International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 358-363 www.ijaem.net ISSN: 2395-5252

Evaluation of a Dual (Maize and Soy-Bean) Seeds Mobile Planter

*V.M Dagala; *Z.A Mshelia; **A. B. Udin
** Department of Mechanical Engineerig University of Maiduguri, Nigeria*
***Department of Technical and Engineering Education Universiti Teknologi, Malaysia*

Submitted: 15-06-2021 Revised: 27-06-2021 Accepted: 30-06-2021

ABSTRACT
The combined (maize and soy-bean) seed mobile planter was conceptualized, design and constructed with local materials available, all of which was aimed at establishing a reasonable efficiency with minimum effort and cost. The machine is simple to operate and can plant maize and soya bean simultaneously. The machine was tested and was found to have 75% efficiency with an average drop of two seeds of soybean and 3 seeds of maize per drop. The construction cost is (₦44,450)affordable for local farmers. It can coverthe field capacity of 0.048ha/hour at 0.5m row spacing. The machine has the efficiency at the speed of 0.267m/s.
Keywords:-Efficiency, Cost, Effort, (Maize and Soybean)seed

I. INTRODUCTION

A planter is an automotive tool used in spreading seeds over a certain area of land. In small-scale landscaping and gardening, a hand-operated seed planter can be used. Special planters are required to place plants or plant part into the soil. This indicates that plants which are not propagated seeds can also be planted using a special kind of planter. Direct seeding is generally preferred for re-vegetation project because seed is relatively inexpensive, easily stored and transported and is usually readily available or can be collected.

In this era of technological development, many ideas of designing arises from the modern designers (Engineers) to assist man in his physical environment and to simplify human labour in the daily activities by serving them with the best of products. This led us to designing of a simple manually operated dual seed planter with the available raw materials within our locality. Its physical appearance is in the form of a truck push, but it has a seed container (conical) attached to it. It has a spur gear. One attached to the rotating axle of the two wheels and the other attached to a horizontal plate beneath the seed box (hopper). The hopper has a hole in it which seeds can be dropped through it.

The main principle of operation of this planter is as that of (Sonewane et al, 2017) that whenever the wheels rotate, the gear on the wheel axle drives the gear on the horizontal plate and axle drive the gear on the horizontal plate and when axle drive the gear on the horizontal plate and when the hole on the horizontal plate and that of the hopper coincide, the seeds drop from the seed box into the soilbeing dug by the furrow opener and subsequent closing of the hole or soil by a furrow closer.

For a maximum yield of crop plants, accurate metering between seed rows is required (Fischer, 2005; Fila.G et al, 2018; BayhanY, et, al, 2015; Navid.H. et al, 2011; YooSN et al, 2005). Most of the rural farmers have no idea of the exact size of crop spacing. This design of the dual seed planter can help farmers in solving this problem. The planter has the ability of an accurate metering system which distributes the seeds (at least 2 and 3 seeds) per hole and increases the probability of success over the entire seed area. The machine places the seeds in the soil at targeted depths, and covers the seeds, thereby increasing the chance of seedling germination and emergence. This therefore, will encourage the rural communities not to rely on imported planters, and based on the available resources, different types of planters can be designed and produced to suit the planting requirement of different crops that can be found in a particular geographical area.

II. DESIGN ANALYSIS AND CALCULATION

The power source ofamanually operated machine of this type is the effort made by the operator at the handle (through the stroke action) of the operator as a result of which sowing of seed is done Sangheon, et al (2007). The combined seed

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 358-363 www.ijaem.net ISSN: 2395-5252

planter is a complete operational stroke, where the depth of the hole, the number of seeds per hole and the sand covering of the furrow are all determined.

2.0.1. Cost Analysis

Table1. Bill of Engineering Measurement and Evaluation (BEME)

S/n	Item	Quantity	Unit cost (N)	Total (N)
1	Flat bar 50mm X 3mm	5486.4mm	12,500	2,500
2	Rod	5486.4mm	1050	1,050
4	Shaft	2	1,000	2,000
5	Square pipe 2 X 1 inch	5486.4mm	2,600	2,600
6	Ball bearing	4 pcs	1,500	6,000
7	Sheet metal 20G	¼ sheet	2,000	2,000
8	Bevel Gear	4	900	3,600
10	40mm Q pipe X 25mm X 200mm	2	1,110	2,200
11	Electrodes 12G	50 sticks	150	7,500
12	Opening and covering device	4	500	2,000
13	Painting	Half liter	2500	2,500
	Bolts and nuts ϕ17	8 pieces	100	8,000
14	Labour			25,000
	Sum total			44,450

The shaft is used for the transmission of torque (twisting moment) and bending moment. A shaft of stainless steel is selected for strength. The shaft used in the planter is subjected majorly to a torque only.

