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AN OVERVIEW OF DEVELOPMENT OF A RICE PROCESSING PLANT FOR RURAL USE

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ABSTRACT

The short fall in capacity and quality between locally produced rice for example in developing countries like Nigeria (2.8 million tons) and domestic consumption (5.9 million tons) called for developing a low cost and efficient rice processing machine for improved capacity and quality for sustainable agricultural production. Rice processing plant development was carried out to the point of production at Federal University of Agriculture, Abeokuta, Nigeria for rural farmers. Out of locally available materials searched for, industrial rubber roller material performed best with coefficient of dehulling, coefficient of wholeness, dehulling efficiency and cleaning efficiency of values 66.00%, 0.77, 0.88 and 97.00% respectively.

INTRODUCTION

In developing countries, most of rice crop is produced on small scale farms in rural areas, where rice sale faces competition from imported rice which is favoured for it long white grains. The short fall in capacity and quality between locally produced rice (2.8 million tons) and domestic consumption (5.9 million tons) in Nigeria (USDA, 2012) called for developing a low cost and efficient rice processing machine for improved capacity and quality. Imported rice, although widely considered less tasty, demands less preparation as it contains no dirt and stones. Eliminating stones and dirt from rice produced by using a dehuller/destoner made from locally available materials at low cost when compared with expensive imported parts would allow rice produced from rural areas to compete favourably with imported rice. Raising the quality of local rice might discourage rice importation and boost local production.

Rice Dehusking Technology

Rice dehusking is the process by which it grain is separated from the glumes that enclose it. Apart from the labour intensive type of small scale rice dehusking by pestle and mortar, there are generally two major principles of mechanical dehusking of paddy rice which are shearing and impact types. According to International Rice Research Institute (IRRI, 2009), three different husking technologies are commonly used which are steel husker, under runner disk husker and rubber roller husker. Roller husker method of hulling can achieve hulling efficiencies of 85% to 90% with minimum broken or cracked grain. Many simple and sophisticated machines have been developed to carry out these processing operations in developed countries. There is need to move from making use of hand tools and develop more efficient simple rice processing machines to meet rural farmers' need in food production.

METHODOLOGY

Overview Development of Rice Processing Plant

A team of researchers in March 2010 commenced work on rice dehusking/destoning machine project at Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR) of Federal University of Agriculture, Abeokuta, Nigeria for use in rural areas where most of the rice production comes from, Adisa *et al* (2016). The machine prototype was developed from locally available materials, a continuation of past work done earlier and now to production stage.

Design and development of roller rice dehusking and destoning prototype machine was carried out which include design of small capacity roller rice dehusking machine, assessment of power demand, minimized the power requirement, incorporated a destoning unit, grain metering unit and selected suitable roller material and found alternative sources of power like petrol engine and electricity. Rice hulling operation is shearing principle of the roller huller where paddy passes between two horizontal rollers that revolve in opposite directions at 30% difference in speeds.

