*COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH*

# MID YEAR TECHNICAL REPORT

**(JULY - DECEMBER, 1997)**

# DEVELOPMENT OF A PILOT FUFU FLOUR PRODUCTION PLANT

**BY**

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# Development of a pilot fufu flour production plant

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| Title of Project: | Development of a pilot fufu flour production plant |
| Principal Investigator: | Daniel Blay |
| Collaborating Scientists: | Mrs. Agnes Osei-Yaw (Food Research Institute) |
| Reporting Period: | June to November, 1997 |
| Money released with dates: | ¢2,200,000.00 (May, 1997) |
| | ¢5,300,000.00 (July, 1997) |

## ABSTRACT

The need to conduct techno-economic studies which is a prerequisite for investment decision has resulted in this project to develop a pilot fufu flour production plant. Part of the production plant already available at the Food Research Institute before the inception of the project include a hot air dryer, a disintegrator, a Y-cone blender, a weighing machine and a heat sealer at the Okponglo premises and wet starch production plant at the Pokuase premises. Machines and equipment needed to compliment the existing units of the plant include a peeling/washing bench, a pressure cooker with hoist system, trolleys for receptacles and holding tanks and a hammer mill. The designs of the additional units of the plant which were based on the capacity of the hot air cabinet dryer are completed and the final engineering drawings are 70% complete. Three mobile holding tanks and one trolley for the receptacles have been constructed. The

construction of the peeling/washing bench and the pressure cooker with the hoist system are 80% and 90% complete respectively. Some of the existing units of the plant have been rehabilitated and reconditioned. These include the control panel of the hot air dryer and the Y-cone blender. Additional developments made to some of the existing units include the construction of one hundred (100) aluminium perforated trays to replace the aluminium wire netting used and a permanent metal stand for the control panel of the Y-cone blender.

It is expected that the plant will be ready for trials and the techno-economic studies by March, 1998.

## OBJECTIVES OF PROJECT & EXPECTED OUTPUT/RESULTS

The objectives of the project are:

1. To develop a pilot fufu flour production plant.
2. To develop a method of operation of the plant to achieve optimum output.
3. To obtain data on the operating parameters of the plant.
4. To determine the production capacity of the plant.
5. To undertake techno-economic studies to establish its technical feasibility and economic viability in order to assist entrepreneurs/investors in decision making.

Expected results will include the availability of a pilot fufu flour production plant with complete engineering drawings, operational manuals, technical specifications of the plant, data on the operating parameters and economic indicators on its operations.

## METHODOLOGY

### Plant Design

The designs of the additional units of the pilot plant were based on the production capacity of the hot air cabinet dryer which is a batch type and constitute the limiting

factor to the production. The designs also took into considerations the various unit operations involved in the production of the flour and the effect of their respective levels of mechanization and or automation on the operation of the batch dryer.

## Plant description

The plant consists of a peeling/washing bench, a pressure cooker with a hoist system, a disintegrator (optional), mobile holding tanks and receptacles, hot air cabinet dryer, a hammer mill or attrition mill, a Y-cone blender, a bagging machine, a heat sealer and starch/cassava flour production unit. Schematic diagram of the plant is presented in figure 1.

