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Tractor drawn turmeric planter's performance evaluation and its cost economics

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Abstract

Turmeric is an important commercial spice crop grown in India since ancient times and named as "Indian saffron". In India turmeric was grown in an area of 2, 96,181 ha with a production of 11,78,750 tonnes during the year 2019-20. Telangana state ranks first in area and production of turmeric. In Telangana turmeric crop was grown in an area of 55,444 ha with a production of 3,86,596 tonnes during the year 2019-20 (www.indianspices.com). In Telangana state, the farmers are following conventional method of sowing for the turmeric crop which is tidy, time consuming and laborious process. The performance evaluation and cost economics of tractor drawn 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planters were done to alleviate these problems and provide required technical information to the farmers. During the field evaluation, it was observed that the field capacity of the 4- row turmeric seed drill and 2- row raised bed turmeric semi-automatic planter (wheel based) as 0.189, and 0.083 ha h⁻¹ at an average speed of 1.259 and 1.004kmph with the field efficiency of 83.72 and 79.305 percent respectively. The seed rate was observed as 1543 and 1239 kg ha⁻¹ for 4- row turmeric seed drill and 2- row raised bed turmeric semi-automatic planter respectively. The fuel consumption was recorded as 5 l/h for both sowing machines. The higher yield (dry rhizomes) was recorded as 1.11 kg m⁻² for 2- row raised bed turmeric semi-automatic Planter sowing method compared to 4-row Turmeric seed drill sowing method with 0.82 kg m⁻². As per the results the lowest operating cost was obtained for 2- row raised bed turmeric semi-automatic planter with Rs. 98,692.92 per hectare when compared to 4-row Turmeric seed drill with Rs. 1, 13,674.15 per hectare. The highest yield was obtained for 2- row raised bed turmeric semi-automatic planter even though it has obtained with the lowest seed rate when compared to 4-row Turmeric seed drill. The performance of 2- row raised bed turmeric semi-automatic planter has shown satisfactory results for sowing of turmeric.

Keywords: Turmeric seed drill, semi-automatic raised bed planter, cost economics, performance evaluation

Introduction

Turmeric is an important commercial spice crop grown in India since ancient times and named as "Indian saffron". It is known as the "golden spice" as well as the "spice of life." Turmeric is now grown in countries like India, China, Pakistan, Bangladesh, Vietnam, Thailand, Philippines, Japan, Korea, Sri Lanka, Nepal, South Pacific Islands, East and West Africa, Malaysia, Caribbean Islands and Central America (Naresh babu *et al.*, 2015) [5]. India accounts for about 80% of world turmeric production and 60% of world exports (Vaijanath Bomble, 2020) [3] and (Dhanalakshmi *et al.*, 2018) [1]. India produces 75 percent of world's turmeric and is the largest exporter in trade (Ajaib Singh and Sumanjit Kaur, 2015) [2].

In India turmeric was grown in an area of 2, 96,181 ha with a production of 11,78,750 tonnes during the year 2019-20 (www.indianspices.com). Major turmeric producing states in India are Telangana, Maharashtra, Andhra Pradesh, Orissa, Karnataka, Tamil Nadu, West Bengal, Assam, Mizoram and Gujarat. In India, Telangana state ranks first in area and production of turmeric. In Telangana turmeric crop was grown in an area of 55,444 ha with a production of 3,86,596 tonnes during the year 2019-20 (www.indianspices.com). In Telangana state, the farmers are following conventional method of sowing for the turmeric crop by indigenous plough with a pair of bullocks for making furrows and keep the turmeric rhizome seeds in the furrows which is tidy, time consuming and laborious process. In this method recommended seed rate may not be achieved and affects the yield. Considering all these constraints in view the performance evaluation and cost economics of tractor drawn 4-row turmeric seed drill and tractor drawn 2-row raised bed turmeric semi-automatic planters were carried out to alleviate these problems and to provide required technical information to the farmers.

Material and Methods

The turmeric sowing equipment's namely tractor drawn 4-row turmeric seed drill and tractor drawn 2-row raised bed turmeric semi-automatic planters were selected to study their field performance to provide required technical information to the farmers. The tractor drawn 4-row turmeric seed drill consists of seed hopper, seed tubes, furrow openers, ridging body and seat arrangement. Four persons are required to drop the turmeric rhizome seeds in the seed tubes during operation. The tractor drawn 2-row raised bed turmeric semi-automatic planter consists of wheel type metering mechanism, seed hopper, furrow openers, raised bed making arrangement, seat arrangement and ground wheel. Two persons are required to

place the turmeric rhizome seeds in the metering mechanism during operation. The metering mechanism contains 10 numbers of compartments and rotated by ground wheel through gear drive mechanism. The seeds drop due to gravity in the furrow openers. The experiment was conducted at College of Food Science and Technology, Regional Sugarcane and Rice Research Station and Krishi Vigyan Kendra, Rudrur during Kharif 2020 in the extent of an area about 1050 m² (21mx50m) for each turmeric sowing equipment respectively. The technical specifications of selected turmeric sowing equipment's are given in Table 1 and the views are shown in Fig.1 and Fig. 2 respectively.

