Roots and Tubers

1. Cassava
2. Dasheen
3. Sweet Potato
4. Tannia
5. Yam

TECHNOLOGY PACKS

YAM

November 2015

Background

Production decisions concerning how much effort and resources to invest and which farming practices to follow, have consequences and create opportunities for the farm affecting production levels, input costs, time constraints, and the potentially size of the operation. They also may have implications for resource use and environmental quality.

Numerous information exist on the various aspects of production and handling/ marketing of crops and livestock, the majority of which are outdated, not easily understood and lacking the where with all for addressing present day challenges such as good agricultural practices (GAPs) and food safety and climate change that impact on the environment and rural livelihoods. These issues are also closely related to the importance of the role of primary producers in increasing the earnings of all actors along the value chain in supporting the development of a commercially viable and sustainable agricultural industry.

The production of high quality and easily understood information packages is critical as this forms a basis for farmers to obtain financing from lending institutions and to efficiently increase their production through the availability of modern technology. This will also result in a reduction of rural unemployment and will greatly help in alleviating poverty and other associated social ills.

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Introduction

This Technological Package (Tech Pack) deals with the production and postharvest aspects of yam.

Also included in the Tech Pack are appendices:

- Template for cost of production
- List of recommended pesticides and application rates
- Good Agricultural Practices data record sheet.

Notwithstanding the identification of any specific pesticide for the control of pests and diseases, this decision is for the discretion of the Ministry of Agriculture Area Extension Officer and the farmer.However, the mention of any pesticides and other products used in the Tech Pack should strictly comply with local regulations and all instructions provided by the manufacturer. Also, the use of trade names in the Tech Pack is for the purpose of citing examples and is not meant to either endorse or discredit any particular product.

Description

Species

Dioscorea alata, called "water yam", "winged yam" and "purple yam". The stems and petioles are green or purplish in colour, spineless, with four or more rows of wings running their entire length, to give the vine a star shaped appearance in cross section. Leaves are heart shaped and pointed as demonstrated in the Banja and White Lisbon (D. *alata*) yams (Plates 1 and2).

Plate 1 Banja plant and tubers (Wild yam D. *alata*)

Plate 2 White Lisbon (D. *alata*) vines and tubers

Dioscorea rotunda, the "Portuguese yam" (Plate 3) and Dioscorea cayenensis, yellow yam (Plate 4). The vines of the D. rotundata and D. cayenensis attain lengths up to 30 - 40 feet (10 – 12m) and are cylindrical and particularly spiny near the base. Leaves are opposite or alternate dark green, rather leathery in texture and shiny or waxy on the axial surface.


Plate 3 Portuguese yam (D. *rotundata*) tuber and plant


Plate 4 Yellow yam (D. *cayenensis*) plant and tubers

Dioscorea trifida, the leaves are large, palmate three to five lobed and opposite or alternate (Plate 5).


Plate 5 *Dioscorea trifida* **tubers and plant**

Dioscorea esculenta, the cultivar of most economic significance is the Chinese yam. Its vines seldom reach more than 10 feet (3 m) in length and the tubers are fairly small. Because of its easy preparation and good flavour the tubers are eaten baked, boiled, or fried much like potatoes (Plate 6).

Plate 6 Chinese yam (D. esculenta) tubers and plant

Ecology and Environmental Considerations

Most suited conditions for growing yams are as follows:

- Temperatures between 75 - 85°F (25 -30°C). Optimum growth occurs at about 85°F (30°C)
- Rainfall of approximately 60 inches (1,500 mm) spread over 5 - 6 months
- Deep well-drained sandy loam fertile soils are essential for optimal yields.

Land Preparation

Tillage reduces the density of the soil, and generally increases yields. Mounds tend to be used when the various forms of mechanizationare not available. The ridging method is preferred because plants can be planted 1½ feet(50 cm) apart, thus maximizing the use of the land, leading to higher yields (about twice than when using mounds).Building the soil into ridges or mounds 1 – 1½ feet (30 - 45 cm) high and about 3 feet (90 cm) apart, provides good drainage. When available, incorporate

organic matter such ascompost into the soil,about 4 - 6 weeks before planting. The soil should also be limed to attain a pH of about 5.5.

