Comparative Study on the Efficiency of Tractor-Based Seed Drills in Ragi Farming

Abstract

Finger millet (ragi) holds significant importance in global agriculture, with India leading in its production, contributing approximately 40-50% of the world's supply. Despite its high nutritional value and growing popularity as a gluten-free grain, the global average yield remains modest, ranging from 1.0 to 1.2 tons per hectare. One of the primary challenges in ragi cultivation is the reliance on traditional farming methods, which involve labor-intensive practices from land preparation to post-harvest operations. This not only increases production costs but also contributes to excessive drudgery. Labor shortages, especially during peak farming periods, further exacerbate the situation by driving up costs and reducing overall productivity. In this context, mechanization has become critical for ensuring timely agricultural operations, which are key to maximizing crop yields. The evaluation of tractor-operated seed drills has shown promising results, including a reduction in seed usage when compared to traditional methods. Moreover, the mechanization of ragi sowing has effectively eliminated the drudgery associated with manual sowing, making the process more efficient and cost-effective.

Key words: Tractor-operated, seed drills, Mechanization, line sowing, broad casting

Introduction

In 2023, India cultivated finger millet on approximately 1.1 million hectares, producing around 1.8 to 2.0 million metric tons, with Karnataka being the largest producer, accounting for nearly 60% of the country's output. Africa, particularly Uganda, Kenya, and Ethiopia, is also a significant producer. Global production is estimated at 4 to 5 million metric tons annually.

In Tamil Nadu, finger millet, known locally as "Kezhvaragu" (கேழ்வரகு), holds cultural and nutritional significance, being a traditional crop cultivated for generations. It thrives particularly well in the dry and semi-arid regions of the state due to its ability to withstand drought and poor soil conditions. Finger millet is especially grown in districts like Dharmapuri, Krishnagiri, Salem, Madurai, Tiruvannamalai, and Vellore, where it serves as both a staple food and a source of income for small-scale farmers.

Tamil Nadu's cultivation practices emphasize organic and traditional methods, recent years have seen efforts to improve yields through better seed varieties and farming practices. The crop is planted during the Kharif season, relying on monsoon

irrigation. On average, finger millet occupies around 82919 hectares in Tamil Nadu, producing a moderate yield of approximately 288627 tons per hectare (Statistical Hand of Tamil Nadu-2020-21).

Sowing of seeds with seed drill at proper seed rate, depth and covering them with soil is very important. This allows plants to get sufficient sunlight and nutrients from the soil and also saves them from being eaten by birds or being dried up due to exposure to sun. Meanwhile it ensures improved ratio of crop yield with saving in time and labour (Naveen *et al.,* 2019). Manual sowing is time consuming requires about 20 to 30 man-hours per ha of land, and that takes away about 8per cent of total manhours in farming and costly. Hence, there is a need for appropriate seed drill for sowing (Kiran and Chandhari, 2001). Chandhari, 2001 evaluated the performance of furrow openers, which show in general that an increase in the rake and horizontal included angles increases furrow depth and furrow area. For light sandy soils, a rake angle of 130° was found to be best for the depth stability of the openers. Quadratic relationships were found for depth force relationships for both horizontal and vertical forces, whereas the force–rake angle relationship was found to be both speed and width dependent

Finger seeds are generally sown under rainfed condition by broadcasting without any land preparation and ploughing is done subsequently to cover the seeds but with advances in management techniques seeds are sown in rows as line sowing at 22.5-30 cm apart manually. Manual sowing has the problem of labour availability as rain is uncertain and labour availability at that time is troublesome and there is also uncertainty in depth of sowing as per the situation. The timeliness of operations has assumed greater significant in obtaining optimal yields from different crops, which has been possible by way of mechanization (Joginder Singh, 2006). But in sowing particularly in rainfed sowing, sowing depth is important to avail the soil moisture at the maximum for better field emergence. In comparison to conventional farming by using improved set of equipment labour dependency and cost of cultivation was reduced (Syed Mazhar Ali Shah, 2017). Mechanical sowing using seed drill is the best alternative for rainfed sowing with option of proper placement in correct depth at the earliest as possible after the receipt rains.Khobragade et al., (2011), in his study reported that, tractor operated seedcum-drill works better than bullock drawn seed drill in respect of effective field capacity, efficiency, depth of placement of seed, yield of crop, yield of fodder and cost of sowing hectare in sorghum cultivation. The crops were also sown with the conventional method sowing on flat surface using a tractor-drawn device fitted with a tine-type cultivator

