IMPROVING PRODUCTION IN THE TESO FARMING SYSTEM THROUGH THE DEVELOPMENT OF SUSTAINABLE DRAUGHT ANIMAL TECHNOLOGIES
LIVESTOCK PRODUCTION PROGRAMME (DFID) R7401

WEED MANAGEMENT USING DRAUGHT ANIMALS IN THE TESO FARMING SYSTEM

PROCEEDINGS OF THE SECOND STAKEHOLDER WORKSHOP HELD AT ENEKU VILLAGE, SOROTI 7-8 FEBRUARY 2002

NATIONAL AGRICULTURAL RESEARCH ORGANISATION

Natural Resources Institute

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IMAGES FROM THE PROJECT:

Left: Farmers on Pingire Village have been testing weeders

Right: Workshop Participants discuss the impact of DAP Weeding

Left: Workshop Participants discuss the impact of DAP Weeding

Right: Some of the tools tested by the project

PREFACE

Weeds are a major constraint to crop production in the Teso Farming System of Eastern Uganda. Despite a long tradition of the use of draught animals (oxen) for land preparation (ploughing) these animals have rarely been used for other agricultural operations and weeding labour constraints severely limit the area that a household can sow to arable crops.

The inter-disciplinary research project 'Improving Production in the Teso Farming System Through the Development of Sustainable Draught Animal Technologies' has been designed primarily to address the issue of weed management and is working with farmers to identify suitable designs of weeders to alleviate weeding labour constraints. It is funded by the Department of International Development (DFID) and jointly managed by SAARI and NRI. The papers presented provide information on the socio-economics, engineering, and weed science aspects of the introduction of weeding and planting technology. Following three years of research the project has established that:

- The 4 weeders tested by the project all perform better than hand weeding (it is a cheaper and quicker method of weeding)
- The preferred and most effective weeder (particularly for groundnuts) is the SAARI machine (it produces the highest yields)
- Sowing in lines is now widely undertaken for most farm crops by contact farmers and those trained by them (their neighbours)
- Sowing in lines is labour intensive and techniques to speed up this task are required by farmers
- The plough (minus its mouldboard) is an effective tool for weeding, but not as good as the SAARI weeder. The plough is widely owned and used (hired or borrowed) and should speed up the widespread adoption of DAP weeding
- There is a need for further extension and training (dissemination) of DAP weeding to farming households in Teso
- Farmers themselves, facilitated by the project have trained in excess of 350 farmers during the second season 2001. 71% of these have already adopted DAP weeding technology (questionnaire survey season 2 2001). 97% of trained farmers intend to use the technology season 1 2002.
- There is potential growing demand for DAP weeders, in particular the SAARI design
- There is a need also to investigate the low cost production of simple weeding implements with farmers and manufacturers

It is hoped that these proceedings will prove to be a valuable resource for those organisations and individuals interested in the development and promotion of draught animal power in Teso and elsewhere in Uganda. Further information is available from:

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It is with sadness that we report the untimely death of Joel Wange, former project co-leader during August 2001. He will be sadly missed by colleagues on the DAP Project and by those farmers practising DAP weeding in the Teso Farming System.

CONTENTS

LIST OF ABBREVIATIONS

AEATRI	-	Agricultural Engineering and Appropriate Technology Research Institute
CPP	-	Crop Protection Programme (DFID)
CV	-	Coefficient of Variation
DAP	-	Draught Animal Power
DFID	-	Department for International Development (UK)
IARC	-	Integrated Approach to Crop Research
LPP	-	Livestock Production Programme (DFID)
NAADS	-	National Agricultural Advisory Services Programme
NARO	-	National Agricultural Research Organisation
NRI	-	Natural Resources Institute
SAARI	-	Serere Agricultural and Animal Production Research Institute
STD	-	Standard Deviation
SWOT	-	Strengths, Weaknesses, Opportunities, Threats
TVC	-	Technology Verification Centre
UK	-	United Kingdom
Ush	-	Uganda Shilling

OPENING ADDRESS

Dr. Lastus Seranjogi
Acting Director, Serere Agricultural and Animal Production Research Institute (SAARI), Soroti, Uganda

Dr Seranjogi welcomed all participants of the workshop and in particular those who had travelled long distances including our collaborators from the UK.

The aim of the research project 'Improving Production in the Teso Farming System Through the Development of Sustainable Draught Animal Technologies' is to seek solutions to the improved use of animal power within Teso. To date most emphasis has been on testing different weeder designs to tackle one of the biggest constraints (weeds) to agricultural production in Teso.

DAP technology has been restricted to ploughing more or less from its introduction and few farmers have been aware of the potential for weeding with draught animals. As a result all weeding is undertaken by hand hoes and usually by women. There is much drudgery associated with this task in Teso given the weed competition suffered by crops.

To increase production, there are two options; namely increase acreage or intensify production by increasing yield/unit area. To succeed with either of these strategies it will be essential to manage weed populations on farmers fields.

A needs assessment carried out in 1998 (funded by DFID) indicated that weeds and weeding represented one of the major constraints to increasing agricultural production in Teso and led to the design of this project (funded by the Livestock Production Programme of DFID). The project was designed to be participatory where all stakeholders are consulted about activities and outputs and the direction of the project. Most of the research has taken place on farmers fields with their co-operation and researchers are able take into account the reactions of farmers to any given technology.

However, if the technologies are confirmed to be efficient by this research further research may be required into how demand can be generated and manufacture of implements encouraged or supported.

We hope that this workshop can contribute to the wider use of draught animals within the Teso farming system. Researchers, extensionists and NGOs all have a responsibility to assist the farmer develop these technologies further. In fact the need to disseminate some of the findings of this research and the technologies tested is one of the future challenges for SAARI and others working in the field of agriculture in Teso.

The manufacture of some of the preferred implements has yet to be organised to facilitate the dissemination of these technologies. Furthermore during the needs assessment for agricultural research in the Teso Farming system undertaken in 1998 rural transport was identified as a constraint to agricultural production and marketing. Apart from a survey of existing solutions to this constraint little progress has been made in this area.

Dr Seranjogi thanked all the delegates for attending and urged all to participate fully in the workshop.

INTRODUCTION AND PROJECT OVERVIEW

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1. Background

One of the major constraints to enhancing production in the Teso Farming System is the weed challenge faced by farmers which has a negative impact on crop yields. This constraint was identified during a participatory exercise conducted in Teso during 1998 (funded by DFID). This needs assessment was undertaken to identify priority researchable constraints and weeding was identified, by farmers, as one of their main problems.

2. Activities

During a stakeholder workshop held at SAARI during 1999 it was established that there were other DAP issues in addition to weeding to which farmers required technical solutions (planting and transport). These issues were therefore included in the project design.

The approach used for this research has been participatory. Farmers have been involved in most of the activities and much of the research has taken place on their fields and farms. Women have also been actively engaged and of the contact farmers (total 63) 36 were women. The reason for this is that traditionally weeding has been women's work and therefore the project aimed to make an impact on the drudgery associated with women's labour use for weeding.

Activities undertaken include:

- Base line survey of DAP technology
- Weed characterisation survey
- PRA to identify collaborating farmers
- On-station/farm trials
- Training farmers
- Participatory assessment of weeders
- Transport survey
- Dissemination/training and extension

3. Project outputs

- The project set out to:
- Characterise labour and power use in the Teso system
- Characterise weed (flora and management)
- Analyse the efficiency of DAP weeders
- Provide specific advice for farmers on weeding technology
- Design and deliver information for stakeholders (extension material)

4. Achievements

To date the following have been achieved:

- The weed flora of the Teso Farming System has been characterised
- The amount of labour required for weeding in both hand and animal powered systems has been quantified
- Five different weeders have been tested both on-station and on-farm
- The weeding efficiency of the these weeders has been established
- Contact farmers have been trained in the use of DAP weeders and assisted to extend the technology to others
- Farmers have trained other farmers
- Farm transport constraints have been identified (questionnaire)
- Field days and demonstrations were organised
- A paper was presented at a British weed conference

5. Further work

However there is still much to be done. For example:

- There is no manufacturer of weeders in the Teso Farming System
- Labour constraints associated with planting in lines have only just begun to be addressed
- Solutions to the problem of on and off-farm transport have only just begun. Increasing yields associated with new varieties, and more efficient weeding will require a solution to this problem in the near future.

COMPARISON OF DRAUGHT ANIMAL POWER (DAP) WEEDERS FOR WEED CONTROL IN TESO

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1. Introduction

Weeders pulled by draught animals help to alleviate the drudgery of hand weeding whilst also speeding up the time to weed crops and allowing farmers to utilise larger areas of their land. In a country with a tradition of using draught animals for ploughing, DAP weeders are an appropriate technology providing they are available, affordable, durable and effective. Field trials on farms and technology verification centers (TVCs) in two seasons in 2000 showed that SAARI, AEATRI and Cossul weeders gave weed control comparable to that achieved by farmers using hand tools. There was also an indication that they produced higher yields of groundnuts and sorghum and also larger gross margins and returns to labour than where crops are managed by hand weeding.

This paper describes research to verify the performance of four DAP weeders by testing them on farms, a TVC at Kaberamaido and SAARI research station in the first season of 2002.

2. Methods

Research protocols were similar to those described at the project stakeholder workshop at Eneku Village on 19-20 April 2001. On-farm trials were done at nine sites: Abalang, Kachede, Kaler, Kibale, Koritok, Obule, Obur, Orungo and Pingire. Of the 63 participating farmers, results were obtained from 43-50 farmers at three assessment dates, i.e. at first weeding, second weeding and harvest. Kaberamaido TVC and SAARI were the locations of trials where weeders could be tested at the same site and assessments were more detailed than could be obtained from farms.

DAP weeders

Weeders that were evaluated were the SAARI, AEATRI and SG2000 models. Also included in the on-farm sites was a mouldboard plough from which the mouldboard had been removed, the advantage being that farmers did not need to purchase a purpose-designed weeder. Weeders were distributed to farmers throughout the trial areas, thereby ensuring that each model of weeder was exposed to a range of soils and weeds. This gave between nine and 16 evaluations of each weeder. The same weeders, with the exception of the plough, were evaluated at Kaberamaido TVC and SAARI.

Planting

Groundnuts were sown in rows at all sites. On plots to be weeded by DAP weeders, the crop was sown in rows at a spacing of 45 x 10/15 cm. On plots to be hand-weeded, the crop was randomly sown, as is the traditional practice.

Layout and design

Each participating farmer had two experimental plots; one plot received traditional hand weeding, the other was weeded by one of the four DAP weeders. Plots were oriented to fit the size of the field and measured about 600 m^2 on average.

At Kaberamaido TVC and SAARI research station, the SG2000, AEATRI and SAARI weeders were compared with a hand weeding treatment on plots measuring 10m x 8m at Kaberamaido and 6m x 4m at SAARI. Each weeder was used once or twice in the season but hand-weeded plots followed the traditional practice of two weedings. The seven treatments were randomly arranged in each of the three blocks.

Assessments

On farmers' plots, weed densities were assessed by counting the weeds present in ten randomly placed, 33 x 33cm (0.11 m^2) quadrats at three times: immediately before the first and second weedings and just before harvest. Aerial parts of the weeds were removed, dried and weighed to determine the biomass present. Weeds were characterized as perennial grasses, annual grasses, sedges and broadleafed species. Immediately after weeding had taken place, a single 100 x 100cm (1 m^2) quadrat was placed on the plot to record the total number of weeds remaining, i.e. with viable parts visible on the soil surface. Using weed densities pre- and post weeding, it was possible to determine the weeding efficiency of each weeder using the formula:

$$\textbf{Weeding efficiency (\%)} = [(W_0 - W_1)/W_0] \times 100$$

Where W_0 = weed density before immediately weeding
and W_1 = weed density immediately after weeding

At Kaberamaido and SAARI research station, ten randomly placed quadrats of 33 x 33cm (0.11 m^2) were used to determine densities of individual weed species and total dry weights of all weeds.

Statistical analysis

For the data collected from the farms, statistical analysis (1-way ANOVA) was carried out on the difference between the DAP weeder and farmer practice for both weed density and dry weight, also for weeding efficiency where this data was available. Data from Kaberamaido TVC and SAARI research station were analysed separately for each site.

