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Design Modification, Adaptation and Verification of Spike Tooth Harrow for Pack Animals

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Abstract
It was observed that, farmers in the test area repeat farm tillage usually from 3 to 6 to prepare seedbed by using oxen and traditional 'Marasha'. But these practices are causing exhaustion for both the farmers and oxen which are less resistive to such conditions. In addition, as the affordability of the oxen is becoming difficult and the traditional 'Marasha' is not suitable for reducing the repetitive tillage. Therefore this activity was aimed at modifying and verifying existing spike tooth harrow for secondary tillage and for donkey and horse harnessing suitability. Field evaluation of the modified implement was carried out to determine plowing width and depth, clod breakage (soil pulverization) and working capacity (hr/ha). Test result of the modified implement showed that 63.4 % clod breakage or soil pulverization within an average time of 3.8 hr/ha, which takes a day by using the ('Marasha'). The average yield of grain worked by spike-tooth harrow was 80 quintal/ha and that of 'Marasha' with oxen was 67quintal/ha.
Keywords: clod size, tillage, spikes

1. Introduction

Optimum tillage to achieve maximum crop yields with minimum energy consumption is the main goal of efficient seedbed preparation. A good seedbed preparation shows finer particles and greater firmness in the vicinity of the seeds (Pandey, 1998). The use of animal traction has enabled farmers to expand their area of farming and contributed to the timeliness of their agricultural operations. The cost of maintaining cattle is often too great to make oxen a feasible source of farm power when compared to pack animals. Donkeys and horses are popular draft animals because they are inexpensive (often less than half the price of oxen on the live market), easy to train, and effective where shallow breaking is practiced before planting begins (Dibbits and Bobobee, 1996)

Spike tooth harrow breaks clods, stirs the soil, uproots the early weeds, levels the ground, and breaks soil crust. It also covers the seeds which usually operate at shallow depths up to 5 cm. It was observed that, farmers around Asassa and Dodola woredas repeat tillage usually from 3 to 6 to prepare seedbed for plantation. This activity is performed in 90 days. During these months of operation, most oxen exhausted and farmers face problem of draft power to overcome the challenge, farmers are practicing the use of pack animals. They use traditional 'maresha' to accomplish these tasks. However, this traditional implement used is not suitable for donkey and horse. They cause wounds and sores on the donkeys' necks, making donkeys inflexible and rendering them unusable for several days (Kathy and Zahra, 1983). Therefore the activity was aimed at modifying and verifying existing spike tooth harrow technology used for secondary tillage and further for donkey and horse to overcome the above problems.

