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Performance evaluation of bullock drawn MAU stubble collector

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Abstract : In India, for stubble collection animal power is not used so extensively. Manual stubble collection can give clean results but it is time consuming, slow process and required more labors. The bullock drawn MAU stubble collector was developed by MKV Parbhani, under AICRP. The performance results of this stubble collector were observed by testing on the field of green gram and bajra crop. The width of operation, for this stubble collector was 1.60 m for both the crop on the field. The depth of operation on the field of green gram was found to be 5.76 cm and on the field of bajra it was found 5.80 cm. The average speed required at green gram field, was found 2.59 km/hr and for bajra crop it was found 2.49 km/hr. The average draft requirement, field efficiency and power requirement during green gram field operation were found 41.87 kg, 84.68%, 0.277 kW, respectively and in case of bajra field 46.0 kg, 83.94% and 0.318 kW, respectively for MAU stubble collector. The stubble collector operation carried out for 6 hrs in a day 2 hrs works and 1 hr rest. On both the field the MAU stubble collector gave very clean results with very less time and only one labor was required to carry out the operation.

KEY WORDS : Stubble collector, Green gram, Bajra, Width of operation, Draft requirement, Field efficiency, Power requirement

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Indian agriculture basically depends upon bullock power as more than 82% of all farmers hold below 2 ha farms. Keeping tractor and any other big machinery is beyond the economical capability of these farmers. They prefer to use a pair of bullock with small matching implements (Anonymous, 1951). India has 85 million of draft animals hence the further prospect of Indian farming largely depends upon the utilization of animal power through different matching implements is efficient work hence by accepting the ways of farm mechanization which helps in reducing the cost of operation and time saving (Anonyms, 1990). Draught animals are mainly used for tillage, sowing and inter cultivation operations. In spite of large application of tractors and electrical power in agriculture, still animal power plays an important role in India. The farmer generally does not possess required knowledge and expertise to repair, maintain and store these implements. This leads to improper use of implements which result in strain to bullocks, this also reduce the working life of implement and puts economic burden on them. Therefore, it is necessary that farmers as well as local artesian be given proper training for proper repair and maintenance of implements. Most small and marginal farmers use different bullock drawn implements to perform different operations.

Stubble collection is an important operation carried out after harvesting and ploughing. It is an art of collecting the stubbles, crop residues and weed residues from the ploughed field. Also high labor wages coupled with its scarcity during the peak period of stubble collection leads to increase in the cost of stubble collection and simultaneously the cost of field preparation which reduces the net profit of farmers. Animal drawn stubble collector helps in the timeliness of operations compared with manual and traditional method of weed collection and cheaper. In India for stubble collection animal power is not used so extensively. Manual stubble collection can give clean results but it is very time consuming operation and it requires 16-17 women labors to collect stubbles from 1 ha field and due to acute labor shortage in the peak season results delayed in stubble collection.

Therefore, stubble collector becomes essential to fulfill the increasing demand of collection of stubbles from ploughed field. Keeping this view in mind, MKV bullock drawn stubble collector was developed to collect various stubbles on field after ploughing and harrowing operations

and the research work has been carried out with an objective to evaluate the performance of this stubble collector in different field crop conditions.

METHODOLOGY

This stubble collector was developed by, College of Agricultural Engineering and Technology, MKV, Parbhani (India) and is known as 'MAU stubble collector' which consists of frame, handle, collecting rack, hitch and beam as a main functional components whose specification as in Table A.

Table A : Specifications of UAE stubble collector

1.	Parts	Frame, handle, collecting rake, hitch and beam
2.	Manufacturer	MKV, Parbhani
3.	Type	Bullock drawn
4.	Power source	A bullock pair
5.	Total weight of stubble collector	28 kg
6.	Spacing between tines	7.5 cm
7.	Width of implement	160 cm
8.	Man power required	One labor
9.	Collecting rake	26 bar at 7.5 cm spacing
10.	Bar diameter	10 mm
11.	Angle frame size	25 × 25 × 5 mm
12.	Standing platform (wooden plate)	Not provided

Experimental methods :

The field test was conducted on 100 m × 10 m size plot of green gram and bajra crop field after ploughing and harrowing operations. The following machine parameters was measured and recorded.

Speed of operation:

During the field trials speed of operation was measured by recording the time to cover 100 m distance by using stop watch. The same trial was conducted three times and average of time required was calculated.

$$\text{Speed (km/hr)} = \frac{\text{Distance covers (m)}}{\text{Time required covering that distance (hr)}} \text{ x } 3.6$$

Draft requirement:

Draft measurement was taken by a digital dynamometer. Dynamometer was attached between yoke and implement and draft was measured for pulling indicated by dynamometer.

Theoretical field capacity :

For calculation of theoretical field capacity, the speed of travel and operated width of stubble collector are taken into account.

$$\text{Theoretical field capacity in ha/hr} = \frac{\text{W (m) x S (km/hr)}}{10}$$

where,

W = Width of stubble collector in m.

S = Speed of operation km/hr.

Effective field capacity :

For calculation of effective field capacity, the time consumed for actual work and all associated activities such as turning, cleaning and adjustment during operation was considered.

$$E = \frac{A}{T_1 + T_2}$$

where,

E = Effective field capacity in ha/hr.

A = Area covered in ha.

T_1 = Productive time in hr.

T_2 = Non productive time in hr (time loss during turning, cleaning and adjustment).

