*Quest Journals*
*Journal of Research in Agriculture and Animal Science*
*Volume 8 ~ Issue 7 (2021) pp: 09-15*
*ISSN(Online) : 2321-9459*
www.questjournals.org

**Research Paper**

# Design And Fabrication Of A Three-Row Grain Planter

*Osadare T., Isinkaye O.D., and Koyenikan O.O.
*Department of Agricultural and Bio-Environmental Engineering,*
*The Federal Polytechnic, Ado-Ekiti, Ekiti State.*

***ABSTRACT***
*A three-row grain planter was designed and fabricated at the Department of Agricultural and Bio-Environmental Engineering, The Federal Polytechnic, Ado-Ekiti. The machine is easy to operate, maintain and repair. It is also easy to transport since the machine is detachable. The planter was designed and fabricated to improve its efficiency and reduce the percentage of seed damage by using TEFLON for its metering device. The major components of the planter include seed hopper, seed metering mechanism (TEFLON), seed tube, furrow opener, furrow closer, hitch point, and wheels. The tests result from the laboratory calibration gives a capacity of 18kg/ha. The planter was designed for each unit to operate independently and the unit is adjustable to suit the various planting distances of other grains. The seed plate is changeable to suit the different shapes and sizes of grains. The laboratory testing/calibration shows that the planter delivers 2 or 3 seeds per hole at an interval of 56.80 cm for maize. The percentage of seed damage recorded by the planter was 7.56%. The cost of the planter is ₦95,500*

***KEYWORDS:*** *Three-row grain planter, TEFLON, Metering mechanism*

*Received 20 June, 2021; Revised: 03 July, 2021; Accepted 05 July, 2021 © The author(s) 2021. Published with open access at www.questjournals.org*

## I. INTRODUCTION

In Nigeria, the major problems grain planting is facing are drudgery, time consumption during planting period and the huge cost of affordable simple planting machinery. This has resulted in the reduction in input and low yield of crops (grains) which then causes the shortage of food supply in the country (Matin *et al*, 2010).

The planting operation is one of the most important cultural practices connected to crop production. An increase in crop yield, cropping dependability, cropping regularity and crop returns all depend on the undeviating and timely establishment of optimum plant populations (Roy *et al*, 2011).

There are two broad areas in optimizing plant establishment. First, plant breeders, seed growers, and seed merchants, which have a duty to provide quality seed. Second, farm managers must be conscious of the agronomic supplies for optimum plant establishment and be able to deduce this information in a meaningful way so as to assist with the selection, setting, and management of all farm machinery, particularly planters. The problem of sufficient grain production as meeting domestic food demand could easily be solved by the mechanization of the planting of grains (Matin *et al*, 2010).

Maximization of yield is the core aim in most of the agricultural sectors. To meet this mandate, there is a need to replace the primitive agricultural system being practiced in Nigeria with a mechanized system that is more profit-oriented. This will result in the production of a machine that can bring good performance. Thus, there is a need to reduce the time involved during planting operations apart from reducing the labor involved in planting. Therefore to eliminate some of these problems and achieve the desired aim of profitability, a simple three-row planter was proposed for affordability, ease of operation and ease of maintenance for small-holder farmers.

## II. MATERIALS AND METHODS

### 2.1 Description of the Planter

The three-row grain planter was developed at the Department of Agricultural and Bio-Environmental Engineering, The Federal Polytechnic, Ado-Ekiti, Ekiti State. The features of the planter include seed hopper, seed metering device, furrow opener, furrow coverer, drive wheels, seed tube and point of attachment to the tractor.

**(i) The frame**

The frame is made of mild steel angle sections and flats. It is strong enough to withstand all types of loads in working conditions. All other parts of the planter are fitted to the frame. It is rectangular and made up of 5mm thickness angle iron which is made up of steel and is used for general engineering purposes because of its good welding properties. It is cut into 100cm length and 30cm breadth. It is like the chassis of the planter, it forms the basis on which other components are fixed. The material of the frame was selected based on achieving a reasonable weight and required strength and reliability and readily available material.

**(ii) Seed hopper**

The seed hopper contains seed and the seed metering device. The amount of seed contained depends upon the size of the seed hopper. The seed hopper is a container in which the seeds to be planted are kept (transitionally) before their gradual release into the furrowed tunnel. The hopper has the shape of a frustum of a pyramid truncated at the top. To ensure the free flow of seeds, the slope of the hopper was fixed at 30°, which is modestly higher than the average angle of repose of the seeds. The material used for the design was 3mm thick mild steel sheet metal. The dimension of the top part of the hopper is 250 by 150 mm.