3. Results from farms

As there were different numbers of farms for each weeder type, different SEDs applied, depending on which comparison was made. In Tables 1, 2 and 3 below, the standard deviation (s.d.) is given, along with minimum and maximum SEDs: these have been calculated for comparing the two means with the highest number of farms and those with the lowest number of farms, respectively. For example, in Table 1, the minimum SED is for comparing Plough (11 farms) and SAARI weeder (14 farms), and the maximum SED is for comparing the AEATRI and SG2000 weeders (both on nine farms). The overall between DAP variance ratio F-prob is also given.

1st weed assessment on farms
There is no evidence of any difference in the weed density and dry weight (compared to farmer practice) between weeders, neither is any difference from farm practice significantly different from zero (Table 1). No differences of statistical significance were found for weeding efficiency.

Table 1. Mean weed density, dry weight and weeding efficiency on farms at the time of the first weeding

DAP weeder	No. of farms	Weed density (no./m^2)			Weed dry weight (g/m^2)			Weeding efficiency (%)
		Farmer practice (FP)	DAP weeder	Difference (FP-DAP)	Farmer practice (FP)	DAP weeder	Difference (FP-DAP)	
AEATRI	9	204.6	185.6	19.0	37.2	49.0	-11.8	77.3
Plough	11	179.7	173.5	6.2	37.1	33.9	3.2	74.7
SAARI	14	303.2	299.9	3.3	47.5	38.7	8.8	84.5
SG2000	9	267.5	291.5	-24.0	61.4	53.1	8.4	77.4
s.d. (39 df)				80.0			27.1	15.4
Min SED				32.2			10.9	6.2
Max SED				37.7			12.8	7.3
F-prob				0.710			0.311	0.426

2nd weed assessment on farms

Again, there is no evidence of any difference in the weed density and dry weight (compared to farmer practice) between weeders, neither is any difference from farm practice significantly different from zero at the time of the second assessment (Table 2). However, the weeding efficiency of the AEATRI weeder was significantly lower than the other three weeders.

Table 2. Mean weed density, dry weight and weeding efficiency on farms at the time of the second weeding

DAP weeder	No. of farms	Weed density (no./m^2)			Weed dry weight (g/m^2)			Weeding efficiency (%)
		Farmer practice (FP)	DAP weeder	Difference (FP-DAP)	Farmer practice (FP)	DAP weeder	Difference (FP-DAP)	
AEATRI	11	125.7	142.3	-16.6	41.6	52.8	-11.2	66.0
Plough	11	164.5	178.1	-13.6	32.4	39.3	-7.1	88.3
SAARI	15	205.8	171.7	34.1	42.4	40.2	2.2	88.8
SG2000	9	190.5	196.7	-6.2	43.8	61.1	-17.3	85.9
s.d. (42 df)				81.6			50.2	14.5
Min SED				32.4			19.9	5.8
Max SED				36.7			22.6	6.5
F-prob				0.349			0.813	0.001

Weed assessment at harvest on farms

There is no evidence of any difference in effect for weed density but there is a slight indication that the SAARI weeder gave a lower weed dry weight than the farmer practice.

Table 3. Mean weed density, dry weight and weeding efficiency on farms at the time of the second weeding

DAP weeder	No. of farms	Weed density (no./m^2)			Weed dry weight (g/m^2)		
		Farmer practice (FP)	DAP weeder	Difference (FP-DAP)	Farmer practice (FP)	DAP weeder	Difference (FP-DAP)
AEATRI	12	73.0	75.4	-2.4	31.2	35.3	-4.1
Plough	13	67.7	72.2	-4.6	31.7	38.2	-6.5
SAARI	16	81.7	76.0	5.8	53.7	30.4	23.3
SG2000	9	126.0	136.3	-10.3	64.3	68.6	-4.3
s.d. (42 df)				42.2			39.4
Min SED				15.8			14.7
Max SED				18.6			17.4
F-prob				0.349			0.145

4. Results from Kaberamaido TVC and SAARI research station

Although a similar experiment was done at Kaberamaido and SAARI, for a number of variates there were large overall differences between the two sites, and also some differences in variance and in patterns of response. Data transformation ameliorates the problem of differing variances to some extent but not completely consistently for similar variates from different recording times. Therefore, data from each site was analysed separately.

1st weed assessment at Kaberamaido TVC and SAARI research station

There was a greater mean weight and density of weeds at SAARI (46.7 g/m^2 and 62.8 weeds/m^2, respectively) than at Kaberamaido (17.9 g/m^2 and 20.7 weeds/m^2, respectively). Comparing hand weeding to DAP weeders, there were no significant differences in dry weights and weed densities.

2nd weed assessment at Kaberamaido TVC and SAARI research station

As at the first assessment, there was a greater mass and density of weeds at SAARI than at Kaberamaido. There was some evidence at Kaberamaido that two weedings with the AEATRI weeder left a significantly greater mass of weeds than the hand weeding or SG2000 treatments but this was not evident at SAARI research station (Table 4). At Kaberamaido, there was a slight indication that hand weeding gave lower total weed densities than the other weeders combined ($p = 0.075$), but this was not apparent at SAARI (Table 4). Hand weeding gave the lowest density of perennial weeds at Kaberamaido ($p = 0.013$) and the SG2000 weeder gave significantly more annual weeds at SAARI than all other treatments (Table 5).

Table 4. Fresh weights (g/m^2) and total densities (no./m^2) of weeds at SAARI research station and Kaberamaido TVC at the second assessment

Site	Assessment	Farmer practice (hand weeding)	AEATRI weeder use twice	SAARI weeder used twice	SG2000 weeder used twice	SED (6 df)
Kaberamaido	Dry wt	10.3	51.3	21.0	12.7	12.78
SAARI	"	61.5	68.0	89.2	126.4	44.47
Kaberamaido	Density	8.7	17.0	15.1	17.7	4.52
SAARI	"	38.0	37.3	46.3	61.2	10.64

Table 5. Mean densities (no./m^2) of annual and perennial weeds at SAARI research station and Kaberamaido TVC at the second assessment

Site	Weed type	Farmer practice (hand weeding)	AEATRI weeder use twice	SAARI weeder used twice	SG2000 weeder used twice	SED (6 df)
Kaberamaido	Annuals	7.9	12.1	12.7	13.3	3.69
SAARI	"	9.9	13.8	14.3	29.1	4.74
Kaberamaido	Perennials	0.8	4.9	2.5	4.4	1.09
SAARI	"	28.1	23.5	32.0	32.1	8.07

Weed assessment at harvest at Kaberamaido TVC and SAARI Research Station

Overall, at Kaberamaido, hand weeding gave significantly fewer perennial weeds at harvest than the DAP weeders (p = 0.042) but there was no difference at SAARI. However, annual weeds on hand weeded plots at SAARI were significantly lower than the DAP weeder treatments combined (p = 0.046). At both sites, there is evidence of hand weeding giving lower total weed densities than the DAP weeder treatments combined (p = 0.057 at Kaberamaido, p = 0.008 at SAARI) (Table 6).

Table 6. Mean densities (no./m^2) of annual, perennial and total weeds at SAARI research station and Kaberamaido TVC at harvest time

Site	Weed type	Farmer practice (hand weeding)	AEATRI used once or twice		SAARI used once or twice		SG2000 used once or twice		SED (12 df)
			x1	x2	x1	x2	x1	x2	
Kaberamaido	Annuals	14.3	22.8	17.3	38.1	22.1	20.7	12.9	8.17
SAARI	"	6.9	16.5	17.3	20.7	11.2	8.3	17.3	4.89
Kaberamaido	Perennials	3.3	20.5	13.7	6.5	12.1	8.9	12.3	5.21
SAARI	"	6.5	9.3	6.1	7.5	10.7	7.2	5.7	3.39
Kaberamaido	Total weeds	17.6	43.3	31.1	44.6	34.2	29.6	25.2	10.60
SAARI	" "	13.5	25.8	23.5	28.2	21.9	15.5	23.1	3.97

5. Discussion

On farms, there were few statistically significant differences in total densities and dry weights of weeds between DAP weeders and hand weeding. At the research centres, there was an indication that hand weeding was better than DAP weeders. However, the overall picture from farms and research centres is that there is little or no practical difference between hand weeding and DAP weeders. The weeding efficiency of the AEATRI weeder was significantly lower for the other weeders at the time of the second weeding but this was not evident at the first weeding and must, therefore, cast some doubt as to whether there is any difference. The SAARI weeder appeared to give the highest weeding efficiency at both times but this was not statistically significant.

6. Conclusions

- DAP weeders are a practical and effective alternative to hand weeding for controlling weeds.

- Judged solely in terms of weed control, there is little or no difference between the weeders.
- Farmers could use a plough with the ploughshare removed to control weeds as well as that achieved by the AEATRI, SAARI and SG2000 weeders. This being so, it is questionable as to whether farmers need to invest in specialised weeders when they can obtain satisfactory results from simple modifying their ploughs.
- Weed control is not the only parameter by which to judge the performance of DAP weeders; labour inputs, crop yields and cost/benefits are important considerations for farmers and are dealt with by other papers in the stakeholder workshop.

Acknowledgement

The work reported here is part of a research project (R7401) funded by the UK Department for International Development and the Government of Uganda. However, the DFID can accept no responsibility for any information provided or views expressed. IACR receives grant-aided support from the Biotechnology and Biological Sciences Research Council of the UK.

WEEDER PERFORMANCE DURING 1ST AND 2ND WEEDINGS 2001

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1. Introduction

The performance of the four implements used for weeding during the on-farm trials in the second season in 2001 has been analysed in terms of the major technical performance parameters. These were width of working, depth of working, speed of working, field capacity and weeding efficiency. The draught force requirements were not recorded. The crop was groundnuts, planted at a row spacing of 45 cm.

2. Results

2.1 Working width.

The average widths of working during the first and second weedings are given in figure 1.

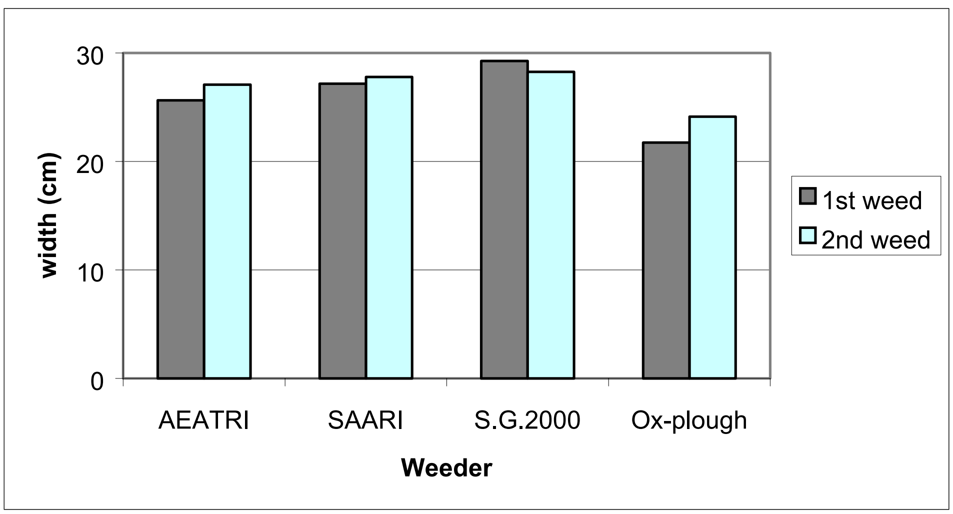

Fig 1 Average width of working

The greatest working width was achieved by the S.G. 2000 weeder, although the differences between weeders were very small and unlikely to be statistically significant. The slightly narrower result for the ox-plough is attributed to the fact that the share is fixed and there is no scope for adjustment.

The SAARI and AEATRI weeders give very similar results as they can both be adjusted for rows not more than 60cm apart, enabling effective performance. The S.G. 2000 weeder has a wider range of adjustment, making it more suitable for crops such as sunflower, cassava, maize, cotton etc.

2.2 Working depth.

The average depths of working during the first and second weedings are given in figure 2.

