Development of a Cassava Peeling Machine
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Abstract

Cassava (Manihot esculenta Crantz), the favoured root and tuber crop of the tropics, is one of the most important energy sources in the human diet in the tropics. It is an important staple, food security, and cash crop that thrives where most other crops fail. Cassava is utilised extensively for human and livestock consumption as well as for other industrial products such as starch. Most of the usages are in processed forms while only a small quantity is consumed directly. However, cassava processing is labor-intensive requiring mechanisation in order to meet up with current demand for these products. One major bottleneck in cassava processing had been cassava peeling, hence the objective of this study was to present a recently developed cassava peeling machine at the Federal University of Technology, Akure, Nigeria. To our knowledge, this is the first efficient cassava peeler in Sub-Saharan Africa. The machine has a capacity of 8 tons/day and performs the dual role of peeling and grating. The cassava peeler consists of a 5 Hp petrol engine, an abrasive drum (150 mm long), frame and transmission system. This prototype has been designed, fabricated and tested in our machine shop and found to be highly efficient. The cost of a single unit (prototype) was estimated at about 750 US Dollars. The machine is required in the production line of the following products: cassava grit, gari, cassava flour, cassava chips and pellets, lafun, pupuru, and starch. The result of this study has positive implications on food quality and security as well as on economic empowerment of the rural poor of the developing countries in the tropics where cassava products are becoming increasingly important.

Keywords: Cassava, chips, lafun, peeling machine, pupuru

1. Introduction
Cassava is a major source of carbohydrate in most developing nations of the world. It can be used as binder in the textile industries as well as in many pharmaceutical and agro allied industries. Cassava (Manihot esculenta Crantz) is a short-lived perennial tropical shrub growing from about 1.0-3.5 m tall. Believed to be first domesticated in South America, its cultivation has spread throughout the humid tropics and subtropics (Rehm and Espig, 1991). Total production of cassava in Africa has increased from 35 – 80 million tons between 1965 and 1995 (Hillocks, 2002). Africa now produces cassava than the rest of the world combined with biggest increase from 22% to 35% (of African total production) in Nigeria and 4% to 8% in Ghana (IITA, 1997). In Nigeria, the crop can be processed into garri, lafun, paki, pupuru, fufu and cassava grit for direct human/livestock consumption. In Ghana it is eaten boiled, it could be pounded to be eaten with soup in addition to some of the processed forms in Nigeria. Co-incidentally the Government of the two respective countries have started ‘presidential initiatives’ to increase cassava
production for local consumption and export promotions. In 2004, a policy was initiated to produce bread with cassava: wheat flour ratio of 1:9 in Nigerian bakery industry. Apart from human food, cassava is also used for animal feed and alcohol production (El-sharkawy and Cock, 1987).

There is an ever-increasing global demand for cassava chips and pellets particularly from China and Brazil. Cassava can therefore be referred to as a multipurpose crop for man and livestock. Cassava starch is an ingredient in the manufacture of dyes, drugs, chemicals, carpets and in coagulation of rubber latex (Odigboh, 1983). Since 1990, Nigeria has surpassed Brazil as the world’s leading producer of cassava with an estimated annual production of 26 million tonnes from an estimated area of 1.7 million hectares of land (FAO, 1991). Other major producers of cassava are Zaire, Thailand, Indonesia, China, India, Malaysia, Malawi, Togo and Tanzania. Cassava processing thus deserves serious attention in order to meet the local and international demand for cassava products. The unit operations involved in cassava processing include peeling, grating, boiling/parboiling, drying, milling, pressing, sieving, extrusion and frying. Several processes have been mechanized successfully, however, cassava peeling remains a serious global challenge to design engineers involved in cassava processing. The way forward is the design of appropriate mechanical device and system for peeling cassava. Initial research efforts in this area resulted in the production of several prototypes with relatively low peeling efficiencies and quality performance efficiencies. It is heart warming to note that a cassava-peeling machine was developed by the author in the Department of Agricultural Engineering, Federal University of Technology, Akure, Nigeria. The prototype of the peeling machine, which was demonstrated at the First Nigerian Universities Research and Development Fair organized by the National Universities Commission (NUC) in November, 2004 in Abuja, was awarded “An Outstanding Indigenous Agricultural Machine”.

An extensive literature search was conducted to determine the state of the art in cassava production and processing. Particular attention was placed on the global trend in the development of cassava /tuber peeling machine. A cassava-peeling machine was designed, fabricated and tested. The machine was demonstrated publicly at six different exhibitions. Various varieties of cassava, which thrive well on Nigerian soils, were identified and used for the performance evaluation of the machine. The tuber was easily manoeuvred round the peeling brush by the operator. The latter being a major advantage and thus make the machine able to peel varying shapes and sizes of cassava. The results of the project was intended to serve as a basis for the commercial production and utilization of cassava peeling machines

*Design Considerations*

In order to obtain high efficiency, and reliability, the machine (Fig.1) was designed based on the following considerations

1. The equipment should be relatively cheap and be within the buying capacity of local farmers.
2. The equipment should able to peel different varieties, shapes and sizes of cassava.
3. The equipment should be made with readily available materials.
4. It should reduce the labour input in traditional methods of peeling.
5. The capacity should be higher compared to manual operations.

3. Machine Description
The machine (Fig. 1) consists of an abrasive brush, 120 mm diameter, 150mm long mounted on a 25 mm shaft. It receives motion from a 5 Hp Honda engine rotating at 200 to 3000rpm. A protective hood to prevent splashing of dust and peels on the operator was provided. The hood also serves as a guide to direct the peel into the delivery chute. The drive system consists of belt
and pulley arrangement with a speed ratio of 1:1 between the drive and the driven pulley. However variation in speed was done by throttling the engine. The cost of the machine was estimated at 750 US Dollars. An improved design (Figs. 2 and 3) uses the abrasive brush in the previous design, but incorporates an auger as well as a guide to monitor tuber movement in the peeling chamber. A 7 Hp Honda engine was chosen as the power source. The Brush-auger arrangement impacts a rotary and linear motion on the tuber. The brush rotates faster at a range of 500 to 1,500 rpm while the auger rotates at 120 to 450 rpm. The brush and the auger also rotate in opposite direction. The relative motion between the brush and the auger and the rotary motion of the tuber effect the required peeling. The guide provided was spring loaded in order to accommodate variation in tuber sizes and shape. The effective operation of this machine was however dependent on tuber trimming and cuttings in order to eliminate bends. The width of the peeling chamber is also adjustable. The latter enhances effective peeling of tubers with various sizes. The capacity of the improved design is 10 tons per day.

4. Conclusion.
A cassava-peeling machine was designed, fabricated and tested by the author at the Federal University of Technology, Akure. The machine has a capacity of 8 tons/day and performs the dual role of peeling and grating. This prototype has been tested in our machine shop and found to be highly efficient. The cost of a single unit (prototype) was estimated at about 750 US Dollars. An improved model of the machine, which eliminates manual feeding and enhances machine capacity, has been designed recently. The machine was first demonstrated at the International Institute of Tropical Agriculture (IITA), Ibadan. The performance of the machine was adjudged satisfactory. The machine is currently subjected to design for commercial production in preparation for commencement of large-scale production of the machine.

References
(A) Double and Single Gang Peelers  (B) Peelers ready for delivery to National Center for Agricultural Mechanisation (NCAM), Ilorin, Nigeria

Figure 1: Cassava Peeling Machine

Fig. 2. Schematic Diagram of the Improved Cassava Peeling machine