DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY

BANANA

PRODUCTION GUIDE

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HALAMAN AY YAMAN

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The BANANA Plant

Banana, a monoecious monocotyledonous plant belonging to the family *Musacea*, is the largest herbaceous plant in the world. This plant is often considered a tree as it grows normally up to 3m in height and is fairly robust. However the stem is in fact a pseudostem that grows from a corm (Simmonds, 1962; Swennen and Rosales, 1994; Swennen, *et al*., 2011).

The Philippines along with other Southeast Asian countries, is one of the centers of banana diversity and domestication (Simmond, 1962; Valmayor *et al*., 2002; Perrier *et al*., 2011).

Bananas constitute the fourth largest fruit crop of the world next to rice, wheat and corn. The production is all year round thus, providing food supply throughout the year. The country's banana supply for human consumption is about 50%, with 32% for export as process and 18% as feeds and turned to organic fertilizer (BAS, 2008).

In the Philippines, the total area planted to banana is 449,443.89 ha (BAS, 2010). Of this, Davao region, Northern Mindanao and SOCCSKSARGEN are the top producing regions with 72% total volume of production where climatic condition is suited to banana production with no typhoon problem (Table 1).

Cavendish bananas gained popular export to Japan, China, Korea, Taiwan and the Middle East. Banana chips from cooking banana particularly Cardaba/Saba' has also been exported to Hongkong, Japan, Singapore and Korea. While Lakatan (Philippines) or Pisang Berangan (Malaysia) are exported to Japan, China and other East Asian and Middle Eastern countries.

Table 1. The area planted (ha) and volume of production (metric ton) of banana by region

Region	Area planted (ha)	Volume (mt)
LUZON		
CALABARZON	29,663.00	105,841.75
MIMAROPA	26,638.00	210,382.85
Cagayan Valley	23,651.00	368,074.23
Bicol Region	18,730.00	77,891.54
Ilocos Region	18,809.30	41,220.27
Central Luzon	6,295.00	58,216.40
CAR	4,842.00	25,668.92
Subtotal	128,628.30	887,294.96
VISAYAS		
Western Visayas	34,428.85	332,177.65
Eastern Visayas	30,565.70	278,305.78
Central Visayas	21,541.00	182,323.07
Subtotal	86,535.55	792,806.50
MINDANAO		
Davao Region	87,313.00	3,804,459.99
Northern Mindanao	51,519.00	1,702,391.84
ARMM	31,552.45	396,539.39
SOCCSKSARGEN	29,243.00	1,043,811.31
CARAGA	26,060.00	210,392.94
Zamboanga	19,618.00	263,643.26
Subtotal	245,305.45	7,421,238.73
Grand Total	460,469.30	9,101,341.19

Source: BAS, 2010

Banana has a great nutritional significance. The fruit is composed mainly of water and carbohydrate that provides energy in the human body. The fruit is a good source of Vitamin A, B, C and some mineral, particularly Phosphorus, Magnesium, Potassium and dietary fiber (Table 2). It contains high levels of carbohydrate that provides energy. One banana fruit provides 380 milligrams which is more than an adult's

daily requirements of Potassium (Englberger, 2003). Banana with yellow to orange pulp contains high levels of proVitamin A carotenoids (pVACs) that can be converted into Vitamin A.

Table 2. Standard composition value of banana

Component	Value
Moisture (%)	70.0
Carbohydrates (%)	27.0
Protein (%)	1.2
Ash (%)	0.9
Crude fiber (%)	0.5
Fat (%)	0.3
Phosphorus (ppm)	290.0
Ascorbic acid (ppm)	120.0
Calcium (ppm)	80.0
Niacin (ppm)	7.0
Iron (ppm)	6.0
Beta-carotene (ppm)	2.4
Riboflavin (ppm)	0.5
Thiamine (ppm)	0.5
Energy (cal/100g)	104.0

Source: Simmonds, N.W., 1959.

Banana is considered as a 'tree of life' or 'Kalpatharu' (an Indian word)'. It has several uses in food, industry, medicine and decorative purposes. The center succulent part of the pseudostem can be consumed as vegetable. The pseudostem, aside from feeds for hogs and cattles, can also be used as source of fiber and organic fertilizer. Banana leaves can be used as food wraps for leaf industry (Temanel, 2008) while the roots, stalk and peduncle can be used as organic fertilizer. Banana can also be processed into flour, puree, jam, jelly, wine, powder, dye, flakes, catsup and banana chips. Moreover, banana can be used as: umbrella (leaves), glue (starch), necklace (seeds), ornaments (decorative type), dye (banana sap), shampoo, and intercrop

CROP VARIETIES

There are two hundred ninety-six (296) banana accessions grown in the Philippines particularly in the Southeast Asian banana germplasm at the Bureau of Plant Industry - Davao National Crop Research and Development Center (BPI-DNCRDC) in Bago Oshiro, Davao City. These are classified into different genomic classification (Table 3). These are local and introduced from Papua New Guinea, Malaysia, Thailand, Indonesia, India, Jamaica, Honduras and ITC-Belgium (Table 4). These are also classified according to use as dessert, cooking and processing type, while seeded bananas are used for breeding. Other cultivars with unique characteristics can be used for decorative and ornamental purposes (Table 5, Figure 1a to 5 and Appendix 1).

From the banana accessions, two hundred twenty-five (225) were known to be distinct. Of which Lakatan, Latundan and Cardaba or Saba' are National Seed Industry Council (NSIC) registered banana cultivars. Other cultivars gained popularity in local and export market include Bungulan, Grand Naine, Williams (Cavendish group), Turangkog or Sab-a, Morado, Amas, Señorita, Kalimpos and Mundo. Some are grown for backyard, home consumption, feeds, breeding/research and decorative purposes.

Table 3. Classification of banana cultivars at the Southeast Asian banana germplasm at BPI-DNCRDC, Bago Oshiro, Davao City (March 2012)

Type	Species and genomic classification/Example of common cultivar
Dessert	*Musa acuminata* AA (Lakatan, Amas, Señorita) AAA (Williams, Grand Naine, Bungulan, Morado) AAAA (FHIA-02) *Musa acuminata x balbisiana* AB (Ney Povan) AAB (Latundan, Hilao-Hinog, Pisang Ceylan) AAAB (FHIA-01) ABB (Katali, Kluai Namwa Khom) *Musa acuminata* x *Australimusa* AAS (Henderneyargh)
Cooking/processing	*Musa balbisiana* BBcv (Abuhon) BBB (Cardaba or Saba', Dali-an or Giant Cardaba, Kalimpos, Turangkog or Sab-a, Mundo, Sab-ang Puti *Musa acuminata x balbisiana* AAB (Tindok, Inambak) ABB (Pelipita) ABBB (Tiparot)
Seeded/breeding	*Musa acuminata* AAw (Agutay, Mambee Thu) *Musa balbisiana* BBw (Butuhan)
Ornamental	Rodochlamys *Musa ornata* *Musa laterita*

Table 4. Number of banana cultivars at the Southeast Asian banana germplasm of BPI-DNCRDC, Bago Oshiro, Davao City by country of origin (March 2012)

Country of Origin	No. of accession	No. of distinct cultivar
Philippines	89	81
Papua New Guinea	34	27
Malaysia	21	18
Thailand	16	13
Indonesia	8	5
India	1	1
Jamaica	2	1
Honduras	1	1
ITC-Belgium	124	78
Total	296	225

Table 5. Number of banana cultivars at the South Southeast Asian banana germplasm of BPI-DNCRDC, Bago Oshiro, Davao City by cultivar type

Type	No. of cultivar
Cooking	71
Dessert	134
Carotene Chip -rich	30
Unique	64
Seeded	23

Name of Cultivar	: **LAKATAN**
Origin	: Philippines
Genome	: AA
Type	: Dessert

Synonyms

Philippines	: Mapang (Misamis Occidental)
Southeaster Asia	: Pisang Berangan (Malaysia) Lakatan (International)

Morphological and Horticultural Characteristics

Pseudostem height	: 2.7 to 2.8 m
Pseudostem diameter	: 18 to 20 cm
Planting to flowering	: 9 mos., 27 days
Flowering to harvest	: 2 mos. 24 days
Bunch Weight	: 13 to 18 kgs
No. of hands/bunch	: 7 to 9
No. of fruits/bunch	: 98 to 122
Fruit weight	: 111 to 150 g
Fruit length	: 13 to 14 cm
Fruit diameter	: 3.5 to 4 cm
Taste	: Sweet and aromatic
Quality	: Excellent
Remarks	: NSIC registered

Figure 1a. The morphological and horticultural characteristics of Lakatan

Name of Cultivar	: **SEÑORITA**
Origin	: Philippines
Genome	: AA
Type	: Dessert

Synonyms

Philippines	: Inarnibal
Southeaster Asia	

Morphological and Horticultural Characteristics

Pseudostem height	: 2.1 to 2.9 m
Pseudostem diameter	: 14.8 to 15 cm
Planting to flowering	: 12 mos., 6 days
Flowering to harvest	: 2 mos. 24 days
Bunch Weight	: 4.6 to 5.0 kgs
No. of hands/bunch	: 5 to 6
No. of fruits/bunch	: 85 to 98
Fruit weight	: 68 g
Fruit length	: 6.0 to 6.2 cm
Fruit diameter	: 3.2 to 3.3 cm
Taste	: Very sweet and aromatic
Quality	: Very good

Figure 1b. The morphological and horticultural characteristics of Señorita

Name of Cultivar	: **AMAS**
Origin	: Philippines
Genome	: AA
Type	: Dessert

Synonyms

Philippines	: Caramelo (Batangas) Kamoros (Agusan)
Southeaster Asia	: Pisang Mas (Malaysia) Sucrier (International)

Morphological and Horticultural Characteristics

Pseudostem height	: 2.3 to 2.5 m
Pseudostem diameter	: 15 to 18 cm
Planting to flowering	: 8 mos., 24 days
Flowering to harvest	: 1 mo. 17 days
Bunch Weight	: 7.0 to 10.0 g
No. of hands/bunch	: 5 to 7
No. of fruits/bunch	: 100 to 130
Fruit weight	: 70 to 80 g
Fruit length	: 10 to 10.3 cm
Fruit diameter	: 3.2 to 3.4 cm
Taste	: Sugary and aromatic
Quality	: Excellent

Figure 1c. The morphological and horticultural characteristics of Amas

Name of Cultivar	: **MORADO**
Origin	: Philippines
Genome	: AAA
Type	: Dessert

Synonyms

Philippines	: Raines na pula (Tagalog regions Tadiao Tumbaga (Sulo) Tinumbaga (Surigao)
Southeaster Asia	: Chuoi Com Lua (Vietnam) Red, Rojo, Morado (International)

Morphological and Horticultural Characteristics

Pseudostem height	: 3.2 to 3.5 m
Pseudostem diameter	: 22 to 25 cm
Planting to flowering	: 10 mos., 24 days
Flowering to harvest	: 2 mos. 15 days
Bunch Weight	: 12 to 14 kgs
No. of hands/bunch	: 5 to 6
No. of fruits/bunch	: 70 to 84
Fruit weight	: 138 to 140 g
Fruit length	: 13.5 to 14 cm
Fruit diameter	: 4.0 to 4.5 cm
Taste	: Sweet and aromatic
Quality	: Very good

Figure 1d. The morphological and horticultural characteristics of Morado

Name of Cultivar	: **BUNGULAN**
Origin	: Philippines
Genome	: AAA (Cavendish-type)
Type	: Dessert

Synonyms

Philippines	: Bunguran (Bicol) Bulunganon (Negros Or.) Balangon (Negros Occ., Iloilo)
Southeaster Asia	: Pisang Masak Hijau (Malaysia) Pisang Ambon Lumut (Indonesia) Tall Cavendish, Lacatan (Int'l)

Morphological and Horticultural Characteristics

Pseudostem height	: 2.8 to 3.2 m
Pseudostem diameter	: 18 to 20 cm
Planting to flowering	: 9 mos., 6 days
Flowering to harvest	: 3 mos. 2 days
Bunch Weight	: 14 to 16 kgs
No. of hands/bunch	: 8 to 10
No. of fruits/bunch	: 144 to 180
Fruit weight	: 120 to 124 g
Fruit length	: 14 to 16 cm
Fruit diameter	: 3.4 to 3.5 cm
Taste	: Sweet and aromatic
Quality	: Excellent

Figure 1e. The morphological and horticultural characteristics of Bungulan

CULTURAL MANAGEMENT

A. Field Establishment

Site selection. Select an area with adequate drainage system and not a water-logged area. Choose the area with no history of Fusarium or Moko infection.

B. Climatic and Soil Requirements

1. **Climate.** Banana grows best in areas with not more than three (3) months of distinct dry season.
2. **Soil.** Banana plant can be grown in nearly all kinds of soil. However, it grows preferably in a deep, well-drained, fertile loam with high humus content with pH ranging from 5.0 to 7.0 (Purse, G., 1994). It requires considerable amount of Nitrogen and Potassium to maintain higher yields.

3. **Elevation.** It can grow at sea level between 100 to 500 meters and 1500 meters altitude for highland bananas.
4. **Temperature.** The temperature requirement for growth of banana is between 19°C to 27°C.
5. **Rainfall.** The annual rainfall of 2,000 to 2,500 mm or 25 mm per week is best for banana.

C. Propagation. Banana is an asexually propagated crop. It can be propagated by corms and suckers. Shoot-tip culture technique is now developed for mass production of banana. This is used for rapid propagation of disease-free planting materials.

D. Selection of planting materials. The selection of planting materials is one of the most important factors to consider. Several types of planting materials such as true-to-type tissue cultured planting materials and suckers that should be obtained from a healthy source mats (Figure 2 and 3).

Figure 2. A tissue-cultured banana plantlet

Figure 3. A sword sucker

Tissue-culture derived

a. can be obtained in bulk
b. disease-free
c. higher survival rate during field establishment
d. more vigorous
e. uniform plant growth
f. earlier to harvest
g. bigger bunches

Sucker-derived

a. vigorously grown suckers
b. narrow leaves
c. 30 to 100 cm high

E. Land Preparation

1. **Land clearing.** Remove shrubs, stubbles, weeds and other materials that hamper the growth of plants. Leave the area without being burned. Burning is advisable as it can destroy the organic matter and its broader effect in climate change. Alternatively, spraying with herbicide is recommended.
2. **Land cultivation.** Plowing the field 2 to 3 times is vital to loosen the soil and to remove weeds. Harrowing must follow particularly those areas that have been previously planted with other crops. Hand forking or hoeing is adopted on the steep slope where plowing cannot be undertaken. The tillage must be done gradually on the contour.
3. **Drainage canal.** Construction of a drainage canal (main and secondary) between 4 rows should be done to prevent water logging and minimize the accumulation of salt and other toxic substance within the root zone. This will promote extensive root development, proper aeration and also prevents the spread of soil-borne disease.

F. Planting

1. **Lay-outing.** Lay-out depends on variety and the planting system to be used. Below are the factors to consider in plant lay-out:

   a. topography of the land
   b. development program of the farm
   c. variety
   d. soil fertility
   e. planting of intercrops

2. **Square system**

   a. Determine the direction of the rows.
   b. Determine the base lines; these two base lines should be at the right angle or 90°.
   c. Plant at the intersection of the corner of the square (Figure 4).