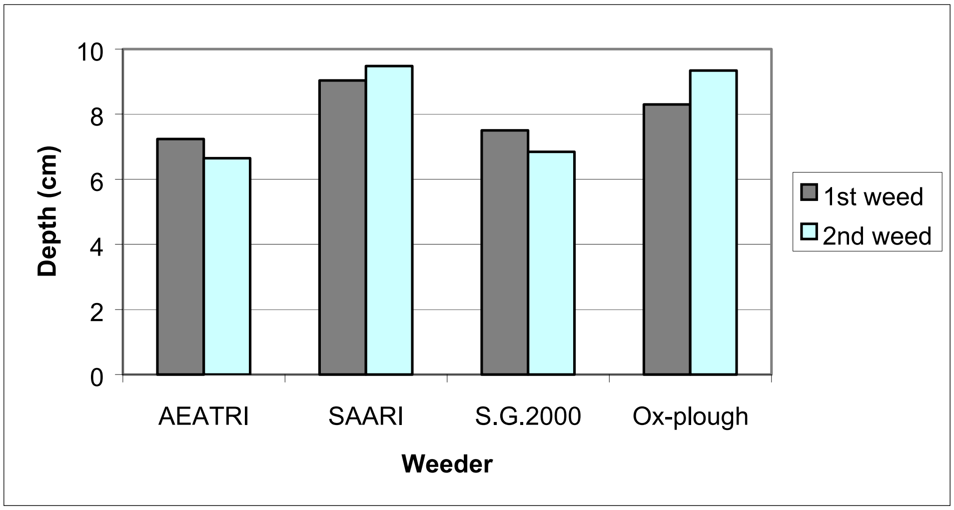

Fig 2 Average depth of working

The SAARI and ox-plough results are almost identical. This is attributed to the rigidity of the tines for SAARI weeder and the non-flexing bottom of ox-plough. In contrast, the AEATRI and S.G. 2000 weeders work slightly more shallowly. This may be because of the flexible nature of the tine supporting elements which allow the tines to yield when encountering deeper and usually less penetrable soil. The AEATRI and S.G. 2000 weeders perform adequately in light sandy soils, but the SAARI weeder and ox-plough may be better suited to the heavier, more clayey soils.

2.3 Working speed

The average speeds of working during the first and second weedings are given in figure 3.

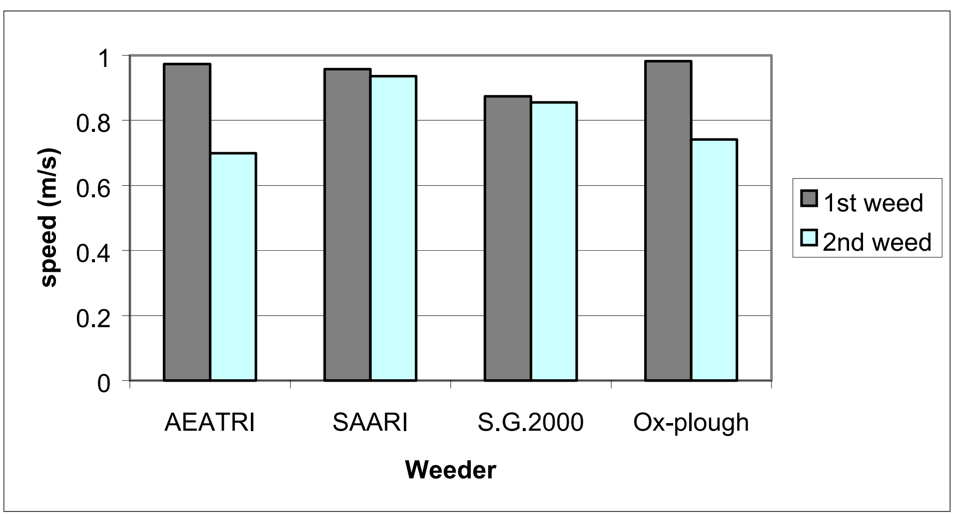

Fig 3 Average speed of working

Considering both weedings, the SAARI weeder works slightly faster than the other weeders. This may be attributable to its rigidity and stability during work. The lower working speed of the AEATRI weeder may be due to the stoppages that occurred when attending to the maintenance and adjustment needs of this weeder.

2.4 Field capacity.

The average field capacities during the first and second weedings are given in figure 4.

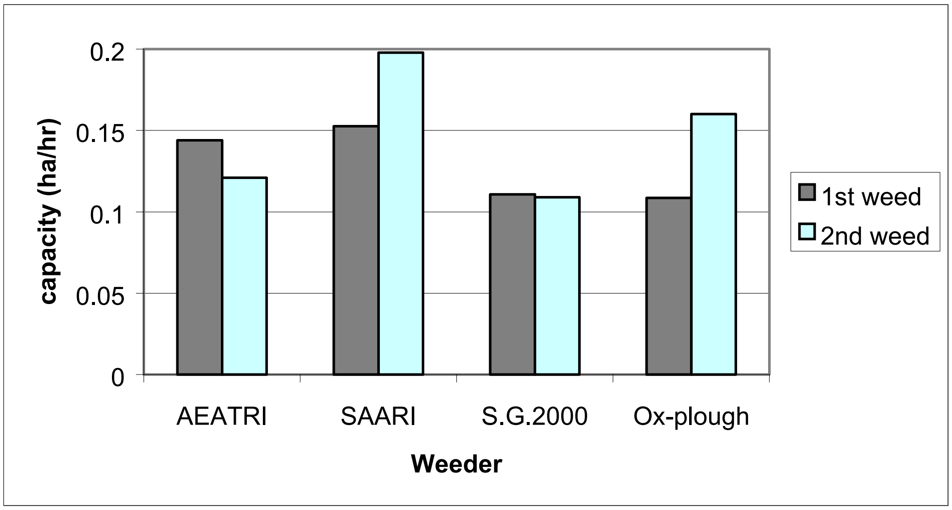

Fig 4 Average field capacities

The higher field capacity of the SAARI weeder is attributed to its greater stability and rigidity that the other weeders. The relatively low field capacity of the SG 2000 may be due to its heavy weight and the stoppages caused by problems of slackening and failing of the spring tine supports.

2.5 Weeding efficiency

The average weeding efficiencies during the first and second weedings are given in figure 5.

The weeding efficiency for all the weeders is above 75%, indicating that, despite minor differences, they all destroy weeds reasonably effectively.

The slightly higher efficiency of the SAARI weeder is attributed to its ability to destroy more weeds by the action of its rigid tines and deeper penetration.

The different modes of action of the implements had no influence on weeding efficiency in these trials. For example, the S.G. 2000 weeder is efficient because of its wide range of width adjustment; the ox-plough share attacks all the weeds in its path and also creates a small ridging effect to cover the weeds.

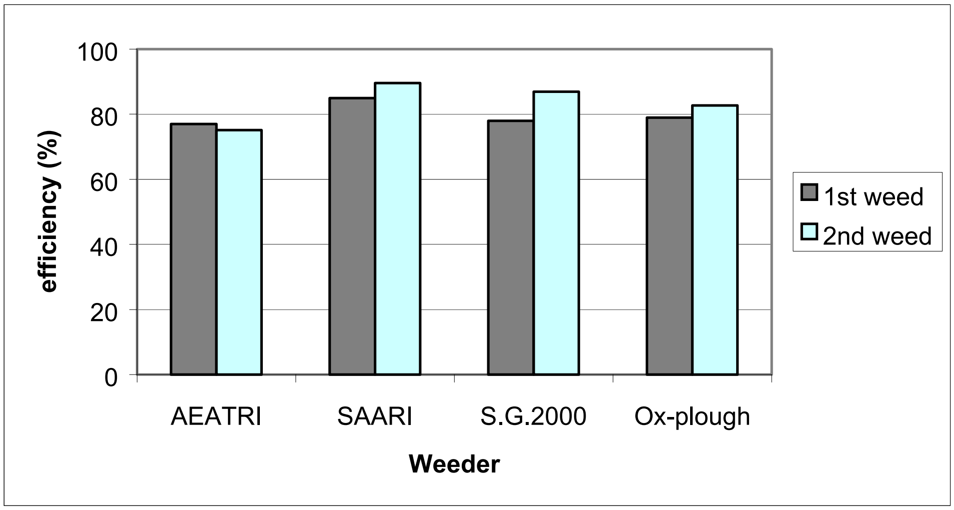

Fig 5 Average weeding efficiencies

The marginally poorer performance of the AEATRI weeder may be because of the relatively narrower design of tine. This may leave some weeds untouched.

3. Conclusions

On the basis of the technical parameters analysed above, there is very little to choose between the weed control and management performance of the four implements. The SAARI weeder was rarely outperformed by the others in any respect. The most important finding, especially because of the implications for the farmers, is that the ox-plough, with the mouldboard removed, can be used quite effectively as a weeding implement.

4. Discussions

Question:
How can the SAARI weeder work the fastest and at the same time dig deeper than other designs. How do you explain this?

Response by project team:
The relatively shallow depth which all weeders work does not affect the speed moved by the oxen. Compared with ploughing weeding is very light work. Actual working speed is often dependent upon the willingness of the team (training) and the skill of the driver.

Question:
What is the number of animals required to pull the weeder and the number of people? Is it possible to weed with 1 ox?

Response by project team:
It is usual to use 2 oxen for weeding, 4 are not required for light work. As most farmers in Teso are used to working with 2 or 4 oxen we did not think it worthwhile to investigate weeding with one ox, although this is technically feasible. In India animal draft fieldwork is often done by one person however in Africa it is more usual to see 2 or 3 people driving oxen (with the exception perhaps of Ethiopia).

Question:
Why does the SAARI ox-weeder penetrate deeper than other designs.

Response by project team:
The action of the SAARI weeder is primarily influenced by the shape and angle of the large tine at the front. This displaces soil and has a ridging effect in groundnuts. The digging action is preferred by farmers because it uproots perennial grass weeds and also because it ridges.

Question:
Were weeders tested under different soil types. In Katakwi there are a variety of soil types, black cotton soils, clays and sandy loams. How do weeders perform on these different soil types?

Response by project team:
Different sites were selected according to a range of criteria, one of which was soil type. The results presented at the workshop cover a range of different soil types, although we have not analysed data according to this criterion. Our major objective was to measure the impact on labour use. However, we are confident that the weeders tested will perform well on most soil types (particularly the SAARI, SG2000 and Plough).

Question:
Why was groundnuts chosen for the study?

Response by project team:
Groundnuts were chosen because it is a commonly grown crop amenable to DAP weeding. Likewise sorghum which was studied during the previous season.

Question:
What happens to the people who used to undertake weeding as day labourers? Presumably they have been replaced on some farms by DAP weeders.

Response by project team:
We are not certain but they will not necessarily be unemployed. Farmers still require some hand work (between the plants in the row). Areas cultivated have increased so there will be more work here. Lets not forget that weeding is and was a major constraint so much of the required work may not have been completed before the use of DAP weeders. Increased areas cultivated implies more harvest and more employment opportunities here also. Experience elsewhere with mechanisation suggests that employers families tend to take more leisure if they have the opportunity and hire labour for the most demanding tasks.

THE IMPACT OF OX-WEEDING ON LABOUR USE, LABOUR COSTS AND RETURNS IN THE TESO FARMING SYSTEM (GROUNDNUTS SEASON 1, 2001)

D. Barton[1] A. Okuni, F. Agobe and R. Kokoi[2]

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1. Introduction

The research project 'Improving Production in the Teso Farming System Through the Development of Sustainable Draught Animal Technologies' is funded by the Livestock Production Programme (LPP) of DFID. It is working in the Teso farming system in the Districts of Katakwi, Kumi, Pallisa and Soroti Districts and is managed by SAARI. The Project forms 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 fully 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 is addressing this issue by testing and evaluating with farmers, on their fields and farms, a variety of implements likely to be appropriate to their circumstances.

Project outputs are as follows:

- Socio-economic data collection and analysis of the relationship between power availability and area cultivated, yields, cropping patterns and returns to labour.
- Weed characterisation and management problems.
- Evaluation of the performance of DAP equipment for weed management. Also included are outputs on the application of DAP for seeding (planting) and transport.

2. Weeder evaluation

Weeder evaluation is taking 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.

For on-farm trials, nine sites of seven farmers each (63 farmers in total) were selected. Given that farmers had developed some experience of using animal drawn weeders during the first 2 years of the project, for the first season 2001 they were given the option of choosing which weeder they would prefer to use on their own fields. Split plot treatments were: T1 SAARI weeder, T2 AETRI weeder T3 SG2000 weeder, T4 Plough (minus mouldboard) T5 farmer practice (hand hoe weeding) in groundnuts. Only one weeder was used during the season by each farmer.