We can determine the diameter of the shaft by using the torsion equation;

$\frac{T}{J} = \frac{T}{\delta}$

Where;

T = twisting moment (or torque)

J = polar moment of inertia

δ = torsion shear stress, and =distance from neutral axis to the outermost fibre= $\frac{d}{2}$, where;

d = diameter.

For the solid shaft used, polar moment of inertia=J,and J = $\frac{\pi}{32}$ X d^4

Equation (1) may be written as

T = $\frac{\pi}{16}$ X τ X d^3

Therefore, diameter of the solid shaft, d = $(\frac{16T}{\pi\tau})^{1/3}$

The twisting moment, T may also be obtained using the following relation

T = $\frac{P X 60}{2\pi n}$, Where;

P = power transmission with

N = number of turns in rpm

The twisting moment (T) transmitted by the shaft used in the planter can be determined

2.0.2. Data

For a diameter of a shaft, d = 23mm (Maina, 2005)

Area (A) of cross-section = $\frac{\pi d2}{4}$

Axial load, P transmitted by the shaft, say 23kg

g = 9.81m/s^2

Shear stress, $\tau = \frac{P}{A} = \frac{mg}{\pi d2/4}$

T = $\frac{4mg}{\pi d2}$

= $\frac{4 X 33.95 X 9.81}{\pi(23)2}$

τ = 0.8N/mm^2

Twisting moment (T)

= $\frac{\pi}{16}$ X τ X d^3

= $\frac{\pi}{16}$ X 0.8 X $(23)^3$

T = 1915 N/mm

2.0.3. The hopper

A cylindrical shaped hopper with a length of 335mm is used. By using a rate of 25kg/ha (i.e. by putting 25kg of maize/soya beans into the hopper), we can determine the volume of the hopper at a volume of 75%. Then the volume of the hopper is determined by the bulk density of the maize/soya beans which is 750kg/m^3

Therefore, 750kg/m^3 = 1m^3

25kg =? m^3

= $\frac{1 X 25 X 1000000}{750}$

= 33.33cm^3

If capacity of 75% gives 33.33% the volume of the hopper at a 100% capacity is determined by;

75% = 33.33cm^3

100% =? cm^3

$= \frac{33.33 \text{ X } 100}{75}$

= 44.44cm3

Also, the volume of the cylindrical shape hopper is determined by:

Volume = $\pi r^2 h$

= area X length

Curved surface area = $2\pi r^2$

Total surface area = $2\pi r^2 h + 2\pi r^2$

= $2\pi r$ (h + r)

Since diameter of the hopper, (D) = 19.5cm

$r = \frac{D}{2}$= 33.5cm

Therefore; Volume = $\pi r^2 h$

= $\pi (9.75)^2 \times 33.5$

= 1000.5cm^3

Curved surface area = 2πr2

= 2 (π) X $(9.75)^2$

= 597.3cm^2

Total surface area = 2πr (h +r)

=2π (9.75) (33.5 + 9.75)

= 2649.88cm^2

= 2650cm^2

2.0.4. Determination of the radius of the pitch circle of the seed hole for soya beans

Distance between seed holes for the soya beans = 17cm (Adamu 2009)

Circumference of a circle = 2πr

2πr = 17cm

$r = \frac{17}{2\pi}$

= 2.7cm,

= 270mm

2.0.5. Determination of the radius of the pitch circle of the seed hole for maize

Distance between seed holes for maize = 30cm (Adamu, 2009)

Circumference of a circle = 2πr

2πr = 30

$r = \frac{30}{2\pi}$

= 4.8cm= 480mm

2.0.6. Diameter of seed hole for maize

Diameter of maize seed = 7mm

Number of seeds require per hole = 3

Diameter of seed hole for 3 seeds = 3 X 7 = 21mm

2.7 Diameter of seed hole for soya beans

Diameter of soya beans seed = 5mm

Number of seeds required per hole = 3

Diameter of seed hole for 3 seeds = 3 X 5 = 15mm

2.0.7. Power requirement on pushing the machine

The equation of the rolling resistance offered by the soil on a land wheel on the sowing machine put forward as:F = ψR (Kawuya, 1992)