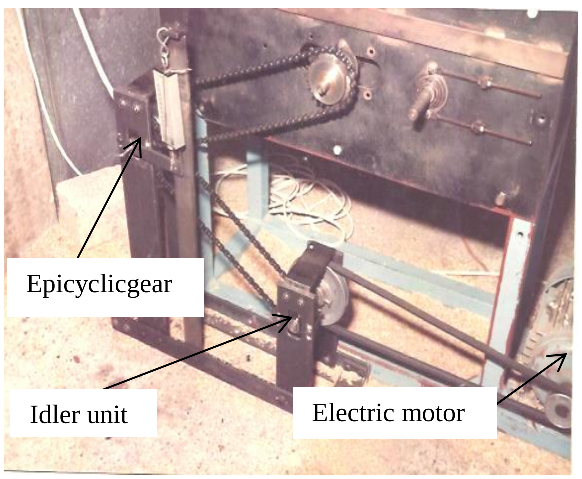


Figure 1. Epicyclic Torquemeter on the first huller

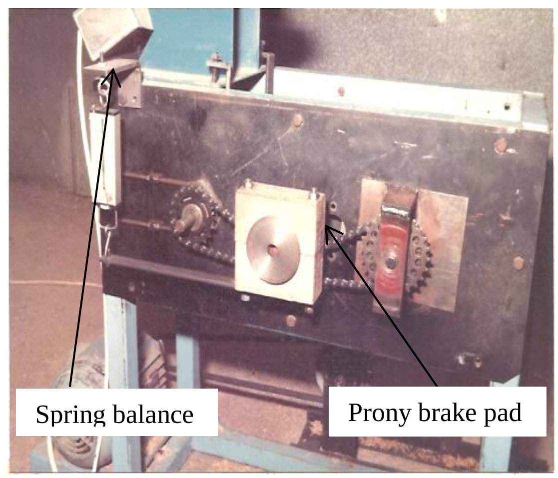


Figure 2. Prony brake assembly on the first machine huller machine

The total power required was found to be 110 watts while 41 watts was absorbed by the machine to dehusk 49kg/h of paddy rice, Adisa and Inns (2012). Figures 1 and 2 shows the epicyclic dynamometer, while Figure 3 is the first dehusker produced which was further worked upon.

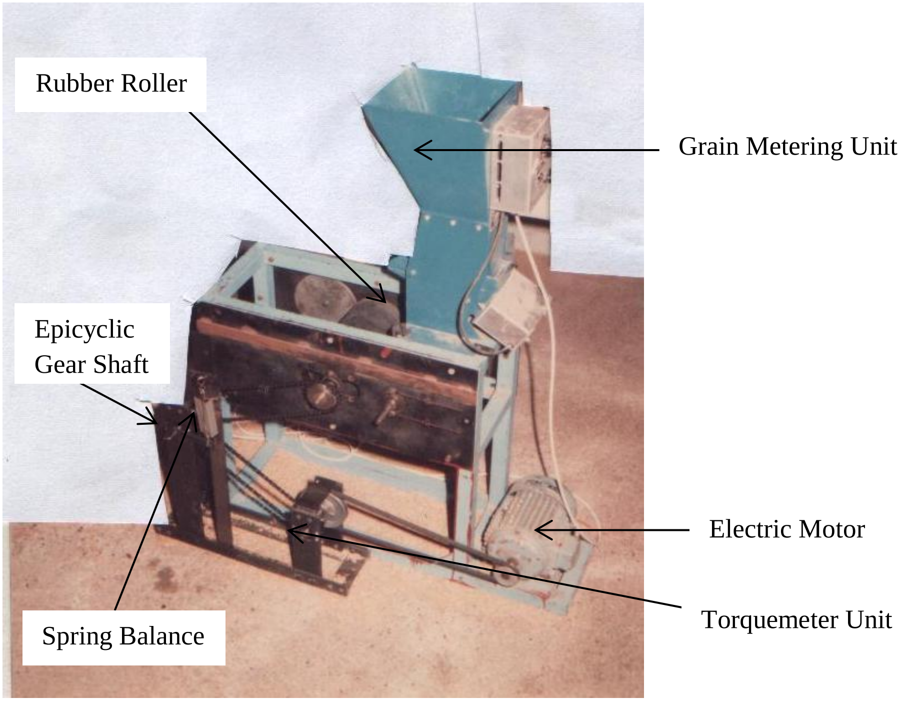
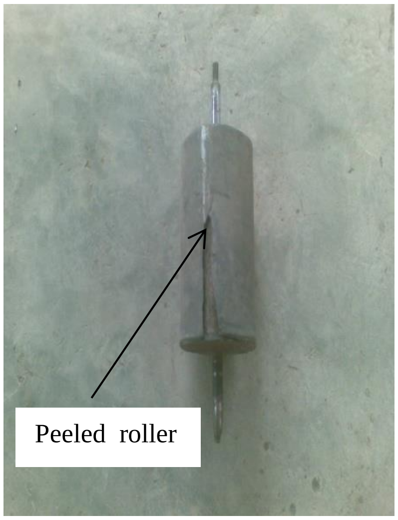


Figure 3. Electric motor, prony brake, grain metering unit and huller of first machine assembly.