3. **Triangular system.** Refers to the planting at the corners of an equilateral triangle (Figure 5).

4. Q**uincunx system**

   a. Done following the square system (Figure 6).
   b. Plant additional hill at the middle of the square.
      c. Distance between hills become closer.

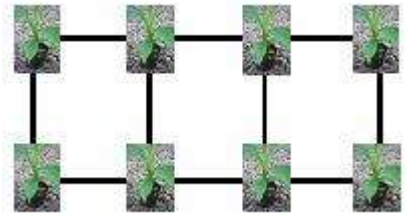

Figure 4. Square method of planting

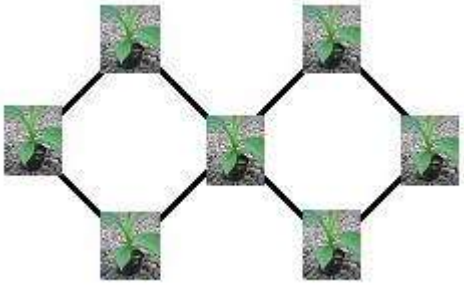

Figure 5. Triangular or hexagonal method of planting

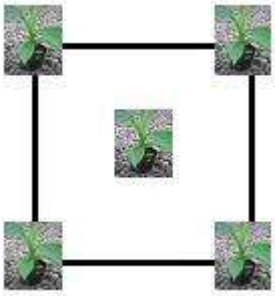

Figure 6. Quincunx method of planting

E. Planting Distance. Planting distance is as well important to consider. The following should be considered:

   a. taller plants require wider space than shorter ones (Table 6).
   b. method of sucker control
   c. topography
   d. system of production management

F. Holing. Dig a hole about 30 to 35 cm deep and 35 to 40 cm wide (for open area) or 45 cm deep and 45 cm wide when you plant under the coconut tree.

G. Planting time. Planting should be done during or at the beginning of the rainy season.

However, this could be also done any time of the year if rainfall is evenly distributed throughout the year.

H. Planting method. In tissue-culture derived planting material, remove polyethylene bags using knife to avoid root damage. Place 50 g or a handful of complete fertilizer (basal application) and cover with 10 cm soil to avoid contact with roots and fertilizer before placing the plant into the hole. Add 1 kg of organic fertilizer into the hole before planting. Replanting for dead plants is advised. Watering the plant after planting is recommended.

Table 6. Planting distance by cultivar type

Type	Planting Distance (m)	No. of plant per hectare
Dessert		
AA		
Lakatan	2 x 2.5	2,000
Amas		
Senorita		
AAA		
Bungulan	3 x 3	1,111
Grand Naine		
Williams		
Morado		
AAB		
Latundan	3 x 3	1,111
Cooking		
AAB (Plantain)		
Tindok	3 x 4	833
BBcv		
Abuhon	4 x 5	500
BBB (Cardaba or Saba' type)	5 x 5	400
Cardaba or Dippig		
Dalian or Giant Cardaba		
Kalimpos		
BBB (Turangkog or Sab-a type		
Sab-a or Turangkog	4 x 4	625
Sab-ang Puti		
Mundo		

G. Water management. Water provides hydrogen and oxygen that helps the plant cells and tissue turgid. This should be done immediately after planting and at weekly interval for two months if there is no rain. Irrigate the plants when the rainfall falls below 5 cm.

H. Weed Control. Weeds should be controlled to prevent light, water and nutrient competition between the plants and prevent from any harboring insect pests. Since banana plant is a shallow rooted crop, weeds can be controlled by mechanical, chemical and natural methods as follows:

1. **Mechanical control.** Mechanical weeding can be done through slashing and ring weeding. Slashing is usually done on the newly established area every 2 to 3 months without herbicide application. Ring weeding is done by removing weeds within the radius of 60 to 75 cm from the base of the plants before fertilizer application.
2. **Natural control.** This is similar to intercropping wherein planting of sweet potato (camote), upland rice, kangkong and ginger as natural weed control between rows which can suppress the growth of weeds, lessen weeding, slashing operations and weedicide.
3. **Chemical control.** The easiest way of controlling weeds is by chemical means using any commercially available weedicide.

I. Cover cropping/Intercropping. Cover cropping/intercropping is the growing of other crops that protects the soil to conserve topsoil and moisture. It can also provide additional income and reduce weeding expenses. Leguminous crops, upland rice kangkong and camote were usually used as intercrops. The study of Rabe *et al*. (1984) demonstrated that abaca intercropped with camote gave the highest income followed by peanut and ginger, the lowest was on abaca-squash.

J. Fertilization. Fertilizer application is important to produce optimum yield. It can be applied 3 to 4 times a year. Important considerations are as follows:

1. Apply fertilizer based on soil and tissue analysis and crop removal.
2. When applying fertilizer, dig a hole around the plant or a canal within the area covered by the canopy.
3. For general fertilizer recommendation, apply 90.0 kg of Nitrogen (N), 30 kg Phosphorus (P2 O5) and 120 kg Potassium (K2O). For Lakatan fertilization guide, refer Table 7.
4. Apply fertilizers during the critical or the earliest stages of growth (1 to 6 months old) by broadcasting, forking-in (poke-hole method) and digging a hole around the plant, and make a canal within the area covered by the canopy.
5. In the absence of tissue analysis, nutrient requirement of banana can be gauged from the deficiency symptoms on the leaves as seen in Table 8 and 9.

Table 7. Fertilization guide for Lakatan production

Application	Amount of fertilizer (gram/mat)
Basal application	100 g complete fertilizer plus 800 to 1000 g chicken dung
2 to 3 MAP[a]	25 to 30 g complete fertilizer plus 46-0-0 g (Urea)
4 to 6 MAP	100 to 120 g (21-0-0) plus 100 to 120 g 0-0-60g (Muriate of Potash)
7 to 9 MAP	200 g Urea plus 300 g 0-0-60 g (Muriate of Potash)
10 months onwards	350 g Urea plus 350 g 0-0-60 g (Muriate of potash)

[a] Months after planting

Source: Personal interview from Lakatan grower.

Table 8. Deficiency symptoms in banana

Nutrient	Deficiency symptoms
Nitrogen (N)	Slow growth, leaf yellowing, pinkish-yellow tinge of petioles and pseudostem and rosetting.
Phosphorus (P_2O_5)	Seldom: cessation of elongation, leaf rosetting, older leaves irregular, chlorotic and necrotic, petiole breaking, young leaves turn dark green.
Potassium (K_2O)	Lower leaves bright-yellow, yellow-orange chlorosis, gradual dying of leaves from the tip with reddish-brown colour, oldest leaf golden-yellow with broken midrib and purple mottling at the base, leaf bending, rapid leaf desiccation.
Calcium (Ca)	Thickening of the veins in the leaves followed by interveinal chlorosis near the tip. Chlorotic patches develop from the margin inward.
Magnesium (Mg)	An older leaf from the 5th to 10th leaves become chlorotic, necrotic spots and green color appear near the margin, midrib, near the wind-teared. Blue mottling in the petioles appears.

Table 9. Percent level of nutrient as a guide to fertilization program in banana plantation

Nutrient	Adequate %	Minimum (severe deficiency)
Nitrogen (N)	2.60	1.50
Phosphorous (P2O5)	0.45	0.20
Potassium (K2O)	4.00	2.50
Calcium (CaO)	1.40	0.75
Magnesium (MgO)	0.60	0.20

Source: De Geus, J.G. 1967.

Sucker Control/De-suckering. De-suckering is the regular removal of suckers to maintain the appropriate density. It will reduce water, light and nutrient competition for maximum production. Use de-suckering tools to facilitate easy separation from the mother plant and prevent damage of other sucker/followers. Followers less than one (1) meter, unwanted peepers, water and floating suckers should

be removed. There are three plants maintained per mat with a ratio of 1:1:1. These are mother plant, follower and sucker for dessert type and a ratio of 1:2:2 for cooking type bananas.

De-leafing. De-leafing should be done when 50% of the leaves are functional. This can be done at 2 to 3 times per month. Removal of dried leaves should be done to reduce inoculum source of leaf diseases and improve light penetration. The trimmed leaves should be disposed properly or pile them in between rows as source of organic fertilizer.

Stem or mat sanitation. Stem or mat sanitation is done to eliminate the habitat of some insect pests. Cut the dried leaf sheath at monthly interval and pile them in between rows as source of mulching materials during dry period and source of organic fertilizer.

FRUIT CARE

1. **Bud removal or de-budding.** Remove the male bud when the false hand appears. This will prevent the infection of the cigar end rot and Bugtok disease of banana.
2. **Bunch spray.** Spraying of bunch will start when 1 to 2 hands appear at weekly interval up to removal of male bud. This will control fruit spots, freckle disease and insect pests of banana that cause damage and injuries to fruits.
3. **Propping.** Propping prevents the bunch from toppling down due to heavy bunch weight and strong wind. Using bamboo poles, set the props in slanting with X position at the top inline with the peduncle base to have a stronger support for the bunch.
4. **De-flowering /removal of stylar end.** Remove the stylar-end and flower relicts at bagging stage or during packing operation for phytosanitary considerations.
5. **Fruit bagging.** Bagging of bunch should be done when the last hand appear to protect the fruits from pests damage and injuries. A perforated polyethylene plastic bags is used leaving the bottom end uncover to prevent the accumulation of any flower relics. Tie a ribbon at the bottom end of the bunch as an index of maturity.

HARVESTING

The qualities of banana fruits depend upon the proper stage of maturity and methods used at harvest. It is also a sign of minimum acceptability for major consumers. The maturity index is an indication of the fruits ready for harvest. This varies on the type of cultivar and target market. Fruits harvested immature are of poor quality upon ripening. When harvesting is delayed, fruits are susceptible to decay.

1. **Maturity indices of banana.** One of the indices is counting the number of days from shooting to harvest. This index is true to all dessert, cooking and processing types of banana (Table 10). Change in the angularity of fingers is also considered for dessert and in some cooking/processing types. Generally, the fruits of cooking bananas like (BBB, Cardaba or Saba' and Turangkog or Sab-a group and some AAB plantain group remain angular even at full maturity. Commercially grown bananas are harvested green at varying degrees of maturity. The most common index is based on the fullness of fruit fingers. Some cultivars are commonly harvested at the full three quarters to full stage of maturity such as Lakatan and Latundan (Figure 7).

In export market, calibration size is the indication of fullness of fingers. Harvesting was done when the diameter of the middle finger of the outer whorl in 2nd hand falls within the range of 38 to 46 mm units using caliper expressed in 1/32 of an inch.

In small-scale farmers, the fullness of fingers is usually determined by dying of leaves and dryness of stylar end but not applicable to some varieties susceptible to leaf spot diseases like Sigatoka.

Table 10. Maturity indices of bananas

Banana cultivars	Maturity Index (shooting to harvest)
Cooking type	
Cardaba or Saba' group	
Kalimpos	4 mo, 2 days
Cardaba or Saba'	4 mo, 4 days
Giant Cardaba or Dali-an	4 mo, 8 days
Abuhon	4 mo, 3 days
Turangkog or Sab-a group	
Turangkog or Sab-a	4 mo, 6 days
Mundo	3 mo, 12 days
Sab-ang Puti	4 mo, 8 days
Dessert type	
Bungulan	3 mo, 2 days
Grand Naine	4 mo, 13 days
Lakatan	2 mo, 24 days
Amas	1 mo, 27 days
Señorita	2 mo, 24 days
Morado	2 mo, 15 days
Latundan	mo, 17 days

Source: Valmayor, *et al*., 2002.

2. **Methods of harvesting.** Harvesting is usually done in the morning. The common practice is to cut the pseudostem partially using harvesting tools partially about 1/3 from the top to ensure gradual falling down of bunch. A 30 cm length in peduncle must be retained for easy handling of bunch. Harvesting of banana cultivars with bigger bunches should be done by a harvester and a backer. The backer carries the bunch on the shoulder pad to prevent the bunch from touching the ground and to minimize bruises and infection.

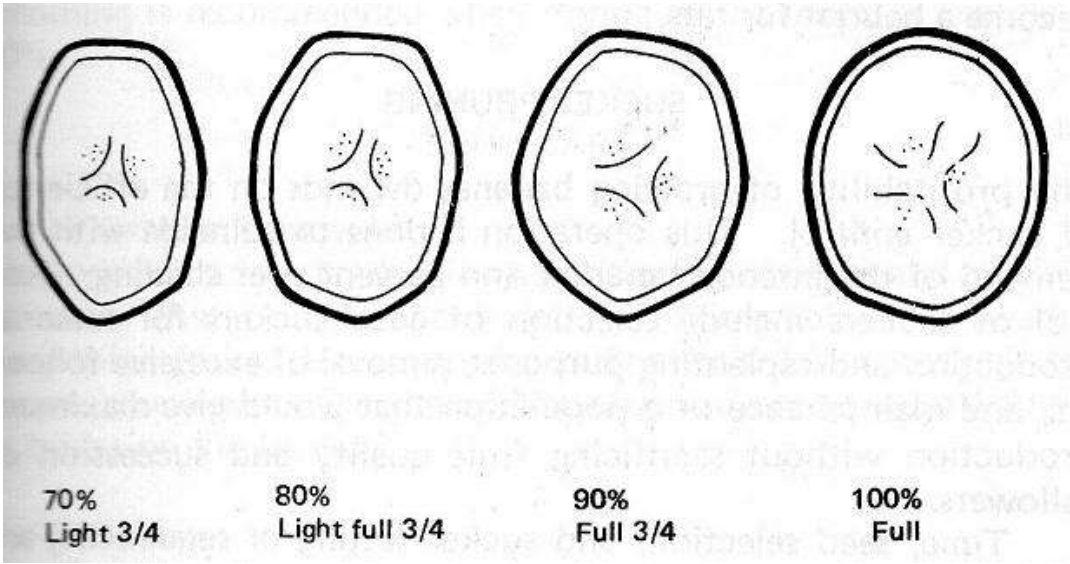

Figure 7. Fullness of fingers as one of the maturity indices for banana

PEST AND DISEASE MANAGEMENT

A. Insect Pests

1. ***Flower thrips*** *(Thrips florum* Schmutz). This is a small insect having whitish-yellow larvae without distinct body region at early stage. After sometime, this becomes yellow. The head and the thorax of the adult are yellow while the forewing and hindwing are light brown. This will easily enter the developing fruits which is still wrapped by the bracts. Its oviposition sites which appear as black specks and the

feeding on the young fruits are the cause of damage. The injuries coalesce as the fruits develop and as injured peels become rough and sometimes crack resulting into blemishes called corky scab.

Control measures. The pest can be controlled through injection of insecticidal solution in the inflorescence using a modified needle attached to the lancer of a knapsack sprayer. Insecticidal solution of chlophyrifos, microencapsulated ethyl parathion, methamidophos and phosphamidon is injected when approximately ½ to ¾ of the bud length emerged or 3 to 5 days after shooting.

