



Adapting the CROPGRO model to simulate biomass production and soil organic carbon of Cayman grass in East Africa

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Introduction

- ▶ Biophysical crop models are useful tools for informing land management practices that can enhance biomass production and soil organic carbon (SOC) sequestration in dairy farming systems.
- ▶ DSSAT CROPGRO Perennial Forage Model is a model that was developed for simulation perennial forage systems (reference).
- ▶ This has been applied and evaluated for simulating *Urochloa* cv. Marandu in the tropical regions of Brazil.
- ▶ Within East Africa there are no modeling studies on perennial forage grasses despite their wide adoption in the region.

Objective

To assess the performance of DSSAT CROPGRO Perennial Forage model in simulating *Urochloa* (syn. *Brachiaria*) hybrid cv. Cayman in the southern highlands of Tanzania and assess the SOC sequestration potential under different manure application rates.

Methodology

Field data and model situations

- ▶ Study relied on data from 6 on-farm replicated trials in the Southern Highlands of Tanzania in Njombe (Kichiwa and Ikuna wards), Mufindi (Igowole and Mtango wards), Rungwe (Lufingo and Kiwira wards) (Table 1).
- ▶ Trials comprised of 13 replicated treatments with pure forages and forage-legume intercrops, among them *Urochloa* Cayman grass.

Table 1. Percentage of articles cited in Web of Science (WoS) from predatory journals.

Properties	Igowole	Mtango	Ikuna	Kichiwa	Kiwira	Lufingo
Elevation (m)	1,958	2,035	1,825	1,833	1,412	1,346
Rainfall (mm)	1,512	1,466	1,345	1,345	1,612	1,612
Max. temperature (°C)	25	26	22	22	22	22
Min. temperature (°C)	15	16	13	13	14	14
Soil texture	Sandy clay	Clay	Clay	Clay	Sandy loam	Sandy loam
Soil organic carbon (%)	1.63	3.51	2.28	2.48	4.23	4.41
pH (in water)	5.2	5.2	5	5.1	5.8	5.4

- ▶ Biomass data for 12 seasons collected between 2018 to 2021 and SOC for Cayman was used in evaluating the DSSAT CROPGRO - Perennial Forage Model.
- ▶ The model parametrized for Marandu was initialized with soil profile data from the sites (i.e., clay and silt, organic carbon, bulk density, and Ph), and run with weather data and management information.

Soil water holding properties (i.e., saturated water content, drained upper limit, and lower limit of plant extractable water) and percentage of carbon in the stable organic pool adjusted during the model evaluation.

- ▶ Evaluated model was applied to assess the impacts of long-term manure application on SOC with rates of 0, 1, 5 and 10 t/ha every year for a period of 30 years (1990–2021).

