PRODUCTION GUIDE FOR PINEAPPLE

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Pineapple (*Ananas comosus*), a tropical plant with edible multiple fruit consisting of coalesced berries, named for resemblance to the pine cone, is the most economically important plant in the *Bromeliaceae* family. It is mainly grown for its fruits, either fresh or in processed forms. Pineapples may be cultivated from a crown cutting of the fruit, possibly flowering in 20-24 months and fruiting in the following six months.

In the Philippines, Pineapple is extensively cultivated in the Northern Mindanao, SOCCKSARGEN (Southern Cotabato, Cotabato Province, Sultan Kudarat, Sarangani, General Santos City), Bukidnon, Bicol and CALABARZON (Cavite, Laguna, Batangas, Rizal, Quezon) for domestic and foreign markets either fresh and for processing. The Philippines is the second biggest pineapple-exporting country in the world next to Thailand. In 2009, 57,687 ha were planted to the crop with a total production of 2,198,497 MT.

Pineapple may be consumed fresh, canned, juiced, and are found in a wide array of food stuffs - dessert, fruit salad, jam, yogurt, ice cream, candy, and as a complement to meat dishes. Like the other fruit, pineapple has vitamins, minerals, fiber and enzymes that is good for the digestive system and helps in maintaining ideal weight and balanced nutrition. Pineapple is a good source of Vitamin C . Pineapple has minimal fat and sodium with no-cholesterol. It is believed to protect against cancer and break up blood clots and is beneficial to the heart. It also relieves intestinal disorders and soothes the bile and has the capacity to stimulates the kidneys and aids in removing toxic elements in the body. This also helps accelerate the healing of wounds due to injury or surgery. It also reduces inflammation.

In addition to consumption, in the Philippines the pineapple's leaves are used as the source of fine grade textile fibers which can be used in the manufacture of the luxurious and famous piña cloth, twines and cordage and is employed as a component of wall paper and furnishings, amongst other uses. Its leaf juices and the unripe fruit is a source of medicine for anthelmintic, diuretic and digestive refrigerant. The by-products from fruit processing can be used in making wine, vinegar and 'nata' or gel. Other waste from canning can be pulped and dried for livestock feeds.

PINEAPPLE CULTIVARS:

Among the cultivars of pineapple commonly grown in the country Smooth Cayene (Hawaiian) is the most favored for canning and fresh fruit consumption. It matures in 18 months and yields 25,000 fruits per hectare. The fruit is cylindrical in

shape (2.5–3 kg) and the flesh is pale yellow, soft and juicy with high sugar (from 13° to 19°Brix) and acid content. Well adapted to canning and processing. Leaves are spineless and cylindrical.

Other cultivars grown locally are Queen (Formosa) and Red Spanish (Native Philippine Red). Queen variety is grown in some places for its fresh fruit. The small and very spiny plant gives a small fruit (0.5 to 1 kg), with a full yellow shell and small prominent eyes. The golden yellow pulp is crispy and sweet (14 to 18°Brix), with an excellent flavor and long shelf life.

The Red Spanish (Native Philippine Red) is cultivated for its strong and delicate fiber in Western Visayas, particularly in the province of Aklan. The fruit is squarish in shape (1–2 kg) with pale yellow flesh and with pleasant aroma. Leaves are spiny.

CULTURE AND MANAGEMENT:

Soil and Climatic Requirements

Pineapple thrives best in sandy loam to clay loam soil which is well-drained, rich in organic matter and has a pH of 4.5 to 5.5. It requires mild (24^0C to 30^0C) and relatively uniform temperature throughout the year. It also requires evenly distributed rainfall (100-150 cm/year) and a very short dry season. Pineapple grows best at an elevations of 1,000 feet or 150 to 200 meters above sea level.

Planting Materials Used For Propagation

Pineapple is commonly propagated asexually with the use of its suckers , slips and crowns. Suckers are those that develop at the base and axil of the leaves while slips and crowns are those that develop at the base or above the ground part and on top of the fruit. Planting materials should be obtained six to eight weeks after harvesting. Choose planting materials similar in size and type to drained uniform flowering and fruiting. The crown will bear in 22 to 24 months; slips in 18 to 20 months; and suckers in 16 to 18 months.

