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ANNEX 2

The use of animal-drawn weeders in the Teso farming system in Uganda

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Abstract
Draught animal power (DAP) is used extensively in the Teso farming system but almost exclusively for ploughing. Use of the animal-drawn (mouldboard) plough is attractive to farmers (and their families) as it enables them to increase the area under cultivation by substituting DAP for human labour. However, an increase in cropped area generates an increase in weeding demand, which is particularly burdensome for women and, if it can not be met, will negate the potential benefit of an expansion in cropping. The use of animal-drawn weeders (cultivators) is an established method of increasing the rate of weeding and offers a potential means of meeting greater weeding demands and enhancing the farming system productivity.

The performance of different designs of weeder has been assessed in series of both on-farm and on-station field trials. Wide-ranging quantitative data (e.g. depth, width and speed of work, weeding efficiency, weed density, crop yield) and qualitative data (opinions of the operators – e.g. control during work, control during turning, clogging, ease of adjustment, strength and reliability, ease of transport) were collected for analysis. The comparative performance of the weeders for different crops, soil types and weed varieties will be presented and the implications for smallholder farmers discussed.

Introduction
Draught animal power (DAP) is used extensively in the Teso farming system but almost exclusively for ploughing. The attraction of DAP is that it can increase the area under cultivation, where there is room to expand – and this is well understood in the Teso farming system, but this leads to a greater weeding demand. When weeding is done by hand, which is almost always the case in Teso, there is therefore a tendency to leave some plots unweeded or only partially weeded. This has a negative effect on yield and results in the potential food security or income from the crop not being fully realised. In addition, hand-weeding is regarded as a task for women so any increase in cultivated area adds to their already overburdened routine of daily activities. The use of animal-drawn weeders (cultivators) is an established method of increasing the rate of weeding and offers a potential means of meeting greater weeding demands, enhancing the farming system productivity and reducing drudgery.

Different designs of weeder have been assessed both on-farm and at Technology Verification Centres (TVCs) for two crops, sorghum and groundnuts, over two seasons (2000 and 2001 respectively). Wide-ranging quantitative data and qualitative data, based on opinions of the operators, were collected for analysis.

Methods

Farmers from nine sites participated in the on-farm trials. In all, three designs of weeder were used by the farmers over both seasons plus, in 2001, a plough with the mouldboard removed was used for weeding. The implements that enabled these four weeding treatments are shown in figs 1 to 4.

Fig 1 SAARI weeder

Fig 2 AEATRI weeder

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 was imported and 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 because in Zimbabwe this is fairly widely practised by smallholders with generally successful results. The plough was not tested at the TVCs, where an extra design of weeder – the Cossul (imported from India, see fig 5) – was used in the 2000 season.

Fig 3 SG2000 weeder

Fig 4 Plough without mouldboard

Fig 5 Cossul weeder

A total of 63 farmers participated in the trials at the 9 sites and in each case the farmer's traditional practice served as the control in the experimental design. In the 2000 season the farmers grew sorghum and in the 2001 season they grew groundnuts. Plot sizes were, on average about 600 m^2. In order to make the comparisons, only the weeding treatment was changed – all the other crop production variables were controlled as carefully as possible to be the same. It is important to note that farmer practice entailed broadcasting the seed whereas, for the weeder trials, the crops had to be planted in lines.

Results

Performance assessment

Selected performance variables are presented below to illustrate how effectively the weeders operated and facilitate comparison with the traditional practice. The results for the two seasons, 2000 – sorghum crop – and 2001 – groundnuts, have been kept separate.

Season 2000

The time taken to weed the plots is shown in fig 6. This task is clearly completed much faster with the animal-drawn implements.

