# Performance Evaluation of a Two-Row Okra Planter

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## ABSTRACT

A manually operated two-row okra planter was evaluated for performance by conducting field and laboratory tests. The laboratory investigation included the determination of the variation in weight of seeds discharged from two hoppers, percentage damage of seeds, and average intra-row spacing of seeds. The field tests comprised the determination of effective field capacity, average depth of placement of seeds in the furrows, and mean spacing of seeds within each row. A percentage difference between the weights of seeds discharged from the two hoppers of 4.97% was obtained during testing; while the seed rate was 0.36kg/hr. A reduction in percentage damage of 3.51% was attained with spacing varying from 59cm to 70cm, and an average depth between 8mm and 9mm. The overall average efficiency of the planter was 71.75%.

**Keywords**: OKRA, planter, performance evaluation, field tests, spacing, depth, efficiency

## 1. INTRODUCTION

Cultivation of okra is done mostly during the rainy season. Seeds are sown in rows of about 90 to 120cm apart and plants are spaced about 45cm apart within rows. Seeds may be soaked for 24 hours to soften the hard seed coat and induce better germination (Dessai et al. 1997). Okra can be harvested fresh and included in meals or cut in pieces, dried and stored for consumption during off-season periods. Sowing okra by hand increases production cost as extra man-hours is required for thinning operation as excessive seed is inevitably sown per hill. Moreover, the traditional planting method is tedious, causing fatigue and backache due to the longer hours required for careful hand metering of seeds if crowding or bunching is to be avoided.

Kumar et. al. (1986) developed a manually operated seeding attachment for an animal drawn cultivator. The seed rate was 43.2 kg/hr while the field capacity was 0.282ha/h. Tests showed minimal seed damage with good performance for wheat and barley. Simalenga and Hatibu (1991) tested the Magulu hand planter on the field and found the work rate of the planter to be between 18 man-hours per hectare and 27man-hour per hectare when using conventional hand-hoe planting method. Gupta and Herwanto (1992) designed and developed a direct paddy seeder to match a two-wheel tractor. The machine had a field capacity of about 0.5ha/h at a forward speed of 0.81m/s. Damage due to the metering mechanism was nil for soaked seeds and 3% for pre-germinated seeds. Ladeinde and Verma (1994) undertook a study to compare the performance of three different models of jab planters with the traditional method of planting. In terms of field capacity and labour requirements, there was not much difference between the traditional planting method and the jab planters. However, backache and fatigue were substantially reduced while

A. Bamgboye and A. Mofolasayo." Performance Evaluation of a Two-Row Okra Planter".
Agricultural Engineering International: the CIGR Ejournal. Manuscript PM 06 002. Vol. VIII. July, 2006.

using the planters. Molin and D'Agostini (1996) developed a rolling punch planter for stony conditions, using 12 spades radially arranged with cam activated doors and a plate seed meter.

Preliminary evaluation showed important improvement in the planting operation with reduction in human effort, more accurate stands and high field capacity. To attain optimum planting condition for productivity, Pradhan et. al. (1997) developed a power tiller-operated groundnut planter cum-fertilizer drill with an actual field capacity of 0.160 ha/h.

Okra cultivation has been limited to manual planting, which is very tedious and labourious. There is therefore a need to develop a simple tool that will be used in planting okra seeds. This work is aimed at evaluating a simple manually operated okra seed planter designed by the authors to alleviate the burden of okra planting.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Planter:

The okra planter (Figure1) tested was developed at the Department of Agricultural and Environmental Engineering, University of Ibadan, Nigeria. The okra planter consists of: the feed hoppers, metering discs and housing, drive (ground) wheels, discharge spouts, furrow opening and covering devices, and the handles.

(a) **Feed hoppers:-** There are two feed hoppers made of mild steel, each having a square cross section. The design capacity of each hopper is 1740000 $mm^3$. This capacity is based on the volume of seeds required to plant a hectare of land. The dimension of the hoppers is 84mm x 84mm x 300mm.

