# Conservation tillage with animal traction for soil-water management and environmental sustainability in Namibia

*by*

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***Abstract***

*This paper is based on the outcome of a national workshop on conservation tillage with animal traction for soil-water management and environmental sustainability held 16-18 June 1998, Okashana, Namibia. The Ministry of Agriculture, Water and Rural Development (MAWRD) conducted the workshop. The information gathered through paper submission and presentations reviewed indigenous knowledge on the subject both in the commercial and small-scale farming sectors, implements available, rainwater harvesting techniques and the use of draft animal technology. The status of conservation tillage in Namibia is mixed. In the commercial farming sector conservation tillage has been practised for over 15 years during which several tine implements have been introduced and conventional tillage implements such as ploughs and discs replaced. The trend with small-scale farmers is more towards conventional tillage where nearly all farmers using draft animals, mouldboard plough their fields and those who have access to tractors disc plough and harrow. A handhoe is most common and has been used by some farmers to prepare their fields for dry planting (minimum tillage), a method that has been reported to be restricted to very small portions of land. It is a tiresome operation as it is performed during hot season and farmers only use it because they have no other options. Planting on ridges and broadbeds has also been observed but the practice seems to be a traditional land preparing method that eases planting and weeding. Ridges are rarely made across the slope. Recently, draft animal power projects have introduced animal drawn tine implements such as rippers and results from the two-year trials appear promising. These implements work the soil faster than the mouldboard ploughs and hoes, however, there are also negative outputs associated with their use. They do not allow incorporation of manure into the soil and weeds tend to grow faster than in conventional tillage systems and weeding is constraint if cultivators are not applied.*

## 1. Introduction

Namibian climate can be described as semi-arid to arid. The climate is influenced by two deserts, the Namib in the west and the Kalahari in the east. Of the total area, desert region is 22%; arid land, 33% and semi-arid land, 37%. The climate has a definite bi-modal pattern with rain season normally beginning in October through the end of April. Most rain normally falls between the end of December and the middle of April (Hydrology Division, 1998). In the Northern Communal Areas the mean annual rainfall ranges from 300 mm in the west to 700mm in the east. January and February are usually the wettest months (Hutchison, 1995). In other parts of the country such as the coastline the mean annual rainfall is generally less that 50mm. In the south the mean annual rainfall is 50-160mm and dryland farming with this amount of rainfall is very difficult (Goagoseb, 1998). The mean annual evaporation normally exceeds precipitation by a factor of 5 to more than 10 in most parts of the country. For example the mean annual evaporation is estimated at 2750 mm and 2530 mm for the North Central Divisions and Kavango respectively. These areas have less than 700mm mean annual rainfall. The evaporation values in central-southern areas go up to 3700 mm, this is where rainfall is the lowest (van der Merwe, 1983; Hydrology Division, 1998).

Soils particularly where crop production is practised, are generally sandy with low water retention capacity. Reliable crop production under rainfed conditions is only possible in areas receiving an average of over 400 mm rainfall annually, representing 34 per cent of the country. It is reported that 97 per cent of the soils in these areas have clay content of less than five percent (MAWRD, 1995). These soils have very low organic matter, poor water holding capacity and are generally poor in several nutrients except calcium. Only approximately 1% of the total land has soils with (medium to high) potential for irrigated arable production (Alweendo, 1998).

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## 2. Animal traction: Status and strategies

There is already a tradition of using draft animals for ploughing and transport in various parts of Namibia. Several farmers have used oxen and donkeys for ploughing and transport. This practise can be traced to over 100 years ago. Currently, indicative estimates are that 60-89% of farmers in the Northern Communal Areas use draft animals. Even though crop production in communal areas such as Erongo, Kunene and Omaheke is very limited, draft animals still play a very important role in transport. In these areas probably 80-90% of the rural households use donkey carts for water collection, human transport and trade.

