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DESIGN, CONSTRUCTION AND EVALUATION OF GROUNDNUT SHELLING MACHINE PEDAL OPERATED

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ABSTRACT

Shelling is the removal of grains from their stalk or pod by stripping, impact action, rubbing or any combination of these methods. The most popular method of shelling which is still widely used in the northern part of Nigeria is the method of crushing or pressing the pods between the thumb and the finger to break off the pods and release the seed. This method has low efficiency, it is time consuming, and has high demand of energy. In addition, the output per-man hour is as low as 1-2.5kg of groundnut. There are different methods of shelling and different machines have been fabricated and used to shell wide variety of crops under different condition. The peasant farmer cannot afford these machines because they are too costly and complex in operation and maintenance. Also the operator had to be trained and spare parts imported. These factors increase the overall cost of production which does not make any economic sense to the farmer which necessitated the need for designing, construction and evaluation of a groundnut shelling machine pedal operated. Materials for the design include shaft, chain, sprocket, bearing, Sheller bit and columns. The product to be shelled is fed through the hopper which falls into the shelling chamber which is powered by pedaling by means of chain and sprocket connections. The concave forms the base of the crushing chamber which allow the ground nut to move in between the Sheller bit and the concave where they will be shelled falling through the perforation on the groundnut concave which has higher production output and easy to maintain.

KEYWORDS:- *Groundnut, shelling machine pedal operated*

INTRODUCTION

Groundnut is the sixth most important oilseed crop in the world. 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. Over 100 countries worldwide grow groundnut. Developing countries constitute 97% of the global area and 94% of the global production of this crop. The production of groundnut is concentrated in Asia and Africa (56% and 40% of the global area and 68% and 25% of the global production, (Acharya, 1990). Over 60% of global groundnut production is crushed for extraction of oil for edible and industrial uses while 40% is consumed in food uses and other "such as seed for sowing in the next season crop" (Birthal, Nigam, Narayanan and Kareen, 2011). Groundnut haulms constitute nutrition

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fodder for livestock, they contain protein (8-15%) lipids (1-3%) mineral (9-17%) and carbohydrate (38-40%) at level higher than cereal fodder. The digestibility of nutrients in the groundnut haulm is around 53% and that of crude protein is 88% when feed to cattle. Haulms release energy up to 2337 Cal Kg^{-1} of dry matter. Being a legume crop, groundnut help in improving soil health and fertility by leaving behind Nitrogen (N_2) and organic matter in the soil. (Pasupaleti, Nigam, and Rajeev, 2013)

Shelling is the removal of grains from their stalk, pod or cub, either by stripping, impact action and rubbing or any combination of these methods. Kulbhushan, Nitin, and Abhijit, (2017) in their research paper it is reported that based on the shelling action they can be divided into two categories. Hand operated and pedal operated, hand operated groundnut decorticator 50-75Kg per hour capacity was evaluated, whereas a pedal operated groundnut decorticator was found to have capacity of 75Kg/hour.

The most popular method of shelling which is still widely used in the northern part of Nigeria is the method of crushing or pressing the pods between the thumb and the finger to break off the pods and release the seed. This method has low efficiency, it is time consuming, and has high demand of energy. In addition, the output per-man hour is as low as 1-2.5kg of groundnut. There are different methods of shelling and different machines have been fabricated and used to shell wide variety of crops under different conditions (Ebunilo, Orhorhoro, Oviorunraye, and Owunna, 2016). The peasant farmer cannot afford these machines because they are too costly and complex in operation and maintenance. Also the operator had to be trained and spare parts imported. These factors increase the overall cost of production which does not make any economic sense to the farmer. Hand operated shelling machine which is of concave or semi-rotary design is widely used locally. It had no expelling unit; hence separation is achieved by winnowing. A simple hand operated groundnut Sheller has a semi-cylindrical screen closed on both sides. A shaft carrying a lever at one end is fixed across the centre of the semi-cylinder. On the lever is a pair of plate with shoes or beater bars, having blunts on their undersides. For successful operation of the machine, the operator stands by the side, then holding the operating lever (handle) and swinging it by pushing to and fro to provide shelling action on the shoes assembly. The semi-rotary, action of the shoes shells the pods against the screen. The major short coming of this machine is that it is labor intensive and consumes lots of time. Output is about 60-80kg/hour. This particular design overcomes all those short comings and also has an improved efficiency. It comprises the hopper, crushing chamber, separation chamber and the blower unit. It is also powered by pedaling, which saves time and with a well improved shelling capacity. The machine is also in light weight and easy to operate and maintain, the spare parts are also available locally Ugwuoke et-al (2014). In the beginning the nuts were separate from shell by workers. The hand method by opening the pod up and groundnut is removed from it, the method is very slow and it was also boring and production rate is in small quantity, and also the traditional method of separating nuts from groundnuts by putting the peanut in a cloth bag and rolling over it with a rolling pin, the technique did good job of cracking the shell (deleting the pain full finger problem).This is not a reliable method for shell a groundnut due to the crack the groundnut and nut mixed with shell basic on this the traditional method is not a sufficient method for separating the groundnut. The researchers identify some major problem and to overcome this problem, in views of this research it develops and evaluate groundnut shelling machine pedal operated. The research objectives include to:-

