# On-farm Verification of the Soil Moisture and Yield Response of Tied Ridge on Maize Production in Dry Areas of Silte Zone, SNNPR, Ethiopia

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**Abstract**
The use of in-situ moisture conservation techniques helps to reduce the runoff rate, nutrient losses from soil and improve the soil moisture and nutrient availability for plant growth which in turn, boost the productivity of land and plants. This study were focused on verification of open end tied ridge with furrow planting method as in-situ moisture conservation techniques on soil moisture conservation and grain yield of maize in dry land area of sankura woreda, SNNPR. Two treatments namely tied ridge and traditional practices replicated at four farmers field was compared interms of soil moisture conservation and maize grain yield. The result depicted that tied ridge showed 35.8 % and 27.8% maize grain yield and biomass production advantages over traditional practice respectively. This was directly correlated with 33.7% soil moisture advantage on tied ridge cultivation over traditional practice. Therefore, tied ridge as in-situ moisture conservation is effective measures in storing additional soil water for the next cropping season as compared to traditional practice. It is recommended that, the practice should be demonstrated and scaled up in the study area and at similar agro-ecology across in the region.
**Keywords**: Soil moisture, Tied ridge, maize yield

**Background and Justification:**

Soil moisture and nutrients conservation are the most essential factors for plant growth in Ethiopia. The proper use of soil moisture conservation structures helps to reduce the runoff rate, nutrient losses from soil and improve the soil moisture and nutrient availability for plant growth which in turn, boost the productivity of land and plants. In Ethiopian highland, the agricultural productivity is low due to low soil fertility. The problem is directly related to periodic low soil moisture due to erratic and poorly distributed rainfall, severe soil erosion and runoff loss of water (Heluf and Yohannes, 2002). The extent of soil erosion reported is about 50% (27 million ha) of the highlands are significantly eroded, 25% (13.5 million ha) seriously eroded and over 4% of the former farmlands are severely eroded and converted to rock outcrops (EHRS (Ethiopian Highlands Reclamation Study), 1984). According to Getachew (1998), the rates of annual loss of soil due to erosion for Ethiopia vary from almost zero on lowland grasslands to over 200 tons/hectare/year (t/ha/yr) on steep slopes of the highlands cultivated with erosion promoting crops such as maize or sorghum.

In-situ soil and water conservation measure plays a great role in alleviate the two extremes of rainfall conditions such as erosion and drought. The loss of water as runoff coupled with periodic drought during the cropping season on degraded lands supporting rain-fed crop production was also equally important (Asfaw et al., 1998). The causes rainfall extremities is due to inadequate efforts and absence of technologies proved to conserve the soil and water resources, the consequence of which is the need to increase productivity on limited and marginal land and water resources. As rainfall erosivity, soil erodibility and landform are inherent properties of climate, soil and land, respectively, only little can be done to modify their effects appreciably. Therefore, control of soil erosion and runoff water depends on judicious soil and crop management practices (Lal, 1977a,b; Hudson, 1977).The practice of judicial water conservation undoubtedly plays a significant role in increasing agricultural production in arid, semi arid and sub-humid areas where agriculture is hampered by periodic droughts and low soil fertility (Heluf and Yohannes, 2002).

The erratic rainfall distribution makes cropping to be possible only with the use of water conservation techniques. The use of tied ridge as in-situ moisture conservation techniques should get sufficient attention. It has been effective in reducing surface runoff and increasing soil water storage in different countries as reviewed by Gebreyesuset al. (2006). In many parts of Ethiopia, particularly in the eastern Ethiopian highlands, it was reported that, Proper mechanical soil and water conservation schemes increased maize grain yield by 700-3400 kg/ha (Tamirie Hawando, 1986). Asfaw Belay et al. (1998) also reported maximum maize yield increases of 10, 18 and 23% on Entisols and 54, 35 and 26% on Vertisols of eastern Ethiopia, with crop residue, with residual NP and with both crop residue and residual NP, respectively, due to the combinations of tied ridges and furrow planting over flat planting. Thus, the efficiency of the physical soil and water conservation techniques depends on the soil type, climate, the crop grown and the cropping methods followed.

Soil moisture is the foremost factor that limits the productivity of rainfed cereal crops. However, rainwater harvesting is an important factor for crop production, the use of tied-ridges for on-farm rainwater harvesting for

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crop production is not well known. To maintain required soil moisture in rainfed lands, strategies should be focused on conserving much amount of rainwater as in-situ. Therefore, the present study to verify moisture and yield response of open end tied ridge planting on furrow on maize production in dry areas of sankura woreda, SNNPR.

