International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

Vol.8., Issue.4, 2020
July-August

RESEARCH ARTICLE

ISSN: 2321-7758

ADAPTATION AND VERIFICATION OF IMPROVED ROW CROP CULTIVATOR FOR EQUINE ANIMALS

ABULASAN KABARADIN[1], ASHEBIR TSEGAYE[2]
1,2Asella Agricultural Engineering Research Center
Oromia Agricultural Research Institute, Ethiopia
E-mail: [1]keberedin@gmail.com/[2]tsegayeashebir@gmail.com
DOI: 10.33329/ijoer.8.4.6

ABSTRACT
This performance evaluation was conducted to pave the way for making use of Equine Animal Power row Cultivator and consequently possibilities of adaptation in our local condition in the West Arsi zone of two districts of southeastern Ethiopia on the farmers' field. An experiment was conducted to evaluate the field performance of row cultivator at farmers' wheat field. Various performance parameters such as field capacity, weeding efficiency and plant damage of the row cultivator were considered during the test. The field performance test results show that, the developed row cultivator can work up to 5.0 cm depth of operation with 0.075 ha/h field capacity, 80.66% weeding efficiency, 9.65% plant damage and 114birr/ha cost of cultivation was obtained under field test. Therefore, it had been recommended for popularization in any row planted crops as it gave better field capacity and higher saving in the cost of operation.

Keywords: Row crop cultivator, Manual Weeding, Weeding Efficiency, Field Efficiency

1. Introduction

Weeding is one of the critical stages in crop cultivation and affects yield and quality of the yield. It can decrease crop yields from 15 to 50% depending on species, density and weeding time through competition with main crop for light, water and nutrition (Hasanuzzaman et al., 2009). Weeding is done either manually uprooted or using simple hand hoe. Timeliness of operations is one of the most important factors which can only be achieved if appropriate uses of simple agricultural tools are made. Most of the main crops are planted at the same time, this results in shortages of labor during the peak seasons of weeding. The intensification and modernization of agricultural production is associated with use of better farm implements and increased power utilization. To popularize improved animal-drawn row cultivator, it had been modified to equine animal drawn and evaluated for feasibility in farmers' fields. Therefore, the objective of this study was to evaluate field performance of row crop cultivator and compared to hand weeding and hand hoe for developing appropriate mechanical weed control.

2. Materials and Methods

2.1. Description of the Row Cultivator

The developed row cultivator is light, simple in design, easy to operate, reduce drudgery and manufactured from locally available materials and can be easily maintained. Figure 2.1.shows that the

constructional details and main components of the row cultivator.

The row cultivator was constructed from mild steel square hollow pipe with size of 50 mm x 50 mm and having 700 mm length as main frame, square hollow pipe with size of 30 mm x 30 mm as a shank and mild steel sheet metal as wing or shovel. Row to row spacing was adjusted by bolt and nuts depending on recommended crop row spacing.

Fig.2.1. Photograph of developed row cultivator

2.2. Test Conditions

Performances of row cultivator vary with the conditions of the field, soil, weed, crop, operator and the ambient conditions. As the weed condition; type of weed, population density and the height of weed were considered. Plant population and height were measured as crop conditions.

Figure 2.2 shows that performance evaluation of row crop cultivator at the field on 15m x 20m plot size.

2.3. Experimental Field

The practical field tests were conducted during the 2016/17 cropping season on purposely selected farmers' field in West Arsi Zone of Oromia Region. The row cultivator had been evaluated on wheat (Kubsa variety) was sown in 0.2m rows and single horse was used for test. The test plot was 15 m by 20 m with three replications at each site. Cultivating operations were done after three weeks of sowing with hand weeding, hand hoe and row cultivator.

2.4. Performance Indicator

Weeding efficiency, plant damage, field capacity and field efficiency was taken as performance indicator. The weeding efficiency was determined by counting a number of weeds before and after the cultivation by thrown a quadrant (metal frame of 1 × 1 m). The weeding efficiency of the row cultivator was calculated by the following equation (Remesan et al., 2007):

$$e = \frac{(W_1 - W_2)}{W_1} \times 100 \qquad (1)$$

Where: - e = weeding efficiency, per cent, W_1= number of weeds/m^2 before weeding

W_2= number of weeds/m^2 after weeding

To determine the damaged plant, as a quality of work done, number of plants in a 10 m row length before and after weeding was counted the percentage of plant damage was obtained by the following equation (Yadav and Pund, 2007):

$$q = \left[1 - \left(\frac{Q}{P}\right)\right] \times 100 \qquad (2)$$

Where: - q = plant damage per cent, Q = Number of plants in a 10 m row length after weeding

P = Number of plants in a 10 m row length before weeding

Field capacity and field efficiency were calculated by the following equations (Hunt, 1995):

$$C_e = \frac{(S \times W \times F_e)}{10} \times 100 \qquad (3)$$

$$F_e = \frac{T_e}{T_t} \times 100 \qquad (4)$$

Where: - Ce = effective field capacity (hah^{-1}), S = the travel speed of the cultivator (kmh^{-1}),

W = working width (m), F_e = field efficiency (%), T_t and T_e are the total and effective time (h)

2.5. Cost Analysis:

Cost analysis was done on the basis of fixed and variable costs of equipment. The cost items include purchase price of the machine, salvage value of the machine, machine life (year), interest rate

(%), yearly repair and maintenance cost and labour cost.