Where ψ = the coefficient of resistance for a wheel on soil, and

Ψ = 0.3 (Kawuya, 1992)

R = total weight of the grain pushed by the machine

Now, R = Mg

Where, M = mass of item to be supported by shaft

M = 23kg

g = 9.8m/s^2

Therefore, R = mg

= 23 X 9.81= 225.63N

F = 0.3 X 225. = 67.689N

The power for pushing the sowing machine is given by

Power, (P) = force, (F) X velocity, (V)

Where V = 0.71m/s (speed of normal working man on the field)

∴ P = F X V

= 67.689 X 0.71

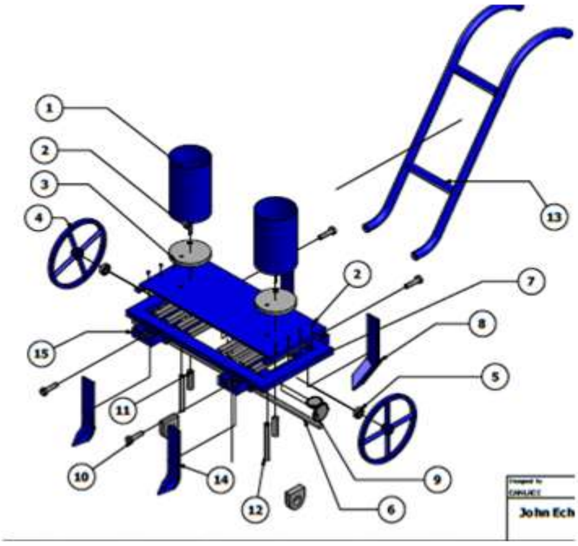
P = 48.1 watts= 48 Watts

Now; 746 watts =1 hp

48 watts $= \frac{48 \text{ X } 1}{746}$ = 0.06hp

The machine (combine seed planter) has been within the human range of operation since 0.05HP – 0.025hp is the rating of man

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 358-363 www.ijaem.net ISSN: 2395-5252



3	Disc Wheel
4	Wheel
5	Rolling bearing 70000AC 46205 GB/T 292-94
6	Shaft
7	Bearing Housing
8	Furrow Closer
9	Bevel Gear (rack & pinion)
10	Bolt Connections
11	Shaft (Hopper)
12	Seed Tube
13	Handle

Figure 1. Exploded View

Figure2. The combined (maize and soya bean) seeds mobile planter

2.0.8. Principle of Operation

The seed to be planted is loaded into the hopper. As the wheel rotates, it causes the motion of a transmission shaft which causes a set of bevel gears meshed together at an angle of 90^o to rotate. This motion causes the disc wheel to rotate. As the disc wheel rotates, the seeds enter into the hole. When the hole on the rotating disc (metering device) coincides with that of the seed tube, the seeds drop into the dug furrow.

The furrow opener (at the front) opens the furrow while the furrow –covering device (at the rear of the hopper) covers the seed in the furrow. The roller then compact the sand to properly cover the seed.

III. RESULTS AND DISCUSSIONS

Testing of the machine was done. The inter-row spacing selected was 50cm (an average spacing between maize and soya bean crops).

3.0.1.Speed of planting

The speed of planting varies depending on the condition of the field and the effort and experience of the operator in using the planter.

Testing of the planter on 0.5m inter-planting spacing between the two seeds (maize and soya beans) rows, it was found that for each 20m it takes 75seconds.

The planting speed at this interval expressed in m/sec is

Speed, (S) = $\frac{\text{distance}}{\text{time}} = \frac{20}{75}$

$= 0.267 m/s$

3.0.2. Anteing rate (field capacity)

This is the rate of field coverage of planter performing intended function at the rated planter speed for a given crop using the selected spacing.This is expressed as:Planting rate, (P_R) = $\frac{SW}{10}$

Where; S = the planting speed in Km/h or m/s, W= the width of planting which is selected row spacing in metre the planting speed determined for the testing of planter is 0.9612km/h, where the inter-row spacing selected is 0.5m each.

