Short-term effects of conservation agriculture on soil erosion and agronomic parameters of tef (*Eragrostis tef*) in the northern Ethiopian highlands

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Background

- Land degradation in the form of soil erosion and declining soil quality is a serious challenge to agricultural productivity and economic growth in Ethiopa (Mulugeta *et al.,* 2005).
- Tigray, the northern-most region of the country, suffers from extreme land degradation as steep slopes have been cultivated for many centuries and are subject to serious soil erosion (Wolde *et al.,* 2007).
- Soil erosion due to high tillage frequency and other soil management problems has seriously affected over 25% of the Ethiopian highlands (Kruger *et al.,* 1996).
- Such detrimental effect of soil erosion and water stress can be improved by management options like conservation agriculture practices, including permanent beds and other traditional practices

Fig. 1. Traditional tillage with *"Mahresha"*

Objectives

- To evaluate the impacts of permanent beds (PB) together with the traditional conservation practice called *terwah (TERW)* and traditional tillage on runoff, soil loss, tef yield and its yield components.

Study location and experimental plots

- Experimental plots located Tigray region, N.Ethiopia 13°14' N and 39°32' E at an altitude of 1960 m.a.s.l (Fig. 2).
- Average weather data (1972-2006): Annual P = 504 mm (unimodal); Annual ET_o = 1540 mm; T = 8-27.5°C; RH = 40-70 %
- Slope: 3 %; soil: Typic Calsiustert according to Soil Survey Staff (1999), Clay texture
- The experiment had three treatments (Fig. 5)

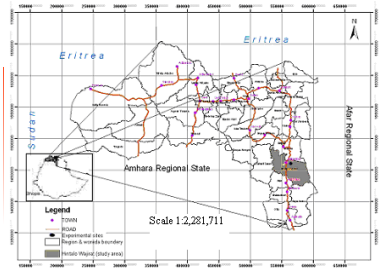

Fig. 2. Map of Tigray with study location (highlighted)

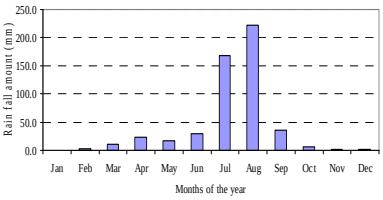

Fig. 3. Monthly rainfall distribution (1972-2006)

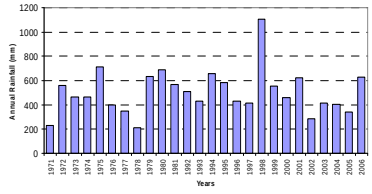

Fig. 4. Yearly rainfall distribution in the study area

- The whole experimental field is isolated from the top by 1.2 m wide and 0.5 m deep ditch.
- Plot size= 19.1 * 5.5 m
- The runoff collection ditches at the bottom of each plot that are lined with plastic sheets (Fig 6)
- The sizes of the trenches were 1.5 m wide, 4.5 m long and about 1m deep

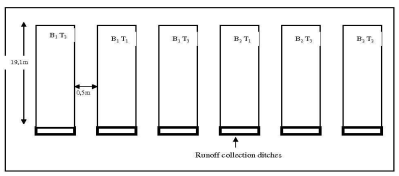

Fig. 5. Experimental layout (B1= Block1; B2=Block 2; T1 =Terwah; T2= Permanent bed; T3= Traditional tillage practice)

Fig. 6. Runoff collection ditches

The three treatments were
Traditional tillage practice (TRAD): Three times plowing using local plowing equipment *("Mahresha")*
•*Terwah (TERW):* This is a traditional water conservation technique in which furrows are made with *"maresha"* along the contour at an interval of 1.5 m.
•*Permanent beds (PB)*: Beds and furrows of 60-70cm (middle of the furrow to the next one) by *"maresha"*

References

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Study location and experimental plots (contd.)

•Runoff volume was measured at 0800 after each storm that caused erosion.

•It was estimated by measuring the depth of the collected runoff in the trench using a graduated ruler and deducting amount of direct rainfall into the ditches.

•Each of the trenches were calibrated for their volume.

•The collected runoff is stirred thoroughly and about 4 liters of it were collected from each trench for the determination of sediment concentration

•Then the runoff was filtered using funnel and filter paper.

•The sediment in the filter paper was oven dried for 24 hours at 105°C and weighed.

Results

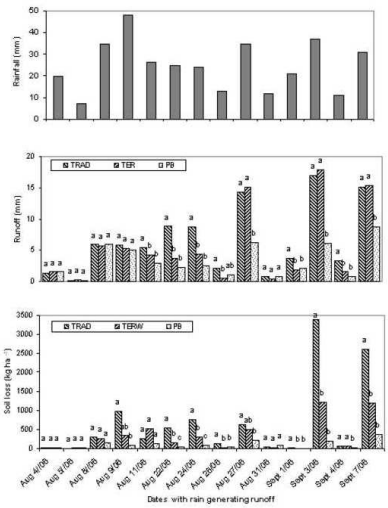

Fig. 7. Rainfall, runoff and sediment loss after each rainfall event that caused runoff

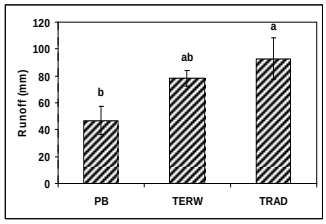

Fig.8. The total runoff depth for the growing period

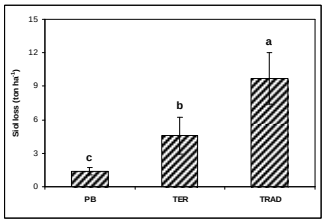

Fig. 9. Total soil loss from each treatment during the whole growing period

•Runoff and soil loss were not significantly different among treatments on the first week after sowing (Fig.7)

•TERW and TRAD had significantly higher runoff than PB especially at high rainfall periods (Fig.7)

•Soil loss was significantly lower in TERW and PB compared to TRAD especially during the end of rainy season (Fig.7)

•PB had significantly lower overall runoff compared to TRAD. Both PB and TERW had significantly lower overall soil loss than TRAD (Fig.8 & 9)

Table: Agronomic parameter; Tef yield, biomass, plant height, weed dry matter at first weeding and harvest index for the different treatments

Treatment	*Tef yield (kg ha^{-1})*	*Weed dry matter (kg ha^{-1})*	*Tef biomass (kg ha^{-1})*	*Plant height at maturity (cm)*	*Harvest index*
TRAD	1173 (50) a	77 (4) c	6.7 (0.18) a	44 (2.5) a	0.18 (0.007) b
TERW	925 (99) b	125 (10) b	4.5 (0.64) b	39 (3.5) b	0.21(0.007) a
PB	678 (73) c	242 (17) a	3.0 (0.69) b	31(1.7) b	0.22 (0.004) a

Values in bracket are standard error.
Values within a column connected with the same letter are not significantly different

•Tef yield, biomass, plant height at maturity were all significantly higher in TRAD (Table)

•Weed (*Cynodon dactylon*) dry matter was significantly lower in TRAD → could not be controlled by hand weeding

Conclusion

•Permanent Beds (PB) showed lowest runoff and soil loss

•The traditional conservation practice *Terwah* (TERW) can be considered as first step towards conservation agricultural practice

•Highest yields were observed for the traditional tillage practice (TRAD) because of better control of weeds (*Cynodon dactylon*)

•Follow-up of appropriate use and dosing of herbicide (Glyphosate) is of utmost importance

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