## Materials and Methods

### Study area description

Sankurra is one of the woredas in the Southern Nations, Nationalities, and Peoples' Region of Ethiopia as shown in the fig.1 below. It is bordered on the west by the Hadiya Zone, on the north by Wulbareg, on the northeast by Dalocha and Lanfuro, and on the southeast by the Alaba special woreda. The administrative center is Alem Gebeya. Based on the 2007 Census conducted by the CSA, this woreda has a total population of 84,736, of whom 42,480 are men and 42,256 women; 3,656 or 4.32% of its population are urban dwellers (CSA, 2007). The dominant soil type of the area is vertic andosols.

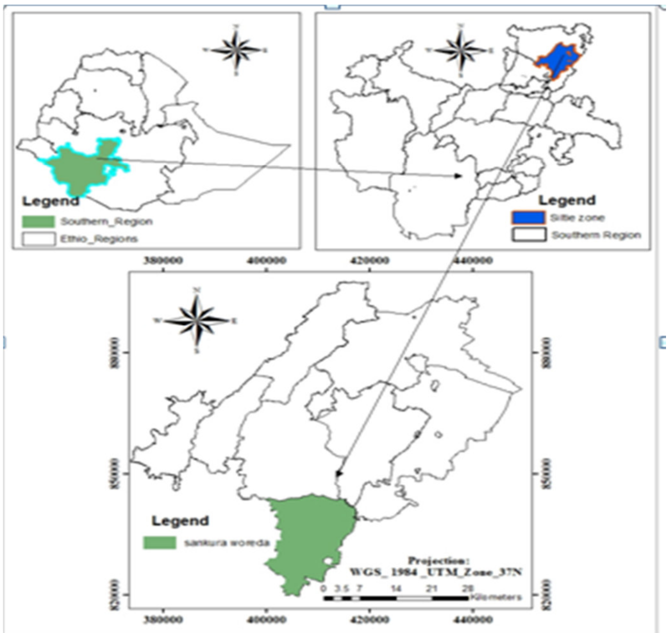
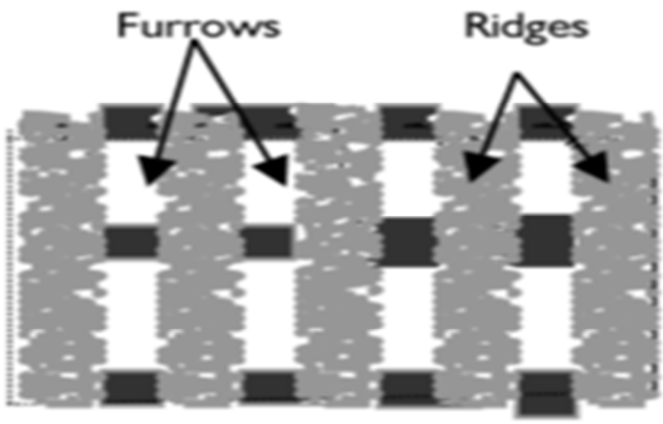



Figure1. Location map of the study area

**Site selection and treatment design:** Based on similar farming system, slope, and management practices, four locations have been selected to verify the tied ridge and traditional practice on soil moisture conservation and maize grain yield under low moisture stressed dry land area of Sankura woreda, SNNPR. Two treatments (Farmers practice and open end tied ridges planting on furrow) were replicated on four farmer's field. Land preparation was done before construction of open end tied ridge and compared with farmers practice. 20cm height of the tie ridges was constructed within a furrow with a depth of 30 cm, 5 m tying interval were used and maize as a test crop planted inside the furrows. High yielding shone maize variety was selected as a test crop and planting carried out with its crop calendar**.** The entire demonstration plot size will be 10m x 10(100m2) and recommended maize seeds per hectare were used in rows at 75 cm spacing and 25 cm b/n plant. 140Kg/ha NPS fertilizer were used and full dose of P and half dose urea fertilizers applied initially and half dose of urea applied at 30-45 days after planting the test crop.




Lay out of furrow planting

**Method of data collection and analysis**

Soil sample before and after crop harvest was collected for analysis of PH, N, P, %OM, % OC. Soil moisture content was collected from tied ridge and traditional practice from 0-50cm soil depth after rain fall event following the standard sampling procedure and analyzed accordingly and comparison was made with control by using volumetric method. Similarly, from Crop data maize grain yield and Biomass production was collected and analyzed.