- To design and construct a simple groundnut shelling machine pedal operated
- To design adjustable shelling bit
- To reduce the fatigue involve during operation of the machine
- A machine which easy to operate and maintain.

Sheller's are generally machine used for the removing of shells (husk) of groundnut, bean, and cowpea e.t.c by opening their bivalves. The groundnut Sheller is a machine designed specifically for shelling groundnut from its shells.

Ugwuoke et-al (2014). Their work focused on the design and fabrication of a groundnut shelling and separating machine electrically powered by a 1hp motor. The machine has a capacity of shelling 400kg of groundnut per hour with shelling and separating efficiencies of 95.75 percent respectively. The machine is cheaper to maintain. It is also light weight and comprises of the hopper, crushing champers, separation champers and the blower unit, but required a trained labour.

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Handa et-al (2014) Design and fabrication of a groundnut Sheller machine, the performance of the machine was evaluated in terms of through shelling efficiency, material efficiently and mechanical change. Anantachar et-al (1997) Development and performance evaluation of pedal operated decorticator. The major component of the decorticator is Sheller shaft, sieve, decortications champers, hopper, and supporting frame of a pedal operated device.

Mathew John (1992) In Nigeria a student of federal university of technology in Adamawa state fabricates the manually operated fabricated in 1992.Sanusi Abubakar (2012) made two improvements on the machine, to reduce the fatigue and difficulty in using the manually conventional type by employing the use of electric motor or diesel engine as the power source.

METHODOLOGY

Materials for the design and construction of the modified groundnut Shelling machine were the shaft, the chain sprocket, and bearing. Sheller bit, the columns. The material were locally purchased and they are selected based on the power required for the groundnut Shelling machine. In order to achieve high efficiency reliability and cheap method of producing the shelling machine, the researcher take into consideration the principles of operation of the machine, convenience of operation rate of shelling to meet commercial needs ease of manufacturer of the machine among others. In this research the vertical is replaced by a pedaling system which was peddled by an operator as it obtains in a bicycle. The Sheller unit is bolted down and can be dismantled for service by loosening the bolts which holds down bearing house.

The following parameter were calculated using the standard formula as given below by Nagesh, Mohan, Dhanush, and kiran, (2018).

Shelling Capacity, $Sc = \frac{60Ws}{T}$

Where Sc = shelling capacity, Kg/h
Ws = Weight of shelled groundnut, Kg
T = Operating time, Minute.

Breakage Percentage, $Br = \frac{Wb}{Ws}$ X 100

Where Br = breakage percentage
Wb = Weight of broken groundnut, Kg
Ws = Weight of shelled groundnut, Kg

Unshelled groundnut, $Ung = \frac{Wng}{Wg}$ X 100

Where Ung = Unshelled groundnut, %
Wng = Weight of unshelled groundnut, Kg
Wg = Weight of total feed, Kg

Separation efficiency, $Es = 1-\frac{Wu}{Wt}$ X 100

Where Wu = weight of unshelled groundnut, Kg
Wt = total weight of groundnut feed in the machine, Kg.

Design Parameters

The researchers put into consideration parts of the groundnut Sheller machine which includes the following: -

Chain

To eliminate the use of large diameter gear on this machine chain is then used. They can either be block chain, roller chain or inverter troth, sometimes celled silent chain and each is suitable for different types of operations. The researchers make used of the roller types of chain because is rugged and durable and if properly selected installed and lubricated it give a very good service.