The planting materials should be cured by exposing them to sunlight for one week or more depending on the weather conditions. Curing prevents infection and rotting of plant materials.

Soil/Land Preparation

The land and soil must be prepared thoroughly. It should be plowed thoroughly and harrowed 2 to 3 times until a fine tilth is attained, modify soil structure, control weeds, incorporate organic matter, evenly distribute lime. Furrows should be made where the seed pieces are to be planted. Drainage canals are necessary in areas with heavy rainfall or with poor drainage.

Land previously planted to pineapple are usually cleared after the first ratoon. In small farms, old pineapple plants are uprooted, collected, and dumped along the borders where they are burned or allowed to decompose. For more efficient clearing in commercial farms, the plants are sprayed with recommended herbicide, chopped into smaller pieces, and then incorporated into the soil by plowing or if herbicide is not used plants are chopped mechanically.

Field previously cultivated require minimal soil preparation. In commercial farms, deep plowing (60-75 cm deep) is practiced. The interval of plowing and harrowing should be sufficiently spaced to attain effective weed control. The plant debris should be allowed to decompose first to ensure faster growth of pineapple after planting.

Planting

A systematic method of planting pineapple is recommended. It is advisable to classify the planting materials such as slips, suckers or crowns. Crowns are commonly used in commercial farms while slips and suckers are preferred in small farms.

There are two methods of planting pineapple; the single –row method and the double row method. Single row method – rows are generally spaced at 80 to 100 cm apart and the plants are set at 25 to 30 cm in a row. A hectare of land will give a population density of 33,000 to 50,000 plants. Double row method – the required distance are 20 to 30 cm in a row, 50 cm within a double row, and 80 to 100 cm between double rows. This will give a population of about 44,000 to 76,000 plants per hectare.

Planting in single rows are commonly used in small farms and double rows in commercial plantations. Planting density depend on preferred market, the higher the planting density the smaller the fruits. Local fresh fruit markets prefer bigger fruits while processors prefer medium-sized fruits (1.3-1.5 kg.). Plant during the onset of the rainy seasons or anytime in places with evenly distributed rainfall.

Nutrition/Fertilization

The recommendation of fertilizer dosage to every crop or even pineapple depends on the inherent fertility of the soil. Before doing such application of fertilizer it is necessary to determine the nutrient requirement of every crop.

Organic and inorganic fertilizers may be used for pineapple. The inorganic form is most popular for small and commercial growers. Organic fertilizers may be used to produce organically grown pineapple for selective markets abroad. Guide to the fertilization of pineapple is presented in the table below.

Table 1. Fertilizer recommended in small farms.

Fertilizer	Months after planting	Amount per Plant (g)	Amount per Hectare (kg)	Number of Bags per Hectare (50 kg bag)
Ammonium sulfate	2	10	500	10
Muriate of potash	2	5	250	5
Ammonium phosphate	4	10	500	10
Muriate of potash	4	5	250	5
Ammonium sulfate	6	10	500	10
Muriate of potash	6	5	250	5
Urea	8	5	250	5

Commercial farms adopt different fertilization program where small dosages are applied at monthly intervals. Five grams of ammonium sulfate are applied per plant at the 2nd, 4th and 6th month after planting and 3 g, 7 g ,and 7 g of potassium chloride (KCL) or potassium sulfate (K_2SO_4) is applied during the same period. About 3-5 g triple superphosphate is applied on the 3rd, 4th, and 6th month after planting. P should be side-dressed in the axils of the old leaves to make it more available to the plant. Urea as foliar fertilizer is applied at monthly intervals. To determine the volume of fertilizer needed, the sprayer is calibrated to enable the applicator to uniformly distribute the amount of fertilizer prescribed in the area.

Flower Induction

Flower induction allows year-round production, ensures more uniform flowering and fruiting, and gives higher income especially during off-season. It also stabilizes production, which assures the fresh market and processors of continuous supply of fruits.

The time of induction is determined by plant size. In small farms, plants are induced when they have 55-60 functional leaves. In large farms, fruit quality required for processing is achieved if induction is done when plants have at least 36 functional leaves, weigh 2.6-2.8 kg, or reached 1.2 m tall in middle elevation and 1.0 m lower in lower elevation.

