International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3 Issue No.10, pp : 1325-1329 1 Oct 2014

Performance Assessment of NCRI Drum Planter for Direct Seeding of Pre-Germinated Lowland Rice

Gbabo Agidi, Kolade Moyosore
National Cereals Research Institute, Badeggi-Bida. Niger State
agidides@yahoo.com kolademoyosore2010@yahoo.com

Abstract : ***The National Cereals Research Institute (NCRI), Badeggi has developed a 12-row manually operated rice drum planter aimed at reducing the cost and labor associated with transplanting of lowland rice. The performance of the machine was evaluated and compared with the hand seeding method. The planter was tested in the NCRI Fadama rice field side by side with hand drilling method. The design is simple and the power requirement (0.0746 KW) to pull the planter was within the capacity of an average man. It enables the direct seeding of pre-germinated rice seeds at an inter-row spacing of 25cm. This makes it easy to apply fertilizer and also use weeders for weed control. A laboratory calibration was carried out with different combinations of drum fills viz., 1/2, 2/3, 3/4, and travel speed viz., 1 km/h, 1.2 km/h, and 1.5 km/h. From the laboratory calibration test the combination of 2/3 drum fill and 1 km/h speed were selected for field evaluation of the drum seeder. The theoretical field capacity was calculated as 0.38 ha/h. The effective field capacity of the machine was observed to be 0.33ha/hr while the seed rate was 65kg/ha with a loading capacity of 9kg. The field efficiency of the machine was assessed to be 86.8%. This performance indicates that the planter is suitable for adoption by small scale farmers.***

Index Terms- direct seeding, field capacity, field efficiency, Rice planter.

INTRODUCTION

More than half of the world's population use rice as a stable food and it is generally grown under wetland condition (Syedul Islam M.D. and Desa Ahmad, 1999; Farouq M. etal. 2011). The most important cultivation methods are direct seeding and transplanting methods. Direct seeding of rice refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. There are three principal methods of direct seeding of rice: dry seeding (sowing dry seeds into dry soil), wet seeding (sowing pre-germinated seeds on wet puddled soils) and water seeding (seeds sown into standing water) (Naresh et al. 2013; Farouq M. etal. 2011).

Transplanting rice which is labor intensive and expensive can be replaced by direct seeding that can reduce the labor needs by 20% and would significantly decrease costs of rice production (Chandrasekharara et. al. 2013; Flinn and Mandac, 1986). Scarcity of labor during planting season can cause delay in transplanting leading to attack from diseases and pest infestation leading to low yield (Das F.C. 2003). Presently, 23% of rice is planted by direct-seeding globally (Rao et al., 2007). A number of countries which includes America, Western Europe such as Italy and French, Russia, Japan, Cuba, India, Korea, the Philippines and some parts of Iran, have adopted direct seeding of rice seed due to high technology requirement, high labour cost and shortage of skilled labour associated with rice transplanting operations (Akhgari, 2004). In addition, the adoption of direct seeding of rice was principally brought about by the expensive labour component for transplanting due to acute farm labour shortage, which also delayed rice sowing (Chan and Nor, 1993). Some studies at the International Rice Research Institute (IRRI) in Philippines confirmed that there is no yield difference between direct seeding and transplanting practices of rice production if the weed control and other intercultural operations are done properly. This finding is applicable for both high yielding and traditional varieties (Syedul Islam M.D. and Desa Ahmad, 1999). Direct seeded rice mature seven to ten days earlier than transplanted rice (Balasubramanian and Hill, 2002)

Direct seeding of pre-germinated rice seed in puddle field (wet seeding) helps to reduce labor and weed cost as it avoids raising of nursery beds, pulling of seedlings and transplanting them and allows the use of mechanical weeders. Farmers in developing countries are increasingly adopting wet seeding because of the migration of farm labour to non-farm jobs and the consequent labour shortage and high wages for manual transplanting (Ho 1995, Pandey 1995, Pingali 1994).

. With this wide spread adoption of direct rice seeding, the National Cereals Research Institute (NCRI) has developed a manually operated drum type planter for lowland paddy. The NCRI seeder is low-cost and easy to operate. The utilization of the drum planter is expected to allow farmers to plant crops in evenly spaced rows, ensuring that seeds are not wasted in addition to efficient uptake of fertilizers by the rice plants.