with manual seed metering and mounted with a planker to cover the seed (Singh et With plots sown by the conventional method, the recommended dose of fertiliser was broadcast after the emergence of the seed. Finger millet sowing using tractor drawn coupled with cycle weeding and harvested mechanically found more remunerative by time, labour and reducing drudgery for the farmers (Sowmyalatha, 2022).Hence studies conducted to evaluate the cost-effective mechanization in finger millet on sowing with machinery like tractor operated seed drill.

Materials and Methods

Calibration of tractor operated Dharti Agro seed cum fertilizer drill for sowing ragi

The selected seed drill for sowing the ragi seeds is tractor operated dharti Agro seed cum fertilizer drill which has 11 furrow openers and operational width of 3.0 m. The seed cum fertilizer drill is provided with 7 types of rotors by the manufacturer for metering the various seeds like maize, sunflower, groundnut, ragi, mustard etc.. For sowing of ragi seeds, rotor number 13 (As recommended by the manufacturer for mustard /pearl millet crops) was fixed to the seed metering shaft of the seed drill. In total 11 seed metering rotors fixed to the seed metering shaft to the seed drill for metering the seeds from the seed hopper.

About Rotor number 13 in seed drill

The rotor part is usually made of durable plastic material chosen for its precision molding capabilities, resistance to wear, and ability to handle various seed types without causing damage. It is plastic moulded rotor which is used to carry the small seeds like ragi, mustard, pear millet etc. and drop the same in the funnel where it reaches the furrow continuously.

Laboratory test was conducted with rotor number 13 to find the number of ragi seeds taken by the rotors of the seed drill. The rotor used to carry 4 to 5 number of ragi seeds seeds. Hence, calibration of the existing seed drill was done by operating the cup feed seed drill on plain ground surface covered with a plastic sheet to collect the ragi seeds metered by the machine. The ragi seed variety Paiyur 2, the current ruling variety is taken and required quantity is filled in the respective hopper of the seed cum fertilizer drill. The seed drill was operated by lifting the implement so that the furrow opener was slightly above the ground. The ground wheel was lowered to transmit the drive to metering mechanism. The quantity of ragi seeds per rotor was recorded based on the unit length of forward travel. The details of calibration of seed drill was as followsList 1.The details of calibration of seed drill

Circumference of ground wheel (π D)	:	3.14 x 40 = 125.6 cm = 1.26 m

Width of seed drill (Number of furrow opener x width of seed drill)	:	11 x 0.30 m = 3.3 m
Area covered for one revolution (Circumference of ground wheel x Width of seed drill)	:	1.26 m x 3.3 m = 4.16 m^2
Number of turns needed/ha	:	10000 m^2 / 4.16 m^2 = 2404
Number of grains taken by the cup	:	5 seeds 5 seeds / cup x 8 cup holes / revolution 40 seeds x 11 rows 440
Therefore for 2404 tunes, the number of grains to be dropped. Calculated 1000 seed weight is 3.47g	:	440 x 2404 = 1057760 seeds / hectare
	:	1057760 seeds
	:	3670 g
	:	3.67 kg/ha

On calibration of the seed drill, it is observed that each rotor cup picks around 4 to 6 numbers of seeds from the hopper and the same was dropped to the funnel for sowing. Around 3.67 kg ha^{-1} seed was used for sowing in the field with the selected tractor operated seed cum fertilizer seed drill. The actual recommended seed rate for sowing ragi seed is also 10 kg ha^{-1} in adoption of broad casting (Crop Protection Guide, 2020).

