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Research Paper

Development and performance evaluation of single row manual seed planter

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Abstract. Planting of seed crops for cash and consumption by the Nigeria farmers is largely done manually using human labour. This is tedious and time consuming, therefore, the need to mechanize planting has led to various researches in the development of seed planters of various capacity. A single row manual seed planter was developed by NCAM to plant maize, cowpea and guinea-corn. The number of seeds per hole depends on the designed seed metering plate for each of the crop. Planting space was 24 × 60 cm, the total area of land used for field operation was 0.09ha and moisture content of the soil was 8.01%. The average values for effective field capacity, theoretical field capacity, field efficiency and the total time for maize, cowpea and guinea-corn during field test are 0.1186, 0.1205, 0.1108 ha/hr; 0.1215, 0.1231, 0.1198 ha/hr; 97.14, 97.91, 97.54% and 0.76, 0.75, 0.77 hr respectively. From this research work, it was observed that there was significant difference (0.007 to 0.031 at P ≤ 0.05) in effective and theoretical field capacity of the machine for maize, cowpea and guinea-corn but no significant difference in field efficiency of the machine for the three crops. Therefore, performance of the machine was satisfactory when compared to manual planters developed by other researchers and the traditional method of planting. Development of this planter has reduced the challenges associated with the traditional method of planting using peasant tools and enhanced planting seed crops to increase food security in Nigeria.

Keywords: Planter, seeds, single row, performance evaluation.

INTRODUCTION

Agriculture is one of the major promising areas for rapid growth and development of Nigeria economy through the use of indigenous agricultural machinery that is readily available and affordable to farmers in Nigeria.

Over the years, researchers have been developing different kinds of planters, each design having its own working principle which is aimed at addressing the issue of planting system in Nigeria. Among the developed planter is the hand operated seed planter otherwise known as Jab planter, the electrostatic planter. The need to solve challenges associated with each planter leads to the development of new planters; the jab planter for an example performed to its capacity, but has the problem of pressing the handle while planting, this resulted to inconsistent spacing which called for an improved planter to increase the output in a shorter time.

Kyada (2014) developed a manual seed planter and made the operation, adjustment and maintenance principles of the planter simple for effective handling by unskilled farmers. Thorat *et al*. (2017) designed and fabricated seed sowing machine. In his design, planting depth, row spacing, seed dropping etc. were considered to ease the sowing operation with little effort.

The common edible foods planted and eaten in Nigeria include:–cowpeas, soybeans, maize, groundnut, okra, cotton, kenaf, sorghum, etc. They are planted by placing

and covering it in the soil at definite distance apart and definite depth or by broadcasting which is accomplished mechanically or manually (Kepner *et al*., 2005).

Under different tillage system, spacing uniformity, timing, rate of emergence and plant population in corn (maize) stand are the most common characteristics used by producers in evaluation of planter performance (Liu *et al*., 2005; Conley *et al*., 2005). Uneven plant density decreased grain yield when compared to uniform stand treatments. Alba - Hurst farms (2004) once reported that plant spacing uniformity and rate of emergence were affected by planter speed.

The recommended seed spacing and depth of seed placement vary from crop to crop and different Agro-climatic conditions to achieve optimum yield. The expected seed spacing and depth for planting maize is 30 cm and 2.5 cm respectively, for guinea corn is 60 cm and for rice is 30cm, (Adisa, 2011). However, in this research work a single row manual seed planter was developed and evaluated to overcome the challenges in seed crop planting and improve food security in Nigeria.

MATERIALS AND METHODS

Description of the machine

The manually operated single row seed planter consists of two handles, seed hopper, furrow opener, ground wheels, furrow covering device, seed metering device, wheel press, chain, sprocket and a support stand. During design stage, more attention was given to the metering device to avoid any damage to the physical properties such as length, width, thickness, density, and roundness of the crop seeds that could happen during planting operation. The same consideration was given by (Ndirika and Oyeleke, 2006; Mohammed, 2002) during the design and fabrication of the seed planter. However, the manual seed planter was set in motion by the operator pushing it from behind. As the operator pushed the machine forward, the ground wheel rotates and drives the seed metering device through the connection of chain and sprocket to drop seed into the soil opened by the furrow opener and covers the seed with soil by furrow coverer. The speed of operator determines the speed of the manual seed planter. Therefore, operator moved in a steady motion to avoid missing hills.

Design considerations

The following factors were considered in the design of the planter:

1. The physical properties of the agricultural material such as length, width, thickness etc. which varies in shape, density and size.
2. The ease of fabrication of component parts.
3. The safety of the operator
4. Resistivity of metering device to corrosion
5. The operation of the machine shall be simple for small scale or rural farmers.
6. Availability of the component parts at the local market.

