CONTENTS

AGRICULTURAL MECHANIZATION IN ASIA, AFRICA AND LATIN AMERICA

Vol.38, No.3, O

Performance Evaluation of Tractor Drawn Weeding Cum Earthing-up Equipment for Cotton

by
K. Kathirvel
Professor and Head
Agricultural Engineering College
and Research Institute,
Tamil Nadu Agricultural University,
Coimbatore - 641 003
INDIA

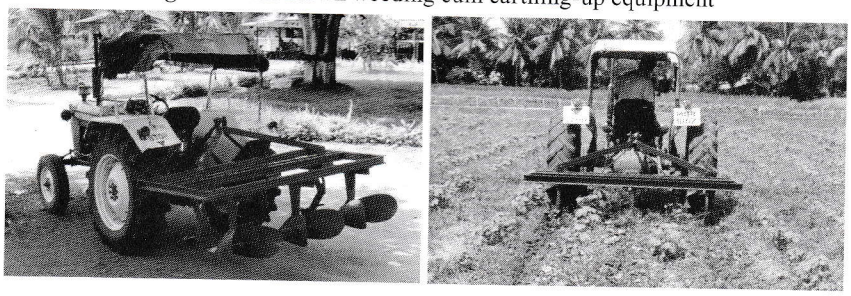
R. Manian
Dean
Agricultural Engineering College
and Research Institute,
Tamil Nadu Agricultural University,
Coimbatore - 641 003
INDIA

T. Senthilkumar
Research Scholar
Agricultural Engineering College
and Research Institute,
Tamil Nadu Agricultural University,
Coimbatore - 641 003
INDIA

Abstract

The arduous operation of weeding is usually performed manually with the use of traditional hand tools in an upright bending posture, inducing back pain for a majority of the labour. The situation necessitates the introduction of a suitable machine for weeding operations. The unit developed consists of an inter cultivator cum earthing-up equipment fitted to a standard tractor drawn ridger. Three sweep type blades 45 cm wide are affixed to the ridger frame with 120° approach angle and 15° lift angle for accomplishing the weeding operation between standing rows of crops. Three ridger bottoms fitted behind the sweep blade work on the loosened soil mass and aid in earthing-up by forming ridges and furrows. The unit was evaluated for its performance with the available weeders and the conventional method. Manual weeding with a hand hoe registered the maximum efficiency of 82.56 % (wet basis) and 82.4 % (dry basis). The weeding efficiency of tractor drawn weeding cum earthing-up implement was 60.24 (wet basis) and 61.62 (dry basis). The savings in cost of the weeding operation with bullock drawn junior hoe, self propelled power weeder and tractor drawn weeding cum earthing-up implement when compared to manual weeding was 78.7, 79.8 and 68.7 percent respectively. The savings in time of the weeding operation with bullock drawn junior hoe, self propelled power weeder and tractor drawn weeding cum earthing-up implement when compared to manual weeding was 96.5, 96.6 and 98.9 percent respectively.

Fig. 1 Tractor drawn weeding cum earthing-up equipment



Introduction

Crop intensification, timeliness in farm operations and efficient use of production resources are critical inputs in increasing the productivity of the agricultural sector. A decrease in the availability of agricultural labour is a direct consequence of migration of agricultural labours

to the industrial sector due to the development of market economy and rural industries. One third of the cost of cultivation is spent on weeding alone when carried out with manual labour. The arduous operation of weeding is usually performed manually with the use of traditional hand tools in upright bending posture, inducing back pain for a majority of the labours. This situation necessitates the introduction of a suitable machine for weeding operations in cotton cultivation.

Review of Literature

The yield of cotton was reduced by 41.46 % when the weeds were allowed to grow unchecked. The treatment of weeding alone and interculture and weeding together, however, did not differ significantly. In the row crops of cotton after the 50th day of sowing with or without application of herbicide, the bullock drawn junior hoe was used for inter cultivation. After 2 or 3 times of inter cultivation with the junior hoe, urea or nitrogen was applied to the crop with the help of a ridger. The bullock drawn blade harrow gave better performance when compared to a bullock drawn three tyne cultivator as seen from **Table 1**. The tractor drawn high clearance cultivator with full and half sweeps gave good results. A bullock drawn lister plough may be used at the later stages of plant growth (Bahl et al., 1988).

