Improving Food Security by Using Tied Ridges in the Semiarid Areas of Northern Tanzania

In semiarid areas, one of the primary factors that limit crop production is soil moisture deficiency. Due to climate change, there have been attempts to optimize crop yield by planting drought-tolerant crops, particularly maize, sorghum and millet in semiarid areas of Northern Tanzania. This is not enough because crop failure due to water stress is still observed (Mahoo *et al.,* 1999). Maize is the most important staple in the drought-prone areas of Longido and the western lowlands of Mwanga and Same districts in the northern part of Tanzania. Most producers of maize are smallholder farmers who intercrop it with cereals and legumes. In these districts, however, there is food insecurity caused by frequent crop failure brought about by drought. Despite the droughts, farmers continue to grow maize. Majority of farmers in these areas do not use available rain water efficiently.

The introduction of tied ridges has beneficial effects of reducing runoff loss; and soil loss and increasing grain yield. Tied ridges are a variation of the micro catchment approach for trapping and holding water. Its construction follows the contours but, in addition, the furrows between ridges are linked by cross-ties to create closed micro basins 1 to 5 m long (Fig. 1). The cross-ties are kept lower than the ridges so they act as spillways in the event of heavy rainfall.

The mechanism behind tied ridges allows small basins to retain runoff so that the retained water basins have more time to infiltrate and increase soil water storage. This practice is particularly effective in areas where rainfall intensity is low to medium and soils are freely drained and on gentle slopes. The construction of tied ridges requires minimum knowledge—local people can do it easily without close supervision from experts.

Fig. 1. The farmer prepares the land by constructing tied ridges.

Objectives

The main objective of the study was to assess tied ridges as a water-smart agricultural practice. The specific objectives are the following:

- To test the effect of tied ridges on the yield of maize intercropped with legumes.
- To demonstrate the efficiency of tied ridges on crop yield.

Materials and methods

Location of sites

Same District is located at 4°15' S and 37°55' E. In this district, the study was conducted in villages Lembeni, Mabilioni, Saweni, and Ishinde. Mwanga District is located at 3°45' S and 37°40' E. The work in Mwanga was carried out in the villages of Kwakoa and Kisangara. Longido District (2°43' 57" S and 36°41' 54" E) has the work sites in Mairowa, Ngoswaki, Mndarara, Olmolock, and Kamwanga villages.

Climate

Same

The western lowlands of the district are semi-arid and receive less than 500 mm of rainfall per annum. The highlands receive between 600 and 800 mm. There are two distinct rainy seasons (*vuli*) from October to December and (*masika*) from March to May.

Mwanga

Mwanga, one of the semiarid areas in the Kilimanjaro Region, experiences 500–600 mm of rainfall per annum in the lowlands and 800–1,250 mm in the highlands. The distinct rainy seasons are *vuli* and *masika*. The district experiences some strong and dry winds blowing normally from east to west.

Longido

All the target sites are located in semiarid areas with unreliable and unpredictable probability of receiving 400–600 mm of rainfall per year. There are two distinct rainy seasons, short (*vuli*) and long (*masika*). The area is characterized by repeated water shortages. Even during an average year, rains may start well and then disappear in a month at the critical plant growth stage.

Experimental method

A randomized complete block design with two replications and 12 treatments was adopted at each site. Dimensions of the plots were 10 m x 10 m per treatment. The technology tested in Same District involved a cover crop (either pigeon pea or *Dolichos lablab)* intercropped with drought-tolerant maize

***Table 1**. Crops tested in Same and Mwanga districts using tied ridges.*

Maize variety	Type of legume used
Situka M-1	Farmer's practice
TZM-309	Farmer's practice
Situka M-1	Pigeon pea
TZM-309	Pigeon pea
Situka M-1	*Dolichos lablab*
TZM-523	*Dolichos lablab*

***Table 2**. Crops tested in Longido District using tied ridges.*

Maize variety	Type of legume used
Situka M-1	Farmer's practice
TZM-523	Farmer's practice
Situka M-1	Green gram
TZM-523	Green gram
Situka M-1	Green gram
TZM-523	Green gram

Fig. 2. Maize planted on tied ridges.

(Situka M-1 and TZM-309) and the use of tied ridges (Table 1, Fig. 2).

For Longido District, maize varieties Situka-M1 and TZM 523 intercropped with green gram (Table 2).

Data collection

Initially, a reconnaissance survey was conducted in the case study areas and the status of maize production was evaluated. Yield-related data were collected from each treatment: plant population, plant height, number of cobs, weight of cobs, grain weight, and biomass.