3. Results and Discussions

The results of field performance of different weeding methods were explained below in (table 3.1).

Table 3.1 Field Performance Test Results

No	Particulars	Row cultivator	Hand-hoe	Hand weeding
1.	Area covered (ha)	0.03	0.03	0.03
2.	Test duration (hr)	0.4	6	5.33
3.	Row to row spacing (mm)	200	200	200
4.	Age of the crop (days)	21	21	21
6.	Mean plant population (per M^2)	157.55	161.78	147.11
8.	Plant damage (%)	9.65	8.01	5.43
9.	Mean weed population(No/m2) - Before cultivation - After cultivation	 113.22 21.89	 170.22 24.44	 130.33 23.11
10.	Weeding Efficiency (%)	80.66	85.64	82.27
11.	Depth of operation (cm)	7	4.67	-
12.	Working width (cm)	550	-	-
13.	Mean speed of operation (m/s)	0.74	-	-
14.	Effective field capacity (ha/hr)	0.075	0.005	0.0056
15.	Length of the row (m)	20	20	20
16.	Grain Yield (kg per plots)	175.67	180.99	166.66
17	Grain Yield (Qun/ha)	58.56	60.33	55.55

3.1. Weeding Efficiency

The weeding efficiency was determined by considering the number of weed before and after weeding operation. Weeding efficiency of hand hoe weeding was observed highest (Table 3.1), which may be due to the fact that more precisely intra row area could be covered. Average value of the row cultivator weeding efficiency was found to be 80.66%. It can be concluded that the row cultivator is efficient because efficiency is more than 80% and also easy in operation.

3.2. Plant Damage

Higher percentage of plant damage was found in case of row cultivator (9.65%) followed by hand hoe (8.01%) and hand weeding (5.43%) (Table3.1). The higher recorded percentage of plant damage for row cultivator might be because of the higher speed of operation, width of cultivator and depth of operation, caused injury to the plants by cutting either their roots or stem.

3.3. Field Capacity

The field capacity of developed row cultivator was calculated by selecting respective plots of size 15 × 20 m the row cultivator was operated and different observations were recorded. The mean field capacity of the developed row cultivator was found 0.075 ha/h (table 3.1). This test result indicates, the row cultivator was easy to operate and outcome of field capacity also satisfactory.

3.4. Cost Analysis

On average, it took 59 and 67 hours for three people to weed a hectare of wheat land by hand and hand hoe respectively, while the time required for weeding a hectare of land using a row cultivator was found 13 hours. On average weeding with a row cultivator was 5 times faster than hand and hand hoe weeding. Hence, one can note that the time requirement per hectare is reduced by one-fifth and labour requirement reduced by the same amount. This clearly indicates that total labour cost of weeding a hectare of land can be reduced to one-fifth.

4. Conclusion and Recommendations

The developed row cultivator attained higher satisfactory field performances of 0.075ha/h effective field capacity, 81.11% field efficiency, 80.66% weeding efficiency, 9.65% plant damaged, 58.56 kun/ha of wheat yield and 114birr/ha cost of weeding. Besides, tests did not report any ergonomics defect or part breakdown throughout the test and it was easy to operate. In general field performance test results indicate a clear view for adopting this row crop cultivator is satisfactory and it can also be used for other crops as row spacing can be adjusted. Thus, it can be concluded that newly developed row crop cultivator could be recommended as the appropriate solution for the weeding problem of small and medium scale farmers. It had been also recommended for popularization for any row planted crops as it gave a better field capacity and higher saving in the cost of operation and labor requirement.

5. References

[1]. Hasanuzzaman M, Ali MH, Alam MM, Akhtar M, Fakhrul Alam K. (2009). Evaluation of pre-emergence herbicide and hand weeding on the weed control efficiency and performance of transplanted rice. American-Eurasian J. Agron., 2(3): 138-143.

[2]. Hunt D. (1995). Farm power and machinery management (9th Edn.). Iowa State University Press. Ames, IA, USA.

[3]. Ahmed R. (2014). Performance Evaluation of Draught Animal Power Cultivator. *Asian Journal of Applied Science and Engineering,* 3(4): 111-115.

[4]. Remesan R., Roopesh MS., Remya N., Preman PS. (2007). Wet land weeding- A comprehensive comparative study from south India. The *CIGR E-journal.* Manuscript PM 07011, 9: 1-21.

[5]. Singh G., Sahay KM. (2001). Research, Development and technology dissemination. *A silver Jubilee Publication*, CIAE, Bhopal, India.

[6]. Yadav R and Pund S (2007). Development and ergonomic evaluation of manual weeder. *Agricultural Engineering International: the CIGR E Journal. Manuscript PM 07 022* IX.