2. Material and methods

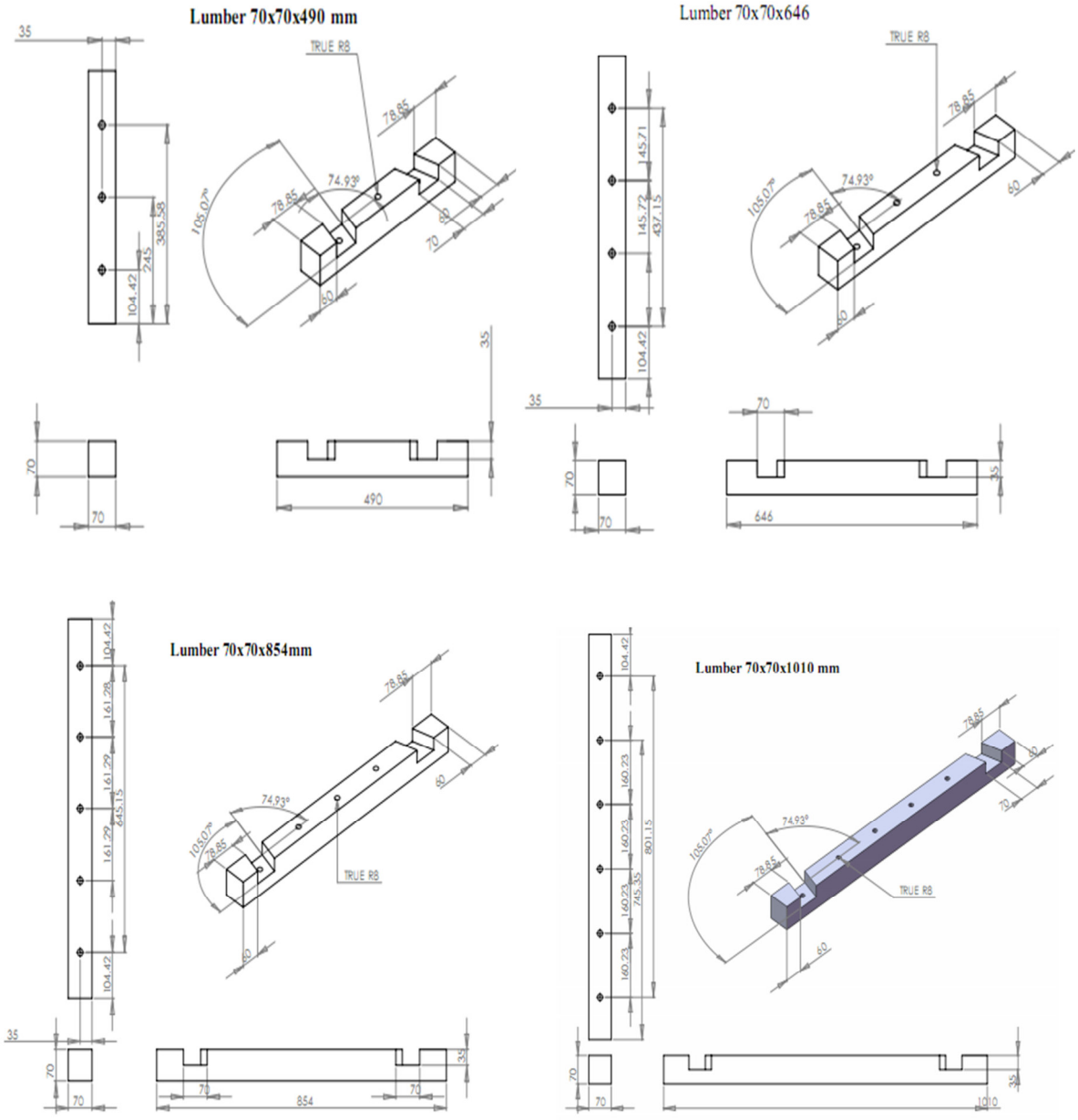
The material required to undertake this activity were:- Wheat grain, fertilizer, Harness attached on the back of pack animal, donkey or horse to pull an implement, (150x150x4000) mm and Ø (70, 80)mm eucalyptus tree, Ø (6, 8, 10)mm of round bar, M (10x120) mm bolt and nut and 8mm nail.

2.1. Technology adaptation

The attachment of spike tooth harrow were modified and attached to harness system on the back of pack animal that have good draft force and equipped to the beam (Fig 1).