Table 1: The technical specifications of tractor drawn 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planter

S. No	Machine parameters	4- row turmeric seed drill	2-row raised bed turmeric semi-automatic planter
1	Cost of machine, Rs/-	55000/-	95,000/-
2	No. of furrow openers	4	2
3	No. of ridge formers	5	-
4	No. of bed formers	-	2
5	Row Spacing, m	0.45	0.30
6	Effective operating width, m	1.8	1.05
7	Type of metering mechanism	-	Horizontal plate with 10 no. of slots
8	Power source	40 hp. and above	40 hp. and above



Fig 1: View of 4-row turmeric seed drill.



Fig 2: View of 2-row raised bed turmeric semi-automatic planter

Field performance of 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planter

The field was prepared by ploughing with MB plough and cultivator, then the soil was pulverized with rotovator to brought a fine tilth to easily formation of ridge and furrows for 4-row turmeric seed drill and raised beds for 2-row raised

bed turmeric semi-automatic planter during sowing operation. The "Erra Duggirala" variety seed rhizomes were selected for sowing operation and cut into single node pieces before operation. During the experiment the parameters like speed of operation, effective field capacity, theoretical field capacity, field efficiency, seed rate and yield were observed by using the following procedure.

Operating time for each operation

To determine operating time, time was noted at starting and ending point of sowing operation by using stop watch, so that actual time required for sowing with 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planter were computed in terms of h/ha. The time required for one turn of the machine and time consumed for adjustments were also noted to compute time loss in operation.

Speed of operation

To determine the speed of operation, mark the length of 25 m and the tractor drawn 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planter were operated in the marked run length. A stop watch was used to record the time for sowing to traverse the marked run so that the speed of travel was computed in m s⁻¹.

Effective field capacity

Effective field capacity was measured by the actual area covered by the implement, based on its total time consumed and its width. Effective field capacity was determined by the following relationship.

$$\text{Effective field capacity, ha h}^{-1} = \frac{\text{Total area covered, ha}}{\text{Total time taken, h}} \times 100$$

Theoretical field capacity

Theoretical field capacity is the rate of field coverage of the machine, based on 100 percent of time at the rated speed and covering 100 percent of its rated width. The theoretical field capacity was determined using the following relationship

$$\text{Theoretical field capacity, ha h}^{-1} = \frac{\text{width (m)} \times \text{Speed (kmph)}}{10}$$

Field efficiency

Field efficiency is the ratio of effective field capacity to theoretical field capacity. It was determined by the following formula

$$\text{Field efficiency, \%} = \frac{\text{Effective field capacity, } \left(\frac{\text{ha}}{\text{h}}\right)}{\text{theoretical field capacity } \left(\frac{\text{ha}}{\text{h}}\right)} \times 100$$

Seed rate

The seed rate was determined by taking the weight of seed before and after sowing operation. Then subtracted the final weight of seed from initial weight of seed so that the seed rate was obtained and the results were expressed in terms of kg ha⁻¹.

Yield

Turmeric yield was determined from one m² area. Five random observations were taken from the field and thoroughly removed the soil from the rhizomes. After completion of cleaning, the weight of turmeric rhizomes were recorded and the converted to kg ha⁻¹.

Cost Analysis

The total cost of operation of both tractor drawn turmeric sowing equipment's in Rs. h⁻¹ were estimated by considering the fixed cost and operational cost of the machine by making following assumptions. The cost of operation was based on the prevailing market rates during the season and location (Jayaprakash *et al.*, 2015) [4].

Fixed cost

Fixed cost includes depreciation, interest, housing, insurance and taxes.

Depreciation

It is the loss of value of a machine with the passing of time.

$$D = \frac{C - S}{L H}$$

Where,

C = Capital cost

D = Depreciation, Rs. /h

S = Salvage value, 10 percent of capital

H = Number of working hours per year, and

L = Life of machine, year.

Interest

Interest was calculated on the average investment of the machine taking into consideration the value of in first and last year.

$$I = \frac{C + S}{2} \times \frac{i}{H}$$

Where

I = Interest per year

i = Interest rate per year, percent

C = Capital cost

Housing, insurance and taxes

Housing, insurance and taxes for the each machine was taken as the 1 percent of the initial investment of the machine.

