

Dear Reviewer,

Thank you for your detailed and constructive feedback on our manuscript. Your suggestions will significantly improve the readability and clarity of our paper. Our response to each comment are written in blue below the corresponding comment and the sentence that were adapted are italicized. We appreciate the time and effort you invested in reviewing our work. Thank you very much.

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**This manuscript is much improved! Well done. Many of my comments are somewhat stylistic, and are just suggestions for further honing the MS before publication. Primarily, I'd love to get more context on why you think manure had this effect, and citing relevant literature to this effect. I'd also like authors to consider including a bit more context on the trajectory of land-use change in the region to contextualize deforestation, and the results presented.**

The following sentence was added in the introduction:

*Eastern Africa followed this trend, experiencing a substantial land use transformation between 1988 and 2017, with cropland expanding by 35% and settlements by 43%, primarily at the expense of woody vegetation*

- I think your overall finding in the abstract could still be a bit clearer and to the point - Overall our findings indicate that SOC in the subsoil... was only impacted by a single type of organic amendment, manure, while other amendments only increased surface SOC. —> Could nest some of the importance of the study in referencing the global importance of the subsoil as a C-reservoir that is under appreciated and that could be impacted by management decisions.

The sentence you are referring to in the abstract was modified as follows:

*Our findings demonstrate that SOC in the subsoil comprised  $48.5\% \pm 1.7\%$  of the total SOC stocks across the 0-70 cm soil profile, yet only manure application affected subsoil OC levels, while other organic amendments only increased SOC in the surface layer.*

- WC “ever-more” is slightly strange. I understand the point but I think the first line could be streamlined. “Satisfy the food demand of an increasingly demanding and growing population.” I also sometimes caution this as the introduction when studies have shown that, calorically, food production is actually sufficient for our current and growing populations, and that food and resource distribution and access are primary forces in solving global hunger.

The first line was adapted as suggested:

*Globally, food production systems need to satisfy food demand of an increasingly demanding and growing population.*

- Citation would be good for SOC functional properties in 55-57.

A citation was included:

*Therefore, agricultural management should not only aim at increasing crop yield in the short*

*term, but also at maintaining SOC at a level that maintains the key functions that it regulates (e.g., nutrient cycling, water retention, improved cation exchange capacity (CEC), soil structure stabilization, promotion of biodiversity) in the long term (Wiesmeier et al., 2019).*

- Could streamline introduction of Organic residues by replacing “organic materials” in line 64 with OR to avoid parenthetical.

The text was adapted as suggested:

*This approach promotes various practices, including the combined application of mineral fertilizer and organic residues (OR) such as plant residues, manure, and compost.*

- Transition to paragraph at line 75 could be smoother. Transition with OR first and then can mention SOC turnover (flip the sentence).

The text was adapted as follows:

*Applying OR over multiple years in tropical croplands can significantly increase the SOC content (Fujisaki et al., 2018), despite the faster SOC turnover rates in tropical compared to temperate climates (Wang et al., 2018).*

- Replace “its” in line 76 with OR’s

The text was adapted as suggested:

*However, the contribution of OR to the amount of SOC is, in part, controlled by the type of added OR (Córdova et al., 2018).*

- Is t”the amount of SOC” the stock?

No, “It” is the OR.

The “It’s” contribution was replaced by “*the contribution of OR*” in the text.

- Do you have to use (lignin + Polyphenol) Could this just be defined as normal C:N ratios?

We chose to use the definition of organic residues as it was initially defined for this long-term field trial and accordingly to the definition of ISFM by Vanlauwe et al. (2005). It is relevant to discern the composition of *Tithonia* and *Manure* which have similar C:N ratio, but different (lignin+polyphenol)/N ratio (Table 1).

- In general, “SOC content” feels a little vague - could you clarify whether it is concentration, or stocks in the various studies that you refer to throughout.

We agree that SOC content is less precise than stocks or concentration. Therefore, we now made sure that when we were discussing about our own data or directly comparing amounts of SOC with other studies, we always used the appropriate unit. We kept the use of content for some cases where we were referring to a mix of studies that were not using the same unit.

- The second to last line (Different factors... line 89) feels like it deviates from the setup of your final line. Think through the logical flow of this paragraph a bit more to better articulate the research gap that you are filling - I think this is the need for more research on OR in SSA and tropical systems,

The paragraph was adapted as follows:

*The contradictory findings across tropical regions highlight the complexity of SOC dynamics in these agroecosystems where different factors, such as initially high SOC contents, favorable conditions to decomposition, and the limited capacity of 1:1 kaolinite clay minerals to stabilize OC, contribute to consistent SOC losses despite the application of organic residues in tropical soils (Laub et al., 2023b; Six et al., 2002; Sommer et al., 2018). While some studies demonstrate increases in SOC stocks through management practices, others report continued SOC losses even with substantial organic inputs, suggesting that local soil properties and environmental conditions play crucial roles. This knowledge gap is particularly evident in tropical agroecosystems, where the interactions between organic amendments, soil properties, and SOC stabilization mechanisms remain poorly understood, necessitating further research.*

- Transition to 95, maybe add “additionally” to start.

The transition was improved as suggested:

*Additionally, while field studies on plant nutrient acquisition from the subsoil are rare, ...*

- Not sure where c3, c4 fits in to the picture of the introduction. I think the introduction of  $\delta^{13}\text{C}$  for aging soil C is much improved, but I don't think the last line on improving models fits in the intro either... this can be saved for discussion.

