Testing and Evaluation of Animal Drawn & Wheeled Hand Hoe Weeders

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Abstract
Weed is the major problem in small holder crop production system. If it is not controlled at the right time, it can significantly reduce crop yield. It also create additional work load on farmers. Under the traditional farming systems as much as 30% of the total labour employed in food crop production is used for weeding. In the case of Amhara region during June to august land preparation and weeding are taking place at the same time which make labor the limiting factor for crop production. To alleviate problems related to weed and weed control and drudgeries in traditional weeding systems, two kinds of mechanical weeders (wheeled hand hoe and triangular tool bar animal drawn weeder) were prepared and evaluated compared to conventional methods of weeding. The test result has shown that triangular tool bar animal drawn weeder has better performance than others. Its labor requirement was 10 person-hr ha^{-1}, while its weeding efficiency was 78% and saving in labor and weeding time was about 83% compared to conventional weeding system. Wheeled hand hoe, on the other hand, requires 30 man-hrs ha^{-1}, with a weeding efficiency of 75% and labor and operation time saving of 71%. Therefore, to get best control of weeding, triangular tool bar animal drawn weeder with a combination of manual weeding enhance weed control and reduces labor requirement. But for small holder farmers where draft animas are not available during peak weeding times, wheeled hand hoe gives best result.

Introduction

A weed is a plant grown un-wonted. Weed compete the crop for light, water, and other nutrients which are important for plant growth. When availability of these essential elements is limited, as it always is, competition occurs and plant growth suffers resulting in reduction of crop yield.

Weeds are constant problem in agriculture, if not controlled at the right time, significantly reduce crop yield and impair crop production. All crops are affected by weeds to some extent, but how serious this effect could be depends on the species and the circumstances under consideration. The institute of Agricultural research (IAR) reported that delayed weeding of maize reduces production by 44%.Average crop loss due to weeds is estimated to be about 25%, but can be as high as 50%-80% with some food crops (Lavabre,1991).

Report of the Institute of Agricultural research (IAR) also shows that when weeds are not removed from the cropped land at proper time, farmers will loss nearly 30% of their

potential yield (Regional weed survey report 1997). Therefore the main objective of weed control is minimizing production losses due to weed effect. Furthermore, most of the mechanical weed control methods will improve the soil moisture status by reducing evaporation and enhancing infiltration.

In the Amhara region weeding is primarily done by hand pulling, but some times it can be assisted by hand hoes. This system involves scraping the soil to cut the roots of weeds just below the soil surface and shaking the soil off the roots to prevent weed re-growth. Under such traditional weeding systems, as much as 30 percent of the total labour employed in food crop production is used for weeding. (Practical field guide for control of weed,1996).This can cause labour bottlenecks specially during Jun-August when land preparation and weeding are taking place simultaneously.

Farmers use hand weeding and ox-weed (*shilshalo*) techniques with family labour. Planting maize behind the plows in parallel rows at least 40 cm apart and cultivating with traditional *maresha*, usually called inter-row cultivation, or *shilshalo,* is used by farmers to weed, to thin maize and to loosen the soil for better moisture retention. *Shilshalo* usually has to be assisted with some hand weeding or hoeing to remove the weeds which are left untouched. The first weeding should take place about two weeks after emergence and subsequent weeding or *Shilshalo* should be done when the maize is at knee height. (Practical field guide for control of weed, 1996)

The labor burden of weeding can be reduced through mechanical weeding. Mechanical methods of weed controls are simple and easily understood by farmers. The tools and implements for mechanical weed control are mostly manual operated or animal drawn. However, in order to use of mechanical cultivation methods, the crop must be planted in rows that are spaced wide enough for the animal tools and farmers to pass through, without damaging the crop.

Weeding with animal traction is much faster than hand weeding, and it is less tedious as well. Animal power makes the timely weeding of all fields possible, with benefits of increasing labor productivity and crop yield. Animal drawn weeding techniques are more cost effective than herbicides and are more likely to be amenable to small holder farmers. But whatever method is used, weeding should eradicate weeds within crop rows at an early stage and significantly reduce weed density (Starkey et.al., 1994).