Operating cost

Operating cost includes fuel cost, lubricants, repairs, maintenance, and other costs.

Fuel cost

Fuel cost was calculated on the basis of actual fuel consumption of the machine for operation.

Lubricant cost

The lubricant cost for the machine was taken as 30 % of the fuel cost

Repairs and maintenance

Cost of repairs and maintenance was taken as 5 percent of the initial investment of the machine.

Other costs

It includes wages for operator, labour cost based on the prevailing market rates per day of 8 hours.

Results and Discussion

The field performance and cost analysis of tractor drawn 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planters were done at College of Food Science & Technology, Regional sugarcane and Rice Research station and Krishi Vigyan Kendra, PJTSAU, Rudrur, Nizamabad to provide required technical information to the farmers to choose best one.

During the field evaluation, it was observed that the field capacity of the 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planter (wheel based) as 0.189, and 0.083 ha h⁻¹ at an average speed of 1.259 and 1.004 kmph with the field efficiency of 83.72 and 79.305 percent respectively. The seed rate was observed as 1543 and 1239 kg ha⁻¹ for 4-row turmeric seed drill and 2-row raised bed turmeric semi-automatic planter respectively. The fuel consumption was recorded as 5 l/h for both sowing machines. The higher yield (dry rhizomes) was recorded as 1.11 kg m⁻² for 2-row raised bed turmeric semi-automatic Planter sowing method compared to 4-row Turmeric seed drill sowing method with 0.82 kg m⁻² because the raised bed method produced heavier rhizomes with mean single rhizome weight of 365.55 g over ridge and furrow method which has the mean single rhizome weight of 214.44 g. Tractor drawn turmeric planter put the rhizome at suitable depth and spacing and it increases the crop yield (Vaijanath Bomble, 2020) [3]. The length and diameter for turmeric rhizomes sown with semi-automatic planter were highest because the rhizomes were grown on ridges and had additional space area for its superior growth (Ajaib singh and Sumanjit Kaur, 2015) [2]. The comparison results of field performance of tractor drawn 4-row Turmeric seed drill and 2-row raised bed turmeric semi-automatic Planter are given in Table 2 and field operation of machines are shown in Fig. 3 and Fig. 4 respectively.



Fig. 3: Sowing operation of turmeric with 4- row seed drill (ridge and furrow method)



Fig 4: Sowing operation of 2- row raised bed turmeric semi-automatic planter

Table 2: Comparison of Field performance of tractor drawn 4-row Turmeric seed drill and 2- row raised bed turmeric semi-automatic Planter

S. No	Machine parameters	4- row turmeric seed drill	2- row raised bed turmeric semi-automatic planter
1	Plot dimensions (L x W), m	50 x 21	50 x 21
2	Area, Sq. m.	1050	1050
3	Date of sowing	6/7/2020	6/7/2020
4	Depth of planting, cm	10-12	10-12
5	Row to row distance, cm	45	30
6	No. of rows	4	2
7	Trapezoidal Bed dimensions (Top width x Bottom width X Height), cm	-	60 x 90 x 25
8	Bed to Bed distance	-	1.05
9	Plant to plant distance, cm	20	20
10	Width of operation, m	1.8	1.05
11	Speed, km/ph.	1.259	1.004
12	Theoretical Field capacity, ha/h	0.227	0.105
13	Effective Field Capacity, ha/h	0.189	0.083
14	Field Efficiency, %	83.721	79.305
15	Fuel consumption, l/h	5	5
16	Seed rate, kg/ha	1543	1239
17	Number of labour required	5	3
18	Fresh Yield , kg/m ²	3.5385	5.3889
19	Fresh Yield , kg/ha	35385	53889
20	Dry yield, kg/m ²	0.823	1.113
21	Dry yield, kg/ha	8230	11130

The cost analysis of selected turmeric sowing equipment's was estimated based on performance of the machines. The total cost of operation per hectare includes both cost of operation of tractor and cost of operation of each turmeric sowing equipment's. The life span of the machine was considered as 10 years. Table 3 comprises the data i.e., initial investment, salvage value, fixed cost, operating and maintenance cost and life of machines for the total cost of operation for sowing of turmeric. The cost of operation for sowing of turmeric with tractor drawn for 4-row Turmeric seed drill and 2- row raised bed turmeric semi-automatic planter were estimated as Rs. 113674.15 per hectare and Rs.