**(iii) Metering device**

The metering device is one of the most important parts of the planter. The seed rate and the seed spacing are adjusted by the metering device. The function is to distribute seeds uniformly at the desired application rates. It also controls seed spacing in a row. Proper design of the metering device is an essential element for the satisfactory performance of the seed planter. The seed metering device used for this work is the Teflon roller type which is 90cm in diameter with a cell on its periphery. The size of the cell on the roller depends on the size and number of the seed and desired seed rate. In this design, the Teflon roller lifts the seeds in the cells and drops these into the seed funnel which is conveyed to the open furrow through the seed tube.

**(iv) Furrow opener**

This is a component that opens the soil for the seeds to drop into. The furrow opener opens the soil where seeds metered out and falling through the seed tube will be dropped into and covered. Soil type, soil condition, angle of attack and depth of planting was considered in designing the furrow opener. The type of furrow opener used for this project is the shovel type in-furrow opener which gives a 'v' shaped displaces the soil sideways for easy planting. The mild steel is slightly beveled at the lower edge to facilitate an easy cut through the soil.

**(iv) Furrow coverer**

This is a component part of the planter which closes the furrow with soil after the seed has been dropped in it. Covering of furrow is usually done by chains, bars, packers, rollers or press wheels, designed in various shapes and sizes. The furrow closer is made of galvanizing steel angular plate of dimension 220 mm by 140 mm. The rod for attachment to the support was welded to the middle of the upper edge of the plate.

**(v) Seed Tube**

This is the channel through which seeds are conveyed to the furrow. The material used was the metal pipe of length 150 mm joined with a rubber hose. The outlet diameter is 25.4 mm.

**(vi) Drive wheels**

This is two wheels fitted on an axle for transporting the planter on farmlands. Iron wheels are used as transport wheels. Some manufacturers use pneumatic wheels. One of the transport wheels is fitted with a suitable attachment to transmit the motion of the wheel to the seed metering mechanism when the planter is in operation.

The wheels have spindles that have to bear bolts and rotate the metering device. The surfaces of the drive wheels are fixed with 10 mm long sheets of steel-cut from10 mm diameter iron rod that provides necessary soil rolling resistance during the forward movement of the machine.

The diameter of the wheels is 600 mm. The circumference of the wheel is designed such that it is twice the required seed spacing within the row to enable the planter discharge twice in one revolution of the wheels.

## 2.2 Design Considerations

The design of a three-row grain planter is based on the following considerations:

(i) The planter is simple in design with the use of locally available materials for the fabrication of the component parts.

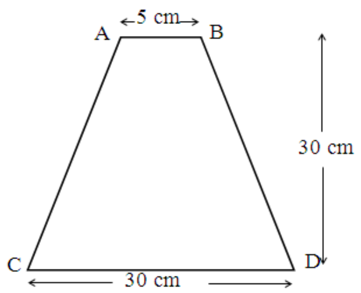
(ii) The ease of fabrication of the component parts with simple joinery methods.

(iii) The planter is detachable for each unit to work independently.

(iv) Affordability of the planter to small-holder farmers.
(v) The planter is easy to operate.
(vi) Rigidity and Stability
(vii)

**2.3 Determination of the weight of the hopper material**

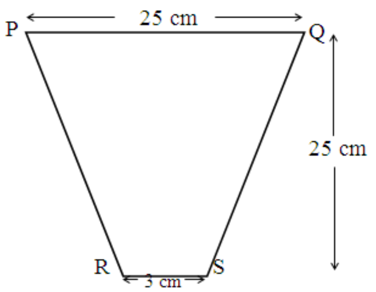
The material used for constructing the hopper is made of mild steel having a density of 7840 kg/m$^3$. The weight of the hopper material is calculated using the equation:




Area of ABCD = ½ (AB + CD) H

Where AB and CD are two parallel sides

H is height of the trapezium




Area of PQRS = ½ (PQ + RS) H

Where PQ and RS are two parallel sides

H is height of the trapezium

$A_{HM} = (2 \times area\ ABCD) + (2 \times area\ PQRS)$

$V_{HM} = A_{HM} \times t_{HM}$

$M_{HM} = V_{HM} \times \rho_{HM}$

$W_{HM} = M_{HM} \times Acceleration\ due\ to\ gravity$

where,

$A_{HM}$ = *Surface area of the hopper material (m$^2$)*
$V_{HM}$ = *Volume of the hopper material (m$^3$)*
$t_{HM}$ = *Thickness of the hopper material (m)*
$M_{HM}$ = *Mass of the hopper material (kg)*
$\rho_{HM}$ = *Density of the hopper material (kgm$^{-3}$)*
$W_{HM}$ = *Weight of the hopper material (N)*

The weight of the hopper material was determined as 43.6 N.