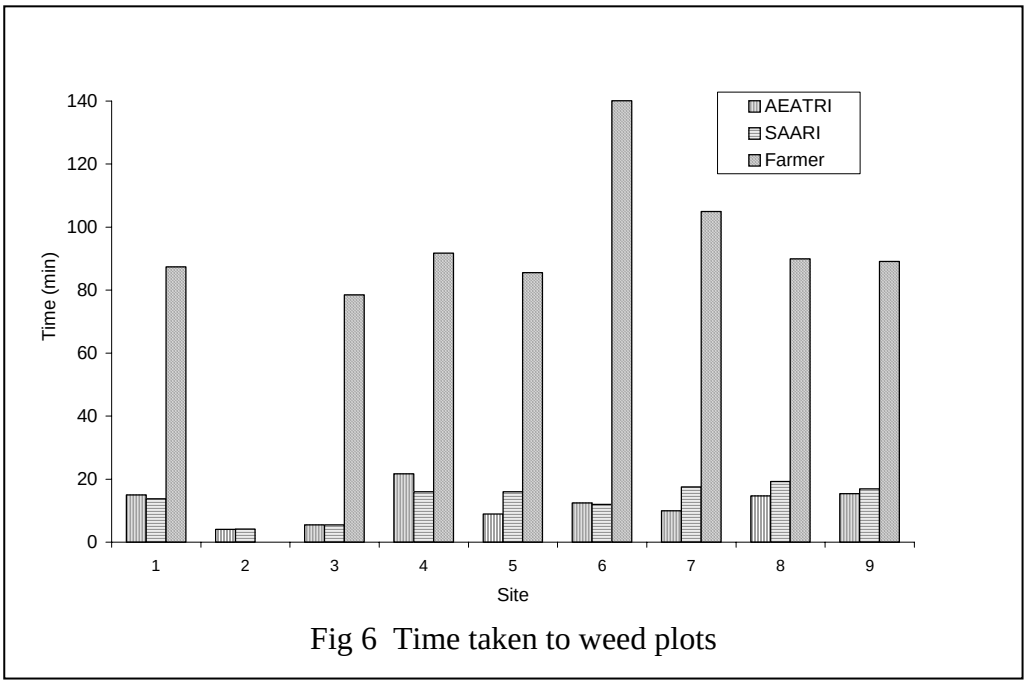

Fig 6 Time taken to weed plots

The weeding efficiency is shown in fig 7. Although the farmer practice gives the highest efficiency in all but one case (site 7), the contrast between hand weeding and animal-drawn implements is less marked than for the time taken (fig 6).

Crop yields were also higher for the animal-drawn implements. The increases for each weeder at each site are shown in fig 8. The general trend is for a 20% to 70% increase in yield for the weeders. Comparison of overall means gives increases of 30% and 25% for the SAARI and AEATRI weeders respectively.

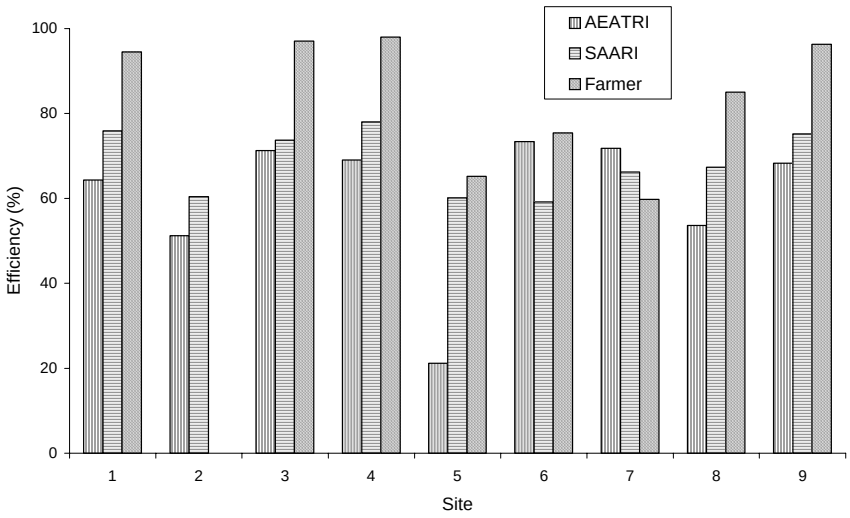

Fig 7 Weeding efficiencies

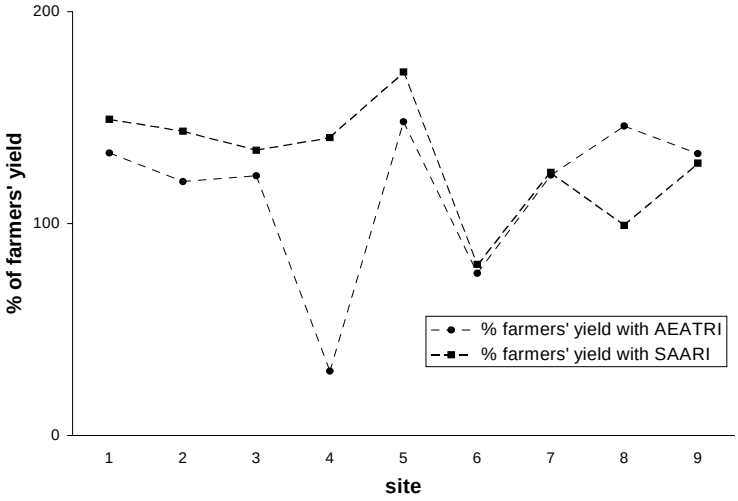

Fig 8 Sorghum yield with weeders compared to farmers' practice

As there were only minimal differences in performance data at the TVCs, no results are presented here.