98692.92 per hectare respectively. As per the results the highest operating cost was obtained for 4-row Turmeric seed drill when compared to 2- row raised bed turmeric semi-automatic planter. The highest yield was obtained for 2- row raised bed turmeric semi-automatic planter even though it obtained with the lowest seed rate when compared to 4-row Turmeric seed drill. The performance of 2- row raised bed turmeric semi-automatic planter has shown satisfactory results for sowing of turmeric. The operating cost of tractor drawn 4- row Turmeric seed drill and 2- row raised bed turmeric semi-automatic planter results are presented in Table 3.

Table 3: The operating cost of tractor drawn 4-row Turmeric seed drill and 2- row raised bed turmeric semi-automatic Planter.

S. No	Machine parameters	Details		Machine parameters	Details	
	Cost of operation of tractor for operating equipments			Cost of operation of Turmeric sowing equipment's		
		For 4-row Turmeric seed drill	For 2- row raised bed turmeric semi-automatic Planter		For 4-row Turmeric seed drill	For 2- row raised bed turmeric semi-automatic Planter
1.	Name of the machine	Tractor	Tractor	Name of the machine	4-row Turmeric seed drill	2- row raised bed turmeric semi-automatic Planter
2.	Cost of the machine(C), (Rs.)	750000	750000	Cost of the machine(C), (Rs.)	55000	95000
3.	Life of the machine (L) in years	10	10	Life of the machine (L) in years	10	10
4.	Working hours per year (H)	1000	1000	Working hours per year (H)	2500	2000
5.	Salvage value (S), (Rs.)	75000	75000	Salvage value (S), (Rs.)	5500	9500
6.	Depreciation per hour (Rs.)	67.5	67.5	Depreciation per hour (Rs.)	1.98	4.27
7.	Rate of interest I per hour (Rs.)	41.25	41.25	Rate of interest I per hour (Rs.)	1.21	2.61
8.	Housing per hour (Rs.)	7.5	7.5	Housing per hour (Rs.)	0.55	0.95
9.	Insurance per hour (Rs.)	7.5	7.5	Insurance per hour (Rs.)	0.55	0.95
10.	Taxes per hour (Rs.)	7.5	7.5	Taxes per hour (Rs.)	0.55	0.95
11.	Total fixed cost per hour (Rs.)	131.25	131.25	Total fixed cost per hour (Rs.)	4.84	9.73
12.	Effective field capacity(ha h ⁻¹)	0.189	0.083	Total fixed cost per hectare (Rs.)	25.60	117.31
13.	Total fixed cost per hectare (Rs.)	694.44	1581.32	Repair and maintenance cost per hour (Rs.)	6.87	11.87
14.	Wages for operator per hour (Rs.)	75	75	No. of skilled labours Required (including seed cutting and seed dropping)	6	4
15.	Repair and maintenance cost per hour (Rs.)	75	75	Wages for skilled labour per hour (Rs 350/day of 8 hours) (Rs.)	262.5	175
16.	Fuel cost per hour (Rs.)	396.2	396.2	Seed cost per hectare (Rs.)	108010	86730
17.	Lubricant cost per hour (Rs.)	118.86	118.86	Total variable cost per hectare (Rs.)	109435	88981.5
18.	Total Variable cost per hour (Rs.)	665.06	665.06	Total operating cost of machine per hectare (Rs.)	109461	89098.8
19.	Total Variable cost per hectare (Rs.)	796.31	796.31			
20.	Total operating cost of tractor per hectare (Rs.)	4213.28	9594.10			
21.	Total cost of operation for sowing turmeric per hectare (Including operating cost of tractor and turmeric sowing equipments)(Rs.)				113674.15	98692.92

Conclusions

The following conclusions were drawn from the study

- It was observed that the field capacity of the 4- row turmeric seed drill and 2- row raised bed turmeric semi-automatic planter (wheel based) as 0.189, and 0.083 ha h⁻¹ at an average speed of 1.259 and 1.004kmph with the field efficiency of 83.72 and 79.305 percent respectively.
- The seed rate was observed as 1543 and 1239 kg ha⁻¹ for 4- row turmeric seed drill and 2- row raised bed turmeric semi-automatic planter respectively.
- The fuel consumption was recorded as 5 l/h for both sowing machines.
- As per the results the lowest operating cost was obtained for 2- row raised bed turmeric semi-automatic planter with Rs. 98,692.92 per hectare when compared to 4-row Turmeric seed drill with Rs. 1, 13,674.15 per hectare.
- The highest yield was obtained for 2- row raised bed turmeric semi-automatic planter even though it has obtained with the lowest seed rate when compared to 4- row Turmeric seed drill.
- From the above conclusions The performance of 2- row raised bed turmeric semi-automatic planter has shown satisfactory results for sowing of turmeric.

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