This was adapted as suggested:

*Also  $\delta^{13}\text{C}$  can be used to detect the portion of C3 compared to C4 plant residues in the subsoil, enabling for example the tracking of maize-derived carbon inputs (Balesdent et al., 1987; Farquhar G D et al., 1989).*

~~*Furthermore, such knowledge would help improving soil models, thereby optimizing predictions to improve land management.*~~

- Are nutrient management treatments from Laub 2023b the same as the ones you have? Be clearer, and the third sentence feels repetitive. The other field sites are not relevant either in 2nd sentence.

The text was adapted as follows:

*In a recent study conducted at the same long-term field studied in the present manuscript (Embu), Laub et al. (2023b) showed that all nutrient management treatments resulted in significant topsoil SOC losses, while the use of farmyard manure was the most effective strategy to minimize the loss of SOC.*

~~*Laub et al. (2023b) studied the Embu trial along with three other trials in different regions of Kenya.*~~

- Delete “at” in 141.

The “at” was removed, as suggested.

- I appreciate the effort to maintain figure y-axes in 2, but I wonder if it’d be clearer to have a slightly adjusted y-axis for the right-most plots to maybe may at ~100? and perhaps reconfigure so that the differences can be seen a bit more clearly - not urgent but if possible.

We are not sure to understand what how exactly you “mean by slightly adjust [...] at ~100?” What is important to us with this plot is that it shows that about 50% of the SOC of the 0-70 cm profile is in the 30-70 cm and to highlight that at this depth only the manure treatment has a significantly higher SOC than the control.

- Re-reference the model number assigned in the methods for the best-fit model in lines 505-506

The text was adapted as suggested:

*According to the ANOVA performed on all the different statistical models, the model including all depth and the OR (i.e., model 1) had ...*

- Line 515 clunky - re-write. “According to the best-fit model for subsoils, manure and depth were the only significant variables affecting OC stocks” or something.

The text was adapted as suggested:

*According to the best-fit model for subsoils, manure and depth were the only significant variables affecting OC stocks (Supplementary Table 2).*

- Line 521-522 “The effect... on SOC stocks not needed here.

It was not clear to us what this comment is referring to.

- Omit “the deepest” and shorten - “Manure significantly impacted OC stocks down to 60cm” is more concise

This was adapted exactly as suggested

- Unsure of which residue treatment is considered in table 3 - all three?

Yes, all three. This was indeed not clear and the title of the table was modified as follows:  
*Table 3: Summary statistics of ANOVA testing the effect of all OR treatments on OC stocks across depth layers*

- “This means that after 38 growing seasons over 19 years, and considering the top 70 cm of the soil, Manure-N, as the most effective treatment to limit SOC losses, could maintain  $38.5 \pm 8.8 \text{ t OC ha}^{-1}$  more SOC compared to the least efficient treatment, Control+N.” A little hard to follow with all the clauses, and also maybe should go into the discussion rather than results

The sentence was simplified as follows:

*Therefore, the Manure-N treatment maintained  $38.5 \pm 8.8 \text{ t OC ha}^{-1}$  more SOC in the 0-70 cm depth layer compared to the Control+N treatment.*

- In the results, you switch to discussion of C/N whereas before you use lignin/polyphenol. I know these are similar concepts but I think uniformity or at least clarifying the transition would be good.

This is true. However, in the discussion, we consider the C/N ratio of the soil, while in the introduction of the concept, the lignin/polyphenol refers to the quality classification of the organic residues.

- 617, I might add a “statistically” significant. I think you do a nice job of showing that there are likely effects, but that for greater statistical confidence, you require more samples... It could also be interesting to discuss the impact that this might have on sampling schemes in general... as many deep samples pose significant logistical challenges

Statistically was added, exactly as suggested

- Line 652: it is at the highest end of typical manure application rates, ranging from... Not sure how the following line actually logically relates... on the impact of manure may not be as gratifying when considering non-longterm trials.

It was not very logical indeed. The sentence was modified as follows:

*Therefore, the impact of using manure may not be as great in the deeper layers when considering a scenario where common rate of manure are applied*

- When you discuss the mitigation in losses of SOC, it would be interesting to have you discuss some of the mechanisms that might be at play - while you cannot make definite statements with your study design, I suspect that there could be work that supports certain hypotheses to support your observations with each of your treatments, and in particular with manure. What is it about manure (C/N ratio, something else) that allows it to make such permeating differences relative to the other treatments? I think something to consider, which is not mentioned, is the fact that DOC and leachates from manure may percolate further down than plant-based leachates? Curious to know what you think is at play here in your system.

This sentence was added in the discussion

*A known mechanism for OC transport across soil profile is in the form of dissolved organic carbon (DOC), which moves downward through cycles of sorption and desorption (Kaiser and Kalbitz, 2012b; Uselman et al., 2007). In a long term in China, Liu et al. (2013) observed that manure applications increased the amount of DOC down to 60 cm as compared to straw residues application, supporting that manure may percolate further down than plant residues.*

- Not “very” responsive, rather than “much responsive” in line 708.

This was modified exactly as suggested.

- Is there increasing deforestation in the area - its something briefly mentioned as the site condition, but having some sense of the broader context of deforestation in your system may add some nice detail for you concluding thoughts, given that the idea of deforestation and land change only come up in passing once, much earlier in the paper.

A reference to this was added at the beginning of the introduction.