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Bedasa Waldaho
Oromia Agricultural Research Institute, Fades Agricultural Research Centre P.O. Box 904, Hagar, Ethiopia

Tekalign Bedada
Oromia Agricultural Research Institute, Fades Agricultural Research Centre P.O. Box 904, Hagar, Ethiopia

Milkesa Alamu
Oromia Agricultural Research Institute, Fades Agricultural Research Centre P.O. Box 904, Hagar, Ethiopia

Teshome Urge
Oromia Agricultural Research Institute, Fades Agricultural Research Centre P.O. Box 904, Hagar, Ethiopia

Corresponding Author:
Bedasa Waldaho
Oromia Agricultural Research Institute, Fades Agricultural Research Centre P.O. Box 904, Hagar, Ethiopia

Modification of FARC engine driven groundnut stripper by incorporation of cleaning unit

Bedasa Waldaho, Tekalign Bedada, Milkesa Alamu and Teshome Urge

Abstract
The study was undertaken to modify by incorporation of cleaning unit of FARC Engine driven groundnut stripping machine. The machine was fabricated from locally available materials. The effects of drum speed and feeding rate on mean stripping capacity and cleaning efficiency indicates that the highest stripping capacity and cleaning efficiency was recorded at drum speed of 310 rpm as 216kg/hr. and 79% while the lowest stripping capacity and cleaning efficiency obtained at drum speed of 250 rpm as 150 kg/hr. and 65.67% respectively. The machine has the capacity of stripping of 190 kg/hr. and cleaning efficiency 66.33% at the recommended speed of operations. At the higher speed of operation the machine has relatively higher pod breakages of 21% and with high scattering of pods due to high vibration of the sieve.

Keywords: Groundnut, stripper, capacity, cleaning unit, efficiency

Introduction
Groundnut is the sixth most important oilseed crop in the world. It has many purposes such as food purpose (peanut oil, peanut butter, peanut flour, Boiled nuts etc.,) [Geleta Tarekegn, *et al*., (2007)] [11]. It contains 48-50% oil and 26-28% protein, and is a rich source of dietary fiber, minerals and vitamins. It grows best on soils that are well drained, loosely textured and well supplied with calcium, potassium and phosphorous. Developing countries constitute 97% of the global area and 94% of the global production of this crop. High demand for proteins creates the need for increased efficiency in production of proteins. Efficient Production of proteins goes a long way in ensuring good health and economic development.
Therefore, imperative for farmers to diversify their production and create added value through post-harvest handling including processing there by reducing risks and opening new local and export markets. There is a necessity to investigate new opportunities for improving efficiency in post-production system. One of the major factors that affect agricultural output is the level of mechanization (Lagat, *et al.*, 2007) [5]. Level of mechanization influences the level of efficiency in the production system.
Threshing is a fundamental step in groundnut processing and is necessary as the activity allows the stalk and hull to be used as well as other post harvesting technologies to take place such as oil extraction or in hull briquetting (Adedeji, O. S., and Ajuebor, F. N. 2002) [1].
Loss in groundnut production occurs at different stages of sowing, harvesting, stripping, threshing, cleaning and winnowing. Separation of pods from the stalks of the plants is one of the important operations in groundnut production. Due to unfavorable climate and pilferage particularly during harvesting season, delay in the operation reduced market value of the crop is a serious concern. Hence it is essential to separate the pods from the stalks just after the harvest of the crop (Glancey, 1997; Prakash, 1979) [3].
Groundnut threshing and cleaning mechanism in Eastern part of the country was done manually or human power. This operation is comparatively difficult because of time and labor consuming. Therefore low cost power operated pod strippers appear to be the best solution. Also, our farmers not aware of the groundnut stripping technology existence in the world or in our home country; hence they were used hand stripping by groups of family "dabo" due to this, they wastes their time and labor of their family. The capacity of traditional method of hand stripping was 10.50 kg/hour.