A ridger should be used between the rows for inter-row cultivation and for collecting soil around the crop rows. Tractor drawn, high-clearance cultivators using full and one-half sweeps has given good results. The bullock-drawn lister plough may be used at later stages of plant growth. A ridger may be used between the rows for inter-row cultivation and for collecting the soil around the crop rows.

Materials and Methods

i. Development of Tractor Drawn Weeding Cum Earthing-up Equipment for Cotton

The unit developed consists of an inter cultivator cum earthing-up equipment fitted to a standard tractor drawn ridger. Three sweep type blades 45 cm wide are affixed to the ridger frame with 120° approach angle and 15° lift angle for accomplishing the weeding operation between standing rows of the cotton crop. The operational view of the unit between the rows of cotton crop is shown in **Fig. 1**. Three ridge toms fitted behind the sweep work on the loosened soil mas aid in earthing-up by forming and furrows. The specificatio the unit are shown in **Table 2**.

The salient features of the are: weeding and earthing-up o tions are simultaneously perfo in a single pass; row to row dis between the sweep blades an ridger bottoms are adjustable 75 and 90 cm); cost of the u Rs.12,000; and the capacity is per day.

ii. Existing Models of Weeder Cotton

The available models of we which can be used for weed the cotton crop are:

a. Self propelled power w (TNAU model)

b. Bullock drawn junior hoe

The description of the above tioned implements and their sp cation are furnished below.

a. Self Propelled Power W (TNAU model)

The weeder was operated hp petrol start kerosene run e The engine power was tran ted to ground wheels thro

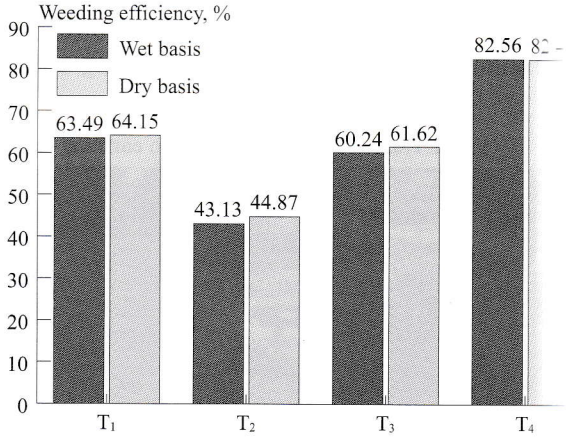
Table 1 Comparative performance of weeders

Name of the weeder	Weeding efficiency, %	Plant damage, %	Man-hrs/ha	Cost of ing Rs
Blade harrow	76.8	12.16	6.63	15.
Three tyne cultivator	67.4	9.7	6.94	17.

Table 2 Specification of weeding cum earthing-up implement

Details	Value
Over all dimensions (L x B x W), mm	2100 x 630 x 1500
Weight, kg	242
Number of rows	3
Number of weeding blades	3
Number of ridger bottoms	3
Shape of the weeding blade	V shaped sweep bottom
Width of sweep blade, mm	450
Approach angle, deg	120
Lift angle	15
Row spacing, cm	Adjustable (60,75,90 cm)
Source of power	35-45 hp tractor
Depth of operation, cm	15