Performance test

Laboratory test

A test was conducted in the laboratory to examine the performance of the metering mechanism and to make any adjustment or modification required by machine before subjecting it to field test. Proper adjustment was made to avoid mechanical damage of the seeds by the metering device. Also it was observed that the seed dropping varies with respect to seed size.

Field test

The total area of the field used for testing was 0.09 ha (900 m^2) and the type of soil used was sandy-loam with 8.01% moisture. The land preparation (ploughing and harrowing) was properly done to provide easy penetration of the tender root into soil to get adequate nutrients required for proper growth and development. The variety of seeds used were dent corn TZB (FARZ-23), cowpea IT89KD-391 and guinea corn. The intra and inter row spacing was 24 × 60 cm (Table 1). Though this is varied depending on the type of seed and agro-ecological zone of each region. The planting depth was not too deep for quick and proper germination and not too shallow to prevent rodent attack on the planted seed. The percentage of plant emergence, size of the grain was calculated using Mabayoje and Verma (1994) and Mohsenin (1970) equation.

$$Percentage\ of\ plant\ emergence = \frac{Average\ percentage\ of\ plant\ emergence\ per\ row}{Average\ of\ total\ seed\ dropped} X\ 100 \quad .....1$$

$$D_a = \frac{L+W+T}{3} \quad ..... \quad 2$$

where,
D_a = arithmetic diameter of seed
L = length of seed
W = width of seed
T = thickness of seed

RESULTS AND DISCUSSION

Table 1 shows the basic specification such as planting depth, planting space, number of seeds drop per hole,

Table 1. The specification of the manual seed planter.

Parameters	Specifications
Average row spacing	24 cm
Number of seeds per hole for maize	1-2
Number of seeds per hole Cowpea	1
Number of seeds per hole Guinea-corn	7-8
Number of rows	1
Planting space	24 × 60 cm
Planting depth	6 cm
Power source	Ground wheel
Type of metering system	Horizontal plate type
Area of field	900 m^2
Type of soil	Sand loamy
Soil moisture content	8.01%
Effective field capacity for maize, cowpea and guinea-corn	0.1186, 0.1205 and 0.1168 ha/h

Table 2. Number of seeds dropping.

Seed crop	Seed size (mm)	No. of dropping in 1st stroke	No. of dropping in 2nd stroke	No. of dropping in 3rd stroke	Average no. of stroke
Maize	8.67	1	2	2	2
	8.69	1	2	2	2
	8.55	1	2	1	1
Guinea-corn	3.75	8	8	7	8
	3.67	7	8	8	7
	3.46	6	7	8	8
Cowpea	7.67	2	2	1	2
	7.56	1	1	2	1
	7.55	1	1	1	1

moisture content of soil, type soil used, horizontal metering device and effective field capacity of the developed manual seed planter. These are very important in determining the effectiveness and efficient of the seed planter and any other related machine.

Table 2 shows the size of maize, cowpea, and guinea-corn, in every complete revolution of planter wheel there is number of seeds drop through a designed seed plate relative to the size of each of the seed crop.

Table 3 shows the results for the performance evaluation of manual seed planter for maize, cowpea and guinea-corn. The effective field capacity, theoretical field capacity and efficiency of the machine for maize, cowpea and guinea-corn are 0.1186, 0.1205, 0.1168 kg/h; 0.1215, 0.1231, 0.1198 kg/h; 97.61, 97.91 and 97.54% respectively. This planter performed satisfactorily when compare to field efficiency of 76.5% obtained by Rabbani *et al*. (2016) and planting capacity of 0.0486 ha/hr obtained by Ibukun *et al*. (2014) during performance evaluation of manual maize planter.

Table 4 shows the percentage of plant emergence. The variation in number of dropping was due to non-uniformity and size of seed which resulted in the number of plant emergence. Also, the figure 1 shows the percentage of plant emergence for the crops and maize has the highest percentage. The higher the number of seeds dropped the more the plant emergence.

Table 5 shows the statistical analysis of result obtained using ANOVA. It was observed that there was significant different in effective field capacity and theoretical field capacity for maize, cowpea and guinea-corn but there was no significant different in field efficiency of the machine for the three crops. It means the three varieties of the crop seeds are suitable for the planter.

CONCLUSION

Manual seed planter was developed and its performance evaluation was done satisfactory. There was significant

Table 3. The results for the performance evaluation of manual seed planter used for planting maize, cowpea and guinea-corn.