Planting Material

Mini-setts

To avoid spreading tuber-borne diseases, only tubers harvested from healthy plants should be cut into mini-setts. Select the tubers you will use for mini-sett multiplication in the field during harvest. Mark weak and diseased plants during the growing season, so that you can recognize them at harvest and avoid using their tubers for mini-setts.

The size of the mini-sett depends on thespecies of yam, the spacing at which the mini-setts will be planted in the field, and the size of the planting setts preferred by the farmers. Use Table 1as a guide for selecting mini-sett size and plant spacing to produce a desired tuber size. *Dioscorea rotundata* usually requires larger mini-setts than D. *alata*.

Table 1 Two different species of yam (*Dioscorea*spp), tuber sizes expected from mini-setts of different weights planted at different spacings

Yam species	**Mini-sett wt**		**Mini-sett spacing**		**Tuber produced**	
	oz	**(g)**	**in**	**(cm)**	**oz**	**(g)**
D. *alata*	0.4-0.7	(10-20)	40 x 10	(100 x 25)	3.5-21.0	(100-600)
	0.9-1.1	(25-30)	40 x 10	(100 x 25)	7.0-28.0	(200-800)
	1.4-2.1	(40-60)	40 x 16	(100 x 40)	14.0-63.0	(400-1800)
D. *rotundata*	0.9-1.1	(25-30)	40 x 10	(100 x 25)	3.5-10.5	(100-300)
	1.6-2.1	(45-60)	40 x 20	(100 x 50)	3.5-14.0	(100-400)
	2.5-3.5	(70-100)	40 x 20	(100 x 50)	14.0-17.5	(400-500)

Cut selected tubers into mini-setts when they begin to sprout. Use a clean sharp knife and disinfect the knife by dipping frequently in a strong (70%) solution of Clorox, or other household bleach containing sodium hypochlorite. First, cut off the head and tail, and cut them each into at least two pieces. Then cut the rest of the tuber crosswise into disks, and cut each disk into two, three, four or more pieces. Each piece should have as much skin as possible and enough flesh to support sprouting.Very small tubers should be planted whole (Plate 7).

Some cultivars of yam produce aerial tubers, and these can also be used for mini-setting. Use small ones whole and cut large ones to the correct size.

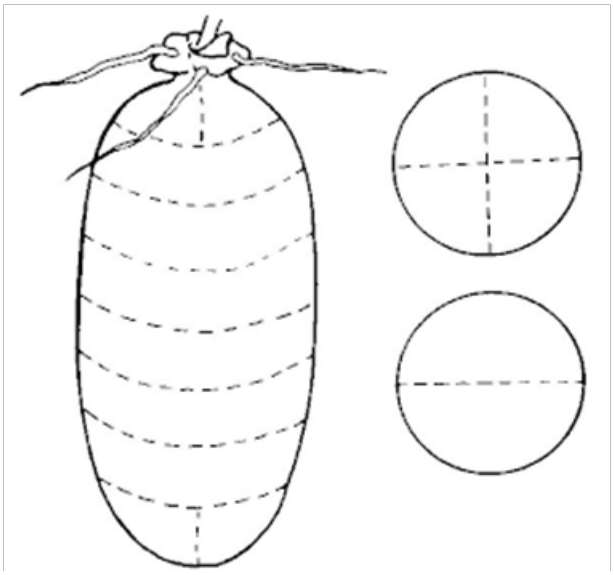


Plate 7Cutting whole tubers into mini-setts

To reduce rotting and spread of diseases, mini-setts should be placed in a nylon or plastic net sack and dipped for about 10 minutes in a fungicide (4 ounces, 100 g Mancozeb) and/or insecticide 2½ ounces, 70 g Diazinon) mix in 2½ gallons (10 L) of water. Airdry the setts for a few hours or overnight, in a shady, well-ventilated area that is protected from rain and sun. Spread the setts in a thin layer with cut surfaces facing up, so that air can circulate freely around them. Drying mini-setts for longer than 2 days may reduce sprouting if to too much moisture is lost.

After drying, mini-setts can be planted directly into the field. However some yam cultivars perform better if mini-setts are pre-sprouted before planting. Place old, rotten coarse sawdust or very light, sandy soil in the nursery bed or box. After burying the mini-setts in the sawdust or sandy soil, apply water as necessary to keep damp, but NOT wet. This is important, because mini-setts that are kept too wet will rot. NOTE: Do not use fresh sawdust because it tends to heat up and that can kill young plants.

