CASSAVA

Production, Processing and Utilization in Nigeria

EXTENSION BULLETIN No 224

CASSAVA

Production, Processing and utilization

An

Extension Bulletin No. 224

Sponsored

By

WAAPP - Nigeria
Agricultural Transformation Agenda
Federal Ministry of Agriculture and Rural Development

Produced and Distributed by
National Agricultural Extension and Research Liaison Services
(NAERLS),
Ahmadu Bello University Zaria

ACKNOWLEDGEMENT

The authors are grateful to the Executive Director and his management team as well as the Chairman and members of the Task Force of NAERLS Extension Publications for their assistance towards this publication.

Special thanks also goes to the Minister of Agriculture and the Federal Ministry of Agriculture and Rural Development for their kind assistance towards the publication of this extension bulletin.

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TABLE OF CONTENT

Content **Page**

TABLE

PLATE

FIGURE

Introduction

Cassava (Manihot spp) is a dicotyledonous plant belonging to the family Euphobiaceae. Cassava is a root crop unlike yam (Diosiorca spp) that is a tuber crop. It is native to Central America. Cassava was introduced to West Africa by Portuguese explorers in the 16th and 17th centuries. In Nigeria, it was introduced at Warri, Yenagoa, Calabar and Owerri about the same time.

It is an important food staple and industrial crop in Nigeria. Cassava is also important as a major source of income for rural households. Nigeria is currently the largest producer of cassava in the world with an annual production of over 54tons from an estimated land area of 1.4 million hectares.

The crop's production generally requires less labour per unit of output than other major staple crops in Nigeria. It can grow and give reasonable yields in relatively poor soil and low rainfall areas. Owing to these attributes it has become a critical food security crop in Nigeria.

Cassava has underground roots that are consumed by man after processing. A few varieties exist that can be eaten raw. The root is also rich in carbohydrates and readily fed to livestock's. In recent times, government has encouraged the processing of the crop into a wide range of industrial products such as ethanol, glue, poultry feed, glucose syrup and bread. The demands for these products are on the increase and Government's interest in cassava research is also increasing with strong emphasis on increased productivity and diversification of uses.

Average yield of 5-9t/ha in farmers' field indicates that the crop is poorly managed as both demonstrated potential and experimental yields are 400% and 250% respectively above farmers' yields. These could be attributed to inadequate information that accrues from use of low yielding planting materials, pest and diseases and poor farming practices by farmers. The purpose of this bulletin is to highlight recommendations from research for high cassava yield, efficient processing and utilization in Nigeria.

SITE SELECTION

Cassava tolerates poor soils usually unsuitable for most other crop like maize. It produces some yield even when abandoned without adequate management. For high yield of tubers, cassava requires well-drained and deep soil that is not stony or gravelly. It can also thrive in poor soils (marginal soils).

PRODUCTION

Production Inputs

The essential materials needed for optimum production of cassava include;

- Land
- Planting material (cassava stem cuttings) of appropriate varieties
- Capital
- Labour
- Agro-chemicals e.g herbicides, inorganic and organic fertilizers
- Farm tools e.g hoe, cutlass, knife, or saw, plough, harrow, ridger, tractor, and wheelbarrow.
- Technical know-how (Technology)

Processing Inputs

These are tools used for processing cassava tubers into various forms for utilization. These include;

- Material e.g knives and machines (where available)
- Washing equipments (bowls and machines where available)
- Graters (manual or machines)
- Dewatering facilities – sticks or machines (manual or mechanical (where available)
- Toasters-manual or mechanical (where available)

Transportation Inputs

- Lorries, trucks, rail, marine transportation, donkeys etc
- Motorcycles, bicycle etc

- Wheel barrows

Marketing Inputs

These are materials used for distributing and marketing cassava products, namely;

- Stores
- Bags
- Basins
- Markets (buyers and sellers)
- Consumers

Land Preparation

Good production requires good land preparations which depend on:

- Climate
- Soil type
- Vegetation
- Topography
- Good management practices

Traditionally after clearing the forest in rainforest ecological zone of Nigeria, no land preparation is required other than the removal of shrubs vines, and cutting off branches of large trees to admit sunlight. As soon as the rain is established, farmers loosen the soil with a hoe, planting stick, or sharp instrument before placing the cassava cuttings and cover back with soil.

Good seed bed preparation is necessary in cassava production.

In the west, south and eastern agro-ecological zones land preparation is carried out between March to early May while in the Northern part it is done in early June to July.

Before planting the land is cleared, raked and do controlled burning of the trashes if the trash is too much to be handled or spray with herbicide if it is mainly grass vegetation. Alternatively, after bush clearing and burning, farmers usually practice stumping in the forest vegetation.

After creating a good soil environment, the land is prepared into;

- Ridges and mounds up to 30 - 60 cm high
- Deep plough to soil depth (25 – 30cm).

- Harrow to fine tilt
- Make 1 meter ridges
- Make tied mounds in a straight line.
- Flat with loosening of the spots with hoe, cutlass or spade

Ridging or mounding is essential in soils which are hard, shallow or poorly drained. Ridging facilitates root penetration, root development and farm operations like fertilizer application and weeding as well as harvesting (Fig. 1).

Making ridges or mounds across the slope and in valleys bottom help to control water logging and erosion since ridges and mounds are usually higher than both the permanent and temporary water fables.

