# The Impact of Ox-weeding on Labour Use, Labour Costs and Returns in the Teso Farming System

**David Barton[1], Anasasio Okuni, Francis Agobe and Rosset Kokoi[2]**

*[1] Natural Resources Institute, University of Greenwich, UK*
*[2] Serere Agricultural and Animal Production Research Institute (SAARI), Soroti, Uganda*

## Abstract

There has been a shortage of draught animals in the Teso farming system following civil disruption during the 1980s and 1990s. This constraint is being addressed by a number of 'restocking' projects and many households are now able to open up land (plough) with oxen. The benefits of using draught animals however, will not be fully realised until animals are used for weeding. Weeder evaluation (4 designs) took place on-farm during 2000 and 2001 in sorghum and groundnut crops. For sorghum DAP weeding made little impact on yield but reduced the time needed for hand weeding from 157 hours to 34 hours per hectare. Hand weeding costs were reduced from 47,000 Ush to 10,000 Ush per hectare. Returns per day of hand weeding labour were increased from 3,700 Ush to 19,300 Ush. For groundnuts DAP weeding gave higher yields (not statistically significant) and reduced the time needed for hand weeding from 73 hours to 31 hours per hectare. Hand weeding costs were reduced from 30,700 Ush to 13,700 Ush per hectare. Returns per day of hand weeding labour were increased from 31,300 Ush to 230,800 Ush. This research has demonstrated that SAARI, AEATRI, SG2000 weeders and a plough (minus its mouldboard) are all technically efficient in terms of reducing the labour required for weeding. There are challenges however, associated with the cost and availability of weeding implements. However, a plough (minus its mouldboard) is an effective weeding tool.. This is an implement widely owned in Teso and thus makes DAP weeding possible for the majority of farmers without a significant additional investment in new equipment. Future challenges therefore will include the extension and dissemination of this technology.

## 1. Introduction

The research project 'Improving Production in the Teso Farming System Through the Development of Sustainable Draught Animal Technologies' worked with farmers in the Teso farming system in the Districts of Katakwi, Kumi, Pallisa and Soroti Districts and was jointly managed by the Serere Agriculutral and Animal Research Institute and Natural Resource Institute of University of Greenwich in the UK. The Project was part of the portfolios of two DFID research programmes, the Livestock Production Programme (LPP) and the Crop Protection Programme (CPP).

There has been a shortage of draught animals in the Teso system following civil disruption during the 1980s and 1990s. This constraint is being addressed by a number of 'oxenisation' or 'restocking' projects and many households are now able to open up land (plough) with oxen. The benefits of using draught animals however, will not be fully realised until animals are used for tasks other than ploughing (particularly weeding). Expansion of the area cultivated, following the re-introduction of oxen for ploughing, often leads to a labour constraint for weeding which is undertaken by hand (mostly by women). The range of implements available for weeding, planting and transport is limited

and the project addressed this issue by testing and evaluating with farmers, on their fields, a variety of implements likely to be appropriate to their circumstances.

## 2.Weeder evaluation

Weeder evaluation took place on-farm after the necessary farmer training in line planting and inter-row weeding with oxen. This paper reports the impact of the use of 4 weeders on labour use, labour costs, returns to labour and gross margins on-farm for the first season (rains) 2001 and the second season (rains) 2000.

Farmers from nine sites participated in the on-farm trials. Three designs of weeder and a plough with the mouldboard removed were used by farmers at each site. The implements are shown in figs 1 to 4.