**Determining Soil moisture content (SMC)**

An auger was used for soil sampling from inside the furrow to measure the soil moisture content for the average depth 0 and 50 cm. The weight of the wet soil samples were measured and put in an oven at 105°C for 24 hours and then the weight of dry samples was measured. The following formula was used for calculating the soil moisture content.

$$SMC = \frac{Ww - Wd}{Wd} * 100$$

Where:

SMC = Soil moisture content dry base (%), Ww = Weight of the wet soil (gm), $W_d$= Weight of the dry soil (gm)
In general, all collected data was subjected to simple descriptive statistical analysis such as Graph and percentage.

**RESULTS AND DISCUSSION**

**Soil physic-chemical characteristics of the study area**

Table1. Soil properties before experiment

| Farmers | Before | | | |
|---|---|---|---|---|
| | PH | %OC | %OM | P(ppm) |
| 1 | 4 | 0.7 | 1.3 | 4.6 |
| 2 | 3.5 | 1.1 | 1.9 | 11 |
| 3 | 3.8 | 0.6 | 1 | 8 |
| 4 | 3.5 | 1.11 | 1.9 | 8.3 |
| Range | 3.5-4.0 | 0.6-1.1 | 1.0-1.9 | 8.3-11 |

Table2. Soil properties after experiment

| Farmers | After | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Open end with tied ridge | | | | Traditional practice | | | |
| | PH | %OC | %OM | P(mg/L) | PH | %OC | %OM | P(mg/L) |
| 1 | 5.5 | 3.4 | 5.9 | 13.4 | 5.5 | 2.4 | 4.2 | 11.6 |
| 2 | 5.4 | 4.5 | 7.7 | 14 | 6.0 | 2.8 | 4.9 | 13.2 |
| 3 | 5.9 | 2.6 | 4.5 | 10.3 | 5.7 | 3.3 | 5.6 | 11 |
| 4 | 5.8 | 3.2 | 5.5 | 13.4 | 5.7 | 3.9 | 6.7 | 12 |
| Range | 5.4-5.9 | 2.6-4.5 | 4.5-7.7 | 10.3-14 | 5.5-6.0 | 2.4-3.9 | 4.2-6.7 | 11.0-13.2 |

As the result shown in table 1 and 2, some of physic-chemical properties of the study soil were analyzed.

Some of the analyzed parameters before and after experiment were PH, % OC, % OM and P (ppm). The minimum and maximum parameter value was analyzed accordingly. Before the experiment PH ranges from 3.5-4.0, % OC ranges 0.6-1.1, % OM ranges from 1.0-1.9 and Available P ranges from 8.3-11.

After crop harvest, soil sample was collected and analyzed for both open end tied ridge and traditional practice. Hence, for tied ridge cultivation the PH ranges from 5.4-5.9, %OC ranges from 2.6-4.5, %OM ranges from 4.5 – 7.7 and Available p ranges from 10.3-14.0. Similarly, for traditional practice the PH ranges from 5.5-6.0, %OC ranges from 2.4 – 3.9, %OM ranges from 4.2-6.7 and Available P ranges from 11.0-13.2.

**Effect on maize grain yield and Biomass**

Table1. Maize grain yield and biomass on different practices .

| | **Grain yld kg/ha** | | **BM kg/ha** | |
|---|---|---|---|---|
| **Location** | open tide ridge | Traditional | open tide ridge | Traditional |
| **1** | 8500 | 6400 | 24713.3 | 20393.3 |
| **2** | 8200 | 5400 | 19833.3 | 15050 |
| **3** | 7700 | 6600 | 26766.6 | 22120 |
| **4** | 9000 | 6200 | 24710 | 17453.3 |
| **Average** | 8350 | 6150 | 24005.8 | 18754.15 |

NB: yld-yield and BM-Biomass

As the result in table1 above, the grain yield of maize between tied ridge with traditional practices was compared on four farmer's field. Thus, the trend of maize grain yield increment was observed in tied ridge over traditional practices. The average maize grain yield recorded on tied ridge and traditional practice was 8350 Kg/ha and 6150 Kg/ha respectively. The result depicted that tied ridge averagely outweigh 35.8 %( 2200Kg/ha) in grain yield over traditional practice. Similarly, the result on biomass production shows increasing trend between both practices. The average biomass in tied ridge was 24005.8Kg/ha and traditional practice was 18754.15 Kg/ha. Similar to maize grain yield, tied ridge showed 27.8% biomass advantage over traditional practice. The current result also agrees with the finding of Asfaw et al. (1998) which reported that tied ridge cultivation could increases maize grain yield by 54, 35 and 26% on Vertisols of eastern Ethiopia. According to Solomon (2015), field experiments conducted to determine the effects of moisture conservation techniques on yields of improved varieties of maize with and without N and P fertilizer applications in the semi-arid areas of Eastern Hararghe showed an average yield increase of up to 37% due to water conservation practice.