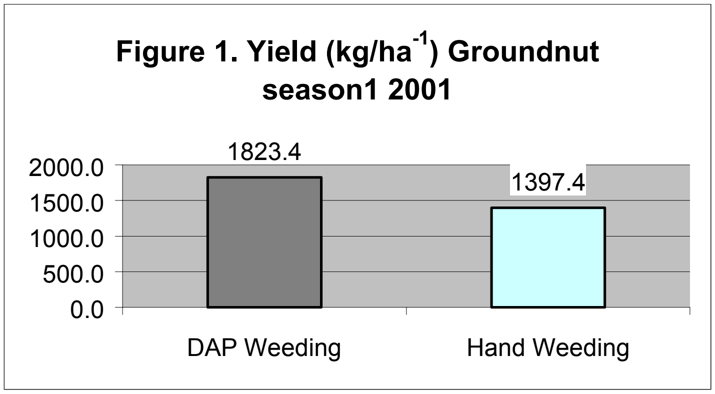
3. On-farm trial results

Full data was collected from 92 farmer plots including 45 weeded by hand (traditional practice) and 47 weeded by draught animals. In some cases farmers weeded before researchers arrived to measure inputs and these plots have been excluded from the analysis. Planting on-farm was timely, rains were good and in general good yields resulted (Table 1 and Figure 1). DAP weeding produced higher yields (1823kg/ha) than hoe weeding (1397kg/ha). The differences in yields between treatments have been subjected to a statistical analysis and the differences between hand weeding and the combined yields for the 4 DAP weeders were not significant reflecting the high variability in yields between farmers. The yield differences may be partly explained by an optimum plant population associated with row planting to facilitate DAP weeding.

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

	DAP Weeding	Farmer practice (hand hoe)	Statistics
Yield (t/ha)	1,823	1,397	ns
Hand Weeding hr/ha	31.8	73.2	P<0.001
Cost of hand weeding (Ush/ha)	13,717	30,727	P<0.001
Gross Margin (Ush/ha)	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	7.7	21.5	P<0.001
Number of observations	47	45	

Individually only the SAARI weeder gave significantly higher yields ($p<0.01$) than farmer practice ($p<0.01$). 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 etc. it is not possible to attribute, with confidence, yield effects to a particular implement. If weeding is undertaken effectively by both implement and by hand, a yield effect would not be anticipated.



Most farmers weeded their crop twice. The use of ox-drawn weeders reduces the hand labour required for weeding from 60.2 hr/ha to 27.6 hr/ha (Table 1 and Figure 2). 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. There were differences between individual weeders with the SG200 model performing relatively poorly but these differences were not statistically significant (Table 2).

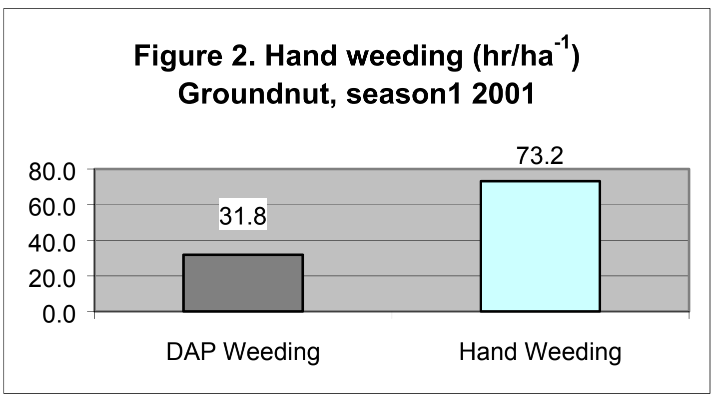


Table 2. Labour use, costs and margins on-farm, season 1, 2001(Groundnuts) (a comparison of 4 DAP weeders)

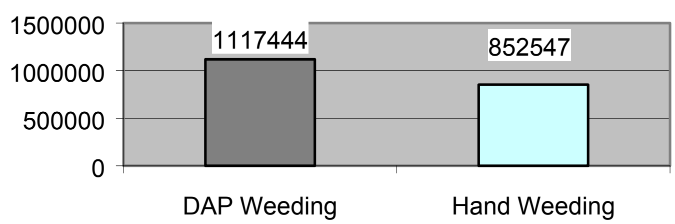
Implement	SAARI (1)	AEATRI (2)	SG2000 (3)	PLOUGH (4)
Yield (t/ha)	2,162	1,897	1,457	1,577
Hand Weeding hr/ha	28.7	22.0	45.2	25.6
Cost of hand weeding (Ush/ha)	12,050	9,250	19,000	10,750
Gross Margin (Ush/ha)	1,348,926	1,173,561	844,691	953,910
Return/day of hand weeding labour (Ush)	191,000	233,300	81,600	162,800
Hand weeding as % of total costs/ha	8.0	6.1	11.4	7.4
Number of observations	15	11	6	15

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 to manage weeds in a groundnut crop (Table 1 and Figure 3). The difference is statistically significant providing strong evidence of the cost savings associated with the adoption of DAP weeding. The hand weeding costs/ha of individual implements was very variable (Table 2) with the AEATRI weeding having the lowest costs/ha and the SG2000 the highest. The differences were not significant reflecting the high variation in wed density and therefore labour use between farms.

Figure 3. Hand weeding cost (USh/ha^{-1}) Groundnut season1 2001

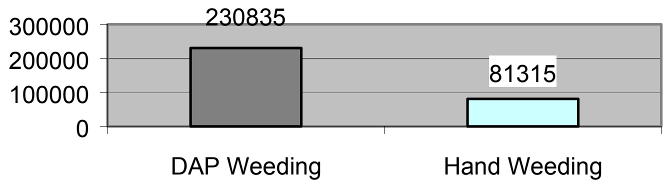
Gross margins were higher for DAP weeded plots (Table 1 and Figure 4) although not significantly so. The SAARI weeder produced the highest gross margin when comparing the individual weeding implements against farmer practice ($p<0.05$) (Table 2). Margins are very dependent upon yield, which were also higher for the SAARI implement.

Figure 4. Gross Margins (Ush/ha^{-1}) Groundnut season 1 2001



Returns per day of hand weeding labour are increased with the use of ox-drawn weeders. The difference was statistically significant ($p<0.001$)(Table 1 Figure 5).

Figure 5. Returns/day to hand weeding labour (Ush/ha^{-1}) Groundnut season1 2001



Returns per day of handweeding labour are also increased with the adoption of DAP weeding. The difference was statistically significant (Figure 6, Table 1)

Figure 6. Returns/day to hand weeding labour (Ush/ha^{-1}) Groundnut season1 2001

5. Conclusions

All four DAP weeders performed well in terms of reducing the labour and costs required for weeding a groundnut crop 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 oxen despite the fact that hand labour is still required to weed within the rows. This has the effect of reducing the costs of hand weeding by a similar amount and of increasing the returns to weeding labour. 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, AETRI, SG2000 and a plough (minus its mouldboard) are all technically efficient in terms of reducing the labour required for weeding groundnuts. There may be challenges however, associated with the cost and availability of weeding implements, which may limit their adoption by farmers. One of the most important findings of this research project therefore is that these experiments have demonstrated 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. Future challenges therefore will include the extension and dissemination of this technology, along with weeders to those households who are able to afford the necessary investment.

PARTICIPATORY ASSESSMENT OF WEEDER TECHNOLOGIES IN THE TESO FARMING SYSTEM

Lucy Aliguma
Nkoola, Institutional Development Associates, Kampala

Highlights of findings:
Labour costs and drudgery on women have reduced with introduction of the DAP weeders.
Most crops are planted in rows.
There is need for planters and ox-carts since larger areas of land are being cultivated.
At least each site has trained on average 22 other farmers on 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.
SAARI and ox-plough are the best weeders while AEATRI is ranked last in all the sites.
SAARI and SG 2000 are the best at removing grass weeds and broad leafed.
SG 2000 is the most comfortable to work with.
AEATRI does most damage to the plants and is the slowest to work with.
Spare parts are available mostly for the ox-plough and SAARI but scarce for the SG 2000 and AEATRI weeders

1. Introduction

A shortage of draught animal power has been a major constraint to agricultural production in Teso for a number of years following civil disruption and insurgency of the 1980s and 1990s during which most households lost their cattle. However, efforts has been made over the past 6-7 years to rectify this problem and around half of the farmers in Teso now have access to their own draught animals. A baseline survey conducted in 1999 in the Teso farming system revealed that almost half of the land available for cultivation (owned land) in the Teso farming system is fallow indicating that there is scope for area expansion. Labour shortages (or cash to hire labour) are still important constraints to planting, weeding and harvesting and only one household (out of 691) reported the use of herbicides and only 4 households used oxen for weeding.

The DAP project began in 1999 with the objective of testing the efficiency of the draught animal equipment for weed management, planting and sowing and on-farm transport. Most research has investigated ways of improving weed management. Research activities have taken place in four districts of Soroti, Katakwi, Kumi and Pallisa among which is on-farm and on-station testing of weeding implements which include the SAARI, SG 2000, AEATRI and the Ox-plough.

Nkoola Institutional Development Associates (NIDA), was contracted to undertake a participatory assessment of DAP weeder technologies in the Teso farming system.

2. Objectives of the participatory assessment

The objectives of the assessment were to:

- Determine the farmers' preferences for weeding technologies.
- Carry out a participatory activity using matrix scoring methods.
- Discuss and record issues arising following the completion of matrices with groups of male and female farmers.

- Document the results in a report for project co-leaders.

3. Methodology

Participatory assessment of weeder technologies was carried out in the four districts of Soroti, Katakwi, Kumi and Pallisa at nine sites where weeders had been tested by farmers on their fields (Table 1).

Table 1. Location of sites visited

Site / Parish	Sub-county	District
1-Abalang	Alwa	Kaberamaido
2-Orungo	Orungo	Katakwi
3-Obur	Asamuk	Katakwi
4-Koritok	Usuk	Katakwi
5-Pingire	Pingire	Soroti
6-Kaler	Mukura	Kumi
7-Kachede	Bukedea	Kumi
8-Kibale	Kibale	Pallisa
9-Asuret	Asuret	Soroti

From each site, 7 contact farmers with knowledge of DAP technologies had been earlier selected making a total of 63 farmers. Focus group discussions were conducted with groups of the participating farmers including their spouses at each site. A matrix was drawn on a flip chart and efficiency of each weeder was assessed against the parameters in each column, (see Appendix 1 for completed matrices)[1]. Using unshelled groundnuts, 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. For the extent of damage done to the plants, the weeder that did most damage to the plants scored less points and vice-versa. Each focus group consisted of both male and female participants because it was not possible to separate them since they often performed the farm activities jointly. Following completion of the matrix, scores for the different criteria for each weeder were summed up and the weeders were ranked. To ensure that any inconsistencies were resolved and to make sure that there is consensus among participants about the results, discussions about the relative merits of each tool were held following the completion of the matrix. Farmers were also given the opportunity to pose questions which were answered by DAP project staff.

4. Results and discussion

Results were analysed in two ways, firstly weeders were assessed for each parameter, and secondly total scores for each weeder from all the sites were compared.

4.1 Assessment of the weeders against each parameter

Weeders were assessed to find out which weeder was best basing on each parameter. Using the performance of each weeder against each criterion from Appendix 2, scores ranging from 1 to 4 were assigned, with 1 given to the best performer and 4 to the worst performer for that criterion. Scores for each weeder across all performance criteria were summed up and the one with the lowest sum was considered the best weeder, (Table 2.)

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

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	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

From the above table, the SAARI weeder appears to be the best because it has the least total score and the AEATRI is the worst. The results display the effectiveness of each weeder in controlling weeds, although differences in scores that exist between the different weeders for different criterion are not reflected.

The SAARI and the SG 2000 weeders are the best at removing both grass and the broadleaved weeds although the SAARI is better at grass weeds and SG 2000 is better at broadleaves. AEATRI in both cases is the worst, (Figs1 & 2). The good performance of the SAARI and the SG 2000 was attributed to their stability during field operations and their ability to cut deeper into the soil while the AEATRI has weak tines that do not penetrate very well especially when the soil is hard.

The most comfortable weeder to work with was reported to be the SG 2000 while SAARI, AEATRI and the Ox-plough are fairly desirable also to work with, (Fig.3). It was reported that the SG 2000 weeder has big wheels which contribute to its stability and that it is also easy to adjust.

The AEATRI does most damage to plants and it is the slowest to complete work. SAARI does the least damage to the plants, (Figs 4 & 5). AEATRI weeder was reported to be difficult to adjust and manoeuvre and heavy to turn, (Fig. 6), therefore time-consuming during work. The AEATRI also has weak tines which loosen and sometimes break during operations. SAARI does the least damage to plants because it is easy to handle and adjust especially during turning and it is stable.

Since the ox-plough is light, it was reported to be the easiest to transport from one field to another and from home to the field and it scored a lot of points. This may be one of the reasons (contributing to its high total). Other weeders especially the AEATRI and to a lesser extent the SG 2000 were reported to be difficult to transport since they are heavy, (Fig. 7).

