

# The role of animal traction in soil and water conservation tillage practices among smallholder farmers in Malawi

by

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## **Abstract**

*Agricultural production in Malawi is carried out by smallholder farmers tilling fields of up to a hectare on customary land usually producing food crops like maize, sorghum, potatoes, cassava, bananas, pulses and others. Estate farmers have fields ranging from 35 hectares and over 500 hectares on leasehold land. While tractors are used on the estates, hand tools predominate on smallholder farms, placing an effective limit on the time and amount of land that can be tilled within a given time. Almost all crops except sugarcane are dependent on rainfall as their source of moisture. Standing agricultural recommendations advocate the use of ridges across slope for soil and water conservation. Ridges, box ridges and small dams have been recommended in dry areas but few farmers have taken up these technologies, mainly due to labour intensity and lack of equipment. The total food production has to be increased quickly to satisfy the demands of rapidly growing populations in this region. This paper presents a review of draft animal based tillage and planting techniques as practised by smallholder farmers in Malawi.*

## **1. Introduction**

The low and unpredictable rainfall that defines dry land farming is found on about 40% of the world's land surface, most of which is in the developing world. Lack of rainfall for Africa was probably less critical in the past than today because of increasing rates of population growth on this continent (Brady, 1988).

Africa's rapidly expanding population is a major factor in changing the face of that continent's agriculture. Agricultural production has not been able to keep pace with population increases and soil erosion has increased in severity.

Malawi is a semi-arid country. This means the country gets less rainfall than the humid tropical regions. Fortunately, however the country is blessed to have a vast mass of water in lakes which cover almost one third of the country and several perennial rivers. The problem that all this water is not used for irrigation to improve crop production except for a limited amount in sugarcane and rice production (Maida, 1986). Agricultural production in Malawi is solely dependent on rainfall. In good years the country has managed to produce enough for its population but of late the frequency of droughts has forced the Nation to import maize for supplementation.

There is standing recommendation that farmers should till their fields between April and June when there is still moisture in the soil. Most farmers do not till their fields during this period because they are pre-occupied with crop marketing, building repairs and the like. They later have to contend with tillage of dry soils, with hand tools. A small percentage of farmers attempt to make ridges during the dry season but these ridges are smaller and highly prone to be eroded by the heavy rains at the beginning of the season. The UN predicts that by the year 2000, soil erosion will have reduced land productivity by 25% from the 1975 level. Because of the dry weather condition, farmers have no choice other than wait for the rain to soak the ground before they can start tilling. This delays their planting time and greatly lowers their yields.

Human energy by itself is inadequate to make a significant impact on agricultural productivity. Acreages and yields are limited by the slow and heavy toil of hand cultivation especially in Malawi where a farmer is expected to split old ridges and move a lot of soil in the process of making new ridges. A man with a hand hoe can comfortably cultivate 0.4ha per year because he can rarely exceed using 1500 calories per day.

The National total food production has to be increased quickly to satisfy the demands of a rapidly growing population. Today, in order to

feed a much larger and rapidly growing population farmers are forced to use their farms year after year with limited inputs and without allowing the land to fallow in order to renew itself. As a result vast areas are becoming totally unproductive. Soil erosion has increased in severity in many parts of the country and has caused soil degradation and siltation of rivers. Less electricity is generated on the Shire River.

## **2. Conservation practices**

### **2.1 Animal traction**

Animal traction refers to the use of animals for ploughing, harrowing, ridging, carting, logging, pumping, threshing, planting and pulling sledges. In areas where insect pests and diseases do not prohibit herding of livestock, the incorporation of animals into the agricultural systems can help farmers in a many ways. Where motorised mechanised farm implements are unavailable or prohibitively expensive, animal traction is often the only alternative to back-breaking human labour. Beyond the energy they provide, farm animals can furnish organic fertiliser, milk, meat, skins and offspring. They can also become the source of additional income for many farmers through hiring of traction services, sale of milk, meat and other products.

