Impacts of Agroforestry conservation practices on soil health, crop nutrients and safety in Zambia

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Credit-Njoloma Joyce

Introduction

The current farming systems rely heavily on the intensive use of external resources and inputs such as water, mineral fertilizers, and pesticides to increase agricultural productivity (Bernard and Lux, 2017) while negatively impacting the soil & other natural resources. The uptake and utilization of the soil nutrients are essential for ensuring proper growth and improving crop yield and quality. Soil health and crop nutrition could be improved by incorporating green leaf biomass of leguminous trees such as *Gliricidia sepium* in agroforestry systems (Fig 1). It is assumed that combining maize-legume-agroforestry conservation practices with *Gliricidia* could provide multiple benefits and reduce production risks to smallholders. A multi-disciplinary *Gliricidia* project was established to explore the assumption by involving smallholder farmers in two maize growing districts in Eastern Zambia. A common practice in the study area is mulching using *Gliricidia* leaf biomass.

Objectives

The study's primary objectives were to

(i) monitor the soil and crop nutrients (e.g., Nitrogen, Organic Carbon) and measure crop yields under agroforestry systems (e.g., *Gliricidia sepium*) at different levels of intensification and land degradation.

(i) assess the impact of agroforestry-based interventions on the nutrients of the selected food crops to determine if agroforestry practices result in healthier and nutrient-rich crop produce.

Figure 1: *Gliricidia* incorporation into the soil (credit-Njoloma Joyce)

Materials and Methods

Farmer-led field trials were established in 15 sites with seven treatments (T) that included *Gliricidia* intercropping with maize, soybean and groundnuts and control (sole crops)(Fig 2). Over the last two growing seasons, crop(179) and soil(360) samples were collected and analyzed for: i) nutritional, antinutritional, functional, and mineral properties, as well as mycotoxin (aflatoxin and/or fumonisin) and *Aspergillus* load (crops); and ii) soil nutrients and microbial loads.

