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Development of a Double Action Self-Fed Cassava Peeling Machine

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Abstract
The federal government in Nigeria opened up the market and challenges of cassava production, processing and export in 2004, since then there has been the need to improve the concept and methods of production/processing of cassava. One of the major challenges of cassava processing is peeling. Engineers at the Federal University of Technology, Akure, Nigeria, initiated a major research effort to address this challenge, the effort resulted in the design of two models of a hand fed cassava peeling machine. Feedbacks from users and the public resulted in the development of a self-fed cassava peeling machine. Three models of the latter have been developed and reported. In this study an appraisal of the prospects and limitations of the previous designs is presented. The result of the appraisal was used as the basis for the design of yet an improved version of the self fed cassava peeling machine. The machine consists of a 7Hp Honda engine, two lines of abrasive brush, two lines of auger arranged in parallel, transmission system, frame and tuber monitor. Further improvement was done on the existing models of the self-fed cassava-peeling machine. Major area of improvement include, increase in the length of the peeling brush from 30 cm to 60 cm and automatic adjuster for a range of cassava tuber sizes. A double action self-fed cassava peeling machine was developed and tested under various crop, machine and operational conditions. The effect of brush type, speed and orientation on efficiency of the peeling process was determined. Tubers were presented as cuttings of 20 to 25 cm long and at three different ranges of diameters as < 8 cm, 8–10 cm and > 10 cm. Results show that auger speed of 250 to 1000 rpm resulted in peeling efficiencies of between 82 to 92% at various peripheral speeds of the peeling brush. Adoption of this peeler is expected to (i) promote timely processing of fresh tubers (ii) reduce labour input and (iii) increase production and hence the income of local processors.

Keywords: *Cassava peeling machine, double action, self-fed*

Introduction
Agricultural Engineers in Nigeria are becoming more aggressive in a major drive to impact on the nation through the design, production, selection, utilization and maintenance of mechanical devices and systems in agricultural production. These efforts resulted in the development of appropriate/user friendly devices and systems for enhanced agricultural productivity. Several crops and products now require urgent engineering solutions. Cassava seems to be more promising due to its potentials in Nigeria, which have been estimated at over 100 billion dollars per annum (Agbetoye, 2003) Cassava production and processing in Nigeria and Ghana took the central stage since 2004 through the introduction of the Presidential Initiative on Cassava Processing and Export. Thus an enabling environment for the production, processing and export

of this commodity was created. Nweke (2004) reported that one way to make Cassava production, processing and export a reality is to identify any cassava harvesting or peeling machine designed for smallholders anywhere in the world and to urgently put such to on-farm test in Africa with a view to adapt, fabricate, and diffuse it to farmers. Several efforts have been made to develop effective cassava peeling machines in China, Brazil and in some parts of Africa (Odigboh, 1976; 1979; Sherrif *et al*., 1995; Olukunle, 2005). At the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, the integrated cassava project initiated a search for an effective cassava peeler in 2005. Three models (A, Band C) of a self-fed cassava-peeling machine have also been developed (Olukunle et al., 2005). These models represent notable improvement on the hand fed models. Major advantages include elimination of manual intervention during the peeling process, overall reduction in drudgery and also increase in capacity. However, peeling efficiency is generally less than 80% and losses are more than 8%. The capacity of the machine is also less than the requirement of medium to large-scale industrialists. In this study further improvement on models A, Band C was done in order to enhance peeling efficiency and increase machine capacity. A double action self-fed cassava peeling machine was designed, fabricated and tested. This model provides a dual tuber path and specific peeling adjustment for a range of tuber sizes. The major advantage is that fewer adjustments would be required during machine operation.

Materials and Methods.

An appraisal of two models of hand fed and three models of self-fed cassava peeling machines was done in order to determine the strengths and weaknesses of the previous designs. Particular attention was placed on the global trend in the development of cassava /tuber peeling machine. Further improvement was done on the existing models of the self-fed cassava-peeling machine. Major area of improvement include, increase in the length of the peeling brush from 30 cm to 60 cm and automatic adjuster for a range of cassava tuber sizes. A double action self-fed cassava-peeling machine (Fig. 1) was developed and tested under various crop, machine and operational conditions. The effect of brush type, speed and orientation on efficiency of the peeling process was determined. Tubers were presented as cuttings of 20 to 25cm long and at three different ranges of diameters as < 8 cm, 8-10 cm and > 10 cm. The results of the performance evaluation were compared with manual methods.

Machine Description

The double action/self fed cassava peeling machine consists of two conveyors arranged in parallel, two rotating brushes 60 cm long mounted at 90^0 on the auger conveyors, tuber inlets and outlets, tuber monitor, a protective hood, frame and transmission system. The machine impacts rotary/linear motion on the tuber and thus provides the required peeling effect on the tubers as the latter makes contact with the peeling brush. Tubers are fed into the two inlets at the same time and the machine effects simultaneous peeling of the tubers. The resident time is governed by the auger speed and the slippage provided by the combine action of the auger and the brush on the tuber. It is possible to adjust the clearance in this design to obtain a tapering chamber in order to accommodate the phenomenon of tube behaviour in the chamber.