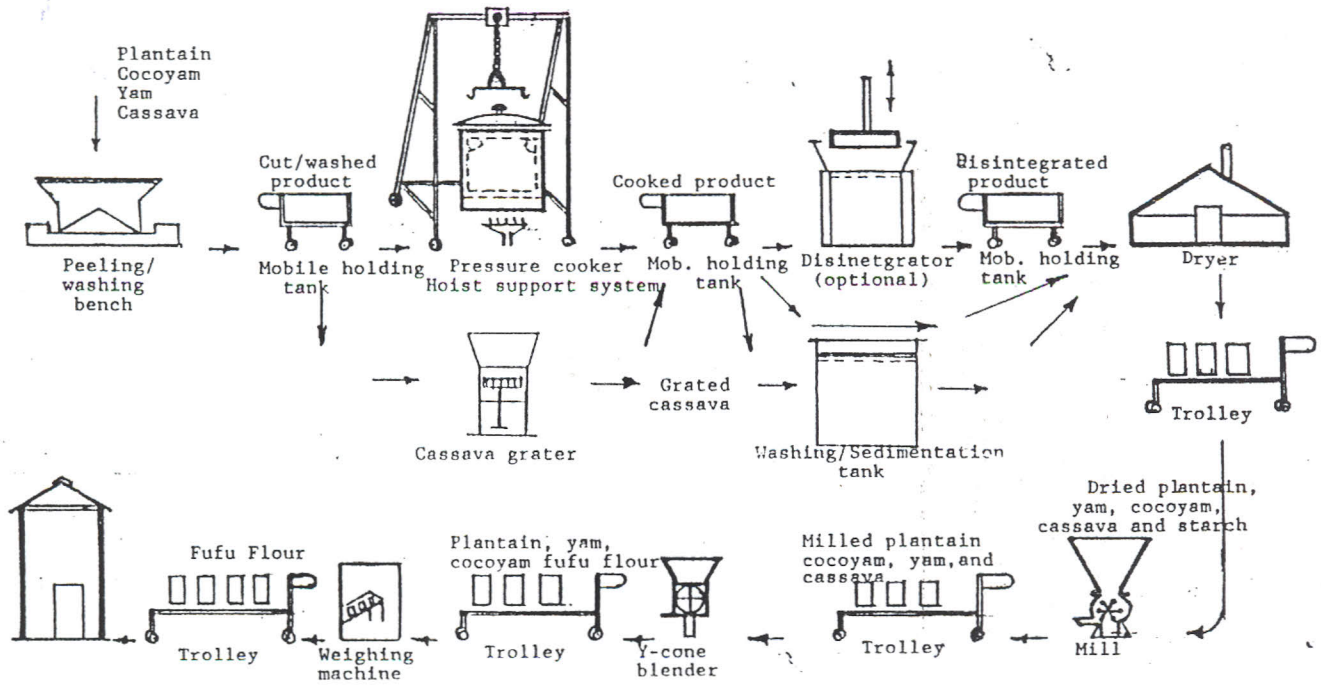


FIGURE 1: Schematic diagram of the pilot fufu flour production plant.

## Peeling/washing bench

The peeling/washing bench presented in figure 2 is designed to accommodate eight (8) persons (peelers). It consists of a wooden square-shaped central hopper E, a wooden base inclined at 30° to the horizontal from the centre to the four (4)

gutters D, at the sides, four (4) peel collectors C, made from 1mm thick mild steel plate, four (4) plastic wash basins F, and eight (8) seats B. Raw materials which are fed into the hopper flow into the gutters where they are picked and peeled. The