Fig.1 Modified spike tooth harrow tested on the field

2.2. Design of modified spike tooth harrow parts



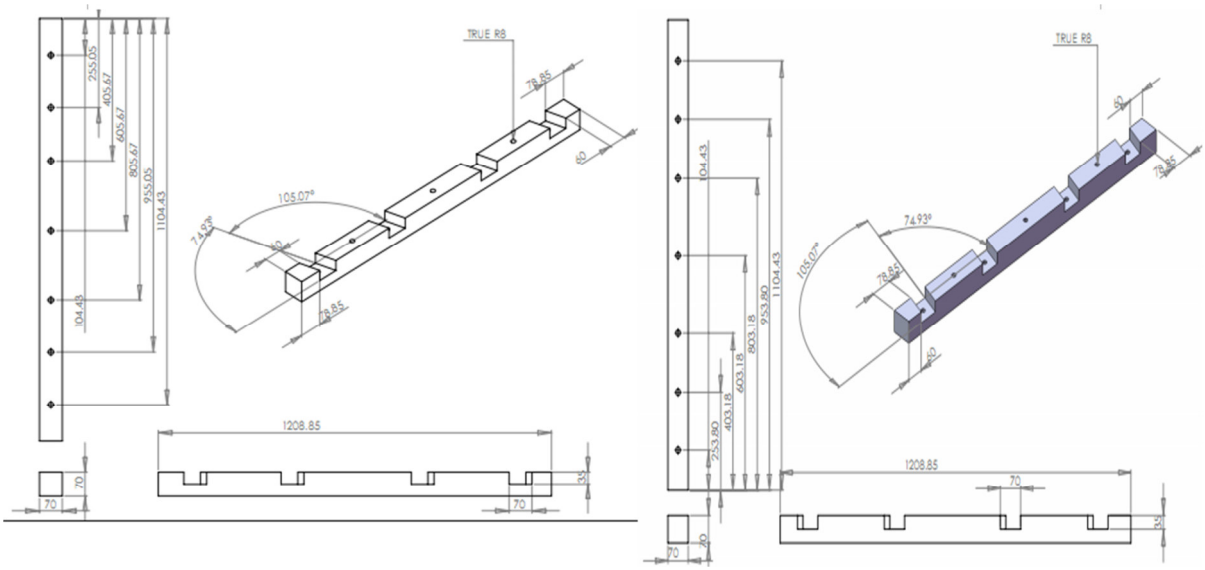


Fig. 2. Design of modified spike tooth harrow parts

2.3. Design of beam attached to harness

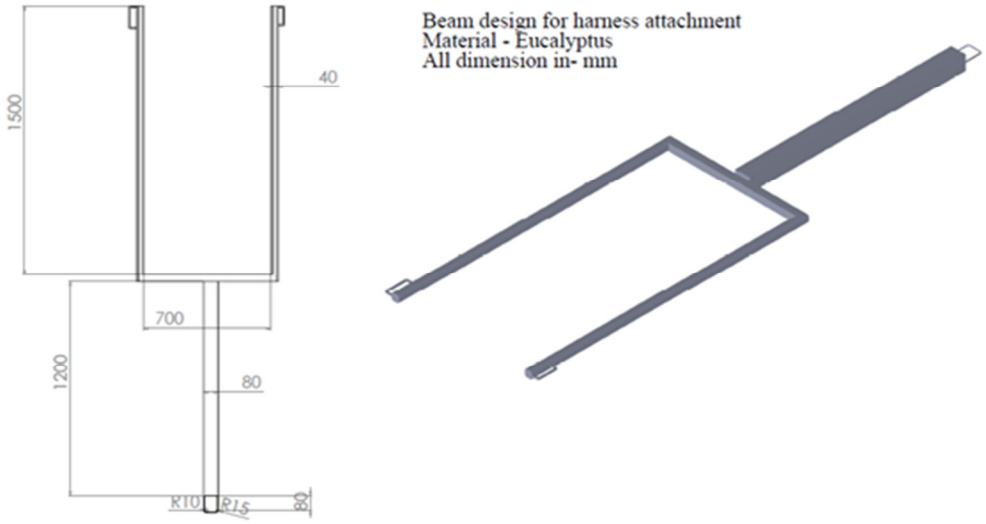


Fig. 3. Design of beam attached to harness

The diagonal dimension before modification of spike tooth harrow is 167cm.These diagonals are designed and modified to 120.9cm. The right and left diagonals are the longest part of spike tooth harrow used to support other parts attached on it. The width of largest bottom before modification is 147cm. It is designed and modified to 101cm.The second part before modification was 127cm and reduced to 85.4cm. The third one was 97cm before modification and minimized to 64.6cm. The top one was 74cm and modified to 49cm.The numbers of spikes available on spike tooth harrow before modification were 29 in numbers and it is reduced to 24 spikes. Weight of modified technology (spike-tooth harrow + harness + 'mofer' attachment was; 40 + 7 + 9=56 kg). Its actual width was 85 cm and height of spikes was 18cm.