Fig. 1. Land prepared in ridges

Recommended Cassava Varieties

Use of poor yielding varieties has been a major factor contributing to the low yields in farmers' fields. Varieties have been bred and selected based on outstanding attributes like root yield, pests and diseases resistance/tolerance, high dry matter and food quality. The following cassava varieties and their characteristics are presented in Tables 1a and 1b

Table 1a. VARIETIES OF CASSAVA AND THEIR CHARACTERISTICS

Cassava variety	Branching habit	Canopy development	Ecological adaptation	Pests & disease resistance	Fresh Root Yield	Dry Matter Yield 80(cm)	Gari Yield (%)	Starch Yield (%)	Hcn in Products (mg/100g)
TMS 90257	Profuse	Moderate	Wide	High	43	25	23	23	15.5
TMS 84537	Moderate	Sparse	Wide	High	35	28	18	27	6.3
TMS 82/00056	Profuse	Moderate	Wide	High	35	28	21	26	6.4
TMS 82/00661	Profuse	Moderate	Wide	High	39	30	22	26	4.1
NR 8212	Profuse	Moderate	Wide	High	27	37	25	21	High
NR 8082	Profuse	Profuse	Wide	High	32	32	22	19	High
TMS 50395	Moderate	Moderate	Wide	Moderate	36	29	24	12	High
TMS 3001	Moderate	Moderate	Wide	Moderate	16	28	23	22	Low
NR 8208	Profuse	Moderate	Wide	Moderate	26	32	25	23	High
NR 8083	Profuse	Moderate	Wide	High	31	43	36	25	High
TMS 81/00110	Profuse	Moderate	Wide	High	28	31	24	25	4.5
TMS 91934	Moderate	Sparse	Wide	Moderate	32	34	26	21	High
TMS 30572	Profuse	Profuse	Wide	Moderate	27	34	25	24	750
TMS 4(2)1425	Moderate	Profuse	Savanna	Moderate	26	36	25	22	31
TMS 30555	Moderate	Profuse	Wide	Moderate	17	32	24	20	High
NR 83107	Profuse	Moderate	Wide	High	22	31	22	19	High
NR 41044	Moderate	Profuse	Forest	Moderate	37	34	25	23	High

Source: FMANR (1997)

Table 1b. New Cassava Varieties

CASSAVA VARIETY	PEDIGREE	DAYS OF MATURITY	POTENTIAL POST YIELD	PLANT	HEIGHT BRANCHES
TME 419	Gbase koute op	12	35.2 t/ha	Tall (3-4m)	Not appreciable
TMS 97/2205	TMS 30 572 x TME 6	12	31.8 t/ha	Moderate in height (about 2m)	Low (about 0.5m)
TMS 98/0505	9+DTP REP 2 bulk	12	45.5 t/ha	Moderate in height (about 2m)	Low (about 0.5m)
TMS 98/0510	97 DTP REP 2 bulk	12	37.5 t/ha	Moderate in height (about 2.5m)	Moderately high (about 1.2m)
TMS 98/0581	MPR POP 1 bulk	12	47.3 t/ha	Tall (about 3m)	0.5-1.0m
TMS 92/0057	(TMS 30555 X TME 1) HS	12	30.7T/Ha	Tall (2-3m)	Low (1.0-1.3m)
TMS 92/0326	(PMS 91934 X TME 1)HS	10-12	39.5 t/ha	Tall (2-3m)	Low (0.7-2.6m)
TMS 96/1632	TMS 94/0325 X TME 7	12	43.2 t/ha	Tall (about 3m)	High (about 1.5m)
TMS 98/002	97 DTP REP 1	10-12	48.4 t/ha	Moderate in height (2m)	Low (about 0.5m)
NR 87184	83 DTP REP 1	10-12	34.6 t/ha	Tall about (3m)	Low (0.1-1.1m)
Pro-Vit A	Umucass' eries	8-12	35.4 t/ha	Moderate in height (about 2.5m)	

Source NRCRI (2000)

Climate and Soil Requirement

Cassava requires a temperature of 21ºC-35ºC, rainfall of 150-200 cm, a well-drained, rich, friable, loamy soil. It can also grow in poor soil.

Planting Materials

Cassava can flower and also produce seeds but the seeds are not currently being used for planting. It is the stem-called cuttings that are planted. The use of cutting is sometimes regarded as vegetative propagation of cassava. The seeds of cassava are mainly being used to breed new varieties. Ensure that you select the variety suitable to your location which also has the desired attributes. The quality and yield of cassava depends on the quality of the sticks or cuttings and variety planted, the management practice adopted and the locality where it has been planted. It is advised that cuttings should be obtained from reliable source.

Cassava stem or cutting quality depends on:-

- Age of stem:- The best cuttings for planting are obtained from plants 6 – 12 months old.
- Thickness:- Recommended pith diameter is equal to or less than 50% of the stem.
- Health of Stems:- Ensure that stems are healthy and good sprouting and establishment.
- Number of Nodes:-Cut stem such that each cutting has about 5 – 7 nodes.
- Stem Portion:- Middle portions establish better than the tips and basal portions.
- Stem Storage:- Store cassava stems under shade for 4- 10 days before cutting and planting. This processes makes stem sprout faster than if planted immediately when freshly cut from the field.

Planting Date

The best time to plant cassava has been established for the various ecological zone at the on-set of the first rains of the year and it depends on the cropping systems. However, cassava is planted between March and October in all the agro-ecological zones. Except Northern zones of Nigeria, planting is done between May and July to ensure that cuttings are well established before the on-set of dry season. These covers the period usually described as the rainy season

in all zones. It is however known that in the tropical rainforest zone, cassava can be grown all year round. The determining factor is the availability of water. Even in the drier savanna, cassava can be grown all year round using irrigation. Although cassava is drought resistant/tolerant and can withstand 6 months of drought after establishment.