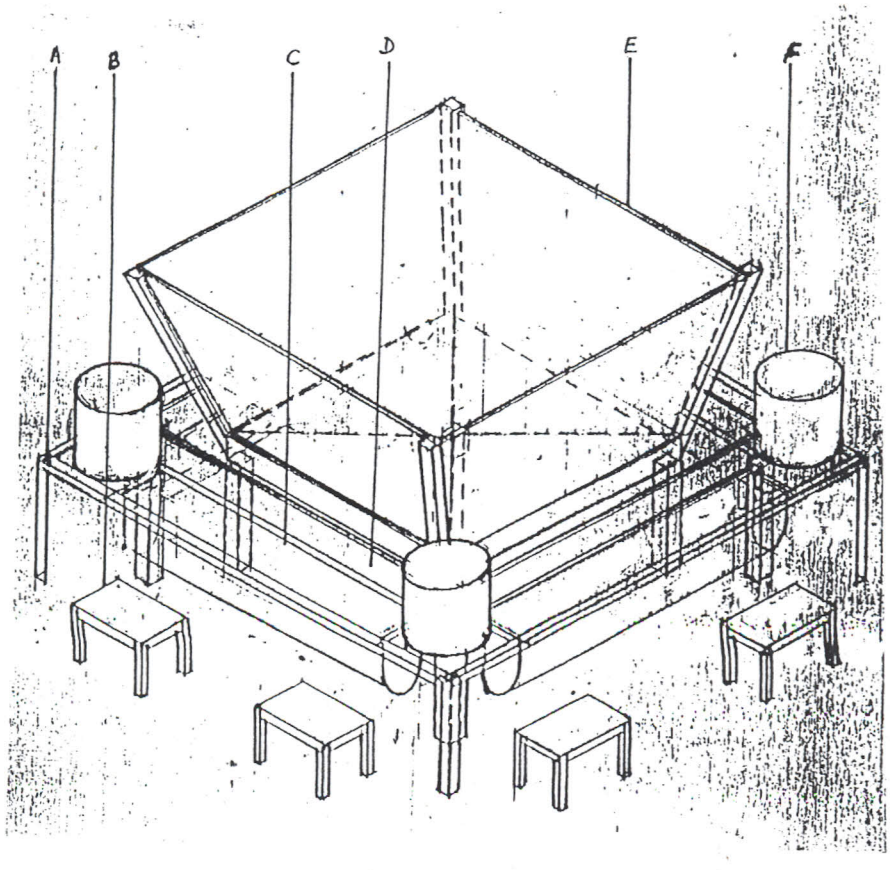


FIGURE 2

Peeling/washing bench: A, main metallic frame; B, seat for peelers (8No.); C, peels container (4No.); D, gutter; E, hopper (4No.); F, wash basin (4No.).

peels are gathered in the peel collectors and the peeled materials are put into the wash basin to be washed. Two peelers at the same side of the bench dispose the peels into the peel collector infront of them whilst one peeler from a side of the bench shares wash basin with a peeler from the adjacent side.

## Mobile Holding Tank

The mobile holding tank consists of a 40 mm x 40 mm mild steel square pipe frame A, on four (4) high tensile plastic casters B, two of which are directional and

a 65 litre - plastic container C, as shown in figure 3. Each one of the three mobile holding tanks is used for the following jobs:

1. To transport materials from the peeling/washing bench to the cooking vessel.
2. To transport cooked products from the cooking vessel to the disintegrator.
3. To transport disintegrated materials to the dryer.

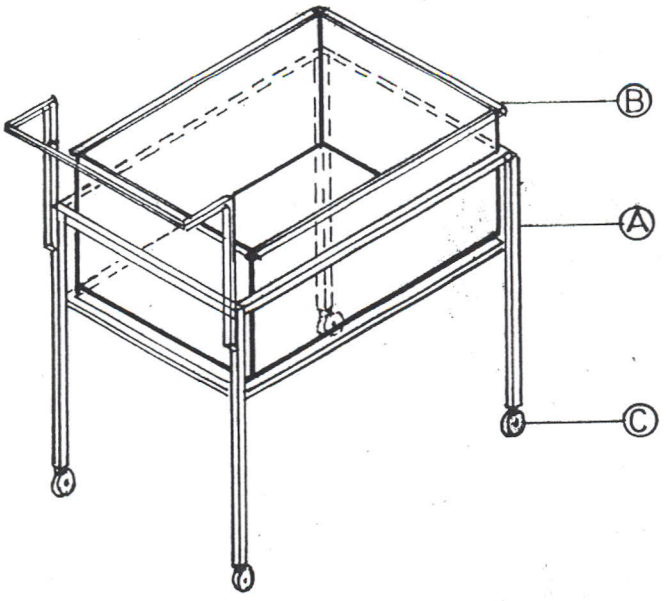


FIGURE 3

Mobile holding tank: A, square pipe frame; B, casters (4No.); C, plastic container.

## Trolley

The general purpose trolley presented in figure 4 is capable of accommodating six (6) 65 litre - plastic containers C, at one level. Its main structure which sits on four (4) metal casters B, two of which are directional, is made from 50 mm x 50 mm mild steel angular steel A, 40 mm x 40 mm mild steel square pipe D, and 50 mm thick hard wood boards E. The trolley is used to transport dried materials from the dryer to the mill, milled product to the blender, fufu flour from the blender to the bagging machine and final product for storage.