2. **Red rust thrips** (*Chaetanaphothrips signipennis* Begnall). The adult has yellow thorax with two dark spots on the back while the larva is white. It congregates at the point of contract between adjacent fruits during feeding. Feeding can cause reddish brown discoloration called red rust. Fruits with severe damage may split open.

Control measures. Enclose the fruits with chlorphyrifos-impregnated polyethylene bags. Practice regular stem sanitation to disrupt the life cycle.

3. **Aphids** (*Pentalonia nigronervosa* Coq.) The wingless aphid has shiny brown color at the dorsal part while the winged aphid has a very prominent dark wing venation. This can easily be found in between leaf sheath and at the base of a pseudostem. Feeding on banana sap can transfer the most dreadful banana virus disease known as bunchy top.

Control measures. Apply malathion, fenitrothion and chlorphyrifos to the identified bunchy top-infected plants and to surrounding plants to eradicate pests.

4. **Mealy bugs**. The color of the young nymph is pinkish while the adult has a soft body with white powdery wax. During summer, high infestation is observed on the fruit and in the pseudostem.

Control measures. Use chlorphyrifos, diazinon and fenithrothion impregnated polyethylene bags when populations are high and supplement with a pseudostem spray.

5. **Corm weevil.** The newly emerged corm weevil is reddish brown but after one week it turns black. The reddish-brown head larvae will tunnel into the corms and destroy a large portion of the tissue. The larval damage will lessen the uptake of water and nutrients from the soil.

Control measures. Chop the pseudostem into small pieces to hasten drying which eventually disrupt breeding of pest. Trapping, collecting adult weevils and application of insecticide such as pirimiphos-ethyl and chlorphyrifos granules around the mat are also done.

6. **Scarring weevil** (*Philicoptus iliganus* Heller). The head of the larvae is light brown while the hind body is white. The adult has metallic green scales in irregular pattern on the elytra, thorax, head and parts of abdomen. Gold sheen is commonly reflected at the elytra. The adult feeds near the base of the youngest leaf, petioles, ridges and veins and on the flower bracts.

Control measures. Use chlorphyrifos-impregnated polyethylene bags to protect the fruits from the pest. Spraying the pseudostem with decametrin and fenitrothion is recommended. Hand picking of the adult weevils can also help.

7. **Other insects.** Banana leaf roller (*Pilipidas thrax* L.), Scale insect (*Aspidiotus destructor* Sig.), and Bagworm (*Eumeta fuscescens* Snell)

B. Nematodes

1. **Burrowing nematode.** The burrowing nematode (*Radopholus similis*) is considered as one of the most important root pathogens attacking bananas. The *R. similis* is a migratory endoparasitic nematode which complete its life cycle in 20 to 25 days in the root and corm tissues. The juvenile and adult females are active mobile forms which may leave the roots in case of adverse conditions. This nematode invades any portion of the root length. As nematode migrates inter and intracellularly, feeds on the cytoplasm of the cortex cells, collapsing cell walls, and causing cavities and tunnels. The stele is not damaged by *R. similis* although it can penetrate young stelar tissues.

Symptoms. (a) dark patches or spots in the roots, (b) dark lesions with reddish borders when root is cut lengthwise, (c) toppling or uprooting of plant particularly during strong winds and heavy rains.

Control measures. Use of nematode-free planting materials is highly recommended. Paring the corms superficially to remove lesioned tissue. Sun exposure of pared material for two weeks (only for

bigger suckers). Hot water treatment (52 to 55ºC for 15 to 20 minutes) is also advised. Establishment of a drainage canal and nematicide application as chemical control are also recommended.

2. **Root-knot nematodes.** The root-knot nematodes *Meloidogyne incignita* and *Meloidogyne javanica* occur on the roots of banana and plantains. Root-knot nematodes often occur on banana roots together with the other nematode species *R. similis* and *Pratylenchus* spp. The damage caused by the other nematode species is more visible (root necrosis) and more destructive (toppling of plants) than the symptoms (galling) and other adverse effects caused by *Meloidogyne* spp. Moreover, *R. similis* and *Pratylenchus* spp. tend to outnumber and eventually replace root-knot nematode populations. When they occur together, the root lesion including nematode destroy the roots tissues and thus provide feeding sites for *Meloidogyne* spp.

Symptoms. (a) Swollen, galled primary and secondary roots, and (b)Root tips are invaded.

Control measures. Use resistant varieties. Establishment of a drainage canal and nematicide application as chemical control are also recommended.

3. **Root-lesion nematodes** (*Pratylenchus* spp.) The root-lesion nematodes *Pratylenchus coffeae* and *P. goodeyi* are both major pests of banana. The damage they cause is very similar to that of *Radopholus similis*.

Symptoms. (a) Extensive black or purple necrosis of epidermal and cortical root tissues resulting in lesions and snapping of roots. (b) Stunting of plants, decreased bunch weight, long production cycle, toppling or uprooting.

Control measures. Expose planting material (sucker) to direct sunlight for two weeks to reduce the nematode densities of planting material. Hot-water treatment for 20 minutes, using a warm-water bath of 53ºC to 55ºC, eradicates almost all of the nematodes from the planting material. Use nematicides as chemical control.

C. Viral Diseases

1. **Banana bunchy top virus (BBTV)**. This is one of the most serious virus diseases of banana. This is transmitted locally in a persistent, circulative manner by the banana aphid (*Pentalonia nigronervosa* Coq*.).* Distribution over long distances occurs by the movement of infected vegetative planting material such as suckers, corms, and tissue-cultured plantlets. This is not soil-borne and is unlikely to be spread on cutting tools. No cultivars has so far been identified resistant to BBTV, that in natural field condition where the virus inoculum is present and the aphid vector is endemic, all banana varieties are susceptible to the disease (Figure 8).

Symptoms. (a) The plants have a rosette appearance with narrow, upright and progressively shorter leaves, giving rise to the common name "bunchy top", (b) The plant is stunted, (c) The leaves are stiff and brittle, (d) The leaf edges often roll upwards and show marginal yellowing, (e) Dark green streaks are often found on midrib and petiole, extending down into the pseudostem. These streaks are best seen after wiping away the wax, (f) Plants infected at an early stage of development rarely produce a bunch, though with later infections a distorted bunch may be formed.

Control measures. Eradication of diseased plants can be done as follows: (a) Spray surrounding plants within 6m radius from the diseased plants with insecticide, (b) Spray the diseased plant last, and (c) After 12 to 24 hours, dig-out all plants, chop into small pieces, allow to dry and cover with soil, or cut the pseudostem close to the ground, then stab the growing point of the remaining pseudostem with herbicide-impregnated bamboo stick., (d) use of virus-free planting materials, (e) Avoid intercropping banana with alternative host of the virus/aphid like abaca, heliconia, strelizia, ravenale, canna and zingeber, (f) Regularly inspect for diseased plants, (g) Control must be practiced across a whole production area, (h) Follow strict quarantine regulation.

Figure 8. Banana infected with Banana Bunchy Top Virus (BBTV) showing advance symptoms

2. **Banana bract mosaic virus (BBrMV)**. This disease is widespread in the Philippines. However, there are no reports of mechanical transmission of BBrMV, but the virus is transmitted in a non-persistent manner by several aphid species, including *Aphis gossypii*, *Pentalonia nigronervosa* Coq.) and *Rhopalasiphum maidis*. This disease is also transmitted in vegetative planting material including corm bits, peepers, suckers and tissue tools. It occurs in a wide range of banana genotypes like BBB (Cardaba/Saba', Dalian/Giant Cardaba, Sab-a/Turangkog, Mundo); AAB (Latundan) and some cultivars having a B genomic classification (Figure 9).

Symptoms. (a) Dark reddish-brown mosaic pattern on the bracts of the inflorescence, (b) Consist of spindle-shaped chlorotic streaks running parallel to the veins, (c) When leaf sheaths of the sucker are pulled away from the pseudostem, distinctive dark-colored mosaic patterns stripes or spindle-shaped streaks are visible, and (d) Chlorotic streaks may occur on the bunch, stalks, petioles and even on fruit peel.

Control measures. Eradication of diseased plants by the following steps: (a) Spray all the plants and ground within a 6m radius from the infected plant with insecticide, (b) Spray infected mat last, (c) Dig-out all the plants, chop into small pieces, allow to dry and cover with soil or cut the psuedostem close to the ground then stab the middle of the remaining pseudostem with herbicide-impregnated stick, (d) Weed control, (e) Use of virus-free planting materials, (f) Avoid intercropping with corn and other alternative host of the virus.

Figure 9. Banana infected with Banana Bract Mosaic Virus (BBrMV) exhibiting spindle streaks on a) male bud, b) leaf, and c) fruit

3. **Banana streak virus (BSV)**. The banana streak virus is transmitted by the citrus mealy bug *Planococcus sacchari* and pink mealy bug *Saccharicoccus sacchari* (Figure 10).

Symptoms. (a) Necrotic streaks develop in the leaves and fruits, (b) Characteristic of BSV infection is the periodicity of symptom expression since plants may not show streaks on all leaves and, for several months at a time, emerging leaves may be symptomless or show only slight symptoms, (c) Infected plant

have reduced plant growth and vigor, smaller bunches and less yield, (d) Distorted fruits, and (e) Internal pseudostem necrosis.

Control measures. The disease can be controlled by (a) Eradication of infected plants, (b) Use of virus-free planting materials.

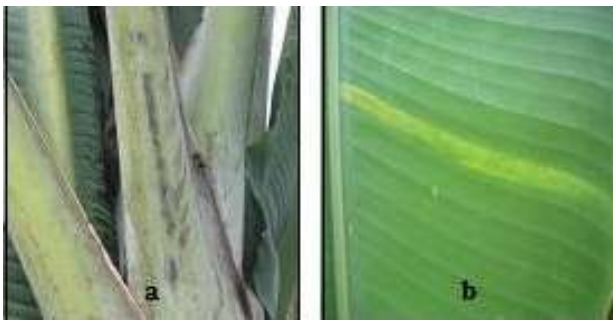

Figure 10. Banana plants infected with Banana Streak Virus (BSV) showing symptoms on a) petiole and b) leaf

4. **Banana mosaic (CMV)**. Banana mosaic is caused by a virus transmitted by the cotton aphid (*Aphis gissypii* Glover) and the corn aphid (*Rhopalosiphum maidis* Fitch).

Symptoms. (a) Small white and yellow flecks mainly along one side of the symptom leaf, (b) Bands or strips that is whitish to yellowish green, (c) Misshapen leaves with waxy margin at later stage.

Control measures. (a) Early detection of symptoms, (b) Remove diseased plants, (c) Proper weed control to eliminate primary host of vector, (d) Use of virus-free planting materials, (e) Regularly inspect banana plants, (f) Avoid intercropping banana with alternate hosts of virus *e.g*. commelina, cucurbits and tomato.

D. Bacterial Diseases

1. **Bugtok Disease.** "Bugtok or Tibagnol" is an endemic bacterial disease severely infecting fruits of a cooking bananas like Cardaba or Saba', Turangkog or Sab-a, Abuhon, Mundo and even dessert type Latundan. Bugtok is a local term in the Southern Philippines used to describe fruits which are discolored and hard even when ripe. This disease is caused by *Ralstonia solanacearum* E.F. Smith (Figure 11).

Symptoms. (a) The male bracts are dry, slightly rolled up and loosely attached, (b) Male bud is misshapen, (c) Discoloration of the fruit pulp such as reddening of the core and eventual hardening of the caramel-textured pulp and dry rotting and total blackening of the fruit pulp, (d) Rusty brown to almost black discolorations of the vascular tissues of bract scars, fruit pedicels, male axis, peduncle, crown, central portion of the stalk and in the corms.

Control measures. (a) Periodic stem/mat sanitation and de-leafing, (b) Early bagging of the male bud before bending stage, (c) De-bud when false hand appears.

Figure 15. Banana infected with Bugtok disease

2. **Bacterial wilt (Moko disease)**. Bacterial wilt (Moko disease) is a highly contagious disease that infects banana in just few weeks. This is caused by a soil-borne bacterium, *Ralstonia solanacearoum*. This is a mechanically-transferable disease through the use of contaminated tools. This can also be transmitted by flower-visiting insects. The symptoms are manifested within ten (10) days after the entry of the bacterium into the plant (Figure 12).

Symptoms. (a) Yellowing on the youngest three (3) leaves of the plant, (b) Breaking down of the junction of the petiole with the lamina, (c) Discoloration of the vascular strands ranging from yellow to dark-brown when the pseudostem is cut crosswise, (d) In infected fruiting banana, fingers are deformed, (e) Dry-rotting of the pulp with brown or black color when fruit is sliced

Control measures. (a) Early detection of the symptoms, (b) Immediate eradication of the infected plants by- Cordon the infected area at a radius of 6 m, Dig a canal around the plant/mat., Dig-out all the plants, chop into small pieces and allow to dry, Spray the chopped plant debris, Apply fumigation by burning it using a rice hulls for heat penetrate into the soil to kill this soil-borne disease, Replanting takes at least six (6) months after eradication, (c) Disinfect used tools and implement with 10% disinfectant solution, and (d) Plant quarantine and phytosanitary measures to prevent the spread of diseased materials.

Figure 12. Banana infected with Bacterial wilt or Moko disease

E. Fungal Diseases

1. **Fusarium wilt (Panama disease).** Fusarium wilt (Panama disease) is regarded as one of the most destructive fungal disease of banana in recorded history. It is first epidemic in Panama in 1890 and proceeded to devastate the Central America and Caribbean banana industries. This has now been reported from all banana growing regions in the Philippines. This disease is caused by a fungus, *Fusarium oxysporum* f. sp. *cubense* (E. F. Smith) Snyd. and Hans (Foc). This fungus has four races which are differentiated on the basis of their capability to cause the disease such as on Gros Michel (Race 1), Bluggoe (Race 2), *Heliconia* spp. (Race 3), and Cavendish (Race 4). The resistance of the different cultivars varies in each race. This is a soil-borne fungus which can be described as a vascular wilt disease since it invades the vascular tissue (xylem) through the roots causing discoloration and wilting. This can also spread in the soil, running water, infected rhizomes and other mechanical tools. Latundan (AAB), Matavia (ABB-Bluggoe), Pisang Awak group (ABB) and even Lakatan (AA) are cultivars susceptible to this disease (Figure 13).

Symptoms. (a) Yellowing and drying-up of the oldest leaves (lower leaves), (b) Leaves gradually collapse, (b) Wilting of the oldest leaves (lower leaves), (c) Cracking at he base of the pseudostem, until it decays and falls, (d) Pseudostem and corm when cut horizontally shows brown to purple discoloration with reddish tinge

Control measures. (a) Eradication of the whole plant/mat, (b) Cordon the infected area at a radius of 6 m, (c) Dig a canal around the plant / mat., (d) Dig-out all the plants, chop into small pieces, allow to dry and burn it using rice hulls, (e) Replanting at least six (6) months after eradication, (f) Implement strict quarantine procedures to prevent the transfer of diseased planting materials into new areas.

Figure 13. The fusarium wilt or panama disease symptoms on banana a) petiole, b) leaf sheath and c) pseudostem.

