# Weed control by draft animals: experiences in the Southern Highlands of Tanzania

*by*

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## Abstract

*Weeds are a major problem in tropical agriculture, and can lead to dramatic reductions in crop yields. Attempts to increase crop yields are rarely successful in the absence of good weed control.*

*Hand weeding can be very effective, but absorbs up to 50% of total farm labour inputs, so when labour is scarce, weeding is not done. Animal-drawn weeders could offer a labour saving of up to 80% compared with hand-hoe weeding. Using draft animals for weeding could also reduce drudgery and may generate additional income from hiring out the animals.*

*The paper describes the development, testing (on-station and on-farm) and performance of a range of animal-drawn weeding implements for use in the Southern Highlands of Tanzania. The trials found that good land preparation and correct planting, in rows, are prerequisites for effective animal-powered weed control. Weeds within crop rows are the ones that most affect yields. If weeding implements cannot control these weeds, supplementary weeding with hand hoes will result in high yields.*

*Approaches to extension of the technology, and to training farmers in its use, are discussed. These include the use of contact farmers, farmer trainers based in villages, group training and institutional capacity building.*

*Constraints to the wider adoption of animal-powered weeding include inadequate support from government, from research institutions, from extension services and non-governmental organisations, low farm incomes (farmers cannot afford to invest in animal traction), poor implement distribution and supply systems, poor animal management, and various social, cultural and gender issues. Addressing these problems could lead to wider adoption of animal-powered weeding in the region.*

## Introduction

Weeds are a major problem in the tropics as their growth is prolific and they are difficult to control. Weeds can deprive crops of up to 50% of the soil moisture and applied nutrients, leading to reduced yields (Sankaran and Mani, 1972; Hay, 1974; Rao 1983). Yield losses from weeds alone can be more than those caused by other pests and diseases combined.

Various studies have indicated that the use of fertilisers, appropriate plant populations and crop protection measures rarely increase yields in the absence of good weed control practices (Armitage and Brook, 1976; Carson, 1987; Croon, Deutsch and Temu, 1984).

The Southern Highlands of Tanzania lie between 7° and 9° South and 30° to 38° East. The highlands comprise the four regions of Ruvuma, Iringa, Mbeya and Rukwa, covering about 244 000 $km^2$. The altitude ranges from 400 to 3000 m above sea level and annual rainfall is between 750 and 2600 mm.

## Review of weeding practices

Traditionally, crops such as maize, rice, coffee, tea, beans, groundnuts, potatoes and cotton are produced in the area both for household food security and as revenue earners. Because the rainfall pattern is monomodal, starting in mid- or late November and finishing in early May, crops have to be established as quickly as possible in order to accommodate the wide range of crops grown. This leads to labour constraints in most households, especially in the busiest months, December to February, when most of the field operations such as land clearing, cultivation, planting and weeding have to be undertaken for most of the crops. During this period the labour input concentration is between 40 and 60% of the total labour input for the whole year (Van der Ende, 1991).

  

Because tillage and planting are delayed until the onset of the rains and go on well into the season, taking up a substantial part (30–45%) of the farmers' labour input, little time is left to carry out proper weed control. Thus weeding starts late and it is usually done hurriedly and ineffectively because it is difficult to work in crops dense with weed infestation. In many crops, such as maize, cotton, beans, potatoes and groundnuts, weed infestation is most critical in the first three to five weeks because these crops never recover fully when weeding is late.

The weed problem is exacerbated by poor or inadequate land preparation, which gives weeds a head start on the crop.

Loewen-Rudgers et al (1990; 2000) reported that 90% of the farmers in Mbeya Region weed late, starting when the maize crop is 30–45 cm high (ie, four to five weeks after planting), because of labour shortage: most farmers finish planting their crops first so as to make full use of the short growing season. Unfortunately, this time of the year coincides with very low food reserves and cash flow and hence hired labour is unaffordable. It has been observed that only 9% of farmers hire labour for weeding at this time of the year, and those who do generally pay in kind and not cash (Harder, 1989; Shetto, Mbwile and Mayona, 1993).

It has also been established that weeding in the Southern Highlands is not only late, but also inadequate: most farmers spend less than 130 hours/ha in maize, and beans are very often left unweeded (Van der Ende, 1991). Thus poor weed control has been identified as one of the biggest constraints to increased maize and bean production in the region (Croon, Deutsch and Temu, 1984; Rain, 1984; Madata and Mkuchu, 1992). In order to maximise yields, two weedings are usually necessary in most crops—the first one within two weeks of planting and the second two to three weeks later. For long-maturing maize varieties in the highlands three weedings might be advantageous; this regime also facilitates harvesting.

Adequate use of a hand hoe can control weeds effectively, but is very time-consuming, requiring 300–400 hours per hectare, or 40–50% of the total farming labour input. When labour is scarce, timely weeding using a hand hoe becomes a big problem. Under these circumstances the use of draft animals could be advantageous. A labour saving of 40–80% over hand-hoe weeding could be obtained when animal-drawn weeders are used (Starkey, 1981; UAC, 1988, 1992).

Apart from ensuring timeliness, the use of draft animals for weeding can offer other advantages: reducing human drudgery; generating additional income from hiring out the animals; and increasing the utilisation efficiency of the animals (Shetto and Kwiligwa, 1992). Using draft animals only for conventional tillage operations means that they are worked for less than 70 days in a year, and so are idle for up to 80% of their productive time each year: spreading the ownership costs over a longer period of time makes animal traction less costly and more attractive.

## Collaborating institutions

Based on these obvious benefits of animal traction, studies on the development of effective and economical weed control systems using animal-drawn implements were initiated at MARTI Uyole in collaboration with the Mbeya Oxenisation Project.

