International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 01 | Jan 2020 www.irjet.net p-ISSN: 2395-0072

DESIGN AND DEVELOPMENT OF A HAND GUIDED MOTORISED RICE HARVESTER

Faleye Tope[1], Adewumi O. Abimbola[2], Adeyi A. Mashood[3], Willoughby F. Ayinde[4], Kamal A. Rasheed[5]

[1,2,3,4]Farm Power and Machinery Department, NCAM, Ilorin, Nigeria
[5]Head of Department, Farm power and Machinery Department, NCAM, Ilorin, Nigeria

---***---

Abstract – The main purpose of this Project is to help small scale farmers whom having land area less than 5 acres by designing small scale Motorised harvester to harvest rice very efficiently. Our project work focused on ease of harvesting operation to the small scale farmers for harvesting rice in less time and at a low cost by considering different factors such as cost of equipment, ease of operation, time of operation and climatic conditions. This machine has cutting blades which cut crops in scissoring type of operation can cut up to two rows of crops. The power unit for this machine is Petrol engine of 8.53 HP. This power is transmitted through gear box, sprocket-chain mechanism to the cutter blades and other power requiring mechanisms for performing cutting, harvesting, and conveying the paddy into the storage unit. This harvester might be the best solution for the problems faced by small scale farmers relating with availability of labors.

Key Words: Harvesting, Rice, Motorised, Cutting, Manually.

1. INTRODUCTION

Rice is the seed of the monocot plants oryza sativa. As a serial grain, it is the most widely consumed staple food for a large part of the world's human population. It is the grain with the third highest worldwide production, after sugarcane and maize, according to data of FAOSTAT [1]. Rice being one of the most important foods for human consumption has a basic roll to play in food security in Nigeria and the world entirely. Although rice grows well in all the six geo – political zones of Nigeria, the desire for polished long grain, stone free and odorless rice by the urban dwellers has fuelled the demand for imported rice. Total demand for rice in Nigeria is put at about 5million tons (MT) a year out of about 3.2million tons (MT) are produced locally. The high cost of importation in recent years has highlighted the desire by the government to encourage import substitution by encouraging increased local production.

Harvesting is an important field operation for any grain crops and its cutting process is carried out when the crops attain such physiological maturity that a maximum recovery of quality product is obtained. Harvesting a crop at an appropriate stage of maturity minimizes the field losses thereby increasing the total yield as well as head yield, Tado et.al (2). Harvesting of field crop is considered a labour intensive operation and takes about 185-340man h/ha to cut and bundle paddy or wheat crop Michael et.al (3) and 170-200man h/ha for cutting paddy crop, Konger (4). Results of investigation in Iran showed that Reapers has higher Effective field capacity than hand harvesting tool, Hasanjani et. al. (5).

Although rice harvesters have been developed in so many developed countries but the cost of purchasing is too high for the peasant farmers in Nigeria, it is therefore necessary to develop a rice harvester that is more efficient, simple, locally made and affordable for Nigerian farmers.

1.1 TRADITIONAL HARVESTING METHOD

In traditional harvesting method, the crop is cut manually by labour and then this crop is get threshed by Thresher. It takes time and it is not effective as they can work only less than 6 hours in a day. Even the small scale farmers who having land less than 5 acres, will spend two to three days to cut and harvest the crops. In case of weed infestation after planting harvesting is more tedious work, it will take additional to separate the weeds from crop.

Fig. 1: Traditional Harvesting Method

1.2 AIM AND OBJECTIVE

The aim of this research work is to design and fabricate a Hand Guided Motorized Rice Harvester.

The objectives are to:

1. To make rice harvesting more easily for farmers.
2. To reduce cost of labour.
3. To enable easier operation.
4. Lower power consumption
5. Simple structure with respect to human ergonomics

2. METHODOLOGY

This is a walk behind type harvester which is motorized and cuts the rice from 10-15cm above ground. This machine is made of locally sourced materials which is easy to maintain or repair and also cost effective. The harvester is powered by the 8.53Kwatt, 3000 rpm petrol engine. With the help of V-belt, drive power is transmitted to gearbox. Here, one end of this output shaft is connected to slider crank mechanism which converts rotary motion of shaft into reciprocating motion of cutter blade. Reciprocating cutter blade slides over fixed blade and creates scissoring action responsible for cutting the crops after which the conveyor conveys the paddy into a container where the harvested paddy will be collected for drying. Collecting mechanism consist of V-belt with collecting plates bolted on it.

The harvester was fabricated and sized based on the designed dimensions shown in the drawing using AUTOCAD. All the materials used for the fabrication of the machine were locally sourced.