Calcium carbide (CaC_2) or 'kalburo' used in the early 60s gives 60-70% flowering. In the early 70s, ethephon was commercially used. It is more effective and could induce 90-100% flowering. Ethephon is sold as Ethrel 480 with 48% or 480,000 ppm (1% = 10,000 ppm) active ingredient. Table 2. Shows the composition of a spray solution containing 25 ppm Ethephon + 2% urea + 0.04% lime.

Table 2. Composition of flower inducer mixture.

Component	Amount	
	50 L	200L
Ethrel	2.6 ml	10.4 ml
Urea	1 kg	4 kg
Lime	20 g	80 g

If calcium carbide may be applied, the solution is prepared by dissolving 2 kilograms of calcium carbide for 19 liters of water and applied at 30 ml (3 tablespoonful) of the solution to the growing point or heart of the pineapple.

If ethephon will be used , the solution is sprayed to the leaves or poured to the growing heart in the afternoon or early morning at 30-50 ml/plant to be more effective.

Flowering commences as early as 40 days after induction (DAI), peaks in 50DAI and is completed in about 55-66 DAI.

Intercropping

In small scale plantings, pineapple is usually planted or intercropped under coconut or papaya, coffee and even bananas. Returns from intercropping can be greatly increased by supplying the fertilizer requirements of all crops.

Pest Management

Several pests and diseases are known to damage and reduce the yield and quality of pineapple fruits.

Described below are the diseases and insect and mite pests considered important or potentially destructive to pineapple in the Philippines.

Diseases

Phytophthora Heart Rot

Causal Organisms.

Phytohpthora nicotianae Breda den Haan var. *parasitica* (Dastur) G. M. Waterhouse (=*P. parasitica* Dastur)

Symptoms and Signs:

- Extensive rotting of the tissue or at the base of the plant.
- Change in color of the 'heart' leaves to a yellow or light brown with a reddish tinge.

- Leaf edges curve back and it is easy to pull from their point of attachment.
- Base of the leaf are yellowish-white, soft and watery with distinct brown margins.
- Growing points of the stem also exhibit a cheese-like appearance.
- A pungent smell is emitted from the rotting bases of the leaves.
- Rotting of the young fruits
- Roots of the young plants will also rot.

Management strategies

Proper weeding and soil cultivation. Care should be taken not to contaminate the growing heart with soil infected with heart rot pathogen.

Proper drainage. Well drained soil with plant beds raised as high as possible at least 23 cm high should be intended for pineapple plantings. Provide drainage canals. For commercial plantations, construct systems of drainage canals and water intercepts for outside run-off, as part heart rot management.

Preplanting chemical dip treatment. Dipping the lower half portion of planting materials into systemic fungicide cleared for pineapple and active against Phytophthora is a standard practice in heavily infected areas. One such fungicide is fosetyl-Al. Prevent the spread of foci of infections in the field by prompt rouging and proper disposal of infected plants followed by spraying fungicides against Phytophthora.

Soil pH management. Maintaining soil pH near optimum for pineapple (pH 4.5 - 5.5) will help minimize damage from heart rot.

Brown spot of Fruit core/Fruitlet Core Rot or Brown Rot

Causal Organisms. Fruitlet core rot or brown rot is a complex disease. The following pathogens have been associated with the disease:

- *Fusarium subglutinans (Wollenweb & Reinking) P.E. Nelson et.al* (=*Fusarium moniliforme* Sheldon var. *subglutinans* Wollebweb. & Reinking);
- *Penicillium funiculosum* Thom;
- *Pantoea ananatis* (Serrano) Mergaert et.al. 1993. (=Erwinia ananas Serrano);
- *Pseudomonas ananas* Serrano; and
- *P. funiculosum* also causes causes interfruitlet corking and leathery pocket.

Symptoms and Signs.

- Uneven coloring or ripening of the fruit.
- Affected eyes may become brown and sunken as fruits ripen.
- Cut fruits turn brown to black discoloration of the flesh below the blossom cup.

- Interval symptoms show light to dark brown, moist, firm decayed, mottled areas at the center of the fruitlet or eye.
- At the later stages, decay may affect all the tissues immediately surrounding the floral cavity.