Field efficiency :

By using computed theoretical field capacity and effective field capacity the field efficiency was determined as follows.

$$\text{Field efficiency in \%} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \text{ x } 100$$

Power output:

By using computed draft and speed of bullock the power output was determined as follows.

$$\text{Power output(kW)} = \frac{\text{Draft (N) x Speed (m/s)}}{1000}$$

Cleaning efficiency:

It can be determined by following formula :

$$\text{Cleaning efficiency} = \frac{W_1 - W_2}{W_1} \text{ x } 100$$

where,

W_1 = Number of stubble before operation

W_2 = Number of stubble after operation

Testing of stubble collector:

The experimental trials were taken on the farm of Sorghum Research Station and Department of Animal Husbandry and Dairy Science, MKV Parbhani on the field of green gram and bajra crop. The procedure adapted is as follows:

– The effective width of the machine was calculated by measuring the distance between first and last tines.

– Area covered in one row of field was calculated by measuring distance covered in one pass.

– Number of rows required to cover one ha area was calculated. This was calculated dividing 10000 m^2 by area covered in the row.

– Measure the number of rows to cover one ha land.

– Then the volume of stubbles was observed which was collected in field.

– Area covered by stubble collector was calculated by following formula :

Area = Number of rows × width of implement

– By this procedure the stubbles can be collected easily by stubble collector.

Instrumentation :

The following instruments and equipments were used during experiment,

Dynamometer:

A digital dynamometer was used to taken the reading of draft. During the operation dynamometer shows various readings which are noted and the average of these readings was considered as a draft.

Stop watch:

A Swiss made gallet stop watch measuring to minimum of 1/10th of second and maximum 30 minutes was used to record the time of operation during test.

A metallic and steel tape:

A metallic tape of 30 m and steel tape of 3 m was used for measuring and marking the field. A steel foot rule was also used for measuring the depth and width of operation.

RESULTS AND DISCUSSION

The performance results of this stubble collector were observed by conducting calibration on the field of green gram and bajra crop separately. In both the plots particular soil

Table 1 : Field performance of MAU stubble collector on greengram crop field

Sr. No.	Particulars	Trials			
		I	II	III	Avg.
1.	Plot size (m^2) (100 m × 10m)	1000	1000	1000	1000
2.	Width of operation (m)	1.60	1.60	1.60	1.60
3.	Depth of operation (cm)	6.1	5.8	5.4	5.76
4.	Speed of operation (km/hr)	2.51	2.57	2.70	2.59
5.	Draft (kg)	39.41	45.0	41.2	41.87
6.	Theoretical field capacity (ha/hr)	0.40	0.41	0.43	0.41
7.	Effective field capacity (ha/hr)	0.34	0.34	0.36	0.34
8.	Field efficiency (%)	87.41	82.92	83.72	84.68
9.	Cleaning efficiency (%)	60.1	60.0	60.2	60.1
10.	Man hr/ ha	2.57	2.57	2.58	2.57
11.	Power output (kw)	0.274	0.321	0.309	0.277

Table 2 : Field performance of MAU stubble collector on the field of bajra crop

Sr. No.	Particulars	Trials			
		I	II	III	Avg.
1.	Plot size (m^2) (100 m ×10m)	1000	1000	1000	1000
2.	Width of operation (m)	1.60	1.60	1.60	1.60
3.	Depth of operation (cm)	6.0	5.8	5.7	5.80
4.	Speed of operation (km/hr)	2.43	2.50	2.55	2.49
5.	Draft (kg)	45.2	44.8	48.0	46.0
6.	Theoretical field capacity (ha/hr)	0.38	0.40	0.40	0.39
7.	Effective field capacity (ha/hr)	0.32	033	0.34	0.33
8.	Field efficiency (%)	84.21	82.5	85.12	83.94
9.	Cleaning efficiency (%)	65.0	66.2	68.2	66.46
10.	Man hr/ ha	2.53	2.55	2.57	2.55
11.	Power output (kw)	0.305	0.311	0.340	0.318

condition was black cotton class of soil and Deoni breed of bullock was used as power source.

Table 1 shows the experimental results of the MAU bullock drawn stubble collector in the field of green gram crop. From Table 1 it was observed that the average width of operation was 1.60 m as the width of equipment was constant throughtout the experimentation and average depth of operation observed was 5.76 cm. The speed of operation varied from the 2.51 km/hr to 2.70 km/hr while average speed of rotation observed that 2.59 km/hr. Also the minimum and maximum draft requirement was 39.41 kg and 45 kg while average draft requirement was 41.87 kg. During operation observed theoretical field capacity was 0.41, effective field capacity was 0.34 and field efficiency was 84.68 %.

The field trials were conducted on the field of bajra crop and Table 2 shows the experimental results of the MAU bullock drawn stubble collector in the field of bajra crop. From Table 2 it was observed that the average width of operation was same as green gram as same stubble collector was used for both operations *i.e.* 1.60 m. Average depth of operation observed was 5.80 cm. The speed of operation varied from the 2.43 km/hr to 2.55 km/hr hence, average speed of rotation was observed 2.49 km/hr. Also the average draft requirement was 46.0 kg which was more than the green gram crop. During operation observed theoretical field capacity was 0.39, effective field capacity was 0.33 and field efficiency was 83.94 % and there was no any considerable difference in these properties in both the case.

Conclusion :

The performance of this stubble collector was evaluated in terms of efficiency, stubble collection efficiency and average draft requirement. The field test conducted on two different fields of MKV, Parbhani with different observation of the stubble collector and from the performance test it was found that the MAU stubble collector makes the field clean by collecting the stubbles in three passes and cleans the ploughed land very efficiently in very less time with only one labor and a bullock pair requirement. So this is time as well as labor saving equipment used for stubble collection. It was also found that the stubbles which are sticked into the soil are easily collected by this stubble collector; it also breaks the soil clods and makes the soil smooth because of its weight

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