Method of Planting

Planting of cassava cuttings could be vertical, slanting (at an angle) or horizontal (Fig. 2). Vertically planting of cassava cuttings is not recommended as this method encourage drying of cuttings and usually has poor root development and establishment. The best recommended method is slanting or horizontal. By this method $^{2}/_{3}$ of cuttings are buried and planted at inclined angle of about 45^{0} and ensure that the buds point upwards from where the stem sprouts. While in horizontal method all the cuttings are buried and covered with soil which always give rise to more than two sprouting. Where it becomes necessary to plant later than the recommended time and to eliminate dipping stakes in insecticides against cassava mealy bug (CMB) and cassava green spider mite (CGM), bury the cuttings completely in the soil (horizontally) at a depth of about 5 cm. Deep planting makes harvesting difficult and increases production costs. In dry sandy soils plant cassava cuttings deep; in moist and heavy soils, plant shallow.

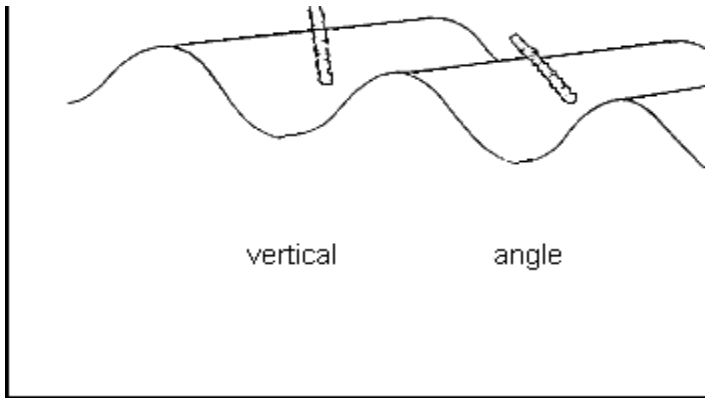

Fig. 2. Planting methods
Source: IITA

Spacing
Cassava cuttings are planted at 1m x 1m spacing either on flats, ridges or mounds. Due to erect (none branching) property of some variety like. TME 419 spacing can be as close as 100cm x 75cm apart to give a higher plant population/ha.

Seed Rate and Plant Population
It is recommended to plant cassava stems one meter apart with 50 stems of 1 m each of 50 bundles of stem cuttings per ha. This gives a plant population of 10,000 stands per hectare. This spacing is convenient and practicable both for mechanization and inter-cropping.

Cropping Pattern
Cassava can be grown as a sole crop. It can also be grown (intercropped) with principal staples, such as yam, cocoyam, sweet potato, maize, melon, cowpea, soybean and plantain. Cassava can also be grown with permanent crops like oil palm, rubber, cashew and cocoa within the first few years of the establishment before their canopies cover and the permanent crops fully take over.

Weed Management
Cassava yield is usually reduced by delay of weed control. Slow initial growth and development make the cassava very susceptible to weed interference during the first 3-4 months after planting. Uncontrolled weed growth in cassava reduces the yield by 80 % /ha loss which could result to a monetary loss of up to ₦30,000.00. Weeds must be controlled during the first 8 – 12 weeks from planting. This period is referred to as "the critical period of weed interference".
Any of or combination of the following methods can be used to control weeds in cassava.

- Cultural method
- Biological method
- Genetic method
- Chemical method

- Integrated method

Cultural Method
This involves using of Hoe or any local tools as well as hand pulling to control weed and is very effective in a small farms. It is done at 4, 8 and 12 weeks after planting. After this period, the canopies of the cassava have fully developed and covered the ground to smother the weeds. Slashing may be done if necessary before harvesting.

Biological Method
This method makes use of "in situ" live mulch in the form of cover crop. By this way, cover crops such as egusi, cowpea, sweet potato, mucuna, groundnut and soybean grown during the season prior to cassava cultivation help to suppress weeds. Cassava cuttings can be planted directly into the mulch cover with little or no land clearing.
Appropriate inter crops can significantly reduce weeding frequencies and weed intensity. Intercropping with leguminous species (cowpea, groundnut and soybean) has the additional benefits of soil improvement and fixing of nitrogen in the soil.

Genetic Method
Use of Early-Branching Varieties:-
Early-branching varieties develop canopies which reduce weed growth when:

- Sprouts are vigorous,
- Crops are weed free in the first 3-4 months due to short growth with good canopy from the branches
- Plant density is higher than 10,000 plants/ha
- Plants are free from disease and pests due to high genetic make up.
- Environment and soil fertility are favourable.

Weed competition reduces branches, canopy and root development as well as overall crop yield. Yield reduction varies from 40% in early-branching cultivars to 70% in late or non-branching cultivars. When canopies do not provide sufficient cover, weed problems become

severe. Weeds also can habour disease organisms and pests that predispose the crop to subsequent infections. Weeds like Imperatacylindrica (spear grass) not only compete for resources, but also pierce cassava roots and create entry points for rot-causing pathogen.

The early branching varieties effectively suppress early weed growth at the time when the cassava plant is vulnerable to weed competition during the first 3-4 months of crop growth due to good canopy produced from the branches.

Chemical Method

Several pre-emergency herbicides have been identified for weed control in sole cassava farms.

- Fluometuron at 2.0 kg ai/ha
- Diuron at 3.0 kg ai/ha
- Chloramben at 1.5-3kg ai/ha (as the case may be).
- Formulated mixture of flumeturon + metolachlor (2 + 2 kg/ha)
- Metobromuron and metolachlor (2 + 2 kg/ha)
- Fluometuron and Pendimethalin (2 + 2 kg/ha)
- Primextra (Pre-mix of Atrazine + Metolachlor (2 – 3 kg/ha)

The following pre-emergence herbicides can equally be used in mixed cassava plots

- Diorun + Paraquat at 4-5 l/ha
- Pumetra at 4-5 l/ha

Herbicides are most effective when applied before weed emergence in the field. When planting or weed control is delayed such that weeds become visible, mix post-mergence herbicide with a systemic herbicide such as Glyphosate. By this way, the contact herbicide will take care of the already emerged weeds.