MARTI Uyole (formerly Uyole Agricultural Centre) is a government research station established in 1973 under the Ministry of Agriculture. The institute is charged with advancing agricultural productivity by generating applied research findings and training agricultural personnel at certificate and diploma level. The major emphasis in its Agricultural Engineering Research Programme has been on animal traction and post-harvest systems for smallholders.

The Mbeya Oxenisation Project (MOP) was established in 1987 with funding from CIDA (Canadian International Development Agency); it is administered through Mennonite Economic Development Associates (MEDA) and the Regional Development Director. Its major goal is to promote agricultural development in Mbeya Region through production, marketing and extension of animal traction technology appropriate to smallholder farmers on a sustainable basis.

## Selecton and testing of cultivators

Engineering research and development on animal-drawn weeding implements carried out by the MOP has focused on effective and commercially viable cultivators, acceptable to farmers.

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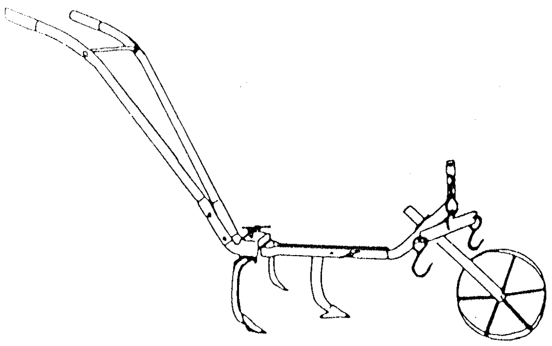

*Figure 1a: Houe occidentale*

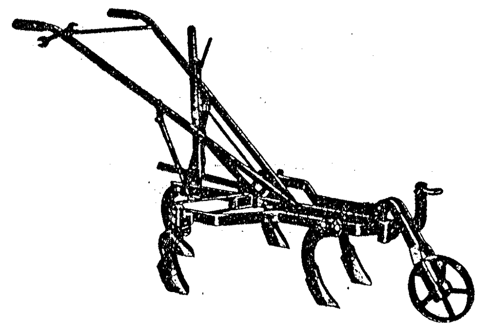

*Figure 1c: Cossul*

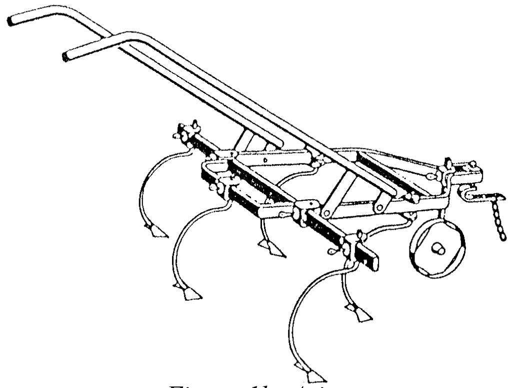

*Figure 1b: Ariana*

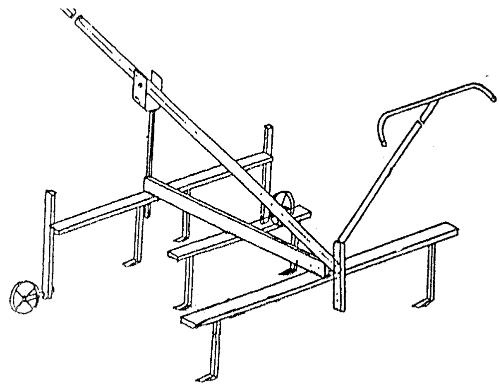

*Figure 1d: MOP over-the-row cultivator*

Cultivators were obtained from several sources: *Houe Sine, Houe occidentale* and *Ariana* from SISMAR in Senegal, *Pecotool* attachment from the UK, and the *Cossul* cultivator from India, imported by Ubungo Farm Implements (UFI). In addition, MOP designed and fabricated its own prototype over-the-row cultivator in an attempt to overcome the shortcomings of the inter-row cultivator. The cultivators (Figure 1) were tested and inspected in the workshop, and evaluated in the field by project staff and subsequently by farmers in their own fields.

Initially, two contact farmers per village were selected in the 15 villages in which MOP was working. Before the test programme, the farmers were shown the correct adjustment and use of the cultivator, after which two cultivators of different makes were left with each farmer to be evaluated over an entire season. At the end of the season the farmers had the option of buying the cultivators at a subsidised price or returning them to MOP. Concurrent field testing of the cultivators in a more controlled on-station environment was carried out at MARTI Uyole in Mbeya.

The MOP offices were strategically located within the compound of Zana Za Kilimo (ZZK), one of the two big implement factories in the country. This was intended to allow easy access to its modern machines and expertise for product development. However, submitting prototypes and/or drawings to ZZK was not enough to ensure the manufacture of implements. Thus MOP equipped its own workshop. Collaboration with the Centre for Agricultural Mechanisation and Rural Technology (Camartec) was not successful either. Camartec was responsible for the testing and certification of farm machinery and implements in Tanzania. However, the test report for the over-the-row cultivator requested and paid for in 1988 had not been received several years later.

## Implement performance

The *Houe occidentale* has short rigid tines and hence very low ground clearance (10 cm). It was found to be unsuitable for the relatively heavy soils of the Southern Highlands which are usually wet during the weeding season. Both the *Ariana* and the *Houe Sine* use spring tines and thick solid members. The *Ariana* was found to be heavy, and both implements were prohibitively expensive (US$ 125) compared with other inter-row cultivators.

Photo: Paul Starkey

*Photo 1: MOP prototype over-the-row cultivator*

The *Cossul* inter-row weeder supplied by UFI was inexpensive (at US$ 18) and performed satisfactorily in spite of several shortcomings including plugging (due to its low clearance of 22 cm) and breakage of the cast-iron parts.

