Tropentag, September 19-21, 2012, Göttingen - Kassel/Witzenhausen

"Resilience of agricultural systems against crises"

Medium-Term Impact of Tillage and Residue Management on Soil Quality and Crop Productivity

Birthe Paul[1], Bernard Vanlauwe[2], Fred Ayuke[3], Marianne Hoogmoed[4], Anja Gassner[5], Tunsisa Hurisso[4], Saidou Koala[6], David Lelei[3], Telesphore Ndabamenye[4], Yusuke Terano[4], Johan Six[7], Mirjam Pulleman[4]

[1] *International Centre for Tropical Agriculture (CIAT), Tropical Forages Program, Kenya*
[2] *International Institute of Tropical Agriculture (IITA), Natural Resource Management, Kenya*
[3] *University of Nairobi, Dept. of Land Resource Management and Agricultural Technology, Kenya*
[4] *Wageningen University and Research Center (WUR), Soil Quality, The Netherlands*
[5] *World Agroforestry Center (ICRAF), Dept. of Research Methods, Kenya*
[6] *Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), Kenya*
[7] *University of California Davis, Dept. of Plant Sciences, United States of America*

Abstract

Soil fertility depletion and degradation are major biophysical causes of stagnating crop yields in sub-Saharan Africa. Conservation Agriculture (CA) is widely promoted for its potential benefits including lower soil erosion, increased soil organic matter, and higher and/or more stable crop yields. CA refers to (i) continuous minimum soil disturbance; (ii) permanent organic soil cover; and (iii) diversification of crops grown in sequence or associations. However, rigorous empirical evidence of CA benefits from sub-Saharan Africa is still limited.

This study aimed to quantify the medium-term impact of tillage and crop residue management on soil aggregate stability, soil carbon and crop productivity in a maize-soybean rotation. A replicated tillage (conventional, reduced) and residue management (retention, removal) field trial was installed in sub-humid western Kenya in 2003. Soil aggregate fractions, soil carbon and crop yields were measured from 2005 to 2008.

Conventional tillage decreased water stable aggregate mean weight diameter by 50 % at 0-15 cm ($p < 0.001$) and 12% at 15-30 cm soil depth ($p = 0.027$), indicating increased susceptibility to erosion. Tillage or residue management alone did not affect soil C contents, but when residue was incorporated by conventional tillage, soil C increased at 15-30 cm ($p = 0.037$). Results did not suggest physical C protection within soil aggregates. Thus soil (aggregate) C results indicate that the potential of CA for climate change mitigation might be overestimated. The weak residue effect on aggregate stability and soil C may be attributed to insufficient residue retention, and removal by termites and rainstorms. Soybean grain yields tended to be suppressed under reduced tillage without residue retention, especially in wet seasons ($p = 0.070$). This is likely explained by high runoff, resulting from slaking and crust formation.

Future research should investigate critical minimum residue retention levels for soil conservation and crop productivity and develop methods for smallholder farmers to retain sufficient residue cover.

Contact Address: Birthe Paul, International Centre for Tropical Agriculture (CIAT), Tropical Forages Program, Nairobi, Kenya, e-mail: b.paul@cgiar.org

Keywords: Crop residue management, crop yields, reduced tillage, soil aggregate stability, soil macrofauna, soil organic carbon, sub-Saharan Africa, termites