# Soil fertility and minimum tillage equipment trials in the North Central, Namibia

*by*

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***Abstract***

*The paper highlights investigations conducted to identify soil types and their fertility status in the North Central Division of Namibia. The survey was necessary to describe the soil status before introducing minimum tillage and soil conservation tillage practices in the area. Several animal drawn implements were tested on the farmers' fields. These included cultivators from Senegal, Zimbabwe and Zambia. Pleriminary results of the survey have been reported and discussed.*

## 1. Introduction

The Northern Namibia Rural Development Project (NNRDP) started its activities in 1994. The project adopted an Action Oriented Research approach, working with farmers as equal partners in pilot communities of the North Central Division (NCD). Project staff and farmers identified weeding as a major constraint in the area. Consequently, in 1994/95 and 1995/96, tests on three animal drawn cultivators, the Senegalese cultivator, French cultivator and BS 41 were conducted. By 1996, the use of the cultivator for weeding had become an extension message.

During the 1996/97 and 1997/98 seasons, tests on minimum tillage and dry sowing with animal traction in the North Central were initiated. It was realized that the selection of appropriate equipment and the definition of comprehensive extension messages would be incomplete without a fair knowledge of the soil types in the area.

In 1996 a soil survey was therefore initiated and carried out in 1997 and 1998.

### 1.1 Objectives

The main objectives of the survey were:

- to assess farmers' knowledge of the different types of soil
- to assess soil characteristics
- to identify and investigate some of the fertility problems in the NCD
- to gather information on farmers practices and
- to analyse the rational of the use of implements for minimum tillage in the North central regions.

## 2. Materials and methods

The following activities were carried out:

- 22 interviews, specifically on soil fertility, with farmers from 4 NNRDP pilot communities namely: Eefa (Central Oshana area, Oshana Region), Eunda, Onesi (Western area, Omusati Region), and Onamutanda (Central and Eastern Oshana area Ohangwena Region).
- Collection of 42 soil samples which were analysed by the agricultural laboratory in Windhoek. Soil profiles were drawn from 15 sites.
- Other interviews with farmers, related to soils, minimum tillage and weeding.
- Literature review.

## 3. Results

### 3.1 General problems related to fertility

During the survey, some common features which were observed included:

- Soils are sandy and poor in some nutrients (nitrogen, phosphorus).
- Soils are very poor in organic matter and have very low structural stability.
- Soils have a poor water retention capacity and tend to form a hard pan naturally or after repeated ploughing at the same depth.
- Although farmers are well aware of the benefits of applying manure on their field, they do not always have the means to do so.
- Water-logging is common although rainfall is limited and water content of some soils may change drastically over short periods (from water-logging to surface crusting).
- Rainfall is low, erratic and often occurs as big storms.
- Direct sun light is extremely high and temperatures are high.
- Farmers practice continuous cereal cropping.
- Land is completely bare during the dry season.

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- Most of the current practices to manage fertility are labour intensive although labour is a major limiting factor in the farming system.

### 3.2 Identification of soil types

| ***So**il type* | **Farmers' assessment** | **Technician assessment** |
|---|---|---|
| **Soft and deep** *Sandy soils* | These soils are deep and sandy, very soft, forming neither hard crust nor hard pan. Water percolates very easily but water retention is poor.<br><br>These soils are found mainly in the highest Part of the field. They occupy large Portions of the field in the cuvelai basin and western areas.<br><br>Local names of these soils are "ehenge", "omuthitu" and "efululu". | These soils are characterised by a poor potassium, phosphorus and calcium content and a low pH. They often have low magnesium content.<br><br>*These soils can be classified as arenosols. They have the lowest chemical fertility (but not the lowest fertility, since they do not tend to water log).* |
| **Low ground and swamps, loamy sandy soils** | These soils contain more clay than other types. Have low percolation and are found in lowest parts of the field. These soils constitute the oshana system. They cover large areas in the cuvelai basin, smaller areas in the eastern and western parts of the NCD. *Local names of these soils are: "okashana", "oshana", "edhiya" and "okatenhegue".* | These soils, well described by farmers, are also characterised by a fair amount of silt and a rather high fraction of clay (20%) in the deeper horizons (deeper horizons are sandy clay loam soils) |
| **Water logged/ Hard dry soils** | These soils are characterised by a hard pan, between 20 to 30 cm depth. Have low percolation and after a rain shower, the soil they turn to mud. When rain evaporates, a hard crust is formed on the surface.<br><br>These soils have the poorest fertility, are often found in the lowest and the middle part of the field. They are common in the cuvelai basin and the western areas.<br><br>Local names of these soils are: "ehenene" and "olundanda" | These soils are characterised by: a thin layer (10 to 30cm deep), high concentration of calcium, which may hamper the absorption of other nutrients. The thin layer is very hard, prevents water percolation. pH neutral on the surface, alkaline deeper (8.5 to 10.5)<br><br>Deeper horizons are saline, which limit the ability of the plant to absorb water. Furthermore, the high Na concentration induces a low structural stability (the soil turn to mud very easily). |
| **Good deep** *And dark soils* | These deep soils are relatively soft. The water penetrates easily and those soils have a good water retention capacity.<br><br>These soils are found in the highest parts of the field, in both the cuvelaï basin, the western and the eastern areas.<br><br>Local names of these soils are : "omutunda" and "elunda" | These soils, have the following Characteristics :<br>• pH neutral,<br>• poor phosphorus content,<br>• normal Ca content,<br>• relatively good concentration of the various other nutrients,<br>• gentle transition between the horizons and<br>• a good water retention capacity. |
| **Very hard** *Soils/ new fields* | These soils are very hard, with a very poor water penetration and a very poor fertility. These soils are mainly found in the western areas. Local names for these soils are : "etunda" and "oshikalanga" | It has not been possible to take samples from this type. |