References

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Results

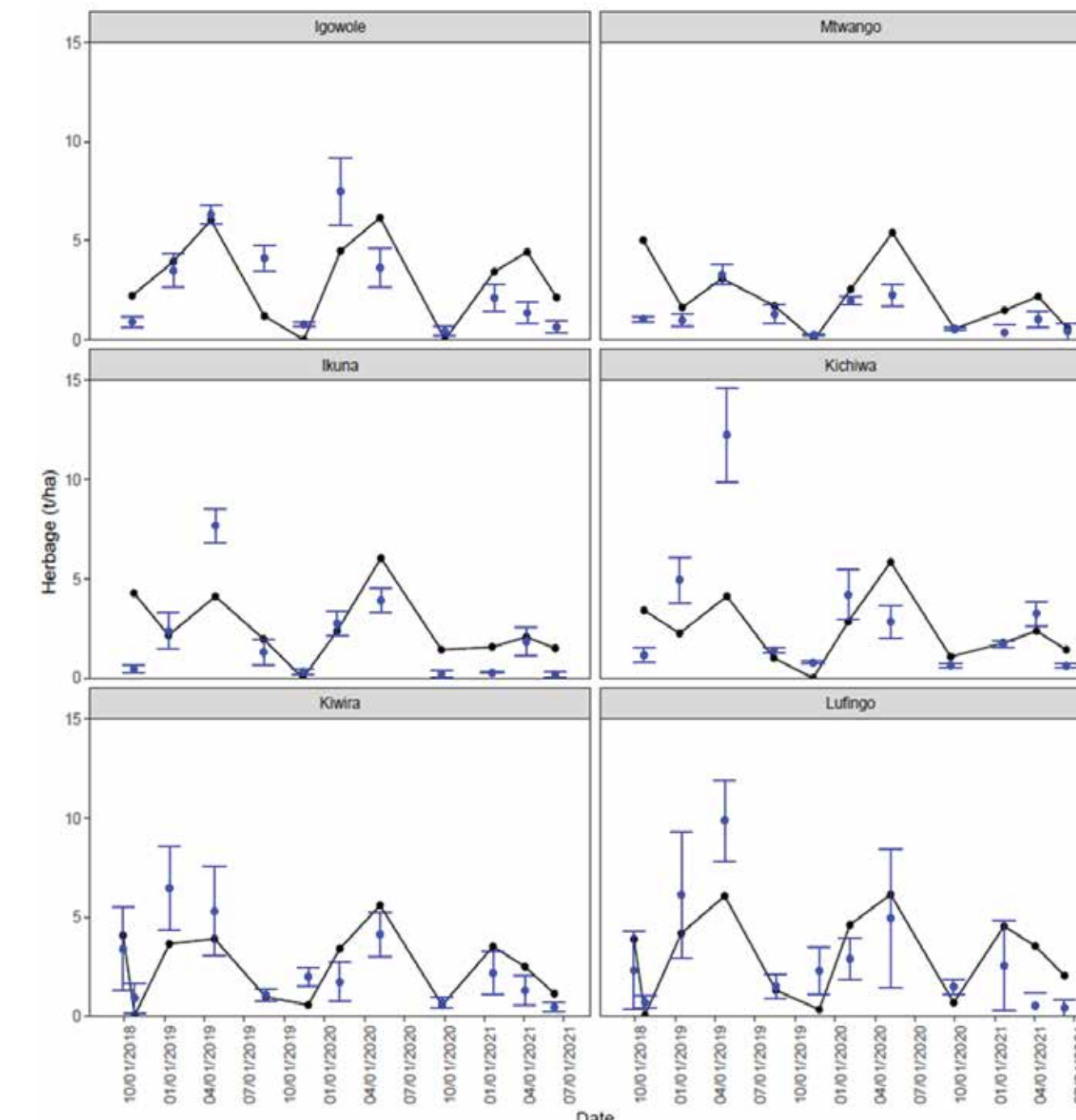


Figure 1. Observed versus simulated herbage of *Urochloa* Cayman for all the study sites from 2018 to 2021

Blue point = Mean observed herbage for the three replicates with the error bars indicating the standard deviation. Black dot and line = Simulated herbage.

Growing *Urochloa* Cayman without manure application and under 1t/ha of manure would result in decreased SOC in all the six sites (Fig 2). Higher manure applications rates of 5 t/ha and 10t/ha resulted in increased SOC in the sites in Njombe and Mufindi districts. However, a decline in SOC was simulated under 5 t/ha of manure for Kiwira and Lufingo in Rungwe district and an increase with 10 t/ha. Kiwira and Lufingo had a higher initial SOC compared to the other four sites (Table 1). Thus, the decrease in SOC even with 5 t/ha of manure is likely due to the land use history.