2. **Sigatoka leaf spot**. Sigatoka leaf spot disease can be caused by two (2) related ascomycetous fungi: *Mycosphaerella fijiensis* Morelet, which is the black Sigatoka and *Mycosphaerella musicola* Leach ex Mulder causing yellow Sigatoka. Compared with yellow Sigatoka, black Sigatoka causes more rapid death of the banana leaves. The later is therefore the most important as it can kill all leaf tissue reducing the ability of the plant to manufacture the food needed for growth and filling up of the fruit. This is seen to be more serious in the rainy than dry season because the fungi require water for producing and spreading the spores infecting other leaves or plants. High humidity in the field also encourages rapid development of the diseases. Conditions that encourage high humidity in the field include high planting density, poor field sanitation, high weed growth and poor drainage in addition to heavy rainfall.

Symptoms. (a) Yellow Sigatoka appears to have small yellow streaks (1 to 2 mm long) parallel to the secondary veins of the blade. (b) The yellow streaks grow into brown spots that turn into dark-brown (dead) spots that are more or less round, (c) Black Sigatoka streak are brown and gradually enlarge and fuse to form patches which later develop spots with grey centers.

Control measures. (a) Periodic field sanitation, (b) Proper drainage canal, (c) Foliar spraying, (d) Use of resistant varieties.

3. **Cordana leaf spot**. The cordana leaf spot caused by fungus *Cordana musae* (Zimm.) has been reported from a number of banana producing areas throughout the world. Although widely distributed, this disease is not economically important. It appears to be localized and sporadic in nature.

Symptoms. (a) Presence of large oval spots having yellow margins and pale brown centers with faint concentric zonation, (b) Spots are located along the edges of the leaf or where torn leaves are present, (c) The entire edge of the leaf may be necrotic with uneven zigzag and a bright yellow band separating the diseased from the green, healthy tissue.

Control measures. (a) Spray with fungicides such as dithane M-45 at 3 to 5 g/L and benlate at 1 to 2 g/L water.

4. **Banana freckle**. This disease is caused by a fungus *Phyllostictina musarium* (Cooke) Petr. This disease is normally found in the local banana cultivars.

Symptoms. (a) Small black freckles about 1 mm in diameter formed in the midrib and lamina of the older leaves, (b) Leaf surface becomes rough due to the presence of numerous slight raised black pycnidia.

Control measures. (a) De-leafing, (b) Spraying with fungicides

5. **Banana periconiella leaf speckle**. The blemishes caused by *Periconiella musae* Ellis is present in banana leaves grown in damp shady conditions.

Symptoms. (a) The speckles appear velvety and are grayish to black covering the lower surface of the oldest leaf, (b) The irregular, circular, black blotches are composed of tiny and black specks.

Control measures. (a) Leaf pruning/de-leafing, (b) Spraying with fungicides

6. **Banana rust**. This is a minor foliar disease caused by *Uromyces musae* P. Henn which is an obligate fungus.

Symptom. Presence of powdery brown to black, elongated, rust pustules on the lower surface

Control measures. (a) Application of fungicide through aerial or ground spray, (b) Regular field sanitation.

IPM for BANANA

(in all clean culture of the field is of utmost importance for insects and disease management)

Insects:

Corm weevil:

1. Field should be cleaned by removing dried leaves and plant debris from the field and destroy by burning or dumping in mulching pit and covering with soil.
2. Use healthy uninfected sucker or rhizomes for planting time.
3. Regular monitoring by keeping banana traps treated with entomopathogenic fungus Beauvaria bassiana.
4. Cut banana plant after harvest at ground level and treat with recommended insecticides.

Aphids:

1. Rogue out the virus infected plants.
2. Use bamboo stakes treated with broad leaf herbicide by inserting into the corm to kill infected plants. Then burning after drying.
3. Removal of weeds, alternate hosts and unwanted suckers will reduce incidence of aphids.

Beetles (flea beetles, fruit/leaf scarring weevils):

1. Follow clean culture and sanitation in orchards
2. Use entomopathogenic fungus

Nematodes:

1. Fallowing for 3 months after banana harvest effectively suppress the nematode population, while flood fallowing for 5 months destroys not only burrowing nematode but also Fusarium sp.
2. Neem cakes @ 400grams per plant can also be used to reduce nematode populations
3. Crop rotation with paddy, sugarcane, mungbean, cotton will suppress nematode population and increase the yield.

Diseases:

Sigatoka:

1. Regular field sanitation
2. Drainage system must be proper. Water logging will increase humidity which favors infection.
3. Removal of infected leaves regularly once a month from second month of planting , destroy leaves by burning outside field or dumping in manure pit and cover with soil.

Panama Wilt:

1. Restrict movement of infected suckers to non- infected areas.
2. Sanitation by immediate removal of diseased plants with surrounding soil from the field.
3. Cleaning of implements used after planting to prevent spread of inoculum in other areas.
4. Planting of healthy suckers from healthy plantations.
5. Application of trichoderma @ 15 grams for 4 times once at time of planting and remaining doses at 3rd, 5th and 7th months after planting around the plants.
6. Provide good drainage during rainy season.

Viruses:

1. For establishing new banana plantations, virus-free certified propagation materials should be used.
2. Domestic quarantine of this disease may play a major role in limiting the spread to other sites.
3. Community approach is needed to completely eradicate bunchy top affected plants increase where severe infection is observed.

4. Affected plants should be dug out along with whole mat, chopped into pieces and incinerate after drying them.
5. Removal of alternate hosts, weeds, and unwanted suckers can reduce the aphid population.
6. Affected plants can be killed by injection of herbicides.

POSTHARVEST HANDLING

This is a series of operation to prepare bananas for long term storage as banana is a highly perishable crop with fruit loss of about 13 to 30% (Esguera, 2001), care during handling is very important to maintain the quality before reaching the market.

Losses are the change in the availability, edibility, acceptability and quality of fruits. This includes quantitative (weight loss) and qualitative (loss of chemical constituents or change in appearance) as in the following: (a) mechanical loss, (b) physico-chemical environment such as temperature, relative humidity (RH), gasses (O2,CO2,C2H4) wind and chemical,and (c) biological- fungi, bacteria, insects, rodents and man

A. Packinghouse operation

1. **De-flowering.** De-flowering is the first step in packing house operation. Flower relics on fruit apex should be removed when the bunches are still hanging in cables using gloves to avoid fruit injury.
2. **Dehanding.** Dehanding is the removal of hands in the stalk of the bunch using a scope-shaped dehanding knife to fit in the crown to prevent fruit damage. In Thailand, Myanmar and in some areas of the Philippines, about 10 cm of the stalk are retained for local market for easy handling.
3. **Washing and delatexing.** After de-handing, the hands are immediately washed in the first washing tank with clean and flowing water to remove dirt on the fruit surface. From the first washing tank, the hands are transfer to the 2nd washing tank for final washing mixed with alum for delatexing and sodium hypochlorite at 75 to 125 ppm for disinfection.
4. **Grading.** Grading is a process of classifying fruits into groups based on set of criteria of quality and size accepted by industry (Table 11). These are free from mechanical damage, foreign matter, disease and freshness, maturity and size. Fruits with bruises, scabs, scars, over-sized and under-sized fruits were classified as rejects.

There is no established quality standard followed by the local market. The price is based on agreement between the supplier and buyers. Hotels and supermarket also prefer quality fruits. The classification of fruits are as follows: (a) Small (36 to 75 g), (b) Medium (76 to100 g), and (c) Large (111 to 200 g).

Table 11. Grading of banana fruits for domestic and export market

Characteristics /Appearance	Grade 1	Grade 2	Grade 3
Mature, well developed, and free from discoloration and hard lumps	excellent	fair to good	poor to fair
Decay	1.5%	4 %	more than 4
Damage	5 %	10%	more than 10%

B. Packaging. In preparation for packing, the hands of banana are then air-dried after washing/cleaning.

For local market. The packaging materials such as bamboo baskets, wooden crates, plastic crates, and cartoons have liners or cushion like newspapers, banana leaves, banana leaf sheath and plastic film to prevent damage between fruits.

For export market. Bananas from the Philippines exported to Japan, Hongkong and Singapore are packed with cartoons and fiberboard at the bottom. To provide proper ventilation, the box has holes on the sides with polyethylene film (0.02 mm) liners. This will reduce moisture loss and prevent from chaffing damage during transport. Each box contains 12.5 kg with 4 to 6 hands. Over and underpacking should be avoided to prevent bruising and compression between fruits. Bananas which are exported to Middle East are vacuum packed in 0.05mm plastic bag with 13 kg per box.

C. Transport. During transport, the fruits should be properly handled inside the container van, jeepney and trucks so as to maintain fruit. Bananas which are commonly shipped in a non-refrigerated container vans normally results to green and pre-mature ripening. An innovation (Lizada and Maunahan, 1992 and Nuevo *et al*., 2002) was adopted to minimize the incidence of green soft disorder as follows:

a. Leaving one door of the van open during transit to dissipate heat and provide ventilation. Let the back part of the van open covered with bamboo slats to prevent pilferage.
b. Lining hog vans and steel banana crates to cushion the sides and putting vertical or horizontal dividers in container vans. This method will prevent heat buildup, depletion of oxygen and accumulation of ethylene resulting to green soft disorder of banana. Horizontal dividers are better than vertical ones since this allow heat dissipation and takes off load on bottom fruits. However, this is more difficult to build inside the van than vertical dividers.
c. Using ventilated vans to allow heat to escape and fresh air to enter.
d. Using block ice as cooling source inside the cargo space.
e. Capacity of bulk containers used in banana handling and transport (Table 12 and 13).

Table 12. Capacity of bulk containers used in banana handling and transport

Type of container	Capacity (kg)
Sack	20 to 30
Bamboo basket	20 to 30
Animal-driven cart	100
Farm cart/push cart	300
Old truck	1,800 to 2,000
Long jeep	3,500 to 4000
10-Wheeler truck	6,000 to 8,000
Fruit van (10 footer)	6,000 to 8,000

Source: Maunahan, M., 2011.

Table 13. Shipment of bananas in non-refrigerated vans via Nasipit to Manila

Packaging	Percent Ripe	Percent Compressed	Percent Bruised
Bulk load	39	95	88
Top	-	93	91
Middle	-	91	74
Bottom	-	100	98
Crated	0	21	4

Source: Maunahan, M., 2011.

Problems in transporting

1. **Loading problem-** Rough handling and placing of fruits on the ground
2. **Inter-island shipment problem-** Poor port and shipping facilities and improper port practices
3. **Hauling problem-** Poor roads and Inappropriate containers

D. Storage. Storage is a way to maintain the quality of fruits after harvest period to extend market season, avoid market gluts and limit fruit losses due to deterioration. Based on the report of Pantastico (1990) as cited by Dr. Maunahan (2011), the optimum storage for most Philippine bananas is 13°C. For Latundan, the optimum temperature is 14°C for a period of 21 to 28 days while Lakatan was 13°C for a storage period of 28 days. Only Cardaba/Saba' bananas can be stored at 10°C even for three weeks without injury.

Storage technique

1. **Refrigeration**. Refrigeration has been the most effective method to minimize deterioration of fruits. Temperature control is a common method used for extending the postharvest life of bananas. The

optimum storage condition for most bananas either mature green or ripe are 13 to 14 °C at 95% RH. Shelf life can be extended by two or more weeks.

2. **Atmosphere modification**

1. **Controlled atmosphere (CA) storage**. This is a technique used to maintain the quality of produce in a controlled environment where in the levels of O2, CO2 and N2 are precisely controlled with in a sealed chamber.

2. **Modified atmosphere (MA) storage**. The atmospheric composition of this storage is not precisely controlled. This has been successfully used for extending the storage life of various bananas using low density polyethylene bags (LDPE) bags. This will allow the natural respiration of the fruits to deplete O2 to the level that is equilibrium with O2 diffusion though the packaging materials. At the same time, CO2 (product of respiration) accumulates in the package until it reaches a level balance by CO2 diffusion out of the package.

   Latundan can be stored in 0.08 mm thick polyethylene bags at 26 to 30°C ambient temperature up to 13 days. Lakatan showed a lag of 3 days before color break upon exposure to air (Aguilon *et al*., 1987).

   Studies conducted by Tiangco *et al*. (1987) showed that Cardaba/Saba' can be stored in ambient temperature of modified atmosphere at 12.5°C in air extend storage life. Meanwhile, bananas stored in modified atmosphere combine with refrigeration further extend the storage life (Tongdee, 1988).

3. **Ethylene removal**. Ethylene can be removed by absorption of potassium permanganate (KMnO4). It is a strong oxidizing agent that converts ethylene to CO2 and H2O. This has been found to extend market life at about 50% than storage in polyethylene bag alone.

4. **Chemical treatments**

   a. **Waxing**. This is chemical treatment to reduce transpiration that minimizes desiccation and shriveling. The effect arises from a modified atmosphere generated by increased resistance to carbon dioxide and oxygen permeability through the fruit surface. It has similar ripening delay in polyethylene bag storage but has the advantage for its glossy appearance (Wills, 1990).
   b. **1 MCP Treatment**. This treatment is a promising postharvest treatment to extend the storage and shelf life of bananas. It prevents the action of ethylene through permanent binding with the ethylene receptors in the tissue. Thus, ripening is delayed. Esguerra *et al.* (2009) reported that the inhibition of ripening of Lakatan for 3 weeks was attained at 1.0 µl L^{-1} 1-MCP 25°C. The normal ripening behavior of Lakatan was obtained when induced to ripen in 2000 ppm ethephon after 2 to weeks of I-MCP treatment. Latundan requires a lower concentration of 0.1 µl L^{-1} however it failed to ripen normally when ethephon treatment was done 1 to 2 weeks after 1-MCP treatment.
   c. **Ripening**. This is a series of physiological, biochemical and physical changes that transform physiologically mature. At ripening stage, the softening of tissue commences when the starch is degraded to sugar both in the peel and pulp and rupture strength of cell wall deteriorates slowly. Yellowing of peel is primarily due to chlorophyll (start of unmasking of the carotenoid pigments).

E. Ripening

Changes during ripening

1. Yellowing of the peel for most dessert cultivars like Latundan, Cavendish and Lakatan except Bungulan.
2. Softening of tissue due to breakdown of starch into sugar and solubilization of peptic substances.
3. Flavor development brought about by an increase in simple sugars, thus, sweetness increased.
4. Decrease in fruit astringency.

Requirements during ripening

1. **Maturity.** Matured fruits have good eating quality and command higher prices than immature

fruits.

2. **Temperature.**Room temperature is a factor to consider in ripening of fruits. The optimum temperature for full flavor and aroma development in Seňorita and Latundan occurs at 23 to 25°C. However, importers in Japan still follow the conventional procedure for Cavendish. Starch content and astringency remain at the full yellow stage following this procedure (Nakamura *et al*., 1984) Hence, treatment of ethanol to remove astringency was employed. A mist application of ethanol was practiced in Japan during the 24-hour exposure to ethylene for ripening.
3. **Relative humidity**. The higher relative humidity (RH) of 90 to 95% is essential in ripening rooms to avoid fruit dehydration. If the RH is low, the moisture loss is high. In Lakatan and Latundan, the relative humidity is lowered from 90 to 95% to 75 to 80% when yellow color appears to prevent fruit splitting during ripening process.
4. **Good air circulations and proper ventilation.** This ensures equal distribution of ethylene and removes CO2 produced by the fruits. The CO2 competes for the binding site of ethylene in the enzyme involved in ripening thereby ethylene production is inhibited.