The ex-government of the Republic of Namibia has recognised the importance of draft animal power technology and policy statements relating to DAP have been pronounced in the National Agricultural Policy (MAWRD, 1995). In collaboration with some donor-funded projects, implementation of the DAP technology have been undertaken by establishing the National Draft Animal Power Programme centre at Mashare Agricultural Development Institute (MADI), (Misika, 1998).

An ox-drawn plough is the most common animal drawn implement available in the northern communal areas. Nearly all farmers owning draft animals particularly oxen own at least one plough. Farmers have expressed confidence in working with a plough and many feel that they are satisfied with their ploughing operations. Implement stockists appear to have no problem in selling ploughs and farmers know where to find them, even in in remote areas. Generally there are no repair facilities in these areas and some farmers end up purchasing new ploughs as sources of worn out parts (Mwenya, 1998).

The interest in weeding with draft animals is increasing in communal areas. Some cultivators have been tested and tried with farmers. The light Senegalese, BS41 and Maun cultivators have been accepted by several farmers and need effective strategy for farmer adoption. In some parts of North Central Division there is already a steady increase in the number of cultivators in use. However, stockists also demand assurance of business when contacted to take interest in stocking cultivators. This is particularly because implement distributors do not know the actual demand for cultivators yet. Moreover, not many farmers have shown "real demand" for importers to enter this market.

A ripper is another implement being promoted in Namibia. There are approximately 100 rippers available in Namibia. These implements have been mainly on trial basis and very few farmers know about their usage. Where rippers are promoted they are mainly used as tools to open up furrows for planting in dry lands.

### 2.1 Rural transport

Rural transport by use of sledges and carts is common in rural areas. There are more sledges than animal drawn carts being used in Northern Communal Areas especially the Caprivi and Kavango Regions. In the Northern Communal areas, farmers normally make sledges themselves while carts are manufactured by small workshops in towns. This is not the case in the South, West and East of the country where farmers manufacture the carts themselves. There has been not much deliberate intervention from projects or the National Draft Animal Power (DAP) Programme to promote rural transport through training or supply of components. Unlike land preparation and weeding, transport is an activity conducted throughout the year and should be seen as an integral part of farming systems in the communal areas.

### 2.2 Management issues

Management of draft animals is normally a major concern by farmers, financing institutions and promoters of draft animal power technologies. The productivity of draft animals is normally questioned in some areas where grazing land is poor and usually the animals in these areas are weak at the beginning of the land preparation season when they are needed most. This situation threatens the success of the DAP technology as financial institutions sometimes fear giving loans to farmers for reasons that farmers may not pay back. This in some cases leads to late land preparation. Strategies to improve care and nutrition are being formulated to guarantee productivity of draft animals. Conservation of feed resources that are abundant during rainy season and after crop harvest is one way of addressing the situation. The Northern Namibia Rural Development Project (NNRDP) has in the past season (1997/98) initiated treatment of millet straws for supplementary feeding of draft animals. Initial results appear to be positive but more work needs to be done.

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Another strategy could be to encourage a few farmers getting credit from financial institutions to enter into production of fodder under irrigation. These farmers could supply feed to other farmers who may not afford irrigation systems (Misika, 1998). Moreover, in the commercial farming sector feed conservation is already being practised in Namibia. Strategies to explore this practice and adapt it to communal farmer level are also being investigated.

## 3. Conservation tillage methods

### 3.1 Indigenous knowledge

Conservation tillage has been acknowledged as a more productive technology for crop production in the commercial farming sector. The commercial farmers in Namibia are reported to have started shifting towards conservation tillage practices over 15 years ago and results have been well-appreciated (Maltzahan, 1998). Some farmers have benefited from increased soil productivity and increased yields due to expanded crop fields. The technology has allowed the farmers to prepare their fields much faster than the conventional tillage systems. Methods used to conserve soil-water include minimum tillage, zero tillage, ridging, mulching and timely weeding.

