade trees and windbreaks reduce the movement of air, thus reducing moisture evaporation.

   a. Cacao will not grow if the climate is dry and hot. Irrigation may supply needed moisture for short periods in absence of rainfall.

3. The young leaves are extremely sensitive, even to breezes.

4. In the Philippines, cacao thrives at elevation from sea level to 1000 meters, if temperature does not drop below 60°F.

B. Soil

1. Plant trees in a deep, porous, loamy, fertile, well-aerated soil.

   a. The soil must be loose and friable, not impervious and sticky, to allow excess water to sink through and permit free circulation of air within the root feeding area of the plant.

   b. Cacao grows and produces much better on loam, silt loam or clay loam soils than it does on sandy, or heavy clay soils.

2. Deep, well-drained soil is necessary because a complete loss of the crop may result when the soil is flooded or waterlogged for long periods of time.

3. The water table must drop to not less than three feet below the surface of the ground soon after a heavy rainfall.

4. Soils high in organic matter are necessary to promote satisfactory growth and yield.

   a. Well-aerated organic matter, litter or mulch, promotes extensive growth of feeder roots.

   b. Feeder roots of cacao are believed to manufacture a special hormone from the organic matter which is essential to the normal, healthy growth of the tree.

c. Mycorrhiza (a type of fungus) which flourishes in soils with high organic matter content aids in the nitrogen and mineral nutrition of cacao.

5. A neutral or slightly acid soil PH 6.5 produces the highest yield.

6. Do not plant cacao on heavy, clay soils that harden and crack during dry periods.

7. Cacao will thrive well on soils that produce good crops of corn, bananas, robusta coffee or avocado, and where wild fern grows well.

C. Selecting Varieties

1. Criollo

a. Only variety grown in the Philippines with very rare exceptions.

b. Native of Central America, Colombia and Western Venezuela.

c. Pods are long, pointed, thin-walled, warty and deeply ridged.

1) Red, white or lead colored.

d. Seeds are large, oval and white or pale violet in color.

e. Produce higher quality products than forastero.

f. Varieties recommended are red or white criollo.

2. Forastero

a. Native of the Amazon and Orinoco River basins.

b. Pods are variously shaped, with smooth, thick hard walls.

c. Fresh beans are purple in color, bitter and relatively flat.

Typical criollo pods are long pointed and deeply ridged with a warty appearance.

The different forms of Forastero pods.

d. Produces lower quality products but is more productive than criollo. Constitutes approximately 80% of world output of cacao.

e. Variety recently introduced in the Philippines but still being tested.

3. Trintario (Criollo-Forastero crosses or hybrid Forastero).

a. Produce a wide variety of pod forms which are classified according to shape:

1) Angoleta or Liso-Criollo-like.

2) Cundeamor or Cundeamor Verrugosa - bottle-necked.

3) Amelonado - melon form.

4) Calabacillo - globular and smooth like a squash.

b. These varieties were recently introduced into the Philippines but are still being tested.

c. Suggest the trinitario as well as the forastero not to be planted in the Visayas and Mindanao provinces; in order to protect the purity of the choice, high quality criollo cacao in these areas.

4. Commercial classifications of cacao.

a. Flavor or choice quality types

1) Nearly always contain criollo influence.

b. Ordinary or bulk types

1) Nearly always contain forastero influence.

D. The Cacao Plant

1. An evergreen tree.

The cacao tree is an evergreen with large, dark-green leaves. More branches are produced than are necessary for maximum fruit production.

a. Attains maximum height of 4 to 5 meters in 10 or 12 years.

b. Size of tree is influenced by type and fertility of soil and climatic conditions.

2. Root system is shallow and sensitive to severe drought.

a. Produces a taproot about one meter deep.

b. Numerous secondary side or lateral roots branch from taproot in upper 40 centimeters of soil.

c. Largest percentage of fine roots and fibrous rootlets are confined in surface 30 centimeters layer of soil, especially in the rotting organic matter and humus on the surface of the ground.

d. Horizontal spread of roots averages five meters.

3. Stems and Branches

a. When grown from seed, a straight main stem forms first.

b. At height of one to one and two-thirds meters, stem forks into a jorquette of two to five almost horizontal branches.

c. At later stage, vertical shoots (water sprouts or chupons) grow from the main stem below the jorquette.

1)Chupons form a jorquette the same as the main trunk.

2) Remove most of the chupons at early stage of growth.

d. Chupons arise from old wood.

e. Fan branches grow from jorquettes or as secondary horizontal branches and are called auxiliaries.

Jorquette is indicated by circle showing five branches growing from the same level or plane on the tree.

4. Leaves

a. New shoots or leaves (flush) are produced several times a year.

1) Before a new flush grows, the tree sheds about one-half of its leaves.

2) The flush replaces, with new leaves, those that have been shed.

5. Flower

a. Flowering varies among trees.

b. May vary on the same tree at different months of year.

c. Bear flowers throughout the year but there are two periods when flowering is heaviest.

1) Results in two main harvesting periods.

2) Main crop when most of the pods are produced.

3) Mid crop when a lesser amount is produced.

d. Flowers produced on the main trunk and older parts of the branches.

e. Healthiest trees may flower on trunk when three years old, but very few fruits are produced at this age.

f. Flowers are white or rose colored.

6. Pollination

a. Flowers start to open in evening and continue during night.

b. Anthers dehisce pollen before sunrise.

c. Stigmas are receptive from sunrise to sunset of first day.

d. Pollination on second day gives very low percentage of fruit sets.

e. Pollinated by insects.

1) Flying and crawling

a) Ants

b) Thrips

c) Wasps

d) Flies

e) Bees

d) Possibly Aphids

7. Fruit Setting

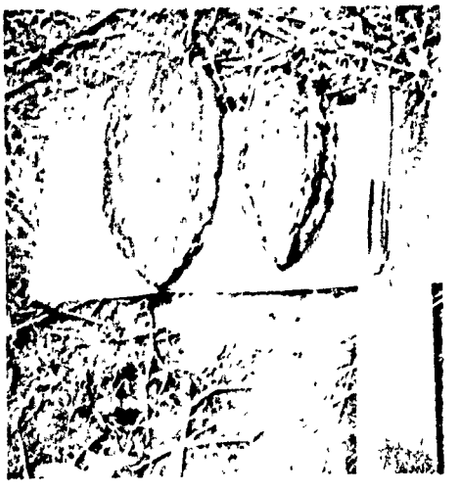
a. A very small percentage, 2 to 4 per cent, of the flowers produced, develop into fruit.

1) Pollen grains are of sticky nature and difficult to transfer to receptive stigmas.

2) Fruit setting is possibly restricted by a new flush which deprives the reproductive activity of food nutrients.

3) Self-sterility of flowers and between other flowers on the same tree reduces fruit setting.

8. The Pod



Cacao pods.

a. Fastest growth occurs during fourth month after fertilization.

b. Attains maximum growth in about five months.

c. Matures during sixth month.

d. Contains twenty to forty seeds. Fifty is the maximum possible because this is the number of ovules in the ovary.

1) Each seed is surrounded by a sheath of mucilage and;

2) Embedded in a pulp.

e. Large variation in number of seeds produced due to:

1) Loss of ovules at time of fertilization due to lack of pollen grains when stigmas are receptive.

2) Physiological factors that hinder growth of pollen tubes.

3) Abortion following fertilization.

E. Establishment of a Plantation

1. When selecting desirable mother trees as the source of propagating materials.

A preliminarily-selected, heavily-laden cacao tree, indicating high yield. The white tag is identification to facilitate keeping production records for final selection of mother tree.

a. The inherent production capacity and vigor of seedlings the cacao planter uses will determine a considerable degree of his success.

b. Extreme importance must be given to selection of seeds and care and management of the subsequent seedlings.

c. Yield is a factor of prime consideration.

1) Selection for yield is based on:

a) Number of matured pods produced, per tree, per year, with not less than 75 as a minimum.

1)) 75 large pods will yield approximately 3 kilos of dry beans.

2)) Just prior to the two main harvest periods, usually March and September.

a)) Count the pods on the selected mother tree.

b)) If 40 or more mature or nearly mature pods are on the tree at this time, the tree will normally produce 75 pods per year.

c)) After the 40th mature, healthy pod is harvested, the tree should be well covered with flowers and new young fruits, if a total of 75 pods is to be produced.

b) Size of the pods, large and uniform in shape.

c) Pod index

1)) Number of pods required to produce a kilo of dry beans.

)) Percentage of dried beans obtained per pod.

a)) Determine fresh weight of seeds including pulp from a known number of pods from a tree.

b)) Approximately 40% of fresh weight will be weight of dried beans.

c)) Approximately 60% of fresh weight will be lost in fermentation and drying.

d)) Pod index formula*

Pod index - number of pods from which seeds were extracted divided by calculated weight of dry beans in grams X1000.

e)) Prefer fruitful trees with a pod index of not more than 25.

d) Ordinarily, about 30 pods will be required to produce one kilo of dried beans.

d. Individual tree records should be kept to determine which trees produce the greatest number of pods.

e. Mark with a system of identification trees which are chosen in preliminary selection.

1) The final selection of the mother tree is made after:

---

*Cacao: I. How to Raise Seedlings. Coffee and Cacao Institute of the Philippines, Manila, 1958.

a) The yield per tree is interpolated to yield per hectare.

b) One tree may be larger or occupy a wider area than another tree, resulting in a larger yield of dried beans.

1)) Due to this, compute yield of selected trees on a per hectare basis.

2)) Determine size of tree and actual space it occupies. Then compute number of such trees that could occupy a hectare.

3)) Estimate by proportion the yield for one hectare.

4)) Trees giving greatest computed yield per hectare are selected as sources of planting material.

Select trees with other characters such as:

1) Resistance to pests, diseases and adverse conditions.

a) Select trees unaffected or only slightly affected by disease when there is a heavy infestation in the plantation.

1)) Immediately following a week of rainy weather or fog, in October, November or December.

2)) At this time, the incidence of pod rot is usually high.

3)) Crop is at its heaviest yields.

b) Resistance to disease is second only to production.

1)) A high-producing, non-diseased or only slightly diseased tree, which is surrounded by diseased, low-producing trees, indicates high production capacity and resistance to disease.

2)) Such a tree with two or three diseased pods should not be discounted.

2) Vigor.

3) Final determination of these characteristics can be determined by individual yield of pods and marketable beans of acceptable quality.

g. Do not select young trees which have not reached full bearing.

1) These trees have not proven their capacity for production.

2) Select from trees between 12 and 15 years old.

h. Select for quality based mainly on size and form of beans.

1) Large in size, uniform in color and shape, plump and possessing fine aroma and flavor.

2) Manufacturers prefer uniform, plump beans.

