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 in 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].

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 identify 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.

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Land use</th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>pH</th>
<th>Bulk density (g cm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>Cropland</td>
<td>49.24 (4.73)</td>
<td>7.93 (3.56)</td>
<td>42.8 (3.56)</td>
<td>4.82 (0.36)</td>
<td>1.11 (0.09)</td>
</tr>
<tr>
<td>Rhodes</td>
<td>49.50 (4.88)</td>
<td>8.45 (4.87)</td>
<td>42.1 (3.18)</td>
<td>4.83 (0.30)</td>
<td>1.08 (0.09)</td>
<td></td>
</tr>
<tr>
<td>20-50</td>
<td>Cropland</td>
<td>47.0 (5.2)</td>
<td>7.93 (3)</td>
<td>45 (5)</td>
<td>4.66 (0.30)</td>
<td></td>
</tr>
<tr>
<td>Rhodes</td>
<td>48.5 (5.1)</td>
<td>8.45 (3)</td>
<td>46 (5)</td>
<td>4.77 (0.31)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Total SOC content in maize versus Rhodes plots

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

4. Aggregate fractions and aggregate SOC content

- 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.

References

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