The SAARI and the ox-plough are the most durable, easy to clean and maintain while the AEATRI is the weakest and hardest to clean and maintain, (Figs 8 & 9).   Spare parts are reported to be available for the ox-plough all the time and sometimes for the SAARI but scarce for the SG 2000 and AEATRI weeders, (Fig.10). Availability of spare parts for the ox-plough may be due to its long existence with the farmers, therefore black-smiths in these areas are conversant with their manufacture.

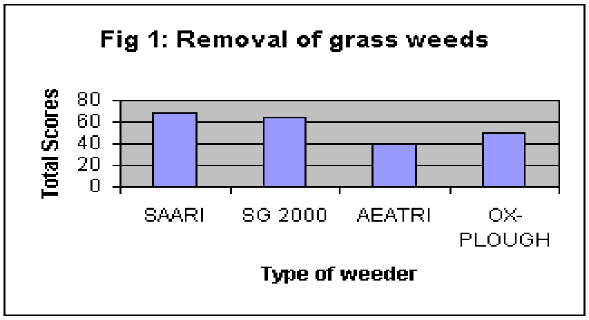


Fig 1: Removal of grass weeds

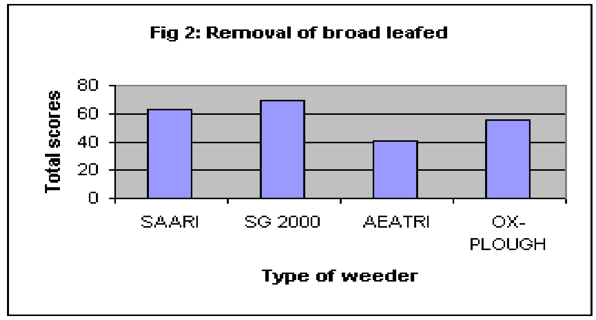
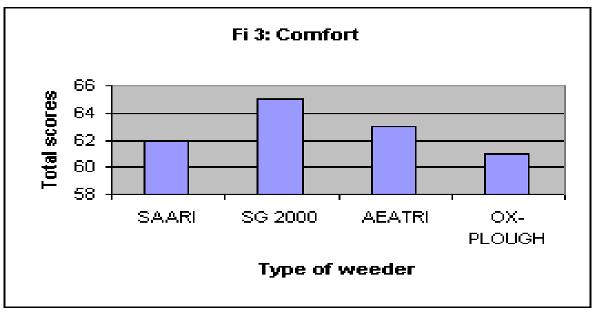


Fig 2: Removal of broad leafed



Fi 3: Comfort

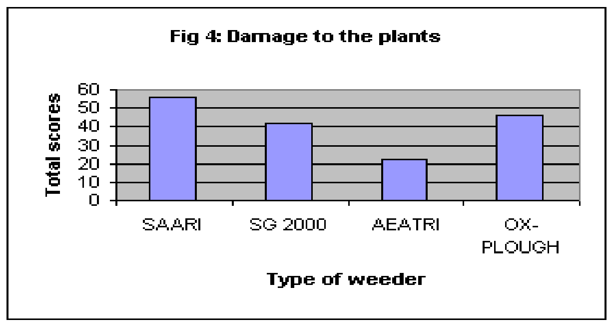


Fig 4: Damage to the plants

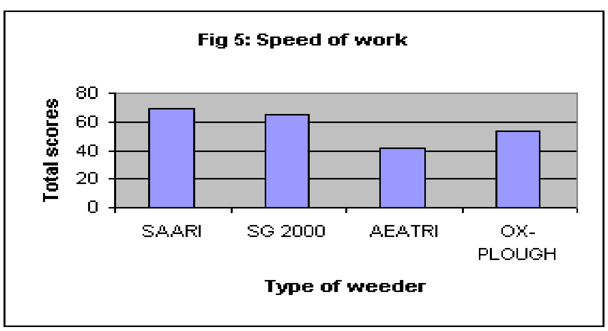


Fig 5: Speed of work

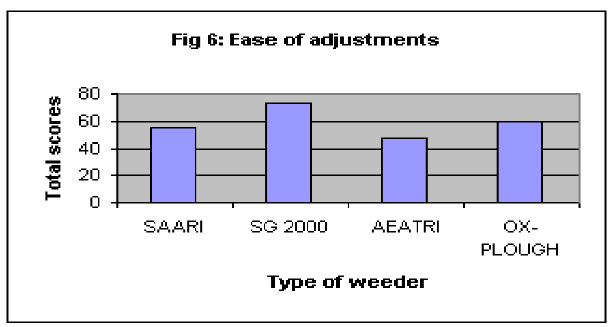


Fig 6: Ease of adjustments

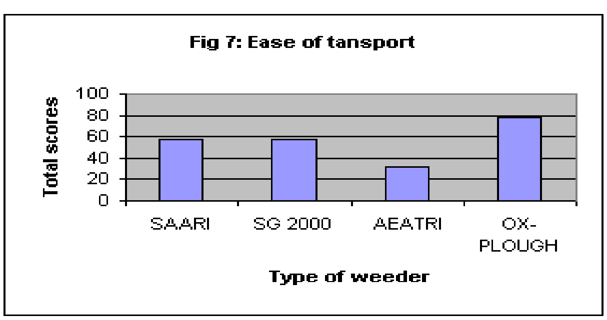


Fig 7: Ease of tansport

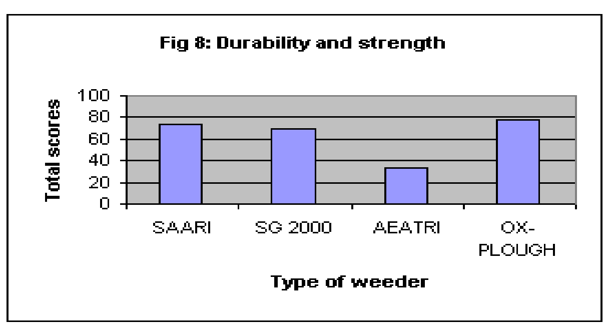
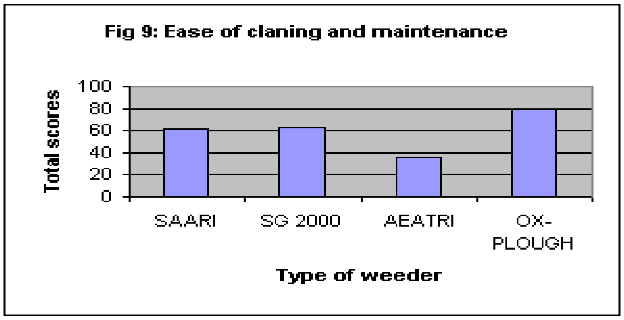
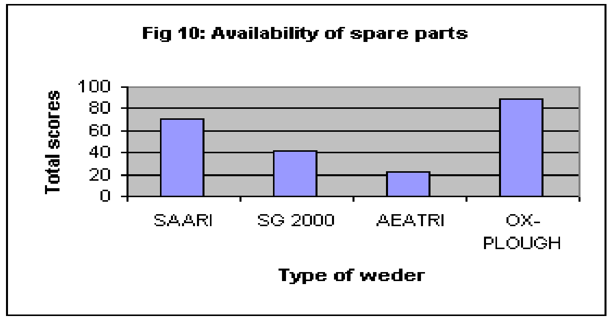


Fig 8: Durability and strength





4.2 Total scores for each weeder at each site

The ox-plough scored the highest average of 72% followed by SAARI with 70.88%, then SG 2000 with 67.11% and the least was the AEATRI with 41.77%, (Table 3). Completed matrices from the nine sites are presented in Appendix 1.

Table 3. Summary of the total scores for the weeders from the nine sites

SITE	SAARI Weeder	SG 2000 Weeder	AEATRI Weeder	Ox-plough
Abalang	69	56	44	77
Orungo	76	56	40	80
Obur	72	73	43	63
Koritok	70	72	54	80
Pingire	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	70.88	67.11	41.77	72.00

- Ox-plough scored highest in four sites of Abalang, Orungo, Koritok and Pingire, while in Kaler, Kachede, Kibale it was the second best and scored third in Asuret and Obur.

- SAARI was ranked the best weeder in Kaler and Kachede and second best in Abalang, Orungo, Obur and Pingire after the ox-plough and in Asuret after the SG 2000. SAARI was ranked third in Korotok and in Kibale.

- SG 2000 scored highest in Obur, Kibale and Asuret and it was third best at 5 sites of Abalang,Orungo, Pingire Kaler and Kachede.

- The AEATRI weeder scored the least points in all sites with an average of 40%. The highest score of 54 points was in Koritok and the least points in Asuret of 27 points.

Table 3 indicates that SAARI is the best weeder followed by SG 2000 and the ox-plough while in table 3.2, the ox-plough appears to be the best. The ox-plough appears to be the best among all the weeders because it scored a lot of points for particular criteria such as ease of transport, durability and strength, ease of cleaning and maintenance and for the spare parts which are always available. In conclusion, it is worth comparing these implements with regards to effectiveness of controlling weeds, whereby the SAARI weeder performs best.

4.3 Focus group discussions

(a) Since the beginning of the project, in your view, has the drudgery on

women and labour costs reduced?

In all the nine sites, it was reported that labour costs for weeding had reduced and the whole exercise had become lighter. Drudgery on women had also reduced drastically because weeding had become a male dominated activity since they operated the weeders most of the time. The problem of planting in rows and transportation of the produce was emphasized since they expected to open up larger pieces of land because of the weeding activity. At this point, participants pointed out the need for planters and ox-carts.

(b) Have you planted some crops in rows this season?

All the participants confirmed having planted most of the crops in rows and there was little variation among the crops planted in the four districts, (Table 4).

Table 4. Crops planted in rows in the four districts

District	Crops planted in rows
Katakwi & Kaberamaido	Sorghum, groundnuts, soybean, maize, cassava, beans
Soroti	Sorghum, millet, groundnuts, maize, beans, cowpeas
Pallisa	Cotton, groundnuts and maize
Kumi	Groundnuts, cowpeas, maize, cassava, millet

(c) Have you trained other farmers on DAP technologies?

Training was carried out by all the farmers and it was mainly on row planting and weeding using the different weeders and a few trained the oxen. This was conducted mainly during field operations at the demonstration sites and at the contact farmer's fields where other farmers came to give assistance in the various field operations. Although all the contact farmers reported having trained a good number of farmers, those who had adopted were few, (Table 5.) and the low adoption was attributed to lack of oxen and planting in rows, which is reported to be expensive. These results verify the findings during the baseline survey in which 47% of the households were reported to be without their own animals and probably depend upon hiring to undertake their land preparation activities.

Table 5. Estimated number of farmers who have adopted DAP technologies at each site

SITE	Number of farmers who have adopted*
Abalang	26
Orungo	26
Obur	24
Koritok	23
Pingire	12
Kaler	26
Kachede	22
Kibale	20
Asuret	16

**Total number of adopters was obtained by asking each contact farmer to give the number of farmers who had adopted the DAP technologies, the figures may not be very accurate.*

(d) What observations have you made on yields when you compare these plots vs farmers' Practice?

Apart from Kaler site in Kumi district where participants reported that farmer fields yielded higher than plots weeded by machines, in all the other sites, it was reported that plots weeded by machines yielded higher than farmer plots. Reasons for the high yields were that weeding with machines is timely and weeders have some kind of water harvesting effect (ridging). The low yields in Kaler were attributed to failure of some seeds to germinate when planted in rows[2].

(e) Is planting in rows a problem to you or not?

Planting in rows was reported to be a problem especially after increasing the areas under cultivation because it is labour intensive and expensive (since they need to hire people).

(f) Suppose the different weeders were brought to the open market, would you buy them willingly or you would consider the cost?

All farmers expressed the willingness to purchase their own machines, although there are constrained by lack of funds. Majority could afford at least between Shs 50,000/= and 70,000/= only for each weeder but to be paid in instalments.

(g) Is it easy for a group of farmers to contribute some money for at least buying one weeder?

All the farmers are willing to purchase the weeders in groups and it is easy to contribute towards one weeder at ago. Farmers also are willing to share the weeders with those who cannot afford to buy.

(h) Do you share ox-ploughs and are there black smiths in the area who can avail spare parts?

Ox-ploughs are shared and all sites reported the presence of black smiths in their areas who would avail the spare parts for most of the weeders apart from those for SG 2000 and in some cases for the AEATRI weeder.