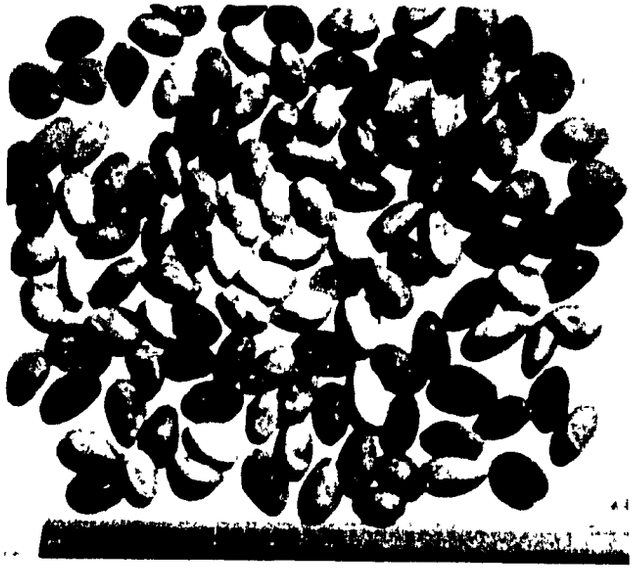
Large, plump, uniform beans roast more evenly and produce better flavor. Flattened non-uniform beans on right produce poor flavor and do not roast evenly.

a) Can be roasted more evenly than flattened, non-uniform beans.

b) Give better flavor.

3) Plumpness or roundness of the beans is a criollo characteristic.

4) Well-developed, plump, smooth seeds give higher percentage of germination.



Well-developed, plump, smooth seeds, which will have a high percentage of germination.

i. After final selection of mother trees

1) Pick only fully mature large pods, from the main trunk and largest branches.

Only the mature pods from the main trunk and largest branches should be picked from the selected mother tree as source of seeds for planting.

a) Do not pick pods from small branches and twigs for seed.

1)) Not as fully developed and may be less vigorous and healthy.

2)) Resulting from a reduced flow or supply of food nutrients available to these branches and twigs.

2) Approximately 35 pods will be required to supply seed for each hectare to be planted.

2. Propagation by seed (sexual)

a. Fastest, easiest and most practical way of multiplying selected planting material.

b. Seeds occupy less space than seedlings and are less bulky to transport to distant places for distribution or multiplication.

c. Unlimited supply of planting material from seed.

d. Mature plants have better-developed root system.

e. Cacao seeds do not have resting period between ripening and germination.

1) Beans germinate immediately in healthy, over-ripe pods left unpicked on the tree.

2) Beans do not germinate in pods affected by fungal infection or dessication.

f. Usually trees grown from the seed from selected mother trees produce substantial increase in yield over those from unselected mother trees. However:

1) Seldom uniform in yield or other characteristics, resulting in greater variation in individual plants.

2) Peeled seeds remain viable about 5 days if:

a) Mixed with moist moss or shredded paper, then;

b) Wrapped in waxed paper or placed in a plastic bag.

b. When selecting pods for shipping or transporting which will be in transit longer than one day, select those which are mature but not fully ripe.

1) Free from bruises and fungal infection, then

2) Place pods in boxes capable of withstanding rough treatment.

a) Pack pods individually in protective material such as paper wrapper to prevent them from brushing or rubbing against each other.

b) Bruising or breakage would result in spoilage and loss.

c) Pods, if properly packed, can remain in transit at least one week.

c. If pods will remain in transit for more than one week, immerse pods in disinfectants, such as mercuric bichloride.

1) Kills disease-causing organism on surface of pods.

2) Prevents damage from organisms pod may contact in shipment.

d. After immersing, smear pods with thin layer of carbolic vaseline to control or minimize dessication.

e. Extended periods of storage should be at 50°F to 60°F.

f. Untreated pods stored at room temperature (80°F) will be spoiled by rotting and dessication in 20 days.

4. Preparing seeds for planting

a. Pick only fully-developed, mature pods from selected trees as source of seeds for growing seedlings.

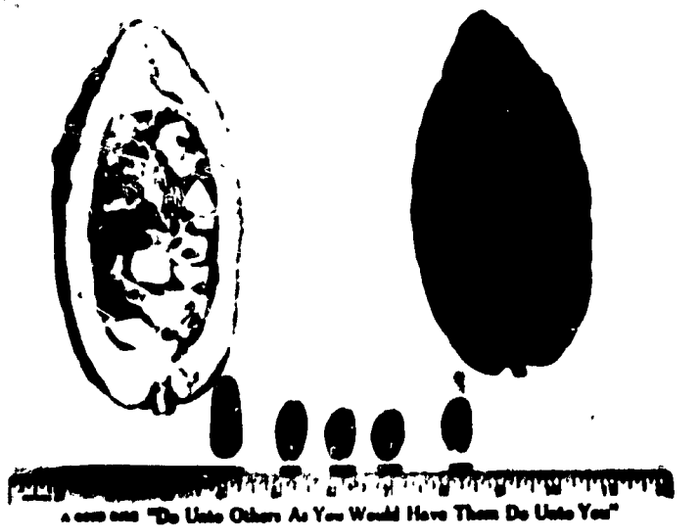
1) Only the plump, well-developed seeds should be selected from each pod.

2) Discard the defective seeds.

b. Seeds may remain viable up to 5 days if they are packed in moisture-absorbent material and kept moist.

c. The sooner seeds can be planted after harvesting the better.

d. Remove mucilage from beans.



Beans covered with mucilage inside the opened pod. Mucilage has been peeled from the five Forastero beans, showing their dark color. Criollo beans are white.

1) Thoroughly clean beans after extracting them from pod.

a) Remove as much of the mucilage that covers them as possible.

b) Otherwise, fermentation may occur in the seedbed before the seeds germinate.

2) Place seeds in a rough cloth with sand or sawdust and rub together.

3) In some countries, usually where labor is cheap, the seeds are peeled.

a) Removes mucilage.

b) Facilitates germination because peeled seeds germinate faster than unpeeled seeds.

5. Planting seeds at stake

a. Seeds are planted directly in the field.

1) Determine spacing for the mature cacao trees and place a stake where each tree will grow.

2) Plant two or three seeds with eyes down by each stake.

a) Allow plants to grow 30 centimeters in height.

b) Thin seedlings at this time, leaving the healthiest seedling by each stake.

b. Advantages:

1) Saves time and labor in transplanting.

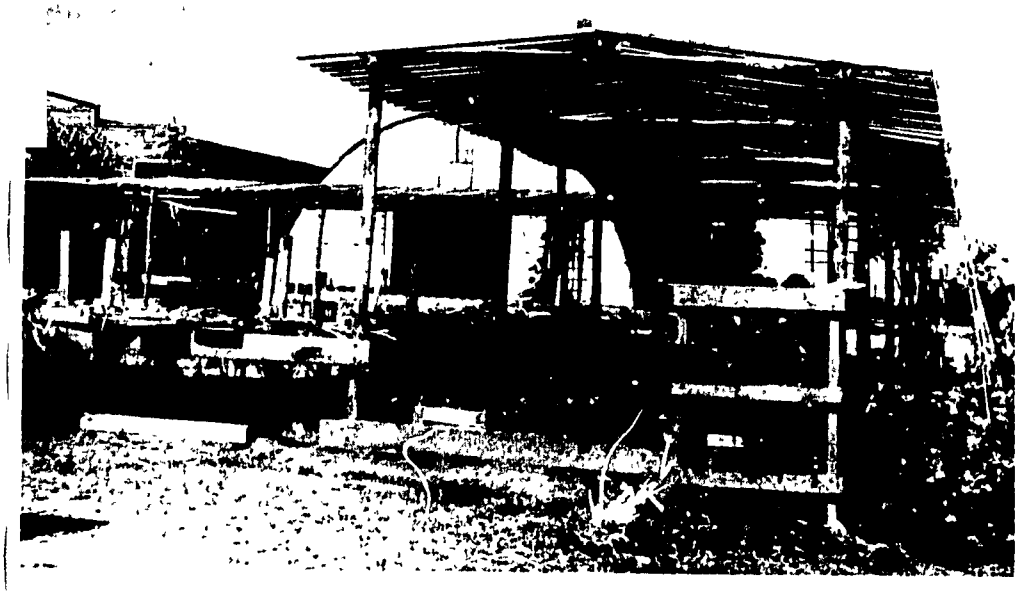
2) Developing seedlings become acclimatized in the place where they will grow.

c. Disadvantages:

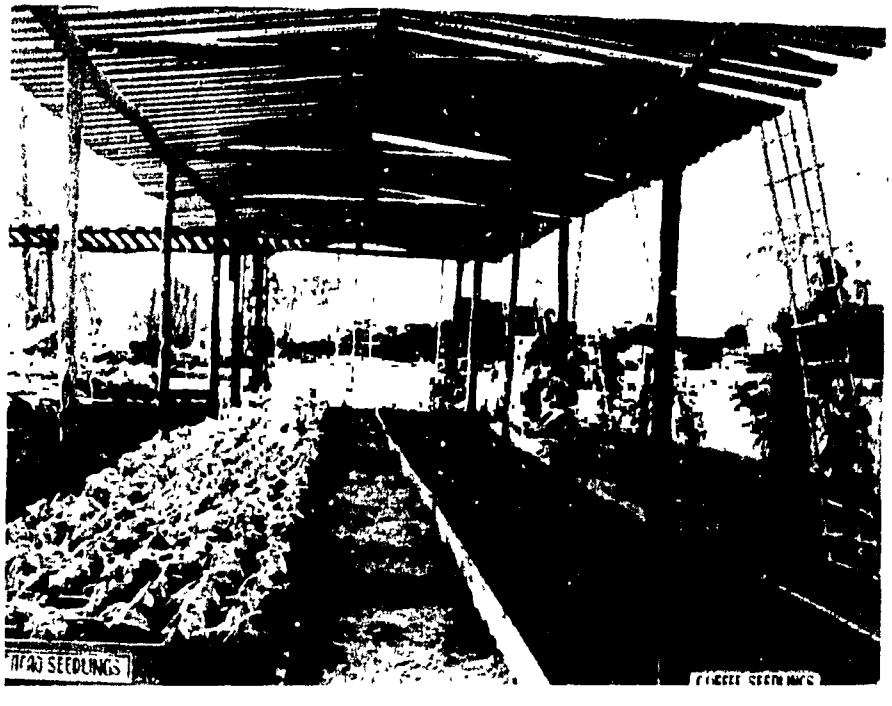
1) Difficulty of giving proper care to seedlings scattered over a wide area.

2) Difficulty of preventing damage to the plants by pests, diseases and wild animals.

6. Raising seedlings in the nursery.



A nursery growing cacao seedlings both in seed beds and seed boxes. The seedlings in the seed bed (inset) are old enough for transplanting (#11 main picture - #12 inset in lower right-hand corner).



a. Locate nursery on elevated ground.

b. Soil should be cool, moist, friable, deep and rich in organic matter.

1) A rich, black, loam soil is best.

2) Use soil of same texture and fertility as that used for potting seedlings.

c. Good drainage is necessary.