*(b)* **Metering discs**:- The metering discs or flutes are made of *Ayan* (***Distemonanthus benthamianus)*** wood, because of its durability, high strength, and resistance to shrinkage. On each flute are two cylindrical cells bored, equidistant from each other along the periphery. The dimensions of the cells are 6 mm diameter and 10 mm deep. These dimensions are such that two seeds can be accommodated if they are oriented on the major axis.

*(c)* **Drive wheels**:- The drive wheels are made of mild steel and are integral parts of the seed metering mechanism. The wheels have spindles that bear keys that rotate the metering devices. The diameter of the wheels is 30 cm and spokes of 130 mm long cut from 10mm diameter iron rod were welded to the wheel and the periphery of the bushing which suspends the shaft. The circumference of the wheel is designed such that it is twice the required seed spacing within row to enable the planter discharge twice in one revolution of the wheels.

*(d)* **Metering disc housing**: The material used for the construction of the two metering discs housings is a mild steel hollow pipe, 109 mm internal diameter and 50 mm long. Two slots (100 x 25 mm) were made at the upper and lower portions on each of the metering housing. Seeds from the hoppers pass through the upper slot to the metering disc (flute) from where they were discharged through the lower slot into the discharge spout.

*(e)* **Discharge spouts:-** The discharge spouts essentially have a trapezoidal shape that links with a short cylindrical pipe from which the seeds drop into the furrow.

*(f)* **Furrow opening device**: - The furrow opener is a 40 mm mild angle iron with a length of 120 mm. The angle iron is slightly beveled at the lower edge to facilitate an easy cut through the soil. To facilitate the attachment of the furrow- opening device to its support, a pipe of diameter 17 mm (3/4") and 25 mm long was drilled to accommodate an 8 mm diameter bolt with the nut welded on the periphery of the hole drilled. The pipe was then welded at the underside (i.e. in the v–notch) of the top portion of the furrow- opening device.

*(g)* **Furrow covering device:** The furrow-covering device is made of rectangular mild steel plate of dimension 95 mm x 130 mm. The pipe for attachment to the support was welded to the middle of the upper edge of the plate. The covering device is inclined at an angle of $45^{o}$ to the direction of travel for optimum covering of the soil.

*(h)* **Handle:** The handle consists of two mild steel pipes of 17 mm internal diameter, each of length 1230 mm. At the two ends of each of the aforementioned pipes, two bushings each of 21 mm internal diameter and 30 mm long were welded in a horizontal position. These bushings have been previously drilled to accommodate 8 mm bolts. A crossbar, which is a pipe, 17 mm internal diameter and 900 mm long, was slotted through the upper sets of bushing of the pipes; the main shaft passes through the lower bushings.