Animal powered weeding can be carried out using whatever animal is most appropriate to the environments and culture of the people. Mules and horses are better established in weeding roles through they tend to be less suited to delicate crops and soils. A pre-requisite for animal based systems is the presence of proper care and training of the animals (Lavabre, 1991). Hence the objective of this study was to prepare mechanical weeding implements (Triangular tool bar weeder & wheel hand hoe) and test their suitability for maize cultivation under local conditions.

Materials and Methods

Two types of weeders (triangular toolbar animal drawn weeder and wheeled hand hoe) were designed and fabricated at Bahir Dar Agricultural Mechanization Research Center. The wheeled hand hoe was developed at Punjab Agricultural University and its design obtained from Central Institute of Agricultural Engineering (Bhopal, India). But triangular tool bar weeder was developed in the centre

Wheeled Hand Hoe

Wheeled hand hoe (Figure1.) is manually operated implement suitable for weeding and inter-culture. The handle is manufactured from ½" Galvanized iron pipe and it's height is adjustable according the operator size. The wheel and the frame were fabricated from 12 mm diameter deformed bar and 40x3 mm flat iron respectively. Duck foot type sweep weeder body, which is preferred for general weeding purpose, was selected and produced from 3 mm sheet metal. Depending to the soil condition one or two persons will be required to operate the weeder.

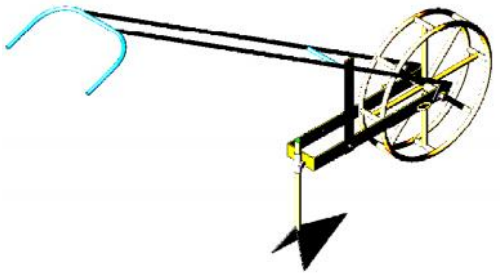

Figure-1 wheeled hand hoe weeder

Triangular Toolbar Animal Drawn Weeder

Triangular tool bar animal drawn weeder (Figure 2.), equipped with facilities for row-to-row spacing adjustment, is used as weeder and an inter-culture implement. The frame was manufactured from 30x30x3 mm angle iron to which three sweeps were attached by bolt and nut. The height of the shank, which is adjustable, is between 180mm-200mm. The duck foot sweep is designed to cut the soil beneath weeds with a superficial roots system or to cut through the roots of weeds deep inside. Taking this into consideration, the angle of attack, which is approximately 15^0, is ideal to lift and separate the weeds from the soil. Approach angle of 30^0-50^0 were selected. (Brian and Sims, 2000)

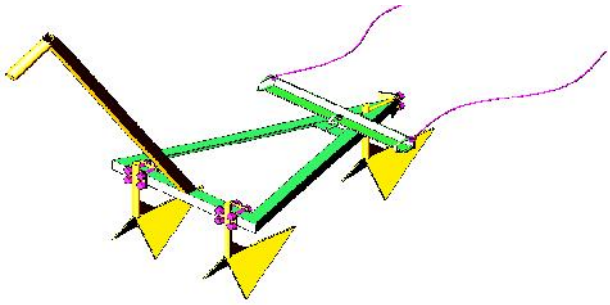

Figure- 2 Triangular tool bar animal drawn weeder

Test procedure

The test was conducted on maize farm planted in rows and a mule harnessed using breast band, was used as a source of power for the animal drawn weeder. The mule was trained on pulling the weeder for a few days prior to actual testing. The time taken to complete a particular operation was measured using a stop watch. Data was collected on representative field samples and field capacity, labor requirement, and weeding efficiency were then calculated and the mean value of at list three measurements reported. Important parameters were determined as follows;

- Weeding efficiency - is quantitatively expressed as the ratio of number of weeds present after weeding operation or passes to that before. Samples of weeds within and between the maize were taken using a 1 m^2 quadrant sampler and weed collected was dried and weighed. The frame is dropped on the un-weeded and weeded land randomly. Replicated samples are taken, oven dried at 130^0c for 18 hours, and weighed. Weeding efficiency is thus calculated by

$$\eta_{weed} = \frac{(W_p - W_e)}{(W_p)} \times 100$$

Where:

η_{weed} = weed efficiency,
W_p = Weight of oven dry weed per unit area before weeding
W_e = Weight of dry up-rooted weed after weeding

