Tropentag, October 6-8, 2009, Hamburg

"Biophysical and Socio-economic Frame Conditions
for the Sustainable Management
of Natural Resources"

Carbon Sequestration and Microbial Residues in Secondary Grassland Top Soils in the South African Highveld

Raimund Kösters[1], Anne Preger[1], Franziska Lauer[1], Chris Du Preez[2], Wulf Amelung[1]

[1] *University of Bonn, Institute of Crop Science and Resource Conservation, Division of Soil Science, Germany*

[2] *University of the Free State, Department of Soil, Crop and Climate Sciences, South Africa*

Abstract

Soil restoration is a prerequisite for combat desertification in semiarid and arid parts of the world. This study was designed to evaluate how fast and to which degree degraded cropland may resequester carbon when converted to permanent secondary pastures. We determined the soil organic matter stabilisation in soil particles as well as the influence of soil structure and influence of microorganisms on the C and N dynamics during the regeneration of the secondary pasture soils. Top soil samples (0–5, 5–10 and 5–10 cm) were taken from chronosequences of secondary pastures (1–31 years old) at three agro-ecosystems in the South African Highveld. Long-term cropland and primary grassland served as control. Soil samples were fractionated according to particle size and to aggregate size and characterised by their C and N content. Amino sugars as indicators for microbial residues were analysed to elucidate the influence of microorganisms on the C and N sequestration in the secondary pastures. In all ecosystems, the carbon stocks increased exponentially until a maximum was reached 10–95 years after land conversion. This gain in soil C was clearly pronounced for the top 0–5 cm of soil but already hardly detectable at 10–20 cm soil depth. The sand fraction recovered carbon more rapidly than did the finer size separates. Yet, in all three ecosystems the extend of restoration of total carbon stocks varies between 57 % ant 74 %.

In contrast, soil structure recovers nearly completely within 20 years. This suggests that the influence of the physical protection in the aggregates affects the regeneration of soil organic matter very slowly. The amino sugar concentration increased exponentially to some extent but a complete regeneration was not feasible. Previous intensive cropping resulted in a change of microbial residue composition towards more fungal residues. Increasing glucosamine to muramic acid ratio indicates a continuing increasing contribution of fungal-derived C and N to the microbial residue pool during the pasture management. We concluded that previous losses of soil organic matter cannot easily be counterbalanced and that the native grassland ecosystem are only partly resilient to land-use change.

Keywords: Amino sugar, chronosequence, land-use change,grassland restoration, secondary grassland, soil aggregation, soil organic matter

Contact Address: Raimund Kösters, University of Bonn, Institute of Crop Science and Resource Conservation, Division of Soil Science, Nussallee 13, 53115 Bonn, Germany, e-mail: raimund.koesters@uni-bonn.de