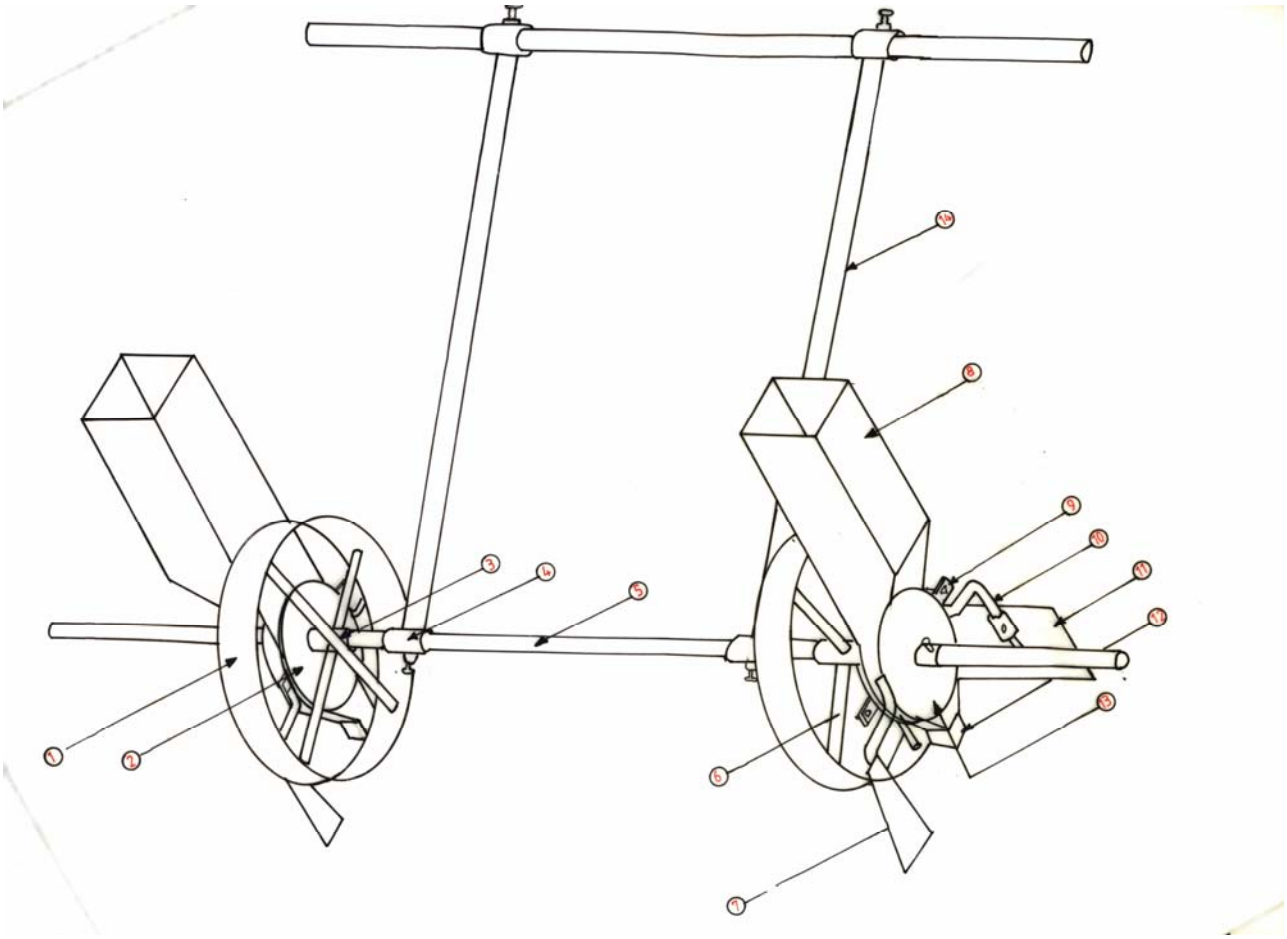

Figure 1 Okra Planter

Key to Figure 1
1. Drive wheel
2. Detachable cover plate
3. Wheel bushing
4. Stopper for wheel
5. Axle
6. Strokes
7. Furrow opening device
8. Hopper
9. Cover Plate hanger
10. Support for covering device
11. Furrow covering device
12. Discharge spout
13. Metering disc housing with fixed cover
14. Handle

**2.1.1 Seed**: The seed variety used for the testing was NH 47-4, having moisture content of 14.89%. In evaluating the machine's performance, the standard code proffered for seed drills by Mehta et. al. (1995) was used. The major tests carried out on the machine were done in the laboratory and on the field. The laboratory and field tests were carried out at the Federal College of Agriculture, Institute of Agricultural Research and Training, Moor Plantation, Ibadan.

**2.2 Laboratory Tests**: The machine was calibrated in the laboratory to determine the rate of discharge, evenness of seed spacing in rows and seed damage.

**2.2.1 Calibration:** Each of the hoppers of the planter was loaded with 100g of okra seeds. The planter was held in the vice to free the drive wheels were removed. A paint mark was made on each of the drive wheels to serve as reference points to count the number of revolutions when turned; and a polythene bag was placed on each of the discharge spouts to collect the seeds discharged. The drive wheels were rotated 50 times at low speed as would be obtained on the field. A stop clock was used to measure the time taken to complete the revolutions. The seeds in each bag were weighed on a balance and the procedure was repeated five times.

**2.2.2 Damage Test:**

The test for percentage seed damaged was done with the machine held in a similar position to that described above, but 500g of seeds were loaded into each hopper. The wheels were rotated twenty times in turns and the time taken to complete the revolution was recorded with the aid of the stop clock. The seeds discharged from each spout were observed for any external damage.

