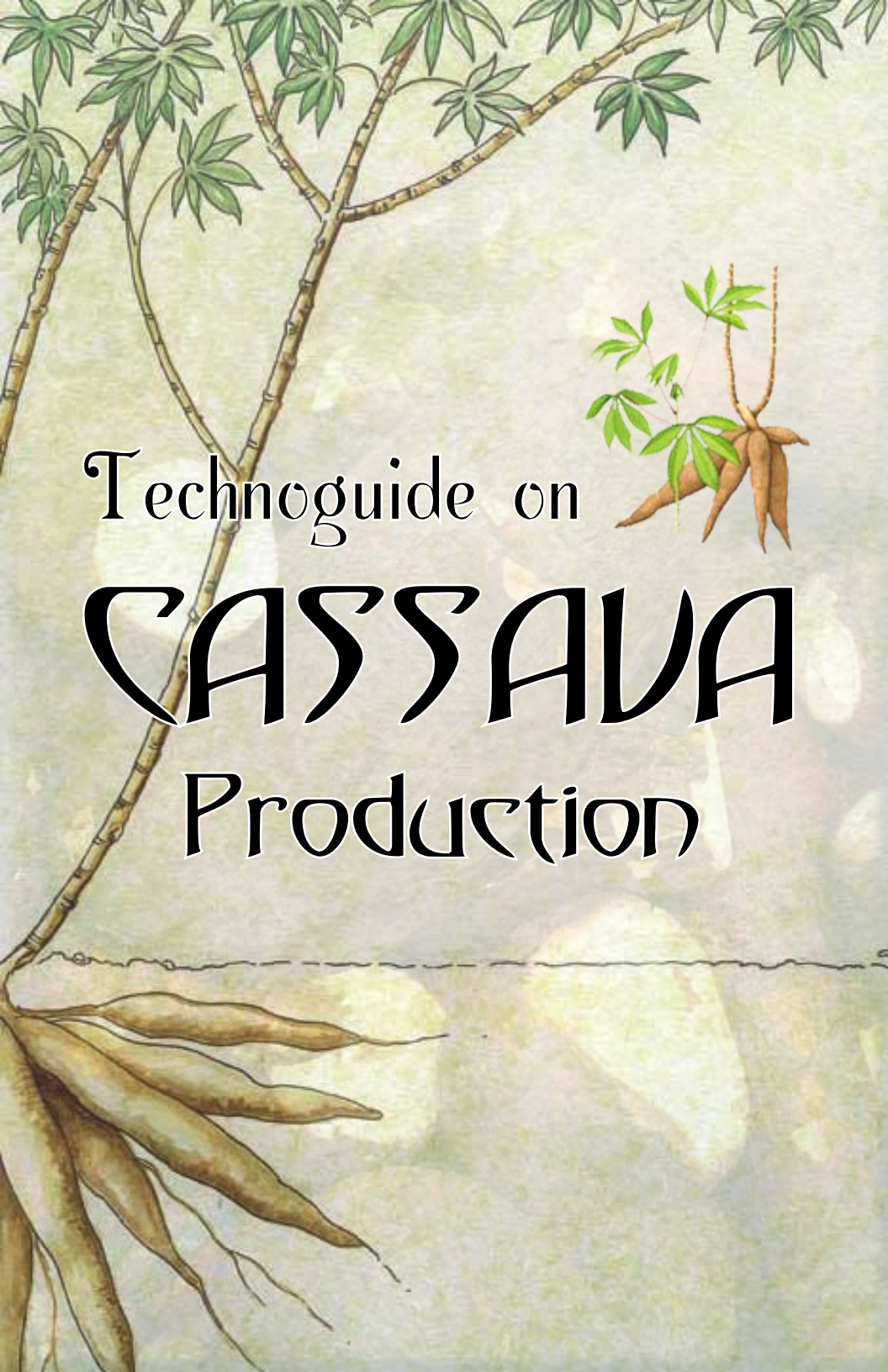


A detailed botanical illustration of a cassava plant. The main illustration shows a woody stem with several green, deeply lobed leaves. At the bottom left, the thick, brown, tuberous roots are shown. In the upper right, there is a smaller, separate illustration of a cassava plant with its roots and leaves.

Technoguide on

CASSAVA

Production

INTRODUCTION

Cassava is one of the important root crops in the Philippines because of its many uses. Aside from being used as food, and feed ingredients, cassava is also used in the manufacture of industrial products. It is also used as raw material in the production of ethanol. Moreover, cassava can be processed into different food products with higher economic value.

The demand for cassava as raw material for industrial uses dramatically increased. However, this demand is not fully satisfied due to low cassava production.