1) Promotes proper soil aeration.

2) Standing water detrimental to germination of seeds and growth of plants.

d. Must be protected from strong wind.

e. Locate as close to plantation as possible.

1) Cacao seedlings cannot withstand long transit because they are delicate.

f. Locate close to ample supply of water.

g. For large-scale production, divide nursery into beds measuring one meter by ten meters, leaving a path 45 centimeters between each bed, or use seed boxes.

Nursery beds for large-scale production of cacao seedlings, with shade shelters.

1) Provide a shade shelter which allows only about 50 per cent sunlight on the seed beds.

a) Direct sunlight will hinder growth and development of seedlings.

2) Before planting seeds, remove weeds from seed beds and work soil until thoroughly pulverized and level.

3) Mulch the seed bed with rice straw or other organic matter to soften and loosen the ground.

a) Makes transplanting of seedlings to the plantation or field easier.

b) Lessens damage or injury to roots.

h. Germinating seeds

1) Plant seeds in seed box or plot.

2) Ideal germinating medium

a) Fine, well-cured sawdust (partly decomposed)

b) Sandy soil or fine river sand

3) Treat seeds and medium with any seed disinfectant

a) Protects seeds from disease

4) Sow well-developed seeds with larger end or eyes down.

a) Place seeds as close to each other as possible.

b) Do not completely cover the seeds. Allow the tip of the smaller end of seed to extend out of the medium.

c) Germinating beds must be under shade.

d) 1000 seeds can be germinated in an area 1 meter by 1.2 meters.

e) The germinating beds must be kept moist but not saturated.

f) There should be a protrusion or beginning signs of germination in 3 to 4 days on tip of the seeds.

1)) This is primary root.

g) If protrusion is on exposed tip, reverse position of seed, placing end with primary root down.

5) Put seedlings in individual containers when first pair of true leaves develops.

a) Use loam or sandy loam, rich in organic matter, for potting medium.

1)) Fill container with medium within 2 centimeters of top.

2)) Use containers for potting large enough to allow ample root space.

a)) 14 inches deep and 8 inches wide for seedlings to remain in the nursery more than 8 months.

b)) 8 inches deep and 6 inches wide if seedlings will remain in the nursery for a shorter period.

3)) When healthy seedlings are grown from seeds

a)) Sown in October and November ready for field transplanting following June.

b)) Sown March and April ready for field transplanting following November.

1-1 In areas where the dry season starts in December, do not field transplant until beginning of next rainy season.

Use larger container.

4)) Saturate germination beds with water before removing seedlings.

a)) Seedlings can be removed with minimum of root damage from the saturated medium.

b)) Use trowel or flat-pointed stick to dig seedlings.

1-1 Do not disturb soil around roots because roots and rootlets will be injured.

2-2 Do not dig more seedlings at one time than can be potted in one-half an hour.

5)) Plant seedlings same depth in pots as they were in germination beds.

a)) Compact soil by pressing toward the base of the plant.

6)) Water and place potted plants under dense shade immediately.

a)) After plants have recovered, reduce shade to about 50 percent.

Seedlings transplanted in individual containers and placed under shade. Bananas or other trees are used by small growers instead of constructing artificial shade shelters.

6) Fertilize potted plants one week after potting with ammonium sulphate.

a) 2 grams per plant (a handful, or 50 grams, for every 25 plants)

b) 2-3 centimeters away from plant in a shallow trench one-half centimeter deep.

c) repeat every 3-4 months.

7) Protect seedlings from pests by spraying regularly.

a) Dieldrin, DDT or endrin controls leaf-eating insect pests.

b) EPN or other phosphatic insecticides control mealy bugs and scale insects.

8) Protect seedling from tip defoliation.

a) Caused by wind

1)) Protect from wind.

b) Caused by fungus

1)) Fungicides containing copper or zinc as active agent.

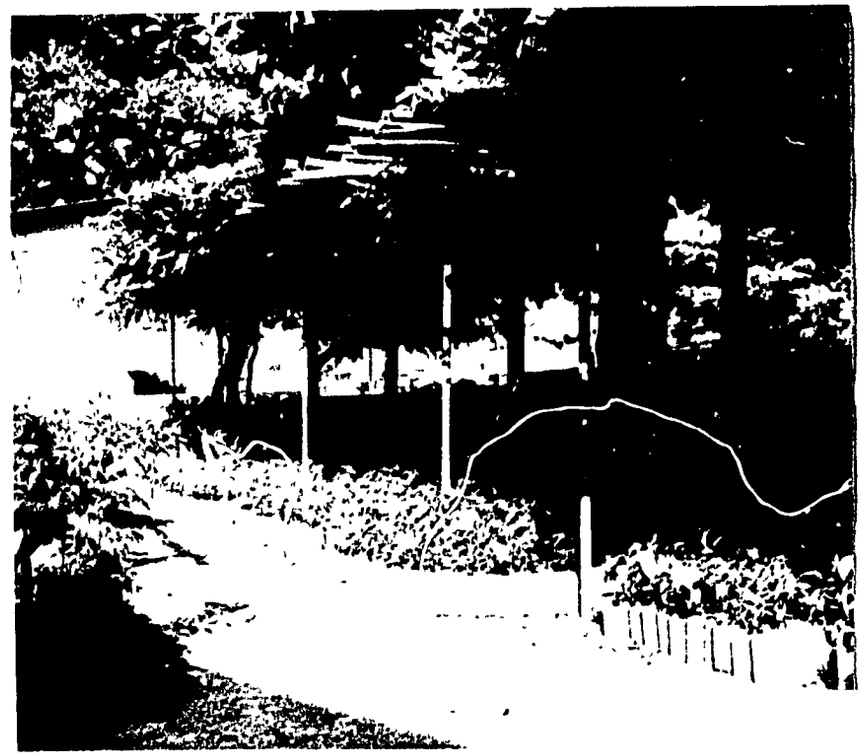
a)) Bordeaux mixture or any copper fungicide.

b)) Dethane or any zinc-based fungicide.

c)) Contact local dealer of agricultural chemicals.

9) Harden seedlings before transplanting to field.

Seedlings potted in cans in a backyard nursery and placed where they can be gradually exposed to increased sunshine in order to harden before transplanting to the field.



a) Reduce shade by approximately one-fifth at one week intervals.

b) By fifth week very little shade is left.

c) Seedlings are hardened for field conditions.

d) Continue protecting seedling from wind during this hardening period.

i. Seeds can also be germinated directly in pots.

A seedling germinated directly in an individual container.

1) Pots may be bamboo tubes, cans, baskets, plastic bags, etc.

2) Make small holes three millimeters in diameter to allow drainage of excess water.

   a) Larger holes will allow soil to be washed out of container.

3) Cut bamboo section 2 centimeters below the node.

4) After perforations are made, place a handful of gravel in bottom of container.

5) Fill container with proper soil up to two centimeters from top.

6) Sow seed with eye down in center of container.

7) Water often enough to keep soil moist, but do not drown the young plants with too much water.

8) About one week after sowing, seed germinates and emerges.

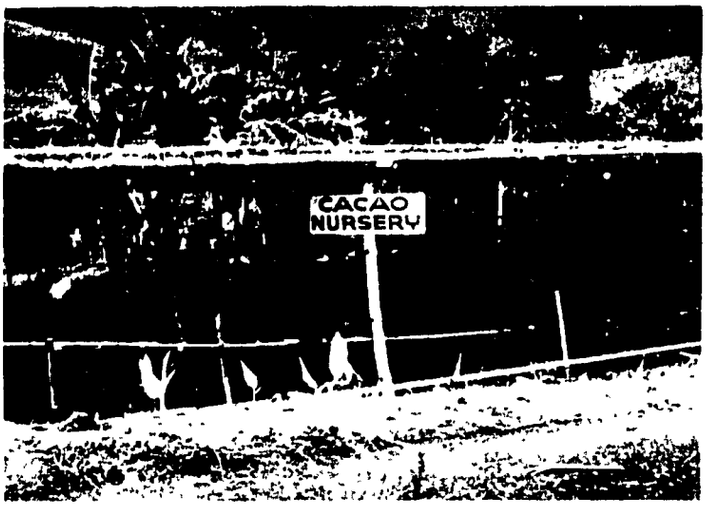
   a) Top dress each plant with two grams of ammonium sulphate.

      1)) Apply just prior to watering plants.

      2)) Speeds growth and development of seedling.

9) Place container so seedlings get some early-morning sunshine.

j. Partial shade to allow only about 50 percent sunlight is necessary when growing seedlings either singly in pots or in large numbers in seed beds.



The percentage of shade can be controlled on the seedlings by adding or removing roofing material from the shelter.

k. Seedlings raised first in a germination bed before they are individually planted in containers usually grow more uniformly.

7. Vegetative propagation (Asexual)

a. Cacao trees are heterogenous and do not breed true to type from seed.

1) Vegetative propagation is the only way to perpetuate true type.

b. Plants grown from buddings or cuttings bear earlier and are more precocious.

1) Are less damaged by strong winds because they grow shorter and closer to the ground.

2) Growth and appearance are more uniform.

3) Control of pests and disease is easier, cheaper and more effective.

4) Pods are easier and cheaper to harvest.

c. Vegetative propagation of cacao is possible by:

1) Inarching

2) Grafting

3) Budding

4) Soft wood cuttings

d. Only budding and soft wood cuttings are used on a large scale.

1) Budding

a) Budding is a slow and expensive method of propagating.

1)) Used primarily for multiplying the choicest and rarest cacao trees.

2)) Preserve the genetic identity and purity of mother tree.

3)) After increasing number of selected local criollo trees by budding, seeds of these trees can be planted to produce quality cacao commercially.

b) Essential steps to be observed when budding:

1)) Bud on sunny days.

2)) Bud when stocks are in flush because at this time the sap is flowing in the stocks and the bark separates easily from the cambium layer.

3)) Place budwood in container and cover with moistened moss, burlap bag or other such material. Do not leave budwood exposed in warm air or sunshine.

4)) Use a razor-sharp, clean budding knife.

5)) Use only the current or previous year's growth.

6)) Cut the bud smooth and clean without tearing or breaking the tissue.

7)) When the bud is cut, insert it into the stalks immediately to prevent it from drying and/or dirt or dust from coming into contact with the tissues. Tie the incision immediately and cover it completely to prevent air, water, dirt or other foreign material from entering the bud incision.

8)) Prepare budding or wax tape by soaking the tying material in mixture of one part paraffin, two parts beeswax and two parts resin.

9)) Unwrap buds 14 to 18 days after insertion.

10)) Partially lop the stocks 10 centimeters above the points of union which have been taped in order to help the bud develop faster.

11)) Remove all water sprouts that start to grow on the stocks.

12)) When the buds are 30 centimeters high, completely cut off the stocks just above the points of union in order to divert all the plant food to the growing buds.