Fruits affected by interfruitlet corking take on unnatural glossy appearance and show cork formation beneath the skin in between fruitlets. Leathery pocket is manifested by cork formation at a deeper level, in the ovaries at the base of individual flowers. *Fusarium subglutinans* also cause Fusariosis or gummosis. On the other hand Pantoea ananatis and *Pseudomonas ananas* cause bacterial fruitlet rot and fruitlet black rot, respectively. Bacterial fruitlet rot (*P. ananatis*) infection starts in the floral parts of cracks in the eye cavity and result in an internal browning, which is usually not apparent externally. However, badly infected fruits are dull and hard. Fruit black rot (*P. ananas*) is characterized by brown to almost black discoloration of the placental lobes and loculi of one or more fruitlets. Like the bacterial fruitlet rot, black rot symptoms are difficult to see without cutting the fruit.

Management Strategy. No effective control measure had been found. Decreasing mite population is suggested in other countries.

Marbling

Causal Organism. Marbling is due to the bacterium *Pantoea ananatis* Mergaert et al. 1993. (=*Erwinia uredovora* (Pon et al.) Dye; E. ananas Serrano). Certain species of Acetobacter have also been reported to be associated with the disease.

Symptoms and Signs

Marbling is a disease of the ripening fruits. Diseased fruits show no visible surface or symptoms but it has a hallow sound when tapped. When cut, affected fruits shows the brown blemishes or spots and abnormal hardening of the internal tissues; browning of internal fleshy tissues which varies from yellowish or reddish brown to very dark dull brown occurring as speckles and streaks or in large continuous masses.

Management Strategies. Fruit is susceptible to to fruit marbling if the fruit is of low acidity. Application of potash fertilizer which may usually increase fruit acidity, is a practical control measure.

Pink Disease

Causal Organism. *Acetobacter aceti* (Pasteur) Beijerink (1898), *Gluconobacter oxydans* (Henneberg) De Ley 1961.

Symptons and Signs

Pink disease is is difficult to diagnose because the infected fruit has no external symptoms. When cut, fleshy tissues of infected fruits produce a peculiar odor and watery exhibiting purplish or brownish-pink color. During canning, a dark brown is observed when it is sliced.

Management Strategies.

- Maturity indices of fruit must be properly observed.
- The fruit should be harvested before 90% of the eyes become yellow.
- Careful handling of fruits will minimize the disease damage.

Yeasty Rot

Causal Organism. The disease is caused by unidentified yeast and other fermenting organisms.

Symptoms and Signs.

- Bubbling exudation of gas is occurring in the infected areas or injuries
- The skin turns brown, leathery and the whole fruit become spongy.
- The presence of large gas cavities of the decaying flesh of the fruit.
- Fibrous tissues are left in the leathery skin.

Management strategies.

- Adequate protection of maturing fruit against sunburn.
- Avoid bruising of fruit during harvesting, handling and packing.

Butt Rot and Black Rot, Soft Rot.

Causal Organism. Butt rot and black rot are caused by the same fungus *Chalara paradoxa* (de Seyn) Sacc. [*Thielaviopsis paradoxa* (DeSeyn) Hohn]. *C. paradoxa* is also known to attack other crops like sugarcane, coconut, and banana.

Symptoms and Signs

Butt rot sometimes called base rot- affecting the base or butt of planting materials and young plants. The affected central tissues of the base are destroyed leaving stringy fibers. The tissues turn black because of the pathogen. Infection may extend up to the stem causing wilting, browning, and drying of the lower and central whorl of leaves. Affected newly planted crowns and young plants are killed and can be easily pulled off the ground. Plants that may survive become severely stunted.

Black rot is a postharvest disease. It is also called water blister or sometimes Thielaviopsis rot. The disease may start at the base or in growth cracks or injuries on

the surface of the fruit. Early symptoms are the water-soaked and slightly darkened skin over rotten tissues that readily break under slight pressure. If the fruit is cut open, a soft decay characterized by water-soaked and dark yellow tissues can be seen. In advanced stages, the core disintegrates with the flesh; diseased tissues become grayish black and may be covered with black spores of the fungi. A peculiar odor accompanies the decay.