**2.4 Determination of the weight of main frame material**

The weight of the main frame material is determined using the equations:

$A_{MFM} = [W_{MFM} + (W_{MFM} - T_{MFM}](2x\ L + 4\ x\ l)$
$V_{MFM} = A_{MFM} \times t_{MFM}$
$M_{MFM} = V_{MFM} \times \rho_{MFM}$
$W_{MFM} = M_{MFM} \times$ Acceleration due to gravity

where,

l = *length of the shorter bar (m)*
L = *Length of the longer bar (m)*
$A_{MFM}$ = *Surface area of the main frame material ($m^2$)*
$w_{MFM}$ = *Width of the main frame material (m)*
$V_{MFM}$ = *Volume of the main frame material ($m^3$)*
$t_{MFM}$ = *Thickness of the main frame material (m)*
$M_{MFM}$ = *Mass of the main frame material (kg)*
$\rho_{MFM}$ = *Density of the main frame material ($kgm^{-3}$)*
$W_{MFM}$ = *Weight of the main frame material (N)*

The weight of the mainframe material is determined as 64.9 N.

### 2.5 Determination of maximum bending moment

Figure 2 shows the load distribution on the shaft. The following expressions may be used to calculate the reactions at the support.

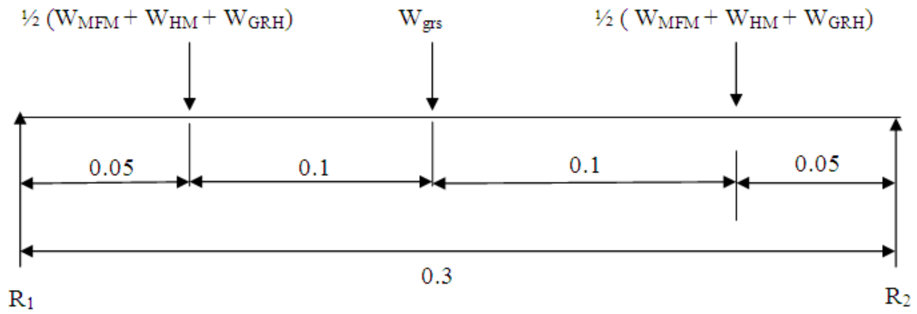



Fig. 3: Load distribution on the shaft

$R_1 + R_2 = \frac{1}{2}(W_{MFM} + W_{HM} + W_{GRH}) + W_{GRS} + \frac{1}{2}(W_{MFM} + W_{HM} + W_{GRH})$

$R_1$, $R_2$ = Reactions at the support ***(N)***
$W_{GRH}$ = Weight of grain resting on the hopper ***(N)***
$W_{GRS}$ = Weight of grain resting on the shaft ***(N)***

The maximum value of 10.92 *Nm* is chosen as the bending moment of the shaft.

### 2.6 Determination of the Shaft Diameter

The design of shafts of ductile material based on strength is controlled by maximum shear theory (Bamgboye, 2006). The material for the shaft is a mild steel rod. For a shaft having little or no axial loading, the diameter may be obtained using the ASME code equation (Khurmi and Gupta, 2005) given as:

$$d^3 = \frac{16}{\pi S_a}\sqrt{(k_b M_b)^2 + (k_t M_t)^2}$$

where,

$d$ = Diameter of the shaft *(m)*
$M_b$ = Bending Moment *(Nm)*
$M_t$ = Torsional Moment *(Nm)*
$k_b$= Combined shock and fatigue factor applied to bending moment
$k_t$ = Combined shock and fatigue factor applied to torsional moment
$S_a$ = Allowable stress = 40 $MNm^{-2}$ *(for shaft with keyway)*

For rotating shafts, when load is suddenly applied (minor shock) (Khurmi and Gupta, 2005):

$k_b$ = 1.5 to 2.0 $k_t$ = 1.0 to 1.5

For shaft without keyway, allowable stress, $S_a$ = 55 $MN/m^2$

For shaft with keyway, allowable stress, $S_a$= 40 $MN/m^2$

A shaft diameter of 16 mm was obtained.