13)) Carefully paint the wounds with Bordeaux mixture or any copper fungicide paste to prevent rotting and exclude fungi, water and other foreign materials which will adversely affect the growth of buds.

c) Select vigorous seedlings or chupons of trees to be renovated.

1)) Size of a lead pencil or larger.

2)) About six months to one year old.

d) Size of stock rather than age influences degree of success.

e) Budwood taken from selected mother trees should be about the same size as the stock.

1)) The bud to be used as a scion is ready when the subtending leaf falls.

a)) Do not use immature buds.

2)) Artificial maturing of buds is possible.

a)) Prune off the leaves.

b)) Leave part of the petiole intact.

c)) Cut off the tip of the branch.

d)) Budwood prepared in this manner can be used in 7-10 days.

2) Soft wood cuttings

a) Use terminal branches or flushes for propagating material.

1)) When not available, use chupons.

2)) One produces as well as the other.

b) Take cuttings from selected mother trees.

1)) Wait until leaves have hardened after a vigorous flush.

2)) Select cuttings with 22 to 38 centimeters of new growth.

3)) Cut apical leaves in half crosswise or at 90° to main veins to reduce transportation.

4)) Remove leaves from lower half of branch entirely.

c) Fan branch cuttings

1)) Cacao trees produce more fan branches than chupons.

2)) Thus permitting more selection and faster multiplication.

3)) Systematic pruning is necessary to form fan branch cuttings into regular trees.

d) Chupons

1)) Susceptible to wilt or die back.

2)) More shapely trees possible because they grow in same manner as seedlings.

e) Source of cuttings

1)) Select high-producing, non-diseased, healthy young trees.

a)) Cuttings from an old tree are difficult to root.

b)) Should be under good cultivation.

2)) Select mature terminal branches or flushes

a)) Do not select branches with immature leaves or those losing their green color and turning brown.

3)) When collecting cuttings

a)) Guard against dessication of cuttings or branches due to rapid transpiration.

1-1 Place cut branches in a pail of water; or

2-2 In a box lined with wet paper or burlap bags.

b)) Keep the leaves of the cuttings wet as they are prepared.

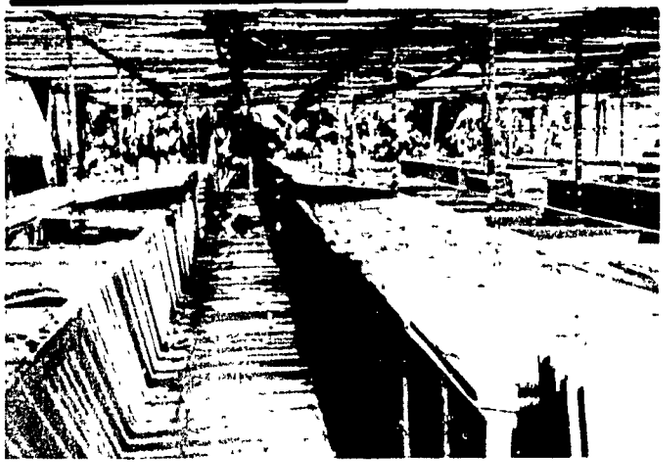
1-1 Use a sharp, clean knife to cut the branches into lengths containing 3 or 4 nodes each.

a-a Make basal and terminal cuts clean and slanting.

b-b May be done in or out of water.

c-c Prune off the apical half of the leaves.

8. Propagating bin



A propagating bin used for developing roots on soft wood cuttings.

a. A box containing a medium of sand, rotten wood, sawdust or other material in which soft wood cuttings are placed to develop roots. Sunshine, moisture and humidity can also be controlled.

b. Propagating bins are constructed of different materials and plans depending upon the finances available.

1) Type used in Trinidad is a permanent bin constructed of concrete, with holes in the floor to drain off excess water.

a) 90 centimeters long by 75 centimeters wide. The back is 90 centimeters and the front 85 centimeters above the ground. The sloping lid is made of glass.

b) Place a layer of large stones in the bottom, next a layer of gravel, then a layer of sand.

c) Sand is rooting medium.

d) Surface of rooting medium should be 30 centimeters below the lower surface of lid.

2) Modified type used by the cacao center of Inter-American Institute of Agriculture Sciences, which small farmers can afford to construct of wood.

a) 1.8 meters long, 90 centimeters wide and 30 centimeters deep. Lid can be of celo-glass cover instead of glass.

b) No bottom in box; place on level, well-drained ground.

c) Germinating medium is 20-25 centimeters of rotten wood or compost.

3) Insert 25 cuttings per square meter diagonally into the rooting medium.

a) When cuttings are placed in the propagating bin

1)) Make a new cut at the basal end.

2)) If possible, dip basal end in a rooting hormone solution, such as alpha naphthalene acetic acid (ANAA).

b) Keep seed bed or medium saturated until at least two weeks after the cuttings have developed roots.

1)) Sand medium requires about 3 waterings daily.

2)) Rotten wood, decomposed sawdust or compost medium requires about 3 waterings a week. Water-holding capacity of these materials allows for less frequent watering.

c) About four weeks are required for the cuttings to develop roots.

4) Shade is necessary, allowing only 25 percent sunlight.

a) Cuttings will be killed by direct sunlight.

b) Construct artificial shade.

c) Place propagating bin under trees.

d) In addition to natural or artificial shade, cover the glass lid with cloth.

1)) Insures cuttings only diffused and indirect sunlight.

5) Cuttings must be hardened before transplanting to the field. This can be accomplished by two methods:

a) After six weeks in propagating bin

1)) Transplant cuttings to individual container.

Cacao seedlings transplanted to individual containers.

2)) Place containers in an acclimatizer, a bin similar to propagating bin.

3)) Keep hardening bin humid by leaving lid closed for one week.

4)) Harden seedlings by raising lid a few centimeters on one side against the source of light on the first day.

5)) Increase opening each day until plants are hardened to warrant complete removal of lid.

) Harden cutting in propagating bin

1)) When cuttings are about seven weeks old

a)) Raise lid of bin a little the first day.

b)) Increase opening each day until plants are hardened.

c)) Transplant to nursery bed, or into individual container under 50 percent shade.

c) Transplant cuttings to field after at least 2 to 3 months, or after the hardening of the next new flush.

9. Preparing Land for Planting

a. Proper land preparation is fully as necessary for cacao as it is for corn, rice, garden vegetables or other crops.

1) Consists primarily of removing trees, brush and grass and;

2) Providing shade and windbreaks.

b. Virgin forest land

1) Leave suitable leguminous trees to serve as permanent shade and border trees to serve as windbreaks. Remove the rest of the trees and underbrush.

a) Particularly important where topography of land or climatic conditions are unfavorable.

b) Saves time and labor later.

c) Rolling or hilly area

1)) Strips of trees three to five meters wide should be left across the direction of the slope every 32 to 40 meters apart.

a)) Protects cacao from wind.

b)) Reduces soil erosion.

d) Level windy areas

1)) Strips of trees should be left across direction of prevalent winds for windbreaks.

2) May be necessary to burn the cut vegetation.

a) Organic matter, fertility and nitrogen will be lost, however.

b) Woody plants decay very slowly.

c) If possible, move large tree trunks and branches which do not burn out of plantation site.

1)) Will obstruct operations later.

d) Remove brush and small trees before falling the large trees.

e) Pile all cut vegetation, allow to dry, then burn.

c. Brush and grass land

1) Remove brush

2) Burn cogon and other grasses when they are dry, or

3) Obtain "lallang oil or other weedicide from agricultural chemical dealers.

a) Follow directions or dealer when applying.

b) Do not spray on cacao seedlings as they may be damaged or killed.

4) Following burning or spraying, plow soil as deep as possible.

a) Exposes underground runners of cogon which produce new plants.

b) Leave runners exposed until completely dry.

5) Plow area a second time

a) May expose additional underground runners not plowed to surface with the first plowing.

b) Buries weeds which have germinated after the first plowing.

c) Leave second plowing exposed until runners are completely dry.

6) Just prior to or at beginning of rainy season

a) Disc and harrow plowed area thoroughly.

b) Plant temporary shade.

d. Staking

1) Marking with a bamboo or wooden stake the place where each seedling will be planted.

2) Two methods are used:

a) The square system

1)) A seedling is planted on each corner of a square.

2)) Seeds may be planted directly at stake.

b) Alternate or quincunx method

1)) Seedlings are planted at the vertices of an equilateral triangle.

2)) A larger number of trees can be planted in the same area using the same planting distance.

c) Space plants 3 meters apart in rows and 4 meters between the rows.

d) Space seedlings 3.5 to 4 meters in the row and 4. to 4.5 meters between rows on very fertile soils.

e. Shade

1) Shade is natural habitat of cacao.

a) Changes in habitat shorten life and reduce productivity.

2) A constant, moist, highly humid condition of the soil and atmosphere is necessary for successful production of cacao.

a) Radical changes or fluctuations in this moisture condition or content adversely affect essential vegetative processes of cacao trees.

1)) Leaf flushing

2)) Flowering and fruit setting

3)) Shedding of flowers and drying of fruits

4)) Wilting of leaves

3) The amount of shade required for cacao is determined by the atmospheric conditions.

a) Areas of high humidity having constant cool, moist soil and air, with little fluctuations of these conditions, require less shade.

b) Areas of low and/or fluctuating humidity, having dry soil and air, with considerable fluctuation of these conditions, require considerable shade.

4) Shade trees in the cacao plantation help:

Cacao trees well protected from too much sunshine and wind by shade trees.

a) Stabilize atmospheric conditions.

b) Prevent too frequent leaf fall and growth of flushes, which would be detrimental to flowering and fruit setting.

c) Protect cacao trees from strong winds and direct, intense sunlight.

1)) Without shade, leaves may become scorched and the growth of the tree stunted, causing low yield.

2)) Plant ipil-ipil in strips 1/2 to 1 meter wide across the direction of prevailing winds.

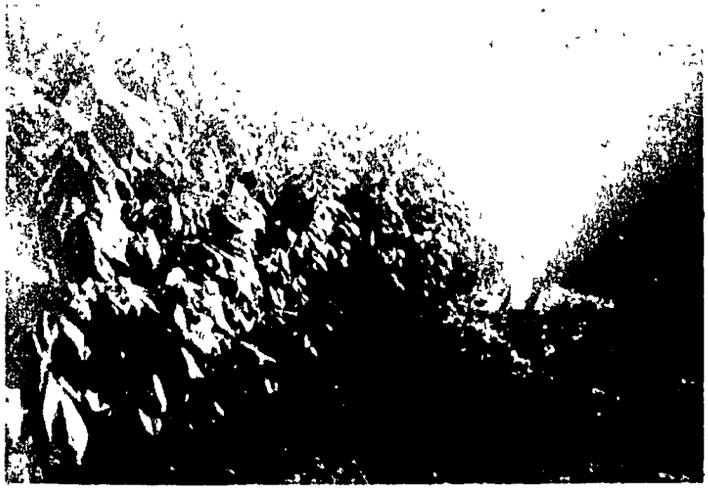
3)) Plant very thick.

d) Protect soil from erosion.

e) Maintain soil fertility.