Management Strategies:

Butt rot control

- Storing newly detached crowns, slips or suckers by piling with their butt on top, and exposing them to sunlight for at least a week before planting.
- Freshly detached crowns, slips or suckers must be treated with an appropriate systemic fungicide before planting.
- Previous pineapple plantation site must be free of pineapple trash; disc-in pineapple trash in soil and let them decompose; if plenty of trash remains on the site, spot burn it during the dry season.

Black rot control

- Fungicide dip treatment. To control black rot, treat fruits within two hours after harvesting by dipping into systemic fungicides cleared for use in pineapple fruits.
- Low temperature storage. Refrigeration of the fruit at 7.2°C will prevent the development of the disease and such condition may be used for short term storage.
- Sanitation. Packing stations should be regularly disinfected.
- Proper packing. Avoid packing injured, sunburned, and wet fruits. Infected fruits should not be shipped because considerable decay may ensue even before the container shipping temperature is attained.
- Harvesting precaution. When the dry growing season is followed by wet periods, plants are usually under stress and fruits are more prone to growth cracks, which predispose them to the disease.

Plant Parasitic nematodes

Causal Organisms. The following nematodes have been reported to be the most important and most destructive:

- *Meloidogyne incognita* Chet (root knot)
- *Pratylenchus brachyurus* (Godfrey) Filipjev & Schurrmanus- Steckhoven (root lesion)
- *Rotylenchuluis reniformis* Linford & Oliviera (reniform nematode)

Management and Strategies

- Crop rotation. Avoid frequent replanting of pineapple in the same field. Practice rotation with cereals if economical.
- Proper land preparation. Plow or disc soil during summer to expost it to solar radiation. Fallow field for 6-8 weeks before final harrowing and planting. Field should be free of pineapple trash
- Nematicide soil treatment. Examine the soil for nematodes before planting. If severly infected, treat the soil with nematicides.

Insect and Mite Pests

1. Insects

California Red Scale, *Aonidiella aurantii* (Maskell)
Florida Red Scale, *Chrysomphalus aoinidum* (Linn.)
Fern Scale, *Pinnaspis aspidistrae* (Signoret)
Coconut scale *Aspidiotus destructor* Signoret

Nature of Damage

Scale insect sucks plant sap mainly on the undersurface of leaves, which consequently turn yellow or dry up.

Management Strategies. Natural enemies like the Aphytis parasitoids cause about 60-80% parasitization of both the male and female scale insects. Like wise, larvae and adults of minute and black coccinellid beetles are quite active and efficient in checking scale insect population in the field. Spray recommended insecticides when scale insect population is at moderate level (2-3 scale insects per leaf), following the manufacturer's recommended dosage. Spraying may be repeated at a 3-week interval when necessary.

2. Mites

Pineapple Mite, *Steneotarsonemus ananas* (Tyron)
Acarina: Tarsonemidae
Pineapple Flat Mite, *Dolichotetranychus floridamus* (Banks)
Acarina: Tenuipalpidae

Nature of Damage

Infested leaves become brownish and in severe infestation, the affecte plants become stunted.

Management Strategies for Mites.

Mites can be controlled by using acaricide. Apply at the first appearance of mite damage smf repeast the spraying after 8-10 days if necessary. Test the chemicals on a few plants first for any varietal toxicity before using in commercial scale.

3. White Grub, June Beetle, Toy Bettle

Leucopholis irrorata

Coleoptera: Scarabidae

Nature of Damage.

Very young grubs feed on organic matter and then on roots as they grow older. Roots are eaten up and plants become stunted. Patches of yellowing in the field are signs of grub infestations.