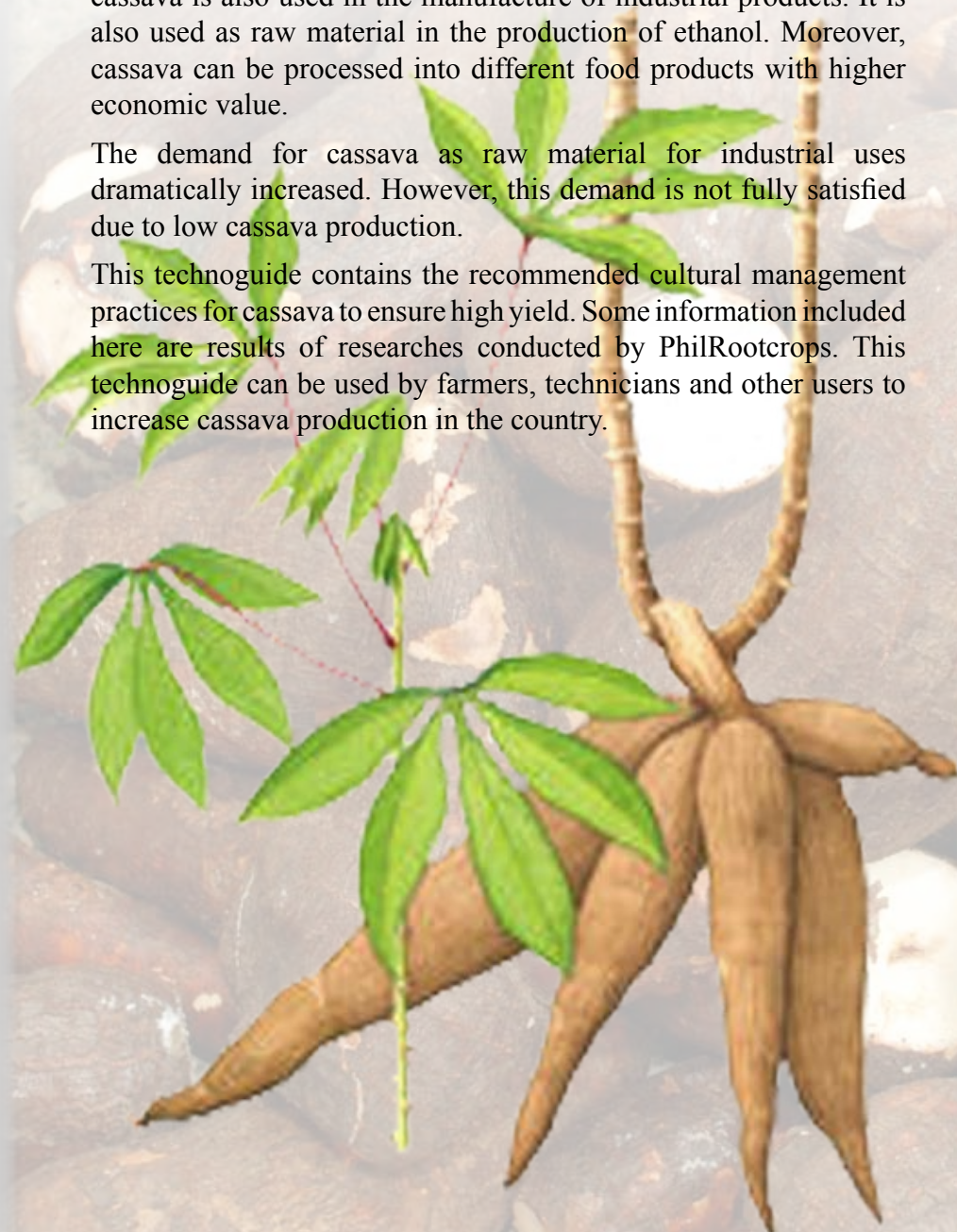
This technoguide contains the recommended cultural management practices for cassava to ensure high yield. Some information included here are results of researches conducted by PhilRootcrops. This technoguide can be used by farmers, technicians and other users to increase cassava production in the country.

SITE SELECTION



Select a site with the following characteristics:

- Flat or undulating slope (not more than 15%). If the slope of the area is very steep, use water and soil conservation techniques (Example: Sloping Agricultural Land Technology or SALT specifically the establishment of contour hedgerows).
- An open field
- Sandy loam to clay loam soil
- Soil pH ranging from 5.5-6.5
- Enough rainfall or water source that can support the growth of cassava plants throughout the year. Cassava plants produce low yield and deformed roots when subjected to drought stress especially during the first 3 months after planting.
- A well-drained area; no waterlogging for more than 24 hours. Young cassava plants (1-3 months old) will have stunted growth while mature cassava plants will have rotten roots when waterlogged for more than 24 hours.