Fig. 2 Efficiency of weeders evaluated in cotton crop



V belt-pulley and sprocket-chain mechanism. A replaceable sweep blade was fixed at the back of the machine. Sweep blades of different width can be fitted to the machine depending on the row to row spacing of the crop. A tail wheel was provided at the rear to maintain the operating depth. The sweep blade could be raised or lowered so as to have the desired operating depth. A rotary weeding attachment to the power weeder was developed. The rotary tiller consisted of three rows of discs mounted with six curved blades in opposite directions alternatively in each disc. These blades, when rotating, enabled cutting and mulching the soil. The width of coverage of the rotary tiller was 350 mm and the depth of operation could be adjusted to weed and mulch the soil in the cropped field. In addition to the rotary tiller and sweep type blades, the ridger or cultivator could be easily fitted to the unit, in place of the rotary tiller by the operator for field operations. The cost of the machine was Rs. 53,000/- (Rs. 35,000/- excluding the prime mover). The capacity was 0.75 ha per day. Additional features of the unit make it useful for weeding between rows of crops like tapioca, cotton, sugarcane, maize, tomato and pulses whose row spacing was more than 45 cm. The specification of the power weeder are furnished in **Table 3**.

b. Drawn Junior Hoe

The bullock junior hoe was an intercultural implement used primarily for weeding between the rows of standing crops. It consisted of reversible shovels with curved tynes attached to the framework with a hinge arrangement. A handle and beam were fixed to the framework for guiding and attaching the unit to the yoke. The spacing between the shovel could be adjusted according to the row spacing of the crop. The cost of the unit was Rs.1500.

iii. Conventional Method of Weeding

In the conventional method of weeding the cotton crop, weeding is performed by women with a hand hoe. The hand hoe consists of a triangular shaped mild steel-weeding blade of 75 mm width attached to a short wooden handle of 450 mm length. The weeding operation is carried out in an upright bending posture.

iv. Treatments Selected for the Investigation

The treatments selected for the investigation included:

T_1: Operation with junior hoe
T_2: Operation with self propelled power weeder (TNAU model)
T_3: Operation with tractor drawn inter cultivator
T_4: Control (Manual with hand hoe)

The developed tractor drawn weeding cum earthing-up implement was evaluated for its performance in terms of weeding efficiency (wet basis and dry basis), depth of operation and percent breakage of cotton plant. The moisture content of the soil during evaluation was 14.48 percent on dry basis.

v. Weeding Efficiency and Percent Breakage

The weeding efficiency (wet basis) was computed by using the following expression.

$$\eta_{ww}\ \% = \frac{(Wr)_w}{(Wr)_w + (Wr)_w} \times 100$$

Where,

Table 3 Specification of power weeder (TNAU model)

Details	Value
Over all dimensions (L x B x H), mm	2400 x 1750 x 1100
Weight, kg	300
Source of power	3.5 hp petrol start kerosene engine
Number pf blades	Sweep blade: 1, Shovel: 5
Nominal working width, mm	2,250 (Adjustable depending on row spacing)
Depth of operation, mm	30 (Adjustable)

Fig. 3 Depth of operation of weeders and percentage of plant damage in cotton field

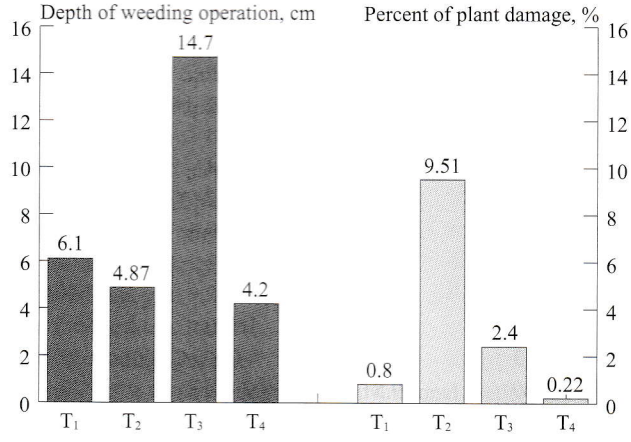
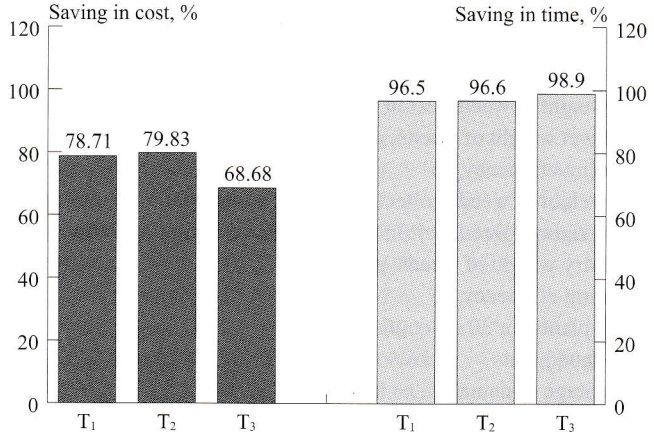