MATERIALS AND METHOHD

Description of the NCRI drum planter

The NCRI drum seeder is a manually operated machine suitable to sow pre-germinated paddy seeds in rows. It is made up of the following parts as shown in plate 1 and fig. 1.

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Frame: The frame was designed from a 3.5 x 3.5 cm square mild steel pipe to form a platform on which the seed drums were linked to the axle of the machine.

***Seed drums*:** The seed drums were hyperboloid shape made of plastic drums of 23cm diameter at the maximum point, 18cm diameter at the minimum point and 35cm in length. The seed drums were re-enforced with a 12cm diameter, 1mm mild steel plate welded to a 7cm length 4.5 x 4.5cm square pipe which the frame passes through. The slopes of the cone facilitated the free flow of seeds towards the metering holes. Six numbers of seed metering holes of 1cm diameter at 10cm spacing were made on the circumference of the drums at both ends for dropping of the seeds by gravity at a row-to-row spacing of 25cm. A 9.5cm x 8.5cm opening were made on the seed drums for feeding the seed rice. The coverer was also made of plastic which has a dimension of 10cm x 10cm.

***Axles*:** The axles of the wheels were made from a 12mm diameter rod fitted at both ends of the axle.

***Wheels*:** The wheels were made from a 1.2mm mild steel plate. The wheels have a diameter of 45cm and 12cm width which are re-enforced internally with a 1 inch flat bar.

***Handle*:** The handle was made from a 12mm iron rod and hitched to the frame by welding it to a 3cm length mild steel round pipe.

Plate 1 The NCRI rice drum planter

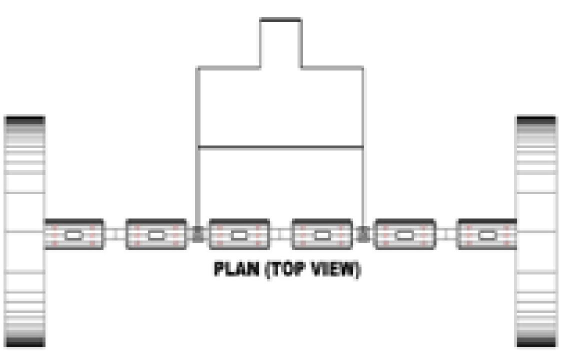

Figure 1. Plan of the rice drum planter.

- All dimensions in cm

Testing of machine

A laboratory calibration of the planter was carried out with different combinations of drum fills *viz.*, 1/2, 2/3, 3/4, and travel speed *viz.*, 1 km/h, 1.2 km/h, and 1.5 km/h. From the laboratory calibration test the combination of 2/3 drum fill and 1 km/h speed were selected for field evaluation of drum seeder. The field test was conducted on the loamy soil of NCRI Fadama rice field to evaluate the performance of the drum type rice planter and was compared with the hand drilling method. Two plots of land measuring 0.25ha were prepared side by side. They were puddle, leveled and excess water was drained out before planting operations were carried out. The seeds were soaked in water for 24 hours and incubated for 36hours to enable them sprout (plate 2) before they were sown in the field using the planter and manually by hand in the two plots. The soil type on the location was loam. Planting of the rice seed was also done on the same day. The seed placement by both the rice drum planter and the manual hand drilling was on the surface of the soil.

Sowing with the planter was done by filling the pre-germinated rice to two-third of the drum planter volume through the seed inlet opening (plate 3). The planter was pulled by one operator at a steady pace to allow for uniformity of seed dropping by gravity (plate 4). The seed drops by virtue of gravity on the surface of the soil through the seed openings in rows 25cm apart. During the planting operation, the data on actual seeding time, turning time and loading times were collected in order to calculate the effective field capacity and field efficiency. The roots were allowed to anchor for 3 days before irrigation was done. The depth of water was gradually increased as the seedlings grew but not completely submerging the seedlings.

The planting of rice seed by hand drilling was also done by four (4) farmers on the second plot adjacent to the one planted with the drum planter. The placement of seedling in the hand drilling method was also on the surface with the help of fingers and in bending position which stimulates stress and several occupational health hazards. The same inter row spacing of 25cm was maintained. The machine and manual planting operations were repeated twice in two more pairs of adjacent plots to make three (3) replications. The following parameters were calculated and the results obtained are presented in table 1.

***Seed rate*:** The number of seeds planted per hectare was calculated by obtaining the difference of the amount of seed loaded before planting and amount seed remaining after planting per hectare of land.