1)) Deposition of leaves and stems supply organic matter.

5) Growing cacao without shade



Cacao trees growing in the plantation without shade trees.

a) Growers who are opposed to using shade trees maintain

1)) Closer planting of cacao trees, ten to fourteen feet each direction, will furnish shade and cover to the ground to maintain moisture and humidity.

2)) Shade trees compete with cacao plants for moisture and food nutrients from soil, because the roots of the two plants interlace, hindering growth and yield of the cacao.

3)) Shade trees may serve as habitat for animals and insects that are destructive to cacao.

4)) Shade trees increase humidity, reduce air circulation and produce ideal conditions for multiplication of disease-causing organisms.

b) Trials have shown that removal of shade trees results in:

1)) Temporary increase in yield, but

2)) Yield declines later on.

6) Temporary shade

a) Where permanent shade trees are not available, provide temporary shade.

b) Plant temporary shade in the field about one year before the cacao plants are set out.

c) Ideal temporary shade plants are those that:

1)) Yield an income until the cacao becomes productive.

2)) Supply shade for the cacao and add fertility to the soil.

3)) Last until permanent shade trees have been grown.

d) Plants used are:

1)) Bananas

a)) human food

2)) Cadios or Pigeon peas (Cajanus indicus)

a)) Young pods and seeds are nutritious human food.

3)) Crotolaria (Crotolaria juncea)

a)) Bast provides fiber for manufacture of bags.

4)) Castor bean (Ricinus communis)

5)) Cassava (Manihot utilissima)

a)) human food

b)) starch for laundry and other uses

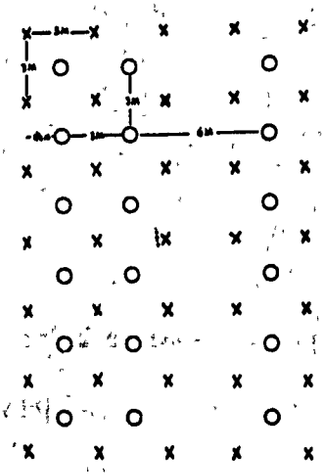
6)) Bananas, castor bean and cassava provide income, but

a)) are heavy feeders on soil nutrients, and

b)) extensive use may seriously reduce soil fertility.

c)) Use as temporary shade and remove when permanent shade is available.

f) If bananas are used, plant suckers of the saba variety 4 meters apart and other varieties 3 meters apart in the rows.



Banana, Latundan variety, 3m x 3m;
3m x 4m if Saba variety is planted
O- Cacao, 3m x 3m x 6m

1)) Use the tall varieties, not the dwarf varieties.

2)) Supplement bananas with crotolaria.

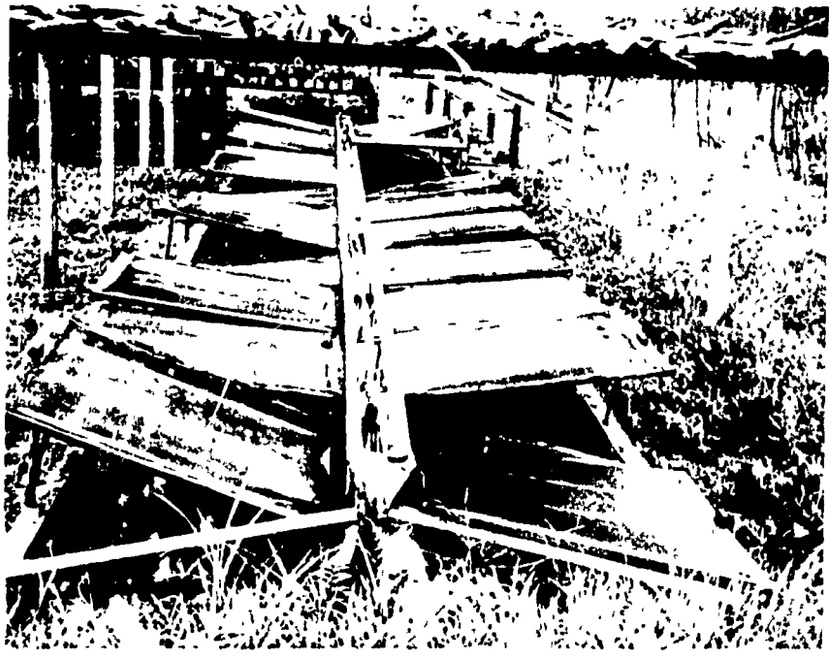
3)) Plant crotolaria six months before planting cacao seedlings.

4)) Plow between rows of bananas to destroy weeds.

a)) Make furrows 1 to 1-1/2 meters away from and on each side of the banana rows.

Soft wood cuttings with roots. The leaves have been cut in half crosswise, or at 90° to the main vein to reduce transpiration in preparation for planting.

Soft wood cuttings are hardened in an acclimatizer bin after being transplanted to individual containers.



Temporary shade shelter over newly transplanted seedlings for first few months until they become well established.

Ipil-ipil planted 2 years prior to the cacao seedlings to insure adequate shade and protection for the new seedlings when they are transplanted.

A cacao plantation utilizing Madre de Cacao or Kakawate as shade.

b)) Sow crotolaria seeds thinly in furrows.

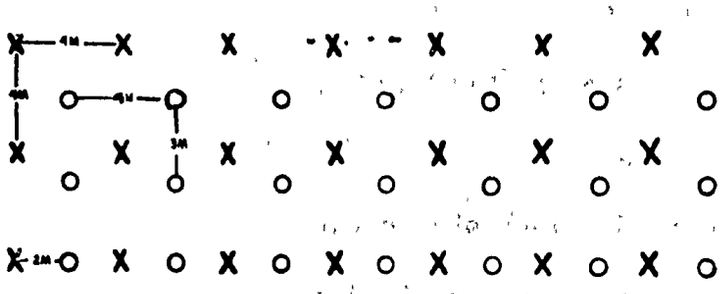
c)) Six kilos of crotolaria seed per hectare.

g) If topography permits, plant leguminous annuals between the rows the first two years.

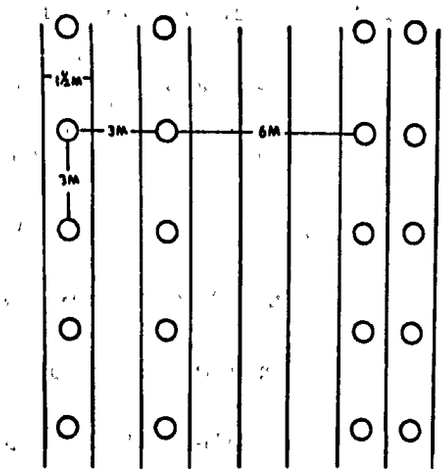
h) Plant a tall variety of crotolaria (crotolaria anagyroides) in cogonal or other grassland areas.

1)) Six months before planting cacao seedlings.

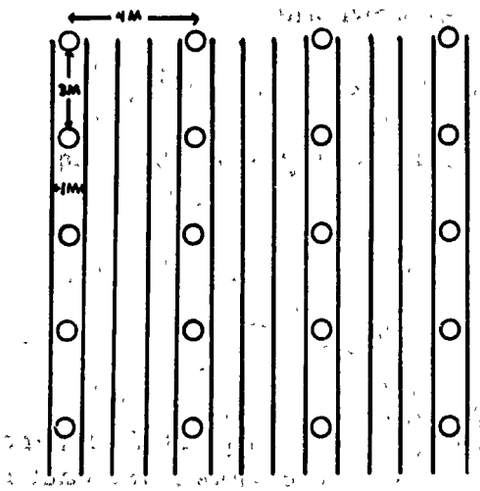
2)) Grows fast, shading ground, minimizing growth of grass.



X - Banana, 4m x 4m (Saba variety)
O - Cacao, 4m x 3m



Lines of Crotolaria, 1 1/2 m apart
O - Cacao, 3m x 3m x 6m



Lines of Crotolaria, 1m apart
O - Cacao, 4m x 3m

*Cacao: II. Where and How to Start a Plantation. Coffee & Cacao Institute of the Philippines, Manila, 1958.

i) If forest land cannot be plowed after excess forest trees are removed

1)) Plant bananas and/or crotolaria after burning

2)) Use string to mark line

3)) Place 2 or 3 crotolaria seeds in a hole made with a sharp stick, as done when planting rice in a kaingin.

4)) Make holes 10 centimeters apart.

j)) If cogonal land cannot be plowed after burning

1)) Plant crotolaria or ipil-ipil soon after burning.

2)) Suppresses growth of cogon.

k) On land which cannot be plowed, do not plant cacao for at least two years after clearing and planting temporary shade.

1)) Above all, keep weeds down and

2)) Fertilize temporary shade, if necessary, at the start to make it grow faster than the weeds.

7) Permanent shade

Ipil-ipil planted as permanent shade trees in the cacao plantation.

a) Select trees that:

1)) Are adapted to the soil and climate.

2)) Provide uniform protection from the sun.

3)) Grow rapidly and live long.

a)) Have an abundance of branches and leaves

b)) Are resistant to heat, otherwise the leaves will fall during hot summer, when shade is needed most.

c)) Are deep-rooted

1-1 So they will not compete with cacao plants for nutrients.

2-2 Will be less damaged by winds.

d)) Have smooth trunks to minimize harboring of insects.

e)) Do not have fruit or any other part of the plant which will act as a host for insects or disease organisms that attack cacao.

b) Plant shade trees long enough in advance of planting cacao seedlings to insure shade and protection for the seedlings at the time they are transplanted.

c) The planting distance depends upon:

1)) Size of the crown of the mature tree.

2)) Amount of shade desired.

3)) If mature tree has a crown diameter of 7.5 meters, plant the trees 7.8 meters apart each way.

d) Plant shade trees between the cacao rows to minimize interference with the main crop.

1)) Avoid excessive shade.

2)) If cacao trees begin growing too tall and slender, lacking branches, gradually remove one-third of the shade trees.

8) Permanent shade trees

a) Dapdap (anii) (Erythrina sp.)

b) Madre de cacao or kakawate (Gliricidia sepium)

c) Ipil-ipil (Leucaena glauca)

F. Planting

1. Transplanting cacao plants to the field

a. Seedlings at 6 to 8 months of age or 30 centimeters high are ready to be transplanted.

b. Soft wood cuttings soon after hardening, but not when in flush.

c. Budded plants soon as scion is well developed but not when in flush.

d. Begin hardening the seedlings one month before transplanting to the plantation.

1) Remove 1/5 of the roof of the nursery shed each week to allow more sunshine on the seedlings.

2) Place potted seedlings in spot where they are exposed to more sunshine.

e. Transferring seedlings to field.