LAND PREPARATION



Plow and harrow the field twice using a tractor or animal-drawn plow and harrow. Do these operations when there is enough soil moisture. Plow the field at least 6 inches deep.

VARIETY SELECTION



Plant only high yielding varieties which fit the intended purpose:

Use varieties with low to high hydrocyanic acid for industrial uses such as: flour, animal feeds and ethanol production.

- UPL Ca-3 (Sultan 1) PSB Cv-10 (Mcol 1684)
- UPL Ca-2 (Lakan 1) PSB Cv-11 (Lakan 2)
- PSB Cv-12 (Lakan 3) PSB Cv-14 (CMP21-15)
- PSB Cv-15 (Lakan 4) PSB Cv-19 (SM 803-1)
- NSIC Cv-22 (KU-50) NSIC Cv-30 (Rayong 5)

Use only varieties with low hydrocyanic acid (HCN) for food such as:

- UPL Ca-2 (Lakan 1)
- PSB Cv-11 (Lakan 2) PSB Cv-12 (Lakan 3)
- PSB Cv-13 (CMP 61-15) PSB Cv-15 (Lakan 4)
- PSB Cv-16 (CMP 31-10) NSIC-Cv 30 (Rayong 5)

(Please refer to last page for additional cassava varieties.)

PREPARATION OF PLANTING MATERIALS



1.5 cm



Select only physiologically mature, fresh and healthy stems.

- A stem is healthy if it is free from insects, pests and diseases and its diameter is not less than 1.5 cm.
- A stem is fresh if the latex or sap comes out within 3 seconds after cutting.



A stem is mature if the diameter of the pith or cork is not more than half the diameter of the cortex.



Cut the stems using a sharp bolo.



If planting is delayed store the stems under a cool and shady place. Storage under such condition is possible up to one month. In storing, make sure that the base of the stem faces the ground.



Do not let the stems lie on the ground to avoid sprouting of the eye buds. A cutting with sprouted eye buds easily dies when exposed to sunlight.

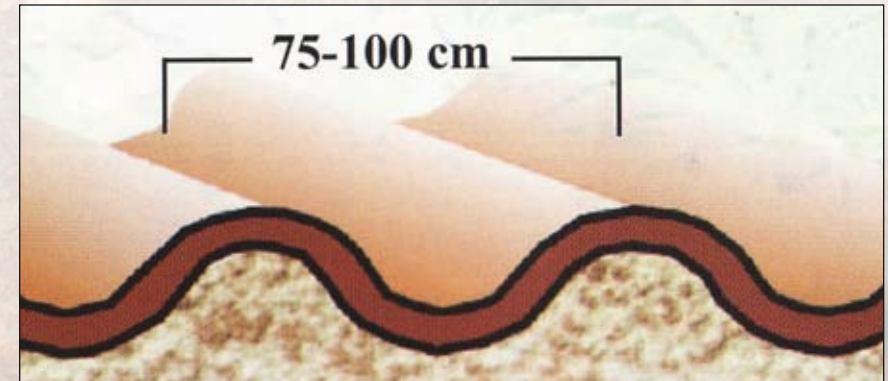
Cut the stem into stakes 15-30 cm long. A cutting or stake must have at least seven viable nodes.



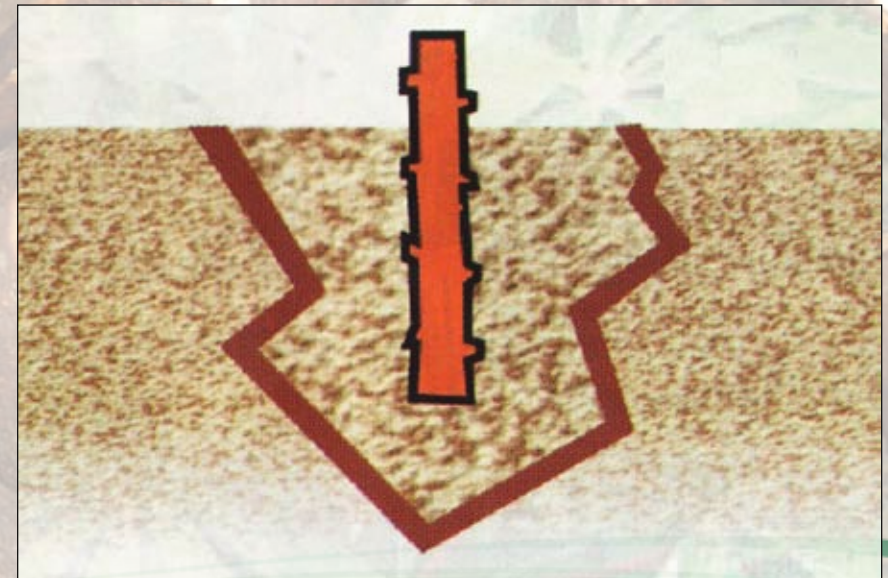
Handle the cuttings properly. Do not throw them to avoid damage of the nodes.