The *Mkombozi (Pecotool)* cultivator, initially manufactured by MOP/ZZK and now by SEAZ Agricultural Equipment, is an attachment to a multipurpose toolbar. The cultivator frame is made of rectangular hollow steel and its tines are of thick solid steel. The *Mkombozi* cultivator was supplied with a variety of shares ranging from duckfeet and sweeps to weeding hoes. It proved excellent in terms of strength and effectiveness. Farmers, in particular, liked the cultivator for its easy manoeuvrability due to its large 23-cm wheel, its effective 25-cm wide sweeps combined with a light pointed nose ridger attachment for hilling. Its main drawback was its high cost (US$ 130).

The over-the-row cultivator (Photo 1) differs from the others in several respects: it has greater ground clearance (45 cm), it is drawn by a pole instead of a chain and it weeds on either side of row, allowing an ordinary length yoke to be used (Mkomwa, 1989; Rempel, 1989). The implement performed satisfactorily as a harrow, a planting furrow opener and a weeder, but not without problems. Weeding was possible only if the crop was less than 45 cm tall. The wooden pole made it seem 'primitive'. It required a larger turning radius at the end of the field (larger plot boundaries). A major problem was the high frequency of breakage of the shear pins protecting the long rigid tines.

A wide assortment of cultivators was necessary for the cycle of tests to assess implement design. However, the test marketing cycle, whereby farmer preference was counterchecked by willingness and ability to purchase the cultivator, needed a smaller number of cultivators, preferably just three. What constituted the best cultivator technically was straightforward. The choice or justification of the best cultivator overall needed a more critical approach. Cultivator prices varied with time and with government promotional policies. Thus the question of affordability and farmer choice had to be assessed with care.

## On-farm trials

Research in agricultural engineering at MARTI Uyole began in 1975 with post-harvest technology as a major programme. The activities expanded, and by 1977 animal-drawn technology became a fully fledged programme. Toolcarriers and ox carts were developed and tested on-station using Friesian bullocks. Because the 'slogan' in technology development at that time was to use materials available locally, these prototypes were made almost entirely from wood (Photo 2).

The field performance of the toolcarrier as a planter and weeder was promising, but its development and evaluation did not go beyond the research station (Kwiligwa, 1980). As it was made of wood, it was big and cumbersome and required high draft to pull. Moreover, the research approach was 'top-down' and the whole exercise had no impact on the potential end users (Starkey, 1988).

*Photo 2: Prototype wooden toolcarrier with planter and weeding options at MARTI Uyole*

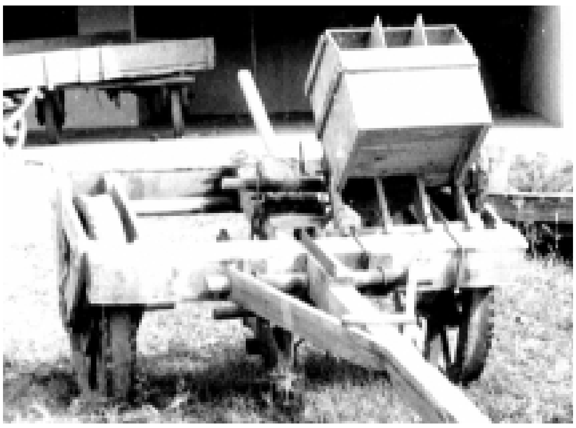

Photo: Paul Starkey

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In the late 1980s on-station and on-farm cultivation trials were initiated in collaboration with the MOP. The over-the-row cultivator was developed by MOP and evaluated together with the Cossul inter-row cultivator and other weeding systems.

Before on-farm trials were conducted a survey was carried out to select villages and farmers and to establish the level of oxen training. Most of the selected farmers claimed that their animals were well trained and did not need any extra training. However, to the disappointment of the researchers and farmers themselves, it proved impractical to use the animals. Besides not being used to the long weeding yoke, the animals were more interested in grazing the crops than in working. So the on-farm trials were not successful during the first season. As a result an intensive training programme was initiated. The ox handlers at Uyole were attached to the selected farmers, spending not less than 10 days training the animals using the nose ring method. In addition, sisal muzzle baskets were made to stop the animals grazing the crop. Initially the exercise covered three villages, and was extended to six villages in Mbozi District.

After the training programme the on-farm trials were successfully carried out. Combinations of weeding systems that included hand hoe, herbicides, over-the-row and inter-row cultivators were evaluated in maize production. Similar weeding trials were subsequently initiated for bean crops.

## Trial results and implications

Summaries of some important trial results are provided in Table 1 and Figures 2–6. The use of animal-drawn cultivators in weeding markedly reduced labour input. It could help relieve labour bottlenecks in farming systems.

The performance of the two cultivators (Cossul inter-row and MOP over-the-row) was not significantly different although the Cossul cultivator tended to be better. The MOP over-the-row cultivator had the advantage that it required the normal plow yoke, so the oxen did not lose the spirit of team work. However, it was difficult to manoeuvre, required well-trained animals and could not operate in crops more than 45 cm high.