On the other hand, indigenous knowledge on soil-water management by small-scale farmers in the communal areas appears to be mixed. Some farmers in this category have practised dry planting, planting on ridges, minimum tillage and zero tillage. However, not all of them are aware that their tillage systems conserve soil-water for crop production and to others these practices were passed traditionally, from one generation to another. According to Matanyaire (1993, 1998) the majority of farmers in the North Central Division (81%) planted on ridges and broadbeds while those in Kavango (94%) planted on flat land. This is a strategy out of indigenous ingenuity to facilitate drainage and increase the crop-rooting zone in shallow profiles. The ridges are generally made up and down the slope and are rarely across the slope. Most farmers in the North Central Division (NCD) were using this system as a traditional land preparation method that eased planting and weeding. This suggests that the practice is not connected to conservation tillage for soil-water management nor connected to soil erosion prevention. Other farmers are planting on ridges to encourage drainage. Nonetheless, several communal farmers have used minimum and zero tillage practices simply because they were late to prepare their fields. These farmers are mainly using hand hoes (dry hoeing) to open up planting holes at desired spacing. Dry hoeing does not allow rain water to seep too far beyond the root zone. Equally important, is that seeds sown at shallow depth benefit from the first rains and get a chance to establish early (Naunyango et. al. 1998). However, the practice is labour intensive and cumbersome. Poor germination is also common due to insufficient rains at the beginning of the season.

In the Caprivi Region crop farming systems may be divided into river-lands and dry-land farming systems. Some conservation tillage practices that can be acknowledged in dry land farming are such as animals being left on the field to graze after harvest. Animal droppings spoil some stover, which they cannot eat. The spoilt stover together with the dung partially form some mulch on the top of the soil and this is reported to give soil sponge-protection during the first rains. It also helps in water retention. However, the contribution from this practice is minimal. In most cases, stovers are not grazed because harvesting is usually done after animals have been taken to the upper lands. The stover rots in the field and acts as a water collector and retainer.

### 3.2 Implements used for conservation tillage in Namibia

The early 1980's marked a shift, in the commercial farming sector, from conventional tillage to conservation tillage practices. Very few practised conservation tillage before 1980. From 1980 tine implements were introduced and these slowly started replacing conventional implements such as disc harrows, disc ploughs and mouldboard ploughs. With small-scale farmers the trend has been more towards conventional tillage. Ploughing with tractor drawn discs and animal drawn mouldboard ploughs has been most common. These implements work the whole land and in some cases has been reported to cause negative effects to the soil. A few farmers, particularly in Kavango Region have observed accelerated loss of soil fertility because of the use of animal drawn ploughs and tractor disc ploughs. They believe that in fields where hand hoe is used the soil takes longer time to show signs of infertility compared to where a plough or disc had been used. This is normally confirmed when a certain weed called *esusu* becomes prominent.


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Since 1996 the trend to use tine implements with draft animal power has been observed. Draft animal power projects have introduced chisel tines attached to cultivators and rippers attached to the mouldboard plough beams. So far the Magoye ripper and the Zimbabwean curved ripper have shown good results in various soil types. The improved "manipulated" chisel tine adapted on the Senegalese cultivator is also promising but needs modifications for deeper penetration.

The Magoye and Zimbabwean rippers have been used mainly to open up furrows for planting while the manipulated chisel tines on the Senegalese cultivator were used to loosen soil without inversion. Some conclusions in land preparation with regard to the use of chisel tines and rippers by NNRDP (1996/97 and 1997/98 seasons) include the following:

- Minimum tillage speeds up soil preparation
- Dry sowing increases yields in case of terminal droughts
- With minimum tillage weeds grow earlier and faster than in conventional tillage
- Dry sowing with DAP results in a better germination than dry sowing with a hand hoe; more water is easily captured in the furrow.
- Ripping does not allow incorporation of manure into the soil, thus, conventional tillage should be allowed after a few years.