Pedal operating machine was to work with an average stripping rate with 3 persons 25 kg per hour and 2.48 times more than traditional hand stripping. According to Jamal (2012), it has the following performance evaluations. The machine has the maximum threshing or stripping capacity of 501 kg per hour. The stripping efficiencies of this machine was ranges from 94.7% to 98.2% for wet (immediate at harvest stripping with 400 rpm or (60%) and groundnut dried for 5 days (17.5%) at 600 rpm operating speed respectively. Both moisture content ground vine and operating speed had significant influence on stripping rate and percentage of unstripped pod.

Hence to addresses the gab on the problem mentioned in the above, FARC Engine driven groundnut stripper can solve the problems of manual threshing. And also the machine lack cleaning unit and is mandatory to incorporate cleaning parts to modify the machine. In order to solve this problem some modification on FARC Engine driven groundnut stripper parts is crucial. Therefore, this project is needed with the objective of modifying and evaluating engine driven groundnut stripper.

Materials and Methods

Stopwatch, tachometer and balance were used during machine testing. The experiment was carried out at eastern Hararghe zone of Oromia, from this zone Babile district was selected based on high potential groundnut producing areas.

Design Preparation

At this stage it would be planned to prepare the required design at the beginning for modifying of groundnut stripper. And then materials that are necessary for prototype production of groundnut stripper were identified and selected properly. Accordingly sheet metal having thickness of 1.5mm for outer cage and drum, fan, round bar of Ø6mm, V-belts, different size pulley, bearings, shafts, medium diesel engine, different size of angle iron, flat irons, for whole support and others remain materials were made ready for complete prototype production of the machine.

Material selection: Selecting the appropriate materials for each element of the machine so that they can sustain all the forces and at the same time they have least possible cost.

Parts of groundnut stripper

Engine: an engine is a machine designed to convert one form of energy into mechanical energy. It burns a fuel to create heat, which then creates a force.

Pulley: a pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of that cable or belt along its circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power.

Belt: a belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement.

Bearing: a bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. Many bearings also facilitate the desired motion as much as possible, such as by minimizing friction.

Shaft: a shaft is a rotating member, usually of circular cross section used to transmit power or motion. It provides axis of rotation, or oscillation, of element such sieve, by in centric.

Cutting Plate: a Cutting plate consists of bar as a teeth for separating the groundnut pods from the plant.

Modified parts

In the previous machine the tests were conducted in three steps, at harvesting time, three days after harvesting and five days after harvesting. The best results were obtained from the fifth day after harvesting during testing. And also starting from farmer's opinion (comments) the activity was initiated for modification the following parts.

Size: The size of the previous machine was minimized, because of it is very huge and not simple for handling and transportation.

Fan (cleaning unit): Fan was added to it in order to get cleaned pod and minimize human intervention.

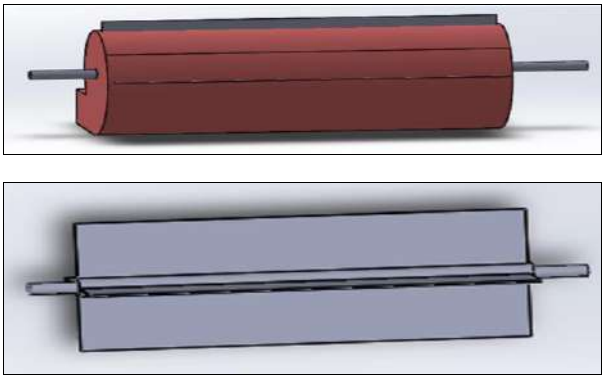

Fig 1: Fan cover and fan blade

Feeding Table: In previous machine there was no feeding table that was one problem on the efficiency of the machine, in order to gain best efficiencies it is necessary to add feeding table.