Animal power plays a significant role in crop-livestock mixed farming systems in a number of ago-ecological zones of sub-Saharan Africa which include Malawi. Draft oxen are predominantly used in these regions. However their use is limited mainly to tillage and transport. Motorised mechanization is out of reach of many farmers in the region because of the size of their fields, technical know how and resources that are available to them.

Shortage of feed and water in some areas of the country before and during planting renders the animals generally weak at the time when they are needed most. Cultivation using animals typically allows a farmer a threefold increase in the amount of cropland that can be prepared by an average family using hand hoes.

### **2.2 Tillage practices**

Tillage practices in Malawi have been heavily influenced by historical events in the country. During the late 1940's agricultural planners made a number of recommendations that were

designed to protect the soil, environment and water. This was good intention especially for a country that has no mineral resources but unfortunately no effort was made to extend civic education on these recommendations to the farmers. Farmers viewed the blanket recommendations as part of a punishment plan. Some of the recommendations were too general to be applicable. An example of some of the recommendations which resulted in a lot of resentment were:

- (a) the compulsory digging of bunds in every farm which was introduced in 1948. Farmers who neglected or failed to dig the bunds were imprisoned.
- (b) the making of ridges on every farm before planting. This is still a hot issue in many flat areas including the Lower Shire Valley.

These recommendations were made hoping that there would be adequate rains every year. It has been reported (Harsh, 19995) that conservation plans virtually ignored the involvement and knowledge of local communities both at planning and execution level of projects. No recommendation was made for farmers in dry and drought prone areas. The current persistent occurrence of droughts calls for a review of the recommendations on ridge making, to suit the prevailing weather conditions and specific areas with critical slopes.

### **2.3 Primary tillage**

Primary tillage for many of the smallholder farmers at present involve splitting the old ridges and with the soil from the old ridge make a new ridge on the previous furrow. If this is done using a hand hoe like most farmers do, it is best done when the ground is moist, which is usually after the first rains.

Those farmers who have access to animal traction can till their fields at the end of the rainy season or depending on the soil type during the dry season. The implements frequently used by farmers using draft animals is the plough for cutting the soil, the harrow for levelling or breaking the clods and the ridger.

### **2.4 Conservation tillage**

Conservation tillage systems provide the most practical means of controlling soil erosion by wind and by water. This is achieved by

reducing the number of tillage operations and maintaining crop residues as mulches on the soil surface which in turn reduce runoff, evaporation, energy use and mechanical disturbance of the soil (Anderson, 1992).

Conservation tillage systems also utilise cover crops to ensure effective water conservation practices which help to offset soil degrading processes, to maintain soil productivity. Conservation tillage can increase the available water during the growing season through increased infiltration and reduced evaporation. It enhances crop yields where water is in limited supply (Parr et al. 1990).

Small scale farmers in Malawi tend to leave trash that has been cut and removed from the top of the ridge either scattered or heaped in the furrows. This trash will reduce the flow of water so that more water can sink into the soil. At the same time it reduces evaporative loss of soil water from the furrow area. Small amounts of crop residues in these systems can effectively control both wind and water erosion.

## **2.5 Rationale for water conservation**

Malawi practices dryland farming which is characterised by low and unpredictable rainfall. With increasing frequency of droughts in the country, lack of adequate rainfall for agricultural production is perhaps the most critical factor currently. Researchers are developing technologies that farmers can use to sustain productivity at a profitable level, while conserving renewable natural resources. However, these can only be useful if there is rainfall or irrigation facilities. Water is important in crop production, livestock farming, fish farming and for human use.

Conservation of water resources is an important element in productive agriculture and a major consideration in dryland areas. In areas where rainfall is barely adequate to support crop cultivation with less than 250mm annually, farmers must have technologies to conserve all available water.