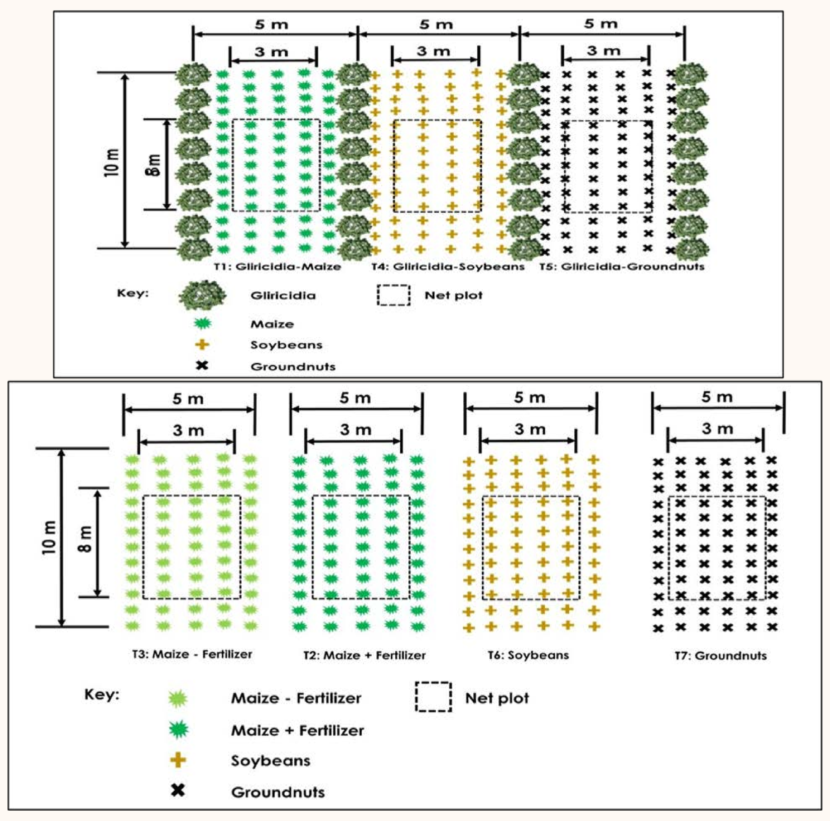

Figure 2: 2D plots design for the trial

Results and Discussion

Our research findings

- Maize yield from the control plots (T3) was lower (1.2 t/ha) than T1 (4.5 t/ha) and T2 (6.0 t/ha).
- The soil organic carbon (SOC) content of the sampled soils ranged from 0.32% (0.60% organic matter, OM) to 1.10 % (2.0% OM), which is very low despite some positive increase observed since the incorporation of *Gliricidia* leaf manure (Fig 3) into the treated soils (T1, T4, T5).
- The soil bulk density (BD) ranged between 1.26 and 1.36 g/cm3, within 1.0 to 1.7 g/cm3 for typical agricultural soils (Brady and Weil, 2002).
- The treatments intercropped with *Gliricidia* (T1, T4, T5) showed, in general, higher ash, total carbohydrate, starch, amylose, and crude fibre contents than the controls: sole maize (T2 with fertilizer, T3 without fertilizer), soybean (T6) and groundnuts (T7).
- *Gliricidia* intercropping significantly ($p<0.05$) reduced the tannin and phytic contents in soybean, groundnuts, and maize grains. Moreover, *Gliricidia* increased the nitrogen content in the grains, resulting in increased protein content (Fig 4).

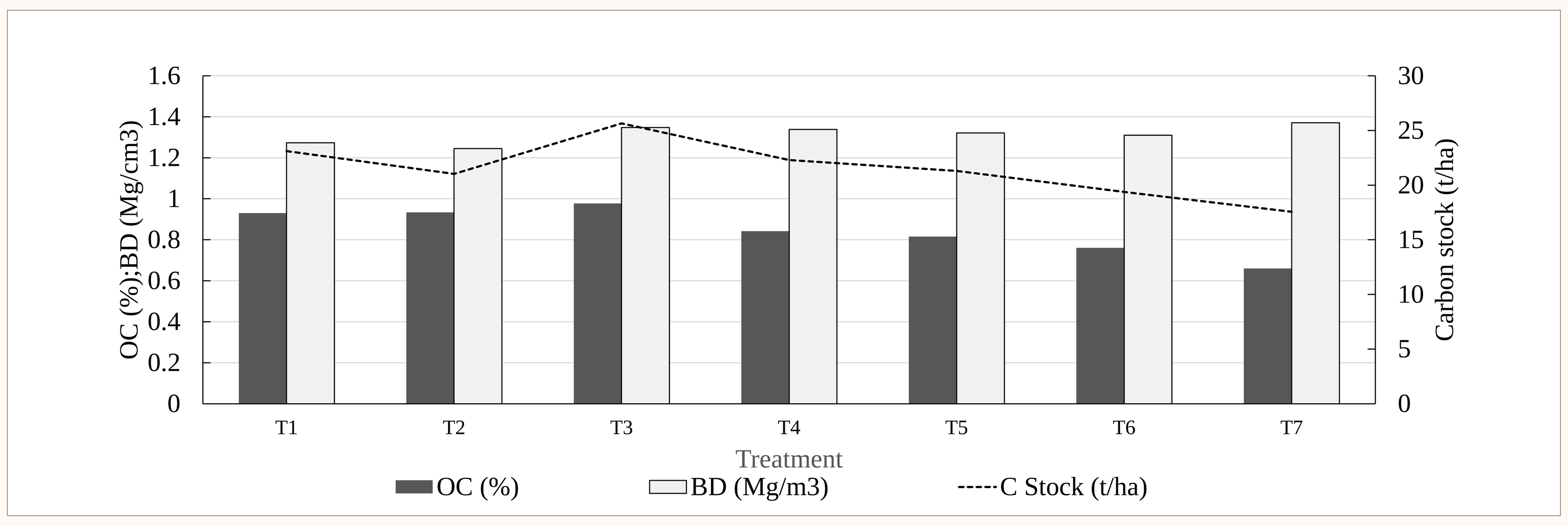

Figure 3: Mean Organic carbon, BD and carbon stock estimates from the seven treatment plots

