

Building resilience against drought and soil erosion: impact of field water conservation in northern Ethiopia

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ABSTRACT

Field water conservation practices are a way forward to build resilience against drought. They increase the amount of productive green water and crop yield, while reducing runoff and soil erosion. A long-term tillage experiment was carried out (2005 to 2010) on a Vertisol to quantify changes in soil moisture, runoff, soil loss and crop yield from a combination of traditional field water conservation practices with Conservation Agriculture principles in a rainfed field in northern Ethiopia. The experimental layout was implemented in a randomized complete block design with 3 replications on permanent plots of 5 m by 19 m. The tillage treatments were (1) conventional tillage (CT), where the soil is ploughed three times per year to create a fine seedbed and with crop straw being completely harvested without leaving crop residues on the surface, (2) terwah+ (TER+), based on a traditional field water conservation method, called terwah, especially used in tef where broad seedbeds are created using the marasha ard plough by making furrows on the contour at regular intervals of ca. 1.5 m, and (3) derdero+ (DER+), which is based on another traditional field water conservation technique derdero, where at the last tillage operation, the farmers broadcast the seeds over the surface and then prepare beds and furrows at intervals of ca. 0.6 m along the contour using the marasha, moving the soil and seeds to an upper position on the beds. It protects the crops from waterlogging, while excess water drains towards the furrows where it can slowly infiltrate. The 'plus' in TER+ and DER+ stands for the improvements made, including the introduction of permanent beds with standing stubble (>30%), and tillage being limited to sowing when furrows are reshaped. Data on soil loss, runoff and grain yield were collected since 2005, and on soil moisture from 2009 on. The crops in rotation were wheat, barley and tef. Glyphosate was sprayed starting from the third year (2007) at 2 L/ha before planting to control pre-emergent weed in DER+ and TER+. Crop stands were evaluated with local farmers and NDVI was measured on the spot at several phenological stages, using green seeker. Significantly different ($p < 0.05$) mean soil losses of 4, 13 and 17 t/ha/y were recorded for DER+, TER+ and CT, respectively. Similarly, the mean runoff was 430, 683 and 866 m³/ha/y from treatments with DER+, TER+ and CT, respectively. The mean runoff coefficients of 2 yrs of tef were higher than the 3 yrs of wheat. Soil water storage (0-120 cm depth) during the growing season was always highest in DER+, followed by TER+ and CT. The average grain yield of wheat over three years was 2.46, 2.02 and 1.61 ton/ha for DER+, TER+ and CT, respectively, with differences being significant ($p < 0.05$). Correlation coefficients were significantly strong between crop yield, farmers' evaluation and NDVI measurements in 2008, 2009 and 2010.

NDVI records in wheat (2009) and tef (2010) were found significantly highest in DER+ throughout the growing season.

Keywords: Conservation agriculture, field water conservation, permanent bed, crop residue, wheat, tef, barley