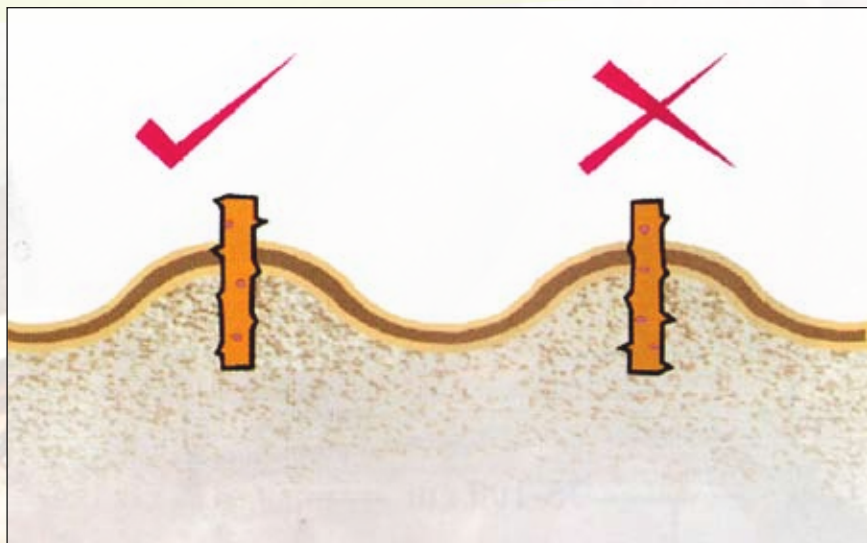
PLANTING

- Planting begins at the start of rainy season.
- Before planting, make ridges 15-20 cm high at a distance of 75-100 cm between ridges.



- Follow the planting period in your place.
- Plant the seed piece vertically/slanting on ridges. Cuttings can be planted in vertical, slanting or horizontal position. If planted in vertical or slanting position, 2/3 of the length of the cutting (approximately with 3-5 nodes) must be buried in or covered with soil.





- Be sure that the cuttings are in upright position during planting.



- Plant one cutting per hill at a distance of 50-75 cm between hills and 75-100 cm between rows.
- Monitor dead cuttings 2-3 weeks after planting. Replant dead cuttings immediately.

FERTILIZER APPLICATION AND SOIL FERTILITY MAINTENANCE



Cassava prefers a good soil but is also grows in poor soils since:

- it can tolerate low pH;
- it can tolerate higher level of soluble aluminum and low available phosphorous;
- it grows in soil where other crops fails.

The crop removes considerable amounts of nutrients from the soil (see Table below). The degree of nutrient removal depends on the yield level. Hence, continuous production without replacement of the nutrient loss in the soil will reduce the soil productivity.

Nutrient uptake of cassava (Howeler, 2000).

Plant Part	Yield (t/ha)	Nutrient Removed (kg/ha)				
		N	P	K	Ca	Mg
Roots	28.87	67.1	11.2	88.1	3.5	3.5
Whole plant		179.5	22.7	156.1		

To maintain adequate amounts of essential nutrients in the soil:

- Return the residues of healthy harvested plants to the soil by gathering them in one area to let them decompose and later apply it as organic fertilizer or by applying it as mulching material in the next cropping.
- Apply fertilizer. Fertilizers supply the essential nutrients that are lacking in the soil. Fertilizers are classified either as inorganic (i.e. complete, muriate of potash, solophos, etc.) or organic (manure, compost, etc.).

