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DESIGN AND CONSTRUCTION OF MANUALLY OPERATED FLUTE PLANTER WITH FERTILIZER DISTRIBUTOR

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ABSTRACT

Planting requires careful control of seed planting depth and uniform plant spacing which improves crop stand levels that produces more even plant emergence for good crop yield. A manually operated flute planter with fertilizer distributor was designed and constructed to plant grain crops. The machine's field performance test for planting maize and guinea corn trials shows that the planter was able to plant with adjustable furrow opening depth and seed spacing. Average field seed planting space by flute metering unit for maize was found to be 34 cm compared to the theoretical value of 32 cm while it was 64cm field spacing against the theoretical value of 60cm for guinea corn. Machine draft requirement was found to be 149.5N and average seed filling efficiency of the metering unit was 90% at machine speed of 1.82 km/h. The average machine planting capacity was 0.18ha/h and fertilizer distribution could be achieved for drilling alone and not for spot application which will require further work.

Keywords: Flute planter, fertilizer distributor, manually, untilled soil

INTRODUCTION

Seed planting can be accomplished by broadcasting (seed uniformly scattered over field surface) and also by placing and covering seeds in the soil at definite distance apart and definite depth either mechanically or manually (Kepner *et al.,* 2005). Planting is still mostly done manually in Nigeria which is tedious, inefficient and time consuming. Precision row crops planter performs uniform seed metering (seed spacing), proper depth of soil opening and covering of the seed with proper compaction.

There are three types of planters which are representing the range of current planting technology. The vacuum meter type represents a well- maintained planter with the most current technology for ensuring accurate seed singulation and placement. Air seeder type represents a planter with poor seed singulation and placement capabilities. The finger- pickup planter type represents a commonly used planter with intermediate seed singulation and placement capabilities. Overall performance on plant spacing uniformity is in the order of vacuum meter which is greater than finger- pickup which is also greater than air seeder (Liu *et al,,* 2005).

Under different tillage systems, spacing uniformity, timing and rate of emergence, and plant population in a corn (maize) stand are the most common characteristics used by producers in evaluating planter performance (Liu *et al.,* 2005). Conley *et al,* (2005) found that uneven plant density decreased grain yield when compared with uniform stand treatments. Plant spacing uniformity and rate of emergence are affected by planter speed as reported by Alba- Hurst farms (2004). Careful control of planting depth will improve stand levels and produce more even plant emergence with optimum found to be 5cm while the minimum was 4cm for maize. This depth varies from region to region as reported by Farnham (2001).

Several attempts were being made to design and construct planters that are suitable for Nigeria's farming system, some of which are highlighted as follows. Shebi (1978) designed a manually operated pedestrian seeder and found that the seed dropping was not uniform, seed spacing was 43cm instead of the calculated 32cm and turning the machine at the end of bends was very difficult. International Institute of Tropical Agriculture (I.I.T.A.,1978) produced a rotary injector planter which was found suitable for planting minimum tilled soil of high rainfall places and irrigated fields in Nigeria. It was able to plant 1 ha/day and was commercially manufactured. Major problems of this planter were soil sticking, blocking of the furrow opener and seed tube in clay and heavy soils. An improved planter to solve the I.I.T.A planter problem was developed by Adisa (1980). Further modification of the improved planter is still ongoing.

The main purpose of this design and construction work was to design a planter and fertilizer applicator that can perform and function better than manual seed planting.

METHODOLOGY

Machine Design and Construction

The design was undertaken to operate at proper seed spacing, row spacing and planting depth for uniform plant density and seed rate of emergence. The gage wheel was designed and constructed to keep furrow opening depth constant. A 16cm diameter cylinder made of sheet metal was used as the gage wheel. Runner type of furrow opener was fabricated from mild steel with adjustable depth of soil opening of between 3cm- 6cm. This would allow for various crop to be planted.

Bearing in mind that the expected seed spacing and seed depth for planting maize were 30cm and 2.5cm respectively (A.E.R.L.S., 1977a), for guinea corn it was 60 cm (A.E.R.L.S, 1978) and for rice was 30cm (A.E.R.L.S., 1977b). In designing seed metering unit, physical properties of the agricultural materials like grain length, width, thickness etc. which varies with shape, size and density (Ndirika and Oyeleke, 2006) and Mohammed (2002) were considered. Seed metering was designed and constructed of 8cm diameter by 4.75cm cylindrical wood flute with 6 seed cells on the surface to obtain 32 cm and 64 cm seed spacing for maize and guinea corn respectively. Fertilizer metering unit was designed and constructed of 8cm diameter by 4.75cm cylindrical wood flute with 6 groves made on the surface for fertilizer drilling. Seed and fertilizer boxes were designed and constructed of galvanized sheet metal of $0.01m^3$ capacity each with cover. Drive wheel shaft carries the machine weight and transmits power which was designed and constructed of mild steel rod. The drive wheel was designed and constructed of steel bar which was shaped into 42cm diameter, 3.8cm width and 0.5cm thickness with metal lugs welded to the surface for better traction. Figures 1 and 2 are the planter/fertilizer applicator assembly. Belts and pulleys transmission system was used within the machine system.