2.4. Performance evaluation of modified spike tooth harrow

2.4.1. Field test

Field test was done at two different sites of Asassa and Dodola woredas. The evaluation was carried out to determine the following parameters under field conditions: plowing width and depth of a modified spike tooth harrow, clod breakage into finer pieces (soil pulverization) and for good soil bed and maximum working capacity (hr/ha). Total area of the tests was 20mx20m (400m^2) which is divided to 20x10 m plot size for working with the spike-tooth harrow and the other 20x10m for oxen with 'Marasha'. Land preparation of the experimental area before the test was coarse except compacted at Dabara walta'i kebele and soil type is sandy loam.

3. Result and Discussion

3.1. Field test for clod breakage

The clod breakage was measured using Varner caliper in selected 1m x 1m ploughed area.

Table 1- Average clod breakage

No	Test site	Parameter	Tot.average (lxwxt)cm
1	Kachama chare Kebele	Clod diam. Before	25x18x10.5
		Clod diam. After	13x10x6
2	Dabara walta'i kebele	Clod diam. Before	26.5x20.5x10
		Clod diam. After	16x11x7
3	Huruba walkite kebele	Clod diam. Before	26.5x20.5x10
		Clod diam. After	16x11x7

An average actual plowing width per pass for modified spike tooth harrow was 85cm and actual plowing depth was 9.3cm. Clod breakage or soil pulverization of about 54.9 % was done at Kachama chare Kebele, 73.6 % at Dabara walta'i kebele and 61.4 % at Huruba walkite kebele.

An average time used for assembling the modified implement was 4.2 and 2.1 minute for disassembling during field operation. Two persons were used during assembling, operation and disassembling. Generally, we found that an average of 63.4 % clod breakage or soil pulverization was done by the technology modified. Time taken for spike-tooth harrow was 3.8 hr/ha which is approximate to 4 hr/ha.

3.2. Grain Yield and yield related data

An experimental crop harvested was taken by placing (1 x 1) m^2 quadrant on the experiment plot at three places.

Table 2- Average yield of experimental crop

No.	Parameter	Average yield for Harrow covered	Average yield for Oxen covered
1	Weight of bundle (qt/ha)	194	166
2	Weight of cleaned grain (qt/ha)	80	67
3	Weight of straw (qt/ha)	125	99
4	Grain straw ratio	0.62	0.68
5	Sheave length (cm)	80.6	81.3

The total average weight of cleaned grain yield was 67 qtl/ha for oxen covered and 80 qtl/ha for spike-tooth harrow. Generally, the average weight of cleaned grain covered by modified technology had good result as compared to oxen covered.

4. Conclusion and recommendation

Spike tooth harrow is used to break down the clod size and to assist with field leveling after ploughing. The technology recommended was not gender dependent, so that male and female farmers can use equally. An average time used for assembling was 4.2 minute but 2.1 for disassembling during field operation. Time taken for spike-tooth harrow was 3.8 hr/ha. 63.4 % clod breakage or soil pulverization was done by the technology modified. Wheat cleaned grain yield is 67 qtl/ha for oxen covered and 80 qtl/ha for modified spike-tooth harrow. In this test, it has been found that utilizing indigenous knowledge; features of traditional implements and farmers' know how in agricultural technology design, development and testing process is a very effective approach for appropriate technology development.

5. References

Dibbits H.K. and E.Y.H. Bobobee (1996), Animal Traction Technology; Interim Report. National Agricultural Extension Project of Agricultural Extension services. Ministry of Food and Agriculture, Accra.

Kathy Marshal and Zahra Ali, 1983, Gender issues in donkey use in rural Ethiopia.

Pandey (1998), Present Status and Future Requirement of Farm Equipment for Crop Production

Watson, Peter R, 1982, Animal Traction, Appropriate Technologies for Development. Manual M-12, Washington D.C.