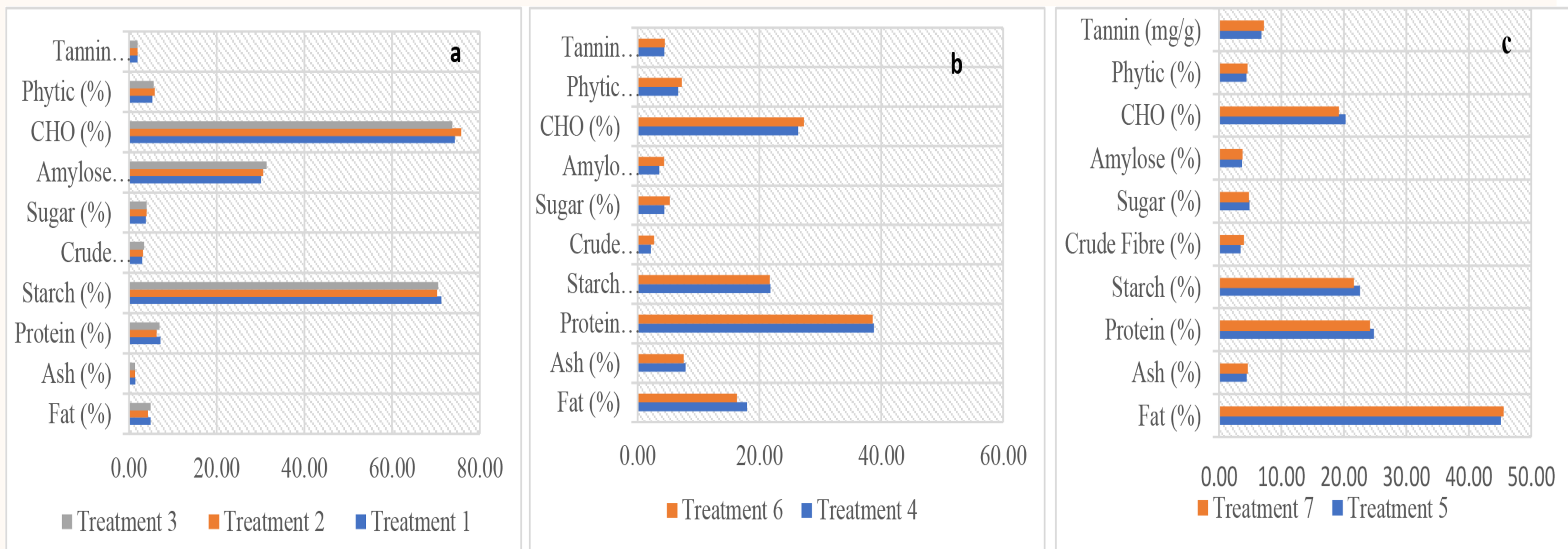

Figure 4: Effects of treatment on the nutritional & antinutritional properties of (a) maize, (b) soybean, and (c) groundnuts.

- *Gliricidia* incorporation had minimal effect on the occurrence and distribution of *Aspergillus spp.* in the soils and crops. Overall, treatments with *Gliricidia* recorded lower mycotoxin prevalence, while sole maize (T3) registered the highest mycotoxin prevalence (Table 1).
- There was a higher prevalence of mycotoxins in Gliricidia plots than in sole groundnuts in groundnuts.
- Various multimedia platforms, including social media, were used to disseminate information on Gliricidia agroforestry practices and their benefits to farmers and others.

