PERFORMANCE OF TRACTOR AND MULTI-PAIRED BULLOCK DRAWN M.B. PLOUGH

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Abstract: A study was conducted in light soil at Anwi (Akola District) to determine the field capacity, field efficiency and cost of ploughing using tractor operated and multi paired bullock drawn M.B. plough. In Anwi, for multi paired bullock drawn M.B. plough observations were taken on average depth (cm), h.p., field efficiency(%), average speed(km/hr), average moisture content(%) & total cost of ploughing(Rs/ha) were calculated. Multipaired bullock drawn M.B. plough found more efficient and cost effective than tractor drawn M.B. plough. Also the animal power are the source of renewable and sustainable clean energy. Whereas regular use of tractor makes the soil hard and compact and also reduces fertility and moisture content of the soil.

Keywords: Animal Power, M.B. Plough, h.p., field efficiency, cost of ploughing

Introduction: According to the 1972 census, (1976) the working animal population in India was 80 million and the total cropped area 167 million hectares (www.indiastat.com). Thus on an average one pair of working animals, i.e. bullock was available for 4.16 hectares of land. Management studies have shown that a pair of bullocks can manage about 3 hectares farm. According to Roy S.E. (1966) the maximum area of land which can be cultivated by a pair of bullock, not only depends on the efficiency of bullocks and the size of holding but also on factors such as period available for cultivation, nature of soil, crops grown and timeliness requirement of each operations and transportation work. It is pertinent to state that there is a direct relation between energy inputs to crop production in terms of output. The "tractorization" has grown at a rapid space and about 2.5 lack tractors are being added annually to the Indian farms to help farmer to supply energy for conducting various farm operation and transport activities. The tractors are suited for big size farms but farmers are not aware with the bad effect of tractorization.

Regular use of tractor makes the soil hard and compact and also reduces fertility and moisture content of the soil. Due to the compacted layer of the soil beneath the earth infiltration and percolation properties of the soil goes on decreasing and so sufficient soil moisture is not available for the depth of deep rooted crops and there is no rise in water table. For removing deep rooted weed and preparation of smooth seed bed multi-paired bullock drawn M.B. plough is used.

Considering these factors it was decided to undertake an experiment to evaluate the performance of multi-paired bullock drawn M.B. plough on the field over tractor drawn M.B. plough.

Materials and Methods: The experiment trials were conducted in light soil at Anwi, Sawalapur, Dabhadi for multi-paired and Dhaga for tractor drawn M.B. plough on 2000 m^2 area. The trials were conducted according to RNAM test codes. The parameters like depth of operation (cm), operating speed (Km/ha), field efficiency (%), H.P., cost of ploughing (Rs/ha) were evaluated as per standard procedure mentioned below. The data was used for comparing the performance of tractor operated M.B. plough and multi-paired bullock drawn M.B. plough.

Table 1. General specification of tractor and bullocks used throughout experiment.

Particulars	Specification
Tractor used (HP)	35
No. of bullock pairs used	2 pairs
Size of M.B. plough for tractor drawn (cm)	52.5
Size of M.B. plough for bullock drawn (cm)	30
Average age of bullocks (years)	12
Breed of bullocks	Jersey breed

Site Selection: The site was selected by considering the suitability of land with uniform topography. The different sites were selected in different villages during kharip season.

Neck method of harnessing animals: This method is most commonly used with bullocks in India and other countries because the neck muscles of bullocks are well developed and have sufficient strength against the depression caused by the harness. There is no direct compression given to any bone or muscular structure of the animal (Swamy Rao, 1966).

Procedure for Conducting the Trials: The trials were conducted as per the method generally followed in the rural areas and the parameters were tested according to the RNAM Test Codes for testing the implement.

Hitching: Hitching of bullocks to the implement was done according to the method generally followed in rural areas. In this method two yokes for two pairs were tied with the help of strong iron chain and it was connected to the ring of the plough with the help of peg.

M.B. plough arrangement: The selected plough was cleaned before operation and adjustment of horizontal and vertical clevis was done. The specification of the mould board plough used for multi-pared bullock and tractor drawn in different villages are given in Appendix- A and Appendix- B respectively.

