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The Impact of Long-Term Tropical Grassland Conversion on Soil Quality and Soil Carbon Stocks

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Abstract

Enhancing the capacity of livestock systems to sequester carbon is an important measure to tackle soil degradation and climate change. Therefore, accurate assessments are required, particularly at farm level, to estimate soil carbon sinks under different land use systems by available predictors. This study evaluated the impact of different long-term land-use scenarios on soil carbon storage and ascertained the impact of condensed tannins (CT) and soil chemical properties on soil C dynamics in grasslands of southern Ghana. Soil samples were taken (0–30 cm depth) from 50 years old food crop fields, seeded grazing fields, monoculture fields of fodder grass, legume herbs, legume browse, non-legume browse species and native grassland. CT concentration in the forages ranged from 4–67 $^{mg}/_{kg}$ dry matter and were higher ($p < 0.01$) in browses compared to herbs. Nitrogen (N) levels were highly correlated with soil carbon stocks and were significantly higher ($p < 0.01$) for fodder grass fields and legume herbs fields. C:N ratio in soils was not significantly affected by the land use system ($p > 0.05$). Plant available phosphorus and potassium represented highest ($p < 0.01$) values in food crop fields. Soil pH varied only with a significant rate ($p < 0.001$) between food crop fields and seeded gazing fields. Soil carbon stocks ranged from 16.6 — 64.1 t C ha^{-1} (mean ± s.e: 33.1 ± 1.13 t C ha^{-1}) across land use systems and were lower ($p < 0.01$) for grazed seeded-pasture fields and herbaceous legume plots compared to the other land use systems. Conversion of the natural grassland resulted in a mean loss of 480 kg C ha^{-1} $year^{-1}$. There was significant ($p < 0.05$) positive correlation between the long-term changes in soil C stock and CT fractions (r = 0.33–0.49). Also, correlation tests showed positive relationships between change in soil C-stock and soil chemical traits (r = 0.043–0.91). The current case study indicated that a multiple linear regression equation with N, CN and K as principal factors could explain 98 % of the long-term changes in SOC stock.

Keywords: C4 grasses, carbon sequestration, condensed tannins, soil nutrients, sub-Saharan Africa

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