Sprocket

This involve the use of bicycle sprocket to provide the power, it was a simple task to attach the bicycle sprocket to a platform where the operator sits on the platform and pedal, which in turn powered the sprocket B. And it is cheaply found in local market and for this reason it is selected for the machine. The choice of sprocket and the chain is based on power take off.

Sheller Bit

It is made up of wood and steel fixed to a rotating shaft, as it rotates. It creates a pressure there by shelling the groundnut seeds on the groundnut concave where both the shells and the groundnut seeds comes out from it.

Bearing

The shaft is supported by ball bearing which are located inside the bearing housing and bolted to the mainframe. The ball bearing has the following advantage.

- Low coefficient of fraction
- Have less axial space.
- Lubrication is simple
- Wear is negligible if lubricant is correct

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Columns

They are vertical supports that carry machine or structures. They can be made up of wood, metal, or concrete. But in this research, the researchers make use of metal.

Design Analyses

The various dimensions of the machine have to be determined for the successful operation of the machine. The important parameter includes: -

Shafts

For solid shaft as in the groundnut shelling machine the required shaft size is given by

$Ss = 16Mt/\pi d^3$ ---------- (1)

Where: - Ss =Shear stress 4000N/m² for shaft with key ways.

Mt =Tensional moment.

D = shaft diameter

but the tensional moment acting on shaft can be determined from Mt =9550Kw/rpm and the power produced by a normal human is 50w. Also the average number of revolution per minute is 15.

Angle of Twist (θ) = $584MtL/Gd^4$

Where:- G =Tensional modules of elasticity N/m.

Θ = Angle of twist (degree).

L = shaft length (m).

D = shaft diameter (m).

Sprockets

To determine the pitch diameter of the bigger and smaller sprocket is given by: -

Bigger $D1 = P/\sin(180/T_1)$

Smaller $D2 = p/\sin(180/T_2)$

Where: - D = diameter of the sprockets.

P = pitch diameter 1.24 standard.

T = Number of teeth.

Speed Ratio for two Sprockets is given by

$U = T_1/T_2$

Chain The length of the chain is given by

$L = P(2c/p) + N1 + N2/2 + (N2 - N1)^2/NT\pi^2 (c/p)$

Where:- L = length of the chain

P = chain pitch

N1 = number of teeth on smaller Sprocket

N2 = number of teeth on the larger Sprocket

Volume of the Sheller

The volume of the Sheller is given by

$V_O = V_1 - V_2$

But V1 = Volume of the drum containing

$V1 = \pi r_1^2 L_1$

Similarly, V2 = Volume of the shelling drum is given as

$V2 = \pi r_2^2 L_2$

Where:- d_1= diameter of the drum

d_2 = diameter of the shelling drum

r_1 = radius of the drum

r_2 = radius of the shelling drum

L_1 = length of the drum

L_2 = length of the shelling drum

The Volume of the Shelling Unit is given by

$V_0 = V_1 - V_2$

Assembly of the Machine

In this research the hopper was be welded to the shelling unit casing, and the discharge unit were also being welded to the shelling unit at the bottom side which covers the groundnut concave as intended to. The shelling unit which carries the hopper and the discharge unit was mounted into the frame and were bolted to the frame. And the transmission shaft passes through the horizontally inserted or place inside the shelling unit casing. two bearings were fitted into the two bearing housing and the two bearing were welded permanently into the two bearing housing case which was inserted into transmission shaft from both ends and bolted to the drum casing.

Chain sprockets was fitted to the shaft, thus the smaller one on the shaft, while the bigger one was placed under the operator seat as it is with the bicycle, also the handless and seat were also fitted into the mainframe by bolt and nuts.

Operation of the Machine

The product to be shelled is fed through the hopper which falls into the shelling chamber. The machine is powered by the operator by means of pedaling which is transmitted through the chain and sprockets connection. The concave forms the base of the crushing chamber enable the groundnut to move in between the Sheller bit and the concave where the shelled groundnut fall through the perforation in the groundnut concave.