1) Partly prune the leaves to reduce transpiration.

a) Prune leaves of seedlings with sharp knife or shear prior to removing them from the nursery.

1)) One half of each leaf across or 90° to the main veins of the leaf (Cross section not longitudinal).

2) Carry seedlings to the field for transplanting.

a) Leave potted seedlings in containers in which grown.

f. Spacing cacao seedlings in field

1) Three meters apart in the row and four meters between rows (3M x 4M).

a) Requires 833 seedlings per hectare.

2) Four meters apart in the row and four meters between rows (4M x 4M) on newly opened or fertile land.

a) Requires 625 seedlings per hectare

3) Place a stick in the ground to mark where each seedling will be planted.

g. On cogonal land plow a strip one meter wide where cacao rows will be planted before digging holes.

A strip one meter wide plowed in the cogonal land. Plant cacao seedlings in the center of this plowed strip.

1) On cogonal land dig holes in the field 40 centimeters wide and 40 centimeters deep several weeks before transplanting.

   a) Minimize competition from cogon roots.

2) Dig smaller holes 15 centimeters deep and 10 centimeters wide on newly opened forest land.

3) Place a handful (50 grams) of superphosphate fertilizer in each hole before transplanting.

   a) Place 5 grams (50% W. P.) Dieldrin in each hold.

   b) Cover above mixture with a 2 centimeters layer of soil.

c) Promotes strong root development and protects them from root grubs, wire worms, mole crickets and termites.

4) Spraying holes with copper fungicide and insecticide such as dieldrin or aldrin also protects against root diseases and grubs.

5) Use oil fumigant (D-D soil fumigant) to guard against nematodes, especially where abaca (what other crops) has been grown.

h. Remove containers before planting seedlings

1) Tin cans - cut with tin shears from top to bottom, then cut along bottom of can, forming letter L.

a) Remove can very carefully.

b) Do not crush, break or disturb the ball of soil around seedling roots.

2) Plastic bags - use sharp knife to cut bag on four sides.

a) Follow directions under a) and b) above.

3) Regardless of type of container, do not disturb ball of soil around roots when the container is removed.

i. Set seedlings in the holes without disturbing the roots and bury the same depth as they were in the container.

Seedlings transplanted to field placed same depth as when in the individual container.

1) Fill hole with mixture of well-rotted leaves or other organic matter and loose, fertile surface soil.

2) Seedlings will get a much faster start and be more vigorous.

3) Press the soil with feet hard enough to exclude air spaces around the roots and in the hole. Air spaces will dry out the roots of the seedling.

4) On a dry day, thoroughly water seedlings immediately after transplanting to prevent wilting and to get plants started.

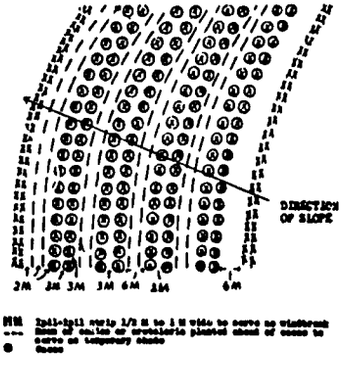
j. Best time to transplant is on a cloudy day at the beginning of the rainy season.

k. If seedlings are planted on sloping land, take precautions to prevent heavy rains from washing soil out of lower side of hole.

1) Plant on the contour on sloping land.

2) The recommended layout is two rows of cacao 3 meters apart with an alley 6 meters wide, then two more rows of cacao 3 meters apart. Place the cacao seedlings 3 meters apart in the rows. Repeat this process until the whole field is planted.

A 3M x 3M x 6M double hedge-row layout adapted for rolling land.



3) Facilitates use of machinery in plantation.

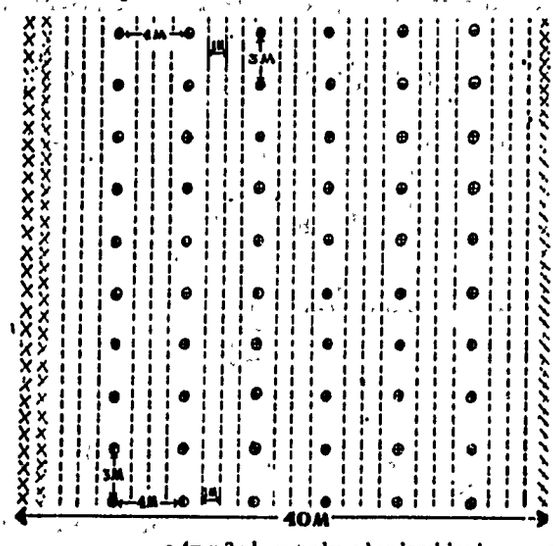
4) Requires about 740 seedlings per hectare.

l. A mulch of leaves or cut plants around seedlings will be effective to reduce erosion and retain moisture.

Place mulch of cut leaves around the seedling after it is transplanted to the field.

m. If seedlings are planted on flat land.

1) The recommended layout for native criollo is to plant rows of cacao 4 meters apart. Place the seedlings 3 meters apart in the rows.



a 4m x 3m layout adapted on level land

xxx Strip of Ipil-Ipil, ½ to 1m thick to serve as windbreak.

:::: Rows of Crotolaria or Cadios planted ahead of cacao to serve as temporary shade.

●● Cacao

G. Maintenance and Management of the Plantation

1. In the future cacao production will become more and more competitive. Success against this competition will require:

   a. A willingness to work hard.

   b. Adapting scientific production methods.

   c. Labor saving devices.

   d. Implementation of an economic and systematic plan of operation.

2. Production and profit from the cacao plantation is primarily dependent upon the management, particularly during the first four or five years.

3. Labor

   a. All labor, whether hired or that of the owner, must:

      1) Be dependable, understand the work and be interested in making improvements in the plantation.

      2) Be efficient and receive training and experience in all phases of cacao production.

4. Control weeds and underbrush:

Plantation kept free of weeds and underbrush.

a. Facilitates passage between the cacao trees during harvest.

b. Permits better ventilation within the plantation, thus making conditions less favorable for the existence and multiplication of disease-causing organisms.

c. Chop weeds and brush often enough to control them and insure that they do not crowd out the young cacao trees.

d. To reduce expenses in field operation and give more effective control of pests and diseases, cut weeds and brush during dry weather.

e. After cacao and shade trees are large enough to shade the ground.

1) Growth of weeds and underbrush is reduced.

2) Two or three choppings per year are sufficient.

3) Hand chopping with bolos and sickles is common practice.

4) Large, well-cleared plantations may find it more economical to use mechanical methods.

f. Leave the cut weeds in the plantation:

1) Serve as a mulch.

2) Reduce evaporation of moisture.

3) Add organic matter and fertility to the soil and increase its water-holding capacity.

g. When trimming temporary shade (banana, crotolaria) use trimmings as mulch.

5. Mulching

a. Weed a radius of 30 centimeters or more around the base of each plant depending on size of tree.

1) Should be same radius as lateral spread of branches.

b. Place mulch of cut plants around each plant after weeding.

1) Expand radius of mulch as lateral area of cacao branches expand.

c. If a cover crop is not growing, till the soil between the rows of cacao.

1) Plow the grass and other vegetation under.

2) Disc and harrow the soil several times to make a clean dust mulch.

3) Practice this at least twice each year to keep the plantation clean.

6. Cover Crops

a. Effective and useful for many purposes:

1) Reduce soil erosion during hard rains.

2) Conserve soil moisture.

3) Controlling weeds

4) Fixing nitrogen in soil.

5) Adding organic matter

b. Select cover crops which do not act as hosts for pests for disease of cacao, or become dry during dry season, creating a fire hazard. Plants to use are:

1) Pega-pega (Desmodium intortum)

2) A creeping species of indigo (Indigofera)

3) Tropical kudzu (Pueraria phasioloides)

c. Mow or cut the cover crop regularly and use as mulch around trees:

1) Prevent from climbing or crowding cacao trees.

7. Fertilizing the soil

a. To obtain maximum production from cacao, organic and/or commercial fertilizer must be applied regularly.

b. Highly fertile soils soon become deficient in plant food nutrients unless replenished by fertilizers.

c. Signs of plant food deficiency in the soil, as they affect cacao trees.

1) Lack of nitrogen causes

a) yellowing of leaves

b) stunted growth

2) Lack of potassium causes

a) premature falling of leaves

3) Lack of phosphorus causes

a) small, underdeveloped beans

4) A lack of any one fertilizer element, a combination of the fertilizer elements, or organic matter causes

a) drop in yield plus the corresponding signs mentioned.

d. Place one third to one-half handful (20 to 30 grams) of ammonium sulfate per plant.

1) As soon as seedlings transplanted to the field have recovered.

a) Two to three weeks after transplanting.

b) In shallow trench around seedling 10 centimeters from the stem without harming the roots.

e. Second year jorquette of two or more branches form and roots spread laterally.

1) Apply a complete fertilizer containing all three fertilizer elements nitrogen, phosphorous and potassium (N. P. K.).

Apply fertilizer in a band at the outer edge of the lateral spread of the branches and work it into the surface of the soil.

a) Commonly available in the Philippines 12-20-8 (N. P. K.).

1)) 12 percent nitrogen

2)) 20 percent phosphorous

3)) 8 percent potassium

2) One and one-half to two handfuls per tree every three to four months.

3) Increase application of nitrogen and potash when flowers appear.

a) Supplement the 12-20-8 fertilizer with ammonium sulfate and muriate of potash or

b) Apply 12-12-12 complete fertilizer at the same rate.

4) Cacao trees planted without shade are more active, thus growing faster and normally need more fertilizer.

f. Third year cacao trees flower more profusely with more pods formed.

Three-year old cacao tree bearing fruit.

1) Trees will need more nitrogen and potash but less phosphorous.

2) Apply 10-8-18

a) Two to three handful (100-150 grams) per tree every three to four months.

b) In unshaded plantations supplement with one handful of ammonium sulfate per tree.

1)) One month following application of 10-8-18.

2)) Yellowing of leaves indicates this supplement is needed.

g. Fourth year and thereafter

1) Apply 10-8-18

a) At time of general fruit setting

b) Every three months thereafter

c) One kilo fertilizer for each kilo of dry beans harvested per tree is general guide.

2) Supplement with ammonium sulfate if leaves become yellowish.

h. Place organic fertilizer around cacao trees at any time available.

1) Work into surface of the soil.

Commercial or inorganic fertilizers and fertilizer elements contained

1) Ammonium sulfate - nitrogen - sulfur

2) Ammonium nitrate - nitrogen

3) Basic slag - phosphorous

4) Superphosphate - phosphorous

5) Potassium sulphate - potassium

6) Kainit - potassium

j. Organic fertilizers and fertilizer elements contained

1) Farmyard manure	N. P. K. and organic matter
2) Compost or humus	mainly organic matter
3) Dried blood	nitrogen
4) Guano	N. P. K.

k. Use of fertilizer increases plant growth and yield.

l. Rate and kind of fertilizer depends upon soil and conditions in the plantation:

1) Over-application of superphosphate adds too much calcium sulfate to the soil, which tends to depress growth and yield.