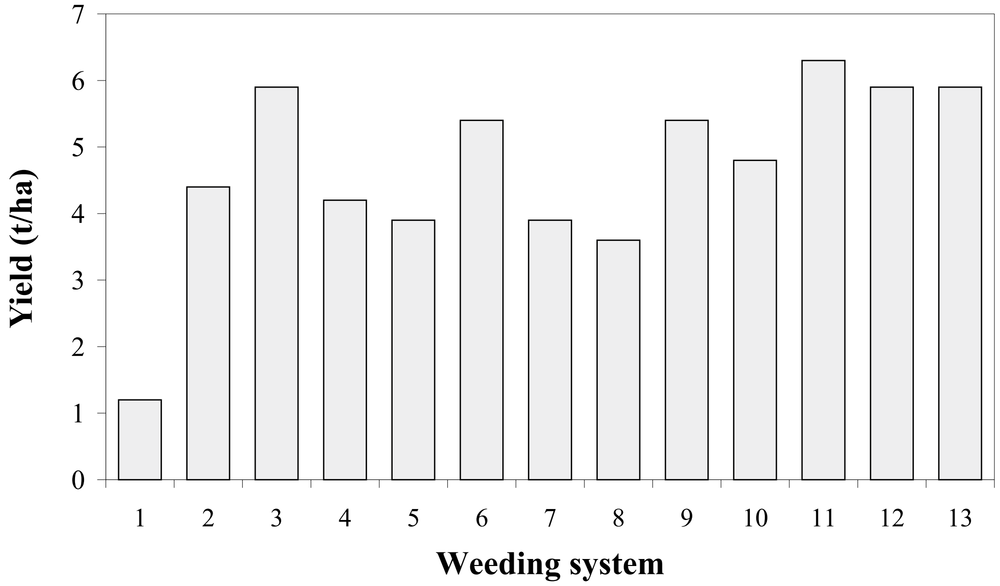
Weeds within crop rows were the ones which affected yields. The MOP over-the-row cultivator was designed to cultivate very closely and on both sides of the crop row, thus eliminating weeds within the rows by covering them. The implement was not very effective in performing this job, so supplementary weeding with a hand hoe (within crop rows) or herbicide (pre- emergence) was necessary

Good land/seedbed preparation and correct planting are prerequisites for effective weed control by animal-drawn cultivators. If these operations are done well, cultivators can be effective and successful. However, many farmers in the Southern Highlands do not prepare their seedbeds properly. Introducing animal-drawn cultivators without proper seedbed preparation will have minimal impact.

**Table 1: Partial budgets from promising weeding systems in maize production (1992/93)**

| *Weeding system* | *1* | *2* | *3* |
|---|---|---|---|
| Labour input (h/ha) | 245.80 | 146.60 | 34.35 |
| Yield (t/ha) | 2.85 | 6.00 | 5.65 |
| Adjusted yields (20%) | 2.28 | 4.80 | 4.52 |
| Gross field benefits (000 Tsh/ha) | 64.30 | 135.35 | 127.45 |
| Labour cost (000 Tsh/ha) | 6.00 | 3.60 | 0.80 |
| Implement cost (000Tsh/ha) | 0.20 | 0.60 | 0.50 |
| Herbicide cost (000Tsh/ha) | - | - | 12.50 |
| Total cost (000 Tsh/ha) | 6.20 | 4.20 | 13.80 |
| Net benefit per unit variable cost (Tsh/Tsh) | 9.35 | 31.20 | 8.25 |
| Return to labour (Tsh/h) | 236 | 883 | 3309 |

*1) Hand weeding (twice)*
*2) Cossul cultivator + hand weeding, Cossul cultivator and then ridging*
*3) Pre-emergence herbicide, Cossul cultivator and then ridging*
*US$1≈Tsh100 at the time of the study*



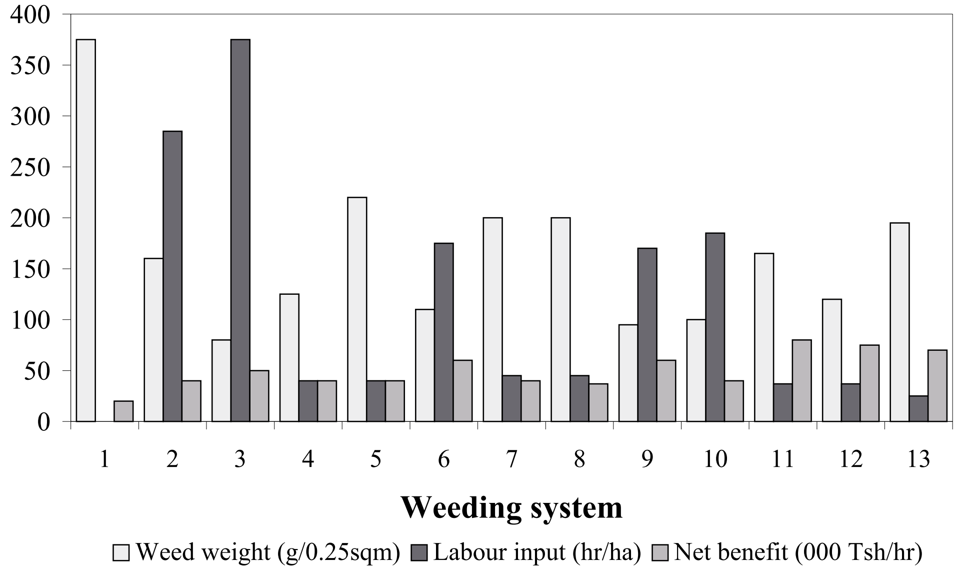




*Figure 3: Performance of weeding systems when used in maize production*

### The weeding systems for Figures 4 and 5

1 No weeding
2 Hand weeding twice (farmers' practice) 35–40 and 90 cm maize height
3 Hand weeding three times (recommended practice) at 15 and 90 cm
4 Cossul cultivator twice at 15 and 45 cm, then ridging at 90 cm
5 MOP cultivator twice at 15 and 45 cm, then ridging at 90 cm
6 Cossul cultivator four times at 5, 15, 25 and 45 cm, then ridging at 90 cm
7 MOP cultivator four times at 5, 15, 25 and 45 cm, then ridging at 90 cm
8 Cossul cultivator + hand weeding at 10–15 cm, Cossul cultivator at 45 cm, then ridging at 90 cm
9 MOP cultivator + hand weeding at 10–15 cm, Cossul cultivator at 45 cm, then ridging at 90 cm
10 Cossul cultivator + hand weeding twice at 5 and 15 cm, followed by Cossul cultivator twice at 25 and 45 cm, then ridging at 90 cm
11 MOP cultivator + hand weeding twice at 5 and 15 cm, followed by MOP cultivator twice at 25 and 45 cm, then ridging at 90 cm