**Effect on soil moisture conservation**

Soil moisture is an important component used as a medium for supply of nutrients to growing plants. To ensure its availability for crop production, soil sample was collected from traditional and inside of the furrow from open end tied ridge after crop harvest. The result clearly shows tied ridge showed 33.7% soil moisture advantage over traditional practice as shown in (Fig.1) below.

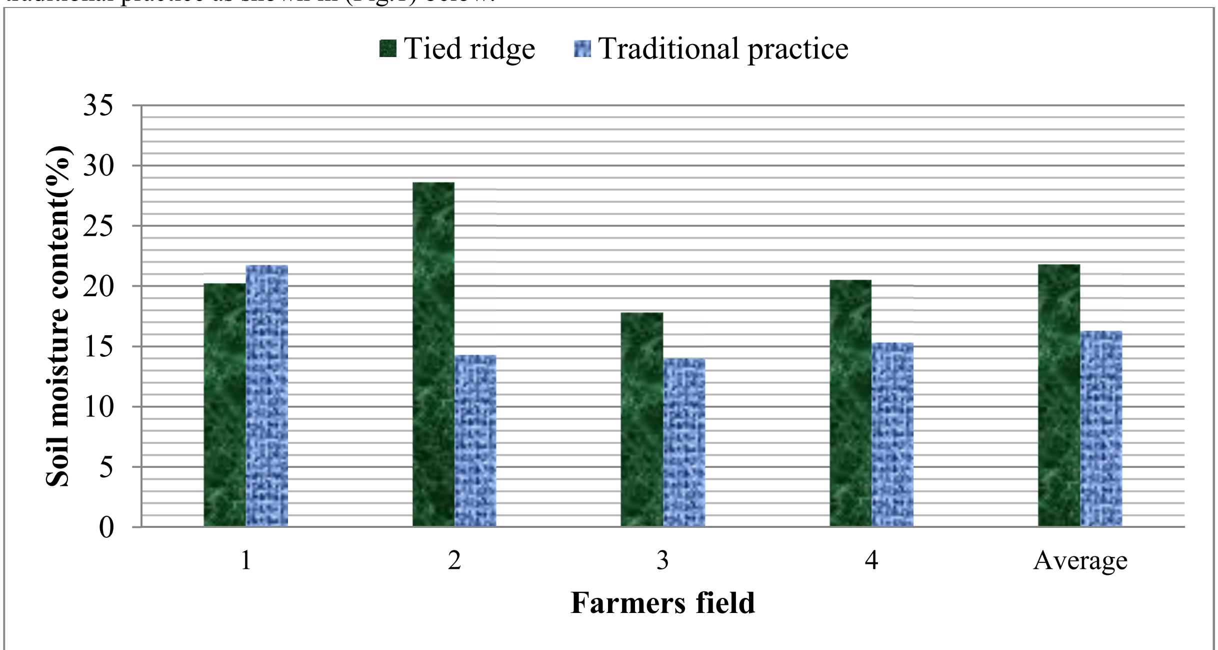



Figure1. Soil moisture content

The biomass and grain yield increment in tied ridge was directly correlated with soil moisture as presented in Fig.1 above. The current result agree with the finding of (Heluf and Yohannes,2002) which reported the importance of the practice of tied ridging in increasing crop yields by increasing the time for the water to penetrate into the soil.

**Conclusion and Recommendation**

Moisture conservation at farm level is the current important issue in world today for sustainable crop production. In current on farm trail, the effect of selected in-situ soil and water conservation measure (tied ridge) was compared with traditional practices in terms of maize productivity parameters like grain yield, Biomass production and soil moisture conservation. The tied ridges showed 35.8 % and 27.8% grain yield and biomass production advantage over traditional practice respectively.

The low crop productivity in the country particularly in the study area is directly related to periodic low soil moisture due to erratic and poorly distributed rainfall which could result on low soil fertility. This calls to design effective and efficient in-situ soil moisture conservation strategies which have better role in sustaining crop production. Currently, tied ridge and traditional practice was compared each other from moisture conservation point of view and crop productivity.

Open end tied ridge planting on the furrow showed a promising result on maize grain yield and soil moisture conservation as compared to traditional practice. Therefore, tied ridge as in-situ moisture conservation is effective measures in storing 33.7% additional soil water for the next cropping season as compared to traditional practice. It is recommended that, the practice should be demonstrated and scaled up in the study area and at similar agro-ecology across in the region.

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