Data analysis

The data taken for analysis were the grain yield of maize, grain yield of pigeon pea, grain yield of *D. lablab,* and grain yield of green gram. These were subjected to statistical analysis using the GenStat computer package.

Results and discussion

Maize yield

In the Same sites, the lowest maize grain yield was found in Lembeni (0.3 to 0.5 t/ha), followed by Mabilioni (0.7 to 1.3 t/ha). The highest maize grain yields were observed in Saweni and Ishinde, 1.6 to 2.6 and 2.3 to 2.9 t/ha, respectively. The average yield was 0.4 in 2012 and 1.5 for 2013 (Fig. 3).

In the Mwanga sites, the highest yields were recorded in Kwakoa and Kisangara, 0.7 to 2.0 and 1.4 to 2.3 t/ha, respectively. Maize grain yield at Kisangara was inferior to those of the two sites above. Mean yield varied significantly for each site and treatment. Hence, in 2012, average maize grain yield was 0.65 t/ha; and 1.26 t/ha in 2013 (Fig. 3). In the western part of Longido District, the highest maize grain yield of 3.9 t/ha was recorded at the Mairowa site, while Ngoswaki and Mndarara sites had the same grain yield. There were significant differences among the treatments tested. In eastern Longido, the highest maize grain yield was recorded in Olmolock; the value ranged from 1.3 to 2.2 t/ha. The Kamwanga site had the lowest maize grain yield ranging from 0.7 to 1.0 t/ha. There were significant differences among treatments within the Olmolock site, whereas in Kamwanga, no significant differences were seen among the treatments. Generally, Longido's average maize grain yield was 0.53 t/ha in 2012 and 1.72 t/ha in 2013 (Fig.3).

Legume yield

At the same sites, both pigeon pea and *D. lablab* were intercropped with maize. Average *D. lablab* grain yield was 0.7 t/ha in 2012 and 1.4 t/ha in 2013. Grain yield of pigeon pea averaged 1.64 t/ha in 2012 and 2.1 t/ha in 2013 (Fig. 4).

In the Mwanga sites, pigeon pea and *D. lablab* were intercropped with maize. Average *D. lablab* grain yield was 1.3 t/ha in 2012 and 1.9 t/ha in 2013. Grain yield of pigeon pea averaged 1.9 t/ha in 2012 and 2.4 t/ha in 2013 (Fig. 5).

In the Longido sites, green gram was the only legume intercropped with maize. Average green gram grain yield was 1.1 t/ha in 2012 and 1.15 t/ha in 2013.

This study demonstrates the beneficial effects of intercropping drought-tolerant cereal and legume varieties, coupled with efficient soil and water conservation with a focus on water harvesting using tied ridges (Figs. 5, 6, and 7).

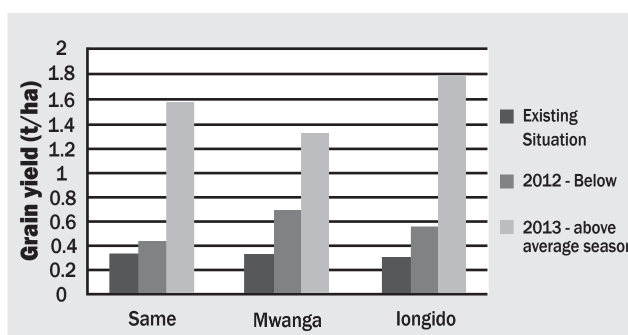

Fig. 3. Results after practicing the smart-water technology of using tied ridges in comparisonwith existing situation.

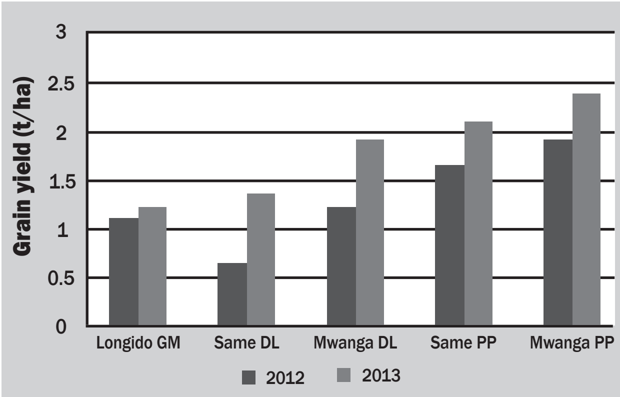

Fig. 4. Average legume grain yield in two seasons.

Fig. 5. Maize and pigeon pea intercrop with tied ridges.