**Other soils**

Termite hills ("oshiwanda"), old termite hills ("oshitunu") and riverine type of soils ("omulonga") have been described by farmers but have not been investigate properly.

### 3.3 Farmers' conclusion

At the field level soils are extremely heterogeneous. Basically, all the types described previously can be found within the same field. Therefore, a transect representing the location of the soil types has been established.

Consequences have been as follows:

- Farmers consider water in the soil and not only rainfalls, to be the first determinant of the yield. Water penetration and water retention are indeed the key issues.

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- Farmers consider that the hardness of the soil is an important criteria. Ssoft soils are preferred in the NCD.

### 3.4 Technician's conclusion

In the NCD soils vary from sandy to sandy loam. On average, the sand content is 87%, the clay content is 9.5% and the silt is 3.5%.

In the NCD, soils have a rather poor water holding capacity and soils are poor in nutrients.

## 4. Discussion

### 4.1 Farmers' management of fertility

Cattle and goat manure are well known by farmers to improve the fertility of their field. Donkey manure is hardly use in the NCD.

Manure is always applied in big quantities, when available, spread all over the field, under the form of a "dry kraal powder" (and not "fresh manure"). It is usually used pure, only few farmers mixing it with straw or grass.

Manure is usually applied in November/ December, to allow the crops to take benefit from it. However, to apply manure is labour intensive and manure is not always available in adequate quantities, especially if cattle are sent to cattle posts and do not stay around the homestead, in kraals.

### 4.2 Ridges and soil preparation

Reasons for erecting ridges, in the NCD, are to eliminate the excess of water in water logging soils. Crops are cultivated on top of the ridges. The ridges evacuate the excess of water toward an Oshana or a water reserve area. It has to be noticed that excess water in the furrow can constitute a reserve of soil moisture.

In sandy soils (eastern areas) farmers sometimes cultivate their crops in the furrow left by the plough and water may settle in it.

### 4.3 Use of fertilisers

Fertilisers are hardly used by farmers because they are expensive (poor cost/benefit ratio) and not always balanced. In the NCD, fertilisers should have phosphorus predominant.

Some well-balanced fertilisers could be useful to upgrade the phosphorus and magnesium content of the soft and deep sandy soils.

### 4.4 Other management practices

In the NCD, farmers do not practice fallow and do use crop rotation.

It is the traditional to use the hand hoe for land preparation. However, it is time consuming and this technique does not allow farmers to prepare their whole field on time.

Furthermore, farmers can erect ridges using the hand hoe, but it is time consuming and labour intensive.

### 4.5 Utilizing animal drawn implements

Such implements allow farmers to prepare the field on time, to erect ridges easily and to control the plough depth.

However, in water-logged or hard dry soils, continuous ploughing at the same depth must be avoided, as it will enhance the formation of the hard pan. Animals must be ready, trained and healthy at this time of land preparation yet this is usually the time of great fodder shortage.

### 4.6 Use of tractors

Tractors allow farmers to prepare large fields quickly. However they are not always available when needed or on time. Like with animal traction, on water logged and hard dry soils continuous disking at the same depth must be avoided due to the formation of the hard pans. According to farmers disking can create hard pans in "hard-pan-free" sites and disking does not allow farmers to control tillage depth.