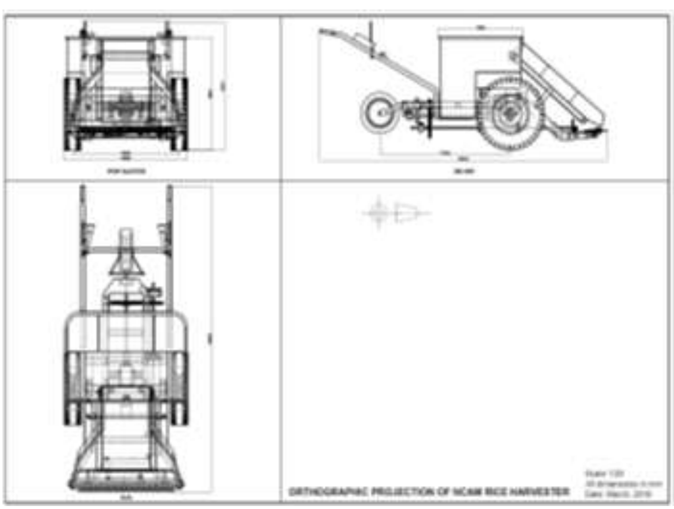

Fig. 2: Orthographic projection of the harvester

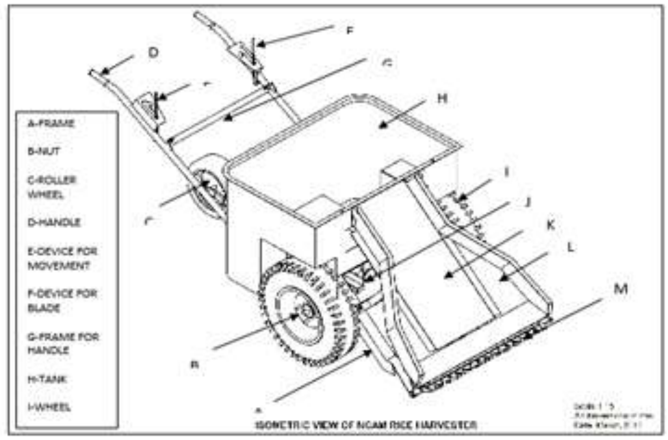

Fig. 3: Isometric view of the harvester.

2.1 DESIGN OF MACHINE COMPONENTS

A. DESIGN FOR CUTTER BAR KNIFE

The shape and dimension of a standard cutter bar knife is given according to Celik (6)

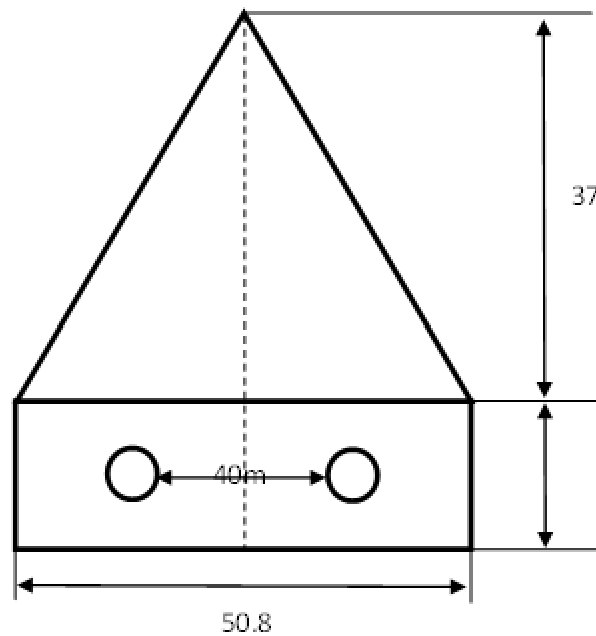

Fig. 4: Cutting Knife

The shape of the knife is typically combination of a triangle and rectangle and considering the area of the two shape;

1. Area of triangle = $\frac{1}{2}bh = \frac{5.08 \times 3.7}{2}$ = 9.398 cm^3
2. Area of rectangle = $lb = 3 \times 5.08 = 15.24$ cm^3

∴ Total area of knife = 9.398 + 15.24 = 24.638 cm^3

Volume of Knife = Area x Thickness = 24.638 x 0.25

= 6.1595 cm^3

Mass = Density x Volume

Density of mild steel = 7.85 g/cm^3

Mass of (1 knife) = 6.1595 x 7.85 = 48.35208 g

= 0.04835 kg

Weight of (1 knife) = 0.04835 x 9.81 = 0.4743 N

Since assumed theoretical cutting width = 900 mm

and width of knife = 50.8 mm

∴ Number of knife on a gang = 17

Mass of moving gang of knife = 0.04835 x 17 = 0.822 kg

Hence weight of moving gang = 0.822 x 9.81 = 8.06 N

The knives was bolted on a rectangular bar.