Ripening methods

1. **Ethylene treatment.** Exogenous ethylene application is necessary during pre- climacteric stage prior to the burst of ethylene production in fruits. Cavendish banana requires 25°C for 7 days to ripen. This treatment induces the autocalytic ethylene production and ripening process in banana. Ethylene applied at 1to 5000 ppm and 1 to 1000 ppm in Latundan and Cavendish bananas stimulates ripening as evidence in the rate of peel color change, respiration and ethylene production and changes in sugars and organic acid contents.
2. **Calcium carbide (CaC2).** This is the most common ripening methods used by small banana growers because of its low cost, availability and ease in application. Calcium carbide reacts with water to produce acetylene (C2H2).
3. The 1.1 to 2.2 g Calcium carbide can ripen a kilogram of Lakatan fruits and 50 g for 1000 g Latundan fruits at 24 to 36 hours after peel color change (Shukor *et al.,*1990).
4. **Ethephon application.** Application of ethephon (ethrel) at 5000 ppm as pre-harvest spray or as postharvest dip accelerates ripening in Saba' and Morado (2 to 3 days) at ambient temperature (Bondad, 1972).
5. **Bio-ethylene sources.** Bio-ethylene is the ethylene released from biological sources like leaves and fruits. Kakawate or Madre de cacao leaves is the most common bioethylene source used in rural areas. It produces low CO2, a gas which can act as antagonist against ethylene production and action. Rain tree, acasia and squash peel are also potential source of bioethylene. A kilogram of Cardaba or Saba' requires 70 to 100 g leaves of *Gliricidia* (Kakawate) for 24 hours in drum covered with jute sacks or thick cloth to hasten fruit ripening (Acedo and Bautista, 1991).

F. Postharvest diseases. Post harvest diseases limit the potential storage of bananas. These are considered as major threats to the marketing quality of fruits.

1. **Anthracnose**. Anthracnose disease of banana is caused by *Colletotrichum musae.* It consists of two infections: (1) Non-latent infection - occurs in small wounds, starting from harvest and continued to develop thereafter without dormant period, (b) Latent infection – starts early in the season when the fruit is still on the tree but the pathogen remains dormant as a sub-cuticular hypha until the fruit approaches maturity (Sepiah *et al*., 1990), (c) The typical symptoms are numerous small dark circular spots which enlarge, coalesce and become sunken and eventually produce a salmon-pink spore masses.

2. **Crown rot**. This is caused by a fungal complex consisting *Collettotrichum musae*, *Fusarium* spp. and *Lasiodiplodia theobrome*. The incidence rises periodically during rainy season. The symptoms first appear at or near the cut surface then becoming black and soft with the molds penetrating pedicel. The pedicel weakens then the fingers detach from the crown.

Symptom. Numerous small dark circular spots which enlarge coalesce and become sunken. Salmon-pink spore masses are eventually produced (Snowdon, 1990).

3. **Brown spot or Diamond spot** This disease is caused by *Cercospora hayi*, considered as a serious problem in large plantation in Mindanao (Quimio, 1986). It has also been reported in South and Central America.

Symptoms. (a) This is manifested by the appearance of depressed lesions. These are sub-circular to oval, with 3 to 5mm in diameter, rough textured, dark brown-black-colored which appears on the peel of developing fruits (Sepia *et al.,* 1990). Infected cells are unable to expand as the fruit grows and consequently in each lesion a longitudinal crack forms. As the lesions enlarge, it takes on a diamond shape and sometimes the pulp is exposed, (b) Dwarf and giant cavendish, Bungulan and Lakatan bananas are susceptible to brown spot while Cardaba or Saba' are resistant.

4. **Fusarium rot**. There are three species of fusarium reported to cause fruit rots. These are *Fusarium roseum*, *Fusarium semitectum* and *Fusarium monoliforme*.

Symptoms. The typical early infection of Fusarium rot appears as a small crack surrounded by a yellow ring. The crack then increases in length and width. As it progresses, the peel tissue become necrotic, collapsed, dark brown to black and a sunken diamond-shaped lesion. Several spots may coalesce, become irregular in shape and cover large areas of the finger. Its advanced stage is white cottony growth of the fungus covers the rotten tissues of the fruits (Sepia *et al.,* 1990).

5. **Finger stalk rot.** This is a minor malady frequently observed on individual fingers. This is characterized by the blackening of pedicel. Finger-stalk rot develops when fingers are injured, twisted and bent inwards or outwards during pre-harvest and postharvest handling. It is caused by *Colletotricum musae* and *Fusarium* ssp.

Control measures. (a) proper sanitation, (b) good handling practices, and (c) post harvest treatments

Proper sanitation and handling

1. **Chemical method.** Application of fungicides after harvest either by spraying and dipping.
2. **Physical method.** Hot water treatment at 45°C for 15 to 20 minutes after dehanding reduced crown rot from 100% to less than 3% (Paul, *et al*., 2000). Hot water treatment of Latundan at either 55°C for 5 minutes or at 60°C for 1 minute was shown effective in controlling anthracnose and crown rot. This treatment did not affect the ripening behavior as well as in sensory qualities of the fruits at the ripe stage. For Lakatan, a lower temperature of 45 to 50°C but dipping time is longer for 5 to 10 minutes at 50°C and 10 minutes for adequate degree of disease control.

G. Physiological disorders

1. **Chilling injury.** This refers to fruit disorder induced by exposure to low temperature below the optimum level for storage. The symptoms are pitting, peel discoloration and abnormal ripening. Other symptoms include brown skin discoloration and dull skin color, brittleness of finger, hardened cores and uneven ripening.
2. **Green soft disorder.** This is an impairment of the ripening process in both peel and the pulp of banana due to prolonged exposure to an abnormally high temperature or inappropriate gas composition during modified atmosphere storage. It is characterized by pulp softening and eventual rotting while the peel remains green. But this is not applicable to Bungulan since this variety is said to be a "green-ripe type" banana which means the peel remains greenish yellow even ripe. This is disorder is associated with levels of ethylene, low oxygen levels, elevated carbon dioxide and temperatures, high ethanol and acetaldehyde levels. This can be minimized by adequate ventilation and temperature management during shipment.
3. **Carbon dioxide injury.** This is caused by prolonged exposure to excessive high levels of CO2 and/or low levels of O2 during storage under modified atmosphere, controlled atmosphere and hermetic condition. The symptoms are characterized by the failure of fruit to ripen satisfactorily, poor organoleptic properties, uneven firmness, poor color development, presence of brown patches on the skin.
4. **Finger drop.** This occurs when the ripe fruits readily fall off from the crown. This is the weakening and softening of the pedicel which causes the fruit pedicel in the hand drops. Hands of bananas with missing fingers reduce their marketability and command lower price. Hands are also more prone to microbial attack thereby reducing the shelf life and market value. The application of CaCl2 and ethanol appeared to have the potential to control finger drop particularly Latundan.

H. Marketing channels for domestic trade

1. Farmer → Assembler → Wholesaler → Retailer → Consumer
2. Farmer → Wholesaler → Retailer → Consumer
3. Farmer → Retailer → Consumer

COST AND RETURN

Appendix 3a to 3c shows the estimated costs of establishing and managing a one-hectare Cardaba, Lakatan and Latundan banana farms. Table 14a to 14b shows the estimated volume of production and cost and return of a one (1) hectare Cardaba, Table 15a to 15b for Lakatan and Table 16a to 16b for Latundan banana farms.

Table 14a. Estimated volume of production of one-hectare Cardaba banana farm

Crop Cycle	Volume of Production/ha (kgs)				
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Plant Crop		17,500.00			
First ratoon		17,500.00			
Second ratoon		8,764.00	8,736.00		
Third ratoon			17,500.00		
Fourth ratoon			17,500.00		
Fifth ratoon			8,764.00	8,736.00	
Sixth ratoon				17,500.00	
Seventh ratoon				17,500.00	
Eight ratoon				8,764.00	8,736.00
Ninth ratoon					17,500.00
Tenth ratoon					17,500.00
Eleventh ratoon					8,764.00
Total		43,764.00	52,500.00	52,500.00	52,500.00

Yield assumptions:

Y2 = 100% of plant crops are harvested
100% of 1st ratoon are harvested
50% of 2nd ratoon are harvested

Y3 = 50% of 2nd ratoon are harvested
100% of 3rd ratoon are harvested
100% of 4th ratoon are harvested
50% of 5th ratoon are harvested

Y4 = 50% of 2nd ratoon are harvested
100% of 3rd ratoon are harvested
100% of 4th ratoon are harvested
50% of 5th ratoon are harvested

Y5 = 50% of 2nd ratoon are harvested
100% of 3rd ratoon are harvested
100% of 4th ratoon are harvested
50% of 5th ratoon are harvested

Average weight per bunch = 28 kgs
Rejects/Non-marketable = 3% (farmgate) = 10% (processor)

Table 14b. Five years estimated cost and return of a one-hectare Cardaba banana farm

ITEM	YEAR					
	1	2	3	4	5	Total
Gross Yield (kg/ha)		43,764.00	52,500.00	52,500.00	52,500.00	201,264.00
Net Yield (kg/ha)						
- Farmgate		42,451.08	50,925.00	50,925.00	50,925.00	195,226.08
- Processor		39,387.60	47,250.00	47,250.00	47,250.00	181,137.60
Price of Output (P/kg)						
- Farmgate		7.00	7.00	7.00	7.00	
- Processor		12.00	12.00	12.00	12.00	
Gross Return						
- Farmgate	-	297,157.56	356,475.00	356,475.00	356,475.00	1,366,582.56
- Processor	-	472,651.20	567,000.00	567,000.00	567,000.00	2,173,651.20
Production Costs	125,651.00	93,170.00	117,633.00	124,838.00	138,788.00	600,080.00
Marketing Costs						
- Farmgate	-	-	-	-	-	-
- Processor	-	40,600.00	49,980.00	49,980.00	50,728.00	191,288.00
Net Income/Loss						791,368.00
- Farmgate	(125,651.00)	203,987.56	238,842.00	231,637.00	217,687.00	766,502.56
- Processor	(125,651.00)	338,881.20	399,387.00	392,182.00	377,484.00	1,382,283.20
Return on Investment (ROI %)						
- Farmgate		(64.20)	(5.73)	19.00	27.73	27.73
- Processor		(17.81)	43.46	66.95	74.67	74.67

Basic Assumptions:

1. One-hectare land is owned.
2. Population density - 625 hills (4 x 4 m distance of planting)
3. Plants mortality rate in the field = 5%
4. Cost of Labor = P200.00/MD and P300.00/MAD (1st and 2nd year), 10% increase every 2 years.
5. Cost of materials inputs = increase by 10% every 2 yeaqrs except for water,fuel and vehicle rental.
6. Marketing system:
   - Farmgate - produce are sold at farm level or buyers pick the fruits at farmgate price
     - farm owner take charge in the harvesting and postharvest handling activities
   - Processor - Farm owner deliver or sell his produce to processors
7. Prices of outputs are based on current buying and selling prices in the local markets particularly in Davao City.
8. Farmgate = 3% of gross yield is accounted for non-marketable fruits or rejects.
   Processor - 10% of gross yield is accounted for non-marketable fruits or rejects.
9. % ROI = $\frac{\text{Net Income - Total Costs}}{\text{Total Costs}} \times 100$

Table 14c. Estimated costs of establishing and managing a one-hectare Cardaba banana farm

Labor Inputs	Unit	YEAR 1			YEAR 2			YEAR 3			YEAR 4			YEAR 5		
		Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt
1. Land Clearing	MD	12	1	2,400												
2. Land preparation - Plowing and harrowing	MAD	8	2	4,800												
– Lay-outing, staking and holing	MD	6	1	1,200												
– Basal fertilization	MD	2	1	400												
3. Construction of drainage	MD	6	1	1,200												
4. Maintenance of drainage canal	MD	2	1	400	2	1	400	2	1	440	2	1	440	2	1	484.
5. Planting	MD	3	1	600												
6. Replanting	Mhr	3	1	75												
7. Weed control - Ring weeding	MD	3	6	3,600	3	6	3,600	3	6	3,960	3	6	3,960	3	6	4,356
– Underbrushing	MD	3	4	2,400	3	4	2,400	3	4	2,640	3	4	2,640	3	4	2,904
8. Fertilizer application	MD	2	3	1,200	2	4	1,600	2	4	1,760	2	4	1,760	2	4	1,936
9. Watering/Irrigation	MD	1	12	2,400	1	12	2,400	1	12	2,640	1	12	2,640	1	12	2,904
10. Pest and disease management - Chemical spraying	MD	1	12	2,400	1	12	2,400	1	12	2,640	1	12	2,640	1	12	2,904
11. Sucker Control/Desuckering	MD	2	4	1,600	2	4	1,600	2	4	1,760	2	4	1,760	2	4	1,936
12. De-leafing	MD	2	6	2,400	2	6	2,400	2	6	2,640	2	6	2,640	2	6	2,904
13. Stem/mat sanitation	MD	2	5	2,000	2	5	2,000	2	5	2,200	2	5	2,200	2	5	2,420
14. Bud removal / debudding	MD				2	4	1,600	2	4	1,760	2	4	1,760	2	4	1,936
15. Harvesting and postharvest handling	MD				4	8	6,400	4	8	7,040	4	8	7,040	4	8	7,744
Sub-total				29,075			26,800			29,480			29,480			32,428
Material Inputs	**Unit**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**
1. Planting Materials (Tissue Cultured)	pcs	688	15	10,320												
2. Fertilizer - Chicken dung	bag	21	60	1,260	42	60	2,520	63	66	4,158	83	66.	5,478	104	73	7,592
–14-14-14	kg	4.38	1,200	5,256	15	1,200	18,000	18.75	1,320	24,750	7.5	1,320	9,900	7.5	1,452	10,890
– 45-0-0	bag	7.5	1,000	7,500		1,000	18,750	18.75	1,100	20,625	26	1,100	28,600	26	1,210	1,460
– 0-0-60					18.75	1,600	24,000	18.75	1,760	33,000	26	1,760	45,760	26	1,936	50,336
3. Pesticide					15											
– Fungicide	kg	1	900	900	1	900	900	2	990	1,980	2	990	1,980	2	1,089	2,178
– Insecticide	li	1	1,200	1,200	1	1,200	1,200	2	1,320	2,640	2	1,320	2,640	2	1,452	2,904
4. Water				1,000			1,000			1,000			1,000			1,000
5. Tools and equipments - Knapsack Sprayer	pcs	1	3,500	3,500												
– Deleafing Knife	pcs	6	150	900												
– Tumbling Bolo	pcs	4	300	1,200												
– Slashing Bolo	pcs	4	300	1,200												
– Harvesting knife	pcs	4	60	240												
– Grasshook	pcs	2	350	700												
– Shovel	pcs	2	350	700												
– Spade	pcs	2	350	700												
– Irrigation facilities				60,000												
Sub-total				96,576			66,370			88,153			95,358			106,360
Total Production Costs				125,651			93,170			117,633			124,838			138,788

