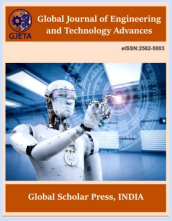
Global Journal of Engineering and Technology Advances
eISSN: 2582-5003
Cross Ref DOI: 10.30574/gjeta
Journal homepage: https://gjeta.com/



(RESEARCH ARTICLE)

Check for updates

Development and performance evaluation of a cowpea threshing machine

Olajide O.G, Oladimeji A.O * and Ale M.O

Department of Agricultural and Bio-Environmental Engineering Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Global Journal of Engineering and Technology Advances, 2022, 13(01), 022–026

Publication history: Received on 26 August 2022; revised on 03 October 2022; accepted on 06 October 2022

Article DOI: https://doi.org/10.30574/gjeta.2022.13.1.0168

Abstract

A cowpea threshing machine was designed, constructed and evaluated in the Department of Agricultural and Bio-Environmental Engineering Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. The machine was constructed using locally available materials with the primary aim of reducing drudgery attached to the traditional method of threshing cowpea. The machine consisted of the hopper, the threshing unit, the cleaning unit, the outlet and a single phase electric motor. The machine was evaluated based on the varied operating speed of 450rpm, 550rpm and 650rpm and moisture content of 13.5%, 14.5% and 15.5% respectively. The results showed that the machine efficiency increases with increase in feed rate and decrease in moisture content. An optimum level of 94.4% efficiency was observed at the speed of 650rpm and moisture content of 13.5%.

Keywords: Cowpea; Threshing machine; Operating speed; Feed rate; Efficiency

1. Introduction

Cowpea (*Vigna unguiculata L. walp*) is an annual legume crop which is widely grown in Africa, Latin America, south East Asia and the southern United States (Allen and watts, 1998). The value of cowpea lies in its high protein content which enables it to fixes atmospheric nitrogen and improves poor soils.

Cowpea which is rich in protein is the second economic cash crop in Africa after groundnut and is used for human consumption and animal feed (Rachie and Sigh., 1985).

Many Nigerians earns their living directly or indirectly through the cultivation of cowpea as it is one of the staple crops that provide much needed protein requirement in the dietary table (Olaoye 2011). This grain as it was reported by Lawrence, 2006, Adekanye and Olaiye 2013 could be prepared in several ways for consumption, such as boiling, grinding, and processing into Akara ball, 'moinmoin'', etc

Production of cowpea is incomplete without threshing operation. Threshing of cowpea could be done through manual and mechanical means to remove grains from the pods either on hard dry ground or rock. To reduce the incidence of stone from the seeds during threshing, nylon, tarpaulin or leaf materials are spread before threshing is done using sticks or pestle and wooden mortar. Manual threshing is usually characterized with wastage, breakage to the seeds and high drudgery, after threshing, the seeds are then separated by winnowing. Both the chaff and the haulm are fed to livestock animals as hay or fodder. Olatunji, (2001).

High technology which is very expensive helps to maintain the quality of the final products, it eliminates drudgery associated with local threshing system and reduces threshing losses.

* Corresponding author: Oladimeji AO
Department of Agricultural and Bio-Environmental Engineering Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Improper post-harvest operations, including threshing usually result to losses of up to 5% of the cowpea. (Bruce et al. 2001, Olaoye (2011). Better production techniques alone are not sufficient to solve the problem of field losses in production of cowpea attention must also be paid to the suitable method of harvesting and threshing to minimize field losses. To achieve a better efficiency during the design of threshing machine, consideration must be given to feeding method, cylinder speed, concave to cylinder clearance and moisture content of the cowpea. (Kepner et al 1978).

There is now a general awareness in Nigeria and other developing countries that the rapid development of agriculture depend to a large extent on the successful introduction of modern agricultural machinery. Many grain threshers have been developed but reliable information and performance data on them are limited. Most of the imported threshers are very costly and beyond the reach of Nigerian small-scale farmers. Some are found unsuitable for threshing the local varieties. Among the various ways by which the agricultural production of a country can be increased rapidly, the part played by improving agricultural machineries and equipment become very significant.