4.4 Attributes of tested weeders

Participants at each site were asked to give both the advantages and disadvantages of each weeder and below are their contributions

[2] This probably is due to other factors like poor quality seeds which are of low germination rate.

Table 6. Attributes of tested weeders

Type of weeder	Positive attributes	Negative attributes
SAARI	Light Multipurpose (digging, ploughing &weeding) Easy to adjust and handle Clears most weeds Ridges both sides Stable Covers wider area Buries weeds Does not damage crops Strong and durable due to the material used for making it Very easy to get spare parts in market	Transporting is a problem Tines come up when they meet hard parts Cannot weed mature weeds properly Bolts loosen Limited to narrow rows Most bolts wear out very fast Wheel arms are weak Wheel does not rotate freely Slightly difficult to adjust especially the width adjustment
SG 2000	Weeds very well Easy adjustment Stable Strong (Blades and tines are strong) Covers wider area Big wheels (doesn't get stuck) Very comfortable when handling during weeding	Not easy to transport especially if gardens are far Handles are high (Not fit for short people) Heavy Difficult to get spare parts and spanners
AEATRI	Good for weeding cereals especially millet Light weight Easy to roll Weeds wider rows	Heavy in terms of turning Tines are weak and sometimes loosen/break Cannot penetrate deeper Does not clear and bury weeds properly Difficult to adjust Damages more plants Difficult to manoeuvre Transportation is a problem Spare parts are scarce (Not available especially the bushes which are made of cement)
Ox-plough	Light Multipurpose (weeding & harvesting) Easy to manoeuvre and clean Easy to adjust Does not need training on its use Spare parts readily available Very strong and durable	Small size so has to go twice Ridges on one side so it is time consuming Does not cover wider spacing Unstable Pours soil on one side Leaves some weeds untouched

Appendix 1: Completed matrices from the nine sites

Table 1 : ***Completed Matrix for Abalang***

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	8	6	3	7
Removal of broad leafed	5	7	3	9
Comfort	5	4	9	7
Damage to the plants	7	4	2	4
Speed of work	8	4	3	6
Ease of adjustments	5	8	9	7
Ease of transport	7	5	3	9
Durability and strength	9	8	5	9
Ease of cleaning and maintenance	8	8	6	9
Availability of spare parts	7	2	1	10
Total	69	56	44	77

***Table 2** :* Completed Matrix for Orungo

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	8	5	4	6
Removal of broad leafed	6	4	3	8
Comfort	9	7	7	8
Damage to the plants	8	3	2	9
Speed of work	9	8	7	6
Ease of adjustments	6	9	7	6
Ease of transport	8	5	2	9
Durability and strength	8	6	4	9
Ease of cleaning and maintenance	6	7	3	9
Availability of spare parts	8	2	1	10
Total	76	56	40	80

***Table 3* :** Completed Matrix for Obur

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	8	7	5	7
Removal of broad leafed	6	8	5	9
Comfort	7	7	7	8
Damage to the plants	6	7	5	8
Speed of work	9	9	7	6
Ease of adjustments	7	8	4	9
Ease of transport	5	6	7	8
Durability and strength	7	8	4	7
Ease of cleaning and maintenance	8	8	6	9
Availability of spare parts	7	4	4	9
Total	70	72	54	80

Table 4 : Completed Matrix for Koritok

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	6	8	5	4
Removal of broad leafed	9	7	7	5
Comfort	8	10	5	5
Damage to the plants	9	6	4	2
Speed of work	5	8	3	7
Ease of adjustments	8	10	4	6
Ease of transport	5	7	3	9
Durability and strength	8	6	5	9
Ease of cleaning and maintenance	6	5	3	8
Availability of spare parts	8	6	4	10
Total	72	73	43	63

Table 5 : Completed Matrix for Pingire

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	10	8	5	7
Removal of broad leafed	9	10	4	8
Comfort	8	6	10	5
Damage to the plants	5	6	1	8
Speed of work	8	6	4	7
Ease of adjustments	6	8	7	4
Ease of transport	8	6	4	9
Durability and strength	8	7	2	10
Ease of cleaning and maintenance	5	7	3	9
Availability of spare parts	8	2	2	10
Total	77	66	42	77

Table 6 : Completed Matrix for Kaler

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	8	7	4	6
Removal of broad leafed	7	8	3	5
Comfort	9	8	5	7
Damage to the plants	3	2	1	6
Speed of work	9	7	6	4
Ease of adjustments	8	7	5	9
Ease of transport	8	3	3	9
Durability and strength	8	9	7	8
Ease of cleaning and maintenance	7	6	4	8
Availability of spare parts	8	7	4	10
Total	75	64	42	72

Table 7 ***: Completed Matrix for Kachede***

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	8	6	5	3
Removal of broad leafed	9	5	5	1
Comfort	8	4	6	8
Damage to the plants	7	4	3	1
Speed of work	8	5	7	3
Ease of adjustments	7	6	4	8
Ease of transport	6	8	4	9
Durability and strength	8	7	1	9
Ease of cleaning and maintenance	7	5	3	10
Availability of spare parts	9	3	2	9
Total	77	53	40	61

Table 8 : Completed Matrix for Kibale

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	5	8	7	6
Removal of broad leafed	4	10	8	5
Comfort	4	9	6	7
Damage to the plants	4	6	2	7
Speed of work	5	8	4	6
Ease of adjustments	4	5	2	7
Ease of transport	5	7	3	8
Durability and strength	7	8	5	7
Ease of cleaning and maintenance	5	7	4	8
Availability of spare parts	6	7	3	10
Total	49	72	44	71

Table 9 : ***Completed Matrix for Asuret***

Criteria	**SAARI Weeder**	**SG 2000 Weeder**	**AEATRI Weeder**	**Ox-plough**
Removal of grass weeds	8	10	2	4
Removal of broad leafed	8	10	3	5
Comfort	4	10	8	6
Damage to the plants	7	4	2	1
Speed of work	8	10	1	8
Ease of adjustments	4	10	3	5
Ease of transport	6	10	2	8
Durability and strength	10	10	1	10
Ease of cleaning and maintenance	10	10	4	10
Availability of spare parts	10	8	1	10
Total	75	92	27	67

Discussion

Question:
Was gender not considered here. Why were men and women not asked to participate separately?

Response by project team
Males & Females do their farming together we felt that when easing the woman's problem of weeding we were helping the man too. There was no reason of segregation. However it is accepted that it may have been better to have separate PRA exercises for men and women.

IMPACT ASSESSMENT

N. Nangoti

Serere Agricultural and Animal Production Research Institute (SAARI), Soroti, Uganda

1. Introduction

A brief questionnaire (Appendix 1) was designed to assist the DAP project assess to what extent weeding technologies and associated practices (line planting) had been adopted by non- contact farmers in those areas where the project has been working (9 sites in 4 Districts).

2. Results

The following is a summary of the findings of the survey:

- A total of 105 farmers interviewed who had received training in DAP weeding from their neighbouring farmers; 88 were male and 17 female. Their average area cultivated season 1 (2001), was 4.2 acres (±2.1) and in season 2 (2001), 2.1 acres (±2.2)
- 75 out of 105 (71%) had used DAP weeders (season 2 2001)
- Average area weeded with draught animals season 2 (2001) 1.7 acres (81% of total area planted)

Crops weeded using draught animals include:
- ❖ Cowpeas
- ❖ Greengrams
- ❖ Groundnuts
- ❖ Beans
- ❖ Sorghum
- ❖ Maize
- ❖ Cassava
- ❖ Soya

- (97%) farmers intended to use DAP weeders during season 1 2002
- Average area to be weeded (planned) with draught animals season 1 (2002) 2.8 acres (66.6% of total area planted during 2001)
- Crops to be weeded (planned)
- ❖ Beans
- ❖ Soya
- ❖ Sunflower
- ❖ Groundnuts
- ❖ Cassava
- ❖ Maize
- ❖ Cowpeas
- ❖ Sorghum
- ❖ Cotton

- Major benefits of using DAP weeders (described by farmers) include:
- ❖ Faster than hand weeding

- ❖ Cheaper than hand weeding
- ❖ Harvesting is easier (crops sown in lines)
- ❖ Yields are higher
- ❖ Weeding is easier
- ❖ Uses less seed than broadcasting
- ❖ Crops grow faster
- ❖ Saves time and money
- ❖ Reduces drudgery
- ❖ Larger areas can be cultivated
- ❖ Good water infiltration
- ❖ Reduces labour costs
- ❖ Ridges groundnuts (higher yields)
- ❖ Easy to spray (between lines)

- Problems associated with the use of DAP weeders include:

- ❖ Too few weeders (to share)
- ❖ Shortage of weeders
- ❖ No credit to buy equipment
- ❖ Transport shortages (harvest)

3. Discussion

Question:
Development projects normally separate results of a project impact on male and female differently why are the results not disaggregated in this way.

Response from project team:
There were a limited number of female respondents. The objective was simply to get a rapid overview of adoption by trained farmers. Men and women's views have been presented collectively as they often work in this way. Analysis is not complete and there may be an opportunity to address this issue later.

Appendix 1. IMPACT QUESTIONNAIRE

Date-------------------- ENUMERATORS NAME.------------------------------------

DAP PROJECT.
IMPACT ASSESSMENT SURVEY QUESTIONNAIRE:

District--

County--

Sub-county---------------------------------------

Parish---

Village--

1. Name of respondent ---------------------------------

Age ---

Gender ---

Education (Highest level attained)--------------------

2. Land under cultivation by household members.

	1st season	**2nd season**
Major crops grown	Area (acres)	Area (acres)

3. Have you received training in DAP weeding? Y/N

3.1 Who provided this training (ie DAP project contact farmer/neighbour/other [specify])

3.2 If yes did this training include (please tick):

	Demonstration only	**Practical (hands on) experience**
Row planting		
Yoke making		
Ox-training		
Inter-row weeding with oxen		

4. How much of the training you received has been put into practice (ie. in 2nd rains 2001)?

	Y/N	**Crop**	**Area (acres)**
Row planting			
Ox-training			
Inter-row weeding with oxen			
Yoke making			

5. Which of the following do you intend to practice next season (1st rains 2002)?

	Y/N	**Crop**	**Area (acres)**
Row planting			
Ox-training			
Inter-row weeding with oxen			
Yoke making			

6. Please list the reasons (in order of importance) why you prefer ox-drawn weeding to farmer practice (broadcasting and hand weeding)?

1…………………………………………………………………..

2…………………………………………………………………..

3…………………………………………………………………..

4…………………………………………………………………..

7. Comments

Thank you for your response.

GROUP REPORT 1: MANUFACTURE & REPAIR OF IMPLEMENTS FUTURE OPTIONS

Odeke J.P.

Farmer

The following are the conclusions of group 1:

1. Local blacksmiths should be trained to improve accessibility of weeding equipment
2. Involve private sector in manufacture of implements and importation
3. Develop linkages between research-manufactures-farmers
4. Create awareness amongst farmers of availability of weeders especially farmer groups
5. Implements be sold to community at subsidised prices at 60,000/= - 90,000/-.
6. Assist farmers with the development of seeders.

Discussion

Question:
Is the USh60,000 – 90,000 for an attachment (ie the SAARI type) or for a stand-alone implement.

Group response:
Either. What the farmer requires is a serviceable weeder. If it attaches to the plough beam then that is OK. Most farmers would prefer an attachment as ploughs are found in all villages. The attachment will be cheaper than the stand-alone machine.

Question:
Who should facilitate the linkages between research-manufacture-farmer?

Group response:
Researchers supported by donors should facilitate this. NGOs could also be involved. Farmers do not have the resources, or the skills to begin the dialogue with manufacturers. We fear they would not take us seriously. We all need to work together but we need the knowledge of research and extension to help us.

GROUP REPORT 2: FUTURE RESEARCH & EXTENSION NEEDS

Edikoi J

Farmer

Research Needs:

1. Adaptability to different soil condition types. Which soil is suitable for which implement? This has not been precisely determined.
2. Development of weeders which can weed various types of weeds especially notorious weeds e.g. spear grass
3. Transport system, from fields to homes (i.e. on-farm is most important)
4. Research on multipurpose planters which can be attached to ploughs
5. Research for low cost implements and spares that farmers can afford
6. Research for women friendly implements easily adjusted, not too heavy
7. Research on harvesting implements because yields are high e.g. animal powered harvesters
8. Research on other sources of farm power e.g. donkeys.