Principle of operation

When mechanical motion is supplied from motor or engine, it starts to rotate due to this pulley mounted on that motor shaft also rotates and power is transmitted from motor to the machine pulley with the help of V-Belt. Due to this, shaft also starts to rotate. Now when groundnut pod is held inside the machine it cuts the groundnuts from the pods and groundnuts are collected at the bottom. In our machine stripping is done by holding the pod portion of a bunch over the rotor of the stripper and when it fall to the bottom the fan was gives air through under outer cage. Then the cleaned pod was collected.

Prototype Production

After complete set of design and necessary materials preparations, modification of the required parts of the stripper was taken place as follow. At the first the drum was made by bending sheet metal on bending machine at the required size. The next step is to provide holes intended for

welding the cutting plate with the shaft. After this, cutting plate's attachments are inserted in the hole and welding operation is carried out. The cutting blade separates the pod from the straw according to the average size of the groundnuts and the cutting operation is done. Then, Pulley is connected at one end of the drum shaft. The engine shaft transfer power to drum shaft using belt drive. Fan is fitted on machine frame below drum to remove lightweight materials and impurities from groundnut pod by air flowing and cleaning the pods.

Testing procedure and evaluation

After the necessary modification of the stripper is ready, the tests were conducted at selected districts of eastern Hararghe zone of Oromia. A data was collected from repetitive testing of the replica and was analyzed to evaluate its performance. The most significant parameters that affect general operations like size of pods, concave and drum clearance were critically considered during commencing of the test.

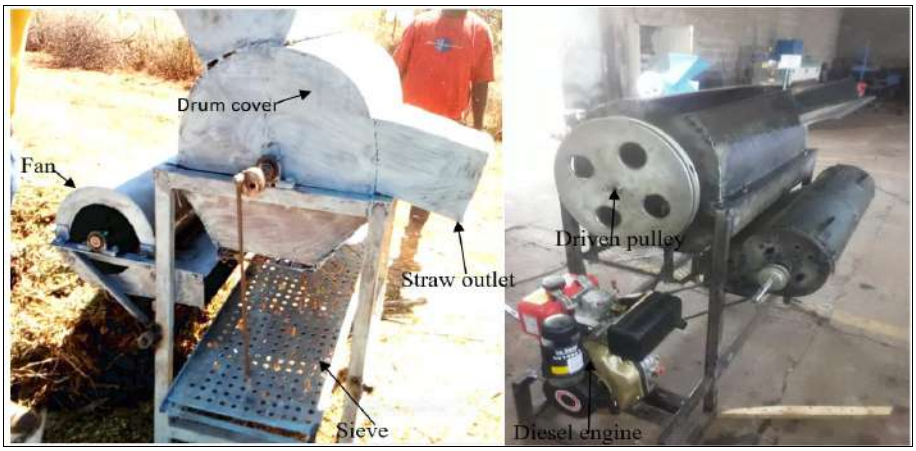

Fig 2: Testing procedure and evaluation

Stripping capacity

It was the quantity of the groundnut pods detached from the vein in unit time. It was calculated as (Mahmoud *et al.*, 2007):

$$\text{Stripping capacity} = \frac{\boldsymbol{Wt.of\ pods}}{\boldsymbol{Time}} (\text{kg/hr.}) \quad (1)$$

$$\text{Percentage of unstripped pods} = \frac{\textbf{Wt.of unstrippedpods}}{\textbf{Total wt.of pods}} * 100 \quad (2)$$

Percentage of unstripped pods

It was the quantity of the groundnut pods not detached from the vein in unit time. It was calculated as (Mishram and Desta, 1990):

Pods damage

Damaged pods was calculated as follows (%) (Mishram and Desta, 1990):

$$\text{Damaged pods} = \frac{D_P}{T_P} * 100 \quad (3)$$

Where:
*D*p = Mass of damaged pods kg
*T*p= Total mass of pods, kg

Cleaning efficiency

Cleaning efficiency of the machine was calculated as by (Ukatua, 2006):

$$\text{Cleaning efficiency} = \frac{C_P}{T_P} * 100 \quad (4)$$

Where: Cp= clean pods kg
Tp= Total weight of the sample pods kg

Treatment and Experimental design

The experimental design was a RCBD design according to the principle of factorial arrangements with three replications. The three levels of drum speed and the three levels of feeding rate were used, and each replicated three times. The experiment design was laid as 3^2 with three replications and had total of 27 test runs (3x3 x3 = 27).