2) Potash is more essential to cacao than nitrogen or phosphate and tends to improve bean weight and yield.

3) Over-application of nitrogen tends to depress the beneficial effects of potash by promoting excessive vegetative growth.

m. Add fertilizer at time of general fruit setting in June or July or 5-6 months before the main crop is harvested and every 3-4 months thereafter.

8. Pruning

a. Pruning is practiced in order to obtain more health, beauty and productivity in the cacao plantation. Prune tree in order to:

1) Obtain uniform size and shape, avoid overcrowding of branches which leaves the tree too topheavy with foliage to allow maximum yield.

2) Direct strength of tree to produce more fruit.

3) Make trees more precocious and increase length of bearing life.

b. Cacao trees produce more branches than are necessary for maximum fruit production.

1) Prune excess branches

a) Tree will be induced to place growth in production of fruit instead of excess branches.

b) Tree will have a more desirable form and proportion of leaves.

c. Do not allow crown to become too dense:

1) Normal circulation of air must be possible to minimize possibility of multiplication of disease-causing organisms.

d. Remove water sprouts or chupons regularly.

e. Remove all diseased weak and overlapping branches.

f. Scrape parasitic plants off the branches or twigs, if noticed during early stages of growth. Otherwise, remove these branches and twigs.

g. Prune cacao during dry season:

1) Tree is at rest or dormant.

2) Development of new buds is less affected.

3) Wounds dry up easily and danger of disease infection is minimized.

h. Follow these essential practices:

1) When removing branches, make a clean, smooth cut and paint wound with coal tar, lead paint, or Bordeaux paste.

2) Either remove branches with cracks and rough surfaces or paint areas with coal tar or lead paint.

3) Cut diseased branches or water sprouts off as close as possible to the main trunk, being careful not to leave stubs.

4) Only sharp, clean knives or saws should be used for pruning.

9. Removal of Temporary Shade

a. It is more practical and economical to plant ample shade trees originally than to remove the unnecessary excess shade (temporary or permanent) as the cacao trees grow than to wait and plant shade trees later on if they are needed.

b. When crowding and competition is evident between the cacao, temporary shade and permanent shade, gradually thin out and remove the temporary shade.

1) Do this gradually to avoid creating an abrupt change in shade, moisture or wind protection conditions.

2) Best time is when cacao trees are not in flush and just prior to rainy season.

c. When permanent shade trees can adequately shade the cacao, remove all of the temporary shade trees.

1) Chop the plants and leave them in plantation as mulch or

2) Place in compost pit.

3) At this time, when cacao trees are about 4-5 years old, they usually start yielding fruit.

4) Do not leave temporary shade in the plantation, especially when the cacao is being crowded, thinking such plants as bananas will supply additional income, This will have an adverse effect on the cacao and the yield of the main crop is reduced.

10. Rejuvenating an old plantation:

a. Problems with cacao are nearly the same as when rejuvenating other kinds of permanent fruit trees, such as:

1) Cut down old trees and plant new seedlings;

a) same as establishing a new plantation.

b) if all old cacao trees are removed at one time, it necessitates total stoppage of income for 4-5 years until new trees start bearing.

c) better practice is to replace the old trees gradually, so all income is not stopped.

d) remove old trees from part of the plantation or from alternate rows and replace with seedlings, leaving the balance of old trees to continue production until the new trees reach bearing age.

2) Plant seedlings between rows of old trees.

a) thin out old unproductive cacao trees as young trees grow

b) when young trees are about to flower third to fourth year remove all of the old cacao trees.

3) Renew top growth by severe pruning:

a) If age of tree is limiting productivity, severe pruning will incite new top growth.

b) Some plantation owners heavy prune trees every 3-5 years to renew top growth and maintain productivity.

4) Bud on basal chupons.

H. Diseases

1. Cherelle Wilt

a. Young cherelles or pods wilt and dry up.

b. Some wilt, however, may be caused by fungal infection.

c. Physiological factors (inability of tree to maintain an ample supply of water and nutrients to sustain developing fruits, flowers, and vegetative parts) are the major causes of wilt.

1) Young pods extremely sensitive to these adverse conditions.

2) Main reason only small percentage reach maturity.

d. Young cherelles susceptible to wilt from time they are set to about 70 days of age.

1) During this period cherelles develop most rapidly, requiring a large supply of water and nutrients.

e. When a large number of cherelles are set on the tree, there is a heavy demand for nutrients, at which time a shortage of water and nutrients may arise.

1) If the tree sets more fruits than it can support, it is natural for some of the fruits to wilt until the balance is adjusted (supply of water and nutrients equal to demand).

f. Control:

1) Application of fertilizers, especially potassium and phosphorous, during the general fruit setting period and a general leaf flush when the essential mineral elements are most needed.

2) During periods of drought

a) Water plants with mixture of liquid fertilizer

1)) Dissolve 25 grams of 6-12-15 fertilizer in one gallon of water.

2)) Put this on one bearing tree.

b) If irrigation is available

1)) Make furrows between rows of trees

2)) Run water slowly in furrows

c) If no water is available

1)) Mulch trees heavily with any organic matter available.

2. Pod Rot

a. Caused mainly by the fungus (Phytophtora palmivora Butler)

Cacao pod severely attacked and killed by black pod rot still hanging on tree.

1) Also causes bud rot of coconut trees, canker on rubber trees and various other tropical crop diseases. Disease is prevalent in all cacao growing countries causing greater damage in the more humid areas. Fungus attacks pods of any size and age.

a) Small pods

1)) First sign of disease is a small black dot which spreads rapidly until whole pod is covered, turns black and becomes shrivelled and dry in a few days.

2)) Death of pod causes death of fungus before spores are produced.

3)) Then pod becomes covered with the sporophores of saprophytic fungi.

b) Large pods, half to full grown

1)) First sign of disease is slight brownish discoloration on pod surface, usually at tip of basal end.

Cacao pod affected by black pod rot at the basal end. Disease will cover complete pod in a few days.

a)) Covers complete pod in a few days.

b)) Traces of white spores appear on surface especially along the furrows.

c)) Fungus mycelium penetrates pod and destroys developing seeds of young pods.

d)) Seeds are not affected in pods nearing maturity as they are no longer in contact with inner wall of husk.

e)) Later saprophytic fungi follows phytophthora infection, causing whole pod to rot if weather is dump or become black and shrivelled during dry weather.

Pods attacked by black pod rot. The pods have become completely black and shriveled, destroying the beans.

b. Control

1) Good sanitation through clean culture and management of trees in the plantation.

2) Gather and burn diseased pods.

3) Prune some branches from trees which are overcrowded

with branches and leaves.

a) Allows more light and sunshine into center of tree.

b) Free movement of air through tree top around pods.

4) Remove all plants or trees that interfere with free air movement or provides unnecessary shade.

5) Proper and adequate soil drainage in the plantation to avoid excess moisture.

6) Spray plantation with copper fungicide.

Spraying a cacao tree to control pod rot.

7) Use in intertillage between the trees.

3. Water Disease

a. A pod rot caused by a fungus (Monilia roreri Ciferri et Parodi).

1) Attack pods over a month old.

a) Once pod becomes infected, the disease spreads internally throughout the fruit changing the pulp

and seeds into a "watery mass."

b. Control

1) Gather and burn infected pods regularly.

2) Spray with 4-4-50 Bordeaux mixture (copper sulphate and lime) or any copper fungicide.

3) Clean culture

4) Avoid overshading cacao trees

5) Proper drainage of plantation.

4. Witches Broom or "Escoba de Bruja"

a. The disease is prevalent in South American countries and is caused by the fungus (Marasmius perniciosus Stahel).

1) Attacks any actively growing tissues of the plant (flowers, flower cushions, young fruits and vegetative buds).

2) Infected flowers are abnormally large with thick pedicels that stand straight out from the cushion instead of hanging limply as is normal.

3) If the cushion is infected, clusters of abnormal flowers sometimes called "star brooms" are formed, or shoots which may be wholly vegetative or with auxiliary flowers may develop.

4) Pods infected by the witches broom fungus exhibit swellings on the points of infection.

a) Whole pod may be hyperthropied (or excessively

developed) and, although symmetrical, have thickened pedicels and broad shoulders that taper to a blunt tip.

b) Do not reach maturity, because necrosis sets in before seeds ripen.

1)) The tissue of the pod dies, thus prohibiting maturation and ripening of the seeds.

c) If necrosis develops internally, disease is difficult to detect until pods are nearly mature, then brown and black patches appear on the surface.

b. The name, witches broom, is derived from the dense broomlike growth caused by an overproduction of lateral shoot and shortening of the internodes of the affected cacao twig.

c. Control

1) Susceptibility to witches broom varies from tree to tree.

2) Select and plant resistant varieties or strains.

3) Gather and burn all infected parts of the plant.

4) Spray with Bordeaux mixture.

5. Swollen Shoot

a. Caused by a virus and is prevalent on the African continent.

1) Mealy bugs and possibly other sucking insects which feed on cacao are capable of transferring the virus from infected plants to healthy plants.

2) Mealy bug (pseudococcus nialensis) is the major vector

a) Negatively phototropic (do not like direct sunshine)

b) Prefers to feed in cracks of bark or cavities around the pod stalk.

c) Live in the tree canopy and are associated with

b. First sign of swollen shoot is chlorosis of young leaves.

1) On close inspection, leaves appear to be mottled with fine mosaic, which may later develop into a general chlorosis.

2) Shedding of leaves follows the chlorotic condition

a) Followed rapidly by dieback

b) Main trunk may not die completely for a year or more.

3) Typical swelling of shoots which identify the disease may not appear if defoliation and dieback occur rapidly.

4) During early stages of infection, trees may produce a heavy crop but defoliation occurs and the few pods formed are dwarfed and rounded.

c. Control

1) Roguing

a) Cut down and burn the infected tree or trees, plus a ring of non-infected trees surrounding the infected tree.

b) Use insect parasites to eliminate insect vectors

c) Apply insecticide to control mealy bugs and other sucking insects.

6. Tip defoliation or die-back

a. Caused by two species of fungi (phytrophthora palmivora Butler and Colletotrichum sp.).

b. First signs are spots on the leaves

1) Spots coalesce grow larger and join forming larger spots

2) Leaves dry up and fall off tree

3) In serious cases trees are completely defoliated leaving only stipules intact on the stem.

c. Control

1) Spray seedlings monthly from time of emergence with Bordeaux mixture.

2) Sterilize seed and soil in which seed is planted with a drenching spray of Bordeaux mixture or any copper fungicide.

7. Canker of Cacao (caused by Phytophtora palmivora)

a. Phytophtora palmivora also causes coconut bud rot and rubber canker.

b. Control

1) If whole tree is affected, remove and burn to reduce possible spread of infection.