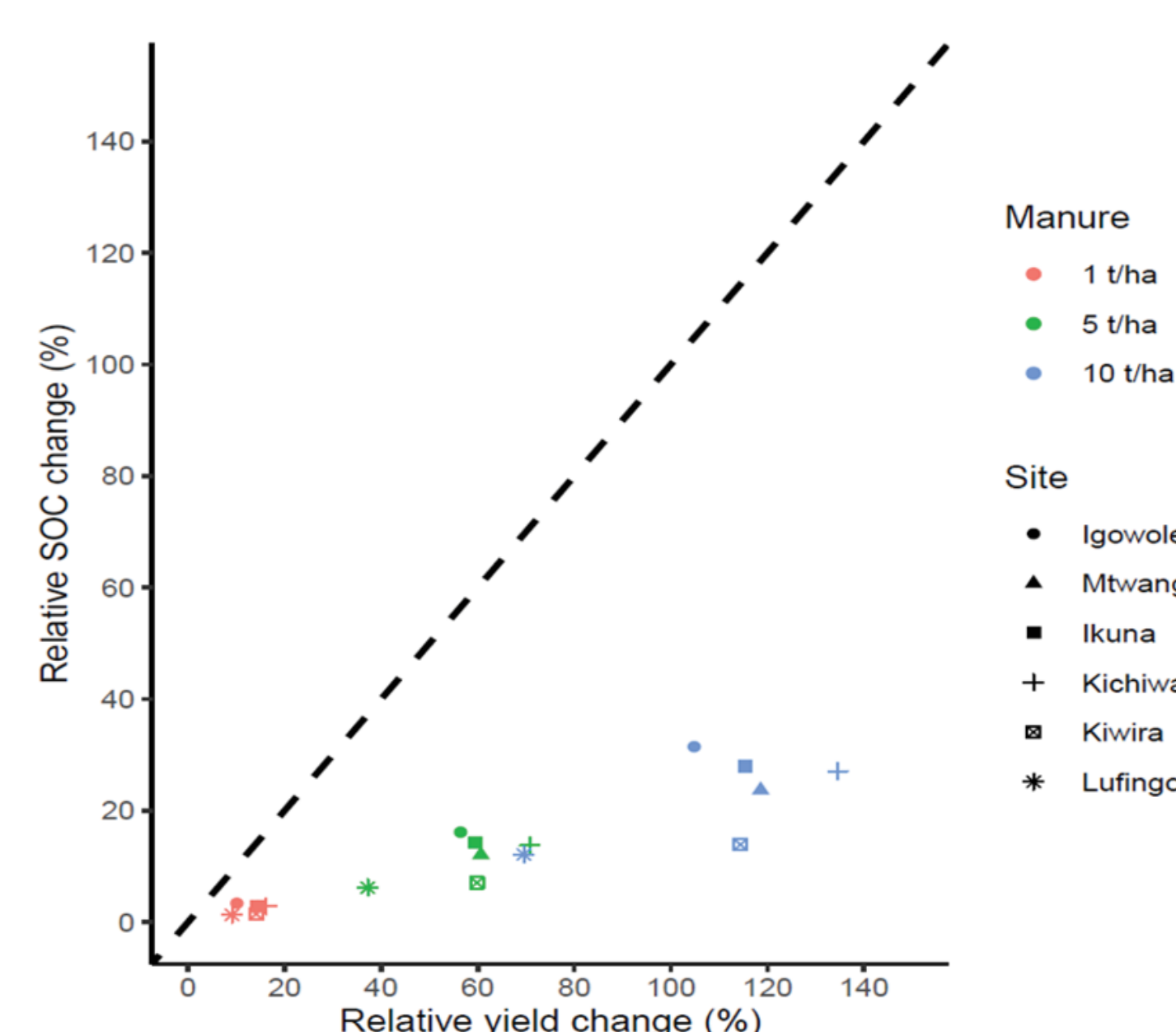


Figure 2. Simulated SOC stocks under different manure application rates for the period 1990 to 2021

The increase in SOC associated with increased manure application resulted in higher herbage (Fig. 3), with the relative changes in the herbage yields being much more than the increase in SOC.

Figure 3. The simulated relative change in yield versus SOC in response to different manure rates compared to the zero application of manure, averaged for 1991–2021 and shown per study site.

Conclusions

- ▶ The CROPGRO-Perennial Forage model parameterized for Marandu was successful in simulating herbage productivity for Cayman and SOC in southern highlands of Tanzania.
- ▶ Improved management practices, e.g., application of farm yard manure, are needed to increase harvested biomass and SOC in perennial forage systems.