- Working speed - is calculated from the time taken to weed a distance of 25m
- Theoretical field capacity (F_{ct})- is calculated from mean values of working speed as

$$F_{ct} = WxV$$

Where:

W= working width (m),
V= working speed (m se^{-1})

- Soil moisture content – was measured by gravimetric method in which soil samples were taken, weighed immediately in the field, and then oven dried at 105 ^{0}c for 48 hours. Percentage soil moisture content (dry bases) was determined from;

$$M_s = \frac{(W_{twet} - W_{tdr})}{(W_{tdr})} \times 100$$

Where:

M_s - Soil moisture
W_{twet} - wt of wet sample
W_{tdr} - wt of dry sample

Results and discussions

The test result (Table1) has shown that the hand hoe weeding method gives better weed control result. However, it is a slow process, which is labor- intensive compared to the other mechanical methods. It is hard and tedious work. As labor requirement is about 232 person hr ha^{-}1, total area coverage per person per day is limited. It can, however, be useful for areas where labor is available during the season and wages are low.

However weeding with pair of oxen using traditional plough at weeding tine is much faster and saves labour and time by about 79% compared with this hand hoe method (table 1). If weeding is performed at early stage, about two weeks after emergence, the plough throws enough soil on the crop rows which will burry and suppress small weeds without harming the crop. Weeding efficiency is 81% (table 2). However, this system too has some series short comings. During weeding or cultivating using a pair of oxen, one of them will probably pass on the free space between rows of plant while the other will ride on planted rows, causing breakage on germinated crop. Besides, cultivating depth, which is about 12cm, is greater than the required depth.

The test result also shows that it was easier to weed with single animal than two. Weeding with one mule by triangular toolbar weeder is much faster (table 1) and, of course, less tiring. Labour requirement was observed to be 10 person h ha^{-1} and saves labour and operation time by 83% compared to hand hoe. On the other hand, it was observed that weeding with of wheeled hand hoe was cumbersome when the implant was to be push by one person, especially when the soil moisture content was low. To simplify this problem, two framers were used to work at a time, one person pushing the implement while the other pulls it by a rope. In such conditions, labor requirement was 30 person h ha^{-1} and still saves labor and operation time by about 71% compared to hand hoe system. Field observation has also shown that cultivation should be performed when weeds are not more than 15 cm tall and the soil is not too wet.

Table 1 Average working performance of different weeders

Implement	Working width (cm)a	Working speed (m s-1) *
Hand hoe	80	0.0148
Wheeled hand hoe weeder	15	0.625±0.12
Triangular toolbar weeder	40	0.714±0.06
Traditional Maresha	20	0.583±0.035

*= Mean ±standard deviation of three measurements

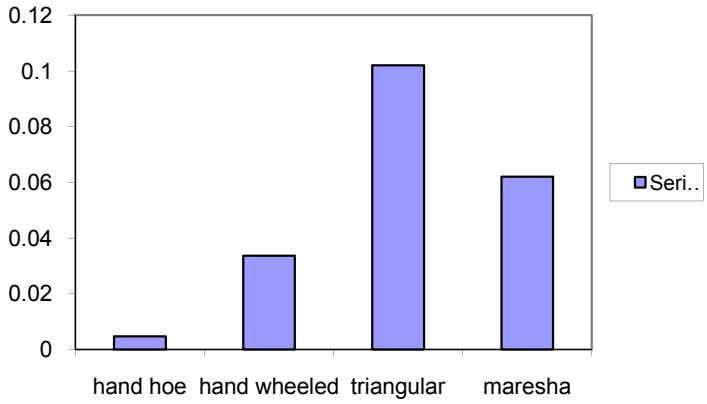

Figure 3, Working capacity of weeders

Table 2 Weeding efficiency of treatment weeders

Implement	Average Weeding efficiency %
Hand hoe	91
Wheel hand hoe	75
Triangular toolbar	78
Traditional maresha	81

Conclusion and Recommendation

Using triangular toolbar weeder drawn by a single mule, with a combination of manual weeding enhance weed control, reduce labour requirement and can suppress the effect of weeds on crop yeald. During high output, triangular animal drawn weeder can help in the timeliness of operation and saving time. For small farmers where draft animals are not

available wheel hand hoe with a combination of manual weeding gives best control of weeds. The weeders can be made and maintained in the small workshop.

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