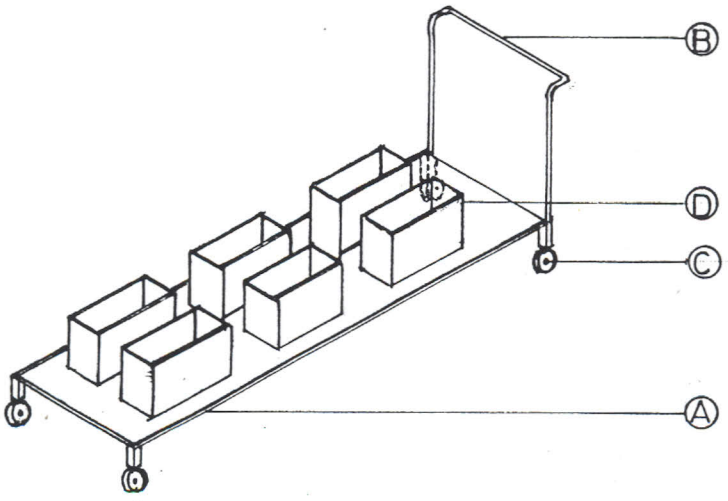


FIGURE 4

Trolley: A, angular steel frame; B, casters (4No.); C, plastic container (6No.); D, square pipe handle; E, hard wood floor.

## Pressure cooking vessel

The pressure cooking vessel in figure 5 consists of a 6 mm - thick reinforced stainless steel body A, which is capable of withstanding pressures up to 10 kg/cm$^2$,

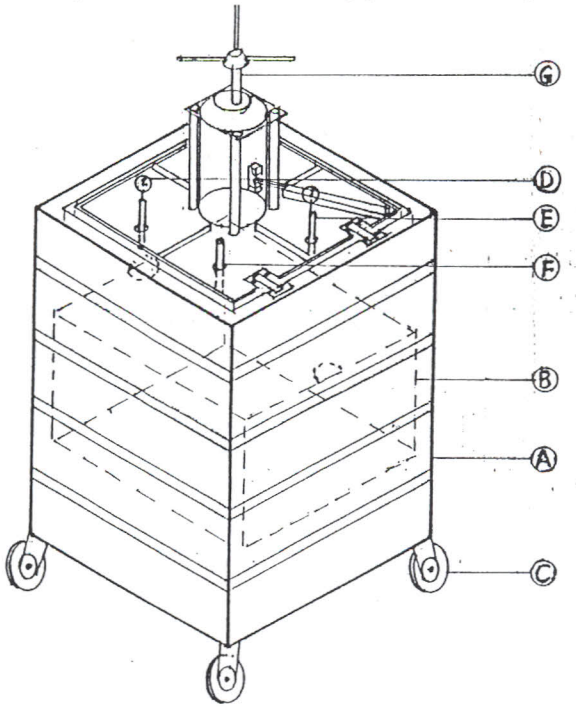


FIGURE 5

Pressure cooking vessel: A, stainless steel body; B, perforated stainless steel basket; C, casters (4No.); D, thermometer; E, pressure gauge; F, pressure relief valve; G, cover locking device.

perforated stainless steel basket B, four (4) casters C, two of which are directional, thermometer D, pressure gauge E, pressure relief valve F, and cover locking device G. The vessel's cover and locking device are designed such that the vessel is air - tight when fully closed. Casters were fixed under the vessel to make its movement easier and a one tonne - mobile hoist system constructed to be used in opening the heavy cover of the vessel as well as lifting the stainless steel basket with cold and hot products into and out of the vessel respectively. The basket containing materials to be cooked is placed in the vessel at a height above the water level. Industrial gas burner supplies process heat to boil the water to produce steam which cooks the material in the basket under pressure.