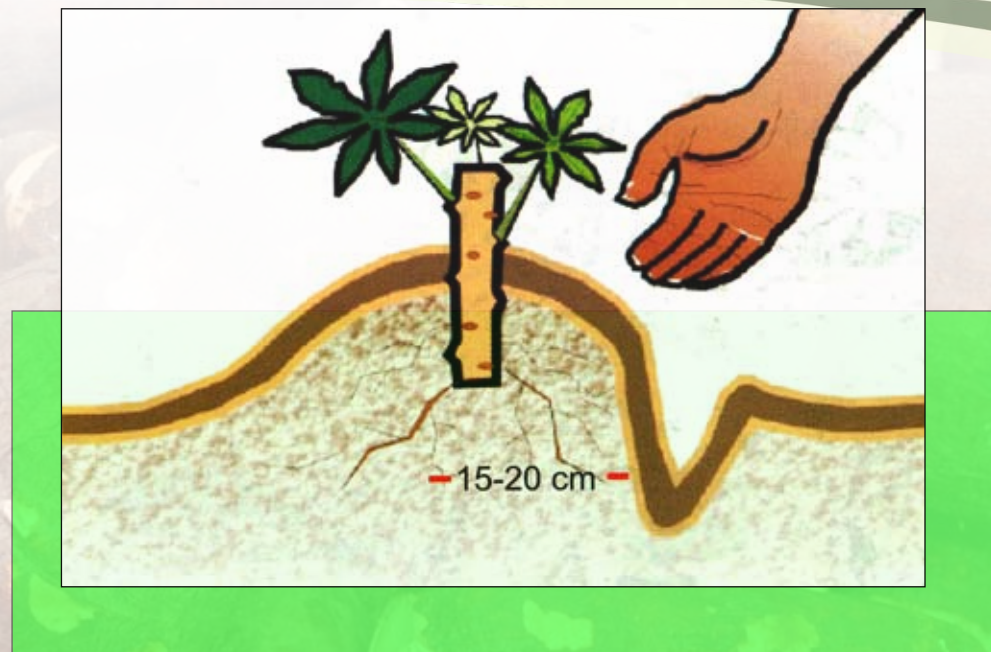
Inorganic Fertilizer

- The rate of application of inorganic fertilizer should be based on soil analysis. However, in the absence of soil analysis, use the general recommendation of 8 bags of complete fertilizer (14-14-14) per hectare. This is equivalent to 56 kg N, 56 kg P₂O₅ and 56 kg K₂O per hectare.

Recommended methods inorganic fertilizer application (IFA Cassava Manual for methods 1 and 2)

Method 1 at 1 MAP at 3-4 MAP	1/2 N, all P1 1/2 K 1/2 N, 1/2 K
Method 2 at planting	all NPK
Method 3 at planting at 3-4 MAP	1/2 N, all P, 1/2K 1/2 N, 1/2 K

MAP - months after planting



- To apply fertilizers, make a small canal 15-20 cm away from the base of the plant using a plow. Cover the fertilizer immediately after application.
- On sloping areas, dibble the fertilizer 3-5 cm away from the base of the plant, then cover with soil.

Considerations in fertilizer application

- Do not apply fertilizer if soil fertility is high.
- Do not apply fertilizer during rainy days or when rain is eminent right after fertilizer application.
- Do not over fertilize the plant especially nitrogen. Excessive nitrogen promotes vegetative growth at the expense of root development and susceptible to diseases and insect pests.

Organic Fertilizer

- Apply organic fertilizer before land preparation for proper incorporation into the soil if abundant. The volume will depend on the availability of organic fertilizer.
- For limited volume apply the organic fertilizer along the furrows during planting. Apply at least 10 bags/ha of organic fertilizer.
- Supply at least 30 percent of recommended fertilizer rate with organic fertilizer.

WEEDING AND CULTIVATION



- Off-bar the plants at 3-4 weeks after planting to loosen the soil and kill the weeds.
- Hill-up the plants just after side-dressing not later than three months after planting (MAP).



- For the remaining weeds, handweed within the rows at 4-5 weeks.

PEST MANAGEMENT

Major insect pests that attack cassava are the red spider mites (*Tetranychus kanzawai* Kishida) and the scale insects (*Pseudaulascaspis pentagona* Targionia - Tozzetti). These pests could severely damage the plants resulting to yield reduction and even loss of planting materials.

1. Red Spider Mites

Damages:

- Yellow stippling or tiny dots on the surface of the leaves.
- Dots spread and later coalesce resulting in complete yellowing and gradual browning.
- Defoliation occurs during heavy infestation.



Control:

- Biological control - Release predatory mites (*Amblyseius longispinosus*) in infested area.
- Use resistant or tolerant varieties

2. Scale Insects

Damages:

- Grayish-brown circular or ovoid discs on the stem surface.
- Presence of cottony substance during heavy infestation.
- Reduction in the germination rate of planting materials.

Control:

- Use healthy planting materials.
- Treat planting materials (spray or dipping) with contact insecticide such as Dimethoate following the recommended rate of the manufacturer.



Symptoms:

Symptoms are visible on both sides of the lamina but are more pronounced on the upper surface where the spots are uniform brown with distinct brown borders. Spots are generally 3-12 mm diameter and roughly circular but becoming more irregular as they enlarge. A yellow halo around the spot is observed in some varieties. The leaves turn yellow, dry and eventually fall off as the disease progresses.