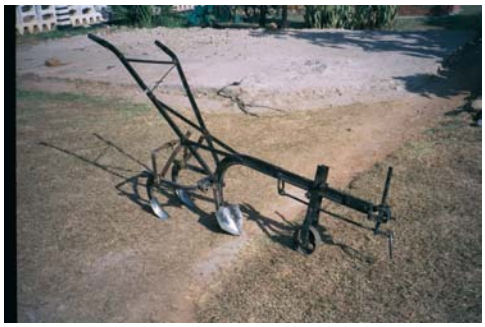

Fig 1 SAARI weeder

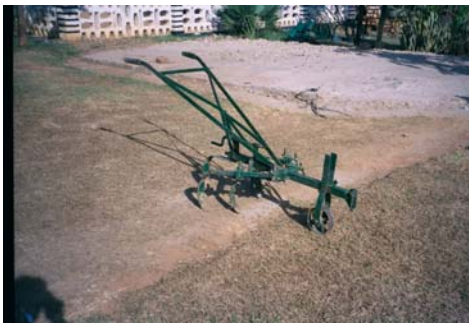

Fig 2 AEATRI weeder

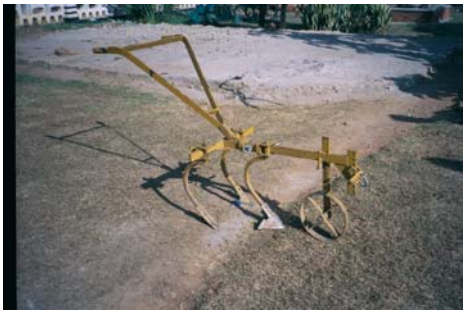

Fig 3 SG2000 weeder

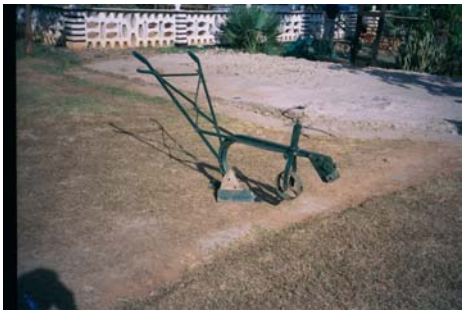

Fig 4 Plough (minus mouldboard)

The SAARI and AEATRI weeders were designed and made by the NARO Institutes Serere Agricultural and Animal Production Research Institute and the Agricultural Engineering and Appropriate Technology Research Institute respectively. The SG2000 weeder is imported into Uganda from Kenya. These three types of weeder were provided

by the project and delivered to the 9 project sites. The use of the plough without the mouldboard (see fig 4) was tested as a possible cheaper solution and was known to be widely used in Zimbabwe (Riches et al, 1997).

For on-farm trials, seven farmers at each of the nine sites (63 farmers in total) were chosen by their communties to participate in the research. During 2000 2 different weeders were tested by farmers (SAARI and AEATRI) and in 2001 four weeders were used (SAARI, AEATRI, SG2000, Plough). Split plots were marked out on collaborating farmers fields (half the plot was weeded using draught animals and the other half weeded by hand (traditional practice) (Sims, 1993).

## 3. On-farm trial results

*2000 season 2 (sorghum)*
Full data was collected from 66 farmer plots (43 hand weeded and 23 weeded with draught animals). Planting on-farm was timely and reasonable yields resulted (Table 1). Only one weeding was undertaken by the majority of farmers as crop growth was rapid following the first weeding and a second weeding was not necessary. The differences in yields between DAP and handweeding treatments were not large or statistically significant. Given the variation between sites and plots in planting dates, rainfall (which was not recorded) and other factors such as soils, cultural practices etc. it is not possible to attribute yield effects from this data to a particular weeding technique. If weeding is undertaken effectively by both implement and by hand, a yield effect would not be anticipated.

The use of ox-drawn weeders reduces the hand labour required for weeding from 157 hours/ha to 34 hr/ha.. Hand weeding costs (at the prevailing market rate) are significantly reduced to around Ush 10,000/ha compared with Ush 47,000/ha for farmer practice.