Field efficiency: Field efficiency the percentage of time the machine operates at its full rate speed and width while in the field.

Theoretical field capacity: The theoretical field capacity of the machine was calculated using the formula below:

$$\text{Theoretical capacity (Acres per Hour)} = \frac{\text{Speed (mph)} \times \text{Machine Width (feet)}}{8.25}$$

Effective field capacity: The machine could not operate at its theoretical capacity while it is in the field due to the following factors: turning and idle travel, time required to fill the planter.

$$\text{Effective Capacity} = \text{Theoretical Capacity} \times \text{Field efficiency}$$

Plate 3. Pre-germinated rice seed

Plate 4. Planting with drum planter

Plate 5. Planting by manual hand drilling

RESULTS AND DISCUSSION

The various performance parameters for the manual hand drilling of rice seed and drilling with drum planter are discussed as follows:

***Seed rate*:** Seed rate of the rice drum planter was 65kg/ha while that of the manual hand drilling operation was 188kg/ha. This shows that a lot of rice seed was wasted in the manual hand drilling operation and this resulted to overpopulation in the manual hand drilling filed as recorded in table 2 and shown in plate 6 and 7.

Effective field capacity: The effective field capacity of the NCRI rice drum planter with seeding rate of 65 kg/ha was found to be 0.38 ha/hr. However, the field capacity of manual hand drilling with a rate of 188 kg/ha was 0.18 ha/hr and significantly lower than that of the drum planter (Table 1). In the rice drum planter operation, about 92% time was actually required for seeding, 3.7% time was lost in turning and about 4.3% time was lost in loading. In the case of the manual hand drilling, about 93% time was engaged in actual planting and 7% time was lost in loading the seed pot.

Field efficiency: The rice drum planter has a theoretical capacity of 0.38ha/hr. Therefore, the field efficiency of drum planter at the rate of 66 kg/ha was 86.8 percent, but that of manual hand drilling at the rate of 188 kg/ha was 92.60 percent with a theoretical capacity of 0.18ha/hr. The result revealed that the field efficiency of manual hand drilling was slightly higher than that of machine seeding because in case of hand seeding no time was lost in turning.

Labour and cost of operation: In the drum planter operation, only one operator is required for planting a hectare of the rice field. Therefore, the cost of operation for the drum planter is N1000. In the case of the manual hand drilling operation, 12 men were required to sow seeds on one hectare of land, resulting in a labour cost of N12000. This shows that N11000 is saved on sowing with the rice drum planter.

Plate 6. Direct seeded plot with drum planter

Plate 7. Manual hand-drilled plot

CONCLUSIONS

After the assessment of the performance of the NCRI drum Seeder, the following conclusions are drawn:

1. Use of drum planter helps in timely sowing of rice. Farmers can take up paddy cultivation at any time, right away, as there is no requirement or delay of raising a nursery.
2. Compared to the manual hand drilling, the use of drum planter saves a lot of seeds.
3. The drum planter reduces labour requirement and cost of sowing. The demand for agricultural labor is at its peak during planting time, forcing farmers to pay high wages for regular field operations. Direct seeding method avoids raising of nursery, pulling up seedlings and transplanting them so that labor requirement and cost for crop establishment is negligible.
4. Line sowing by using drum planter reduces weeding cost due to use of mechanical weeder.

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Table 1.Comparison of average values of various performance parameters for planting operations using manual hand drilling and drum planter.

Parameters	NCRI drum planter	Manual planting
Soil type	Loamy	Loamy
Type of seed	Sprouted	Sprouted
Seed placement	Surface	Surface
Sprouted seed fed per drum (kg)	1.50	-
Seed rate (kg/ha)	65	188
Labor requirement (man/ha)	1	12
Labor cost of sowing operation(N)	1000	12000
Working width of machine (cm)	319	-
Seeding time (hr/ha)	2.95	5.44
Time loss/turn (s)	18	-
Turning time (hr/ha)	0.12	-
Loading time (hr/ha)	0.14	0.43
Total time of operation (hr/ha)	3.21	5.87
Effective field capacity (ha/hr)	0.33	0.16
Theoretical field capacity (ha/hr)	0.38	0.18
Field efficiency (%)	86.80	92.60
Plant population (no/m^2)	247.30	879.30
Average plant height (cm)	23.33	22.33
Average root length (cm)	7.70	6.50