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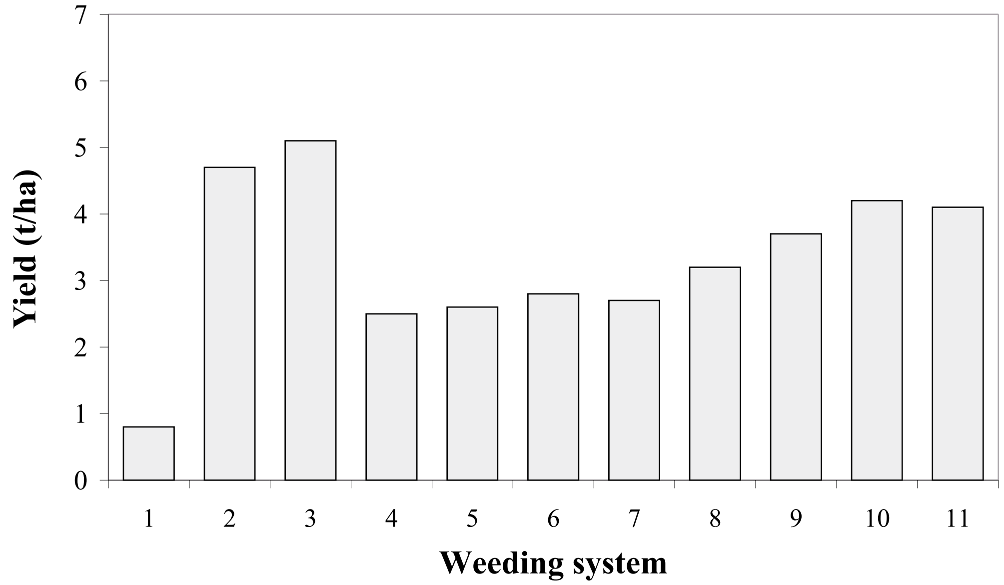


*Figure 4: Effect of frequency of weeding on maize yields*

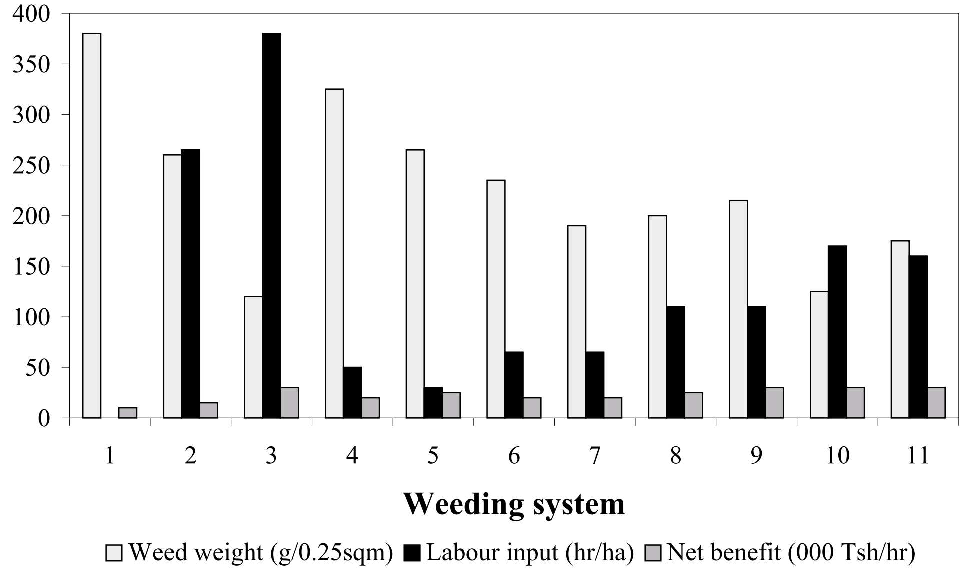


*Figure 5: Performance of weeding systems as weeding frequency increases*

## The weeding systems for Figures 4 and 5

1. No weeding
2. Hand weeding twice (farmers' practice) 35–40 and 90 cm maize height
3. Hand weeding three times (recommended practice) at 15 and 90 cm
4. Cossul cultivator twice at 15 and 45 cm, then ridging at 90 cm
5. MOP cultivator twice at 15 and 45 cm, then ridging at 90 cm
6. Cossul cultivator four times at 5, 15, 25 and 45 cm, then ridging at 90 cm
7. MOP cultivator four times at 5, 15, 25 and 45 cm, then ridging at 90 cm
8. Cossul cultivator + hand weeding at 10–15 cm, Cossul cultivator at 45 cm, then ridging at 90 cm
9. MOP cultivator + hand weeding at 10–15 cm, Cossul cultivator at 45 cm, then ridging at 90 cm
10. Cossul cultivator + hand weeding twice at 5 and 15 cm, followed by Cossul cultivator twice at 25 and 45 cm, then ridging at 90 cm
11. MOP cultivator + hand weeding twice at 5 and 15 cm, followed by MOP cultivator twice at 25 and 45 cm, then ridging at 90 cm

Cultivators performed better when weeds were short and the soil was not too wet. When it was too wet, the soil and the uprooted weeds tended to clog the tines, making the cultivator act like a rake, with minimum soil penetration

The importance of weeds within crop rows was emphasised. Increasing weeding frequency had no effect on yield as long as the weeds within the rows were not removed; in fact it led to reduction of net benefits. For any weeding system to be efficacious it should be directed towards suppressing weeds within crop rows.