**Table 1. Labour use, costs and margins on-farm, season 2, 2000 (sorghum) (DAP weeding versus farmer practice)**

| | DAP weeding | Farmer practice (hand hoe) | Statistics[3] |
|---|---|---|---|
| Yield (kg/ha$^{-1}$) | 894.1 | 833.7 | ns |
| Hand weeding (hr/ha$^{-1}$) | 34.7 | 157.8 | p<0.001 |
| Cost of hand weeding (Ush/ha$^{-1}$) | 10,401 | 47,343 | p<0.001 |
| Gross Margin (Ush/ha$^{-1}$) | 14,359 | 771 | ns |
| Returns to hand weeding (Ush/day) | 19,388 | 3,735 | p<0.001 |
| Hand weeding costs as % of total | 13.2 | 51.3 | p<0.001 |
| Number of observations | 43 | 23 | |

Hand weeding costs as a percentage of total costs are reduced from more than 50% to 13%. Gross margins were higher for DAP weeded plots but there were large variations

[3] Direct variance ratio test F probability

within the sample and the difference was not statistically significant. Returns per day of hand weeding labour are significantly increased with the use of ox-drawn weeders.

The relative performance of the 2 weeders is shown in Table 2. Although the SAARI weeder appears to perform better than AEATRI in terms of yield and margins neither of these differences was statistically significant. In terms of reducing the time required for hand weeding and labour costs there is little to choose between the 2 designs.

**Table 2. Comparative performance of 2 weeders (sorghum, season 2, 2000)**

| | SAARI | AEATRI | Statistics [4] |
|---|---|---|---|
| Yield (kg/ha$^{-1}$) | 1,016.6 | 776.8 | ns |
| Hand weeding (hr/ha$^{-1}$) | 32.2 | 37.0 | ns |
| Cost of hand weeding (Ush/ha$^{-1}$) | 9,656 | 11,114 | ns |
| Gross Margin (Ush/ha$^{-1}$) | 25,004 | 4,176 | ns |
| Returns to hand weeding (Ush/day) | 21,978 | 16,911 | ns |
| Hand weeding costs % of total costs/ha$^{-1}$ | 12.4 | 13.9 | ns |
| Number of observations | 21 | 22 | |

*2001 season 1 (groundnuts)*

Full data was collected from 92 farmer plots including 45 weeded by hand (traditional practice) and 47 weeded by draught animals. Planting on-farm was timely, rains were good and in general good yields resulted (Table 3). DAP weeding produced higher yields (1823kg/ha) than hoe (hand) weeding (1397kg/ha) but these differences were not significant reflecting the high variability in yields between farms. The yield differences may be partly explained by an optimum plant population associated with row planting to facilitate DAP weeding.

**Table 3. Labour use, costs and margins on-farm, season 1 2001(Groundnuts) (DAP weeding versus farmer practice)**

| | DAP Weeding | Farmer practice (hand hoe) | Statistics[4] |
|---|---|---|---|
| Yield (t/ha$^{-1}$) | 1,823 | 1,397 | ns |
| Hand Weeding (hr/ha$^{-1}$) | 31.8 | 73.2 | p<0.001 |
| Cost of hand weeding (Ush/ha$^{-1}$) | 13,717 | 30,727 | p<0.001 |
| Gross Margin (Ush/ha$^{-1}$) | 1,117,444 | 852,547 | ns |
| Return/day of hand weeding labour (Ush) | 230,835 | 31,315 | p<0.001 |
| Hand weeding as % of total costs/ha$^{-1}$ | 7.7 | 21.5 | p<0.001 |
| Number of observations | 47 | 45 | |

[4] Direct variance ratio test F probability

Most farmers weeded their crop twice. The use of ox-drawn weeders reduces the hand labour required for weeding from 73hr/ha to 32hr/ha. The difference is statistically significant demonstrating that DAP weeding provides important benefits in terms of reducing the time and drudgery associated with hand weeding a groundnut crop.

Hand weeding costs (at the prevailing market rate) are reduced by at least 50% (from Ush 25,290 to 11,580 per hectare) when DAP weeders are used. The difference is statistically significant providing strong evidence of the cost savings associated with the adoption of DAP weeding. Gross margins were higher for DAP weeded plots (Table 3) although not significantly so. Returns per day of hand weeding labour are increased with the use of ox-drawn weeders. The difference was statistically significant.