2) If only parts of tree are infected, remove the infected parts and burn.

3) Apply Bordeaux paste to lesions.

I. Pests

Cacao seedlings attacked by leaf-eating insects.

1. Cacao thrips (Selenothrips rubrucinctus Giard)

a. Very small insects with sucking mouth parts

1) Live on juice of plants, particularly on the leaves and pods.

b. Widely distributed, occurring in most cacao growing countries.

c. All stages of life cycle of insect live on leaves and pods.

d. Fast and severe attack usually results in complete defoliation of tree.

e. Control

1) Spray with contact insecticides.

a) Use caution so insecticide used on thrips does not kill the insects which assist with pollination.

b) E.P.N. or other phosphatic insecticides.

2. Cacao Capsids

a. (Sahlbergella singularis and Distantiella Theobroma) cause damage on pods, and vegetative parts, especially young, tender leaves, shoots and pods.

b. Bryocoropsis laticellis and Helopeltis Sp. cause damage only on the pods.

c. Damage to pods is usually not serious.

d. Punctures on young shoots may be fatal.

e. These sucking insects may serve as vectors of virus diseases.

f. The capsid lesions usually become infected by a fungus (calonectria rigidiuscula) which causes dieback or canker or large branches.

g. Control

1) Spray tree with nicotine sulfate or DDT

a) Just before flowering and just after setting of pods.

b) Spray on bright, warm days.

2) Paint branch unions with a 2.5% of DDT emulsion, as insects take shelter here during the day.

3. Cacao pod borer moth (Acrocercops cramerella Snellen)

a. One of the most serious pests in Java and the Philippines, especially in southern Tagalog provinces, Visayas and Mindanao.

b. Adult is a large, dark gray moth, 7 millimeters long.

1) Forewings are oblique, with narrow white crosslines or strips and the apical portions appear orange to yellow in color.

c. Caterpillar or worm spends most of life inside cacao pods eating its way through pods and seeds until the pupa stage.

d. Disease organisms enter the pod where larvae cause mechanical injury, resulting in decay and rendering the pod useless.

e. Larvae pupate on the leaves and/or in the pods.

f. Control

1) Collect and destroy by burning infected fruits or leaves containing pupae.

2) Apply drenching spray on trunk, branches, leaves and young fruits.

a) Endrin 19.5% E.C.	3-1/2	tablespoons
sticker	3	"
water	5	gallons

b) Also controls leaf eating insects, aphids, bark borers, and capsid bugs.

c) Add 5-8 tablespoons of copper fungicide to control disease infection and reduce spraying labor costs.

3) Light infestation

a) Spray monthly with mixture of 5 tablespoons of E. P. N. or 50% wettable DDT and 10 tablespoons of Dithane dissolved in 5 gallons of water with a sticker.

b) If Dithane is not available, use 3-3-50 Bordeaux mixture.

c) Spray monthly 3 to 5 level tablespoons DDT in 5 gallons (kerosene can) of Bordeaux misture.

4) In badly infected plantations

a) Spray with arsenical solution or (what mixture).

b) Dust with mixture of one part lead or calcium arsenate and 50 parts lime.

4. Chinch bug (Monalonium sp.)

a. Have sucking mouth parts that can puncture pods of any size.

b. Attacks fruits of all sizes.

c. Elevated scars result where pods are punctured.

Elevated scars on pods caused by puncture of sucking insects after the pods are attacked.

d. Serious infestation leaves the whole surface of the pod covered with scars.

e. Control

1) Spray with contact insecticides such as kerosene soap emulsion.

2) Bury or burn all rubbish in plantation.

5. Bark borer

a. Tagalog name is Uod sa balat.

b. Control

1) Scrape off affected bark on the trunk and branches.

2) Paint scraped surface with following mixture:

a) One-half ounce of DDT and three ounces of copper fungicide and one-half pound of clay soil, dissolved in gallon of water.

6. Wood borer of cacao, or great borer in Colombia (lepidoptera)

a. Larvae is creamy white color, 5.5 centimeters long and 7 to 8 millimeters in diameter.

b. Attacks trunks and larger branches

1) Makes a tunnel one centimeter in diameter and 2-1/2 meters long.

2) Causes mechanical damage and creates entry for secondary infections and diseases caused by (Phytophtora faberi Maub).

c. Control

1) Open and clean entrance of tunnel.

2) Treat opening with 25% aldrin (proportion of 20-25 grains per one liter of water).

3) Seal entrance with cotton or wax immersed in solution.

7. Small stem borer

a. Attacks branches by chewing bark.

b. First stage larvae bores through wood, making tunnel 3 to 5 millimeters in diameter 20 to 30 centimeters in length.

c. Later attacks floral stem.

d. Control

1) Same treatment as for wood borer.

J. Harvesting

1. Trees grown from seeds bear fruit in 4-5 years.

2. Trees grown from cuttings bear in 2-3 years.

3. Harvest fruits as soon as they are ripe.

a. Usually the pod changing color from green or white to yellow and red to a lighter or dull color indicates ripening.

1) Yellow color between ridges of pod.

2) Seeds become disengaged from inner wall of husk forming a cavity.

3) Ripe fruit or pod gives a hollow sound when tapped.

b. Do not leave the pods unharvested more than one month after they become ripe or the seeds may germinate inside the pod.

c. Do not harvest pods prematurely.

1) the seed pulp will not contain enough sugar to promote the fermentation process.

2) roasted beans will be deficient in aroma and flavor.

d. Pick individual fruits as they mature on the tree.

1) requires approximately 8 pickings yearly.

2) a larger percentage of the fruits may be lost if this practice is not followed.

e. Clip or cut the pods from the tree with clean, sharp shears, bolos or other sharp tools.

1) Do not twist the fruit from the stem.

2) Use a sharp, long-handled tree pruner to harvest pods in top of tree. Climbing tree is a slow process and may damage it seriously.

f. Collect pods in a central place and remove the seeds.

Extracting the seeds from the cacao pods prior to fermenting the seeds.

g. Place seeds in containers to be transported to the fermentation shed.

h. After the seeds have been removed from the pods, place the empty pods in a pile or a compost pit to decompose.

1) Helps keep the area clean and sanitary.

2) Gives a valuable supply of compost.

3) Reduces possible breeding grounds for fungus and insects.

i. <u>Compost pit</u>

1) size of compost pit or pits depends upon size of plantation.

2) construct compost pit with two compartments, or two separate pits.

a) one compartment or pit can be decomposing while the other one is being filled.

3) Place straw, sawdust, rice hulls or other highly absorbent material in the bottom of the pit.

a) considerable liquid is produced during the decomposition of the pods.

b) concentrated liquid fertilizer is absorbed in organic matter and saved instead of being lost.

c) do not place this liquid in direct contact with roots of cacao plants because they may be harmed due to concentration of fertilizer elements.

K. Preparing Beans for Market

1. Fermentation

a. The individual farmer must learn from experience proper fermentation procedures and practices, such as time required for fermentation, number of times beans are turned and increasing or decreasing humidity and temperature as needed.

1) the time required to reach the maximum temperature for safe fermentation of the beans will vary according to the weather.

2) turn or stir the beans thoroughly every six hours during fermentation to allow equal heat to all beans.

3) during fermentation the temperature within the pile or bin of beans must be between 100°F (37.8°C) and 120°F (49°C) for optimum results.

4) Complete and proper fermentation is necessary in order to obtain top quality beans.

   a) Top quality fermented beans when dried are friable and break easily when pressed between the thumb and finge

   b) If beans feel leathery or spongy, they are of inferior quality.

5) Wash beans lightly following fermentation

   a) Produces top quality cacao.

b) Removes fruit juices, alcohol and acids which are usually present on the beans.

6) Fermented and dried beans lose 60-65 per cent of their original green weight.

b. Small growers

1) Place the beans in piles covered with leaves or in baskets or barrels lined with banana leaves.

Three fermentation boxes or baskets, one above the other in step-like position, lined with banana leaves. When the fermenting beans require turning or stirring, they are placed or poured into the box or basket below: The beans are stirred with a minimum of labor and time.

2) Turn beans occasionally to insure equal fermentation.

3) After beans are fermented.

a) Place on concrete or asphalt floors or drying mats to dry.

4) Construct drying shed so that floor to be used as drying platform can be pulled out on sunny days and pushed back under the roof on rainy days.

c. Large growers

1) Large fermentation boxes are used

a) Place layer of beans 30 centimeters thick in box.

b) Stir or turn beans every 8 hours to insure even fermentation.

2) Beans are dried in drying drums.

a) Drums revolve slowly.

b) Beans placed inside.

c) Hot air is blown on the beans.

d) 30-60 hours required for drying.

d. Three-fold objectives of fermentation

1) Kill the bean which will allow important factor in the process of these changes.

a) Color changes from white to brown.

b) Characteristic chocolate aroma and taste are developed.

c) High temperature is most important factor in the process of these changes.

2) Removal of pulp to facilitate drying.

3) Separate the cotyledons from the seed coat to facilitate their extraction as nibs when roasting.

2. Drying

a. Two methods used

1) Sun drying by small growers

2) Mechanical hot air drying by large firms

b. Speed removal of moisture governs enzyme action in the bean.

1) Slow drying promotes proper biochemical processes.

a) Thorough oxidation of cacao tannins

b) Reduction in astringency of beans

2) Fast drying

a) May result in undesirable biochemical changes.

b) Shrinking of skin of bean, making it difficult to remove.

c) Hardening of the surface of the cotyledons, making the interior or core difficult to dry.

c. Three phases of drying beans

1) Slow drying with loss of heat by beans.

a) Spread beans about 10 centimeters thick.

b) Leave in the sun for four hours.

c) Heap and thoroughly cover until next day.

d) Spread beans about 10 centimeters thick and leave on drying floor for two days to prevent rapid desication.

2) Periods of oxidation and enzyme action

a) Spread beans about 5 centimeters thick and leave in sun for three days.

3) Spread beans as thinly as possible to promote fast and thorough drying.

d. Spread beans to dry on a split bamboo floor without cracks (so the beams will fall through) sawali mat or cement floor.

e. Stir beans constantly during drying with a bamboo or wooden rake to give uniform drying.

f. Place completely dried beans in gunny sacks and store in a dry place.

g. If beans are to be kept for an extended period, clay them.

1) Sprinkle powdered clay on the beans while they are being stirred.

2) Thin coat of clay powder helps prevent growth of molds and fungi on the surface of the dry beans.

3) Sack beans and store in dry place.

3. Expected earnings from cacao

a. 830 trees are planted in a hectare if cacao rows are 4 meters apart with trees 3 meters apart in rows.

1) A properly managed tree will produce at least 50 pods.

2) 30 pods will produce a minimum of one kilo of dry beans.

3) A minimum of 1,300 kilos of dry beans would be produced.

4) ₱2.50 per kilo for dry beans would earn ₱3,250. per hectare.

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