### 2.2.3 Evenness of Seed Spacing

To determine the evenness of seed spacing, 200g of seeds were smeared with paint to make them visible when discharged to the ground. The seeds were then sundried to ensure that the seeds do not stick together. 100g of seeds were loaded into each hopper. A 10m run was marked out on the

plain ground and the machine run within the length at walking speeds, recording the time of travel. A measuring tape was used to measure the distance between successive hills dropped.

**2.3 Field Test**:

Two plots of 100$m^2$ area, each, were marked out on a sandy loamy soil. The plots were ploughed and harrowed to obtain a fairly flat ground. The tests conducted were the determination of effective field capacity and efficiency, average depth of placement of seeds, evenness of seed spacing in the field and ease of setting, operation and adjustments.

Investigation into the field efficiency and effective field capacity of the planter involved continuous observation and timing of each activity involved in the planting operation. Two stop clocks were used to time the activities, while three people were involved in the determination of field efficiency. One person operated the planter on the prepared field, while others observed, took and recorded the time for the activities. One stop clock was used to record the time losses such as those for turning at field ends, removal of clogs and adjustment. The other stop clock was used to continuously measure the time during which the planter actually performed the intended operation. Field efficiency was obtained using the relationship given by Kepner et. al. (1978).

$$\text{Field efficiency} = \frac{\text{Time for actual planting operation}}{\text{Total time taken}} \times 100$$

The average depth of seed placement was determined by running the planter to and fro over an area of 10 square metres without the furrow covering devices and with medium setting of the furrow openers. During the process, the time taken to traverse the length of the field was recorded to determine the average speed of operation in the field. Along each furrow, five hills were randomly sampled and investigated for depth of placement. A steel tape was used to measure the required depth.

About 3 weeks after planting, the distances between successive seedlings within a row were determined over a distance of 10metres using a measuring tape. During the field operation of the machine, all the operational and adjustment difficulties were recorded to assess the handling characteristics.

## 3. RESULTS AND DISCUSSION

Table 1 shows the results obtained from the calibration of the machine. It could be seen from the table that the average weights discharged from the first and second hoppers are 4.32g and 4.55g respectively; while the total average weight discharged by the two hoppers is 8.87g.

Table 1 Calibration of the planter

| Trial | Wt discharged (g) Furrow 1 | Time for 50 rev (min) | Speed 1 rev/min | Wt discharged(g) Furrow 2 | Time for 50rev/min | Speed 2 (rev/min) |
|---|---|---|---|---|---|---|
| 1. | 4.01 | 1.48 | 27.8 | 4.70 | 1.50 | 27.3 |
| 2 | 4.53 | 1.40 | 30.0 | 4.87 | 1.43 | 29.1 |
| 3 | 4.12 | 1.46 | 28.3 | 3.98 | 1.49 | 27.5 |
| 4 | 5.01 | 1.51 | 27.0 | 4.94 | 1.50 | 27.3 |
| 5 | 3.95 | 1.41 | 29.2 | 4.26 | 1.44 | 28.8 |
| Average | 4.32 | 1.45 | 28.56 | 4.55 | 1.47 | 28.0 |

Total average weight discharged = 8.87g
Percentage difference between the weights of seeds discharge from the two hoppers = 4.97%
Seed rate = 0.36kg/hr

The percentage difference between the weight of seeds discharged from the first hopper and that discharged from the second hopper is 4.97%. This value falls within the range of ± 7% recommended for optimum inter-furrow variation (Mehta et. al. 1995). It was observed that the rate of discharge was affected by the speed of the machine. The second hopper with a lower speed of 28 rev./min. discharged more than the first hopper with a speed of 28.56 rev./min. It was observed that the planter was able to effectively meter out two seeds per hill on the average. This is good enough and the design is such that the number of seed metered out could be regulated by using adjustable metering device.

The total average percentage of seed damaged was 3.51% (Table 2). The first and the second hopper incurred seed damage rates of 4.40 and 2.62% respectively.