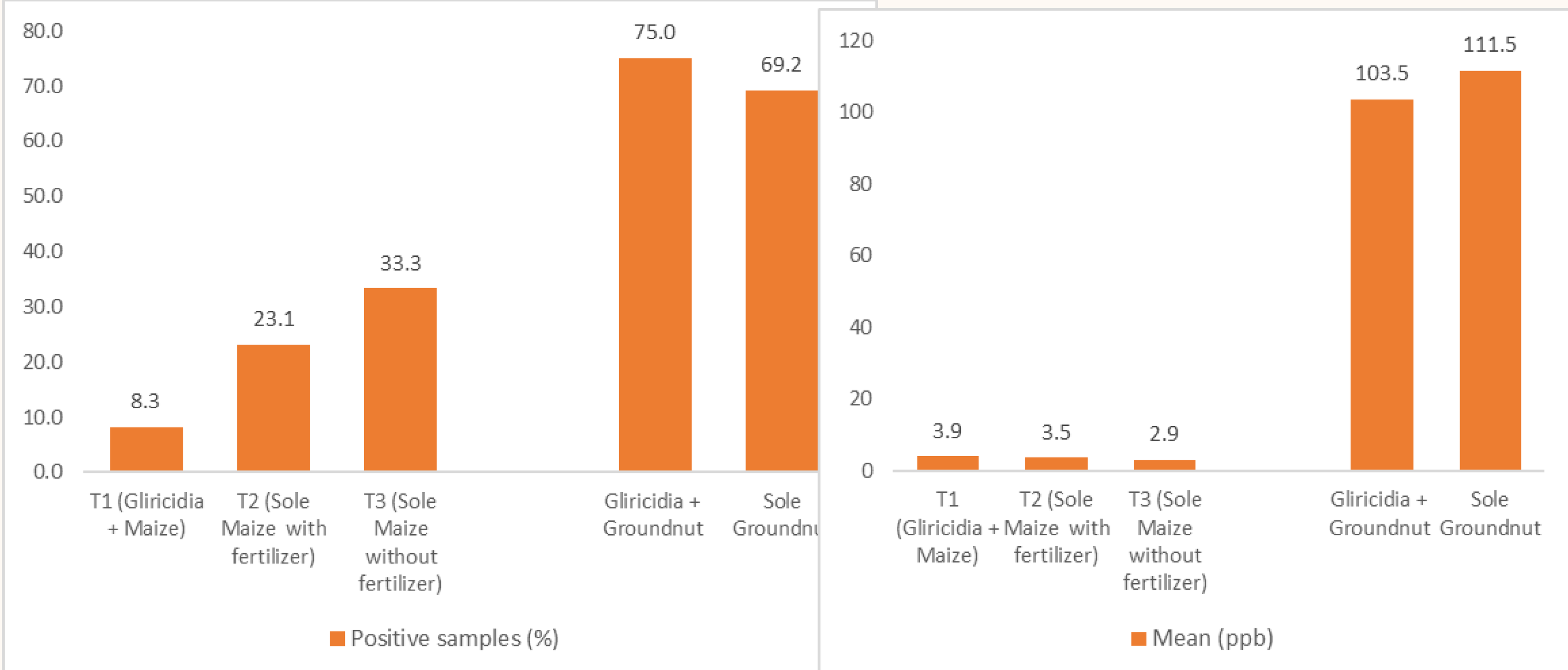

Table 1: Effects of *Gliricidia* and mineral fertilizer application on mycotoxin (aflatoxin, ppb) prevalence in maize and groundnut.

Conclusion

Crop diversification through intercropping of cereals with legumes and intercropping with *Gliricidia* trees enhanced diversity (in crops, trees, habitat, healthy food diets, markets), synergies (combining annual & perennial plants), resilience (to climate change) and culture and food traditions (increasing healthy food production & consumption and supporting the right to adequate food). *Gliricidia* incorporation increased the soil organic matter, improved the nutritional quality and reduced the mycotoxin prevalence. Policy and institutional support are needed to increase the adoption of agroforestry systems with *Gliricidia* trees by smallholder farmers.

Acknowledgements

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Brady, N.C. and Weil, R. R (2002) 'The Nature and Properties of Soils', 13th Edition, Prentice-Hall, NJ; 960 p; ISBN: 13-016763-0.

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