Control:

- Cut and burn severely affected plants.
- Use disease-free planting materials

2. Cassava Bacterial Blight [*Xanthomonas campestris* pv. *manihotis* (Berthet and Bondar) Dye]

Cassava bacterial blight (CBB) is the most serious bacterial disease of cassava. Strong genotype environment interaction occurs and losses varies with variety, ecozone and weather condition. Disease outbreaks and associated loss are unpredictable.

Symptoms:

Infected plants show typical water-soaked angular spots, leaf blight, leaf fall and formation of cankers on the stem. In severe cases, shoot die-back and typical candle sticks' symptoms are observed. The pathogen invades the plant system and the seed but often producing no symptom initially. The bacterium may survive for a considerable period within the seed.



DISEASES OF CASSAVA

1. Cercospora Leaf Spot (*Cercospora henningsii* Allesch.)

Cercospora spp. induce leaf spot of cassava but the most important is the *Cercospora henningsii*. It occurs in the lower canopy of crops more than 5 months old. The disease is favored by high temperature and humidity. Cercospora leaf spot complex can cause yield loss up to 20%.



Control:

- Practice crop sanitation.
- Plant resistant varieties or cultivars.
- Crop rotation method to completely break the life of the pathogen.
- Cut and burn infected plants.
- Apply potash to reduce the severity of the disease.
- Use disease-free planting materials.

3. Witches' Broom (*Phytoplasma candidatus asteris*)



Cassava Witches' Broom is the most destructive new systemic disease of cassava. It is caused by specialized bacteria, *Phytoplasma*. The disease reduces root yield and starch content significantly. Total yield loss may occur if symptoms appear on the onset of crop establishment.

Symptoms:

Infected plants show a wide range of symptoms. Asymptomatic indications are stunted growth and general plant decay. Visible symptoms include yellowing and purpling of leaves, shortening of internodes resulting to bouquet-like or topiary-like appearance of top portion of the plant. Profuse lateral branches are produced in highly susceptible varieties. White pith turn brownish and water-soaked in infected stem.

Control

- Use healthy planting materials; restrict movement
- Treat planting materials with antibiotics
- Uproot infected plants, dry and burn

HARVESTING



- Harvesting of cassava is done at 8-12 months after planting. This can be done manually or mechanically.
- Harvesting should be done during the dry season. This minimizes the occurrence of molds in cassava chips or granules.
- Harvest only what is needed for food or processed within 2 days.
- Cassava roots cannot be stored under ambient condition for more than 2 days because they develop vascular streaking which affects the quality of the by-product.
- Avoid wounding the cassava roots because it causes rapid deterioration of the roots.
- Separate & process first the damaged and small roots in order to minimize the growth of molds.
- Sorting may not be necessary when roots are immediately delivered to the processing plant.

POST-HARVEST PRACTICES

Pre-drying

Sun-dry newly harvested roots for 4 hours or less to easily remove soil particles.

Chipping

This can be done through manual or mechanical chopping of fresh roots. The ideal thickness of chips is $\frac{1}{2}$ inch.

Manual chipping can be done by cutting the roots diagonally or crosswise using a sharp knife or bolo.

Mechanical chipper can process larger volume of roots in a shorter period of time with lesser cost.



Granulation

Fresh roots can also be chopped into smaller size of about 8-10 mm using a cassava granulator. Granules require shorter period of drying, higher price and are less bulky to transport.



Drying

Spread chips or granules evenly not more than 3 inches thick in a clean dry pavement or tarpaulin/plastic net for 2-3 days for sun drying. Dry to 14% moisture content or lower for longer storage. Do not dry chips/granules in sandy areas to avoid contamination.

In areas with frequent rains, the use of plastic-roof shed with elevated flooring can serve as drying facilities. This can also be used as the initial (1-2 days) stage before transferring the chips/granules to a mechanical dryer.



Storage

Pack dried chips/granules in clean laminated sacks or Polypropylene sacks and tie it tightly. Store cassava in dry, shaded and well ventilated area. Use wooden pallet to elevate the sacks from the flooring.