Management Strategies

- Collect grubs during planting.
- Timing of planting/weeding. As much as possible do not plant from June to August to escape high population of ovipositing adults. Likewise weeding should not coincide during these months since females prefer to lay eggs on freshly tilled and weed-free fields than one crop-covered fields.
- Trapping gravid females. Gravid females are strongly attracted to lay egg on moist soil high in OM. Decomposing sawdust and animal manure are preferred by the insect as a substrate for egg laying. Plots measuring 2 m x 1 m can be prepared around the periphery of the plantation where animal manure or sawdust is mixed with the soil. In a 1-ha plantation, about 10-12 such plots can be prepared in June to mid-August. Which is the peak of egg laying. These plots should be mulched with dried leaves, maintained moist, and should be located in shaded areas to minimize water evaporation. Grub collection can be done during late August to September. Grubs can be fed to chicken.
- Use of recommended insecticides. Control should be directed against the first and second larval instars since they are more susceptible than the third instar larvae. The first instar larvae are mostly found near the soil surface and feed on OM while the second instar larvae start to feed on the roots. In contrast, the third instar larvae are much bigger than the early instars, stay deeper in the soil; and feed voraciously on the roots.

4. **Pineapple Mealybug**

Dysmicoccus brevipes (Cockerel)

Homoptera: Pseudococcidae

Nature of Damage.

Mealybugs infest all plant parts, from the crown of the fruit all the way down to the roots. Infestation of new plantings may arise through mealybugs being carried over on new planting materials. Symptoms include black spot and a viral infection on the fruit tissue (mealybug wilt). Infected plants becomes stunted as the root system is progressively affected and eventually collapses, finally the leaves curl up and become discolored.

Management strategies.

- Monitor mealybug infestation and presence of ants starting at four months after planting and repeat at monthly intervals until flower induction.
- Examine all plants in the periphery and after every ten rows.
- Record the exact location of plants infested with mealybugs on a field map. Indicate if mealybugs are attended by ants.
- Spray the base of the plant with recommended insecticides following the manufacturer's recommended dosage.
- Repeat spraying at a four-week interval if necessary.
- Practice crop rotation in heavily infected area.

Rodent Pests

Ratus tanezumi and *R. exulans* are the common species of rats observed in pineapple plantations in Luzon. *R. argentiventer* or other less common species may also cause damage when present in the field as in the islands of Mindanao and Mindoro.

Rat damage in pineapple begins during flowering and continues up to maturity in the absence of control methods. It is more serious when pineapples are grown underneath coconuts and are adjacent to rice fields. Evidently, there is an active movement of rodents between the rice fields and the coconut-pineapple intercrop. Once rice is harvested, the rats move in to the adjacent field planted to pineapple for harborage and food source.

Management Strategies.

The main target of rodent control should be to reduce crop damage. Killing rats should be a secondary goal**.** Rat control must be safe to human beings and animals, not harmful to the environment, and acceptable to farmers.

No single method fits all situations, in fact, several methods may be necessary to reduce or prevent crop damage. Some techniques in regulating rodent populations in pineapple fields are cultural, mechanical, and chemical methods.

Cultural Method.

Reduce harborage (such as clean culture) to limit the incidence of burrowing animals and discourage animals from using the crop fields as breeding sites. Generally weedy fields would sustain more damage than clean fields. Incorporate crop residues in the soil after harvest to reduce harborage. This is applicable only in a certain growing period of the crop since the crop itself can also serve as a shelter or harborage for the animals.

Mechanical Method.

The mechanical method involves direct killing or exclusion by manual or mechanical means. Two of the most popular ones are the trapping and bounty system.

Trapping system – maybe use in small areas where use of poisons may pose safety hazards. This should be done continuously since rats from other places may migrate to the area being protected.

Bounty system - This system is supported by local and national laws, which requires all citizens to help regulate rodent population. The people are given rewards or cash payments for carcasses or rats' tails turned in. The campaign is usually intensified when crops are susceptible but the timing is often too late

Chemical Method.

Chemical method or baiting with rodenticides is still considered the most popular means of rodent control. Rodenticides that are used in the country are either acute or slow.

Acute rodenticides – Zinc phosphate is the best known and most readily available.

Slow-acting or chronic rodenticides – Rodenticides under this category are warfarin(Ratoxin™), coumatetralyl (Racumin™), coumachlor (Tomorin™), diphacinone (Diphacin™). They are referred to as the first generation anticoagulants.

Weed Management

Weeds are one of the major constraints in obtaining high yields in pineapple. Weeds compete with pineapple for nutrients, water and sunlight. They also serve as alternate hosts of other pests and ideal place for breeding and multiplication of rodents.

