Quantifying rainfall-runoff relationships on the Melkassa Hypo Calcic Regosol ecotope in Ethiopia

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Abstract

Droughts, resulting in low crop yields, are common in the semi-arid areas of Ethiopia and adversely influence the well-being of many people. The introduction of any strategy that could increase yields would therefore be advantageous. The objective of this study was to attempt to assess the influence of in-field rainwater harvesting (IRWH), compared to conventional tillage, on increasing the amount of water available to a crop like maize on a semi-arid ecotope at Melkassa situated in the eastern part of the Rift Valley.

To achieve the objective of the study rainfall-runoff measurements were made during 2003 and 2004 on 2 m x 2 m plots provided with a runoff measuring system and replicated 3 times for each treatment. There were 2 treatments: conventional tillage (CT) on which hand cultivation was practised in a way that simulated the normal local CT; and a flat surface simulating the no-till, undisturbed surface of the IRWH technique (NT).

Rainfall-runoff measurements were made over 2 rainy seasons during which there were 25 storms with > 9 mm of rain. From the 25 storms, only the 2nd season storms (8 storms) had runoff measurements. These storms were used for calibration and validation of the Morin and Cluff (1980) runoff model (MC Model). Appropriate values for final infiltration rate (I_f), surface storage (s) and for the crusting parameter (γ) were found to be: 6 mm·h^{-1}; 1.0 mm for NT and 6.0 mm for CT; 0.6 mm^{-1}, respectively.

The measured runoff (R) for the 2004 rainy season expressed as a fraction of the rainfall during the measuring period (P), i.e. R/P, gave values of 0.59 and 0.40 for the NT and CT treatments, respectively. There was a statistical difference between the runoff on the 2 treatments.

Selected results from 7 years of field experiments with IRWH at Glen in South Africa were used together with measured maize yields and climate data over 16 seasons on the nearby Melkassa Experiment Station to estimate the yield benefits of IRWH compared to CT on the ecotope studied. The results ranged between 35 and 1 437 kg with a mean of 711 kg·ha^{-1} over the 16 years. At Melkassa this was an estimated yield increase ranging from 13% to 49%. The mean increase was 33%.

Keywords: in-field rain-water harvesting, maize, yield increase, rainfall intensity, runoff, semi-arid ecotope