Herbicides are cost effective when available in appropriate quantities, and when cassava fields are too large to be weeded by hand (manual).

Integrated Weed Management

This is the control of weeds through a long-term management approach, using a combination of weed management techniques such as physical control, chemical control, biochemical control or cultural control. This method reduces the chances of weed species being adapted to a particular control technique, which is likely to occur if only one technique is used. For an example, if a herbicide is used over a long period of time, a weed species can build up a resistance to the chemical. Examples of integrated weed management include;

- Combining one hand weeding with the use of an improved variety, planted at optimum density.
- Combining a pre-emergence herbicide with late weeding.

Fertilizer and Fertilizer Application

Cassava has an extensive root system and uses plant nutrients which are not easily accessible to other crops. In traditional farming, farmers can obtain yields of up to 5.6t/ha without fertilizer on soil that would not support other crops.

Any compound fertilizer – NPK 15:15:15, 20:10:10; 25:10:10, 27:13:13 or any other planting. Applying ring form around the cassava stands. One match box full of fertilizer is enough for one stand of cassava. One level of standard (normal) peak milk container is enough for five stands of cassava and these are equivalent to 400kg/ha of NPK (15:15:15 or 10:10:20 (8 bags) which is ideal or recommended for a normal/standard soil. However, for good yield of roots from a fairly rich soil, Table 1 shows the number of bags/ha of various compound fertilizers per hectare.

Table 2. Compound Fertilizer for Cassava (bags/ha)

	FERTILIZERS (NPK)			
	15:15:15	20:10:10	25:10:10	27:13:13
Bags/ha	12	9	7	6 ½ = 6½

Two or three tons per hectare of poultry, cattle manure can also be applied for good yield of cassava roots in the absence or combination of chemical fertilizer.

For good growth and yields, cassava requires friable, light textured and well drained soils containing sufficient moisture and a balanced amount of plant nutrients. However, farmers can produce up to 1.4 – 7.4 t/ha across all the agro-ecological zones in Nigeria and research has shown that yields of 40-60 t/ha are possible.

Pests and Diseases

Pest of Cassava:- Cassava is affected by a number of pests. These include:-

* **Variegated grasshopper:-**

This causes complete defoliation of the cassava plant by eating up the leaves and young stems at adult and nymph stages of the insect life.

Regular weeding and hand picking are among the control measures. (Plate 1). Spraying the crop and the surrounding bush with 30ml (6 tea spoonful) (2 gallons) of water as soon as the first nymphs are observed towards the end of September provided effective control. For very effective and total control, get surrounding farmers to do same.

* **Vertebrate Pests:-**

Rats, grasscutters (can rat) and bush fowls dig up and eat cassava roots.

Control:-

- ♦ Keep the farm and surroundings weed free
- ♦ Trapping
- ♦ Shooting with gun
- ♦ Wire fencing round the farm (where practicable).

* **White Ants and Termites:-**

Dip cassava stem cuttings in a solution of chloropyrifos insecticides for 5 minutes at the rate of 2 mls to 1ltre of water and allow to dry before planting.

- ♦ This "seed" treatment will also control cassava mealy bug, green spider mite and millipedes.

Destroy ant hills. Spray the destroyed ant hills with Agrothion (Fenitrothion) 20 at the rate of 40 ml/4.5 litres of water and 9 litres/ant hill.

- ♦ **Green Spider Mite (GSM)**

These cause damages to the leaves thereby reducing the photosynthctic ability of the plant resulting in eventual yield reduction. They (spider mites) can also act as vectors for transferring diseases from on plant to another. Isolated cases can be treated by spraying with 0.1% (1 table spoonful/4.5 litres of water) solution of Perfekthion 40 or Rogir 40. Where the cassava is young (less than four (4) months old and at the on set of dry season, treat with foliar spicy of 0.1% (1 tablespoonful/4.5 litre of water) solution of the following chemicals:-

- ♦ Supracide for Ultracide; Rogor or Perfekthion (Diamethoate); Diazinon or Dasudin; Azodrin or Nuvacron (monocrotophos).

Start spraying as soon as the symptons are noticed. Repeat 4 times at 2 weekly intervals.

Diseases

Cassava is known to be attacked by more than 30 diseases, but the following are the important cassava diseases in Nigeria:-

a) African Cassava Mosaic Disease (ACMD):-

This disease is caused by virus which is transmitted by a piercing and sucking insect known as white flies.

Symptoms:- The symptoms include vein cleaning, distortion of the leaves and stunted growth of the plants.

Control:-

- Grow resistant varieties
- Uproot and burn infected plants

- Use diseases free planting materials

b). Bacterial Blight:- It is caused by bacteria which are transmitted when infected cuttings are used

Symptoms:- These include; angular and water soaked area of discoloured leaf tissue, blighting, wilting and general reduction in yield.

Control:-

- Use resistant varieties
- Use clean and disease from stem cutting.

c) Leaf Spot:- It is caused by a fungus

Symptoms:- This includes spots which produce pale, brownish colour on affected leaves.

Control:-

- Spray with fungicide e.g Bordeaux mixture, Benlate (Benomyl), Dithane m45 and myloxls

d) Cassava Root Rot Diseases:- These are caused by various kinds of fungi living on or in the soil. The fungi occur mainly in poorly drained soils.

Symptoms:- The leaves on cassava plants affected by root rot diseases turn brown, wilt, and the plant appears scotched. The disease kills both feeder and storage roots of cassava. The affected storage roots have an unusual and develop colouration mainly common in over mature cassava field.

Controls:-

- Use resistant varieties
- Use clean and disease free stem cuttings
- Avoid flooded field
- Avoid late harvesting

Cropping System

Cassava is commonly planted sole, but also intercropped with many other crops. These are various combinations of cassavas base enterprises

The combinations includes:-

- Yam/maize/cassava

- Yam/maize/cassava/okra
- Cassava/maize/egusi
- Maize/cassava/cowpea
- Yam/maize/cassava/plantain

In these intercropping combination systems, cassava is usually planted as last crop due to its longer maturity period than other crops.