Table 2: Percentage seed damage

| Hopper | No of seeds Discharged | No of Seeds damaged | Time for 20 rev (s) | Speed (rev/min) | Percentage damage (%) | |
|---|---|---|---|---|---|---|
| | 66 | 3 | 45 | 26.7 | 4.5 | |
| | 58 | 2 | 41 | 29.3 | 3.4 | |
| 1 | 61 | 3 | 40 | 30.0 | 4.9 | Av. damage = 4.4% |
| | 72 | 4 | 40 | 30.0 | 5.6 | |
| | 56 | 2 | 40 | 30.0 | 3.6 | |
| | 75 | 2 | 40 | 30.0 | 2.7 | |
| 2 | 66 | 5 | 42 | 28.6 | 7.6 | Av. damage =2.26% |
| | 68 | 1 | 37 | 32.4 | 1.5 | |
| | 75 | 1 | 40 | 30.0 | 1.3 | |
| | 64 | 0 | 37 | 32.4 | 0 | |

Thus, the second hopper gave a better result than the first hopper, probably because of the minimal clearance between the metering device (flute) and its housing. The impressively low average value of percentage seed damage of 3.51% observed in this work is probably due to the low speed at which the planter wheels were rotated during the laboratory tests.

Table 3: Evenness of Seed Spacing in the Row (Laboratory and Field)

| Hopper | Trial | Times (s) | Speed (m/s) | Ave. Spacing, cm (Lab.) | Ave. Spacing, cm (Field) |
|---|---|---|---|---|---|
| 1 | 1 | 23 | 0.4 | 49 | 70 |
| | 2 | 23 | 0.4 | 55 | 59 |
| 2 | 1 | 29 | 0.3 | 46 | 70 |
| | 2 | 29 | 0.3 | 53 | 82 |

Table 3 shows the measurements taken for intra-row spacing in the laboratory and on the field after three weeks of planting. In the laboratory test, the mean intra-row spacing of seeds for the two furrows was 47.5 and 54cm respectively. This shows a fairly uniform spacing of seeds within the rows when the planter was run on plain ground. The spacing obtained from the field test was higher than that obtained in the laboratory test. However, it was closer than the laboratory test i.e. 70cm for the first furrow and 70.5cm for the second furrow. In comparison with the recommended intra-row spacing of 45cm (NIHORT, undated), it could be seen that the laboratory test gave a better spacing result than what was obtained on the field. This could be due to the clogging of the seed and the germination rate of seeds planted, since the seeds did not attain 100% germination. The other reason is the operator's level of experience: taking inevitable stoppages into

consideration, the ability of the operator to operate the machine at a uniformly low speed would achieve better spacing.

Table 4: Field Efficiency and Field Capacity Determination

| Trial | 1 | | 2 | |
|---|---|---|---|---|
| Activity | Time for 1/10 hectare (s) | Time/hectare (min.) | Time for 1/10 hectare(s) | Time/hectare (min.) |
| Turning at field ends | 62 | 10.3 | 71 | 11.83 |
| Removal of clogs | 293 | 48.83 | 54 | 9.00 |
| Adjustment | 67 | 11.17 | 50 | 8.33 |
| Actual planting | 720 | 120 | 720 | 120.00 |
| Total time | 1142 | 190.3 | 895 | 149.16 |
| Efficiency (%) | 63.05 | | 80.45 | |
| Field capacity (ha/hr) | 0.315 | | 0.402 | |

As shown in Table 4, the average value of field efficiency obtained from the trials was 71.75%. This shows a satisfactory performance as it falls within the range of values obtained for planting operation by various investigators (Kepner et. al., 1978). Furthermore, from the time studies shown in the tables, the effective field capacities for the first and second trials are 0.315 ha/hr and 0.402 ha/hr respectively, giving an average value of 0.36 ha/hr. This value corresponds to those of the literature cited and even has a higher value than those of the manually-operated seeding attachment of 0.282ha/h for an animal drawn cultivator developed by Kumar et. al. (1986), and the Magulu hand planted developed by Simlenga and Hatibu (1991) which had a work rate of between 18 man-hours per hectare and 27 man-hours per hectare compared to the two-row okra planter with a work rate of 3 man-hours per hectare. The satisfactory result may be due to its maneuverability, which saves time in turning or moving the planter from one point to another.