Marketing Costs	Unit	YEAR 1			YEAR 2			YEAR 3			YEAR 4			YEAR 5		
		Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt
B. Marketing																
– Farmgate																
Total Marketing Costs (farmgate)																
– Processor																
– Hauling	MD				2	14	5,600	2	17	7,480	2	17	7,480	2	17	8,228
– Transporting (rent a delivery truck - 3 tons capacity at P2000.00	unit				1	14	28,000	1	17	34,000	1	17	34,000	1	17	34,000
– Fuel @ P50.00/li	li				10	14	7,000	10	17	8,500	10	17	8,500	10	17	8,500
Total Marketing Costs (processor)							40,600			49,980			49,980			50,728
TOTAL PRODUCTION AND MARKETING COSTS																
– Farmgate				125,651			93,170			117,633			124,838			138,788
– Processor				125,651			133,770			167,613			174,818			189,516

Assumption:
Price of labor = P200/MD (1st and 2nd year)
P300.MAD
10% increase in prices of inputs every 2 years
Organic fertilizer (chicken dung) = 30 kgs/bag

Table 15a. Estimated volume of production of o ne-hectare Lakatan banana farm

Crop Cycle	Volume of Production/ha (kgs)					
	YEAR 1		YEAR 2		YEAR 3	
	Gross Yield	Marketable	Gross Yield	Marketable	Gross Yield	Marketable
Plant Crop	32,000.00	25,600.00	8,000.00	6,400.00		
First ratoon			40,000.00	32,000.00		
Second ratoon			40,000.00	32,000.00		
Third ratoon					40,000.00	32,000.00
Fourth ratoon					40,000.00	32,000.00
Fifth ratoon					28,000.00	22,400.00
Total	**32,000.00**	**25,600.00**	**88,000.00**	**70,400.00**	**108,000.00**	**86,400.00**

Yield assumptions:
Y1 = 80% of plant crop are harvested
Y2 = remaining 20% of plant crops are harvested
100% of both 1st and 2nd ratoons are harvested
Y3 = 100% of both 3rd and 4th ratoons are harvested
70% of 5th ratoon are harvested
Average weight per bunch = 20 kgs
Rejects/Non-marketable = 20-%

Table 15b. Three years estimated costs and return of a one-hectare Lakatan banana farm

	YEAR			
	1	2	3	Total
Gross Yield (kg/ha)	32,000.00	88,000.00	108,000.00	228,000.00
Net Yield (kg/ha)	25,600.00	70,400.00	86,400.00	182,400.00
Price of Output (P/kg) - Farmgate	20.00	20.00	20.00	
- Wholesale	23.00	23.00	23.00	
Gross Return - Farmgate	512,000.00	1,408,000.00	1,728,000.00	3,648,000.00
- Wholesale	588,800.00	1,619,200.00	1,987,200.00	4,195,200.00
Production Costs	314,710.00	281,775.00	333,140.00	929,625.00
Marketing Costs - Farmgate				
- Wholesale	24,300.00	56,700.00	75,600.00	156,600.00
Total Costs - Farmgate	314,710.00	281,775.00	333,140.00	929,625.00
- Wholesale	339,010.00	338,475.00	408,740.00	1,086,225.00
Net Income/Loss - Farmgate	197,290.00	1,126,225.00	1,394,860.00	2,718,375.00
- Wholesale	249,790.00	1,280,725.00	1,578,460.00	3,108,975.00
Return on Investment (ROI %)				
– Farmgate	(37.31)	121.82	192.42	192.42
– Wholesale	(26.32)	125.91	186.21	186.21

Basic Assumptions:

1. One-hectare land is owned.
2. Population density - 2000 hills (2 x 2.5 m distance of planting)
3. Plants mortality rate in the field = 5%
4. Cost of Labor = P200.00/MD and P300.00/MAD (1st and 2nd year), 10% increase in the 3rd year.
5. Cost of materials inputs = increase by 10% in the 3rd year except for water,fuel and vehicle rental.
6. Marketing system:
   - Farmgate - produce are sold at farm level or buyers pick the fruits at farmgate price
     - farm owner take charge in the harvesting and postharvest handling activities
   - Wholesale - Farm owner deliver or sell his produce to wholesaler-retailers
7. Prices of outputs are based on current buying and selling prices in the local markets particularly in Davao City.
8. 20% of gross yield is accounted for non-marketable fruits or rejects.

   Net Yield = Gross Yield - 20%
9. % ROI = $\frac{\text{Net Income - Total Costs}}{\text{Total Costs}}$ x 100

Table 15c. Estimated costs of establishing and managing a one-hectare Lakatan banana farm

Labor Inputs	Unit	YEAR 1			YEAR 2			YEAR 3		
		Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt
1. Land Clearing	MD	12	1	2,400						
2. Land preparation - Plowing and harrowing	MAD	8	2	4,800						
– Lay-outing, staking and holing	MD	12	1	2,400						
– Basal fertilization	MD	4	1	800						
3. Construction of drainage	MD	6	1	1,200						
4. Maintenance of drainage canal	MD	2	1	400	2	1	400	2	1	440
5. Planting	MD	12	1	2,400						
6. Replanting	MD	2	1	400						
7. Weed control - Ring weeding	MD	4	6	4,800	4	6	4,800	4	6	5,280
– Underbrushing	MD	2	4	1,600	2	4	1,600	2	4	1,760
8. Fertilizer application	MD	4	3	2,400	4	4	3,200	4	4	3,520
9. Watering/Irrigation	MD	1	12	2,400	1	12	2,400	1	12	2,640
10. Pest and disease management - Chemical spraying	MD	1	12	2,400	1	12	2,400	1	12	2,640
11. Sucker Control/Desuckering	MD	1	4	800	1	4	800	1	4	880
12. De-leafing	MD	4	6	4,800	4	6	4,800	4	6	5,280
13. Stem/ mat sanitation	MD	4	5	4,000	4	5	4,000	4	5	4,400
14. Bud removal / debudding	MD	4	1	800	4	1	800	4	1	880
15. Bunch spraying	MD	1	6	1,200	1	6	1,200	1	6	1,320
16. Fruit bagging	MD	20	1	4,000	20	1	4,000	20	1	4,400
17. Propping	MD	20	1	4,000	20	1	4,000	20	1	4,400
18. Harvesting and postharvest handling	MD	10	3	6,000	10	7	14,000	10	7	15,400
Sub-total				54,000			48,400			53,240
Material Inputs	**Unit**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**
1. Planting Materials (Tissue Cultured)	pcs	2200	15.00	33,000						
2. Fertilizer - Chicken dung (basal,1 kg/hill)	bag	67	60	4,020						
- 14-14-14 (basal, 100 g/hill)	kg	4	1,200	4,800						
- 46-0-0	bag	23.2	1,000	23,200	56	1,000	56,000	56	1,100	61,600
- 21-0-0	bag	4	900	3,600						
- 0-0-60	bag	30	1,600	48,000	56	1,600	89,600	56	1,760	98,560
3. Pesticide - Fungicide	kg	3	1,200	3,600	3	1,200	3,600	3	1,200	3,600
- Insecticide	li	3	1,500	4,500	3	1,500	4,500	3	1,500	4,500
4. Bagging materials	pcs	2000	5	10,000	4000	5	20,000	6,000	5	30,000
5. Water				1,000			1,000			1,000
6. Propping materials - Bamboo poles	pcs	4000	8	32,000						
- Tying materials	kgs	10	250	2,500						
7. Packing materials (cartoon boxes)	pcs	854	25	21,350	2347	25	58,675	2,880	28	80,640
8. Tools and equipments - Knapsack Sprayer	pcs	1	3,500	3,500						
- Deleafing Knife	pcs	6	150	900						
- Tumbling Bolo	pcs	4	300	1,200						
- Slashing Bolo	pcs	4	300	1,200						
- Harvesting knife	pcs	4	60	240						
- Grasshook	pcs	2	350	700						
- Shovel	pcs	2	350	700						
- Spade	pcs	2	350	700						
- Irrigation facilities				60,000						
Sub-total				260,710			233,375			279,900
TOTAL Production Costs				314,710			281,775			333,140

Marketing Costs	Unit	Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt

B. Marketing - Farmgate		-	-	-	-	-	-	-	-	-
- Wholessale (deliver to local buyers)										
- Transporting (rent a delivery truck - 100 boxes @ P2000.00	unit	3	3	18,000	3	7	42,000	4	7	56,000
- Hauling cost	MD	3	3	1,800	3	7	4,200	4	7	5,600
- Fuel @ P50.00/li	li	30	3	4,500	30	7	10,500	40	7	14,000
Total Marketing Costs - Farmgate		-	-	-	-	-	-	-	-	-
- Wholesale				24,300			56,700			75,600

Assumptions:
- Price of labor = P200/MD (1st and 2nd year)
  P300.MAD
- 10% increase in prices of inputs in the 3rd year.
- Proppping materials recycled for 2 years
- Organic fertilizer (chicken dung) = 30 kgs/bag

Table 16a. Estimated volume of production of a one-hectare Latundan banana farm

Crop Cycle	Volume of Production/ha (kgs)					
	YEAR 1		YEAR 2		YEAR 3	
	Gross Yield	Marketable	Gross Yield	Marketable	Gross Yield	Marketable
Plant Crop	13,335.00	10,668.00	3,333.00	2,666.00		
First ratoon			16,665.00	13,332.00		
Second ratoon			16,665.00	13,332.00		
Third ratoon			16,665.00	13,332.00		
Fourth ratoon			8,336.00	6,669.00	8,336.00	6,669.00
Fifth ratoon					16,665.00	13,332.00
Sixth ratoon					16,665.00	13,332.00
Seventh ratoon					16,665.00	13,332.00
Eight ratoon					13,335.00	10,668.00
Total	**13,335.00**	**10,668.00**	**61,664.00**	**49,331.00**	**71,666.00**	**57,333.00**

Yield assumptions:
Y1 = 80% of plant crop are harvested
Y2 = 20% of plant crops are harvested
  100% of 1st, 2nd and 3rd ratoons are harvested
  50% of 4th ratoon are harvested
Y3 = remaining 50% of 4th ratoon are harvested
  100% of 5th, 6th and 7th ratoons are harvested
  80% of 8th ratoon are harvested
Average weight per bunch = 15 kgs
Rejects/Non-marketable = 20-%

Table 16b. Three years estimated costs and return of a one-hectare Latundan banana farm

	YEAR			
	1	2	3	Total
Gross Yield (kg/ha)	13,335.00	61,664.00	71,666.00	146,665.00
Net Yield (kg/ha)	10,668.00	49,331.20	57,332.80	117,332.00
Price of Output (P/kg)	8.00	8.00	8.00	
Gross Return	85,344.00	394,649.60	458,662.40	938,656.00
Production Costs	167,565.00	111,980.00	129,374.00	408,919.00
Net Income/Loss	(82,221.00)	282,669.60	329,288.40	529,737.00
Return on Investment (ROI %)		(28.29)	29.54	29.54

Basic Assumptions:

1. One-hectare land is owned.
2. Population density -1111 hills (3 x 3 m distance of planting)
3. Plants mortality rate in the field = 5%
4. Cost of Labor = P200.00/MD and P300.00/MAD (1st and 2nd year), 10% increase in the 3rd year.
5. Cost of materials inputs = increase by 10% in the 3rd year except for water, fuel and vehicle rental.
6. Marketing system:
   - Farmgate - produce are sold at farm level or buyers pick the fruits at farmgate price
   - farm owner take charge in the harvesting and postharvest handling activities except for packing the fruits.
   - Buyers take charge in packing the fruits.
7. 20% of gross yield is accounted for non-marketable fruits or rejects.

   Net Yield = Gross Yield - 20%

9. % ROI = $\frac{\text{Net Income - Total Costs}}{\text{Total Costs}}$ x 100

Table 16c. Estimated costs of establishing and managing a one-hectare Latundan banana farm

Labor Inputs	Unit	YEAR 1			YEAR 2			YEAR 3		
		Qty	Freq	Amt	Qty	Freq	Amt	Qty	Freq	Amt
1. Land Clearing	MD	12	1	2,400						
2. Land preparation - Plowing and harrowing	MAD	8	2	4,800						
– Lay-outing, staking and holing	MD	8	1	1,600						
– Basal fertilization	MD	4	1	800						
3. Construction of drainage canal	MD	6	1	1,200						
4. Maintenance of drainage canal	MD	2	1	400	2	1	400	2	1	440
5. Planting	MD	6	1	1,200						
6. Replanting	MD	1	1	200						
7. Weed control - Ring weeding	MD	3	6	3,600	3	6	3,600	3	6	3,960
– Underbrushing	MD	2	4	1,600	2	4	1,600	2	4	1,760
8. Fertilizer application	MD	3	3	1,800	3	3	1,800	3	3	1,980
9. Watering/Irrigation	MD	1	12	2,400	1	12	2,400	1	12	2,640
10. Pest and disease management - Chemical spraying	MD	1	12	2,400	1	12	2,400	1	12	2,640
11. Sucker Control/Desuckering	MD	1	4	800	1	4	800	1	4	880
12. De-leafing	MD	3	6	3,600	3	6	3,600	3	6	3,960
13. Stem/ mat sanitation	MD	3	5	3,000	3	5	3,000	3	5	3,300
14. Bud removal / debudding	MD	3	1	600	3	1	600	3	1	660
15. Fruit bagging	MD	10	1	2,000	10	1	2,000	10	1	2,200
16. Harvesting and postharvest handling	MD	6	3	3,600	6	7	8,400	6	7	9,240
Sub-total				38,000			30,600			33,660
Material Inputs	**Unit**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**	**Qty**	**Unit Price**	**Amt**
1. Planting Materials (Tissue Cultured)	pcs	1210	15	18,150						
2. Fertilizer - Chicken dung	bag	37	60	2,220	111	60	6,660	85	66	12,210
- 14-14-14	bag	6	1,200	7,200	13	1,200	15,600	13	1,320	17,160
- 46-0-0	bag	7	1,000	7,000	7	1,000	7,000	7	1,100	7,700
- 0-0-60	bag	7	1,600	11,200	13	1,600	20,800	13	1,760	22,880
3. Pesticide - Fungicide	kg	3	1,200	3,600	3	1,200	3,600	3	1,200	3,600
- Insecticide	li	3	1,500	4,500	3	1,500	4,500	3	1,500	4,500
4. Bagging materials	pcs	1111	5	5,555	4444	5	22,220	4,444	6	26,664
5. Water				1,000			1,000			1,000
6. Propping materials - Bamboo poles										
8. Tools and equipments - Knapsack Sprayer	pcs	1	3,500	3,500						
- Deleafing Knife	pcs	6	150	900						
- Tumbling Bolo	pcs	4	300	1,200						
- Slashing Bolo	pcs	4	300	1,200						
- Harvesting knife	pcs	4	60	240						
- Grasshook	pcs	2	350	700						
- Shovel	pcs	2	350	700						
- Spade	pcs	2	350	700						
- Irrigation facilities				60,000						
Sub-total				129,565			81,380			95,714
TOTAL Production Costs				167,565			111,980			129,374

Assumption:
- Price of labor = P200/MD (1st and 2nd year)
  P300/MAD
- 10% increase in prices of inputs in the 3rd year
- Organic fertilizer (chicken dung) = 30 kgs/bag

UTILIZATION OF BANANA

Banana is considered as "tree of life" wherein all parts have many uses (Table 17 and Appendix 2).