## **3. Role of animal power in soil conservation**

### **3.1 Small dams**

There are many farmers in the upland areas of Malawi who would like to have a small dams of water for their own use. These farmers make dams using animal drawn dam scoops

based on the BAIN design of Zimbabwe. The procedure for digging these dams is described in detail by Kumwenda (1988). The scoops which have a capacity of 0.2m<sup>3</sup> were imported from Zimbabwe. The dam scoop is made from a 3mm steel plate. It is 80 cm long and 70cm wide with the back and sides 30cm high. The bottom is flat and is reinforced with 4cm thick flat bar runners every 16.5cm along its length. The digging front edge is a removable metal plate 16.5cm wide by 80cm long. It is attached to the scoop body with eight screws in such a way that 4.5 cm is left protruding, to do the digging. A drawbar is attached to lugs from the centre of the sides. The drawbar must be able to swing freely from the front to the back of the scoop to enable the operator to tip it over. Wooden handles are attached to the sides behind the drawbar attachment point. The length and angle of the handles should be made to suit the operator.

Before digging the pond, an area should be chosen with a fairly flat terrain. The area within the pond should be ploughed or dug by hand hoe to loosen the soil. When the scoop is attached behind the oxen, it should be pulled along the loose soil while tilted slightly by lifting up the handles. When the scoop is filled with loose soil the handles can be released and the scoop let to be dragged to the dumping point where the handles are then lifted up sharply with the oxen still moving forward. This tips the scoop over completely with little effort from the operator. The scooped soil is deposited to form the walls by turning it over on its side or by pulling back on the handles when the oxen have stopped. Usually the finishing touches such as the walls and sloping the banks are best done by hand.

### **3.2 Box and tied ridges**

In dry areas farmers are advised that when they have made their ridges along the contour, they should also make short ridges across the original ridges at every four or five metres along the furrow. This exercise is known as tied ridging. If the ridges are closed with short ridges at the end only then they are called boxed ridges. Box as well as tied ridging requires more time and labour to make therefore farmers are not keen to make them although they are quite useful in dry areas where rainfall is inadequate. If farmers use hand hoes these structures are really difficult to make but with animal drawn implements such as the ridger and tie-ridger, it becomes much easier to construct them.

### 3.3 Use of old ridges

Use of old ridges previously made by animal drawn implements has proved to be quite successful. Planting row crops on preformed (old) ridges has been gaining popularity as a time, energy and nutrient conservation practice especially for maize production in the tobacco growing areas. Maize is planted on the same planting station as previously occupied by tobacco. Advantages are decreased soil erosion since only the planting stations are disturbed and increased water conservation. The method enables the farmer to plant as soon as the rains come and it also allows the maize to use the residual fertiliser that is not utilised by the previous crop. The use of old ridges has been proved by farmers and researchers as being equally effective in production of maize. Kumwenda (1990), found no significant differences in yields of maize grown on new ridges and the yield of maize grown on old ridges. The critical factor that farmers prevent in this case is late planting which is caused by preparing the fields after the first rains, resulting in late planting of crops.

### 3.4 Modified ridges

There is a technique in Malawi which farmers use to capture maximum moisture from rain water. They use modified ridges. In case where farmers are late in making new ridges before the first rains they dig some soil from the old ridge into the furrow where there is more moisture and make a new planting station on top of this soil. After two or three weeks just when it is time for weeding, the farmer will come to make complete ridges along the furrow. This ridging operation combines with the first weeding operation. This type of tillage can only be practised if the farmer is using a hand hoe in the second year to dig ridges that were previously made with animal drawn implements because they retain their big size after a rainy season.

### 3.5 Planting in the furrows

Almost all the farmers in Malawi plant their crops on the ridges. Ridges act as basins in the field because they concentrate rainwater into the furrows. The furrows therefore have more moisture than the ridge. The most suitable place to plant seed when inadequate moisture is expected in the season is in the furrows. Using this technique, farmers are able to plant as soon as the rains have arrived. The only disadvantage of planting in the furrows is if the field has been prepared by hand hoes over

many years. Then, the furrows are part of the hard pan, which cannot be penetrated easily by root crops.

### 3.6 Planting techniques

It is always good to plant early whenever it is suspected that there will be less soil moisture available. It is also advisable to have the correct plant population so that plants can cover the ground as soon as possible. This reduces evaporation water from the soil but allows soil water to escape only through the plant. Plants also act as cover crops that effectively control certain weeds by blocking sunlight and suppressing their growth. Animal drawn planters are available but most of them cannot plant a constant number of seeds, cannot plant on the ridges and require seed that is graded.