Extension Needs:

1. Training Frontline Extension Worker (FEW) on appropriate technology i.e. update on new technologies.
2. Encourage farmer to farmer training approach
3. Provide demonstration implements/equipment to communities for multiplier effect.
4. Organise farmer field days
5. Extension to encourage participation from all stakeholders e.g. politicians opinion leaders etc.
6. Organise farmer competitions (shows) and exchange visits. The winners to be rewarded.
7. Strengthen the linkage between research manufacturers, NGOs, CBOs etc.

Discussion:

Question:
Farmers moving implements from farm to farm do not take good care, they drag them with oxen and they often become damaged. Farmers could build their own sledges to reduce wear. Sledges could also be used for on-farm transport.

Group response:
SG 2000 is very heavy and it is very difficult if not impossible to carry behind the oxen. At least ½ of the farmer participants at the workshop have used sledges.

It would help us if the designers and engineers put wheels on the machine to help us to transport it.

Question:
Is it possible to attach wheels to weeders? Doesn't it raise costs?

Response from project team:
It is possible, but the cost rises

Question:
How do farmer competitions help?

Response from project team:
Competition can teach other farmers that it's better to do things. Ploughing or weeding competitions at shows enable farmers to compare different practices and refine their techniques. Ploughing matches for example have been common in some part of Africa, particularly Zimbabwe.

GROUP REPORT 3: FARMER TO FARMER TRAINING CAN IT SPREAD DAP SKILLS?

Odong. P

Farmer

The overall conclusion was yes given the following conditions:

1. Farmer trainers must be well trained so that they can pass on skills to others (ie the oxen and farmers to be trained.
2. Training facilities and materials must be available in particular, weeders, planters, other appropriate machinery and oxen
3. FEW should be mobilised and sensitised so that they can also learn and pass their experience on to others.
4. If transport is availed to trainers (they need to be able to move freely from place to place.
5. If linked with other developmental actors as NGOs, to share experiences

In the longer term the sustainability of farmer-to-farmer training will be linked to the sustainability and profitability of the Teso farming system to include:

1. Better marketing system for increased yields (joint marketing by farmers)
2. Technology that is applicable for all (ie male and female farmers and children.
3. Access to land and to draught animals (oxen or donkeys)
4. By continuous assessment and sharing information between farmers – extension – research. Farmer hope for a more active extension service in the future.

Farmer-to farmer training will not work where:

1. There is insecurity like cattle rustling as in Koritok (Katakwi).
2. Lack of cooperation amongst farmers
3. If farmers themselves are not committed to the concept (both trainers and trained)
4. Unfavourable weather conditions (drought)
5. When technological change requires constant updating of tools and machinery

In conclusion DAP skills can be spread through farmer to farmer training where there is commitment and desire to build up the community.

Discussion

Question:
As weather forecasting improves will this help the farmers make decisions about planting etc.?

Response by project team:
In theory yes but meteorology is an inexact science. Even if forecasts are good how will the information be relayed to farmers? The radio is one obvious solution, but local weather forecasts may not become available for some time.

Question:
What do farmers think of the idea of using donkeys rather than oxen.

Farmers' response
Keeping donkeys in our areas is difficult as we have not kept then before and do not understand their management and feeding.

In Pallisa a number of farmers own donkeys and interest is growing. They are good for ploughing and transport (as pack animals). They may be the solution to some of our transport problems. They are cheaper than oxen.

In Obur donkeys are available, they are easier to control than oxen, they live longer and are friendly and resistant to diseases. They can also be eaten.

GROUP REPORT 4: ROLE OF NGOS IN EXTENSION TRAINING IN DAP TECHNOLOGIES

Omoding M.
Farmer

NGOs should play the following role in promotion of DAP technologies:

1. Provision of DAP implements and animals on credit/loans
2. Training farmers and their animals
3. Set up demonstration centres for farmers. (FEWs + NGOs set up there sites for training farmers)
4. NGOs to act as a link between research, farmers and manufacturers
5. Set-up stockist for implements (like AT Uganda) in most trading centres.
6. Production of reading materials as leaflets pamphlets (extension material)
7. Media programmes in Radios, TV, Newspapers
8. Organise shows, exhibitions on DAP technology
9. Facilitate farmers for exposure and exchange visits on DAP technology

Discussion

Question:
What is AT Uganda doing with regard to stockists (input suppliers)

Response from project team:
They sell implements and other inputs. Other NGOs could work with them to assist stockists increase their stock because the range is currently limited.

Comment:
NGOs should also strengthen communication among themselves to eliminate duplication of some work

In future NGOs should work closely with farmers and organise exchange visits for sharing of information and experiences.

FARMER PERCEPTIONS OF THE PROJECT

Okurut D.Engulu A.
Farmers

1. Introduction

The farmer representatives opened by thanking all the participants in the DAP Project and in particular the donors who can be sure that the funds provided had been put to good use and the impact has been positive, particularly terms of the contribution the project has made to DAP weeding in Teso. The linkage between researchers, extension workers and farmers was much appreciated and it was good for these to work together as a team.
The communities themselves have also worked together, particularly towards the end of the project with non-participating (in the project) farmers.

They also thanked the government of Uganda, without their support the project would not have been possible. Many farmers have taken up the technology but the challenge now is to extend the message to more farmers.

2. Skills acquired

Skills have been acquired by farmers in the following areas:

- Spacing of various crops
- Data collection: farmers are able to keep records and calculate the costs of production
- Weed identification
- Adjustment of weeders and ox-ploughs
- Harvesting of groundnuts with a plough

Higher yields have been realised as a result of DAP technology. Weed management has improved and household incomes have also improved along with standards of living.

There is now timeliness in DAP weeding and crops planted in rows are easier to manage than broadcast ones. Row planting has also helped very much in control of groundnut rosette disease. Farmers believe that crops where DAP weeding is used have grown well partly as a result of improved infiltration of rainwater and higher moisture retention

The project has stimulated demand for weeders and manufacturers need to be aware of this market.

3. Challenges

- Some of the weeders used were heavy therefore need to be modified to assist users
- The weeders used for training and carrying out DAP activities are not enough in number to cover all the farmers in the selected sites.
- Lack of yoke making tools
- As weeding is now simplified there need to provide planters for rapid planting of crops (sowing in lined is rather labour intensive)
- Its difficult to obtain spares for SG.2000 and AEATRI weeders

- The life span of the project was too short to complete the project objectives e.g. to tackle planting and on-farm transport as well as weeding

4. Suggestions

- Extend the time frame of the project to meet the new challenges presented by DAP weeding
- Provide more weeders to facilitate training and dissemination
- Design and develop planters to overcome labour constraints
- Improve access to yoke making tools
- Provide one bicycle for each farmer chairman (9 sites) to facilitate mobilisation, training and dissemination.

5. Discussion

Question:
Who is going to manufacture the weeding attachments such as the SAARI weeder?

Response of project team:
We hope that manufacturers in Soroti such as Saimmco and Hands in Service Workshop will take up the manufacture

Comments from farmers:
Provide prototype planters soon to reduce labour costs on planting.

Farmers should consider planning training activities this February so that trainees are in a good position to use DAP weeders in the coming rains.

THE FUTURE FOR DAP IN THE TESO FARMING SYSTEM

D. Barton
NRI, University of Greenwich, UK

The following is a summary of the conclusions of the workshop and looks ahead for future research and development in the field of DAP in the Teso farming system.

- All DAP weeders tested on-station and on-farm performed better than the hand weeding in terms of the time taken to complete the task and the costs and in many cases the yield
- SAARI weeder performed best in for weeding of groundnuts
- The plough with its mouldboard removed works reasonable well and provides an alternative to handweeding for all farmers who have access to this tool (ie the majority)
- Sowing in lines has become a constraint but farmers have indicated as they practice this technique it becomes easier?
- DAP is cheaper and faster than hand weeding and reduces the pressure on women and children to perform this task
- Farmers have been able to train other farmers in the use of the technology
- Future challenges include dissemination to the farmers and the availability of machines for weeding

Dr Barton asked the meeting to confirm that each of these conclusions were correct. The response was positive.

He suggested that in the absence of SAARI and other weeders that farmers should try to use ox-ploughs with mouldboards removed as much as possible. He acknowledged however that there is a need to offer farmers a range of options and noted that most farmers who had the opportunity to try the SAARI weeder were impressed with this technology. The challenge now is to find a manufacturer who can produce the tool at a price which farmers could afford. This could be the subject of a new project or an extension to the existing one. This objective of this project should be to disseminate the technology. Activities might include:

- A continuation of the farmer to farmer training
- Facilitation between farmer trainers, extension workers and NGOs/CBOs to assist the spread of the message
- Farmer exchange visits to share experience
- Development of linkages between farmers and manufacturers to assist the development of affordable technologies (including the involvement of blacksmiths in the production of spare parts)
- Development of simple and cheap planting techniques (such as marking fields with oxen rather than string) that do not necessarily involve the purchase of expensive planting material
- Refinement of the plough weeding approach to ensure that the tool can be used under all circumstances (various row widths)

In the future the major organisation involved in the dissemination of technology will be extension workers (NAADS) and NGOs/CBOs. It is essential that these groups are involved in any further work.

Sources of funds for this work include the following:

- COARD Project (DFID funded project based at SAARI)
- Possible LPP and CPP extension

The number of farmers trained (by other farmers) in each location is as follows:
- Abalang - 56
- Obura - 35
- Kibale - 67
- Pingire - 24
- Kaler - 32
- Koritok - 40
- Orungo - 25
- Kachede – 30

This represents a total of 309. This is a major achievement and an indication of the community sprit that exists in Teso. There is a need to build on this experience and assist farmers to train more people.

Finally the speaker thanked all who had been involved in the DAP Project and praised the farmers for their enthusiasm and willingness to share their knowledge with others.

Discussion

Question:
Is it possible for a future project to provide credit for implements and oxen?

Response of the project team:
It will not be possible but any future project will be able to liase with other organisations that may be in a position to provide loans.

Question:
How can farmers approach manufacturers and persuade them to produce equipment.

Response from the project team:
Groups of farmers teams could approach SAIMMCO to discuss the matter. However, a future project should act as a facilitator in this regard and help farmers to identify needs and discuss these with manufacturers.

EVALUATION OF ANIMAL-DRAWN WEEDERS IN ZIMBABWE

D. O'Neill
Silsoe Research Institute, UK

1. Introduction

The DFID Livestock Production Programme is funding three draught animal power projects in total, the other two being in Bolivia and Zimbabwe. There are several similarities between the needs of smallholder farmers here in Uganda and their counterparts in Zimbabwe and the two African-based projects share a common interest in weeders, or cultivators, as they are more widely known. The Zimbabwe project has three main areas of activity – i) on-farm assessment of plough condition and performance for land preparation, ii) on-station trials of rippers to reduce the draught demand for land preparation and iii) on-station trials of cultivators to reduce the time taken for, and drudgery associated with, weeding to improve both labour and crop productivity. This presentation deals with the third area of activity.

2. Methodology

The research trials were conducted at two sites so that weeder performance in two types of soil could be compared. At Hatcliffe (location of the AGRITEX Institute of Agricultural Engineering – IAE) the soil is a red clay loam. At Domboshawa (location of the Domboshawa Training Centre – DTC), about 20 km from Hatcliffe, the soil is sandy loam. This soil is more representative of that in the communal areas of Zimbabwe where smallholder farmers subsist. Being in such close proximity, the rainfall at the two sites was very similar during the research trials. The same experimental design was used at both sites – a completely randomised block in which eleven weeding treatments were carried out in plots of 10 m by 25 m. There were three replications for a simple one-way analysis of variance. The eleven weeding treatments are shown in Table 1.

Four commercially available weeders were used (BS22[3], BS41, Zimplow light-weight cultivator and Contil Toolbar) with different configurations of tines as indicated in Table 1. Examples of the reversible and duck foot tines are illustrated in figure 1. Because smallholders in Zimbabwe rarely use cultivators, the experimental design incorporated weeding with a plough as well as with a hand hoe, the last being the control. The plough provided two treatments – with and without the mouldboard. Weeding with the mouldboard removed and using just the share is quite widely practised by Zimbabwean smallholders. Weeding with the mouldboard in place has, in certain circumstances, been found to be successful (Riches *et al*, 1997).