Many parts of Nigeria are known for the production of cowpea. These parts are yet to be known for commercial production of the product due to drudgery involved in threshing using sticks and pounding in wooden mortar which breaks the seeds and further reduces its market value. Production of cowpea on a large scale is likely to continue to increase with the adoption of improved production technology and availability of wider market due to importance of cowpea in its food value as a major source of protein of high biological value, energy, vitamins and roughage and also its important as a source of animal feed. Among the various ways by which the agricultural production of a country can be increased rapidly, the part played by improving agricultural machineries and equipment became very significant. To this, there is need to develop a local thresher affordable to the purchase of small-scale and medium cowpea processors to reduce drudgery of work to a greater extent.

2. Machine Description

The cowpea threshing machine possess the following components; the frame, the hopper, the threshing unit, the cleaning unit the outlet tray and the power transmission unit. The frame is made up of 2mm thickness angle iron and it is the unit or part in which other parts are directly or indirectly attached. The hopper is made up of 1.5mm thick galvanised metal sheet, it is rectangular in shape and it is the part through which cowpea is being fed into the machine. The threshing unit comprises of beaters enclosed in a housing in which the lower part is perforated or comprises of slots through which both the cowpea seed and the shaft can fall through after threshing. The cleaning unit which is located below the threshing unit consists of a radial type of fan paddle which generate an air blast to clean the threshed cowpea as its being fall from the threshing unit to the outlet tray. The outlet tray is the part through which the threshed and cleaned cowpea is being collected. The power transmission unit is the unit that provides the adequate power needed to run the machine and the unit is located under the cleaning chamber in the machine. The threshing is done by the action of the beaters on the cowpea by impact action.

2.1. Machine operation

To operate the cowpea thresher, electric motor is switched on hence the machine operate automatically, the cowpea is fed into the machine through its hopper and it moves straight to the threshing unit which consist of a rotating beaters, the beaters thresh the cowpea by impact action and the threshed seed and its shaft pass through the housing slots or holes and fall through fan blast to the outlet. As the threshed cowpea passing through the fan blast, the shaft are blown away because of its low density while clean seed pass through the fan blast to the collecting outlet where they are collected.

2.2. Design Features/ Units of the Machine

2.2.1. Feeding unit/hopper

This unit is rectangular in shape and it's made of mild steel. It is the medium through which the cowpea pods are introduced to the machine for threshing. The pods flow by gravity into the threshing chamber.

2.2.2. Threshing unit

The threshing of the cowpea are effected in this unit. It consist of an arrangement of a rotating beaters welded to a shaft and housed in a perforated cylindrical drum. Rotation of the beaters inside the cylindrical drum effects the threshing of the cowpea while the machine is working.

2.2.3. Cleaning unit

The cleaning unit is an enclosed fan with blades built from 16 gauge metal sheet arranged on a shaft and enclosed in housing. The fan produces the air that effects the separation of chaff and other unwanted materials from the cowpea seeds.

2.2.4. Chaff outlet unit

This unit is the passage for the chaff after threshing of cowpea has been accomplished. It is cover to direct the flow of the chaff. It is sited on the side of the threshing unit such that the blower can blow the chaff through it.

2.2.5. Grain outlet

This is the unit through which a clean threshed cowpea is been received after threshing

2.2.6. The frame

The frame is the unit of the machine on which other components are mounted. It bears the load of the machine, it also provide support for the machine during operation.

2.3. Machine Performance Test

The performance test of the cowpea thresher was carried out at the fabrication workshop of Agricultural and Bio-Environmental Engineering Technology, Rufus Giwa Polytechnic, Owo. The test on the cowpea thresher was carried out to determine the effect of varying operating speed of 450rpm, 550rpm and 650rpm and a varying grain moisture content of 13.5%, 14.5% and 15.5% on the performance of the thresher. In the first experiment, a constant feed rate of 5kg/m and a constant moisture content of 13.16% based on the findings of Ogunlowo and Bello (2005) were used to determine optimum speed for the thresher while in the second experiment, moisture content of 13.5%, 14.5% and 15.5% at a constant operating speed of 650rpm and constant feed rate of 5kg/m were used.