Conclusions and recommendations

Field experiments have demonstrated that water-smart agriculture practice using tied ridges increases crop yields and improves food security of smallholder farmers. Tied ridges have been found to be very efficient and have resulted in substantial yield increase in semiarid areas of northern Tanzania.

- Farmers should prepare land and plant early so that their crops get enough water for good growth.
- Efforts should be put into training farmers about other technologies for water-smart agriculture to mitigate climate change and improve food security in their area.

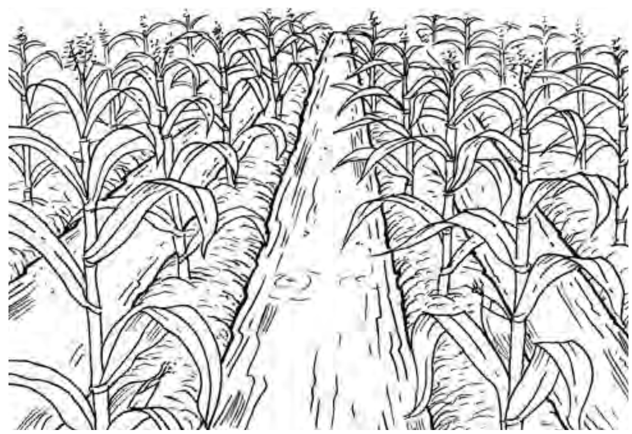

Figure 6. Water harvested through the use of tied ridges.

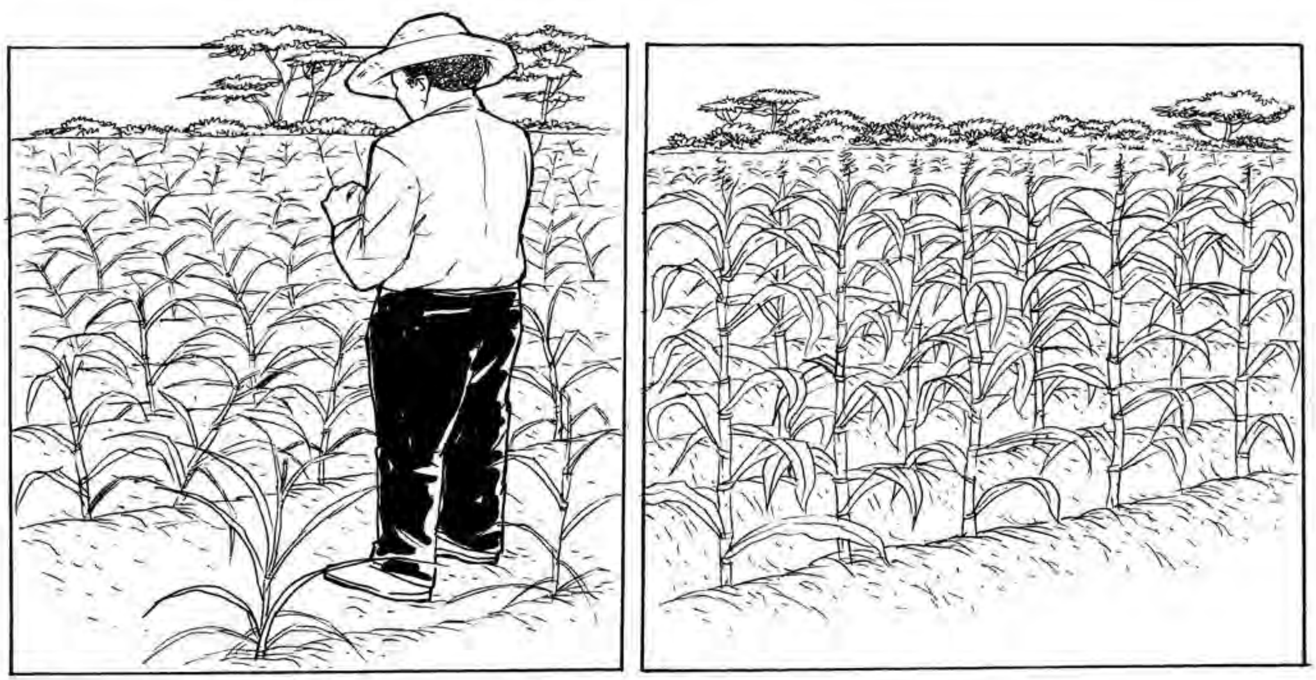

Fig. 7. Field in dire need of using tied ridges (left) and field showing good crop growth (right).

Authors

Erick J. Njau
Researcher
Selian Agricultural Research Institute
Email: ericnjau1982@gmail.com

P. Xavery, P. Massawe, and C. Makalanga

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