Spacing and Planting

After land preparation, an application of pre-emergence herbicide can be applied so as to control the emergence of new weeds during the early stages of plant growth. This must be done about 2 days before planting.

The use ofplastic mulch and drip irrigation along the ridgeis a new method that gives good productivity. When used, there is greater moisture and nutrient retention, reduced weed growth, temperature regulation and the need for staking is eliminated.

Mini-setts can be sown at a depth of 3 inches (7.5cm) and spacingof 1½ feet (0.5m) between plants and 3 feet (1m) between rows. D. *Alata* species are mostly planted around April/May to coincide with sprouting. The other popular species (D. *Rotundata* and D. *Cayenensis*) can be planted throughout the year if the conditions are right, but it is recommended that planting be done at the start of the rainy season (June/July).

Staking

As it is a vine, the yam plants needto be staked or supported. Therefore, as soon as the vines emerge, place stakes next to each plant, 6 - 8 feet (2 - 5 m) in length and about 2 inches(5 cm) thick.

Weed Control

Weeds may be a problem early in crop growth and before the vines cover the beds. It is recommended that after land preparation, a broad spectrum systemic pre-emergent herbicide (as recommended by the Ministry of Agriculture Plant Protection Unit) be applied to control weeds. Allow the weeds to die and act as a mulch. Plant yam at least 2 weeks after spraying the herbicide. From then on hand weed when needed. Sometimes it is required that the plants be molded. This is done generally after weeding and fertilizing.

Fertilization

In collaboration with an Extension Officer, have the soil tested before the application of any type of fertilizers or lime. Leaf analysis should be done if possible. The results of the tests will provide the guidance for fertilizer application. A soil pH of 5.5 - 6.5 is the ideal for plant growth. If the soil pH is not in this range, seek assistance from an Extension Officer on how to correct it.

In addition to inorganic fertilizers, compost can also be used to provide essential plant nutrients. Best results are obtained by incorporating the compost in the soil before planting. Compost also improves the organic content, water holding capacity and texture of the soil andhelps to increase yields.

In the absence of soil and leaf analyses the most common fertilizer that is available and used is NPK (16: 8: 24 + 2MgO).The first application should be made about 4 weeks after planting and the second about 7 - 9 weeks after planting; when tuber bulking is in progress.

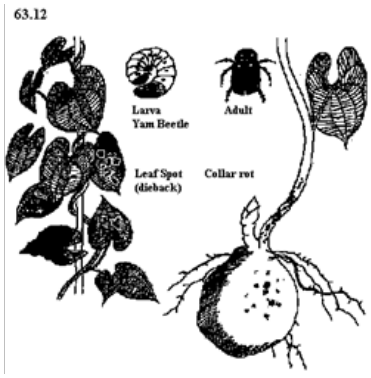
Incorporate the fertilizer in a continuous band along the row, about 4 inches (10 cm) away from the plants. If organic manures are used, they should be incorporated into the soil in the area around the plant.

Pests and Diseases

Walk through yam plots regularly, and pull out all plants with virus symptoms on their leaves. Burn these plants. Also eliminate plants that are weak and are growing slowly. Start rogueing early in the growing season and rogue frequently to prevent insects from spreading virus from infected plants to other plants. Some of the major pests and diseases that affect yam production are shown in Table 2.

Pests and Diseases	Symptoms	Control/Management
Plate 8 Anthracnose 	This is a disease of great economic significance and if left untreated, can cause reduction in yields of over 50%. Black necrotic lesions on leaves and stemscan kill the plant by attacking the terminal bud. On leaves, symptoms range from small brown spots which expand to large black spots. In time the whole leaf becomes affected. Leaves and shoots of the yam will blacken and die, resulting in stunted, small, deformed harvests. The disease is more severe on D. *Alata*yams.	An integrated approach to control is recommended. Control involves use of tolerant varieties, by removal of crop debris and use of foliar fungicides including copper based fungicide treatments: Manzeb, Benomyl, Benomyl + Propineb, Zineb and Mancozeb. Abandoned yam fields in the vicinity of the plot should be destroyed.