Weed management systems that provide adequate control comprise of a blend of several appropriate components or methods. The various possible weed control

components include preventive, cultural, chemical and integrated weed management methods.

Preventive Methods. These include the use of high quality and disease-free planting materials.

Cultural Methods. These include harrowing, handweeding, interrow cultivation, mulching and intercropping. Harrowing removes weed flushes and an effective way of reducing weed reserves in the soil. Handweeding or hoe slashing can be conveniently done only during the early stages of crop growth especially with single-row planting or double rows. As the pineapple plant grows, the foliage covers the spaces between rows and handweeding would be difficult because of the pointed leaf tips and sharp margins. Interrow cultivation with animal-drawn plows can be conveniently done during the early stages of growth of the crop with the same reason as for handweeding. Mulching the base of the pineapple plant with weeds that are cut through handweeding or interrow cultivation help in weed control, water conservation and improvement of soil nutrient status. Intercropping of other crops between pineapple rows can help reduce weed growth and augment the income of pineapple growers.

Chemical Method. The use of herbicides or weedicides to kill the weeds with minimum or no injury to the crop. Use herbicides properly. Read, understand and follow instructions on the herbicide label. Be sure that the weeds infesting the plantation are those that can be controlled by the herbicide. Apply the herbicide at the recommended rate and appropriate stage of growth of pineapple and weeds. Calibrate the sprayer in the area that will be sprayed before applying the herbicide.

Integrated Weed Management. The use of a combination of appropriate weed control components in a system based on ecological, economic and sociological considerations.

Harvesting and Postharvest Handling

Maturity Indices

When pineapple fruit is already mature, the eye of Red Spanish variety develops reddish brown to yellow orange while Hawaiian or Smooth Cayene and other similar varieties will produce golden yellow when it is ripened.

On large scale planting shell color is generally used to determine the various stages of maturity. Harvest Queen fruit when the shell color is green but the grooves between the eyes show widening and yellowing. This maturity stage correspond to a diameter of not less than 10 cm and is appropriate for fresh marketing to distant

markets and for processing into dried pineapple product. For immediate consumption and minimal processing, fruit should be harvested when the first two layers of shells or eyes at the base show yellowing.

Shell color is not a reliable guide for Smooth Cayene but the following harvesting indices will guarantee high eating quality and consumer acceptability. This include the calendar method (harvest not later than 149 days after flower induction), and total soluble solids content (not less than 14^0 Brix).

Harvesting

Harvesting pineapple will depend upon the maturity indices or by its shell color and purpose or utilization.

In small farms, pineapple is harvested manually. The fruit are severed from the mother plant using a knife or by just snapping off the fruit from the main stem of the plant as done in Smooth Cayene. Fruits should be piled or placed on a well-shaded and clean area to minimize weight loss and microbial contamination. Hauling baskets must be provided with liners (leaves, banana, bracts, etc.) if the sides are too rough so as not to injure the fruits.

In semi-commercial plantation mechanized method of harvesting is partly manipulated. This done by harvesters passing along the ailes and placing the harvested fruit to a large container or bin and will be transferred to another carrier cargo truck.

Packinghouse Operations

Fruit must be prepared for marketing in a packinghouse where they are well protected from intense heat, sunlight, and rain. A packinghouse could also serve as a trading post for pooled produced by small farmers. Quality control system can be implemented so that the fruit will meet the quality requirements of the clients. The appropriate size of the packinghouse would depend on the volume of fruits that would pass through the area at one time (As a rule, for every ton, a floor area of 20 m^2 is required).

Trimming

Pineapples harvested with the peduncle on should be trimmed close to the base of the fruit to minimize injury to other fruits during packaging on bulk transport. Trimming can be done using sharp, clean knife or a shear.

Sorting and Grading

Variability in size and degree of ripeness due to variations in growing conditions occur in many harvested pineapples. It is necessary, therefore, to do preliminary sorting in the field where defective fruits are culled and no longer hauled to the

packinghouse. Final sorting and grading in the packinghouse should be made according to the requirements of the client or market.

For local market, sorting according to size forms the basis for pricing (Table 3). For export, fruits should be sorted according to the degree of ripeness and weight and graded following Grades and Standards for Pineapple (Appendix 1). Table 4 presents the peel color indices (PCI) of Queen and Smooth Cayene pineapple which serves a guide in choosing the right maturity for its intended use.