Season 2001

The field capacities associated with each treatment are shown in fig 9. Data from the first and second weedings have been kept separate but the results from all sites have been combined. The slightly better performance of the SAARI weeder is attributed to its slightly greater working width and that of the plough to its simplicity of operation with no adjustments or stoppages for other reasons.

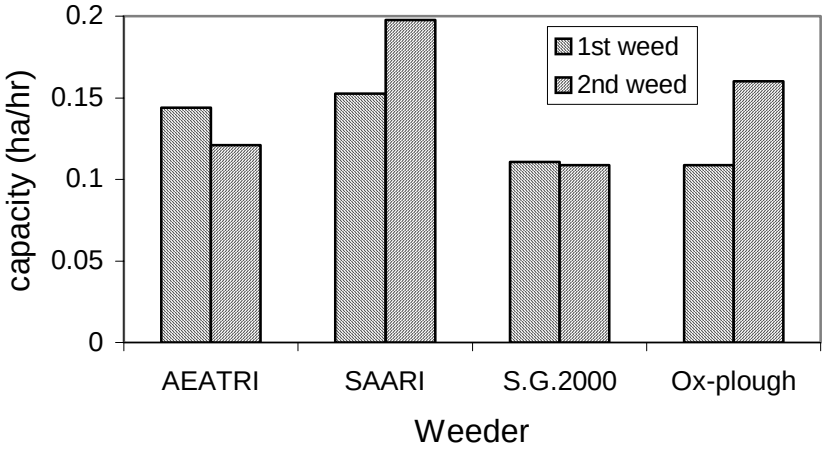

Fig 9 Field capacity associated with each treatment

Weeding efficiencies are shown in fig 10. For the first weeding, there is little

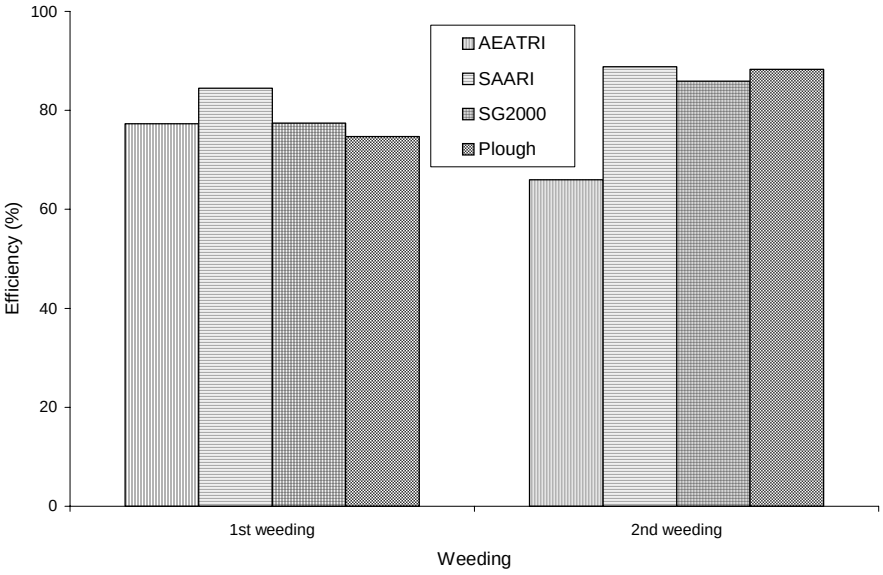

Fig 10 Weeding efficiencies

difference between the weeders, but the AEATRI performance for the second weeding is significantly poorer (p=0.001). Comparing weed densities and weed dry weights from both weedings and at harvest after using the weeder to those results for farmer practice (hand weeding) suggested that the SAARI weeder gave the best overall performance, but the differences were not significant.

Farmers' assessment

An assessment was carried out, at the TVC sites in the 2000 season, of selected operating parameters. These parameters were based on recommendations for agricultural equipment testing given by Smith *et al*, 1994. Comments were elicited from 30 operators and are summarised in Table 1. A value of 100% indicates

complete agreement with the statement in the left-hand column, and a lower value proportionately less.

Table 1 Subjective opinions of the three weeders at TVCs

Operating parameter	AEATRI	Cossul	SAARI
Generally easy to operate	100%	100%	100%
Easy to handle during work	33%	100%	100%
Easy to handle when turning	100%	100%	100%
Easy to handle during transport – Yes, with sledge	100%	100%	100%
Easy to adjust	100%	100%	67%
Easy to maintain depth	0%	20%	56%
Easy to maintain width	44%	100%	100%
Adhesion: wet soil adheres	67%	67%	67%
Clogging: clogs when trashy but easily freed	100%	67%	89%
No deformation / breakage	100%	100%	100%
No wear of working parts	100%	100%	100%

A survey of the participating farmers was conducted during the 2001 season. Their opinions of the four implements used for weeding are summarised in Table 2.