Fig. 4 Saving in cost and time when compared to conventional method



η_{ww}: Weeding efficiency (wet basis), per cent

$(Wr)_w$: Wet weight of weeds removed by the implement/m^2

$(Wu)_w$: Weight of weeds left in the field after the weeding operation/m^2

The weeding efficiency (dry basis) was computed by using the following expression.

$$\eta_{wd}\ \% = \frac{(Wr)_d}{(Wr)_d + (Wr)_d} \times 100$$

Where,

η_{wd}: Weeding efficiency (dry basis), percent

$(Wr)_d$: Weight of oven dried weeds removed by the implement/m^2

$(Wu)_d$: Weight of oven dried weeds left in the field after the weeding/m^2

The percent breakage of cotton stalks was computed by using the following expression.

$$\eta_b,\ \% = \frac{P_b}{P_t} \times 100$$

Where,

P_b: Number of plants broken in the row

P_t: Total number of plants in the row

The cost of weeding with tractor drawn weeding cum earthing-up implement was compared with weeding by power weeder, junior hoe and manual method of weeding. The cost and time saved by the tractor drawn weeding cum earthing-up implement against other methods was compared.

Results and Discussion

During the field trials, it was observed that the power weeder (TNAU model) could not be operated between the standing rows of the cotton crop. One of the ground wheels has to be necessarily run on the ridge resulting in overturning of the unit. As a result the plants were damaged. Hence, the power weeder was used in the plot sown by a pneumatic planter and cultivator seeder, where there was no ridge between the rows, and the performance was compared.

The performance evaluation of the weeders in the cotton crop is presented in **Table 4**. The weight of the weeds collected in treatment T_3 was maximum when compared to T_1, T_2 and T_4. The higher weight of weeds collected was due to complete up rooting of the weeds by the tractor drawn weeding cum earthing-up implement.

The weeding efficiency (wet and dry basis) for all the selected treatments is shown in **Fig. 2**. It was observed that there was no significant variation between the weeding efficiency on wet basis and weeding efficiency on dry basis in all the treatments. Among the treatments, T_4 registered the maximum efficiency of 82.56 % (wet basis) and 82.4 % (dry basis). The efficiency of T_1 and T_3 are comparable. T_2 had the lowest efficiency of 43.13 % (wet basis) and 44.5 % (dry basis) among the tre... ments.

The depth of operation of weed... in all the treatments is shown in F... **3**. The depth of operation was ... highest in T_3. Owing to this m... mum depth of operation the we... were completely uprooted and ... weight of the weeds collected ... unit area was also maximum in ... seen from the observations reco... in **Table 4**.

The depth of operation was ... minimum in T_4. But the weig... weeds collected per m^2 area ... more when compared to T_1 and ... This was because some of the we... were pulled out by hand while m... ual weeding. The depth of opera... was low in T_1 and T_2, which nece... tated additional passes in these ... treatments.

The percentage of plant dama... in the trial field during the opera... of weeders is shown in **Fig. 3** ... percentage of plant damaged ... more in T_2 followed by T_3. This ... because the wheels and the b... caused damage to the plants w... passing the irrigation channels ... while turning of the weeder a... headland. With sufficient he... land and training in the opera... of the units between the rows ... percent of plant damage coul... minimized. The results of the ... for the weeding operation with ... selected treatments are presente... **Table 5**.