Maturity

Cassava is ready for harvest at 9 – 12 months after planting depending on the variety and location (Fig.3). Harvest when the soil is moist so as to minimize damage to the tubers. Cut the stem 30cm above the soil surface and lift roots by pulling the stump gently. Cassava can be harvested both in the raining and dry season, but it is better to harvest when the soil is wet, to avoid damage to the roots, and also to use the stem cutting for new planting. Cassava harvested soon after the drought season loses much starch. Best yields under rain fed are obtained from mature crops after 3 months from the end of dry season.

Fig. 3. Matured plant ready for harvest

Harvesting

Cassava is due for harvesting when tuberous roots have accumulated sufficient amount of starch (Fig. 4). When harvesting is unduely delayed the tubers became woody or fibrous. Time of harvesting depends on;

- Time of planting
- Variety planted
- Climatic and soil factors
- Marketing demand
- Farmers needs

Generally, cassava tubers are harvested manually by hand pulling and digging using hoe, cutlass or spade after cutting of the stems (Fig. 4). For several reasons, it is difficult to harvest all the cassava in a plot because of several factors like spoilage, hence only the quantity required immediately for use should be harvested. Cassava tubers rapidly spoil after harvesting because it does not store well once uprooted.

Mechanical harvesters are available to uproot tuberous roots, which are then picked by hand. Harvesting is easier when the soil is moist and if planting on ridges or in roles in a loose or sandy soils, rather than on flat ground and in clay or heavy soils.

Fig. 4. Harvesting of cassava tubers

Storage of Roots

After harvesting where it cannot be processed immediately cover cassava roots with jute bags and sprinkle water on it to keep moist and store for 2 – 4 days before processing. Cassava roots stored longer than this period does not produced good quality products because there

are black steaks formed inside the roots. This changes the colour of the products.

PROCESSING AND UTILIZATION

Cassava is a very versatile commodity with numerous uses and by products. The roots are generally processed into different food forms for human consumption and industrial uses as well as livestock feed. The stem serves as yam staking and source of fire wood. The leaves are consumed as vegetables in many tropical countries.

Uses and Utilization

Uses and utilization of cassava produce are listed as;

- Gari
- Foofoo
- Flour
- Tapioca
- Cassava chips
- Glucose syrup
- Glue
- Ethanol
- Bread
- Livestock feed
- Starch

Hygiene and Quality Products

Fresh cassava tuber is a high water (moist), low-acid food that is highly susceptible to bacterial and fungal growth. Hygienic practices, especially in the early stages of processing, should therefore ensure minimal contamination. All waste materials from the process should be removed from the site as they are produced to avoid the risk of cross-contamination. Washing should be carried out thoroughly to avoid contamination of the final product with pect, sand and so on.

Formulation must be properly controlled, as too short a period will result in incomplete detoxification and a bland product, while too long a period will give the product a strong sour taste. Both ‘over’ – and ‘under’ – formulation badly affect the texture of the final garri.

If too much liquid is pressed from the grated cassava, the gelatinization of starch during subsequent toasting is affected and the product is whiter. If sufficient liquid is not removed, the formation of granules during toasting is affected and the dough is more likely to form into lumps. The ideal moisture content is 47 – 50% and this is assessed visually by experienced garri producers.

Sieving is important to obtain a high – quality product, free of fibrous contaminants and with similar-sized granules. The granules must be toasted to about 80^0C/175^0F to achieve partial gelatinization of the starch. If lower temperatures are used, the product simply dries and produces a dry white powder. Too high temperatures will cause charring of the product and make it stick to the toasting pan.

Processing Of Cassava

Cassava roots contain 70% (or more) water and therefore cannot store for more than 3-4 days after harvesting. Both the roots and leaves contain cyanide (HCN) and are therefore not eaten without processing except the sweet cassava variety.

Cassava is a reliable food security crop. It is a crop that is extensively used in trade. Cassava processing essentially involves the conversion of the fresh root into other forms acceptable to consumers. There are numerous ways of processing and consuming cassava depending on locality. The successes achieved by increasing yields in cassava production requires to be adequately matched with increasing processing of cassava roots into various food forms since cassava roots are liable to high deterioration.

Cassava processing is a step by step task employed during the conversion of cassava roots into various products. They include:

a. **Sorting/selection of raw material:** Matured and wholesome roots should be selected for processing as this has a direct impact on the product yield and quality.
b. **Peeling:** This eliminates the peel (the inedible portion) which is usually high in fiber and may contain certain anti-nutritional factors.
c. **Washing:** This is aimed at eliminating dirt and other extraneous matter.

d. **Grating:** This unit operation is used for size reduction. It helps to free the moisture, break the cell walls of the crops and initiates enzymes reactions
e. **Chipping:** This unit operation is for size reduction. It makes use of a manual or motorized slicer or chipper. In manual chipping the roots should be thinly sliced to facilitate the drying process.
f. **Drying:** This unit operation is used to reduce the moisture content of the processed crop. The operation is done using solar heat or mechanical dryers such as flash dryer or cabinet drier (Plate B)
g. **Frying:** This provide means of frying the filtered product to gari using oven (Plate C).
h. **Packaging:** In packaging, adequate packaging material is necessary to avoid moisture and extraneous materials uptake from the storage environment (Plate D).
i. **Storage:** Storage rooms should be well ventilated, of low humidity and free from insects and rodents.