### 3.7 Networking

Within the country and among countries there is need for networking if the results of traditional knowledge and modern research in the region are to be delivered in the most comprehensive and timely manner.

Communication within the user community must be enhanced. To this end the results must be made available to decision makers research, extension agents and farmers who will use them. There is a growing worldwide recognition of the importance of sustainable agriculture as a means to ensure that agricultural productivity will be maintained for future generations. While increases in production are needed to meet increased food demands, these demands must be met by practices that will not deplete soil water and degrade the quality of the soils on which the crops are being grown. This is an area where animal traction can play a significant role in providing power to perform timely activities or reduced drudgery.

Some of the technologies researchers are developing are such as:

- a) To maintain soil productivity by adding small amounts of organic manure from the animals and chemical fertiliser.
- b) Using crop and other plants to biologically fix nitrogen.
- c) Employing alternative tillage methods such as conservation tillage.
- d) Conserving the available water resources by better timing of agricultural activities, use of crop residues on soil surface and

- various cultivation techniques such as terracing, tied ridges and furrowing.
- e) Using biotechnology to develop plant varieties that are harder, faster growing and more resistant to pests and diseases, drought and soil conditions that constrain productivity.
  - f) Alternative farming systems such as alley cropping and mixed farming which can help farmers to conserve and improve the renewable natural resources upon which their productivity depends.

#### 4. Discussion and conclusions

According to Harsch (1995), in order to banish the scourges of hunger and poverty, African farmers have to do two things together:

1. greatly boost their farm yields and
2. ensure the long term viability of the natural environment, upon which agriculture depends.

The fertility of Africa's soils, the condition of its rivers and ground water and the abundance of its vegetation, trees and wildlife are all essential elements in Africa's ability to produce enough food for its people. Farmers have to overcome many problems, for them to succeed. The main problems at the moment facing smallholder farmers with their tillage, soil and water conservation are:

1. Smallholders have for many years been using the hand hoe for tillage weeding and all other field cultivation. Due to the nature of this implement and the power required farmers are unable to plough deep enough therefore a hard pan has formed in almost all their fields. During the rainy season, especially at the beginning of the season the pan prevents the water from rapidly sinking into the ground. As a result there is excessive soil and nutrition erosion caused by the water. There is need to break the pan at least once in five years to enable rain water permeate into the soil easily. This is best done by smallholders through the use of animal traction.
2. The mechanisms and structures for soil conservation require that every farmer in a catchment area should have the right structures constructed in the proper manner and in a coordinated manner. Upper catchment farmers can destroy the

farms of those downhill. Gullies also easily develop.

3. On most smallholder farms there is a severe shortage of soil nutrients because of the way farmers have historically been producing their crops. Farmers grow the crops, control the weeds and at the end the season remove all crop residues from the fields either to prevent livestock from coming to their fields and pulverise the soil or the residues are used as firewood. This practice does not allow some biomass to be left on the fields therefore the soil has very little nutrients and soil micro and macro organisms.
4. Smallholder farmers do not have adequate time to prepare their fields. Although it is recommended that farmers should start preparing their fields immediately after the rains, they can incorporate residues that would help improve their soils structure and fertility but most of the farmers are so busy at this time of the year harvesting and marketing their crops. By the time the farmers finish these operations the ground is normally too hard for effective ploughing.
5. The effects of soil and water conservation structures take a long time to be appreciated. There is need to teach farmers the benefits of conservation tillage and that they take a long time to be realized. The civic education should also cover the importance of regular maintenance of these structures for effective results.
6. Use of draft animals can greatly increase farmers crop yields by providing power to perform a number of farm operations on time without drudgery. These efforts have been frustrated by lack of draft animals, poor training, lack of trained personnel, poor animal management, availability of feeds and water, high animal mortality rates, financial problems, uncertain supply of equipment and spare parts, lack of suitable equipment, poor harnessing techniques, land shortage and poor terrain.

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