Original Research Article

Performance Evaluation of Animal Drawn Single Row Maize Ridger

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A B S T R A C T

In the present study, the performance evaluation of developed animal drawn single row maize ridger was observed. The field capacity (0.059 ha/h), field efficiency (74.74 %) with less plant damage (2.92%) and highest weeding efficiency (46.18%) and ridge dimensions bottom width, top width, ridge height (43.75cm, 12.75, 16cm). The developed maize ridger was observed an average draft of about 69.81kg-f with an average power requirement 0.491 hp. Average speed of ridging operation was observed 1.74 km/h. The performance of maize ridger compared with Ridger plough, Tendua plough and MB Plough. The effective field capacity of developed maize ridger was found higher (0.0548 ha/h) followed by Tendua plough (0.0395 ha/h), ridger plough (0.0360 ha/h), MB plough (0.0158 ha/h).and volume of soil handled were found highest with ridger plough (492.38 cm^3) followed by developed maize ridger (452.31cm^3), MB plough (305.38 cm^3) and minimum with Tendua plough (148.36 cm^3) the total cost of operation was found minimum with developed maize ridger (1737.79 Rs/ha) followed by Tendua plough (2652.82 Rs/ha), Ridger plough (3000.00 Rs/ha) and maximum with MB plough (6440.00 Rs/ha).

Introduction

In India, the production of maize witnessed a significant increase of more than 14 times from a mere 1.73 million tons in 1950-51 to 28.72 million tons in 2017-18. Presently it occupies 9.23 million hectare area with the mean yield of 2.56 tons/hectare. In Chhattisgarh, maize is a *kharif* season crop and second most important crop next to paddy in terms of both area and production. In Chhattisgarh maize occupies 119.63 thousands hectare land with the productivity of 2566 Kg/ha in *Kharif* 2017. Maize can be grown successfully in variety of soils ranging from loamy sand to clay loam.

However, soils with good organic matter content having high water holding capacity with neutral pH are considered good for higher productivity. The state has got very good potential for maize but the productivity is very low due to improper input management practices [1].

Crop cultivation in India requires application of both animate (bullock, human power) and inanimate (tractors, tillers etc.) forms of energy at different stages. The bullocks and buffaloes are the main stay of farm power in India and they still command over 60% of the total cultivable land. About 90% of the tillage operation in India is still carried out by the draught animals [2]. The bullocks and buffaloes are the main stay of farm power in India and they still command over 60% of the total cultivable land. More than 55% of the total cultivated area is still being managed by using draught animals as against about 20% by tractors [3]. The marginal farmers who constitute 80% of the total farming community of the country with low purchasing capacity extensively depend on draught animal power for different agricultural operations.

Today animal traction farmers faces many constraints like high draught, poor design of harnesses, forces rapid ploughshare wear, and many other implements [4]. At the same time shortage of agricultural labours due to rapid urbanization is a constraint in crop production. In this context there is a huge scope for introduction of various matching bullock drawn implements in various agricultural operations. Generally the raised bed planting is considered as best planting method for maize during monsoon and winter seasons both under excess moisture as well as limited water availability/rained conditions. Sowing/planting should be done on the southern side of the east-west ridges/beds, which helps in good germination. Planting should be done at proper spacing. Recently in Chhattisgarh maize planting is done by manually by line sowing method but due to unavailability of proper ridging/ earthening equipments the farmers have to make ridge by traditional method, which is laborious. The labour availability is scare during the earthening period in *kharif* and *rabi* season.

The cost of production is also increases due to the manual labor.

In maize the weed control and plant growth can be increased by the adoption of ridge planting. The ridge plant system is well suited to furrow- irrigated crops. Sometimes due to excessive rain in the crop may be damage due to water logging. To make favourable condition the ridge and furrow were provided to drain out excessive water. It also provides better root growth due to proper aeration in root zone. Due to ridge farming the bulk density may improve which consequently improve the water and nutrient intake in the plants. It is well known fact that improved tillage and proper management practice reduces weed growth and enhance crop production. A proper ridging method is still not available for animal drown farming system. In Chhattisgarh still the ridge preparation is perform either by manual or animal drawn method which is slow, time consuming and tedious in nature.

In Chhattisgarh ridge preparation for maize crop performed by the traditional method by either by manual by the help of *Khurpi* or desi/country plough pulled by a man or by a pair of skilled bullock. Traditional method of earthening/ridging adopted in maize cultivation is slow, time consuming, tedious, inefficient and involve drudgery, hence increases the cost of production. Looking to the above points and to reduce drudgery in the earthening operation development of a suitable animal drawn ridger is essential for reducing cost of operation of maize.