Data analysis

Analysis of variance for the design was carried out using Genstat 18th edition software for the parameters studied following the standard procedures applicable to randomized complete block design (RCBD) outlined by Gomez (1984) [4].

Result and Discussions

This study was undertaken to modify the machine by incorporation of cleaning unit. Physical properties of pods involved in the study were investigated to optimize the design of the machine component parts. Performance indicators such as threshing capacity, cleaning efficiency and pod breakage of the machine were identified in the next table1.

Table 1: effect of drum speed and feeding rate on machine performance

Drum speed (rpm)	Feeding rate (kg/hr)	Threshing capacity (Kg/hr)	Cleaning efficiency (%)	Pod breakage (%)
250	630	150	65.67	3
	660	160	66.00	3.1
	890	190	66.33	4.2
280	630	160	74.33	15
	660	160	75.00	9
	890	180	75.67	6
310	630	210	77.00	21
	660	216	78.67	11
	890	190	79.00	8.4
LSD 5%		2.77	3.87	1.5

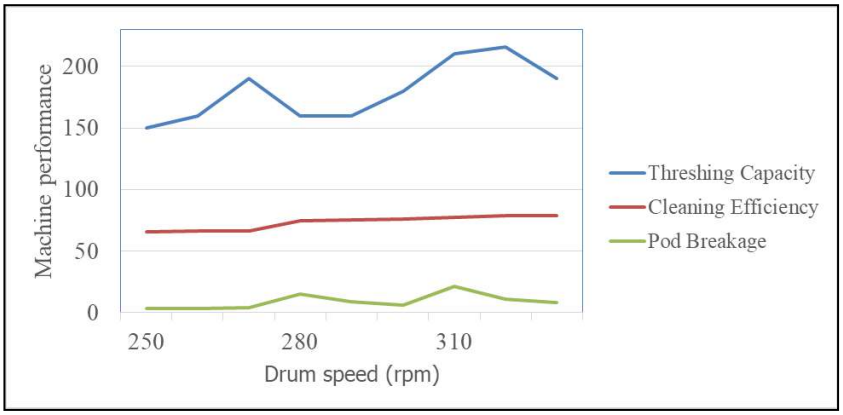

Fig 1: Performance of the machine on stripping (threshing), cleaning efficiency and pod breakage

Operational speed had significant effect on cleaning efficiency. Increasing speed of operation from 250 rpm to 310 rpm had a significant effect on stripping capacity for all feeding rate. From above Table the effects of drum speed and feeding rate on mean stripping capacity and cleaning efficiency identified. The highest stripping capacity and cleaning efficiency was recorded at drum speed of 310 rpm as 216kg/hr. and 79% while the lowest stripping capacity and cleaning efficiency obtained at drum speed of 250 rpm as 150 kg/hr. and 65.67% respectively. But pod breakage at higher drum speed was recorded as 21% and which is not desired. In addition to pod breakage the scattering of stripped pod was very high at higher speed of operation because of high vibration of sieve at this speed. In general, increase in operational speed tended to increase percent of pod breakage and scattering effects. Therefore the machine was recommended at the lowest drum speed.

Conclusions and Recommendation

This study was undertaken to modify the machine by incorporation of cleaning unit. Performance indicators such as threshing capacity, cleaning efficiency and pod breakage of the machine were 190kg/hr, 66.33% and 4.2% respectively at the recommended operating speed. The machine provides better help to farmers so that they can save their time and labor during groundnut stripping. From the above result one can conclude that machine should be operated at lower speed.

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