Table 4 Results of the performance evaluation of weeder in cotton crop

Particulars	T_1	T_2	T_3	T_4
Wet weight of weeds collected after weeding operation, gm/m^2	139.3	160.0	324.9	429....
Wet weight of weeds left in the field after weeding operation, gm/m^2	80.09	211.02	214.4	91.0...
Total wet weight of weeds, gm/m^2	219.39	371.02	539.4	520....
Weeding efficiency, %	63.49	43.13	60.24	82.5...
Dry weight of weeds collected after weeding operation, gm/m^2	72.12	68.15	148.7	245....
Dry weight of weeds left in the field after weeding operation, gm/m^2	40.31	83.73	91.99	51.8...
Total dry weight of weeds, gm/m^2	112.3	151.88	240.7	297....
Weeding efficiency, %	64.15	44.87	61.62	82.4...
No of plants for 30 m length	162.6	150.0	167.0	155....
Damaged plants	1.33	14.0	4.0	0.3...
Percentage of damage	0.80	9.51	2.40	0.2...
Depth of operation, cm	6.1	4.87	14.7	-

The savings in cost and time of weeding operation with the bullock drawn junior hoe, self propelled power weeder and tractor drawn weeding cum earthing-up implement are shown in **Fig. 4**. It is clearly shown from the figure that all the treatments T_1, T_2 and T_3 resulted in savings of cost and time when compared to T_4. T_3, T_2 recorded the highest percent cost saving, followed by T_1 and T_3. High initial cost of the tractor and weeding unit increased the cost of weeding operation in T_3 and hence it was the lowest. There was little difference in time saving among treatments T_1, T_2 and T_3.

Conclusions

Based on the analysis of the results the following conclusions were drawn.

- An inter cultivator cum earthing-up implement fitted to a standard tractor drawn ridger was developed.
- The developed unit was evaluated for its performance in comparison with the existing models of weeders and conventional method of weeding.
- Manual weeding with hand hoe registered the maximum efficiency of 82.56 % (wet basis) and 82.4 % (dry basis). The weeding efficiency of tractor drawn weeding cum earthing-up implement was 60.24 % (wet basis) and 61.62 % (dry basis).
- The cost saving of the weeding operation with a bullock drawn junior hoe, self propelled power weeder and tractor drawn weeding cum earthing-up implement, when compared to manual weeding, was 78.7, 79.8 and 68.7 percent, respectively.
- The saving in time of weeding operation with bullock drawn junior hoe, self propelled power weeder and tractor drawn weeding cum earthing-up implement, when compared to manual weeding, was 96.5, 96.6 and 98.9 percent, respectively.

REFERENCES

Bahl, V. P., M. K. Garg, and M. L. Jain. Role of improved farm machinery in increasing cotton productivity. J Agric., Engg. ISAE, 20(4): 9-10.

Bahl, V. P., D. N. Sharma, and M. L. Jain. 1988. Cotton Cultivation in Haryana State, India. Agricultural Mechanization in Asia, Africa and Latin America, Japan, 19(4): 63-67.

Table 5 Result of the evaluation trail for weeding operation in cotton crop

Particulars	T_1	T_2	T_3	T_4
Width of operation, m	0.45	0.75	2.25	-
Length of the field, m	46.0	46.0	46.0	-
Time taken to travel, sec	65.6	60.54	100.3	-
Forward speed of operation, kph	2.53	2.75	1.66	-
Theoretical field capacity, ha/hr	0.114	0.207	0.373	-
Size of the field, m^2	46 x 11.5 = 1,890 m^2			
Time taken, in 1st pass, min	27.9	29.7	16.0	-
Time taken, in 2nd pass, min	27.0	24.6	-	-
Total time taken, min	54.9	51.4	16.0	450 woman hrs/ha
Actural field capacity, ha/hr	0.058	0.06	0.198	-
Field efficiency, %	50.9	50.0	52.6	-
Cost of operation, Rs/hr	50	55	250	9.0
Cost of weeding, Rs/hr	862.07	887.1	1,268.63	4,050.0
Saving in cost when compared to conventional method, %	78.71	79.3	68.68	-
Saving in time when compared to conventional method, %	96.5	96.6	98.9	-