The comparative performance of the four ox-drawn weeders is shown in Table 4. Although some differences can be discerned from the data none of these were significant statistically reflecting again the high degree of variance between farms. Individually only the SAARI weeder gave significantly higher yields ($p<0.01$) than farmer practice. This can be attributed to the action of the SAARI weeder which digs deeper than other designs, burying weeds and allowing greater infiltration of rainwater. It may also have a ridging effect, which may provide positive benefits for a groundnut crop. Given the variation between sites and plots in planting dates, rainfall (which was not recorded) and other factors such as soils, cultural practices, weed densities and species etc. it is not possible to attribute, with confidence, yield effects to a particular implement. In terms of time required for weeding there were differences between individual weeders with the SG200 model performing relatively poorly but these differences were not statistically significant.

**Table 4. Comparative performance of 4 weeders (groundnuts, season 1 2001)**

| Implement | SAARI | AEATRI | SG2000 | PLOUGH |
|---|---|---|---|---|
| Yield (t/ha) | 2,162 | 1,897 | 1,457 | 1,577 |
| Hand Weeding hr/ha | 28.7 | 22.0 | 45.2 | 25.6 |
| Cost of hand weeding (Ush/ha) | 12,050 | 9,250 | 19,000 | 10,750 |
| Gross Margin (Ush/ha) | 1,348,926 | 1,173,561 | 844,691 | 953,910 |
| Return/day of hand weeding labour (Ush) | 191,000 | 233,300 | 81,600 | 162,800 |
| Hand weeding as % of total costs/ha | 8.0 | 6.1 | 11.4 | 7.4 |
| Number of observations | 15 | 11 | 6 | 15 |

## 4. Participatory assessments of technology

Following on-farm field trials male and female farmers were invited to share their experience of the use of DAP weeders with the research team. A PRA methodology (matrix scoring) was used in 9 locations with a total of 56 male and female farmers. The efficiency of each weeder was assessed against the parameters in the first column in

Table 5[5]. Participants assigned scores ranging from 1 to 10 to each weeder for each parameter with maximum of 10 points for very good and 1 for very poor. This gave an indication of the relative merits of each type of weeding implement. When measuring the damage done to the crop by weeders those machines which did most damage scored less points and vice-versa. The results from the 9 sites have been summarised in Table 5.

**Table 5. Scores and ranks for each weeder**

| | SAARI | | SG 2000 | | AEATRI | | OX-PLOUGH | |
|---|---|---|---|---|---|---|---|---|
| **Criteria** | **SCORE** | **RANK** | **SCORE** | **RANK** | **SCORE** | **RANK** | **SCORE** | **RANK** |
| Removal of grass weeds | 69 | 1 | 65 | 2 | 40 | 4 | 50 | 3 |
| Removal of broad leafed | 63 | 2 | 69 | 1 | 41 | 4 | 55 | 3 |
| Comfort | 62 | 3 | 65 | 1 | 63 | 2 | 61 | 4 |
| Damage to the plants | 56 | 1 | 42 | 3 | 22 | 4 | 46 | 2 |
| Speed of work | 69 | 1 | 65 | 2 | 42 | 4 | 53 | 3 |
| Ease of cleaning and maintenance | 62 | 3 | 63 | 2 | 36 | 4 | 79 | 1 |
| Availability of spare parts | 71 | 2 | 41 | 3 | 22 | 4 | 89 | 1 |
| Ease of adjustments | 55 | 3 | 72 | 1 | 47 | 4 | 60 | 2 |
| Ease of transport | 58 | 2 | 57 | 3 | 31 | 4 | 78 | 1 |
| Durability and strength | 73 | 2 | 69 | 3 | 34 | 4 | 78 | 1 |
| **Totals** | | **20** | | **21** | | **38** | | **21** |