The main objectives of the present study include to study the performance of the developed animal drawn single row maize ridger. And also to workout the cost economics of the developed animal drawn single row maize ridger.

Materials and Methods

Field performance tests were carried out to obtain actual data on overall implement performance and work capacity in the field. The field trials of animal drawn implements were conducted in the field of I.G.K.V., Raipur.

Field performance parameter

The following observations were taken during the field test.

Plant height, Moisture content of the soil, Bulk density of soil, Mean Mass Diameter (MMD), Measurement of draft, Speed of operation, Power requirement, Field capacity (Theoretical field capacity, Effective field capacity), Field efficiency, Soil inversion and Plant damaged/injured.

Moisture content of the soil

The moisture content was determined using the relation.

$$Mc = \frac{W_w - W_d}{W_d}$$

Where,
M_c = Moisture content of soil, % db;
W_w = Weight of wet soil, g; and
W_d = Weight of oven dry soil, g.

Bulk density

The bulk density was calculated by using formula

$$\delta = \frac{M}{V}$$

Where,
δ = bulk density of soil, g/cm^3;
M = oven dry mass of soil, g; and

V = volume of core sampler, cm^3.

Mean mass diameter (MMD)

The following expression was used to calculate Mean Mass Diameter (MMD)

MMD
$= (\sum (M (I) \times (D (I - 1) + D (I)/2 / \sum M (I)$

$= [\{M (1) \times D (0) + D (1)\}/2 + \{M (2) \times D (1) D (2)\}/ 2 + ……] / [M (1) + M (2) +……]$

Where,

$M (I)$ = mass of the soil retained on Ist sieve from top, kg;
$D (I)$ = size of the 1st sieve, mm; and
$D (0)$ = size (second major dimension) of the largest clod on top sieve, mm.

Measurement of draft

The draft was calculated as follows.

$$H = \sqrt{B^2 - [(V - H)]^2}$$

$$H = \frac{V - h}{Tan\theta}$$

$$\theta = Tan^{-1}\frac{V - h}{H}$$

Where,
θ = Angle of pull
h = Height of hitch of implement from ground
B = Length of beam up-to yoke
H = Horizontal distance between hitch point and the neck of the bullock
V = Vertical height of the up-to neck of bullock from ground

$$D = P.\cos\theta$$

Where,
D = draft, kgf.
P = pull (dynamometer reading), kg.
θ = Angle between the line of pull and horizontal, degree.

Speed of operation

$$\text{Speed (kmph)} = \frac{3.6 \times \text{distance travelled (m)}}{\text{time (s)}}$$

Power requirement

Calculation of power is needed to determine the efficient use of animal power. A bullock can produce power equal to 0.5 to 0.75 hp operated for day long work. It was the power required to the implement by the bullock with average pulling force and speed. It was calculated by using the following formula (Michael and Ojha, 1966).

$$\text{H.P.} = \frac{\text{Draft (kg)} \times \text{distance moved (m/s)}}{75}$$

Theoretical field capacity

It is the rate of field coverage that would be obtained if implements were performing its function 100 % of the time at the rated speed and always covering 100 % of its rated width.

$$\text{TFC} = \frac{W \times S}{10}$$

Where,
TFC = Theoretical Field Capacity, ha/h;
S = Speed of Operation, km/h; and
W = Theoretical width of implement, m

Effective field capacity

It is the actual average rate of coverage by the implement. The total time required to complete the operation was recorded and effective field capacity was calculated as follows.

$$\text{EFC} = \frac{A}{T}$$

Where,
EFC = Effective field capacity, ha/h;
A = Actual area covered, ha; and
T = Total time required to cover the area, h.

Field efficiency

It was calculated by using the following formula

$$\text{Field efficiency} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100$$

Results and Discussion

As per objectives, the experiment was conducted on the research fields of I.G.K.V., Raipur and data were statistically analyzed. Based on the experimental findings, the frame having adjustable furrow spacing was designed and developed, which was further evaluated with the traditional method.

The developed ridging implement consists of frame, handle, share, mould board, frog, land-side, hitch and beam. The construction of the implement was studied and matching to the pulling capacity of the local bullocks.

From the test result which was revealed from Table:1 it was observed that the highest volume of soil handled was observed with T4 - ridger plough (492.38 cm^3) followed by T3 – developed maize ridger (452.31cm^3), T2 – MB plough (305.38cm^3) and T1 – Tendua plough (148.36cm^3). From the above results, it was revealed that the ridge dimensions and volume of soil handled by ridger plough and developed maize ridger was at par.