CONCLUSION

The groundnut shelling machine has been designed and developed, performance test was conducted on the machine. There are several numbers of important conclusion that have been observed: -

1. The operation was performed automatically and did not require high skilled labour

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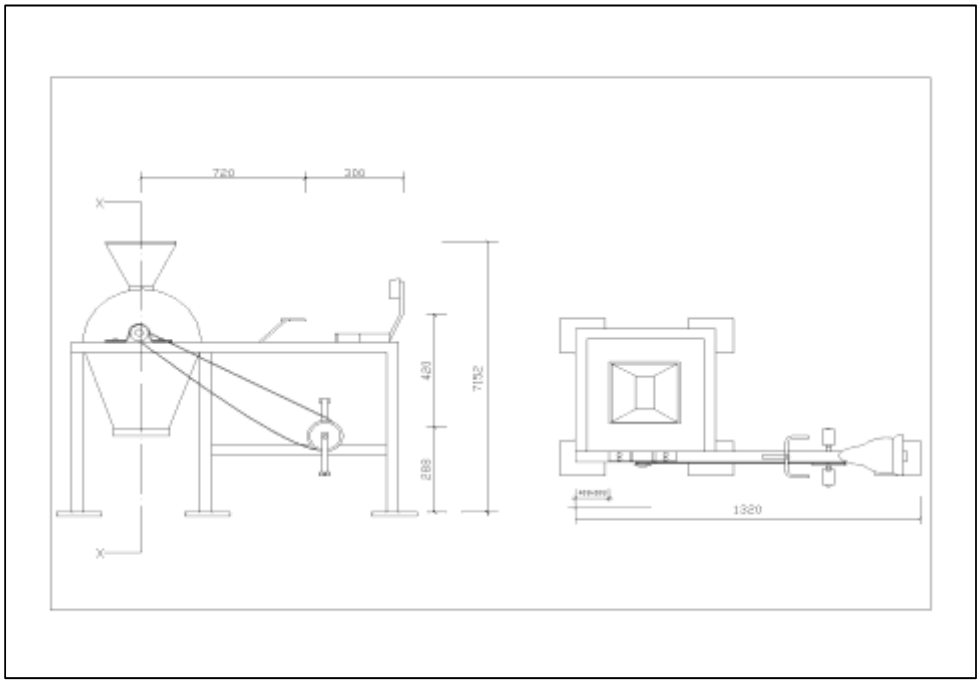
2. It can be used for both household and industrial purposes
3. Government and private sector as well as individuals should engage and encourage the design of this machine, as well as mass production of this type, so that farmers in rural areas can easily get it within their reached.

Working Drawing



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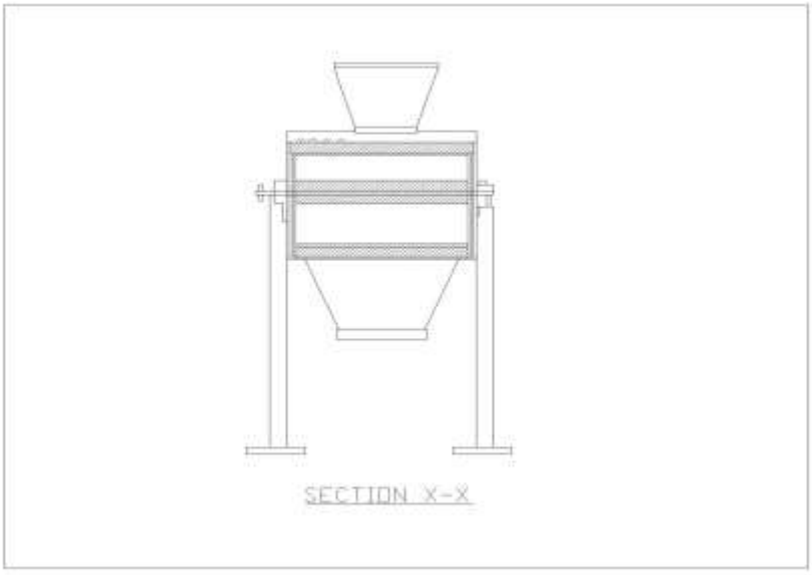