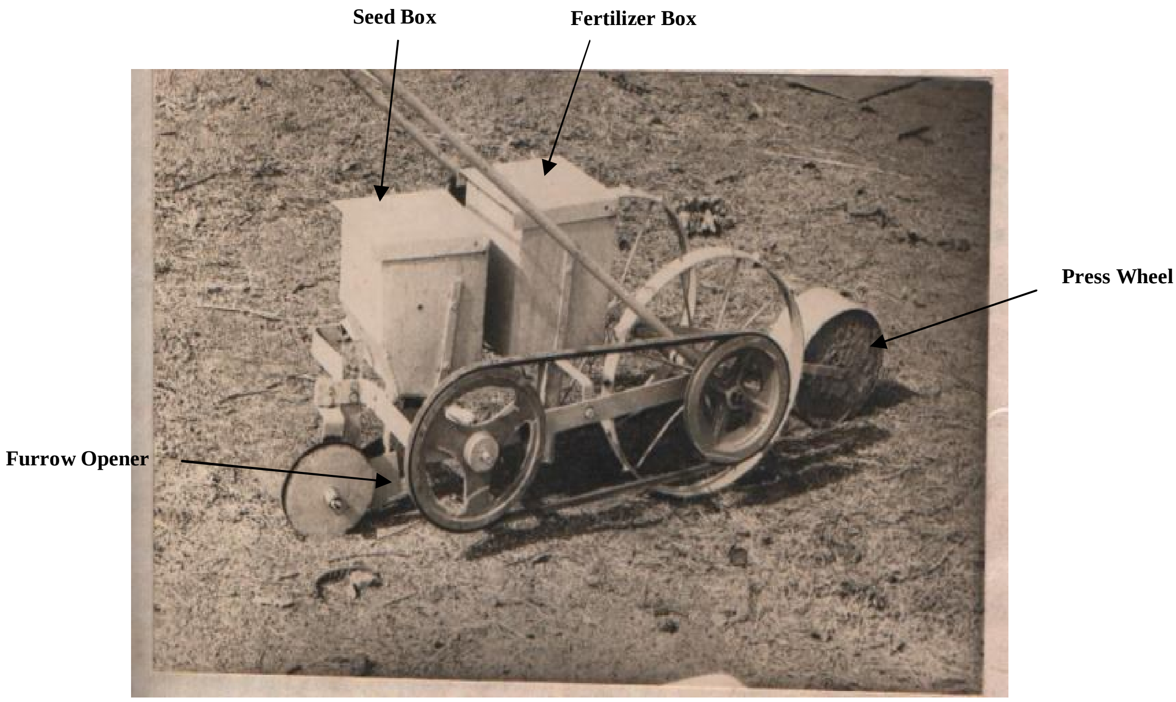
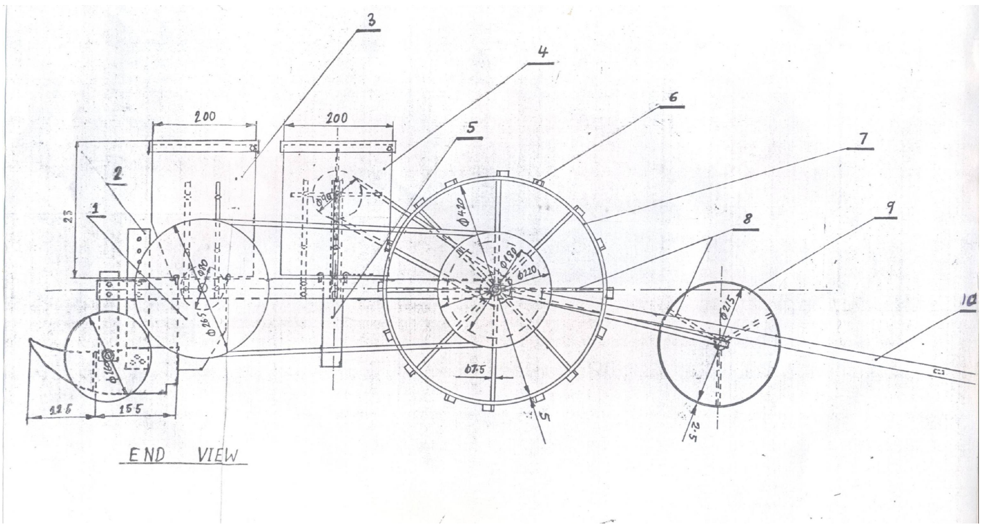


Figure 1: Manually operated planter / fertilizer applicator



LEGEND

1. Seed tube
2. Adjustable Furrow opener
3. Seed hopper
4. Fertilizer hopper
5. Fertilizer tube
6. Tyre lugs
7. Drive wheel
8. Tyre spikes
9. Press wheel
10. Planter handle