## 5. Experimenting with weeders

From preliminary findings were clear that it was worth trying implements for minimum tillage using animal traction. The implements tested in the NCD were for minimum tillage and dry sowing

### 5.1 The Senegalese cultivator

This implement was tested in 1996/97. The tool was 1 cm thick, 24 cm long and was characterised by a working depth of 8 to 10 cm. This tool was attached to the body of the cultivator. The implement was light and could be pulled by a single donkey. It made small line and on sandy soils, sand fell back into the furrows. The positioning of the chisel tine at


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the middle of the frame of the cultivator made the implement unstable.

It was therefore, decided together with farmers, to test an improved tine with a larger angle bar and an attachment at the rear side of the cultivator.

**5.2 The improved chisel tine**

This implement was tested in 1997/98. The angle bar was welded on the chisel tine and was about 5 cm wide. The chisel tine was 24 cm long and it was positioned at the rear side of the body at the beginning of the handle.

The prototype was produced by a local welding company (Oshakati Best welding) at a cost of N$ 20.00. A single donkey could still pull the implement.

With the improved manipulated chisel tine the furrow was still not deep or wide enough. It didn't prove suitable for hard soils (water logged or hard dry soils), sandy soils (soft and deep)s or low ground and swamp, loamy soils). It was suitable only for soft soils (good deep and dark soils).

The improved chisel tine and improved manipulated chisel tine were not adapted to the NCD conditions, except in very special soil conditions which were good, deep and dark.

**5.3 The Zimbabwean curved ripper**

This unit was adapted from the Senegalese cultivator. This implement had been tested in 1997/98. The Zimbabwean curved ripper was bigger than the improved manipulated chisel tine and made larger furrows. But since it was adapted from the Senegalese cultivator it remained lighter than the Magoye ripper which was held on the traditional plough beam.

The Zimbabwean curved ripper was 28 cm in length, 6.5 cm in width and it was attached on the rear side of the body of the Senegalese cultivator.

Adapting the Zimbabwean curved ripper on the Senegalese cultivator required a special attachment system. This one was produced by the same local welding company at a cost of N$ 20.00.

With wings adapted to it two donkeys were needed to pull the equipment.

On performance, depth and width of the lines were correct. On soft and deep sandy soils, wings were compulsory. However, the implement was not tested on farms as farmers were reluctant to try it.

The Zimbabwean curved ripper penetrated hard soils which were water logged and hard and easily so. Draft requirements were low on soft soils.

The Zimbabwean curved ripper was therefore the most versatile and required minimal draft.

**5.4 The Magoye ripper**

This implement which utilized the traditional plough beam was tested in 1996/97 and 1997/98. This implement was 24 cm in length, 9 cm wide and 0.9 cm thick. The unit required two donkeys to pull it.

When wings were added at least two donkeys were needed. A pair of oxen was even better. The depth and the width of the furrows was correct and even better than the ones obtained with the Zimbabwean curved ripper. In soft and deep sandy soils, wings were needed to keep the soil from falling back into the furrow.

The Magoye ripper penetrated very easily, opened the soil nicely but was heavy to pull in water logged and hard dry soils. The Magoye ripper with wings was very well adapted to soft and deep sandy soils.

Occasional problems of the Magoye not fitting on the plough beam were encountered. The mouldboard was also occasionally difficult to remove since farmers did not always have the tools needed to take it off when installing the ripper. Unlike the Zimbabwean curved ripper, the Magoye ripper was applicable in most soil types.

The wings on both the Zimbabwe curved ripper and the Magoye Ripper were well suited for deep sandy soils, which tended to flow back into the furrows. The wings were 19 cm wide and 22 cm high. With the wings, at least two donkeys were needed.

**6. Conclusion**

Soils in the NCD are sandy and very poor in nutrient and organic matter content. They are highly heterogeneous.

It is recommendable that conservation tillage, animal drawn implements have wings and be capable of deep and wide furrows. Two implements appeared appropriate for the NCD conditions These are the Zimbabwean curved and the Magoye rippers.

It was noted that animal drawn implements allow farmers to prepare larger fields. Animal drawn minimum tillage implements encouraged farmers to plant in lines which was conducive to the use of cultivators for weeding.

Two questions remained un-answered :

- What would be the effect of minimum tillage on the hard pan in the long run? and
- How could minimum tillage affect the weed prevalence and weed species under the NCD conditions in the long term?

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