

The design and operation of animal-drawn weeding implements in Tanzania

by

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Abstract

Very limited technology exists in Tanzania to make use of animal power for weeding. The main tool used on farms is the hand hoe, which farmers use to perform a variety of farm operations. The hoe is used for tillage, planting, weeding and even harvesting operations. Where ox plows have been introduced they can similarly be used for tillage, planting, weeding and even lifting groundnuts.

However, it should be remembered that not every implement is multipurpose and that an implement is best used for the operation for which it was designed. A single-bottom mouldboard plow, for example, when used as a hiller for earthing-up during weeding, requires that the crop is planted with the rows spaced not more than 75 cm apart so that weeding is completed on the return pass and that unweeded strips do not remain in between the rows. Furthermore the crop plants have to be taller than the weeds at this time.

Similarly, a ridger used for weeding has to be preceded by a sweep or two to ensure weeds do not erupt on the sides of the ridges after the earthing-up process during weeding.

Generally, a five-tine cultivator fitted with reversible teeth is best used as a harrow rather than as a weeder. As its name implies, it is meant to be used for light cultivations between the rows of crops to break any crust of soil formed as a result of falling rain drops or soil compaction.

Herbicides have many side-effects and require specific conditions. Sufficient soil moisture must be present at the time of application for herbicides to be effective. Their use by smallholder farmers in semi-arid areas may be of limited success. It is here that mechanical control using animal traction may particularly important.

Introduction

Although great efforts have been made in Tanzania to introduce agricultural mechanisation, including animal traction, in rural areas, little success has been achieved in mechanising weeding technology. Generally, weeding with animal traction has meant using an ox plow or ridger to kill weeds between the crop rows and, to a lesser extent, to kill weeds by earthing-up along the rows. The cultivator is almost useless as a weeder when it is fitted with conventional reversible teeth; the teeth are meant for breaking the crust of soil between the rows of a growing crop for better aeration and water infiltration. Therefore, present designs of weeding implements should be evaluated and revised to ensure effective inter-row weeding and earthing-up in one operation.

Weeding methodology

For effective animal-powered weeding the crop must be planted in rows so that inter-row weeding is possible. Good weeding involves cutting the roots of weed plants about 2–5 cm below the soil surface followed by shaking off all soil adhering to the roots to prevent regrowth. The other assumption is that the crop plants being weeded are taller than the weeds so that the weeds, but not the crop plants, are buried during earthing-up (Kayumbo, Chitopela and Mnyau, 1987)

It seems evident that a young crop with a young population of weeds is best weeded with sweeps and small hillers for both inter-row weeding and earthing-up. A sweep can be used without a hiller but the animal has to be trained to work with greater momentum to push some of the soil along the row of the growing crop for earthing-up. Donkeys are therefore often better than oxen for weeding a young crop using a sweep because a donkey tends to move faster for the same power output thus causing more soil disturbance and a slight earthing-up effect. In the absence of a suitable implement,

two passes become necessary—the first for inter-row weeding and the second for earthing-up to bury the weeds.

In perennial crops such as coffee, hillers are best replaced by reversible teeth working side by side with sweeps to cut the roots of weeds along and across the rows of coffee trees, disintegrating and shaking off any soil adhering to the weed roots by way of the reversible teeth. In ridge-cultivation systems weeds have to be scraped off at the bottom and sides of the ridges. The weeds growing within the crop rows can be controlled with hand tools or herbicides on top of the ridges.

Weeding implements

Categories and type

Weeding implements are basically of two types: single- or multi-purpose. Both types are based on a steel or wooden beam toolbar to which tools are attached. In a single-purpose implement they are attached permanently; in a multi-purpose implement, different tools can be attached depending on the job to be done.

Steel- or wooden-frame toolcarriers as described in *Perfected yet rejected* (Starkey, 1988) can be used for weeding, but these more expensive implements are not included in this discussion.

A good example of the steel beam toolbar would be the UFI and KABANYORO toolbars. An example of the frame type is the KILIMO toolbar making use of the ordinary five-tine cultivator drawn by oxen or a donkey.

Mode of operation

A single-action steel toolbar performs one operation at a time so that to complete a farm operation effectively two passes per row are necessary: inter-row weeding and earthing-up would be accomplished only after the return pass. On the other hand, a multiple-action tool-frame is capable of more than one action so that inter-row weeding and earthing-up are effectively completed in one pass, with the combined action of sweeps and hillers on the frame (Kayumbo, Chitopela and Mnyau, 1987).