Crops		Productive time (s)	Turning time (s)	Unproductive time (s)	Total time (s)	Effective field capacity (ha/h)	Theoretical field capacity (ha/h)	Field efficiency (%)
	1	2666	63	6	2735	0.1184	0.1215	97.44
Maize	2	2656	55	5	2716	0.1192	0.1219	97.78
	3	2675	59	6	2740	0.1182	0.1211	97.60
Average		2635	59	5.7	2730	0.1186	0.1215	97.61
	1	2600	60	4	2640	0.1227	0.1246	98.47
Cowpea	2	2645	58	6	2709	0.1196	0.1224	97.71
	3	2650	61	5	2716	0.1192	0.1222	97.54
Average		2632	60	5	2688	0.1205	0.1231	97.91
	1	2700	65	8	2773	0.1168	0.1200	97.33
Guinea-corn	2	2710	60	7	2777	0.1166	0.1196	97.57
	3	2705	58	6	2769	0.1170	0.1197	97.74
Average		2705	61	7	2773	0.1168	0.1198	97.54

The total area of field = 0.09 ha (900m^2)

Table 4. Percentage of plant emergence.

Variety of seed	Planting population/row	Height of germinated seed (cm)	Average number of seeds drop	Plant emergence (%)
	12	11	12	100
Maize	11	9	12	91.67
	10	7	12	83.33
Average	11	9	12	91.67
	8	6	9	88.89
Cowpea	7	7	9	77.78
	9	8	9	100
Average	8	7	9	88.89
	42	10	52	80.77
Guinea-corn	49	9	52	94.23
	51	8	52	98.08
Average	49	9	52	91.03

Table 5. ANOVA results for the performance evaluation of manual seed planter used for planting maize, cowpea and guinea-corn @ P≤0.05 (5%).

		Sum of Squares	df	Mean Square	F	Sig.
	Treatment (Crop type)	8080.889	2	4040.444	13.874	0.006
Productive time (s)	Error	1747.333	6	291.222		
	Total	9828.222	8			
	Treatment (Crop type)	6.222	2	3.111	0.298	0.753
Turning time	Error	62.667	6	10.444		
	Total	68.889	8			
	Treatment (Crop type)	6.222	2	3.111	4.000	0.079
Unproductive time (s)	Error	4.667	6	0.778		

Table 5. Contd.

	Total	10.889	8			
Total time	Treatment (Crop type)	154426192.889	2	77213096.444	1.116	0.387
	Error	415273894.667	6	69212315.778		
	Total	569700087.556	8			
Effective field capacity (ha/h)	Treatment (Crop type)	0.000	2	0.000	6.500	0.031
	Error	0.000	6	0.000		
	Total	0.000	8			
Theoretical field capacity (ha/h)	Treatment (Crop type)	0.000	2	0.000	12.406	0.007
	Error	0.000	6	0.000		
	Total	0.000	8			
Field efficiency (%)	Treatment (Crop type)	0.223	2	0.112	1.057	0.404
	Error	0.633	6	0.106		
	Total	0.856	8			

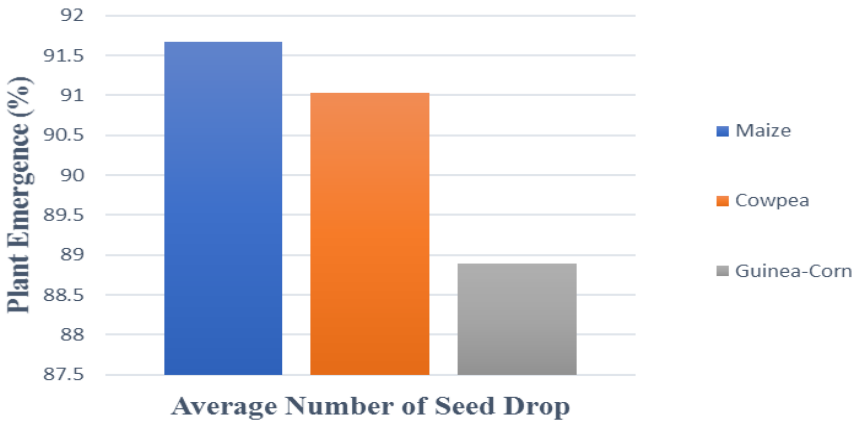

Figure 1. Plant emergence and the average number of seeds drop.

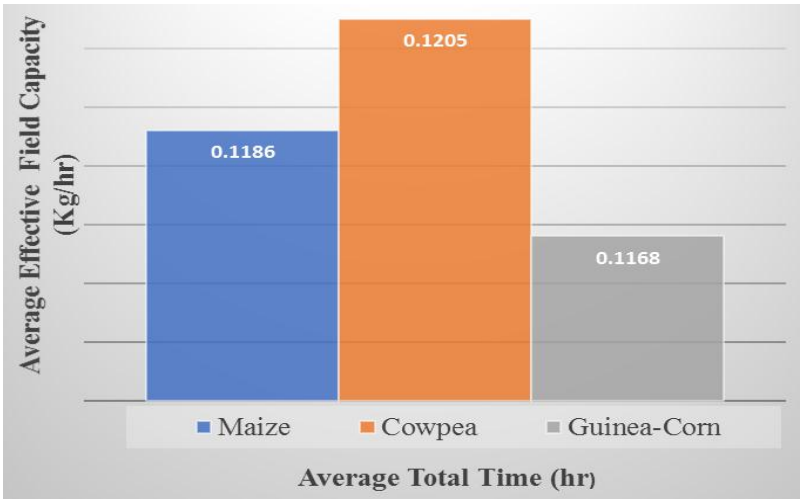

Figure 2. Average effective field capacity vs. average time taking.

