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Field Evaluation of Power-Tiller Drawn Seed Drill for Sowing Maize on Terraces in Hilly Region

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ABSTRACT

Field evaluation of a power tiller drawn seed drill was conducted for sowing of maize on terraces of 2-5 m wide. Various parameters such as machine, soil and crop parameters were considered during the field evaluation. The major parts of the seed drill consisted of main frame, seed box, flutted roller type seed metering mechanism, furrow opener, seed tub and attachment for seed rate adjustment. Maize seeds were sown directly after the harvest of turmeric without any prior tillage operation. Seeds were placed in the furrows at desired depths through adjustable system at the rate of 18 kg. ha^{-1}. The average depth of sowing was 45 mm and row-row spacing was 50 cm. Seed placement pattern in row was continuous. Soil moisture content, soil bulk density and soil strength were 18.35 %, 1.38g.cm^{-3} and 25.40 k.cm^{-2}, respectively at the time of so wing. The results from the study showed that, effective field capacity achieved was 0.12 ha.hr^{-1} at a speed of operation of 1.88 km.h^{-1}. The field efficiency, field machine index and fuel consumption were observed to be 63%, 77% and 0.96 l.hr^{-1}, respectively. Considering the performance parameters, seed drill fitted with fluted feed roller type seed metering mechanism with two numbers of furrow openers was found satisfactory for use on terraces although plant to plant distance could not be maintained.

1. Introduction

Agriculture in hilly region (north eastern hilly region) is distinguished from agricultural sector in the plain areas in terms of its features and performances. The region is characterized by hilly terrain, high rainfall, wide variations in slopes and altitude with spread out hills interspersed by fertile plains. Because of which the region is unique, affecting agriculture in various ways including mechanization of farm activities. Farm machines or equipment for the hilly regions must suit the hilly terrain and small farm sizes. Literature also revealed that machines designed for plain areas are not suitable in the hilly region due to topography and small land holdings (Singh and Vatsa, 2007; Singh *et al.,* 2014; Singh *et al.,* 2017). The available small size farm plots also limit the accessibility of tractor operated implements developed for plain areas (Singh *et al.,* 2014). The weight of prime mover to be used in hill region must range from 100-110 kg that can be lifted by one or two men from one terrace to another (Singh and Vatsa, 2007). In the region, maize is the second important cereal crop after rice in terms of cultivated area. Farmers (mostly tribal) in the region still follow manual dibbling method. This method of sowing is not only time consuming, but also it involves drudgery. Some researchers have reported development and evaluation of equipment for sowing/planting of crops in hilly areas: manually operated multi-crop planter for hilly regions (Gupta *et al.,* 1999); light weight power tiller operated seed drill for sowing wheat on hilly terraces (Singh and Vatsa, 2007); light weight manual planter for planting maize in Sikkim (Khura *et al.,* 2011); self-propelled multicrop planter developed & evaluated at IARI, New Delhi for planting of maize and soybean in hilly areas

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Singh *et al.* (2014); and manual/bullock operated multi-crop for hilly region developed and evaluated at ICAR-VPKAS, Almora (Singh *et al.,* 2017). Moreover, Khura (2011) also identified some equipment such as CIAE seed drill, Naveen dibbler, manual oilseed drill and manual multicrop planter/garlic planter, suitable for sowing small to large seeds in hilly region. Although a number of planters or seed drills have been developed and evaluated, literature on power tiller operated seed drill for sowing maize in north eastern hilly region could not be found. Since power tiller is multi-purpose and becoming popular in hilly region, there was a need to explore the feasibility and adoptability of power tiller drawn seed drill to mechanize sowing operation of maize. Therefore, the present study aimed to evaluate the performance of power-tiller drawn seed drill for sowing maize on terraces in north eastern hilly region of India.

2. Materials and Methods

2.1 Machine Components

A power tiller drawn seed drill (HPKV Palampur Design) having three furrow openers (25 cm spacing between them) was used. Out of three, only two furrow openers were allowed to drop seeds (making it a two-row seed drill) to maintain a row spacing of 50 cm for sowing maize. The major components were main frame, seed hopper, seed metering unit, seed tube, furrow opener, power transmission unit (chain & sprocket) and ground wheels (Figure 1). The specifications of the planter are presented in Table 1.