**4. Rain water harvesting for crop and livestock production**

Namibia has developed an extensive infrastructure for bulk water supply from large dams, aquifers, canals and pipelines throughout the country though very little for crop irrigation. In rural areas there are several small dams, wells and boreholes. Except for some of these small dams that enhance recharge to boreholes and for storage dams, few water harvesting methods are in practice. The most common rainwater harvesting methods in Namibia include harvesting rainwater from the roof, runoff and floods. In the North Central Division it can be said that water harvesting is achieved through the natural "pans" called *Oshanas*. Water harvested on roofs from rainfall, in rural areas, has limited application. Much smaller quantities are harvested for crop production, particularly vegetables. Rainfall water collected even in small dams is usually too little for sustainable crop production. It is however most useful for livestock.

The runoff potential in most parts of Namibia is approximately 2% of the rainfall (Hydrology Division, 1998). The major zones of potential runoff can be distinguished as follows:

- Central strip which has little or no top soils, underlying impermeable geology, covering mostly hilly and mountainous terrain and at the most, moderate vegetation. This area has well developed drainage systems and a relatively high runoff potential with average runoff/rainfall ratios between 1 and 10%.
- Areas where there is no surface runoff due to sand dunes with a high infiltration capacity (Namibia and Kalahari deserts in the south); very flat terrain covered by soils with a good water absorption capacity (Eastern, north-eastern and Central which include Sandveld, Cuvelai, Kavango and Eastern Caprivi areas).

Runoff in the interior of Namibia occurs as a direct response to rainfall during the few heavy showers in the rainy season. The main reasons for this direct response phenomenon include erratic rainfall patterns. The main reasons for this direct response phenomenon include erratic rainfall patterns and high river bed loses. The physical features of the terrain are such that they have little potential for surface or subsurface storage, which would enhance delayed runoff.

**5. Agroforestry as a conservation tillage technic**

In Namibia, there is a very strong case for dry land agroforestry systems which are basically aimed at the deliberate management and introduction of high value trees on farm land, be it cultivated farm land or pasture or bits of uncultivated land between settlements. Examples include trees, to conserve soil fertility and also improve crop production by acting as windbreaks, shade crops and Nitrogen fixers.

**5.1 A Case of riverline agroforestry**

The present practice observed along rivers such as the Kavango and Zambezi, is that huge areas are used mainly for the production of rainfed annual crops. This means that in any year, there is little production on the riverline fields which are within a few meters of permanent water. In addition, no attempts have been made to trap or harvest flood waters to be used in the dry season to grow crops. The clearing of natural riverline vegetation for


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cultivation of mainly annual crops, represents not only a bio-diversity loss but also loss of the total productivity of riverline belts. Riverline agroforestry would attempt to mitigate this by integrating some perennial, biannual and annual crops to be produced along rivers. The philosophy is to maximise the production of these types of lands for the benefit of farming communities, while protecting the soil and maximising the use of available ground and river water.

### 5.2 Environmental sustainability and conclusions

The significance of soil and water loss in itself is not immediately obvious in areas where yields are very low. This is because it may be more efficient for an individual farmer to face a yearly loss of a small percentage of produce than to invest substantial amounts of money or time in methods that reduce environmental damage. Therefore there may be two sources of motivation for promoting conservation tillage from a sustainability point of view: Firstly, the costs of learning a new technique must be low enough to justify doing so for the individual farmer. This is particularly likely to be true in areas that are already degraded and where the farmer either has to invest in new crops or face the expense of moving elsewhere. This is a conventional economic justification of extension generally.

Secondly, the remnants of riverline vegetation in Northern Namibia are likely to have much higher marginal values than they would in a virgin state due to the irreversibility of their loss. Hence conservation tillage will have value in reducing the need to convert woodlands into croplands. These values include bio-diversity generally and in particular, wildlife, in areas of high tourism such as Kavango and Caprivi. One key source of value of woodlands generally is in coping with drought, both providing materials for human use (for food and crafts) as well as browse for livestock. Again marginal values will rise as the amount of the resource falls.

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