Table 17. Parts of the banana plant and its different uses

Parts	Food and or Feed	Industrial
Pulp/Flesh	Flour, puree, chips, figs, flakes juice, jam, jelly, wine, vinegar, preserve, spread, nectar, banana cue, animal feed and powder	Ethyl alcohol
Peel	Jam, jelly, marmalade, vinegar, coffee and animal feed	Ethyl alcohol, dye, biogas, charcoal, floor wax, shoe polish and paste.
Male flower	Vegetable and food seasoning	
Pseudostem and corm	Animal feed	Cork board, medicinal, paper and dye, fiber and handicraft
Leaves	-	Paper dye and packaging materials

Source: PCCARD, 2009.

Appendix 1. List of banana cultivars at Southeast Asian banana field genebank in BPI-DNCRDC, Bago Oshiro, Davao City (BPI-DNCRDC, 2012)

Accession/Cultivar Name		Genome	Cooking	Dessert	Carotene-Chip rich	Unique	Seeded
1.	Lakatan (Philippines)/Pisang Berangan (ITC1287) (ITC-Belgium)	AA	-	/	/	-	-
2.	Suyak, Pusit (Philippines)	AA	-	/	/	-	-
3.	Oonoonoo (Papua New Guinea)	AA	-	/	/	-	-
4.	Tudlo Tumbaga, Bantol Red (Philippines) Tudlo Tumbaga (ITC1231) (ITC-Belgium)	AA	-	/	/	-	/
5.	Amas (Philippines)/Amas (South Johnstone (ITC0567) (ITC-Belgium)/Pisang Mas (1403) (ITC-Belgium) enough	AA	-	/	-	-	-
6.	Bata-Bata (Philippines)	AA	-	/	-	-	-
7.	Eda-an (Philippines)/Edaan (ITC1227)/ITC-Belgium)	AA	-	/	-	-	-
8.	Baukas (Philippines)/Bata-Bata (ITC0974)/ (ITC-Belgium)	AA	-	/	-	-	-
9.	Seňorita, Inarnibal (Philippines)/Inarnibal (ITC1149), Pisang Trimulin (ITC0699)/(ITC-Belgium)	AA	-	/	-	-	-
10.	Kinamay Dalaga (Philippines)/Kluai Lep Mu Nang (Thailand)/Kluai Lep Mu Nang (ITC0533) (ITC-Belgium)/ Pisang Pinang (Malaysia)	AA	-	/	-	-	-
11.	Mintal (Philippines	AA	-	/	-	-	-
12.	Morong Princesa (Philippines) Morong Princesa (ITC1150)	AA	-	/	-	-	-
13.	Morong Princesa (ITC0972) (ITC-Belgium)	AA	-	/	-	-	-
14.	Manang (Philippines)	AA	-	/	-	-	-
15.	Heva (Papua New Guinea)	AA	-	/	-	-	-
16.	Oonoonoo Kengoa (Papua New Guinea)	AA	-	/	-	-	-
17.	PNG 108 (Papua New Guinea)	AA	-	/	-	-	-
18.	PNG 109 (Papua New Guinea)	AA	-	/	-	-	-
19.	Pisang Go Nin Chio (Malaysia)	AA	-	/	-	-	-
20.	AAcv Rose (ITC0712) (ITC-Belgium)	AA	-	/	-	-	-
21.	Pisang Lilin (Malaysia)	AA	-	/	-	-	-
22.	Pisang Raksa (Malaysia)/Pisang Perecet ITC0695) (ITC-Belgium)	AA	-	/	-	-	
23.	Pisang Raja Udang (Malaysia)/Pisang Raja Udang (ITC0976) (ITC-Belgium)	AA	-	/	-	-	AA
24.	Pisang Susu (Malaysia)	AA	-	/	-	-	
25.	Pisang Talas (Malaysia)	AA	-	/	-	-	
26.	Pisang Jarum (Malaysia)	AA	-	/	-	-	
27.	Pisang Lidi (Indonesia)	AA	-	/	-	-	
28.	Pisang Pipit (ITC0685) (ITC-Belgium)	AA					
29.	Pisang Sapon (ITC0679) (ITC-Belgium)	AA	-	/	-	-	-
30.	Pisang Bangkahulu (ITC0689) (ITC-Belgium)	AA	-	/	-	-	-
31.	Ngu (ITC1358) (ITC-Belgium)	AA	-	/	-	-	-
32.	Kluai Namtia, Kluai Hom Thong Son (Thailand)	AA	-	/	-	-	-
33.	Kluai Pa-26 (Thailand)	AA	-	/	-	-	-
34.	Kluai Pa-54 (Thailand)	AA	-	/	-	-	-
35.	Khai Nai On (ITC0663) (ITC-Belgium)	AA	-	/	-	-	-
36.	Mama-on (Philippines)/Pamotion (ITC1129) (ITC-Belgium)	AA	-	/	-	-	-
37.	Ga-o (Philippines)	AA	-	/	-	-	-
38.	Alaswe, Lonsing, Pulutan (Philippines)	AA	-	/	-	-	-
39.	Musa acuminata type Kluai Thong Det (ITC0404) (ITC-Belgium)	AA	-	/	-	-	-
40.	Khai (Kampengpeth) (ITC0532) (ITC-Belgium)	AA	-	/	-	-	-
41.	No. 110 (ITC0413) (ITC-Belgium)	AA	-	/	-	-	-
42.	Pisang Jaran (ITC0678) (ITC-Belgium)	AA	-	/	-	-	-
43.	Pisang Oli (ITC1157) (ITC-Belgium)	AA	-	/	-	-	-

Accession/Cultivar Name		Genome	Cooking	Dessert	Carotene-Chip rich	Unique	Seeded
44.	Nombum (Papua New Guinea)	AA	-	/	-	-	-
45.	Guyod (Philippines)	AA	-	/	-	-	/
46.	Tudlo Datu (Philippines)/Pisang Jaribuaya (Malaysia)/Morong Datu (ITC0309), Huwundu Vita (ITC0308) (ITC-Belgium)	AA	-	/	-	-	/
47.	Laku (Philippines)/Binaktong (ITC1181) (ITC-Belgium)	AA	-	/	-	-	/
48.	Rawari # 1 (Philippines)	AA	-	/	-	-	/
49.	Malaysian Blood (ITC0568) (ITC-Belgium)	AA	-	/	-	-	/
50.	Viente Cohol (ITC1031) (ITC-Belgium)	AA	-	/	-	-	/
51.	Talip (Philippines)	AA	/	-	-	-	/
52.	Marges Elargies (ITC0421) (ITC-Belgium)	AAw	-	-	-	-	/
53.	Rung Hoa Xoan (ITC1432) (ITC-Belgium)	AAw	-	-	-	-	/
54.	Pisang Cici (ITC0681) (ITC-Belgium)	AAw	-	-	-	-	/
55.	Pisang Flava (Malaysia)	AAw	-	-	-	-	/
56.	Kluai Pal (ITC0679) (ITC-Belgium)	AAw	-	-	-	-	/
57.	Pisang Kra (Malaysia)	AAw	-	-	-	-	/
58.	Agutay (ITC1028) (ITC-Belgium)	AAw	-	-	-	-	-
59.	Pa (Musore No. 3x) (ITC0406) (ITC-Belgium)	AAw	-	-	-	-	-
60.	Pa (Musore No. 2x (ITC0668) (ITC-Belgium)	AAw	-	-	-	-	-
61.	Pa (Patthalong) (ITC0409) (ITC-Belgium)	AAw	-	-	-	-	-
62.	Kluai Pa (Thailand)	AAw	-	-	-	-	-
	THA 018 (ITC1067) (ITC-Belgium)	AAw	-	-	-	-	-
63.	Pisang Cici Alas (ITC0415) (ITC-Belgium)	AAw	-	-	-	-	-
64.	Pisang Segun (Malaysia)	AAw	-	-	-	-	-
65.	Mambee Thu (Papua New Guinea)	AAw	-	-	-	-	-
66.	Pisang Surung (Malaysia)	AAw	-	-	-	-	-
67.	Kluai Pa-22 (Thailand)	AAw	-	-	-	-	-
68.	Pa (Songkla) x (ITC0408) (ITC-Belgium)	AAw	-	-	-	-	-
69.	Bungulan (Philippines)/Pisang Masak Hijau (ITC 0340) (ITC-Belgium)	AAw	-	-	-	-	-
70.	Roykerr	AAA	-	/	-	-	-
71.	Pearly Shell	AAA	-	/	-	-	-
72.	Robusta	AAA	-	/	-	/	-
73.	Gros Michel	AAA	-	/	-	/	-
74.	Lacatan (ITC0176) (ITC-Belgium) Lacatan (ITC0768) (ITC-Belgium)	AAA	-	/	-	/	-
75.	HPSDC-105 (Philippines)	AAA	-	/	-	-	-
76.	F- 26 Honduras	AAA	-	/	-	/	-
77.	GCTCV-106 (ITC1442) (ITC-Belgium)	AAA	-	/	-	/	-
78.	GCTCV-119 (ITC1282) (ITC-Belgium)	AAA	-	/	-	/	-
79.	GCTCV-215 (ITC1271) (ITC-Belgium)	AAA	-	/	-	/	-
80.	GCTCV-215 (ITC1436) (ITC-Belgium)	AAA	-	/	-	/	-
81.	GCTCV-247 (ITC1443) (ITC-Belgium)	AAA	-	/	-	/	-
82.	Novaria (ITC1329) (ITC-Belgium)	AAA	-	/	-	/	-
83.	Bodles Altafort (Jamaica)	AAA	-	/	-	/	-
84.	Grand Naine (Honduras)	AAA	-	/	-	/	-
85.	Tall Williams	AAA	-	/	-	/	-
86.	Ecuadorian	AAA	-	/	-	/	-
87.	Valery	AAA	-	/	-	/	-
88.	Pastilan (Philippines)	AAA	-	/	-	-	/
89.	Binawe (Philippines)	AAA	-	/	-	/	-
90.	Oramos (Philippines)	AAA	-	/	-	/	-
91.	Chuoi Teu Lien (ITC1374) (ITC-Belgium)	AAA	-	/	-	/	-
92.	Chuoi Teu Xanh (ITC1406) (ITC-Belgium)	AAA	-	/	-	/	-
93.	Chuoi Vua Trang (ITC1424) (ITC-Belgium)	AAA	-	/	-	/	-

Accession/Cultivar Name		Genome	Cooking	Dessert	Carotene-Chip rich	Unique	Seeded
94.	Sulaybaguio (Philippines)/Kluai Hom Khom (ITC0527), Morong Principe (ITC0415) Chuoi Va Huong (ITC1373) (ITC-Belgium) GN-60A (ITC1328) (ITC-Belgium)	AAA	-	/	-	/	-
95.	Umalag (Philippines)	AAA	-	/	-	/	-
96.	Tai-BF	AAA	-	/	-	/	-
97.	Oma (Philippines)/Pisang Bakar (1064) (ITC-Belgium)	AAA	-	/	-	/	-
98.	Morado (Philippines)/Com Lua (ITC1421) (ITC-Belgium)	AAA	-	/	/	-	/
99.	Moradong Puti (Philippines)	AAA	-	/	-	-	-
	Tanggung (Philippines)	AAA	-	/	-	-	-
100.	Lakem Connetnet (Papua New Guinea)	AAA	-	/	-	-	-
101.	Migea Arize (Papua New Guinea)	AAA	-	/	-	-	-
102.	Muga (Papua New Guinea)/Muga (ITC0007) (ITC-Belgium)	AAA	-	/	-	-	-
103.	Ragus Burung (Papua New Guinea)	AAA	-	/	-	-	-
104.	Walebo (Papua New Guinea)	AAA	-	/	-	-	-
105.	Setkowee Wein (Papua New Guinea)	AAA	-	/	-	-	-
106.	Bagatow (Papua New Guinea)	AAA	-	/	-	-	-
107.	Pisang Molo (Indonesia)/ Pisang Pelembang(Malaysia)/Pisang Papan (Indonesia)/Pisang Papan (ITC1061) (ITC-Belgium)	AAA	-	/	/	-	
108.	MS Hale (ITC1223) (ITC-Belgium)	AAA	-	/	-	-	-
109.	Lai (ITC0403) (ITC-Belgium)	AAA	-	/	-	-	-
110.	Pisang Saripipi (ITC0693) (ITC-Belgium)/ IDO 077 (ITC0688) (ITC-Belgium)/Khai Thong Ruang (ITC0662) (ITC-Belgium)	AAA	-	/	-	-	-
111.	Yangambi Km 5 (ITC1123) (ITC-Belgium)	AAA	-	/	-	-	-
112.	Hom Thong Mokho (ITC0671) (ITC-Belgium)	AAA	-	/	-	-	-
113.	Pisang Umbuk (ITC0686) (ITC-Belgium)	AAA	-	/	-	-	-
114.	Torp, Kotnar, Komargh (Papua New Guinea)	AAA	-	/	-	/	-
115.	Calypso (Jamaica)	AAAA	-	/	-	/	-
116.	FHIA-23 (ITC1265) (ITC-Belgium)	AAAA	-	/	-	/	-
117.	FHIA-25 (ITC1418) (ITC-Belgium)	AAAA	-	/	-	/	-
118.	SH-3436-9 (ITC1283) (ITC-Belgium)	AAAA	-	/	-	-	-
119.	Ney Poovan (India)	AB	-	/	-	-	-
120.	Latundan (Philippines)/Cha Den (ITC1360), Tay Tia (ITC1365) (ITC-Belgium)	AAAB	-	/	-	-	-
121.	Hilao-Hinog (Philippines)	AAB	-	/	-	-	-
122.	Pisang Pulot (Malaysia)	AAB	-	/	-	-	-
123.	Pisang Ceylan (Malaysia)	AAB	-	/	-	-	-
124.	Pisang Keling (Malaysia)	AAB	-	/	-	-	-
125.	Canara (ITC1240) (ITC-Belgium)	AAB	-	/	/	-	-
126.	Radja (Philippines)/Pisang Lingi, Pisang Kapas (Indonesia)	AAB	-	/	/	-	-
127.	Kluai Khai Boran (Thailand)	AAB	-	/	/	-	-
128.	Bom (ITC1438) (ITC-Belgium)	AAB	-	/	/	-	-
129.	Chuoi Man (ITC1379) (ITC-Belgium)	AAB	-	/	-	-	-
130.	Galamay Señora (Philippines)	AAB	-	/	-	-	-
131.	Ternate (Philippines)	AAB	-	/	-	-	-
132.	Pisang Radja Talung (Malaysia)	AAB	-	/	-	-	-
133.	Kluai Nang Nuan (Thailand)/Xiem Mat (ITC1425) (ITC-Belgium)/Kluai Teeb Khom(Thailand)	AAB	-	/	-	-	-
134.	Lady Finger (Nelson) (ITC0582) (ITC-Belgium)	AAB	-	/	-	-	-
135.	Pisang Seribu (Malaysia)/Kluai Roi Wi (ITC0535) (ITC-Belgium)	AAB	-	/	-	-	/
136.	Muracho (Philippines)/Muracho (ITC0036) (ITC-Belgium)	AAB	/	/	/	-	-