Pests and Diseases	Symptoms	Control/Management
Plate 9 Nematodes  	Initial stage of damage consists of cream and lightyellow lesions below the outer skin of the tuber progressing to a depth of about 1 inch (2 cm). The infected tissues first become light brown and then turn dark brown to black. External cracks appear in the skin of the tubers and parts can flake off exposing patches of dark brown, dry rot tissues. The most severe symptoms of dry rot are seen in mature tubers especially during storage when it is often associated with general decay of tubers.	Control can be by several means including a. controlling nematodes in field by cultural or chemical means (use a chemical recommended by the Ministry of Agriculture Plant Protection Unit) b. use of planting material that is naturally free of nematodes c. treatment of seed material prior to planting (use a chemical recommended by the Ministry of Agriculture Plant Protection Unit) d. treatment of tubers after harvesting to prevent storage loss (use a chemical recommended by the Ministry of Agriculture Plant Protection Unit).
Plate 10Yam Beetle 	Adults migrate byflying to other farms/plots; they feed onthe tuber, leavingholes in them. Tubersbecome prone to rotting during storage.	Dust or drench the setts withinsecticide before planting.

Pests and Diseases	Symptoms	Control/Management
Plate 11 Scales 		Removal of pests with abrush and treatment with Diazinon orMalathion prior to planting.
Plate 12 Tuber Rots 	Infection in the field can persist and lead to rotting during storage	1.Plant diseasefreematerial 2.Crop rotation 3 . M i n i m i z e p h y s i c a l damageof tuber during post-harvestoperations 4.Treat the sett ortuber with systemicfungicide 5. Provide adequateaeration and inspect storedtubers regularly.

Good Agricultural Practice (GAP) related to the use of pesticides, requires farmers to maintain up to date records on the application of pesticides to the crop. These records should include trade names, application rates and dates of application. During the harvesting period use pesticides with a very short harvest interval.

Harvesting

Most edible yams reach maturity 7 - 11 months after planting. Harvesting may be done at any time after large-scale leaf yellowing sets in. Yields can vary according to the species, seed piece, growing environment, fertilizer regime, soil type and climatic conditions.

In some species, e.g. D. *rotundata* and to a lesser extent in D. *cayenensis*, an early crop may be taken as well as the main harvest. In this case the tuber is carefully cut below the head and removed, leaving the top to grow again and produce another tuber, or tubers.

Post Harvest Treatment

Prior to long-term storage and marketing, yams are cleaned by removing soil and other debris on the surface with a stiff brush or an appropriate tool. CARE MUST BE TAKEN NOT TO DAMAGE THE TUBERS. The root hairs are also removed, so that the tubers are left with a smooth surface.

Curing of yams before storage is recommended for healing physical injuries, which may have occurred during harvesting and handling. Curing exposes tubers to high temperatures, 85 - 95 °F (29 - 35°C) and high humidity, (90 - 95%) for 4 - 8 days prior to storage. This process allows for suberization of surface injuries, which reduces subsequent water/weight loss and the incidence of decay by wound pathogens.

Storage

The three main conditions necessary for successful yam storage are aeration, temperature55 - 60 °F(12-15°C) and regular inspection of the produce.

APPENDICES

APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: CASSAVA

	Input	Quantity	Units	Unit Cost	Total Cost
1.	**Planting material**				
	Cassava sticks (if purchased)				
	Fungicide, nutrient, insecticide, fertilizer (specify names used)				
	Shade netting				
	Polythene bags				
	Total cost for planting material				
2.	**Land preparation**				
	Pre planting herbicide, fertilizer (specify names used)				
	Other land preparation costs (e.g. equipment rental)				
	Total cost for land preparation				
3.	**Crop maintenance**				
	Water/irrigation				
	Fertilizer (specify types used)				
	Weed control (specify chemicals etc. used)				
	Pest and disease control (specify chemicals etc. used)				
	Total cost for crop maintenance				
4.	**Harvest/storage**				
	Materials (e.g. storage containers etc.)				
	Estimate any utility costs				
	Transport to market				
	Total cost for harvest/storage				
5.	**Labour**				
	Planting material				
	Land preparation				
	Crop maintenance				

APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: YAM

	Input	Quantity	Units	Unit Cost	Total Cost
	Harvest/storage				
	Total cost for labour				
6.	Rent/insurance				
7.	Miscelleneous costs				
	Total cost of production				

Notes

- It is recommended that the above data be completed on a per crop basis.
- The cost of any fixed structures should be considered. For example if an irrigation system is solely used for tannia in the year and is expected to last for 10 years, then one tenth of the cost of the equipment should be added at item 7. If, however, irrigation for other crops is also provided then this also needs to be considered. If tannia accounts for half the irrigation in a year, then the annual cost calculated as above needs to be divided by 2. Similar considerations should be given to the cost of any refrigerator if the crop is stored at a low temperature.
- The revenue obtained from sale of the crop should be compared with the cost of production to determine the profit/loss on the operation.

APPENDIX II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES

INSECTICIDES	APPLICATION RATE
Pronto 35 SC	3 - 5 teaspoons/gallon of water
Target	1 - 2 teaspoons/gallon of water
Pirate	½ - 1 teaspoons/gallon of water
Fastac	1 - 2 teaspoons/gallon of water
Caprid	½ - 1 teaspoon/gallon of water
Diazinon (Basudin)	¾ - 1½ pints/acre
Admiral	¼ teaspoon/gallon of water
Dipel	1½ - 2 teaspoons/gallon of water
Aza-direct	1 - 2 teaspoons/gallon of water
Cure	½ - 1 teaspoon/gallon of water
Danitol	1 - 2 teaspoons/gallon of water
Cypro	½ tablespoon/gallon of water
Dimethoate (Perfecthion, Rogor 40)	1 pint/acre
Phosvel	1¼ - 2 pints/acre
Orthene	3.2 ounces/acre
Permethrin (Ambush)	½ teaspoon/gallon of water
Padan 50 WSP	2 - 3 teaspoons/gallon of water
Lannate	1 teaspoon/gallon of water
Decis	½ teaspoon/gallon of water
Kelthane 42%	1¼ lb/acre
Orthene 75S	1 lb/acre
Malathion	½ - 1 pint/acre
Sevin	1½ lb/acre
BT(*Bacillus thruingiensis*)	Label rates
Rotenone	1 - 2 teaspoons/gallon of water
Neem X.	8 - 10 oz/gallon of water
FUNGICIDES	**APPLICATION RATE**
Bellis	2 teaspoon/gallon of water
Acrobat	2 - 4 teaspoon/gallon of water
Mancozeb (Dithane M45)	1.5 lb/acre
Cabendazim	2 teaspoon/gallon of water
Daconil	1½ - 2 pints/acre
Benomyl (Benlate)	6 oz/acre
Captan	2 - 3 teaspoons/gallon of water
Peltar	3 teaspoons/gallon of water
Manzate DF	2 - 4 teaspoons/gallon of water

Bravo	1½ - 2 pints/acre
Tri-Miltox-Forte	3 teaspoons/gallon of water
Botrilex	5 - 200 lbs/acre
Kocide 101	2 - 4 teaspoons/gallon of water
Cupravit	2½ lb/acre
WEEDICIDES	**APPLICATION RATE**
DCPA (Dacthal W-75)	10 lb/acre¬¬¬
Diphenamide	4 - 10 lb/acre
Paraquat (Gramoxone)	1 - 2 pints/acre
Dymid 80W	5 lb/acre
Atrazine 80 (Gesaprim).	1¼ - 1½ lb/acre
Linuron (Lorox)	1 pint/acre
Prometryn (Caparol)	0.8 - 1.6 lb/acre
Sethoxydim (Poast)	1¼ - 3½ lb/acre
Clethodim (Select)	0.094 - 0.25 lb/acre
Prometryn 50WP (Geagard)	2 - 3 lb/acre
Herbicidal Oil (Stoddard Solvent, Kerosene oil)	40 - 80 gallons/acre

APPENDIX III: GOOD AGRICULTURAL PRACTICES DATA RECORD SHEET

Grower name:							
*Name of applicator	Date	Brand and product name	Rate	Size of area/no. of plants treated	Total application (amount of the product used)	Notes/target pest	Start/finish time

*The applicator should be trained or, if not, supervised by a trained or certified person. Proof of training required.