Table 1. Specifications of power tiller drawn seed drill

Component	Specification
Power source	Power tiller
Overall size (length x width x height)	810 x 800 x 765 mm
Number of row	Adjusted to 2 rows
Row spacing	500 mm
Seed metering	Fluted rotor type
Seed hopper capacity, kg	10-12
Speed of operation, $km.h^{-1}$	1.8-2.0
Type of furrow opener	Inverted T- type
Power transmission	Chain and sprockets
Overall weight, kg	49

2.2 Laboratory Calibration of Seed Drill

Laboratory calibration of seed drill conducted as per BIS standard (IS: 6316-1993). Maize seed was filled in the hopper. Ground wheel was jacked up and 20 revolutions were given to the ground wheel. The seed discharged from each of the two seed tube were collected and measured separately. Ten replications were taken. Variation in seed metering and uniformity of seed delivery between two rows were also evaluated.

Metering unit

Furrow opener

Figure 1. Power tiller drawn seed drill and its components

2.3 Field Evaluation of Seed Drill

The field evaluation was conducted at the experimental farm of the Division of Agricultural Engineering, ICAR Research Complex for NEH Region Umiam-793103, Meghalaya during 2017-18. The field (terraces of approximately 0.1 ha area) was divided into eight plots: four of size 30×5 m; two of size 30×4 m; and three of size 30×2 m. The row-to-row spacing of 500 mm was adopted in the field at 18 kg. ha-1 seed rate for sowing maize on terraces. Observations were recorded on time taken to cover the area, depth of placement, fuel consumption of power tiller, soil strength, and soil moisture & bulk density before operating the seed drill. Machine performance parameters such as effective field capacity, field efficiency, field machine index, speed of operation and labour requirements were calculated as per the standard procedure and compared with traditional method of manual dibbling practice.

2.4 Cost Economics

The total cost of sowing was determined based on fixed cost and variable cost (IS: 1964-1979). The total cost of operation of seed drill on hourly basis and per hectare basis was also determined.

3. Results and Discussion

3.1 Laboratory Calibration

In the laboratory, variation of seed discharged between two rows is shown in Table 2. The average quantity of seeds discharged from two rows in 20 revolutions of the ground wheel was 10.08 g and 9.89 g of maize, respectively. The deviations of seed discharge were within the range of 7% prescribed by the Bureau of Indian standards.

Table 2. Laboratory calibration of seed drill

	Seed collected in 20 revolutions of ground wheel		
	Maize seed (g)		
	Row 1	Row 2	Average
Average	10.08	9.89	9.98
Maximum deviation from average, %	+1.49	+2.12	+1.81
SD	0.13	0.16	0.14
C.V., %	1.32	1.66	1.49

Note: SD = Standard deviation, C.V. =Coefficient of variation

3.2 Field Evaluation

The performance data of the seed drill are presented in Table 3. The average soil resistance recorded was 25.40 $kg.cm^{-2}$ at soil moisture and bulk density of 18.35 % (d.b.) and 1.38 $gm.cm^{-3}$, respectively. The average field capacity of the machine was 0.12 $ha.h^{-1}$ for continuous operation at an average forward speed of 1.88 $km.h^{-1}$. The average field efficiency was 63 per cent. Field tests indicated that the machine index was 77 per cent.

Figure 2. Calibration of power tiller drawn seed drill (Maize variety used: RCM 76)

Figure 3. Field evaluation of power tiller drawn seed drill

The man-hour requirement of the seed drill was 8.33 per hectare as compared to 200 man-hours per hectare with manual dibbling method. The major loss in efficiency was due to the turns at the head land and adjustment of seed drill position before a run so that required spacing was maintained with sown rows of the previous pass. The average depth of seed placement depth was found to be 45 mm. The performance indices indicated that the power tiller operated seed drill performed satisfactorily under field conditions though plant to plant spacing could not be maintained. After 20 days of sowing, plant population of 77,000 per hectare was maintained.