COST AND RETURN

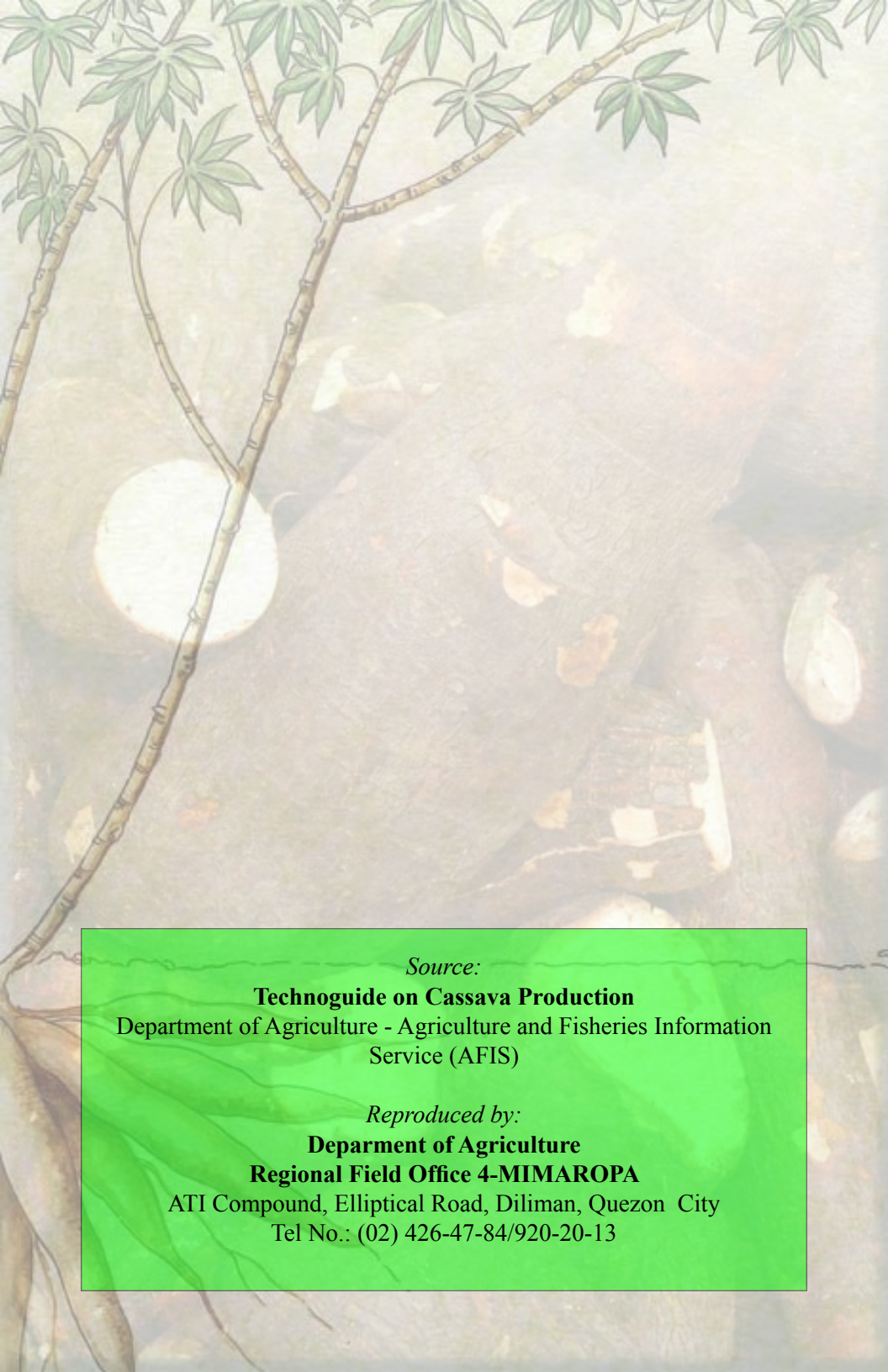
One hectare cassava production

Item/Activity	Quantity	Unit Cost (Php)	Cost/ha (Php)
Farm Input:			10,550.00
a. Planting Materials	40 bundles	20.00	2,800.00
b. Fertilizers			
Organic	10 bags	250.00	2,500.00
Complete Fertilizer (T14)	2 bags	1,250.00	2,500.00
Urea	1 bag	1,250.00	1,250.00
Muriate of Potash	1 bag	1,500.00	1,500.00
Labor:			14,750.00
a. Land Preparation	2 passings	2,500.00	5,000.00
b. Furrowing	3 MAD	300.00	900.00
c. Cutting Stalk/Planting	13 MAD	150.00	1,950.00
d. Basal/Sidedress Fertilization	6 MAD	150.00	900.00
e. Off-Barring	2 MAD	300.00	600.00
f. Hilling Up	2 MAD	300.00	600.00
g. Harvesting/Cutting Stalks	30 MAD	150.00	4,500.00
Production Cost			25,300.00
Post Harvest Cost:			10,500.00
a. Chipping	25,000 kg	0.20	5,000.00
b. Drying	10 MD	150.00	1,500.00
c. Hauling (Farm to Warehouse)	200 bags	5.00	1,000.00
d. Polypropylene Sacks	200 pcs	15.00	3,000.00
TOTAL COST			35,800.00
Fresh Roots	25,000 kg	2.00	50,000.00
Dried Chips @ 40 % DMY	10,000 kg	6.50	65,000.00
Net Income per Hectare			
Fresh Roots			24,700.00
Dried Chips			29,200.00