Field evaluation of seed drill sowing for ragi seed under rainfed condition

The tractor operated seed cum fertilizer drill was evaluated for its performance under field condition in an area of 0.15 ha with the latest ragi var. Paiyur 2 prepared through conventional primary tillage in field No. 3 of F block of Regional Research Station, Paiyur. The furrow opener and the depth control were so adjusted to have a planting depth of 25-50 mm. The tractor was operated at speed of 2.0 to 3.0 kmh^{-1}. The ragi seeds were sown using the seed cum fertilizer drill at row-to-row spacing of 300mm and plant-to-plant spacing of 100mm (Plate 1&2) as rainfed ragi crop. View of the field after sowing operation is shown in plate 3.

Plate 1. Tractor operated seed cum fertilizer seed drill for sowing ragi seeds


Plate 2. Tractor operated seed cum fertilizer seed drill in the actual field

For comparison, seeds were also sown in an area of 5 cents simultaneously adopting broad casting technique. The crop was grown as pure rainfed crop.


Seed drill sowing **Broad casting**

Plate 3. View of the field after sowing operation

Results

Field evaluation

On evaluation of the performance of the cup feed seed drill, initially for the field parameters viz., the field capacity, field efficiency, seed rate and seed germination as follows

Theoretical field capacity (C)

It was calculated by using the below formula

$$C = \frac{S \times W}{10}$$

Where , C= Theoretical field capacity; $ha.hr^{-1}$

S= Forward speed, $km.hr^{-1}$

W=width, m

C = 2.5× (0.30×11) /10

= 0.83 $ha.hr^{-1}$

Effective field capacity, EFC

The effective field capacity of will include time lost during the actual field operation such as time lost due to turning, loading, adjustment and other time losses during the operation. $EFC = \frac{A}{T}$

Where:

EFC=Effective field capacity**,** $ha.hr^{-1}$

A=area, hectare

T=time to finish the area, hr

= 0.164/0.213

= 0.77 $\mathbf{ha.hr^{-1}}$

Field Efficiency (FE) (%)

The field efficiency was calculated by using the below expression

$$FE = \frac{EFC}{C} X\ 100$$

Where, EFC=Effective field capacity**,** $ha.hr^{-1}$

C= Theoretical field capacity; $ha.hr^{-1}$

FE = (0.77/0.83) ×100

= 92.7 %

Seeding Rate (SR), kg/ha

$$SR = \frac{W}{A}$$

Where ,

W = Weight of seeds, kg

A= Area, ha

Sr = 0.637/0.164

= 3.88 kg/ha

Field Emergence (%)

As per the data on seven sowing approximately 100 seeds would be sown. Based on that in thirteen different places the number of seeds emerged were counted and using the following formula the field emergence was calculated in percentage. Similarly by broadcasting 100 seeds in 13 different places were broadcasted and the mean was calculated in percentage and the data were statistically analyzed for significance.

$$\text{Field emergence (\%)} = \frac{\text{Number of seeds germinated}}{\text{Number os seeds sown}} \times 100$$

The results of the above parameters were as follows (Table 1)

Table 1.Field and machine characters on mechanical sowing

Field and machine parameters	Values
Theoretical field capacity, C	0.83 $ha.hr^{-1}$
Effective field capacity, EFC	0.77 $ha.hr^{-1}$
Field Efficiency (FE)	92.7 per cent
Seeding Rate, SR	3.88 kg/ha
Field emergence (%)	87 per cent

Measurement of depth of placement of seeds

Depth of seed placement was measured by removing the plant from soil, and measuring the depth at which the seed was placed. Plot size of one square meter was randomly selected from the field and measured the depth of sowing by removing the plant from soil in five different places . The values of depth of sowing of the seed drill were recorded and the mean reported in mm(Table 2). The results indicated the average sowing depth in seed drill as 52±0.20 mm.

Table 2 Measured values of Depth of placement

Particulars	Depth (mm)
Depth of sowing (mm)	52
S.E	0.10
95% confidence limit	52± 0.20

Summary and Conclusion

- ✓ The performance of the tractor operated seed cum fertilizer drill evaluated under rainfed condition revealed the follows
- ✓ The field information expressed the effective field capacity was 0.77 ha/h with 92.7 per cent field efficiency.
- ✓ The average sowing depth in seed drill is 52 ±0.20.
- ✓ The cost of operation of cup feed seed drill along with tractor is Rs.973/ha.
- ✓ Benefit cost ratio of broad casting and machine sowing are 1:1.7 & 1:2.3

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