Table 2 Scores (%) and ranks for each weeder

Criteria	SAARI		SG 2000		AEATRI		Ox-plough	
	score	rank	score	rank	score	rank	score	rank
Removal of grass weeds	69	1	65	2	40	4	50	3
Removal of broad-leafed weeds	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	**638**	**20**	**608**	**21**	**378**	**38**	**649**	**21**

The scores shown are the averages from focus group meetings at each of the nine sites. For the ten criteria assessed, there is very little to choose between the SAARI, the SG2000 and the plough, with each being regarded as the best (i.e. ranked first) on at least three criteria. The AEATRI weeder, however, was not favoured for any of the listed criteria.

Table 3 presents the 2001 focus group findings according participating sites. Where available, the basic composition of the soil has been included.

Table 3 Scores for the weeders from each of the nine sites (and soil type)

Site	Soil composition (%)			SAARI Weeder	SG 2000 Weeder	AEATRI Weeder	Ox-plough
	sand	clay	silt				
Abalang	41	30	29	69	56	44	77
Orungo				76	56	40	80
Obur				72	73	43	63
Koritok	72	12	16	70	72	54	80
Pingire	49	17	34	75	66	42	77
Kaler				75	64	42	72
Kachede				77	53	40	61
Kibale				49	72	44	71
Asuret				75	92	27	67
Averages				**71**	**67**	**42**	**72**

Discussion

Line-planting is a pre-requisite to the use of animal-drawn weeders and, at the beginning of the project, persuading farmers to plant in lines rather than to broadcast was a major challenge. Farmers were understandably reluctant to allocate extra time and effort to planting during a period when labour is at a premium. However, those who persevered appreciated the benefits at weeding time, another critical period for the availability of labour, and at harvest when they were bringing in higher yields (see fig 8). As the project progressed, the farmers seemed to regard line-planting as less onerous as their experience grew and they anticipated the advantages associated with weeders. Nevertheless, affordable methods of line-planting would facilitate the adoption of DAP weeders (Obuo *et al*, 2001) and, to this end, the project team has designed and constructed (with assistance from a local manufacturer – SAIMMCO) a simple planter.

Using DAP weeders clearly reduces the time spent weeding (see fig6) but this has to be set against the extra time required for planting. Preliminary observations from the 2000 season (sorghum) have indicated that both yield and gross margins are higher for weeders than for the traditional practice (hand weeding) but the difference is not statistically significant because of the large variability associated with hand weeding. The same trends in the 2001 season (groundnuts) were more strongly evident with the pooled data for all weeders showing increases compared to traditional practice ($p=0.033$ for yield and $p=0.056$ for gross margin). Within the group of weeders, the SAARI returned a significantly higher ($p<0.05$) yield and gross margin than the other three (AEATRI, SG2000 and ox-plough). Further trials should clarify these issues.

Except for this SAARI result for the 2001 season, there were no substantial differences between weeder performances, although the subjective data showed a clear lack of enthusiasm for the AEATRI weeder. The most important implication from this is that the ox-plough without mouldboard performed adequately as a weeder. As most farmers possess ploughs, they could have access to animal-powered weeding, with the associated advantages, without having to invest in a new piece of equipment dedicated to a single task.

Conclusions

Significant differences in performance between the use of animal-drawn weeders and the traditional practice of hand weeding were found for certain relatively simple parameters (e.g. time taken to weed experimental plot). For the more meaningful system measures, such as gross margin, the variability of the data prevented significant differences being achieved. Further field trials should clarify these issues.

There was very little to choose between the performance of the individual weeders (i.e animal powered weeding treatments) but, despite the lack of statistical evidence, the performance data suggested that the SAARI design, despite its shortcomings, was best suited to the Teso farming system. Users' opinions indicated that the AEATRI weeder was the least preferred.

For several criteria, the ox-plough performed as well as the purpose-built weeders and scored well in the subjective ratings. This provides a cost-effective option for farmers who wish to investigate or pursue the advantages of DAP weeding without investing in extra equipment. Nevertheless, extra effort or resources would have to be made available for line-planting.

The main advantages associated with the use of DAP weeders in Teso that may be realised are:- higher yields, greater returns, reduced drudgery. These benefits increase the productivity of the farming system and improve community livelihood prospects, particularly for women.

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