## III. Fabrication of the Machine

All the parts of the three-row grain planter were fabricated in the workshop of the Department of Agricultural and Bio-Environmental Engineering, The Federal Polytechnic, Ado-Ekiti. All the parts of the planter were fabricated with mild steel material except for the seed tube which was made from a rubber material and the metering device which was made of TEFLON. The choice of rubber material for the seed tube was because the coefficient of restitution for rubber material is lower than that of a mild steel sheet of the same thickness. The rubber material will go a long way in minimizing seed bouncing, thereby protecting the seeds from damage due to impact. The choice of TEFLON for the metering device is also to reduce the damage done to seeds during metering so as to ensure a higher percentage of germination after planting.

The hopper was fabricated using a 3 mm thick mild steel metal sheet. The main frame which supports other component parts of the planter was fabricated using a mild steel flat bar having a length of 10 cm and a width of 30 cm. The adjustable furrow opener and furrow coverer were both fabricated using mild steel flat bar. The planter's drive wheels were fabricated with the surfaces fixed with 100 mm long sheets of steel cut from a 10 mm diameter iron rod that provides necessary soil rolling resistance during the forward movement of the machine.

Figures 3-6 show all necessary drawings with dimensions and figure 6 shows the photograph of the fabricated planter. The drive shaft of the designed planter directly controls the metering device through the aid of a chain and sprocket drive system.

**PART LIST**

| S/N | DESCRIPTION | QTY | S/N | DESCRIPTION | QTY |
|---|---|---|---|---|---|
| 1 | FRAME | 3 | 9 | METERING DEVICE HOUSING | 3 |
| 2 | BEARING | 12 | 10 | METERING DEVICE | 3 |
| 3 | SHAFT | 2 | 11 | PLANTER FRAME SUSPENDER | 3 |
| 4 | V-BELT AND PULLEY | 3 | 12 | FURROW OPENER | 3 |
| 5 | FURROW COVERER | 3 | 13 | COULTER | 3 |
| 6 | HOPPER | 3 | 14 | CARRIAGE | 1 |
| 7 | BOLT AND NUT | 75 | 15 | LOWER-POINT LINKAGE | 2 |
| 8 | WHEEL | 3 | 16 | DISCHARGE TUBE | 3 |