Figure 4 is a picture of one of the peeled up shoe leather cover on roller which was the case for four types of them that was tried. About 4.5 kg was used for trial run which began to peel off during dehulling and got worn out as a result of friction. About 15% of paddy was dehulled with 50% wholeness which then resulted in the search for alternative roller of more superior property, knolled *Teflon* rollers as shown in Figure 5 and Figure 6 is the second prototype with destoner.

Aerodynamic Mechanism Consideration

Fluid flow occurs around the solids and the problem involves the action of the forces exerted by the fluid on these solids. Determination of some physical properties such as drag coefficient, terminal velocity and Reynolds number were considered in the design, Mamah *et al.* (2016). The air velocity, air volume and relative humidity were measured by digital air flow meter. Moreover, a number of parameters were identified to influence the separation of particles in fluid medium. Such parameters are: (i) fluid velocity (ii) particle direction in air flow (iii) particle feed rate (iv) loading ratio (v) direction at which particle is injected (vi) resilience time of particle in the separation chamber, the ratio of grain to material other than grain (MOG) and air turbulence intensity (Hamilton and Butson, 1979).



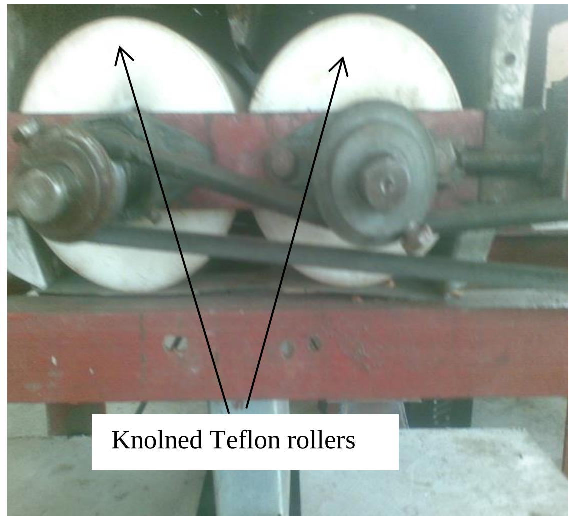


Figure 4. Peeled shoe leather on roller

Figure 5. Teflon rollers on the second machine

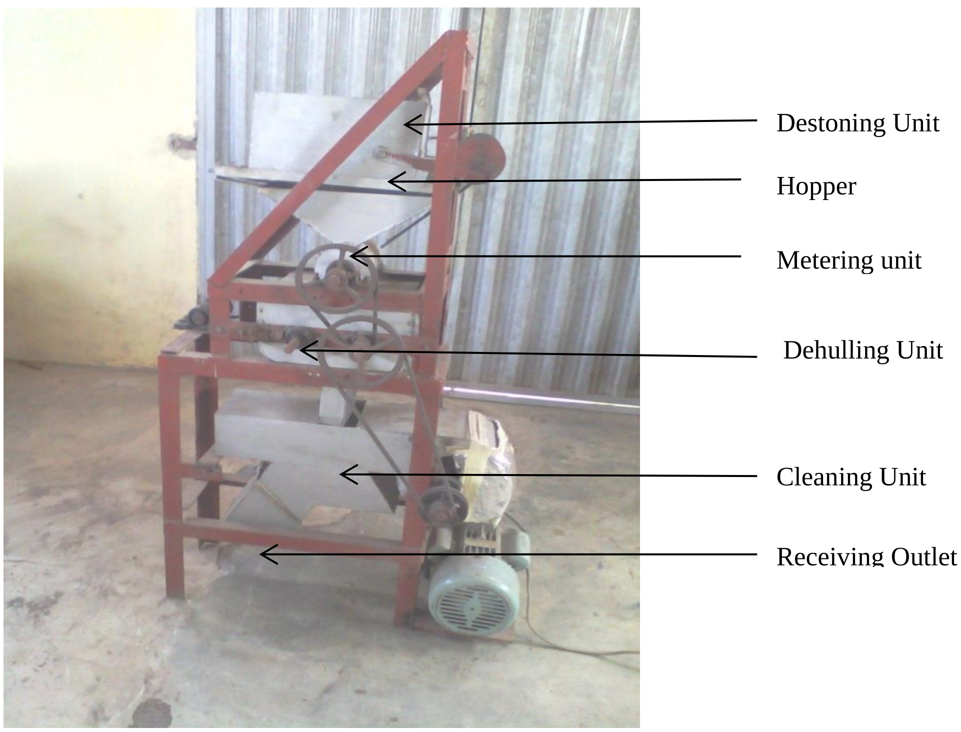


Figure 6. Second prototype rice dehusking / destoning machine with Teflon rollers.

A large amount of air was blown from cleaner blower unit which separates dehulled samples into three items viz. chaff, hulled rice and stones which comes from three different outlets. Figure 7 shows the final prototype dehuller/destoner. Table 1 shows the critical operating parameters with coefficient of dehulling of 0.77, coefficient of wholeness of 0.88, cleaning efficiency of 97% and capacity utilization of 97% which cannot be compared with any known rice processing traditional nor hand tools.