The use of herbicides reduced labour input and effectively controlled weeds and consequently increased yields and net benefits. However, herbicides did not seem the best solution as they were expensive, not readily available and hazardous to the environment and animals.

## Extension and training

A sustainable ox-weeding technology requires well-trained extension staff and good cooperation with farmers. An effective training programme needs to be developed following an analysis of individual farmer needs, and should be designed specifically for the identified needs: off-the-shelf training programmes which try to cover all situations are of no use.

The use of draft animals for agricultural production in the Southern Highlands of Tanzania started about 60 years ago, but it is still limited to plowing and transport (mainly sledges). Thus, training of animals has always been geared towards these two operations.

Before the MOP started, farmers were not aware of animal traction weeding technology, despite the existence of some cultivators which were used entirely for harrowing and raking. Extension advice on animal draft technology was almost non-existent, and government extension agents had limited knowledge of, and few practical skills in, animal draft technology. Thus, from the beginning, MOP felt that an effective extension system was obligatory in promoting animal-powered weeding technology in the region. A number of extension approaches had to be tried in fulfilling this goal. These include the contact farmer, farmer-to-farmer and the farmer training groups approaches.

### Contact farmer/household approach

The contact farmer approach involved direct contacts between individual farmers (men and women) and MOP staff, assisted by village extension workers. Thirty-five contact households in 15 villages in Mbeya Region were selected. MOP staff paid frequent visits (at least once a week) to train farmers in the proper use of animal draft technology implements in their own fields. Although the approach was effective in sending clear messages to the farmers, it proved to be expensive in terms of vehicle running costs and time, so only a few farmers were trained. In the three years in which the system was practised, the project managed to work with only 35 'contact' farmers and 65 'neighbouring' farmers. Sometimes the selection of contact households proved a problem as village leaders entrusted with the exercise tended to select farmers based on personal relationships, precluding some who had the interest and capability to do the job.

### Farmer-to-farmer approach

Some contact farmers underwent an intensive practical training programme in animal and implement handling. These farmers later formed a nucleus of farmers' trainers, based in the villages. Although the approach was effective, it was also limited to a few individual neighbouring farmers because of logistic problems such as transport. Also, at peak times the trainers, being themselves farmers, did not have enough time to carry out the extension role in addition to their normal field activities. In some cases poor interaction between the trainers and the farmers was observed to be due to social differences or prejudices.

### Farmer training group approach

In order to ensure that the weeding technology reached a wider cross-section of the farming community MOP introduced the farmer training groups approach. Farmers, both men and women, formed groups at their own discretion and were trained to use weeding and other implements on a demonstration plot (not less than 0.5 ha) owned by the group. MOP lent the groups a range of implements, including plows, ridgers and weeders. After one year of use the group had to pay for the implements: if the group failed to do this, the implements were sold to individuals within the group or withdrawn. Most groups bought the implements and continued with training activities while inviting others to join. Besides the transfer of animal draft technology, these peer groups of

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farmers established savings and credit societies to make it easy for them to obtain loans from the formal lending institutions.

In order to support these groups effectively MOP increased the involvement of KILIMO (Ministry of Agriculture) staff at regional, district and village level. Village extension workers and village leaders as facilitators received a basic animal draft technology practical orientation course, and incentives were provided to village workers. To make the groups more participatory, joint planning of the group's training activities was undertaken. The group approach enabled MOP to reach some 450 farmers in its first six years.

In order to promote the use of draft animals further, MOP conducted about 200 demonstrations, 150 of which were on weeding and ridging; they were attended by some 10 000 farmers. Eight plowing and four weeding competitions were arranged, the latter attracting 40 competitors and about 250 observers. Radio programmes with clear animal draft technology messages were prepared and broadcast in collaboration with KILIMO.

## Institutional capacity building

In strengthening the extension service, MOP organised three-week practical training courses in animal traction for 160 village extension workers. These have subsequently incorporated animal traction technologies within their normal extension duties. Three District Mechanisation Officers have been trained to handle animal traction development programmes in their districts. They have been involved in planning animal draft technology development activities such as training of village extension staff, facilitating demonstrations and farmer competitions and supervising extension workers.

MOP is a project of limited duration. In order to sustain the extension and training activities beyond the life of the project, MOP has supported the establishment of OXETS, a privately owned extension business. Since its formation in 1993, OXETS has been implementing many of MOP's training and extension programmes. For example, soon after it was formed, OXETS offered a three-week training course to 58 village extension workers from Mbeya, Dodoma, Rukwa and Iringa, sponsored by Sasakawa Global 2000. It trained 28 women's group members in basic skills relating to animal draft technology. It has also carried an animal draft technology consultancy to Isangati Agricultural Development Project in Mbeya, funded by COOPIBO/CDTF. Planned activities include on-site training for 120 women group members in Kondoa and 150 farmers in Kwimba district, under the National Farming Systems Research Programme.

## Supply and marketing of weeders

The sustained availability of cultivators and spare parts acceptable to farmers is important for the success of animal-powered weeding efforts. However, over many years in the Southern Highlands, the supply of cultivators has not been smooth. The main suppliers include Ubungo Farm Implements (UFI), the Iringa Agricultural Development Project, Regional Trading Companies (RTC), MOP and SEAZ Agricultural Equipment.