Table 1 Weeding treatments

Weeding implement (treatment)		Tine configuration	Abbreviation	Notes
1	BS221 Cultivator	2 reversible tines, 2 hilling blades, 1 duck foot tine	BS2212R2H1D	
2	BS221 Cultivator	2 hilling blades, 3 duck foot tines	BS2213D2H	
3	BS41 Cultivator	5 reversible tines	BS415R	Standard set-up
4	BS41 Cultivator	4 reversible tines, 1 duck foot tine	BS414R1D	
5	BS41 Cultivator	5 duck foot tines	BS415D	

[3] BS indicates manufactured by Bulawayo Steel Products Ltd. BSP Ltd and Zimplow Ltd have now merged and all equipment is now marketed under the Zimplow brand.

6	Zimplow light-weight cultivator	2 reversible tines, 1 duck foot tine	ZLW2R1D	Light-weight model has only 3 tine attachments
7	Zimplow light-weight cultivator	3 duck foot tines	ZLW3D	as above
8	Contil Tool Bar	with duck foot sweep tine attachment	CTB	Light-weight unconventional design primarily for donkeys
9	Standard VS8 Plough without mouldboard	plough share	SHARE	A fairly common practice amongst smallholders
10	Standard VS8 Plough	share and mouldboard	MB	For post-emergent ridge weeding
11	Hand hoe	-	HH	The basic practice included as a control

Fig 1 Reversible (left) and duck foot (right) tines

3. Results

Many performance variables were monitored during the trials (see Mbanje *et al*, 2001) but this presentation is concerned only with draught requirement, weeding efficiency, grain yield and economic return for each of the 11 treatments. Data from the two locations have been kept separate as there is no justification for combining them, and any differences might be informative.

Figure 2 shows the draught requirement results, except for the hand hoe (control) treatment for which it is not applicable. There was no consistent difference attributable to soil type and very little between designs, with the Contil Toolbar showing the lowest requirement.

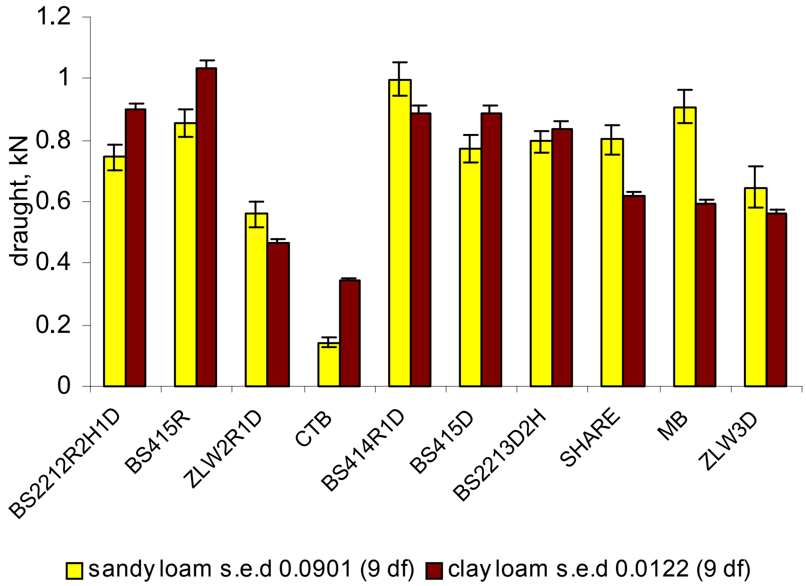


Fig 2 Draught requirement for each weeding treatment

Figure 3 shows the weeding efficiencies associated with each of the treatments. Again, there were no consistent differences, but the results on the clay loam were less variable. Hand weeding on clay was the most efficient.

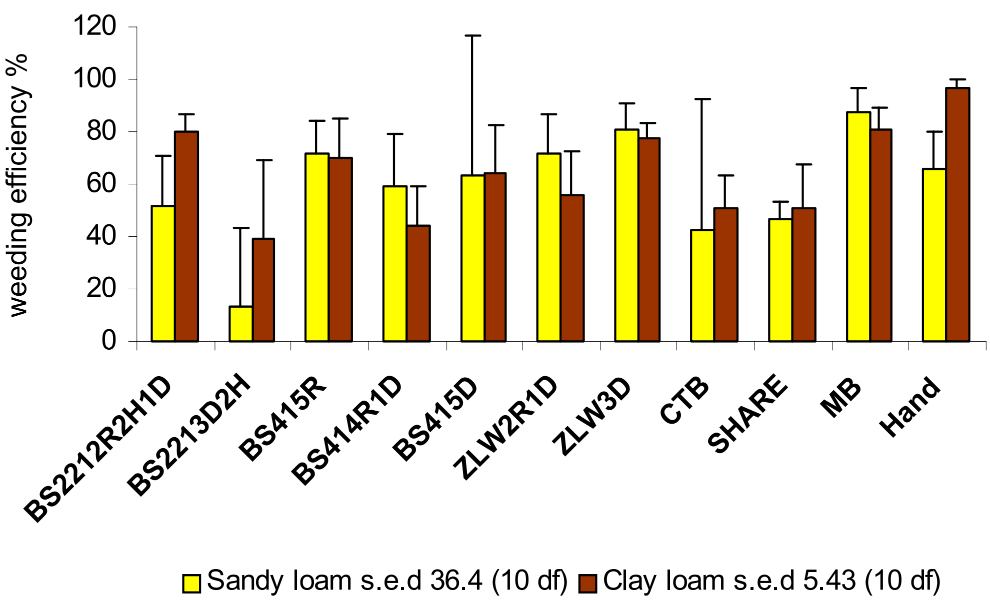


Fig 3 Weeding efficiency for each treatment

Figure 4 shows the grain yield for each treatment. The yield on clayey soil was generally higher than that on sandy soil, with the only cultivator giving a higher yield on sandy soil than on clayey soil being the light-weight Zimplow fitted with duck foot tines.

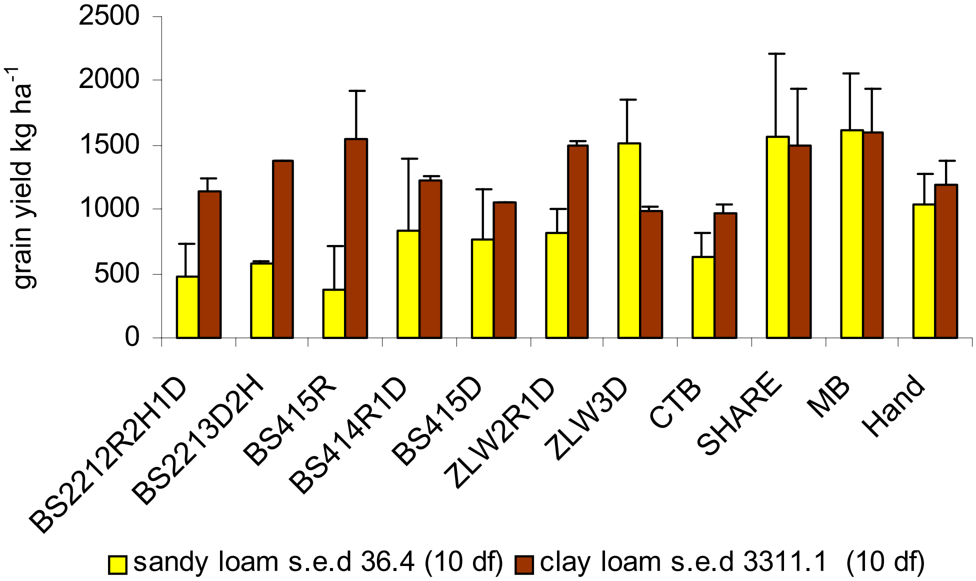


Fig 4 Grain yield for each treatment

Figure 5 shows the overall economic performance of each of the animal-drawn implements compared with the hand hoe control. The analysis is based on partial budget incorporating the most important variables – yields, prices, all input costs, including cultivator cost depreciated over 10 years and harvesting. Family supplied inputs have been included at their opportunity costs. Figure 5 implies that, in general, a farmer would not expect to gain from weeding with a cultivator on sandy soil.

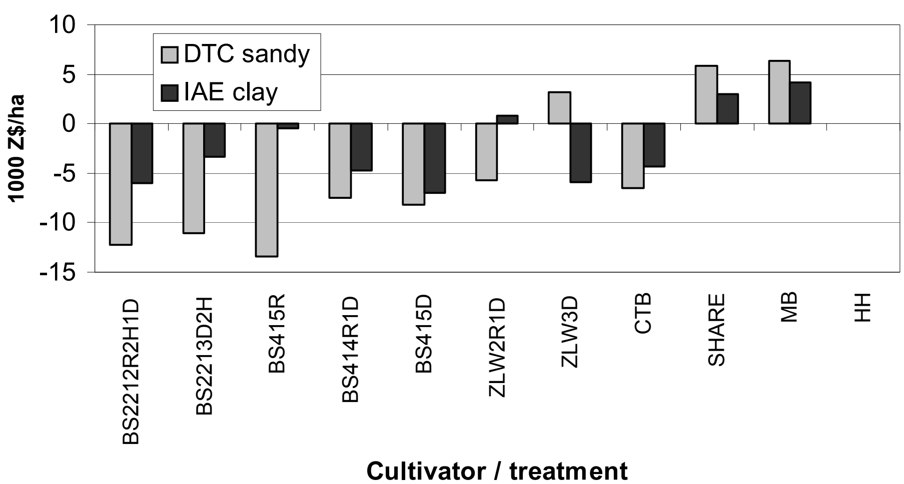


Fig 5 Overall economic return associated with each of the weeding treatments

4. Discussion

There is little to choose between the treatments in terms of draught requirement and weeding efficiency. On these bases, therefore, no one particular design of implement or tine configuration should be recommended. However, when economic, rather than physical, performance is considered, the situation changes. Yields were generally higher on the clayey soil, but this would be expected from the differences in soil quality and properties. The higher yields (see figure 4) of the three animal-drawn implements in the sandy soil contributed to the economic gains but, in most cases, these were negated by the purchase and depreciation costs of the cultivators (see figure 5). The main reason for the better economic performance of the two plough-based treatments would be the absence of purchase costs, as most farmers (c. 95%) already own ploughs. The only cultivator to give a better economic return than hand hoeing was the Zimplow light-weight cultivator, but the improvement indicated an interaction between tine design and soil type.

5. Conclusions

- On heavier, clayey, soils reversible tines should be used.
- On lighter, sandy, soils duck foot tines would be preferred.
- The light-weight cultivator was as efficient as the traditional five-tine cultivator.
- The highest yields and weeding efficiencies were associated with post-emergent ridge weeding.
- The cost of purchasing a cultivator reduces its economic viability compared to using a plough, assumed to be already owned.

The results help explain why many smallholder farmers in Zimbabwe do not use cultivators even when they are available. Fitting them with duck foot tines may increase their effectiveness and, hence, their use.

Acknowledgement

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References

Mbanje, E, Twomlow, S J, and O'Neill, D H, 2001. Evaluation of animal-drawn weeders for smallholder maize production in Zimbabwe. In "Weeds 2001" Proceedings of the BCPC Conference, 12-15 November 2001, Brighton, UK, Volume 2, 913-918

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, 1-15.

CONCLUDING REMARKS

Sarah Godfrey
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Information presented at the workshop has demonstrated that:

Future work is required to extend the technique and assist the development of technology in particular to develop links between extension services, NGOs, farmers and equipment manufacturers (including blacksmiths). Given the superiority of the SAARI design it would be useful to develop links with manufacturers to modify the design (make it cheaper to manufacture). Representations will be made to LPP to seek further funds for machinery development and extension. NGOs came up as the main channel through which the technology findings can be promoted to farmers.

Farmer to farmer extension has been proved by this project to be successful format for extending the results of research. Thus far a total of 309 farmers have been trained at 9 sites in Teso by farmers who have collaborated with the project. This is a major achievement and it is hoped that more farmers can be trained before the next rainy season.

A vote of thanks was proposed by Sarah Godfrey to all the farmers who have participated, without whom this research work would not have been possible. She also thanked the NGOs and representatives of local and national government who had taken the time to attend the workshop, and for their valuable comments. Finally she thanked SAARI for organising the workshop.

Having visited the project at the outset in 1999 it has been very interesting to return and see the results of the work as the project reaches its end. The main objective of this visit was to participate in the workshop but also to is to report back LPP programme management in the UK. The development of linkages between the different organisations with an interest in DAP weeding has been impressive.

There is some optimism that further work may be funded by LPP but the final decision will be made by programme managers in the UK. In the meantime researchers and farmers should approach the CORSU/DFID project based at SAARI where funds are available for the transfer of technology.

APPENDIX 1. LIST OF PARTICIPANTS

Name	Designation
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Omoding Mesulam	Farmer Kaler
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