A sweep has to be fitted on the beam for inter-row weeding in one operation and later the sweep has to be replaced by a hiller for the earthing-up on the return pass during weeding using single-action designs. A possible improvement here is to combine the two operations on the steel-beam toolbar.

Weeding systems

Flat cultivation system

For effective weeding under flat cultivation systems, the selection and operation of an animal-drawn weeder depends on row planting, type of crop, type of soil and type of weeds. It is almost impossible to weed a crop with animal-drawn weeders if it is not planted in rows.

A young crop requires different weeder attachments from those used to weed at a later stage of growth. Although both single-purpose and double-action weeder designs can be used to weed a young crop, 2–5 weeks after germination, weeder attachment combinations may differ. Single-action designs would probably carry a sweep the size of which would depend on the inter-row spacing. It could alternate with a hiller or tie ridger/weeder making use of a bracket fixed on the steel beam-end of the plow/ridger. The double-action frame type would probably carry reversible teeth on the front and two small hillers in the centre, with a sweep on the hind tine (or vice versa—a sweep in the front and reversible teeth on the rear tines).

Generally, young crops do not require a hiller for weeding by earthing-up following inter-row weeding when single-action designs are used, lest crop plants are covered with soil. With double-action designs using frame-type toolbars, inter-row weeding and earthing-up along rows of a young crop are possible only if the attachment combination consists of reversible teeth in the front, small but durable hillers in the centre and a sweep on the rear tine the size of which depends on the inter-row spacing adopted.

Ridge cultivation systems

With this system only inter-row weeding is possible between the ridges. The tie ridger/weeder blade can be used while fitted on the steel-frame toolbars. The tie ridger/weeder has to be fitted on the rearmost tine of the five-tine cultivator with or without the other tines on the frame (Kayumbo, Chitopela and Mnyau, 1987). Likewise the tie ridger/weeder has to be fitted on the steel beam only with the help of a bracket fixed on the beam end to convert the steel beam of the plow or ridger to a steel beam tie ridger/weeder.

The operation of the implement consists of its up-and-down movement; when the implement

is lifted the accumulated soil drops, tying the ridges at the same time. Although the operation requires hard work on the part of the operator, the success achieved is worth the effort because the action combines weed control with soil and water conservation.

Use of herbicides

Herbicides may have an important role to play particularly when dry planting of cereals and pulses is envisaged. However, in semi-arid areas with only marginal rainfall and poor rainfall distribution, insufficient soil moisture could render the chemicals harmless to the weeds. Herbicide use is necessary in minimum tillage systems making use of the animal-powered ripper tine, particularly when effective mechanical weed control methods are lacking.

Implement selection and evaluation

The width of cut of the weeder implement depends on the inter-row spacing used. A suitable implement therefore should be adjustable to cope with varying inter-row spacing. The five-tine cultivator is a frame-type toolbar with an easily adjustable width of cut. The single-purpose toolbar should have a set of sweeps and hillers of different sizes to cope with varying inter-row spacings.

In evaluating implements, the following points should be observed:

- the weeding implement should be assessed for effectiveness against a range of weed species at different growth stages in order to establish its range of action
- the implement should be tested for durability, particularly the soil-engaging parts. The frame or beam should not bend during work
- the effect of animal-drawn weeders on overall yield per unit area is best compared with yields from manually-weeded plots to establish the level of crop loss.

Design modifications

Single-purpose steel-beam toolbar

This design aims at converting all steel-beam plows and ridgers into simple toolbars. This is possible through the use of the steel-beam end of the plow after removing the mouldboard, or through the use of the steel-beam end of the ox ridger after removal of the ridger body. It should be possible to fit all the necessary attachments for furrow opening, weeding, earthing-up and ripping or crop lifting on these brackets.

Multiple-purpose steel-frame toolbar

This design aims at converting the ordinary five-tine cultivator into a weeding implement, harrow, ridger, or hiller and seeder. This is possible through fitting different attachments on the tines in different combinations to enable the farmer to kill all weeds at harrowing time, to open shallow furrows for hand seeding and to perform inter-row weeding and earthing-up in one operation.

Conclusion

Improving weeding technology in rural areas is best focused on existing methodologies already familiar to small-scale farmers. These should be improved rather than replaced by new designs and methodologies. In many countries the conversion of the steel-frame five-tine cultivator to suitable weeding implements for both flat and ridge cultivations of farming should be given priority.

References

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