The machine efficiency and the machine capacity of the thresher were determined using equation (i) and (ii) as reported by Oladimeji and Lawson (2019)

$$Machine\ Capacity = \frac{\text{input weight}}{\text{time taken}}\ (kg/s) \text{ ..... i}$$

$$Threshing\ Efficiency\ \% = \frac{\text{Ws}}{\text{Wi}}\ X\ 100 \text{ ..... ii}$$

Where:

Ws = weight of threshed cowpea (kg)
Wi = Initial weight of cowpea (kg

3. Results and discussion

The results of the machine evaluation are as presented below:

3.1. Time of Operation

Figure 1 below shows the effect of operating speed on time of operation of the cowpea thresher. It can be seen from the figure that increase in operating speed reduces the time of operation of the machine. At 450rpm, the machine threshed 5kg of cowpea for 1.50min while at 650rpm same quantity of cowpea was threshed for 1.35min. As a result of the above trend, the minimum time of 1.35min time of operation was recorded against 650rpm machine speed for the threshing of 5kg of cowpea.

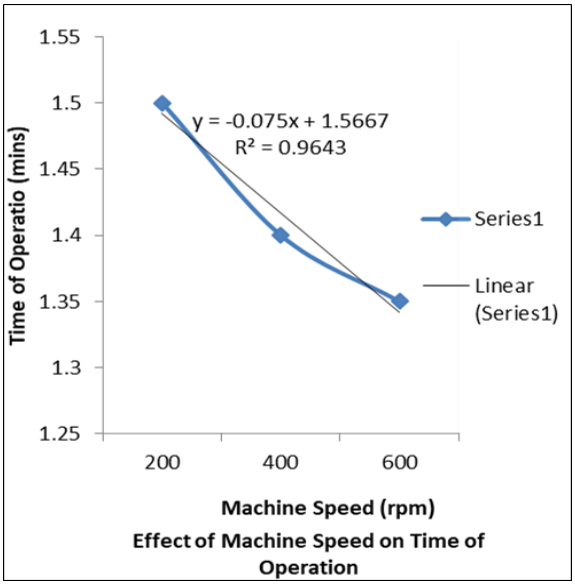


Figure 1 Effect of machine speed on time of operation

3.2. Output Capacity

Figure 2 below showed the effect of machine speed and moisture content on the output capacity of the threshing machine. From the figure, it can be seen that a constant 650rpm machine speed was adopted throughout as against varied moisture content. The output capacity of the machine decreases with increase in moisture content at 13.5% moisture content, the machine recorded maximum output of 234kg/hr while at 15.5% moisture content, it was 176kg/hr. As a result of the above trend, the maximum output capacity of 274 kg/hr was recorded at constant machine speed of 650 rpm and at 13.5% moisture content.