Table 3. Field performance data of the seed drill

Performance parameter	Observed Values
Row spacing, mm	500
Depth of placement, mm	45
Forward speed, $km.h^{-1}$	1.88
Fuel consumption, $l.h^{-1}$	0.96
Field capacity, $ha.h^{-1}$	0.12
Field efficiency, %	63.00
Field machine index, %	77.00
Man-hour requirement per hectare	8.33

During field operation, the machine could be comfortably manoeuvred by the operator on the terraces. No breakdown and repairs of components during the operation were observed. The cost of operation of the seed drill was estimated to be Rs. 1,751/- only per hectare of area covered against a cost of Rs. 7,500/- per hectare for manual dibbling method (Table 4). The cost of sowing with the power tiller operated seed drill was substantially lower as compared to manual dibbling method followed by tribal farmers in the north east hilly region.

4. Conclusion

On the basis of the results obtained from the laboratory calibration, the deviation of seed discharge was within the range of 7% prescribed by the Bureau of Indian standards. At forward speed of 1.88 $km.h^{-1}$, effective field capacity of the seed drill was 0.12 $ha.h^{-1}$ with field efficiency and field machine index 63% and 77%, respectively. The average depth of seed placement was 45 mm. Saving in time & labour and cost of seeding with this seed drill was substantial as compared to manual dibbling method. Therefore, two row power tiller drawn seed drill fitted with fluted roller type seed metering mechanism was found suitable for sowing maize on terraces in hilly region.

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Table 4. Calculation for cost of operation of power tiller drawn seed drill

Assumptions:			
Power Tiller		**Power Tiller Drawn Seed Drill**	
Initial cost	:Rs. 1,85,000/-	Initial cost	: Rs. 20,000/-
Salvage value	:18,500/-	Salvage value	: Rs. 2000/-
Service life	:10 years	Service life	10 years
Annual use	:800 hours	Annual use	100 hours
Fuel price/ Litre	: Rs.65/-	Fuel price/ Litre	: NA
I(a) Fixed cost of power tiller (Rs):			
Depreciation			= 16,650.00
Interest @ 12% per annum			= 12,210.00
Insurance, taxes and housing @ 3.5% of initial cost per annum			= 6,475.00
Annual fixed cost			= 35,335.00
Fixed cost of power tiller per hour			=44.17
I(b) Variable cost of power tiller (Rs)			
Total accumulated repair and maintenance cost (TAR in 1st year) @ 3.8% of initial cost per hour			= 8.79
Fuel cost @ 0.96 l/h fuel consumption rate			= 62.40
Wages of operator (skilled worker) @ Rs. 380 per day for 8 hours			= 47.50
Total variable cost per hour			= 118.69
Total cost per hour			≈ 163
Cost of operation of power tiller (Rs/ha) with field capacity 0.12 ha/h			≈ 1,359
II (a) Fixed cost of power tiller drawn seed drill (Rs.)			
Depreciation			= 1,800.00
Interest @ 12% per annum			= 1320.00
Insurance, taxes and housing @ 3.5% of initial cost per annum			= 700.00
Annual fixed cost			= 3820
Fixed cost of seed drill per hour			= 38.20
II (b) Variable cost (Rs):			
Total accumulated repair and maintenance cost (TAR in 1st year) @ 4% of initial cost per hour			= 8.00
Total variable cost per hour			= 8.00
Total cost per hour			≈ 47
Cost of operation of seed drill (Rs/ha) with field capacity 0.12 ha/h			≈ 392
Total cost of sowing with power tiller drawn seed drill (Rs.ha^{-1}) =1359+392= 1751			

Cost involved in manual planting (manual dibbling):

Man-hour required to plant one hectare = 200 (Devnani, 1991)

Wage rate per man per day of 8 hours (unskilled worker) = Rs. 300

The total cost of manual dibbling per hectare = Rs. [200 x (300/8)] = ***Rs. 7500***