Before trade liberalisation, the primary objectives of the parastatal and cooperative institutions were simply to provide supply services. Unlike the private sector, the profitability of the operations was not a main concern. The bureaucratic procedures and limited profit margins in the systems instituted by the parastatals led to delays in moving implements from central warehouses to the villages. This resulted in erratic supplies.

MOP assumed that the development of good animal-drawn cultivators combined with effective extension would be adequate to ensure the marketing of such implements. It was assumed the growing demands of the farmers would activate the existing dormant parastatal and cooperative official marketing system. This proved unrealistic. However, the unofficial marketing channels (including private companies and traders) were constrained by lack of familiarity with such products, small sales volume and lack of profitability on complete implements.

MOP felt the need to develop a sustainable marketing system physically closer to farmers and implemented by committed partners. Following a search for potential village-based private traders, 14 sales agents were established in the six districts of Mbeya Region.

## Marketing channels

The use of village-based sales agents was of the utmost importance in exposing farmers to new technologies so that they could make up their

  

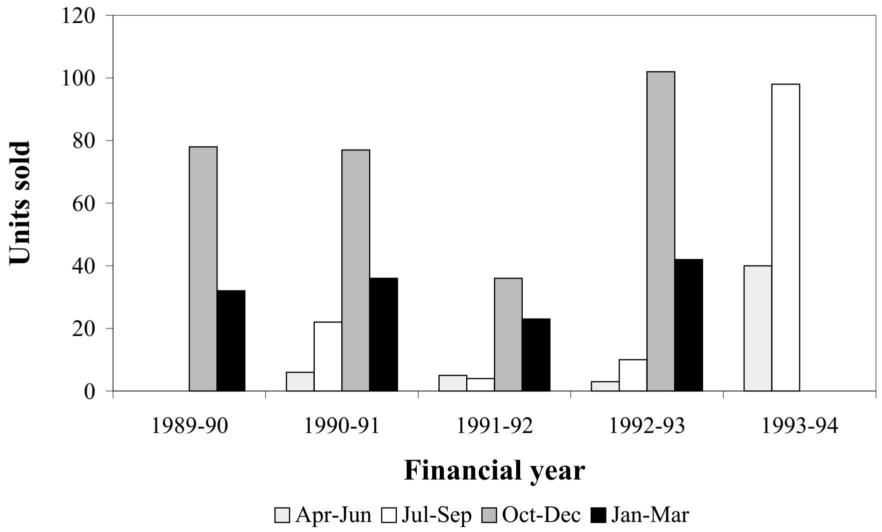


*Figure 6: Cultivator sales of MOP and SEAZ*

minds whether or not to buy. Visibility of the implements in their own village outlet, and continued visits from MOP/SEAZ, provided an opportunity for farmers to analyse implement performance, economic value and dependability or spares/repair services. Without these village-based sales agents, cultivator sales would probably have been much less: perhaps only a quarter of existing sales.

The use of sales agents, although effective in promoting the use of animal-drawn weeders, was risky, especially to the supplier. MOP and SEAZ were both supplying implements to sales agents on credit, payment being due every 30 days for all implements sold. Selection criteria for sales agents had to be carefully drawn, clear communication lines developed on the objectives of the agency, and contracts signed. Above all, frequent contacts had to be made for reimbursement to be maintained. However, this made the marketing of the implements costly, quite apart from the risk of losing money through default by some agents.

After the failure of the MOP/ZZK cooperative approach, in 1992 MOP established an agreement on various aspects of production and marketing of animal draft technology implements with a small local manufacturer, SEAZ Agricultural Equipment Ltd. The company was founded in 1991 by some MOP employees who invested their own resources in an animal draft technology production and marketing venture. SEAZ has taken over the supply functions of MOP.

SEAZ is responsible for the local manufacture of the *Mkombozi* cultivator (Photo 3) and the importation of the Agro Alfa inter-row cultivator from Mozambique. SEAZ acts as the sole agent for this implement in Tanzania. SEAZ is also responsible for sales through the 18 agents. The marketing of weeding implements (including cultivators and ridgers) increased from zero in 1988 to a cumulative total of 538 by 1993, due to effective extension and marketing efforts (see Figure 6). SEAZ's weeding implement sales have now surpassed all MOP quarterly sales in number of units. This has been achieved in spite of the removal of the 50% price subsidy in 1992.

*Photo 3: A demonstration of the characteristics of the SEAZ Mkombozi cultivator*

Photo: Paul Starkey

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## Problems of manufacture and import

In order to ensure the availability of animal-drawn weeders, the question of whether to manufacture locally or import has to be considered. Local production usually provides the best interaction between farmers and designers/manufacturers to incorporate feedback from farmers in equipment design, and improved provision of spares and repair services. Nevertheless, manufacturing like that undertaken by SEAZ for the *Mkombozi* cultivator should only be undertaken after careful consideration of implement performance and durability and profitability compared with importation. Local manufacturing for national prestige should not be a main issue.

Generally, implement supply conditions in the country have been hostile to the private sector. Parastatals such as UFI have distorted prices by quoting below market prices for products. They have also not backed up their products with spares or repair services. In 1993, UFI's price for the Cossul inter-row cultivator was TSh 8800 (US$ 18). However, the Cossul company itself quoted a price of US$ 55, shipped from India to Dar es Salaam. Until recently steel imported for the production of weeders was taxable whereas imported implements were not taxed. The result was that locally weeders were sometimes more expensive than imported ones.

Import of implements has not been smooth either. Import from India or PTA (Preferential Trade Area) countries requires a six-month lead time due to bureaucratic pre-inspection procedures, ambiguous shipping and clearing procedures and poor communications.