Plate A. Cassava grating machine

Plate B. hydraulic press for drying

Plate C. Frying cassava into gari

Plate D. Bagging of gari for storing

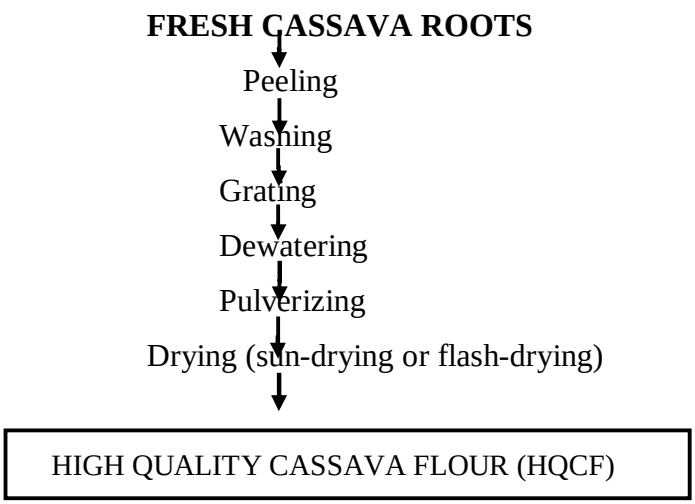

Fig. 5. Flow chart for High Quality Cassava Flour Production (HQCF)

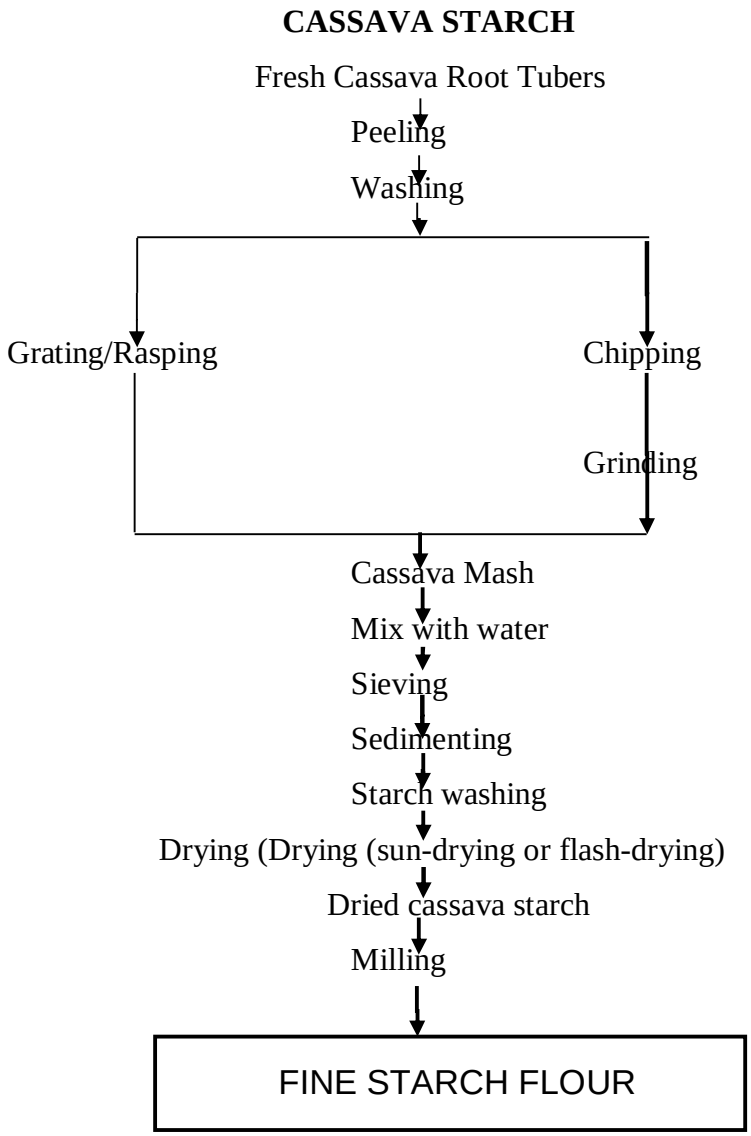

Fig. 6. Flow chart for Starch Production (HQCF)