Figure 2: End view of manually operated grain planter / fertilizer applicator

Testing Procedure

The parameters that were measured during planter testing were number of seeds dropped per hole, seed filling of metering unit, planting spaces, draft requirement and planting capacities at various speeds. Planter seed metering and fertilizer application was calibrated for field test as follows: With the planter in stationary position and drive wheels lifted away from the ground, the seed metering and fertilizer driving shafts were rotated through one revolution, the number of seeds dropped per revolution of the metering device was noted and recorded (six droppings was observed at 1.44 revolutions) for both maize and guinea corn crops. Also subsequent horizontal length to be covered on the ground was calculated from the wheel circumference. The same procedure for the seed was also followed for the fertilizer metering. Number of seeds dropped per hole and fertilizer dropped were recorded. Speed of planting operation was taken by measuring horizontal distance with tape and time taken with stop watch for all the readings to calculate the planter field capacity. A dynamometer was connected to the front of the planter to move it at various speed from which the force required was recorded and the time taken was recorded by a stop watch to determine the planter draft requirement. The parameters that were measured during planter testing , after planter construction were, number of seeds dropped per hole, seed filling of metering unit, planting spaces, draft requirement and planting capacities all at various speeds.

RESULTS

From the test results, it was possible to determine seed metering (filling) efficiency, seed spacing, planting capacity, and planter draft requirement at various planter speeds which are as shown in Tables 1 and 2. Table 1 is from the field test of planter performance while Table 2 is the result of the effect of planter speed on the draft requirement.

DISCUSSION

The planter was designed to plant maize at 32 cm spacing Table 1, however, the average field seed spacing obtained was 33.78 cm on flat (minimum tilled soil) bed as shown in Table 1. This was due to seeds drifting by bouncing in the seed furrow opened which was not V shaped all through at the furrow bottom to trap the dropped seeds at a spot . The seed spacing accuracy was found to be 94% at 1.82 km/h planting speed. From Table 1, the seed filling efficiency increases as the planting speed increases within the human walking speed. Within speed range (1.60km/h – 2.06km/h), the planter metering unit does not experience seed plugging problem. Table 2 is the field readings to determine planter draft requirement at various speeds. It can be concluded that seed plugging was more at lower speed. The planter seed spacing at various planter speed was closest to the designed value of 32cm at about 1.82km/h, which was the average human speed while at work. Also from test result on fertilizer distribution, calibration of granulated type of fertilizer was found suitable for drilling alone for crops that are planted by drilling but not for spot dropping, which was found not to be economical for spot spaced planted crops.

The concept of the greater the speed of a planter, the greater is the draft requirement (Kepner *et al.,* 2005) was proved in the result shown in Table 2. At the average speed of 1.96 km/h the average draft demand of this planter was found to be 149.5N which did not show in the table but was recorded on the field. The gross weight of this planter was 39.4kg. Average planter's seed filling efficiency of the seed metering unit was found to be 90% at average speed of 1.82 km/h as shown in Table 1. There was need to improve on seed furrow opening unit to obtain more uniform seed spacing or placement and reduce occasional seed plugging of the seed metering device. The average planter's field capacity was 0.18ha/h as shown in Table 1.

Table 1: Field Test Result of Planter Performance for maize

No. of Run	Duration of run (s)	No. of seeds expected (se)	Actual no. of seeds (sa)	Filling efficiency (sa/se) (%)	Average seed spacing (cm)	Planter speed (km/h)	planter field capacity (ha/h)
1	7	12	13.0	108.3	31.40	2.06	0.21
2	9	12	8.0	66.7	35.86	1.60	0.16
3	8	12	10.0	83.3	33.13	1.80	0.18
4	7	12	12.0	100.0	34.78	2.06	0.21
5	9	12	11.0	91.7	33.75	1.60	0.16
Average	8	12	10.8	90.0	33.78	1.82	0.18

Table 2: Field Test Result of the Effect of speed on Draft (Maize)

No. of run	Horizontal pull (N)	Time Taken (s)	Length of run (m)	Speed (km/h)	Draft (N)
1	117.72	11.0	8	2.63.	183.08
2	98.10	10.0	8	2.83	152.57
3	107.91	8.6	8	3.35	1167.82
4	98.10	15.0	16	3.85	152.57
5	156.00	12.0	16	4.79	244.11
6	127.53	10.0	16	5.76	198.34

CONCLUSION

From the test result obtained, the planter was able to plant on zero tillage flat field while the seed spacing and planting depth could be varied for maize and guinea corn crops. The seed spacing for planting maize was obtained to be 34 cm (94% efficient), 64cm was obtained for planting guinea corn and average seed filling efficiency was 90% when planting at 1.82km/h speed. The planting field capacity was found to be 0.18 ha/h and the draft requirement was found to be 149.5N.

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