Table.1 Effect of different ridging technology on dimension of the ridge and volume of soil cut

Parameters/ Treatments	Dimension of ridge			Volume, cm^3
	Bottom width, cm	Top width, cm	Height, cm	
T1	59.93	53.00	2.63	148.36
T2	41.75	15.00	10.75	305.38
T3	43.75	12.75	16.00	452.31*
T4	55.00	5.75	16.25	492.38*
SEm	0.468	0.692	1.140	34.871
CD at 5%	1.496	2.214	3.646	111.552
CV	1.867	6.402	19.985	19.949

T1 (Tendua plough), T2 (MB plough), T3 (Developed maize ridger) and T4 (Ridger plough)

Table.2 Effect of different ridging technology on speed, draft, TFC, EFC, FE plant damage and weeding efficiency

Parameters/ Treatments	Speed (km/h)	Draft (kg f)	TFC (ha/h)	EFC (ha/h)	FE (%)	Plant Damage (%)	Weeding efficiency (%)
T1	1.86	32.25	0.0537	0.0395	73.68[a]	1.21*	13.00
T2	1.44	72.25	0.0287	0.0158	54.65[b]	10.48	59.25
T3	1.73	69.50	0.0733	0.0548	74.62[a]	2.02*	51.50
T4	1.30	76.75	0.0698	0.0360	51.62[b]	27.42	68.25
SEm	0.043	1.231	0.002	0.002	2.237	0.902	1.900
CD at 5%	0.136	3.938	0.006	0.006	7.156	2.884	6.079
CV	5.387	3.928	6.410	10.128	7.030	17.538	7.918

T1 (Tendua plough), T2 (MB plough), T3 (Developed maize ridger) and T4 (Ridger plough)

Table.3 Calculation of cost of different ridging technology

S. No.	Particular	Developed maize ridger	Ridger plough	Tendua plough	MB plough
1.	Cost of machine, Rs	2960.00	7500.00	2400.00	2850.00
2.	Life of the machine (year)	5	10	5	10
3.	Annual use (h)	240	240	240	240
4.	Depreciation, Rs/year @10%	532.80	675.00	432.00	256.50
5.	Interest, Rs/year@12%	195.36	495.00	158.40	188.10
Total (4+5)	Fixed cost (Rs/Year) annual use is 240 h	728.16	1170.00	590.40	444.60
A	Fixed cost (Rs/h)	3.03	4.88	2.46	1.85
B	Operational cost				
1.	Wage of 1 operator (Rs 200/day*), Rs/h	25	25	25	25
2.	Hiring charges of bullock (300/day*), Rs/h	75	75	75	75
3.	Repair and maintenance, Rs/h	1.23	4.17	1.00	1.19
Σ(1 to3)	Total operational cost, Rs/h	101.23	104.17	101.00	101.19
(A+B)	Machinery cost, (Rs/h)	104.27	108.00	103.46	103.04
	Machine capacity	0.06	0.04	0.04	0.02
Total machinery cost in, (Rs/ ha)		**1737.79**	**3000.00**	**2652.82**	**6440.00**

*1 day i.e. 8 hour of work

Fig.1 Ridging with tendua plough

Fig.2 Ridging with MB plough

Fig.3 Ridging with developed Rodger

Fig.4 Ridging with ridger plough

The Table:2 shows that the lower plant damage were obtained with T1-Tendua plough (1.21%) followed by T3- developed maize ridger (2.02%), T2- MB plough (10.48%) and higher plant damage was observed with T4- ridger plough (27.42%). The plant damage with Tendua plough and developed maize ridger was at par. The maximum weeding efficiency was observed with T4- ridger plough (68.25%) followed by T2- MB plough (59.25%), T3- developed maize ridger (51.50%) and lowest weeding efficiency was observed with T1- Tendua plough (13%).

The weeding efficiency of ridger plough, MB plough and developed maize were found at par.

Cost economics

The cost of operation of the implement per hour as well as per ha is presented in Table 3. The annual use of the machine was taken only 240 hour per year. The estimated data revels that the cost of operation of the implement mainly depends upon its EFC. In present

assumption the fixed cost was found to be Rs.3.03, operational cost as Rs 101.24 per hour for the developed ridger which was nearer to the other methods of ridging technology. But due to field capacity the cost of operation (Rs 1737.79) with the developed ridger was found lowest among all other techniques.

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