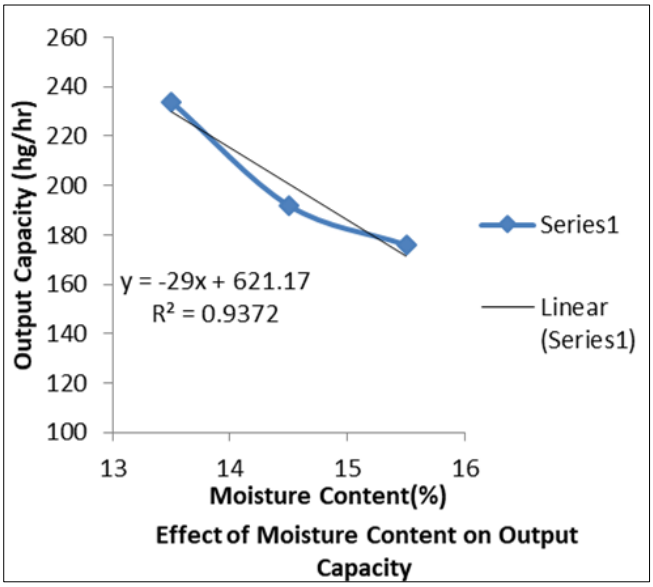


Figure 2 Effect of moisture content on output capacity

3.3. Threshing Efficiency

Figure 3 below shows the effect of machine speed on the threshing efficiency of the thresher. From the figure, it can be seen that the threshing efficiency increases with Increase in machine speed. At 450 rpm machine speed, threshing efficiency of 90% was recorded. At 550 rpm machine speed, threshing efficiency of 92% was recorded while at 650rpm machine speed, 94% threshing efficiency was recorded. As a result of the above trend the maximum efficiency of 94% was recorded at constant 13.16% moisture content (control) and machine speed of 650 rpm.

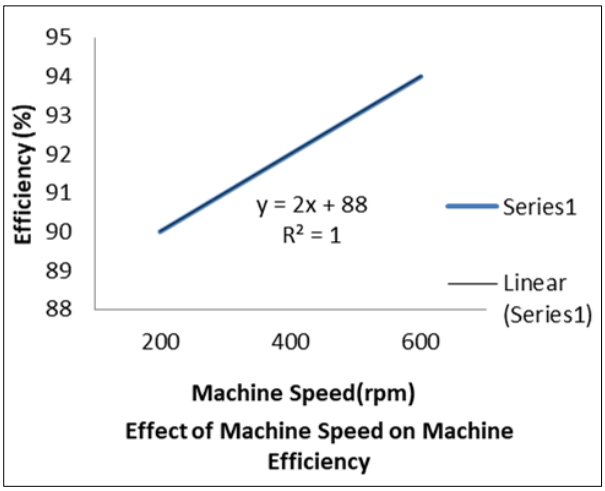


Figure 3 Effect of machine speed on machine efficiency

4. Conclusion

From the results of the evaluation test carried out on the machine, it was concluded that the newly designed and fabricated cowpea threshing machine performed satisfactorily with optimum performance at 650 rpm machine speed and 13.5% moisture content (wb) which gave 94.4% threshing efficiency. The machine will therefore eliminate the constraints in manual cowpea threshing and also provide improved quality product. The machine is therefore recommended for small, medium and large scale cowpea processors.

Compliance with ethical standards

Acknowledgments

We appreciate the department of Agricultural and Bio-Environmental Engineering Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria where the research was carried out.

Disclosure of conflict of interest

There is no conflict of interest.

References

[1] Allen and Watts, (1998): Design of a Belt Thresher for Cowpea Beans. Agricultural Mechanization in Asia Africa and Latin America 129(3) : 42-46.

[2] Bruce, D.R.N Hobson, C.L. Morgan, and R.O. Child, (2001): Threshability of Shatter-resistant seed pod in Oil seed rape. Journal of Agricultural Engineering Research, 80(L): 343-350

[3] Kepner, R.A, Bainer, R, and E.L. Barger (1978): Principles of Farm Machinery. 3rd ed West Port Connecticut, USA. AVI Publishing Company Incorporated.

[4] Lawrence, K, 2006 Essentials of Crop Farming Section Books Limited.

[5] Ogunlowo A. S and Bello R. (2005), Design, Construction and Performance Evaluation of a Cowpea Thresher. Journal of Agricultural Engineering and Technology (JAET) Volume 13.

[6] Oladimeji A. O. and Lawson O. S. (2019), Development and Performance Evaluation of a Groundnut Dehulling Machine. International Journal of Applied Research. Vol. 5(9)

[7] Olaoye J.O (2011): Development of a Treadie Operated Abrasive Cylinder for Threshing Cowpea. International Journal of Engineering Science and Technology 3(12). 8548-855

[8] Olatunji, Q.B.A. (2001). General Agriculture for west Africa. George Allen and Urwin, London.

[9] Rachie, K.O, and S.R Singh, (1985): Research Production and utilization Great Britain Sharme and Devnani (1980): Threshing Studies on soyabean and cowpea (Ama33 (2) 65-68.