Standing of pair: The selected two pairs were arranged in passion i.e. taller pair should be at front and the other pair was behind it shown in Fig 1. Previous work has shown (Adkine, Rapte & Acharya; 1977). Due to this reason maximum power of bullocks can be harnessed, this method was followed generally in villages. The two pairs were located just behind the plough.

Figure 1. Ploughing operation by multi-paired bullock drawn MB plough at Sawalapur.

Harnessing with yoke: The two labours, which were operators of each pair, put the yoke on the neck of front and rear pair.

Arrangement of dynamometer: Mechanical dynamometer was used for measuring draft (Fig 2). The details of dynamometer used while conducting trials is given in Appendix-C. Mechanical dynamometer was tied in between yoke and implement body. As Mechanical dynamometer was connected in the line of pull, the measured force represented the total pull (Ojha, 1958). For calculation of draft, the inclination of the line of pull from horizontal and horizontal angle from the direction of travel was measured. Draft required by the formula. At the same time, depth and width of tillage were measured. While conducting the trials, angle of inclination were also measured

Depth of ploughing: While conducting the trials the depths of different locations were measured by removing the disturb soil from the furrow. Minimum five readings of depths were noted.

Width of ploughing: The width of ploughing was recorded at the place from where depth was taken. The top widths and bottom widths were measured by pushing the crown form on one side of ploughing.

Pull: It is the total force required to pull an implement. Dynamometer was used for measuring pull.

Draft: It is the horizontal component of pull, parallel to the line of motion. It is calculated by following way

$$D = P \cos\theta$$

Where,

D = Draft in (kgf)

P = Pull in (kgf)

θ = Angle between line of pull and horizontal.

The angle θ in calculated as the mean angle between the rope of front pair and rope of rear pair with horizontal.

$$\text{Draft} = P \cos\frac{\theta_1 + \theta_2}{2}$$

Where,

θ1 = Angle between the rope of front pair with horizontal.

θ2 = Angle between the rope of rear pair with horizontal.

Unit Draft: It is the draft per unit cross sectional area of the furrow. The cross sectional area of the furrow is computed by assuming the furrow cross section triangular.

Therefore, Area of Trapezoidal section = ½ (Top width + Bottom width) × Depth

Traveling speed: The traveling speed was computed with the help of stopwatch. It is the distance covered by the bullocks and tractor in given time.

Horse power:

$$\text{Metric hp} = \frac{\text{Draft in (kgf)} \times \text{Speed (metre/sec)}}{75}$$

Theoretical field capacity:

It is the of field coverage of the implement based on 100 percent of time at the rated speed and covering 100 percent of its rated width.

$$\text{Theoretical field capacity} = \frac{\text{width (cm)} \times \text{speed (metre/sec)} \times 36}{10000}$$

Effective field capacity or Actual field capacity: It is the actual area covered by the implement based on total time consumed and its width.

Field efficiency: It is the ratio of effective field capacity and theoretical field capacity expressed in percentage.

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

Soil Inversion Test: Weed and stubble count method suggested by (Prasad & Misgara, 1981) was adopted to find out the soil inversion. Randomly three plots of size 60 X 60 cm were selected in the field. The no. of weed and stubble present in each plot were measured before and after ploughing. The soil inversion was then expressed on percentage basis.

$$\text{Soil inversion} = \frac{\text{No. of weed before test} - \text{No. of weed after test}}{\text{No. of weeds before test}} \times 100$$

Soil Moisture: Moisture content on dry weight basis was selected for soil measurement. Core sample of wet three different location of test plot random will be weighted the sample in balance and it was kept in oven for dry for 105 ^{O}C –110 ^{O}C for at least 8 hours, cool in desiccators and weighted again.

Results and Discussion: Experiments were conducted with the help of bullock and tractor drawn M B plough for draft analysis. It was observed that the higher depth that is 17.50 cm was observed in case of tractor drawn M.B. plough compared to bullock drawn M.B. plough that is 11.50 which is obvious. It indicates the deformation of soil at higher depth by tractor drawn M.B. plough which is sometimes undesirable because soil manipulation below root zone depth is not required. Soil manipulation at greater depth also requires higher energy hence it is wastage of energy. Whenever deep ploughing is require, tractor drawn M.B. plough can be used.

