Soil organic carbon accumulation under perennial forages in the Southern Highlands of Tanzania

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Key Messages

- Results indicate slightly higher SOC in Rhodes grass compared to maize plots in 55 paired sites in Njombe district, with an average difference of about 1%.
- Large variability across the farms associated with different land management and land use history may explain the observed small differences between sites.
- Controlled experiments needed for a robust quantification of SOC in perennial forages, and their sequestration potentials.

1. Introduction

Soil Organic Carbon (SOC) loss in continuously cultivated agricultural systems is a major problem many sub-Saharan Africa countries[1].

Studies show that improved management practices in annual cropping systems only reduce the rate of SOC losses, but are not sufficient to achieve sequestration [2,3].

Introducing perennial grass, such as *Brachiaria* and Rhodes (*Chloris Gayana*) into annual cropping systems can be a viable strategy for enhancing SOC [4].

A picture showing perennial forage grasses, including Brachiaria, Napier and Rhodes, growing in a demonstration plot in the southern highlands of Tanzania.

A picture showing Rhodes grass growing in a farmers plot in Njombe district in the Southern highlands of Tanzania. Rhodes is the most common perennial forage in the district.

Although significant efforts have been made in quantifying the impacts of perennial grasses on different soil properties, studies in sub-Saharan Africa remain scarce with limited field observations and model assessments [5].

Objective: Investigate the differences in SOC between annual maize (*Zea mays*) cropping systems and the Rhodes (*Chloris Gayana*) grass in the southern highlands of Tanzania.

2. Method

- Conducted a survey to identity farmers with planted forages that are more than five years old adjacent to maize plots, and documented land use history.
- Survey results indicated that Rhodes is the dominating perennial forage grass in the district.
- Soil sampling was conducted in 55 sets of paired plots sites, Rhodes versus adjacent maize plots, at depths of 0-20 and 20-50 cm.
- Analysed variables were SOC content and texture for the two depths; aggregate fractions and their SOC content for the 0-20 cm.

Table 1: Mean soil properties for the selected 55 paired plots.

Depth (cm)	Land use	Sand (%)	Silt (%)	Clay (%)	pH	Bulk density (g cm^{-3})
0-20	Cropland	49.24 (4.73)	7.93 (3.56)	42.8 (3.56)	4.82 (0.38)	1.11 (0.09)
	Rhodes	49.50 (4.88)	8.45 (4.87)	42.1 (3.18)	4.83 (0.30)	1.08 (0.09)
20-50	Cropland	47 (5.2)	7.93 (3)	45 (5)	4.66 (0.30)	-
	Rhodes	48 (5.1)	8.45 (3)	46 (5)	4.77 (0.31)	-

4. Aggregate fractions and aggregate SOC content

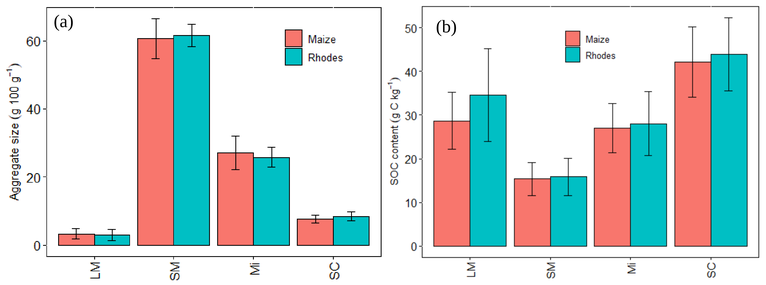

Fig 3: (a) Mean values for the Large Macroagreggates (LM), Small Macroagreggates (SM), Microagreggates and the silt and clay fractions, (b) Mean SOC content in the different aggregate fractions. The error bars represent standard deviations over the sites.

- Statistical analysis indicate no significant differences between the Rhodes and maize plots in the LM, SM and Mi fractions. There were significant differences in the SC.
- There were significant differences in the carbon content in the LM ($p<0.001$) and SC ($p<0.03$) aggregate fractions.
- Higher OC in the LM indicates that there is physical protection of OC, due to reduced tillage in the Rhodes compared to maize plots.

3. Total SOC content in maize versus Rhodes plots

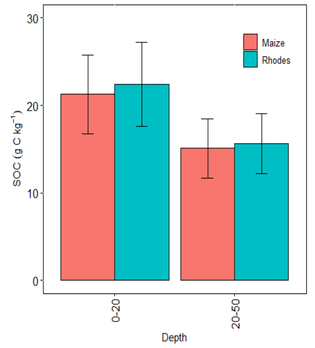

Fig 1: Mean SOC content across the Rhodes and Maize plots for the 0-20 and 20-50 cm depth.

- Mean values across the paired sites indicate slightly higher SOC in Rhodes compared to the maize plots. However, differences were insignificant.
- SOC content varied widely with values ranging between 14.8 and 39.5 g C kg^{-1} in the Rhodes plots and from 13.0 to 35.9 g C kg^{-1} in the maize plots for 0-20 cm.
- Average SOC stocks for the 0-20 cm depth were 47.10 ±10.04 in Rhodes and 47.66±9.8 Mg C ha-1 in Maize.

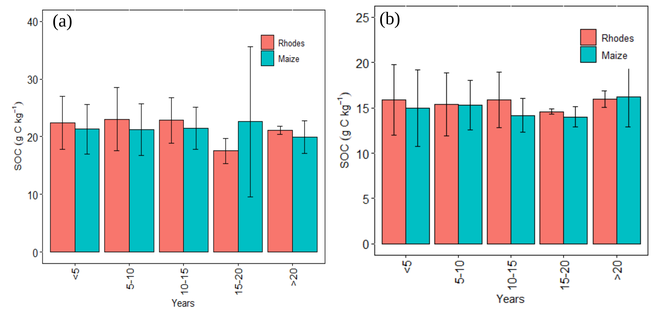

Fig 2: Mean SOC content for the Rhodes and maize plots for (0-20) and (b) 20-50 cm depth. The mean values were calculated by categorizing the sites based on the time of land use of the Rhodes plots.

- Regression analyses indicate a significant relationship between the differences in SOC across the sites and the clay content ($p<0.001$).
- Mean analyses based on the time of land use of the forages plots do not indicate a trend in the Rhodes SOC.
- Lack of large differences between the different land use systems is due to large variability across sites associated with different land use history and land management.

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