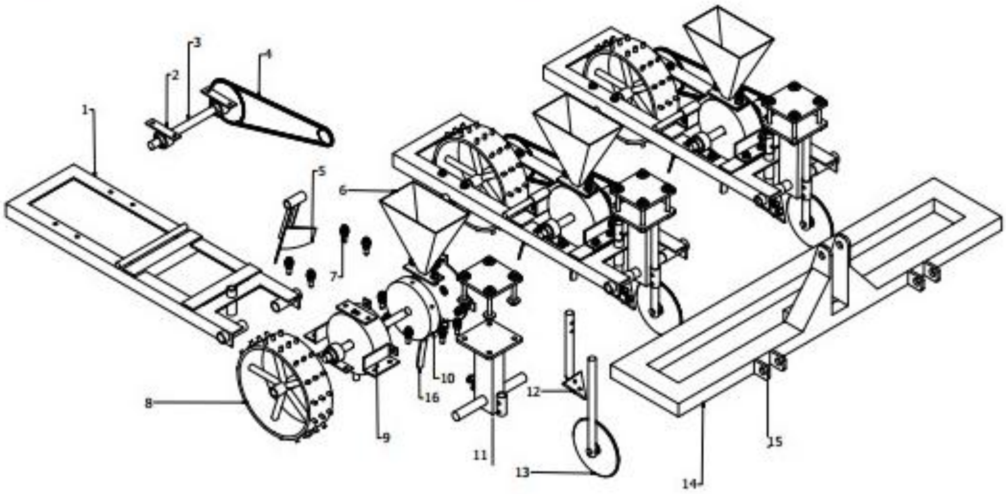


Fig. 3: Exploded view of the planter

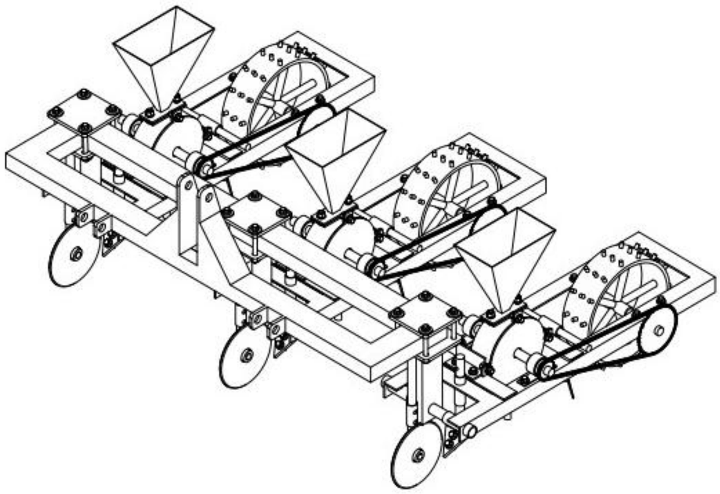


Fig. 4: Isometric view of the planter

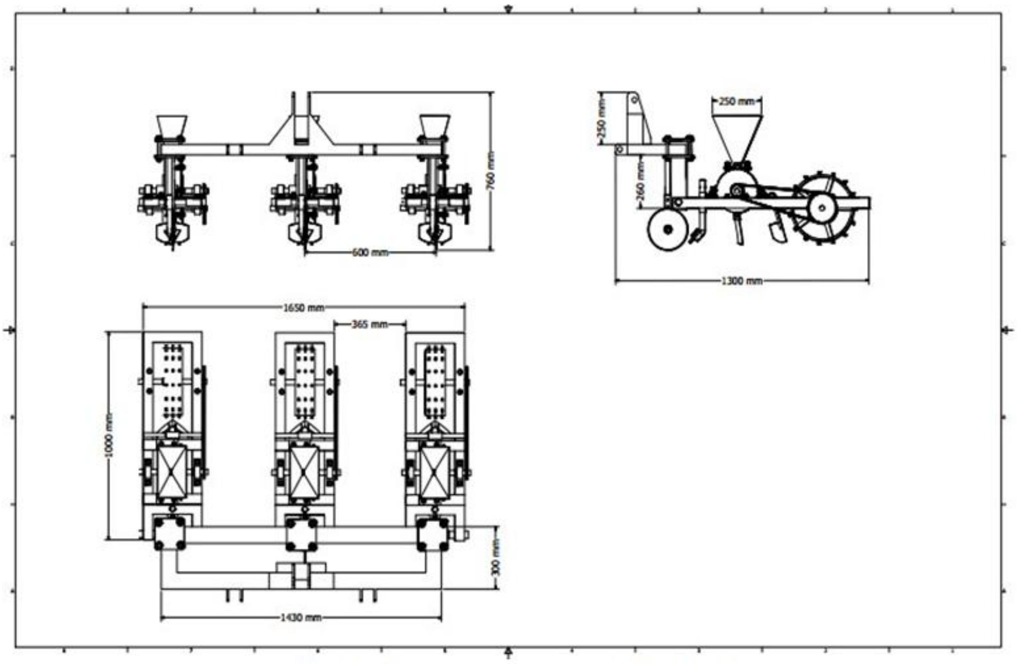



Fig. 5: Orthographic drawing of the planter

Fig 6: Fabricated three-row planter

## IV. Conclusions

A three-row grain planter was designed and fabricated using locally sourced materials. The planter was designed to improve efficiency by including an improved material as the metering device – TEFLON. The planter was constructed in such a way that it can be detachable for easy transportation to the field regardless of the width of the frame. The planter gave a satisfactory performance as the percentage of seed damage was reduced and the intra-row seed spacing for maize which was tested with the machine was achieved. All the parts of the planter were fabricated from mild steel material except for the seed tube and metering device. which was made from a rubber material. The drive shaft of the planter controls the seed metering mechanism through the help of a chain and sprocket drive.

## References

[1]. Bamgboye, A and Mofolasayo, A. (2012).Performance Evaluation of a Two-row maize Planter. Agricultural Engineering International; the CIGR Journal manuscripts PM 06662, Vol. viii.

[2]. Gupta J. K. and Khurmi R. S. (2005). Machine Design 14th Ed. S. Chand & Company Ltd., Ram Nagar, New Delhi – 110055, pp 434 – 960.

[3]. Matin, M. A., Roy, K. C. & Amin, M. N. (2010). Performance of BARI developed planter for establishment of maize. Research Report 2008-2009, Farm Machinery and Postharvest process Engineering Division, Bangladesh Agricultural Research Institute (BARI).

[4]. Roy, S. K., Albu, M. & Rob, A. (2011).The business rationale for investment on power-operated maize sheller in Bangladesh. *Agricultural Engineering International: the CIGR eJournal*. Invited Overview No. 3. Vol. IX.