Fig. 5: Rectangular bar

Volume of bar = 90 x 2 x 0.25 = 45 cm^3

Mass = 45 x 7.85

= 0.353 kg

= 3.463 N

∴ Weight of moving part = 8.06 + 3.463

= 11.527 N

B. POWER REQUIRED TO DRIVE THE MECHANISM

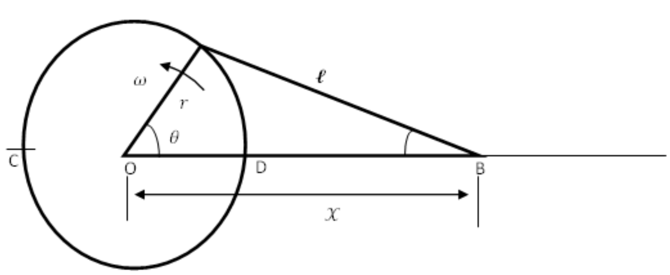

Fig. 6: The line of motion of a slider-crank mechanism

The line of motion of a slider-crank mechanism required to drive the moving part is represented in the Fig 6.

And: r = crank radius

ℓ = length of the connecting rod

ω = crank speed in radians

$q = \frac{\ell}{r}$

$q \geq 3.5$ in the majority of engines , Srivastava et al. (7)

$$\therefore \quad F = m\omega^2 r \left(cos\theta + \frac{1}{q} cos2\theta\right)$$

$$= (1.175)(2\pi)^2(0.05)(cos360 + \frac{1}{3.5}cos2(360))$$

= 2.9815 N

Thereafter, the material, size of component, belt conveyor and engine were selected.

3. FABRICATION AND MACHINE EVALUATION

The harvester was fabricated at the engineering workshop of National Centre for Agricultural Mechanization (NCAM) Ilorin, Nigeria. The harvester was fabricated and sized based on the designed dimension in the prototype drawing using AUTOCAD.

Fig. 7: The Motorised Harvester

3.1 EVALUATION RESULTS

The Motorised harvester is built to be compact and very efficient in cutting the crop, the preliminary test conducted on the machine shows that its cutting capability and efficiency was appreciable and it performed according to the designed specification. The cost of harvesting by this machine is considerably less than manual harvesting, the engine delivered the required power to run the harvester and its reciprocating action was satisfactory.

3.2 COMPARISON OF HARVESTING COST BY TRADITIONAL METHOD AND THE MOTORISED HARVESTER

A. Harvesting done by Manual Process

Amount paid to the labour for one day = ₦1, 500

Total number of labour required to harvest 1 acre in a day = 5

Total labour cost is 1, 500 x 5 = ₦7, 500

B. Harvesting done by Harvester

Quantity of petrol required for 1 acre = 4 Liters

Cost of petrol per Liter = ₦145

Cost of petrol per day = ₦145 x 4 = ₦580

Cost of Labour (Operator) per day = ₦1, 500

Total cost of harvesting = Cost of petrol + Labour Cost + Maintenance = 580 + 1,500 + 200 = ₦2, 280

Amount saved using harvester = 7,500 – 2, 280 = ₦5, 220 per day, per acre.

4. CONCLUSIONS

The primary objective of this work is to develop a hand guided motorised rice harvester which is simple and cost effective. The objective has been successfully met, simple and cost effective rice harvester was developed. The following conclusions were done based on the work carried out.

- A detailed design of Hand Guided Motorised Harvester which included cutting system, transmission of power from the engine to the conveyor and main frame has been carried out.
- All the components of the harvester have been fabricated successfully.
- A complete AUTOCAD drawing of all the components was done and this will aid fabrication process by local fabricators whom depends on technology transfer.
- The assembled harvester has been tested and its working found satisfactory, it makes the harvesting process faster hence reduces the time required to harvest the same area manually, which leads to reduction in cost of harvesting by 60%.

REFERENCES

(1) Food and Agricultural Organization (FAO) 2004, Statistics Bulletin, www.fao.org.
(2) Tado, C.J.M. and G.R. Quick. (2003). Development of pedestrianrice harvester. Proc. Int. Conf. on Crop Harvesting and Processing, ASABE, St. Joseph, Michigan, 9-11, February 2003.
(3) Michael AM, Ojha TP (1987). Principles of agricultural engineering, Vol 1. New Dehli, ML Jain for Jain Brothers. Pp34 - 35
(4) Koniger R (2003). Tentative theory for the cutting of plant stems. Grundlagen der Landtechnik 5: 96-97.
(5) Hasanjani H, Hoseyni M, Khademolhoseyni N, Alizade M (2007). Evaluation of different harvesting method in Guilan. J Agric Sci 9 (1): 23-38.
(6) Celik A. (2006). Design and Operation Characteristics of a push type cutter bar mover. J Canadian Bio systems Engineering Vol. 48, Pp 223-227.
(7) Srivastava, A. K., C. E. Goering and R. P. Rohrbach. (2006). Hay and Forage Harvesting. In Engineering principles of agricultural machines, 325. ed. Anonymous, St. Joseph, Michigan: American Society of Agricultural Engineers.