RECOMMENDED CASSAVA VARIETIES

Variety	Potential Yield (MT/ha)	Starch Content (%)	Dry Matter Content (%)	HCN Content
UPL-Ca1 (Datu 1)	30-40	21.4	33.8	Moderate
UPL-Ca2 (Lakan 1)	35-45	25.0	36.4	Low
UPL-Ca3 (Sultan 1)	40-50	20.9	33.5	Moderate
UPL-Ca4 (Vassorinha)	25-35	21.4	33.8	Moderate
UPL-Ca2 (Sutan 2)	25-35	21.1	33.6	High
VC-1 (CMC-323-52)	40.8	21.4	33.8	Moderate
VC-2 (CMC-40)	40.2	20.3	33.0	Low
VC-3 (CM-3590-1)	30.0	20.9	33.5	Moderate
PSB Cv-9(CM-4014)	32.9	21.4	33.8	Moderate
PSB Cv-10 (Mcol1684)	41.5	21.1	33.5	High
PSB Cv-11 (Lakan 2)	25.0	21.8	34.1	Low
PSB Cv-12 (Lakan 3)	24.1	21.5	33.9	Low
PSB Cv-13 (CMP 62-15)	26.4	22.8	34.8	Low
PSB CV-14 (CMP 21-15)	29.4	20.3	33.4	Moderate
PSB Cv-15 (Lakan 4)	24.0	21.9	34.2	Low
PSB Cv-16 (CMP 32-10)	33.6	20.8	33.4	Low
PSB Cv-17 (Sultan 3)	39.3	18.9	32.0	Moderate
PSB Cv-18 (Sultan 4)	39.0	19.6	32.5	Moderate
PSB Cv-19 (SM 803-1)	32.3	22.9	34.9	Moderate
PSB Cv-20 (Sultan 5)	35.3	23.4	35.3	Moderate
NSIC Cv-21 (SM 818-1)	28.2	27.6	38.4	Moderate
NSIC Cv-22 (KU-50)	31.3	27.0	38.0	Moderate
NSIC Cv-23 (QMR 33-12-3)	26.1	28.5	38.9	Moderate
NSIC Cv-24 (QMR 33-12-7)	24.1	27.2	38.0	Moderate
NSIC Cv-26 (Sultan 7)	30.5	23.0	35.0	Moderate
NSIC Cv-27(Datu 2)	30.7	22.8	34.8	Moderate
NSIC Cv-28 (QMR-36-05-09)	36.9	27.6	38.3	Low
NSIC Cv-29 (Lakan 5)	29.1	30.1	40.1	Low
NSIC Cv-30 (Rayong 5)	32.4	29.4	40.1	Low
NSIC Cv-31 (CG 97-07-05)	32.4	29.4	40.1	Low
NSIC Cv-32 (CM-9165-17)	30.9	29.6	39.3	Low
NSIC Cv-33 (CG-97-16-01)	31.4	39.1	38.0	Moderate
NSIC Cv-34 (CM-9175-25)	37.2	30.6	40.4	Moderate
NSIC Cv-35 (CMR-37-24-1)	31.5	32.8	42.9	Moderate
NSIC Cv-36 (CMR-36-62-03)	42.3	29.1	39.0	Moderate
NSIC Cv-37 (CG-97-17-02)	31.5	27.5	41.2	Moderate
NSIC Cv-38 (SM-2065-2)	34.0	28.2	38.5	Moderate
NSIC Cv-39 (CG 97-05-02)	32.3	27.8	39.2	Low
NSIC Cv-40 (CG 97-03-04)	37.0	27.1	37.9	Moderate
NSIC Cv-25 (Sultan 6)	40.7	26.8	37.6	Moderate
NSIC Cv-41 (CG 97-09-23)	35.4	29.2	39.2	Moderate
NSIC Cv-42 (Rajah 4)	33.4	28.1	38.5	Low
NSIC-Cv43 (LSU-Cv21)	38.2	26.9	39.8	Moderate
NSIC-Cv44 (LSU-Cv22)	29.7	28.6	41.4	Moderate
NSIC-Cv45 (LSU-Cv23)	29.5	30.1	43.6	Moderate

Source: Bureau of Plant Industry



Source:

Technoguide on Cassava Production

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ATI Compound, Elliptical Road, Diliman, Quezon City

Tel No.: (02) 426-47-84/920-20-13