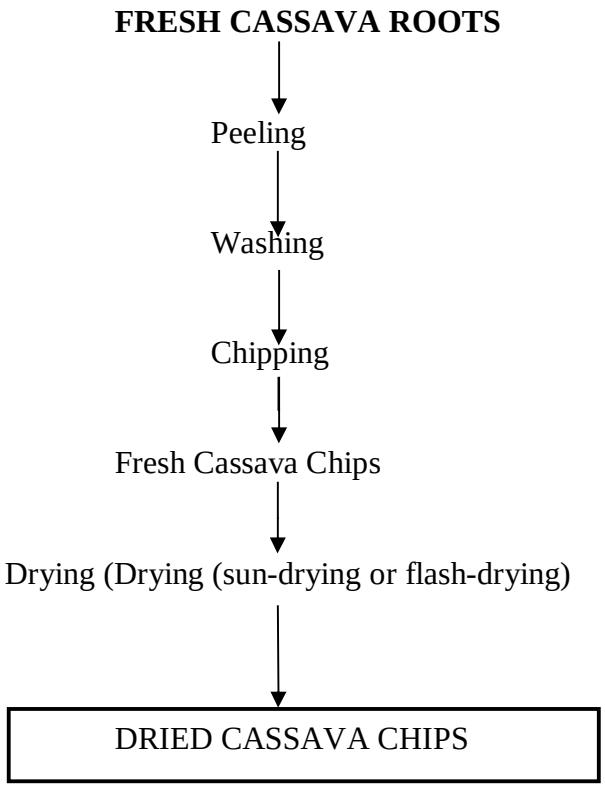

Fig. 7. Flow chart of Cassava Chips Production

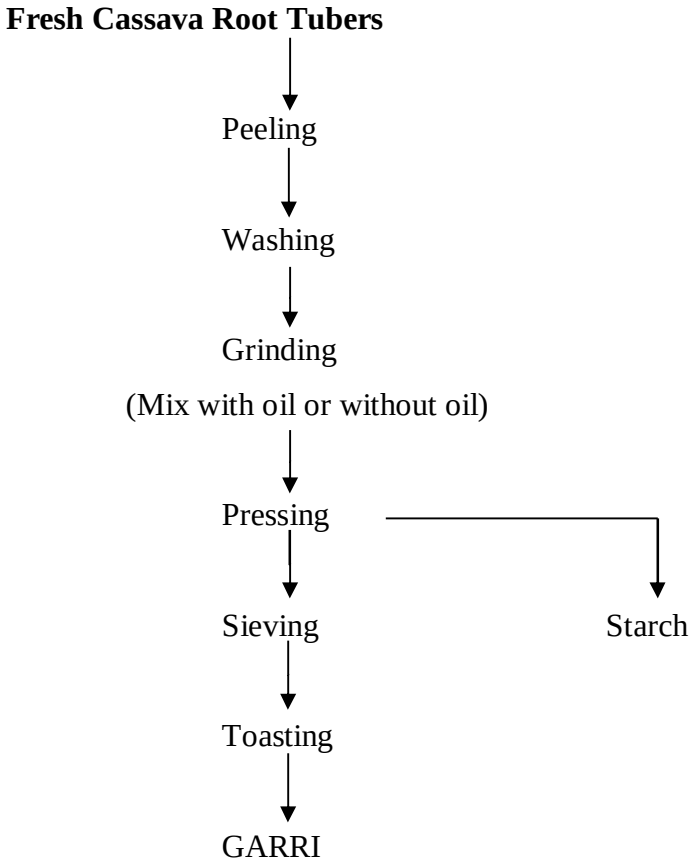

Fig. 8. Flow chart for processing Garri

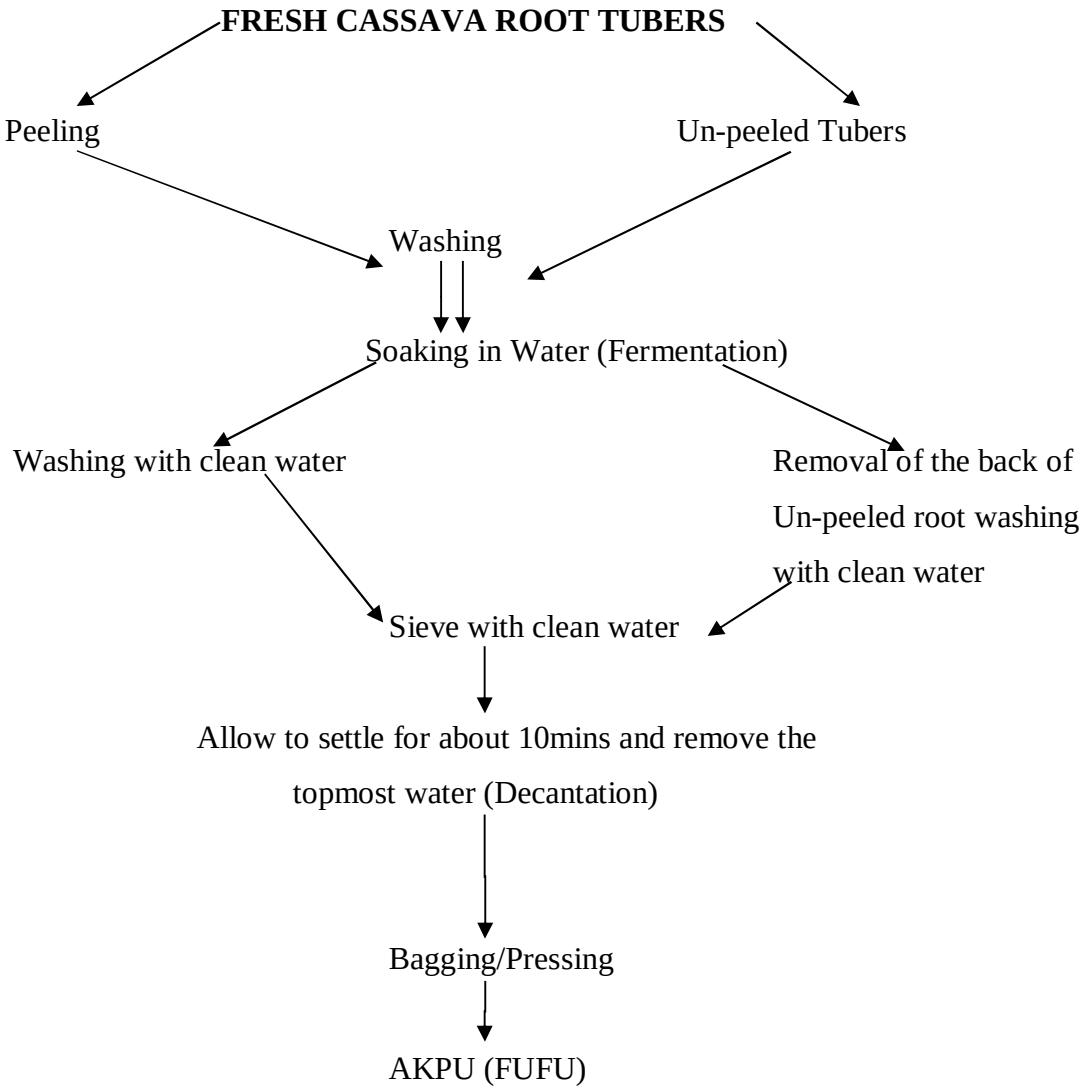

Fig. 9. Flow chart for processing Akpu (Fufu)

CONSTRAINTS IN (TRADITIONAL) CASSAVA PROCESSING:-

A. Environmental Factors:-

- During the raining season, the sunshine and temperature are low for processing and drying in the humid areas.
- In the savannah zone, acute shortage of water hinders cassava processing which usually requires a lot of water.
- The dry matter content is usually lower in the early rainy season than in the dry season therefore resulting in seasonal yield differences.
- During the dry season when the dry matter is highest, the soil is too hard for harvesting resulting in lot of breakages/damages and high labour cost.