Now, converting speed in m/s to km/h

Speed, V = $(\frac{v \text{ X } 3600}{1000})$

$0.267 m/s = (\frac{0.267 \text{ X } 3600}{1000}) km/h$

$= 0.9612 km/h$

We can attain the planting rate by;

$P_R = \frac{SW}{10}$; Where S = 0.9612km/hr

W = 0.5m

$P_R = \frac{0.9612 \text{ X } 0.5}{10}$

Planting rate, (P_R) = 0.048hac/hr

Calculating for 8hrs standard-man-day for operating under average condition (Ilo,2005)

3.0.3.Theoretical capacity (c_{th})

The theoretical capacity was obtained from the area covered in one working day and is expressed as:

Theoretical capacity (C_{th}) = P_R X 7hrs

But P_R = 0.048hec/day

0.048 X 8 = 0.384hac/day

Thus, a whole hectare of land will be planted in four (4) days (theoretically)

Since 0.384 hectares – 1days

1 hectare - ? Days = 2.6 days

3.0.4. Performance evaluation

The planter covers 0.288 hectares in a day. After using the average planting rate of 0.048 hector/hour, the performance efficiency is:

$P_{eff} = \frac{\text{actual hectares covered per day}}{\text{design hectare covered per day}}$

$= \frac{0.288}{0.384} = 0.75$

From the performance efficiency P_{eff}, (0.75) and expressed in percentage as 75%, the planter is said to have an efficiency of 75%.

However, certain factors can limit or lower the efficiency of the machine. For instance, the gap between the disc and plate is a little bit tight and so causes friction between them.

IV. CONCLUSION

After evaluation, the machine could be used successfully to saw maize and soya beans simultaneously. Based on the analysis of the test results, the following conclusions were drawn:

4.0.1. The inter raw-spacing is practically independent of the planter speed.

Lower planter speed gives better result and therefore recommended particularly if the field contain trash or if not well prepared.

4.0.2. The planter performance is sensitive to the quality of field operation say a well harrowed soil which allows for every penetration of the furrow opener into it.

4.0.3. Seed placement was accurate as calculated

REFERENCES

[1]. Adamu U. I, Peter E. O and Ibrahim Y. D (2009). Arable Crop Production.http://www.atlanticplywood.com /docs/Prefinished Hardwood Panel Brochure AR.pdf

[2]. Bayan Y, Fielke J And Saglam C (2015). Performance of a Dual Tine and Presswheel Seeding Module For a Range of Speed, Presswheels and Sawing Tine Alignments. Bulgarian Journal of Agricultural Sciences 21 (2), 454-460.

[3]. Fila G, Bagatta M, Maestrini C, Potenza E and Matteo R(2018). Lenseed as a Dual – Purpose Crop Evaluation of Cultivar Suitability and Analysis of Yield Determinants. The Journal of Agricultural Science 156 (2), 162.

[4]. Fischer K. (2005). Definition of Crops Yield Gaps and of Rates of Change. Field Crops Research 182, 9-18

[5]. Ilo, A. H. (2005), Design and construction of a precision seed planter.Final year project (Unpublished). Mechanical Engineering Department, University of Maiduguri.

[6]. Kawuyo U. A. Design and construction of a manually Operated Seed Drill. Unpublishedfinal year project, Agricultural Engineering Department, University of Maiduguri B. Eng. (1992) unpublished.
[7]. Kurmi R. S. Gupta, J. KA Textbook of Machine Design, Eurasia Publishing House (PVT) Limited, New Delhi, (2007)124-156
[8]. Maina A. H. Design and construction of a precision seed planter. Unpublished final Year project. Mechanical Engineering Department, University of Maiduguri (2005) 98-108.
[9]. Navid H, Ebrahimian S, Gassemzadeh H.R and Mousavi N. Laboratory Evaluation of Seed Metering Device Usung Image Processing Method. Australisl Journal of Agricultural Engineering 2 (1), 1-4.
[10]. Sonewane L. K, Sheikh S.M and Shahare A (2017). Dual Powerd Opersted Tiny Cotton Ginning Machine: A Review. International Journal for Research in Applied Sciences 5 (8), 116-119
[11]. Sangheon, L and Mcdave, N. Working Time Around the World- Trends in Working Hours, Laws and Policies in a Global Comparative. Textbook of Machine Design,
[12]. Yoo S.N, Choi Y.S and Suh S.R (2005). Development of a Precision Seed Mettering Device For Direct Seeding of Rice. Journal of Biosystems Engineerin 30 (5), 261-267.