The results of this assessment are summarised as follows:

- SAARI, SG2000 and the ox-plough are the best weeders while AEATRI was ranked last in all the sites.
- SAARI and SG2000 are the best at removing grasses and broad-leaved weeds
- SG2000 is the most comfortable tool to work with and the easiest to adjust
- AEATRI does the most damage to crop plants and has the slowest work rate
- SAARI and SG2000 have the fastest work rates
- The plough is the easiest to clean and maintain and the most durable implement
- Spare parts are available for the ox-plough and to a lesser extent the SAARI weeder but are scarce for the SG2000 and AEATRI weeders

Following completion of the matrix focus group discussions were held to allow farmers to express opinions about the use of draught animals for weeding. There was a general consensus that the impact had been positive:

- Labour costs and women's drudgery were reduced with the introduction of the DAP weeders.
- Most crops are planted in rows and DAP weeders are used on a range of different crops (not just those for which data was collected, i.e. sorghum and groundnuts)

[5] These parameters were developed and adopted during a participatory exercise with the farmers at one of the sites.

- There is need for planters and ox-carts since larger areas of land are being cultivated as the weeding labour constraint is overcome
- At each of the 9 sites farmers have trained on average 22 other farmers in the use of DAP technologies
- Yields have increased with the use of the DAP weeders.
- Farmers are willing to buy their own weeders at a relatively low cost.

## 5. Conclusions

All four DAP weeders performed well in terms of reducing the labour and costs required for weeding sorghum and groundnuts in the Teso farming system. It requires more than twice as much labour to weed a groundnut crop by hand compared with the use of DAP weeders (despite the fact that hand labour is still required to weed within the rows) and between 4 and 5 times as much labour to weed sorghum.. DAP weeding therefore reduces the costs of hand weeding and increases the returns to weeding labour. Gross margin may increase also (having taken into account the cost of DAP weeding and the extra costs associated with labour use for line planting). Returns per day of family labour may of greater interest to farmers than gross margins as family labour is rarely paid and has a low opportunity cost (i.e. there are limited opportunities for alternative employment, other than working on other farms).

It has been demonstrated that the SAARI, AEATRI, SG2000 and a plough (minus its mouldboard) are all technically efficient in terms of reducing the labour required for weeding sorghum and groundnuts. Farmers have expressed a preference for the SAARI weeder, the plough and SG2000 design. These preferences should be communicated to implement manufacturers to improve the availability of these machines.

Future challenges will be associated with the cost and availability of weeding equipment, which may limit the adoption by farmers. One of the most important findings of this research project therefore is that a plough can weed effectively. This is an implement widely owned or available (for hire) in Teso and thus makes DAP weeding possible for the majority of farmers without a significant additional investment in new technology. The extension and dissemination of this technology is required, along with weeders to those households who are able to afford the necessary investment.

The experience in other African countries suggests that the promotion of the mouldboard plough as a multi-pupose (although imperfect) implement may be the best solution for the Teso farming system. The plough is widely use in Zimbabwe for this purpose (Riches et al, 1997) and a similar use has been reported in Machakos, Kenya (Wellard and Mortimore, 1993). Here, despite negative official reactions, the mouldboard plough is the tool widely used by farmers for both ploughing and weeding. An imperfect technology in the hands of skilful farmers is better than a more expensive innovation, whose adoption demands a major, possibly risky, investment. The spread of this technique has been less due to the efforts of Government extension services than from farmer to farmer.

## 6. References

Riches, C.R., Twomlow, S.J. and Dhliwayo, H.H. 1997 Low-input weed management and conservation tillage in semi-arid Zimbabwe. Experimental Agriculture, 33, 173-187.

Sims, B.G. 1993 Elements of design and evaluation of animal drawn mechanical weeders. Paper presented at the 'Workshop on Animal Power for Weed Control 1-5 Nov, 1993, Tanga, Tanzania.

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