Accession/Cultivar Name		Genome	Cooking	Dessert	Carotene-Chip rich	Unique	Seeded
137.	Maramag (Philippines)	AAB	/	-	/	/	-
138.	Inambak (Philippines)	AAB	/	-	/	/	-
139.	Inampao (Philippines)	AAB	/	-	/	/	-
140.	Laknau (Philippines)	AAB	/	-	/	/	-
141.	Waggie Mawab (Philippines)	AAB	/	-	/	/	-
142.	Pok Pok (Papua New Guinea)	AAB	/	-	/	/	-
143.	Humwey, Kabai, PNG 166 (Papua New Guinea)/Kune (ITC1068) (ITC-Belgium)	AAB	/	-	/	/	-
144.	Pagatow (Papua New Guinea)	AAB	/	-	/	/	-
145.	FHIA-21 (ITC-Belgium)	AAB	/	-	/	/	-
146.	Pisang Tioman (Malaysia)	AAB	/	-	/	/	-
147.	CRBP-39 (ITC1344) (ITC-Belgium)	AAAB	/	-	/	/	-
148.	Chuoi Nam (ITC1382) (ITC-Belgium)	AAB	/	-	/	/	-
149.	Patag (Philippines)	AAB	/	-	/	/	-
150.	Bata-Bata (ITC1226) (ITC-Belgium)	AAB	/	-	/	/	-
151.	Bungaoisan (Philippines)	AAB	/	-	/	/	-
152.	Tindok (Philippines)	AAB	/	-	/	/	/
153.	Duhoy, Duo (Philippines)/Duhoy (1182) (ITC-Belgium)/Leewarp (Papua New Guinea)	AAB	/	-	-	/	-
154.	Pisang Nangka (ITC0004), Pisang Nangka (ITC1062) (ITC-Belgium)	AAB	/	-	-	-	-
155.	Pisang Slendang (ITC1065), Pisang Kenning(ITC1298) (ITC-Belgium)	AAAB	/	-	-	/	-
156.	Ambowga (Papua New Guinea)	AAS	-	/	-	-	-
157.	Henderneyargh (Papua New Guinea)	AAS	-	/	-	-	-
158.	Japaraka No. 1 (ITC0604) (ITC-Belgium)	AAS	-	/	-	-	-
159.	Kluai Namwa Khom (Thailand)/ Namwa Khom (ITC0659), Kluai Namwa Khom (ITC1304) (ITC-Belgium)	ABB	/	/	-	-	-
160.	Kluai Namwa Luang (Thailand)	ABB	/	/	-	-	-
161.	Kluai Namwa Daeng (Thailand)	ABB	/	/	-	-	-
162.	Katali (Philippines)	AAB	/	/	-	-	-
163.	Kundubu (ITC-Belgium)	AAB	/	-	-	-	-
164.	Pisang Awak (ITC0213) (ITC-Belgium	ABB	/	/	-	-	-
165.	Kalapagnon (Philippines)	ABB	/	/	-	-	-
166.	Suisok (Philippines)	ABB	/	/	-	-	-
167.	Pitogo (Philippines)	ABB	/	-	-	-	/
168.	Pisang Kepok Malacacina (Indonesia)/ ITC0710(ITC-Belgium),IDN 107(ITC0710) (ITC-Belgium)	ABB	/	-	-	-	-
	Kluai Teeb (Thailand)	ABB	/	-	-	-	-
169.	Kluai Teeb-15 (Thailand)	ABB	/	-	-	-	-
170.	Kluai Teeb-20 (Thailand)	ABB	/	-	-	-	-
171.	Pisang Ampyang (Indonesia)	ABB	/	-	-	-	-
172.	Java (Philippines)	ABB	/	-	-	-	-
173.	Kunambo (Papua New Guinea)	ABB	/	-	-	-	-
174.	Pisang Rasa (Malaysia)	ABB	/	-	-	-	-
175.	Chuoi Mat (ITC1381) (ITC-Belgium)	ABB	/	-	/	/	-
176.	Pisang Kepok Bung (ITC0698) (ITC-Belgium)	ABB	/	-	-	-	-
177.	Pisang Kepok (ITC0692) (ITC-Belgium)	ABB	/	-	-	-	-
178.	Oroua (Papua New Guinea)	ABB	/	-	-	-	/
179.	Tamadawa (Papua New Guinea)	ABB	/	-	-	-	-
180.	Akee (Papua New Guinea)	ABB	/	-	-	-	-
181.	Gana Sumpu (Papua New Guinea)	ABB	/	-	-	-	-
182.	Karmumpo (Papua New Guinea)	ABB	/	-	-	-	-
183.	Katsila (Philippines)/Silver Bluggoe (ITC0364) (ITC-Belgium)	ABB	/	-	-	-	-
184.	Maduranga (Philippines)/Maduranga (ITC0035) (ITC-Belgium)	ABB	/	-	-	/	-

Accession/Cultivar Name		Genome	Cooking	Dessert	Carotene-Chip rich	Unique	Seeded
185.	Moko (Philippines)	ABB	/	-	-	-	-
186.	Pelipita, Binato (Philippines)/Pelipita (ITC0095) (ITC-Belgium)	ABB	/	-	/	-	-
187.	Pondol (Philippines)	ABB	/	-	-	/	-
188.	Gubao (Philippines)/Saba' (ITC1138) (ITC-Belgium)	ABB	/	-	-	/	-
189.	Cachaco (ITC0643) (ITC-Belgium)	ABB	/	-	-	/	-
190.	Matavia(Philippines)/Matavia (ITC0032) (ITC-Belgium)/Woo-Woo,Waggie, PNG 200 (Papua New Guinea)	ABB	/	-	-	/	-
191.	Abuhong Pondol (Philippines)	ABB	/	-	-	/	-
192.	Pata (ITC0500) (ITC-Belgium)	ABB	/	-	-	/	-
193.	Paa Dalaga (Philippines)	ABB	/	-	-	/	-
194.	Saba' sa Hapon (Philippines)	ABB	/	-	-	/	-
195.	Sabra (ITC0026) (ITC-Belgium)	ABB	/	-	-	/	-
196.	FHIA-01(ITC0504),FHIA-04(ITC-Belgium)	AAAB	-	/	-	/	-
197.	FHIA-02(ITC0505),FHIA-05(ITC-Belgium)	AAAB	-	/	-	/	-
198.	FHIA 18 (ITC1319) (ITC-Belgium)	AAAB	/	-	/	/	-
199.	TMB x 15108-6 (ITC1417) (ITC-Belgium)	AAAB	-	/	-	-	-
200.	SH-3640 (ITC1307) (ITC-Belgium)	AAAB	-	/	-	-	-
201.	Langka (ITC0657) (ITC-Belgium)		-	/	-	-	-
202.	Langka (ITC0670) (ITC-Belgium)		-	/	-	-	-
203.	FHIA- 03 (ITC0506) (ITC-Belgium)	AABB	/	-	-	-	-
204.	TMB x 5295-1 (BITA 3) (ITC1297)	AABB	/	-	-	/	-
205.	Tiparot (Philippines)	ABBB	/	-	-	-	/
206.	TMB x 1378 (ITC1296) (ITC-Belgium)	ABBB	-	/	-	-	-
207.	Inabaniko (Philippines)	BBB	/	-	-	-	/
	Abuhon (BBcv) (Philippines)	BBB	/	-	-	-	-
208.	Cardaba or Saba' (Philippines)	BBB	/	-	-	/	-
209.	Dali-an, Giant Cardaba (Philippines)	BBB	/	-	-	/	-
210.	Kalimpos (Philippines)	BBB	/	-	-	/	-
211.	Sab-a, Turangkog (Philippines)	BBB	/	-	-	-	-
212.	Sab-ang Puti (Philippines)	BBB	/	-	-	-	-
213.	Mundo (Philippines)	BBB	/	-	/	-	-
214.	Butuhan	BBw	-	-	-	-	-
215.	Bago Wild	BBw	-	-	-	-	-
216.	Pisang Klutuk Wulung (Indonesia)	BBw	-	-	-	-	/
217.	Butuhan, intermediate apex (ITC0565) (ITC-Belgium)	BBw	-	-	-	-	-
218.	Hot Rung (ITC1445) (ITC-Belgium)	BBw	-	-	-	-	-
219.	Eti Kehel (ITC0271) (ITC-Belgium)	BBw	-	-	-	-	-
220.	Balbisiana (ITC0545) (ITC-Belgium)	BBw	-	-	-	-	-
221.	Musa ornata (ITC0370) (ITC-Belgium)	Rodochlamys	-	-	-	-	/
222.	Musa laterita (ITC1076) (ITC-Belgium)	Rodochlamys	-	-	-	-	/

Appendix 2. Some utilization of banana

1. **Banana chips**

Materials needed:

oil
salt
sugar
500 ppm sodium metabisulfite
Cardaba or Saba'
stove
fryer

Procedure:

a. Peel bananas and put them in salted iced water.
b. Slice banana fruits into bite-size pieces and lay across a cloth for 10 minutes to remove all moisture.
c. Heat up the oil in the fryer until smoke is rising.
d. Fry banana slices in one-layer batches for a minute or two or until crisp.
e. Lift chips out with slotted spoon and lay on paper towels to remove oil.
f. If you want to make sweetened kind, sprinkle sugar heavily on the cooked bananas and leave overnight in a covered container.
g. Fry again the next day.
h. Store the chips in an airtight container to maintain its crunchiness.

2. **Banana Cake**

Materials needed:

4 eggs
¾ cup or 150 g caster sugar
2 tsp vanilla essence
1 cup or 140 g self rising flour, sifted
¼ cup or 50 g melted butter
2 large, mashed banana fruits
1 tin can (170 g) nestle cream
½ tsp banana essence

Procedure:

a. Whisk the eggs and sugar for 6 to 8 minutes until well combined. Whisk in the vanilla essence.
b. Sift the flour over the egg mixture in three batches using a metal spoon to fold together.
c. Combine the melted butter, mashed banana, nestle cream, glace fruits and banana essence.
d. Fold into the egg and flour mixture.
e. Pour mixture into a cake pan or 22 cm grease and floured round tin. Bake in a 175°C preheated oven for 30 to 40 minutes or until a skewer inserted in the center comes out cleans.
f. Remove from the oven and set aside to cool.

3. **Banana flour**

Materials needed:

green bananas
salt
solar dryer
chopping board
packaging materials
measuring cups/spoon
basin
knife
grinder
sifter
plastic bag

Procedure:

a. Prepare brine solution.
b. Wash the peel of bananas.
c. Cut into halves.
d. Slice longitudinally at 13 cm thick.
e. Dry in solar dryer for 8 to 10 hours.
f. Grind 2 to 3 times or until very fine.
g. Pass through a fine sieve and pack in plastic bags.

4. **Banana puree**

Procedure

a. Peel the ripe fruit.
b. Mash or grind with an equal amount of water. Add preservatives (ascorbic, 0.1% and or citric acid, 0.2 %) until it has uniform consistency.
c. Heat the puree to 82 to 93°C for 10 minutes.
d. Place in sterilized containers and seal immediately.

5. **Banana pastillas**

Materials needed:

1 kg (5 cups) mashed ripe bananas
Cardaba/Saba' or Cavendish
300 g (2 ¼ cups) sugar
butter or margarine

Procedure:

a. Boil the ripe bananas. Peel and slice into 3 cm thick.
b. Grind the sliced bananas until it mashed, add sugar and cook over slow fire. Stirring should be done constantly until a clear mixture is obtained with the desired consistency. The mixture should not stick to the sides of the frying pan.
c. Transfer the mixture over the wax paper. Spread the mashed mixture using a rolling pin until it reaches1 inch thick.
d. Spread butter and small amount of sugar over the mixture.
e. Make slice of about 4 x 1 cm. Cool and wrap individually.

6. **Dried banana blossoms**

Materials needed:

4 cups water
sugar
vinegar
1 tbsp sodium metabisulfite
cheese cloth
colander
soy sauce

Procedure:

a. Dissolve 1 tablespoon sodium metabisulfite in four cups water and boil the solution.
b. Strip banana blossoms apart, wrap in cheesecloth, and blanch in the boiling solution.
c. Mix equal quantities of sugar and soy sauce and soak the blanched blossoms overnight in the mixture.
d. Dry under the heat of the sun and pack in plastic bag.

7. **Banana catsup**

Materials needed:

Cavendish or Cardaba or Saba'
100 g (7 tbsp) vinegar
1 g (3 pcs) peeper, *labuyo*
5 g (1 pc) onion, powdered (medium)
1 g (1 clove) garlic, powdered (big)
10 g (2 tsp) refined salt
80 g (6 tbsp) sugar
g (1/2 tsp) red dye
g (1/2 tsp) yellow dye (No.2)
5 g (1 tsp) cinnamon
200 ml (14 tbsp) water

Procedure:

a. Peel and grind ripe bananas (80% yellow and 20% green).
b. Weigh the ground pulp and add an equal amount of water.
c. Blend in warring blender for one minute.
d. Adjust the pH of the puree to 4.0 to 4.3 by adding citric acid (0.5% of puree) and /or sodium hydroxide.
e. Adjust the pH of vinegar to 4.0 to 4.3.
f. Grind the spices and dissolve them in vinegar. Add them to the puree.
g. Cook the mixture for 10 minutes at 750 to 850°C, stir continuously to prevent scorching.
h. Add coloring and continue heating to desired consistency.
i. Put immediately in a clean sterilized bottle.

8. **Banana sauce**

Materials needed:

750 g banana
65 g salt
75 g garlic
1.5 g all-spice
1.5 g white pepper
50 g modified starch
35 g carboxyl methyl cellulose
sterilized preserving bottles
700 g sugar
517ml vinegar
15 g bell paper
25 g onion
2,750 ml water

Procedure:

a. Wash banana fruits and soaked in chlorinated water (100ppm) for 10 minutes.
b. Blanch in boiling water for 10 minutes.
c. Peel and detach string adhering to the pulp.
d. Add water to the grinded banana, then blend the mixture.
e. Mix the sugar, starch, carboxyl methyl cellulose, salt spices and vinegar. Heat and allow simmering for ten minutes, then strain.
f. Add spice vinegar to banana puree. Blend and heat in a double boiler with constant stirring at 75°C to 80°C for ten minutes until it becomes thick.
g. Immediately pour the hot cooked sauce in clean sterilized air tight bottles.

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