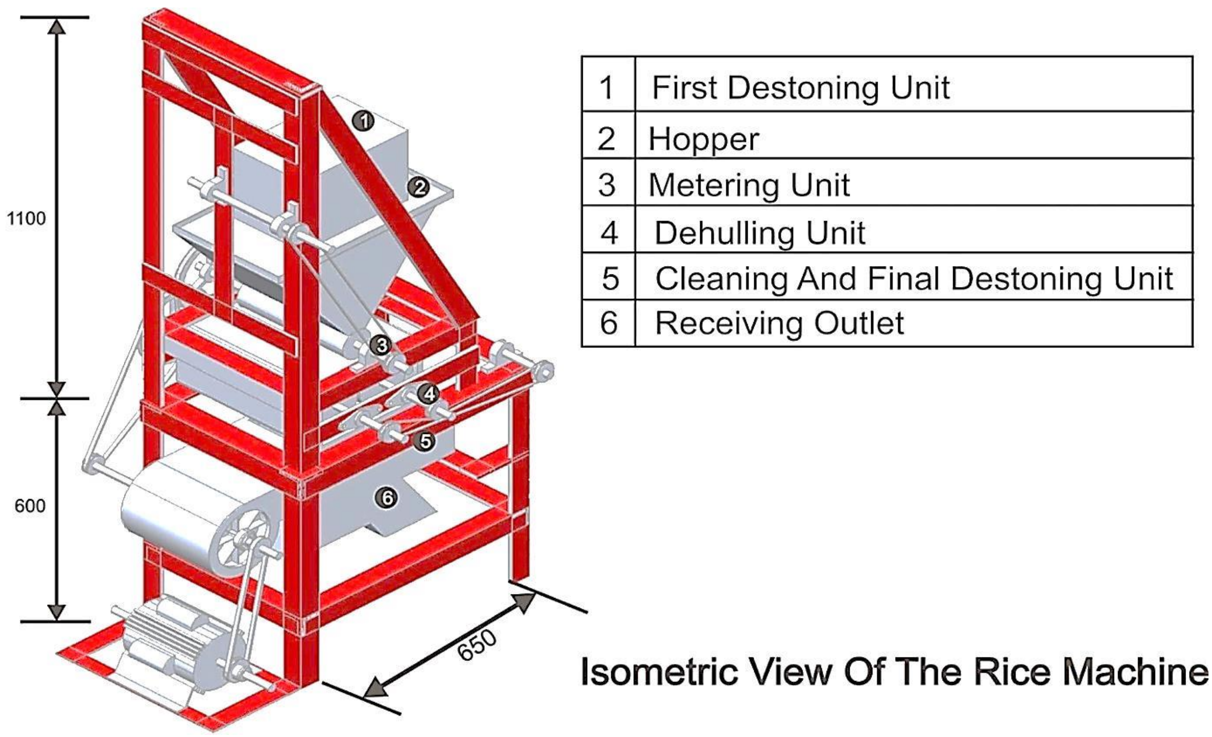


Figure 7. Isometric view of the final rice dehusking and destoning machine

Table 1. Operating parameters of the prototype dehuller

S/No	Performance Parameters	Maximum Values
1	Coefficient of dehulling	0.77
2	Coefficient of wholeness	0.88
3	Dehulling efficiency, %	66
4	Dehulling recovery, %	76
5	Cleaning efficiency, %	97
6	Output capacity, kg/h	18.12
7	Hulling capacity, kg/h	10.86
8	Capacity utilization (CU) , %	97
9	Air velocity	9.8m/s
10	Air volume	$0.25m^3/s$

CONCLUSIONS AND RECOMMENDATION

This research work shows that the milling efficiency was affected by the machine adjustment due to excessive breakage recorded when the machine was operated with single adjustment for all the paddy varieties. The optimum moisture content on wet basis for all the paddy varieties was in group A (12 %). The dehulling efficiency of the rubber roller dehusker was 63.75 %, Coefficient of hulling was from 0.44 to 0.77, coefficient of wholeness was from 0.55 to 0.88 and the cleaning efficiency obtained for the rice varieties was 82 to 97 %. The terminal velocity of the rice grain was 7.5 m/s while the air velocity of blower was 9.8 m/s. The rubber rollers maximum coefficient of dehulling, coefficient of wholeness, dehulling efficiency and cleaning efficiency for the rubber roller dehusking machine were of higher values than using Teflon rollers on the same machine. The introduction of this machine with coefficient of