Effect of intensification and integration of pasture-based beef cattle production systems on soil organic matter

Introduction

- ✓ Problem in beef cattle production systems in Brazil: ↓levels of soil organic matter (SOM), especially in pasture areas
- ✓ Consequences: ↓ soil quality, ↓forage productivity, compromising ecosystem services
- ✓ Intensification and integration of different pasture management systems can help with carbon (C) gain, nutrient use efficiency, and increased animal productivity.
- ✓ Studies by Damian et al., (2023) and Oliveira et al., (2023) demonstrated that intensification and integration of production systems promote in ↑SOM, with carbon sequestration rates ranging from 0.75 to 1.74 Mg C ha^{1} $year^{1}$ in ICL and ICLF systems, and reaching 2.2 Mg C ha^{1} $year^{1}$ in fertilized pastures (Bento et al., 2025).
- ✓ Lack of studies on the impacts of management levels on SOM in the long term
- ✓ Objective of the study: to evaluate the effects of different levels of pasture intensification and integration practices on MOS content over three consecutive harvests.

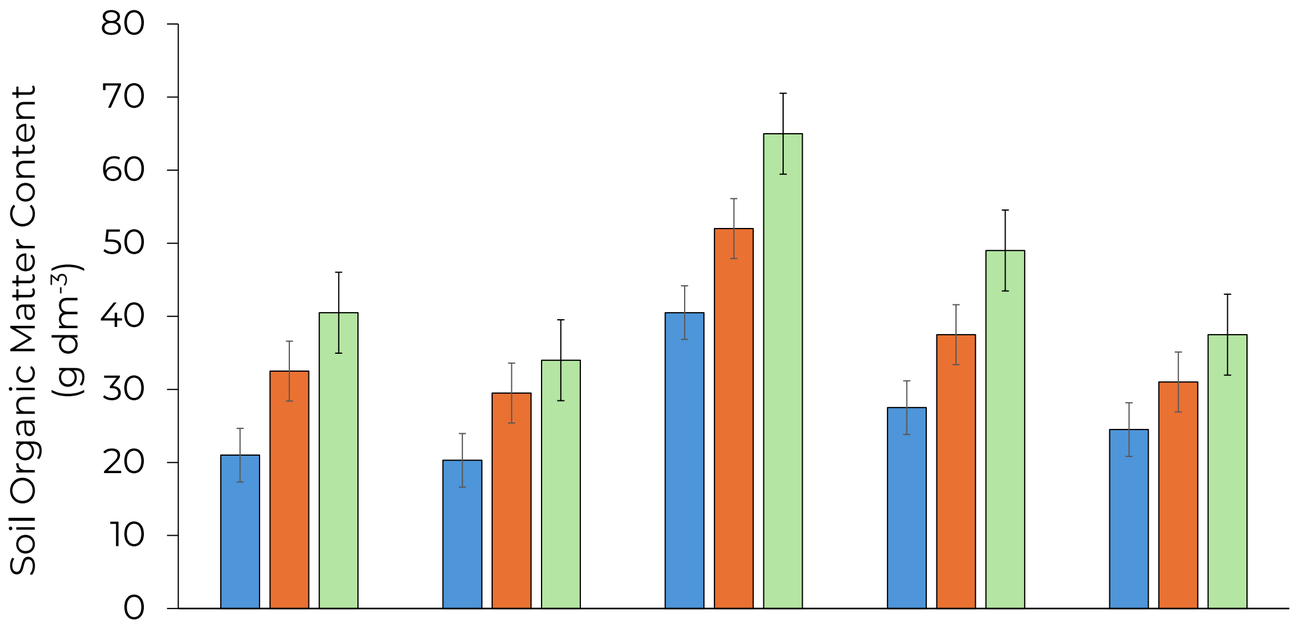
Methods

- ✓ The study was conducted at Embrapa Southeast Livestock (São Carlos-SP, Brazil), across two soil types with different clay textures
- ✓ Five grazing systems were evaluated between 2019 and 2021: degraded pasture (DP0); silvopastoral (SP200); rotational dryland pasture with moderate stocking (RP200); rotational dryland pasture with high stocking (RP400); and rotational dryland and irrigated pasture (IP600)

System	Forage Species	Management Type	N Fertilization (kg/ha/year)	Soil Type
DP0	*Urochloa* decumbens	Extensive	0	Ferralsol (Dystric, Clayic) – 32% clay
SP200	*Urochloa* decumbens + trees	Intensive (Silvopastoral)	200	Ferralsol (Dystric, Clayic) – 32% clay
RP200	*Urochloa* brizantha	Intensive (Moderate stocking)	200	Nitisol (Eutric, Clayic) – 47% clay
RP400	Megathyrsus maximus	Intensive (High stocking)	400	Nitisol (Eutric, Clayic) – 47% clay
IP600	Megathyrsus maximus (Irrigated)	Intensive (High stocking + irrigation)	600	Ferralsol (Dystric, Clayic) – 32% clay

- ✓ Soil samples were taken in the 0 to 20 cm depth layer
- ✓ Total of 120 sampled points in 2019, 2020, and 2021, for soil organic matter (SOM) and fertility analyses.

Results and discussion



RP200 presented the highest MOS levels in all years: 40.5 (2019), 52.0 (2020), and 65.0 g dm^{3} (2021), resulting from the combination of rotational management and moderate nitrogen fertilization, which favor greater root production and carbon input to the soil.

SP200 showed the lowest accumulation of MOS, possibly due to shading and tree density, which reduce forage productivity and carbon input to the soil.

The 2021 SOM values (g dm^{3}) (RP400: 49.0; DP0: 40.5; IP600: 37.5; and SP200: 34.0) suggest that intensification increases SOM stocks; however, integration (silvopastoral systems) may alter the stabilization dynamics.

Conclusion

Pasture intensification significantly increased SOM levels over time, with the greatest effects observed under moderate to high fertilization regimes. Silvopastoral integration, although bringing environmental benefits, showed lower SOM accumulation, possibly due to changes in organic matter inputs and turnover. Future studies should explore root biomass and microbial dynamics to better understand the mechanisms of carbon stabilization in integrated systems.

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