## Mobile hoist system

The mobile hoist system in figure 6 consists of a 1 - tonne chain hoist A, hanging on a mobile support system B, made basically from 50 mm galvanized pipe and four (4) metal casters C, two of which are directional. Two counterweight bars D,

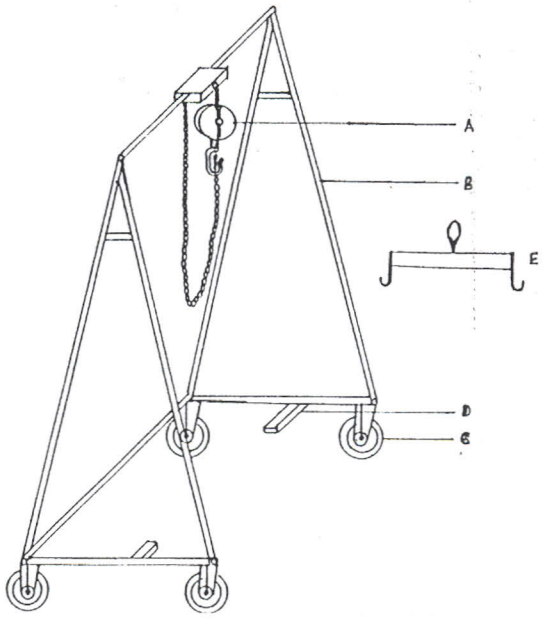


FIGURE 6

Mobile hoist system: A, one-tonne hoist; B, metallic support; C, casters (4No.) D, counterweight bars (2No.); E, basket holder.

positioned at the base of two sides of the support ensure stability when lifting the cover of the vessel. A basket holder E, consisting of a top hook which is hooked to the hoist and two bottom hooks which hook the handles of the cooking vessel's basket serves as a linkage between the hoist and the basket.

## The Disintegrator

The disintegrator presented in figure 7 is a product of the author constructed at the engineering workshop of FRI in 1995. The disintegrating mechanism consists of a circular disk metal crank B, connected to a reciprocating plunger F, via two bearings and two connecting rods C, a stationary pan E, a mesh G, at the base of the pan, a hopper K, and its stand J. Cooked materials from the hopper are continuously directed through the inclined chute onto the mesh using a scoop or a fork. The material is pressed through the mesh by the plunger at each stroke thus breaking the former into smaller pieces which are collected in the receptacle I, below the mesh.

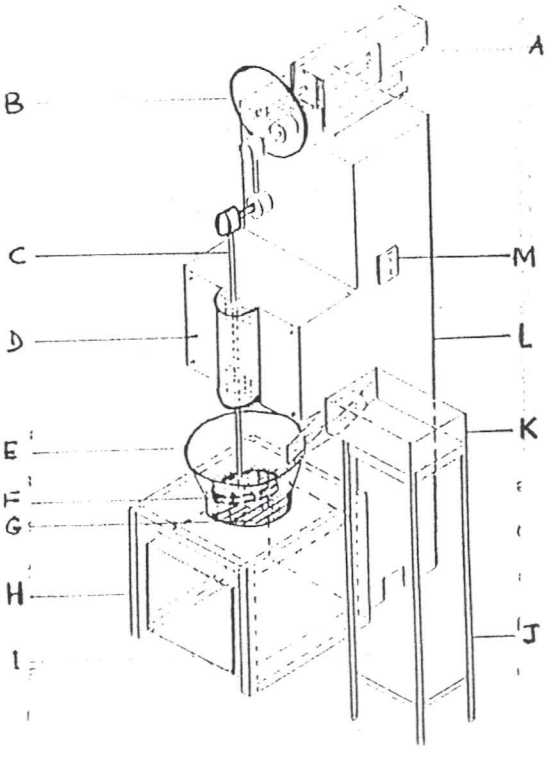


FIGURE 7

Disintegrator: A, gear motor; B, crank; C, connecting rods and bearings (2No.); D, bearing cover; E, pan; F, plunger; G, mesh; H, mesh stand; I, receptacle; J, hopper stand; K, hopper; L, main frame; M, starter.