The speed of operation for tractor drawn M.B. plough was 3.19 Km/h and that of bullock drawn M.B. plough was 1.5 Km/ha. Also the size of M.B. plough used with tractor was 52.5 cm and that used bullocks was 30 cm. Hence the field capacity of the tractor drawn M.B. plough was 0.12 ha/hr and that of bullock drawn M.B. plough was 0.03 ha/hr only. But the field efficiency of bullock drawn M.B. plough was found higher i.e. 91.42% compared to tractor drawn M.B. plough for which it was 85.85%. This was because of the fact that the tractor takes higher turning time at the head lands compared to bullocks.

The cost of operation in case of bullock drawn M.B. plough was found less than that of tractor drawn M.B. plough which is one more advantage of using bullock drawn M.B. plough.

Considering the time limits available for manipulation of soil and field capacity of tractor drawn M.B. plough it is advisable to use it on large fields. But the task can be done more efficiently by bullock drawn M.B. plough on small fields that in turn saves cost of operation. More number of bullocks pairs if used on the field can compensate the time, but it will add to the operational cost. Average value of parameters for comparing multi-paired bullock and tractor drawn M.B. plough, shown in Table 2.

Table 2. Average value of parameters for comparing multi-paired bullock and tractor drawn M.B. plough

S.	Parameters	M.B. Plough			
		Bullock Drawn			Tractor Drawn
		Sawalapur	Anwi	Dabhadi	Dhaga
1	Depth (cm)	14.49	11.50	13.48	17.51
2	Width of cut (cm)	2.217	2.017	1.74	2.79
3	Pull (Kg)	190	304.27	230.13	Use given hp
4	Draft (Kg)	164.54	292.50	204.12	
5	Unit draft (Kg/cm^2)	0.65	1.54	0.97	

6	Horse Power (hp)	1.41	1.5	1.47	35
7	Traveling speed (Km/h)	1.67	1.385	1.95	3.193
8	Theoretical field capacity	0.0542	0.0378	0.057	0.144
9	Actual field capacity (ha/hr)	0.0485	0.0345	0.038	0.144
10	Field efficiency (%)	89.64	91.42	75	85.85
11	Soil Inversion (%)	90.1	93	85	87
12	Soil moisture content (%)	11.52	9.692	15	10.20
13	Cost for ploughing (Rs/ha)	1758.47	1820.25	1799.10	2535.95

Conclusion:

1. It is observed that harnessing of bullock is essential for bullock drawn M.B. plough.
2. Speed of operation by tractor drawn M.B. plough was more as compared to multi-paired bullockdrawn M.B. plough
3. It is observed that average speed of ploughing was 1.5 km/h for bullock drawn M.B. plough
4. It is found that, field efficiency was more in bullock as compared to tractor drawn M.B. plough.
5. It was found, soil inversion test during all the trials was above 90%.

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Appendix A1 Main specification of Mould-board plough for multi-paired bullock Drawn M.B. Plough

Sr. No.	Particular	Specification
1.	Type of Implement	Reversible Mould-board plough
2.	Make	Paras
3.	MARKET PRICE	Rs. 1500 /-
4.	Overall Dimension	
	Length	127 cm

	Width of cut	28 cm
	Height	42 cm
5.	Weight	70 kg
6.	Detail of Soil Working Parts	
	Type of M. B.	General
	Material of Share	cast iron
	Horizontal Suction	2.5 cm
	Vertical Suction	1.5 cm
7.	Detail of Beam	
	Maximum Ground Clearance	36 cm
	Minimum Ground Clearance	28.5 cm
	Length of Beam	110 cm
8.	Detail of Handle	
	Height of Handle From Ground	82 cm

Appendix – B Main specification of Mould-board plough for tractor Drawn M.B. Plough

Sr. No.	Particular	Specification
1.	Type of Implement	Reversible Mould-board plough
2.	Make	Paras
3.	MARKET PRICE	Rs.12000 /-
4.	Overall Dimension	
	Length	165 cm
	Width of cut	16.3 cm
	Height	106 cm
5.	Weight	200 kg
6.	Detail of Soil Working Parts	
	Type of M. B.	General
	Material of Share	cast iron
	Horizontal Suction	2.9 cm
	Vertical Suction	2.6 cm

Appendix C *Details of dynamometer*

Sr. No.	Particular	Specification
1	Capacity	600 kg
2	Model	Th 805
3	Sr. No.	W- 28413
4	Manufacture By	Birdman Chemeng Private Ltd. Calcutta.

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