B. Varietal Factors:-

The root shapes and sizes resulting from differences in cassava varieties result in differences in harvesting and peeling times.

Irregular shapes result in losses during peeling. Small roots consume more labour during peeling. Differences in dry matter and starch content resulting from different varieties affect quality of processed material. Different cassava varieties have different cyanide contents. Bitter cassava varieties have higher cyanide content than the sweet varieties.

C. Agronomic Factors:-

- Time of planting, harvesting and age of cassava at harvesting affect the starch, root yield and quality of product.

D. Socio Economic Factors:-

- Difficulties in harvesting especially during dry season affect labour availability and cost.
- Transportation difficulties due to lack of good roads and none availability of vehicles result in high transport costs from the farm to the markets or collection centers.
- Lack of processing machines and none availability of spare parts plus high fuel costs affect processing costs.

- Non availability of ready labour due to immigration results in high labour costs in the cassava value chain.

Packaging and Storage

The product is hygroscopic (it absorbs moisture from the air) and should be packed in airtight moisture-proof bags, especially in areas of high humidity, to prevent spoilage due to mould growth.

Channel of Marketing Cassava Produce

This refers to all the linkages or pathways through which cassava produce have to pass through before they get to the final consumers.

The Cassava Value Chain

Fig 10: Represents the cassava value chain. This refers to all the linkages or pathways through which cassava produce have to pass through before they get to the final consumer

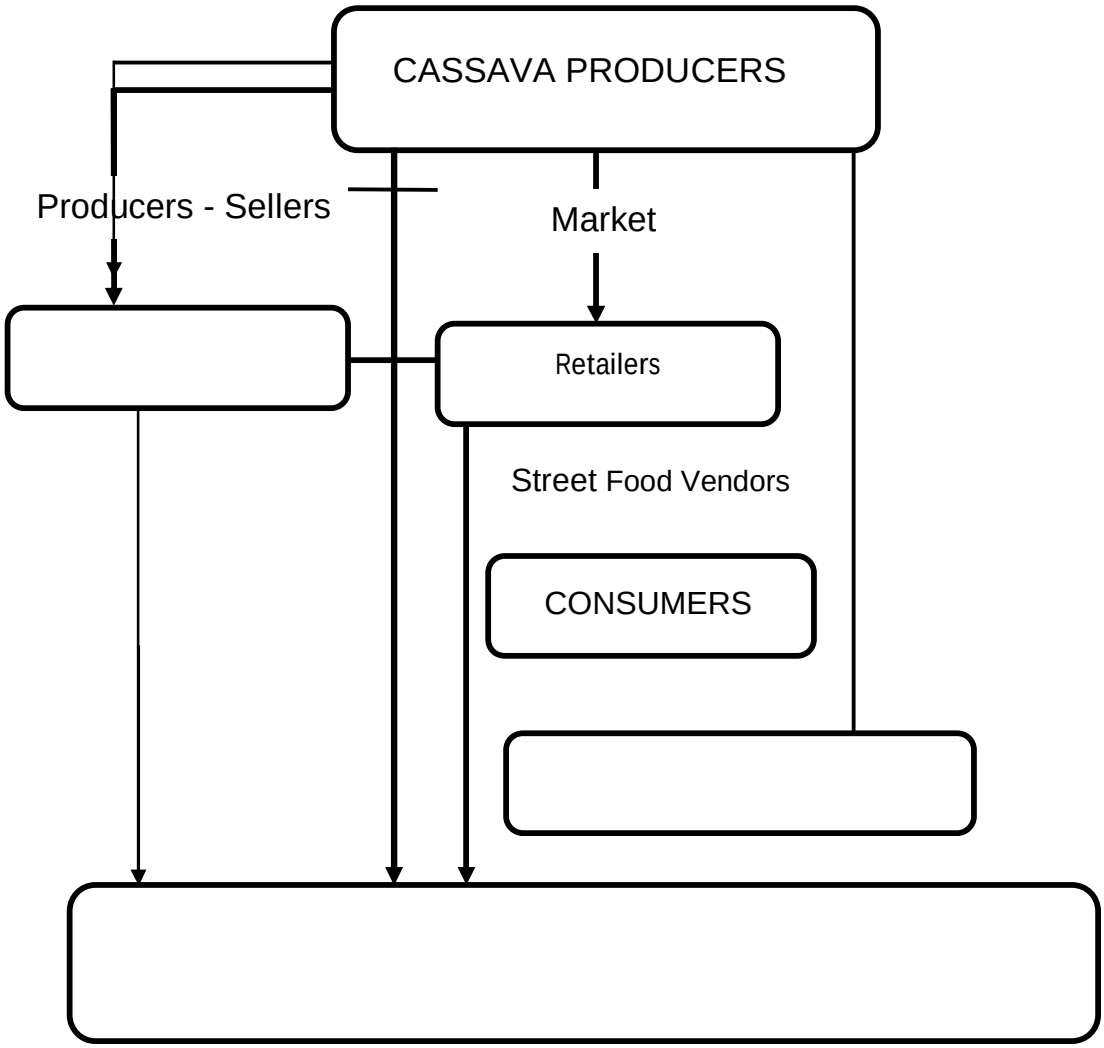

Fig.10. Cassava Value Chain

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