### Promotional activities

In the Southern Highlands, weeders are relatively new products which require a marketing thrust to sell them. MOP designed a promotional strategy which included the interaction of Uyole researchers and MOP extensionists with individual farmers, demonstrations and weeding competitions. Some 4000 calendars illustrating weeding, among other animal-drawn technologies, were distributed, together with 200 posters.

### Credit and pricing

Over the years the relatively low prices for farm produce, and delays in receiving payment, made it difficult for farmers to buy expensive items like cultivators and ox carts. MOP was thus forced to provide credit to various beneficiaries.

Prototype cultivators for testing were supplied free of charge to farmers on condition that payment was made after one year of use or testing. Although this system sometimes jeopardised relations between farmers and extension agents, it was generally a success. The same approach was later used for farmers' groups, women's groups, and small workshops contracted to manufacture axle assemblies and other animal draft technology implements. The overall repayment rate has been more than 80%, being much higher for small workshops.

## Constraints to the wider adoption of animal traction

Although animal traction started to be used in the Southern Highlands in the 1930s, its spread and adoption has been constrained by a number of factors.

### Institutional support

Statements at national level on mechanisation in Tanzania have clearly favour the promotion of animal draft technology. However, there has been little implementation of the stated government plans. There has been little government institutional support for research and extension.

With the exception of MOP and MARTI Uyole, a coordinated approach to tackling animal-powered technology has been lacking. A number of institutions such as Camartec, Sokoine University of Agriculture, University of Dar es Salaam, Ubungo Farm Implements, Small Industries Development Organisation, some donor-assisted projects and NGOs, have been working in various aspects of animal traction. This fragmented approach has spread the few resources available too thinly. The problem has been compounded by the poor linkage between research and extension, leading to the latter failing to deliver clear animal draft technology messages. This situation has been further aggravated by an ill-equipped, poorly motivated and inadequately trained extension service.

In formal training programmes (certificate and diploma), too much emphasis has been placed on tractors and motorised equipment. Moreover, of the little time allocated to animal draft technology, nearly 95% has been theoretical.

This has produced graduates with limited practical skills. Interest in animal draft technology has been very low due to a poor organisational structure, with no clear job descriptions for village extension workers and/or inadequate follow-up on performance.

## Low farm incomes

The use of draft animals calls for relatively heavy investment by individual farmers. The adoption of animal traction for weeding should be profitable enough to warrant the extra investment. However, farmers have suffered from low crop yields, low sales prices and poor crop marketing channels. Resource-poor farmers with low income may find investment in animal draft technology unaffordable.

## Poor infrastructure and supply systems

The poor infrastructure, distribution and supply systems have limited the availability of implements and spares. The toughest challenge has been to ensure the availability of effective quality weeders at prices that are affordable to farmers and at the same time profitable and sustainable to the supplier, even at low seasonal sales volumes. Sometimes the situation has been made worse by inconsistent subsidies offered by some donor-assisted projects. This has created unfair competition for similar products imported or made locally at cost.

## Poor management of draft animals

Inadequate animal management and health services may limit the use of animals for field work. The animals may be poorly fed and they are in poor condition at the beginning of the rainy season. Tick control facilities and drugs are very expensive and not easily obtainable, so tick-borne diseases are rampant, with high mortality rates. In 1993, one prominent farmer in Mbeya Region who used draft animals lost all of his 30 cattle, including six oxen, in a short period of time because of tick-borne diseases. One rapid appraisal survey showed that none of the dips in Chunya District in Mbeya Region was functioning because acaricide was unavailable (UAC, 1992).

## Social, cultural and gender issues

Animal draft technology still tends to be a male domain, even though about 70% of agricultural labour is supplied by women farmers. Men, who are the main decision makers, overlook the importance of draft animals in saving women's labour in weeding, especially for the so-called women's crops such as groundnuts and beans.

# Strategies for future development of weeding technology

Research and extension in animal draft technology have to be strengthened and firmly linked with manufacturers and/or suppliers. Sufficiently farmer-tested and accepted weeders, backed up by a well informed, adequately trained, motivated and vigorous extension system, should be promoted. This is bound to stimulate the demand for weeders and make animal draft technology weeding services more sustainable.

The use of duckfeet and hiller points should be evaluated with the aim of reducing labour input further by minimising additional hand hoeing within rows. The potential for using single oxen for weeding should be assessed. The possible role of donkeys in weeding should be investigated, particularly as women have a closer association with donkeys than with oxen.

The experience gained from the on-farm trials indicates that the introduction of animal-drawn cultivators as a single technology will have very little impact. Weeding is an operation which is closely linked to other field operations, such as land/seedbed preparation and planting. Efforts to promote weeders should go hand-in-hand with emphasising good land/seedbed preparation and adequate animal training. It should be noted that the plow is the 'first weeding implement'.

To ensure a smooth supply of weeders close to farmers, the role of village-based agents should be looked at more carefully. A special fund favouring these agents could be established by the government and administered by a financial institution or an NGO, which would reduce the burden carried by centrally placed manufacturers and suppliers.

Farmer-training groups should be encouraged because, apart from fostering farmer-to-farmer contacts, they enable a wider cross-section of beneficiaries to be reached by the few village extension workers available. The groups may also act as a base for Savings and Credit Societies which could improve the creditworthiness of individual farmers to lending institutions.

Above all, an active government policy on animal traction is needed to influence research

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and extension, manufacturing, distribution, infrastructure and support services. Thus it is proposed that a national coordination unit be set up to coordinate all aspects of animal traction development in the country. A multidisciplinary approach is recommended as animal traction is a wide-ranging topic, encompassing technical, socioeconomic, ecological and agronomic factors.

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