hulling of 0.77, cleaning efficiency of 97% and coefficient of wholeness of 0.88 in Countries where majority of rice processing is done with pestle and mortar will go a long way to contribute and sustain and improve agricultural production.

REFERENCES

Adisa, A. F., Eberendu, N. O., Aderinlewo, A. A. and Kuye, S. I. (2016). Performance Evaluation of a Developed Rice Processing Machine. *Journal of Agricultural Engineering, 47 (506)*: 171-176. Pagepress Publication for Italian Society of Agricultural Engineers, Italy.

Adisa, A. F. and Inns, F. M. (2012). Development of an Epicyclic Gear Transmission Laboratory Dynamometer. *Journal of Emerging Trends in Engineering and Applied Science*, U. K. 3 (6).

Hamilton, A. J. and Butson, M. J. (1979). Approaches to the Problem of Combine Grain Loss on Sloping Ground II. *Journal of Agricultural Engineering Research, 24 (3)*: 293-299.

IRRI. (2009). *Rubber Roll husker*, Rice Knowledge bank. Available online at http://www.knowledgebank.irri.org/rkb/rice-milling/commercial-rice-milling-systems/husking/rubber-roll-husker.html. Accessed June, 2012.

Mamah, K. C., Adisa, A. F., Aderinlewo, A. A. and Ismaila, S. O. (2016). Experimental Research on Performance Evaluation of a Roller Rice Dehusking Machine. *Proceedings of the International Conference on Science, Engineering and Technology*, Abeokuta , Nigeria.

USDA. (2012). *Rice Situation and Outlook Yearbook/RCS-2012/April*. Economic Research Service, USDA.