### The hot air cabinet dryer

The hot air cabinet dryer was manufactured by Rolls Royce Industrial Ovens Ltd of England. It consists of a rectangular chamber of sheet metals with fibre glass insulation, ten (10) trolleys each containing ten (10) shallow trays, two (2) fans driven by two (2) medium speed electric motors, a number of heating elements and inlet and outlet ducts as well as an internal ductwork. Heated air is circulated between the trays and passes over the heating elements. Some moist air is continuously vented through the exhaust ducts whilst makeup fresh air enters through the inlet ducts. Materials to be dried are spread on the trays as evenly as possible and the required drying temperature and expected drying period set before drying commences.

### The attrition mill

The disc attrition mill, Rex, Type A 713 is a product of India. It is driven by a 7.5 kw, 3 phase, and 1400 rpm electric motor.

### The Y-cone blender

The Y-cone blender, Type 255D is a product of Apex Construction Ltd of England. It has two (2) inlet branches which join at the middle to form a single outlet (to give a Y shape). It rotates vertically about the horizontal axis at 33 rpm. It also has an internal horizontally positioned stirrer/agitator which rotates at 1400 rpm.

### Weighing machine

The Trident 414 weighing machine is a product of Ward Bekker Ltd of England. It works on the principle of a weigh balance or a truss. It consists of a truss unit, a weight trough mounted at the rear of the truss unit, a hopper, vibratory feeders and a weigh pan suspended from the front end of the truss unit. The product from the hopper is fed via the vibratory feeders into the weigh pan until the truss unit

assumes a balanced condition where the weight of the product in the weigh pan equals the weight placed in the weight trough.

### The heat sealer

The impulse heat sealer is a product of "Audion Elecktro" of Germany. It is a semi-industrial sealing machine and has a sealing width of 450mm and sealing time controller. Sealing is done by depressing the foot pedal.

### The Process

Processes involved in the production of plantain, cocoyam or yam fufu flour are presented by the flow diagram shown in figure 10. Plantain, cocoyam or yam is peeled, cut to required sizes and washed. The washed commodity is cooked under pressure and mashed (optional) before drying. The dried material is then milled and mixed with required quantities of dried, milled starch and cassava flour to form the fufu flour. The product is weighed into plastic pouches and sealed.

To produce the starch and cassava flours, cassava is peeled, cut and washed. The washed cassava is then grated and some liquid pressed out and the grated material dried and milled to obtain cassava flour. To obtain starch, the grated material is thoroughly washed several times with water in a container and allowed to sediment. The starch is then collected at the bottom of the container, dried and milled. This method of starch production is slow but it is being used here because the facilities already exist at the Institute and will contribute in cutting down the cost of the plant.

## MAJOR FINDINGS

The construction/acquisition of the pilot fufu production plant is not yet completed and therefore there are no major findings to be reported on presently.