difference in effective field capacity and theoretical field capacity for maize, cowpea and guinea-corn but there was no significant different in field efficiency of the machine for the three crops. Figure 2 also showed that the timeliness of operation will be achieved with this simple seed planter. The need of small and medium Farm holders in Nigeria is fulfilled with the development of manual seed planter which reduces the challenges associated with the traditional method of planting using peasant tools and enhanced planting seed crops to increase food security in Nigeria. The planter is available and affordable for the Nigeria farmers.

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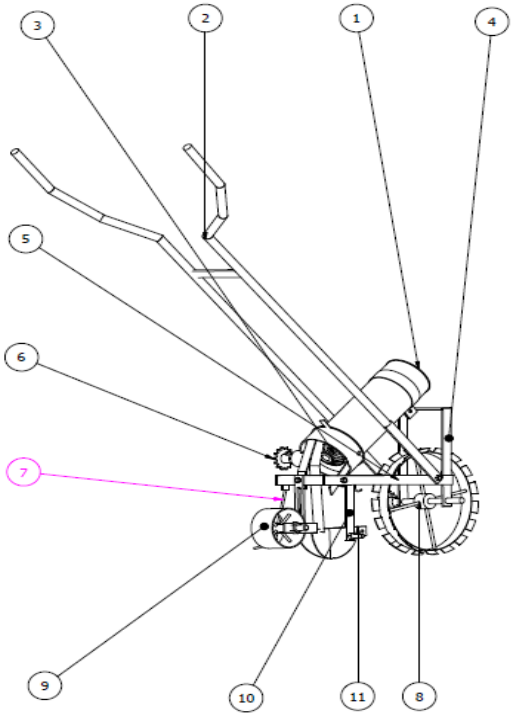
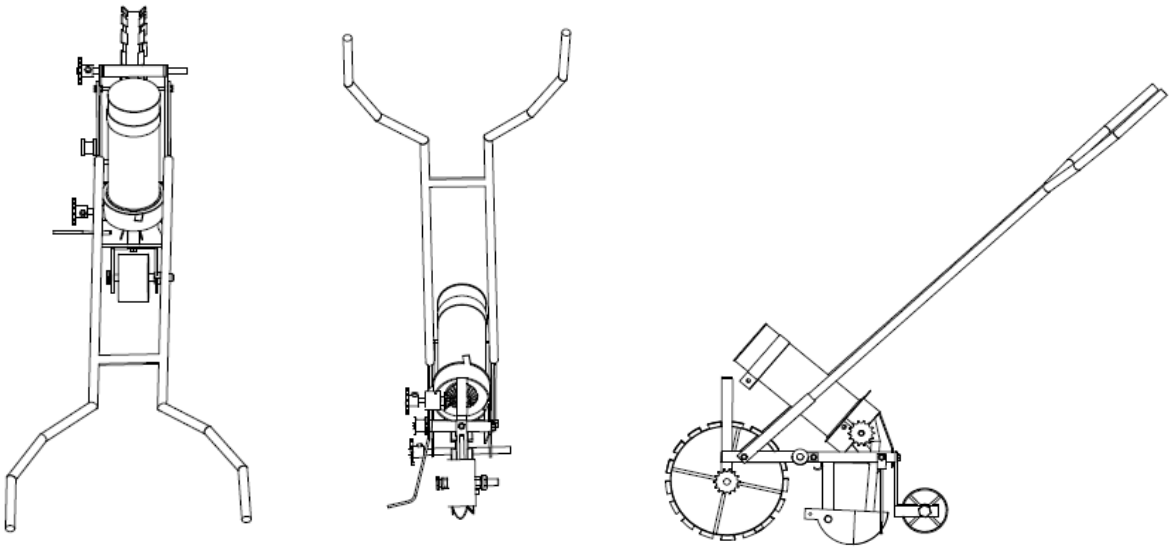
APPENDIX



S/N	Component Name
1	Hopper
2	Handle
3	Metering Plate
4	Frame
5	Guide
6	Sprocket
7	Chain
8	Ground Wheel
9	Wheel Press
10	Auger
11	Delivery Chute

Figure 1. Single row manual seed planter.



Top View Back View Side View

Figure 2. Different views of the single row manual seed planter.