Table 5: Average Depth of Placement of Seeds

| Trial | Depths measured for furrow 1 (mm) | Depths measured for furrow 2 (mm) |
|---|---|---|
| 1 | 5.6 | 8.6 |
| 2 | 14.6 | 11 |
| 3 | 8.2 | 5 |
| 4 | 8.2 | 7.4 |
| 5 | 7.2 | 7.4 |

Table 5 shows the depth measurements taken in the determination of the average depths of furrows opened. The mean depth of furrows opened at the medium setting of the openers is 9 mm and 8 mm for the two furrows. This is less than a sowing depth of 25mm

recommended by Anderson (2002) after soaking the seeds in water prior to planting. However, greater sowing depth is achievable with the adjustment of the opening devices.

Given the conditions of the soil and seedbed as earlier determined, the operation of the machine on the field was without much difficulty. The furrows opening devices are easily adjustable with the spanner as the topography of the land demands. However, it takes a sound sense of judgment and experience to attain effective cover of furrows through the adjustment of the covering devices.

## 4. CONCLUSION

The manually-operated two row okra planter developed from locally available materials to suit the need of the peasant farmers was found to operate at a field capacity of 0.36ha./hr with an average spacing of 51.75cm. The planter was able to effectively meter maximum of two seeds per hill with minimum damage to the seeds. The relative ease with which the machine is adjusted and maneuvered in the field suits the technical know how of the average peasant farmer.

## 5. REFERENCES

Andersen, Craig R. 2002. *Okra*. Home Gardening Series Division of Agriculture, Cooperative Extension Service, University of Arkansas.

Dessai, B. B.; P.M. Kotecha and D.K. Salunke, 1997. Seeds Handbook: Biology, Production, Processing and Storage. Pp 376 – 387.

Gupta, C. P. and Totok Herwanto. 1992. "Design and development of a direct paddy seeder. Agricultural Mechanization in Asia, Africa and Latin America. Vol. 23, No. 1, Pp. 23-27.

Kepner, R. A.; Roy Bainer; Barger, E. L. 1978. *Principles of Farm Machinery.* AVI Publishing Company, Inc. Westport, Connecticut.

Kumar, K.; N.K. Naaresh and T. P. Ojha. 1986. "Design, construction and performance of a manually-operated seeding attachment for an animal drawn cultivator". *Agricultural Mechanization in Asia, Africa and Latin America.* Vol. 17, No. 2, Pp. 35-38.

Ladehinde, M. A. and S. R. Verma. 1994. "Performance evaluation of hand-operated seed planters in light and medium soils in Nigeria". *Agricultural Mechanization in Asia, Africa and Latin America*, Vol. 27, No. 3, Pp. 17 – 19.

Mehta, M.L.; Verma, S. R. Misra, S.K.; Sharma, V.K. 1995. *Testing and Evaluation of Agricultural Machinery.* National Agricultural Technology Information Centre, India. Pp 68 – 79.

Molin, J. P. and V. D'Agostini. 1996. "Development of a rolling punch planter for stony soil conditions". *Agricultural Mechanization in Asia, Africa and Latin America.* Vol. 27, No 3, Pp 17-19.

National Institute of Horticultural Research. Undated " *Guide to the Production of Tomato, Egusi, Melon, Okra and Pepper"*. Extension Research Liaison and Training, NIHORT, Ibadan.

Pradhan, S. C.; M. Mahapatra; P. K. Samal and B.K. Behera 1997. Development of power tiller –operated groundnut planter cum-"fertilizer drill". *Agricultural Mechanization in Asia, Africa and Latin America,* Vol. 28, No 4, Pp. 25 – 28.

Simalenga, T. E. and N. Hatibu. 1991. "Development of low-cost, hand-operated planter". *Agricultural Mechanization in Asia, Africa and Latin America.* Vol. 22, No. 3, Pp. 39 – 41.