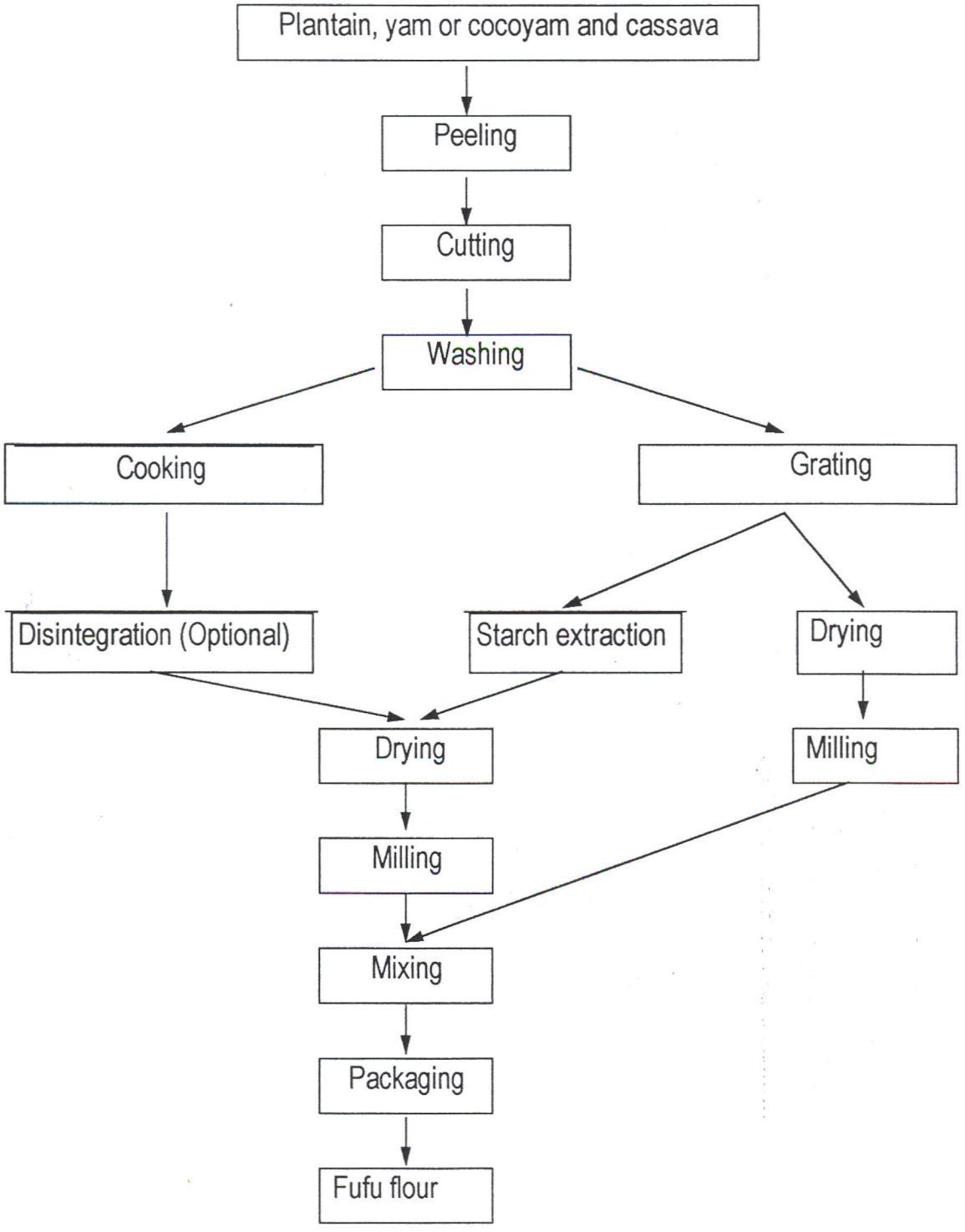


FIGURE 8: Flow diagram of fufu flour production process

## PROBLEMS ENCOUNTERED

Problems encountered include non availability on the local market of some parts and materials for the construction of some units of the plant at the time that they were needed.

## STATEMENT OF ACCOUNTS

1. Amount received directly from NARP secretariat in May, 1997: ¢2,200,000.00

| Total expenditure so far made | Amount, ¢ |
|---|---|
| i. Labour | 0.00 |
| ii. Materials and supplies | 2,134,000.00 |
| iii. Transport and Travels | 0.00 |
| iv. Vehicle running cost | 66,000.00 |
| v. Other recurrent cost | 0.00 |
| vi. New capital items | 0.00 |
| vii. Contingencies | 0.00 |
| Total | 2,200,000.00 |
| Balance brought forward | 0.00 |

2. Amount received from NARP through FRI: ¢5,300,000.00

| Total expenditure so far made | Amount, ¢ |
|---|---|
| i. Labour | 145,000.00 |
| ii. Materials and supplies | 5,040,000.00 |
| iii. Transport and Travels | 0.00 |
| iv. Vehicle running cost | 115,000.00 |
| v. Other recurrent cost | 0.00 |
| vi. New capital items | 0.00 |
| vii. Contingencies | 0.00 |
| Total | 5,300,000.00 |
| Balance brought forward | 0.00 |