Result and Discussion

The modifications introduced into this design are effective. Each producing desired effects on the peeling process. The increase in brush length and hence the resident time of tubers within the peeling chamber influenced the peeling process remarkably. The peeling brush was increased in length from 300 mm to 600 mm. This permitted more contact with the brush as the tuber moves through the peeling chamber. Soft - elastic material on the tuber monitor introduces higher slippage, which is required to increase the resident time of tubers in the peeling chamber. Thus the outer layer was completely removed in one pass of the tubers through the peeling chamber**.**

The three categories into which the tubers were divided aided faster peeling process since the tuber monitor could be adjusted only thrice, each time to handle a specific range of size of cassava tubers. It was discovered that resident time of tubers in the chamber influenced peeling efficiency but not independently of other parameters. Resident time of cassava tubers in the peeling chamber was between 5 to 10 s. Fig.2 shows that auger speed of 50 to 150 rpm resulted in peeling efficiencies of between 82 to 92 % at various peripheral speeds of the peeling brush. This is generally higher than values obtained with Model C. While it is desirable to reduce auger speed for higher peeling efficiency, greater challenge of adequate machine capacity arose. The double action peeler doubles the capacity of model C by providing simultaneous peeling of tubers in the two chambers and on the same machine. In the attempt to synchronize auger speed and brush speed to optimize the process, it was discovered that brush speed of 1000 rpm to 1400 rpm and auger speed of 100 to 200 rpm represent feasible ranges of speed; this is similar to findings in Model C. However, tuber size would not significantly affect the peeling process where tubers have been graded appropriately into correct sizes and corresponding adjustments in the inlet and outlet clearance have been made. Maximum machine capacity was 1000 kg/hour compared with 23 kg per hour recorded during manual peeling Alade (2005) and 500 kg/hour for the hand fed peelers. These values are feasible where average tuber weight is not less than 0.8 kg. The cost of the prototype was estimated at 2,300 US Dollars. However, the cost of the commercial model is estimated at 1,850 US Dollars.

Conclusion.

A double-action self fed was designed, fabricated and tested by the author at the Federal University of Technology, Akure. The machine which is an improvement on self fed cassava peeling machine (models A, B and C) incorporated two peeling chambers fitted with peeling brushes, 60 cm long for enhanced peeling efficiency and machine capacity. It was observed that there was corresponding decrease in peeling efficiency with slight decrease in tuber size and at constant inlet-outlet clearance. Maximum machine capacity was 1000 kg/hour compared with 23 kg per hour recorded during manual peeling and 500 kg/hour for the hand fed peelers. These values are feasible where average tuber weight is not less than 0.8 kg.

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Fig. 1 Double Action Self Fed Cassava Peeling Machine

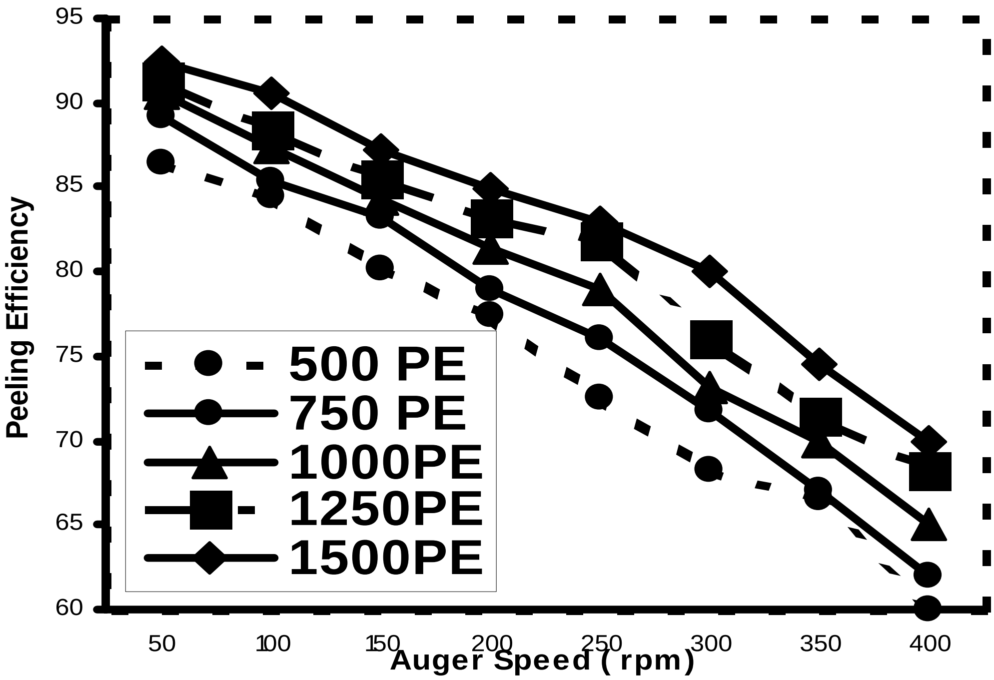

Fig. 2 Effect of Auger and Brush on Peeling Efficiency at tuber diameter > 10 cm