Table 3. Size classification of Queen and Smooth Cayene.*

Size	Term	Weight (kg)	
		Queen	Smooth Cayene
Extra large (XL)	Extra	1.3 and above	1.8 and above
Large (L)	Primera	1.0-1.29	1.6-1.7
Medium (M)	Segunda	0.75-0.99	1.2-1.5
Small (S)	Tersera	0.50-0.74	1.0-1.1
Very small (VS)	Butterball	Less than 0.50	Less than 1.0

*Philippine National Standards.

Table 4. Peel color indices of Queen and Smooth Cayene pineapple.*

Peel Color Indices (PCI)	Queen	Smooth Cayene
PCI 1	All eyes are dark green, greenish bracts cling tightly to the eyes (Immature).	Dark blue green peel (immature)
PCI 2	All eyes are green; whitish bracts are dry, grooves between eyes show separation and yellowing Best to use for dried/candied pineapple, suitable harvest	Eyes are green but show widening and yellowing of of grooves
PCI 3	About 2-3 layers of the eyes at the base show yellowing. Best for fresh consumption; suitable for processing into juice and jams.	One-fourth of the peel surface turning yellow Fit for long distance transport and storage
PCI 4	Fifty percent of eyes are yellow	One half of the peel surface is yellow (half ripe)

PCI 5	More than 75% of eyes are yellow (overripe)	Fit for immediate consumption. Three-fourths of the peel surface is yellow(full ripe).
PCI 6	Full yellow (overripe)	Fit for immediate consumption Full yellow (over mature)

*Philippine National Standards

Waxing

Waxing pineapples is done to delay ripening and minimize moisture loss, thus increase shelf life or marketable life. It also minimizes the development of chilling disorder called blackheart. Wax formulations that can be used include Sta Fresh (imported) or the locally developed ones using edible oil or mineral oil. For Queen pineapple, a mineral oil-based formulation consisting of 1 part mineral oil, 20 parts water, and 1 part liquid detergent can be used. For Smooth Cayene, use of Sta Fresh at 1 part wax, 6 parts water ratio and a formulation consisting of cooking oil and water (1 part oil:6parts water) is recommended. The above wax formulations could extend the marketable life of Queen and Smooth Cayene by 1 week relative to marketable life of unwaxed fruits. Wax formulations can be applied using a soft brush or sprayer.

Packing and Packaging

Pineapples are packed manually in containers (baskets, crates, or cartons) in a flat pack manner with fruits lying on the sides in an alternate crown-to-base fashion. This manner of packing is recommended for Queen because of its small size. For Smooth Cayenne, it is better to pack the fruits inside a container in an upright position in a crown-to-crown or base-to-base fashion. In this method, less damage in terms of bruising and compression is incurred for the relatively large-sized Smooth Cayenne. For export, wooden boxes should be used and the packing methods appropriate for each variety should be strickly observed. Shredded papers are placed between fruits to cushion against vibrations and impact during transit.

Storage

Pineapples can be stored at a low temperature but they are subject to chilling injury (blackheart). Blackheart is characterized by the appearance of dark brown, water-soaked tissues near the core and by a distinct fermented odor. This disorder develops during cold storage below 20^0C and symptoms manifest 2-3 days after withdrawal from the cold condition. For Queen and Smooth Cayenne, the optimum refrigerated storage temperature is 20^0C and no chilling injury develops up to 14 days. Waxing prior to low temperature storage is recommended to alleviate the development of blackheart.

Transport

In the Philippines, bulk transport using jeepneys or small, nonrefrigerated vans is the most economically feasible method of transporting pineapples from growing areas to market centers. To reduce compression or physical damage during bulk transport, the vehicle should be provided with horizontal dividers. Fruits should be arrange lying on their sides in an alternate crown-to-base fashion. Transport should be done during the coolest time of the day or during nighttime. For export, transport by sea or air requires recommended low temperature throughout the handling chain.

COST AND RETURN ANALYSIS

The cost and return of producing fresh pineapple fruits from a one-hectare land area with 50,000 plants is shown in Table 5.

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