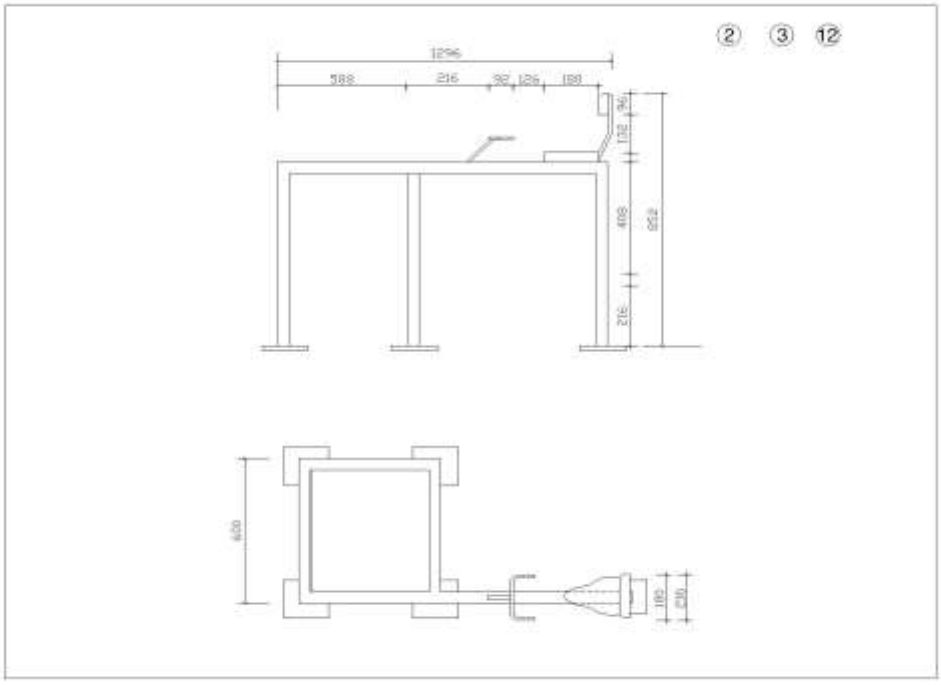

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REFERENCES

1. *Acharya K.T.(1990).Oilseeds and Oil Milling in India: A Cultural and Historical Survey, Oxford ans IBH New Delhi.*
2. *Anantachar M. Maurya, and Naravani B. (1997). Development and performance Evaluation of Pedal Operated Decorticator, College of Agricultural Engineering, Raichur. Department of Farm Power and Agro Energy.*
3. *Birthal, P.S. Nigam, S.N. Narayanan, A.V and Kareen, K.A. (2011). An Economic Assessment of the Potential Benefits of Breeding for Drought Tolerance in Crops. A Case of Groundnut in India. Research Bulletin Number 25 Patancheru: International Crops Research Institute for the Semi - Arid Tropic.*
4. *Ebunilo, P.O. Orhorhoro,E. K. Oviorunraye, E.J. and Owunna, I.B (2016). Design and Development of Low Cost Groundnut Shelling Machine*
5. *Handa C. and Ashish .S. Raghtate (2014). Design and Fabrication of Groundnut Sheller Machine. Department of Mechanical Engineering KDK College Engineering Nagpur India.*
6. *Kulbhushan, M.S. Nitin, B.B and Abhijit, M.B. (2017). Design and Fabrication of Pedal Operated Groundnut Decorticator Machine International Journal for Mechanical Engineering Research (IJMER) ISSN2249-6645*
7. *Ikechuwkwu C. Ugwuoke, Olawale J. Okegbile and Ibukum B. Ikechukwu (2014). Design and Fabrication Of Groundnut Shelling and Separating machine, Department of Mechanical Engineering, Federal University of Technology Minna Niger State, Nigeria.*
8. *Mathew John (1992). Design and Fabrication of Manually Shelling Machine. Federal university of Technology Yola, Adamawa State.*
9. *Nagesh, S.B. Mohan, N. Dhanush, M.G. and kiran, B. (2018). Design and Development Mobile Groundnut Decorticator. International Journal for Research in Engineering Application & Management (IJREAM) ISSN2454 - 9150 ,47 - 50*
10. *Pasupaleti, J. Nigam, S.N. and Rajeev, K.V (2013). Groundnut Improvement: Use of Genetic and Genomic Tools.*
11. *Sanusi Abubakar (1992), Design and construction of an improve groundnut shelling machine. Ramat Polytechnic Maiduguri, Borno State Nigeria.*