

Comment on soil-2021-5

Anonymous Referee #1

Referee comment on "Nonlinear turnover rates of soil carbon following cultivation of native grasslands and subsequent afforestation of croplands" by Guillermo Hernandez-Ramirez et al., SOIL Discuss., <https://doi.org/10.5194/soil-2021-5-RC1>, 2021

In this study, Hernandez-Ramirez et al. use data from a previous publication (Hernandez-Ramirez et al. 2011), coupled with new measurements of C stocks and stable C isotopes to model the trajectory of carbon losses and accruals resulting from grassland conversion to cropland and subsequent afforestation via shelterbelts, respectively, using first-order kinetics. Overall, I feel the manuscript is too long, and needs significant work to shorten it and improve its readability. I realize there is quite a lot going on in terms of explaining the different sites, methods undertaken, and results, but I still feel there is a lot of opportunity to cut text without losing any information. In addition, much of what is presented here has already been presented in earlier publications - though the degree of overlap is not entirely clear - so fewer words can be spent reiterating what has already been described in those publications to further aid in shortening the manuscript. Some more emphasis on what aspects of this work are novel or noteworthy, overall and compared to the previous publications on these sites, would strengthen it as well. What follows are section-by-section suggestions and comments.

Introduction:

Define "long-term" somewhere in the introduction.

The introduction could use some background on SOM accrual rates, and the fact that accrual is assumed to be asymptotic, but that this is rarely tested/quantified. All of the popular models assume or produce this asymptotic behavior, but it's rarely been verified in studies of accrual that are longer than xx number of years.

Some background on any previous studies which have provided data on SOM accrual for longer-term periods (or lack thereof) would be useful here.

I think the trees/shelterbelts ideas could be more clearly linked to SOM accrual and the specific knowledge gap linking the two could be better identified.

Line 76: the phrase "soil microbiology is sustained" is a little awkward and I'd suggest

rewording. Maybe "soil microbial communities are sustained and diversified". Or maybe something like "diverse microbial communities can flourish beneath mature trees"

Lines 91-98 are a bit repetitive and don't convincingly explain why this knowledge gap needs to be filled. I think these lines could be compressed and the need for this knowledge could be more clearly/convincingly stated here. Maybe using logic similar to the above comment about background on SOM accrual.

Methods:

There is no description of soil processing (it may be in the previous publications cited, but I think it still should be stated explicitly here). Were the samples sieved, and roots and plant fragments removed prior to analysis? Was any organic material or O horizon removed?

Line 160: replace "studies" with "studied"

Lines 181-186: I like that multiple scenarios were evaluated, but some explanation of why these two scenarios were chosen would be helpful (why 95% and not some other %age?)

Line 198: Change "tall prairie" to "tallgrass prairie"

Lines 213: Replace "Normal" with "Mean" if you are presenting mean annual precipitation.

Line 214: Replace "Normal air temperature" with "Mean annual air temperature" if that is what you are presenting.

Line 236: "...assuming that net contributions to soil C storage were negligible..." gives me pause. To clarify, you are assuming that there is no total increase in C from crop-derived C inputs, and that allows for these quantification approaches to be used. But there will certainly be contributions of crop-derived C to the C pools, even if they are not increasing in size (see xxx). Can you clarify whether you are assuming no contributions at all (i.e. no change in $\delta^{13}\text{C}$ from that of the native systems during cropping) or you are allowing for that change in $\delta^{13}\text{C}$ but assuming no net increase in total C? This relates to the following comment:

Lines 250-258: does " $\delta^{13}\text{C}$ native soil" refer only to the soil under native vegetation, or just whatever vegetation was present before afforestation? I'm finding this wording confusing because the cropped soils are also being used to represent the " $\delta^{13}\text{C}$ native soil" here (lines 251-252). I think the wording here needs to be clarified or better explained, since this is key to the interpretation of the results. Based on line 395 and the caption of Fig. 5, it seems as though the authors are assuming "the rest of the soil C was attributed to remaining prairie C", but this can not be the case if crop inputs contributed to the C there, which they surely will have.

Results:

In general I found this section to be long and difficult to follow at times. I recommend the authors condense much of the writing and work to make it easier to digest.

Line 288: Remove "(A)."

Line 290: Change "(Fig. 2A, Fig. 2B, and Fig. 2C)" to (Fig. 2A-C), here and elsewhere (e.g., line 300).

Line 296: Can you give the time spans here for reference?

Line 307: change "which can question" to "calling into question the" or "challenging the"

Lines 311-315: Sentence beginning on line 311 is not a full sentence. Maybe "while" need to be removed? Or this needs to be combined with the following sentence. In general these two sentences are a bit awkwardly placed and might make more sense if placed elsewhere.

Line 323-324: I think it would be good to clarify that this is only in the soil underneath the trees, rather than xx% C accrual for the whole field.

Line 318-328: If this data (Table 1) is the subject of another paper, it might be better to summarize it only very briefly and simply refer to the table.

Line 332: What did "normalization" entail?

Line 340: Maybe give unit or context after "i.e., from 1-0.711"

Line 350-353: This sentence is confusing to me. It is not clear what the 81% and the 94.5% represent - are they different timepoints or maybe different sites? After multiple readings I think I understand this to mean that after replenishing 81% of the C lost during cropping, the shelter belts had 94.5% of the C of the native grassland. I think you can word this more clearly.

Line 384: What do you mean by "clearly discernable" ?

Line 421: "stoichiometry of absolute capacities" is an odd phrase and I am not sure I understand what it means. "Proportionality of the initial prairie-C" is also a little odd, so I would suggest rewriting this sentence to be a little easier to understand.

Ind 456: remove "study"

Table 1. Perhaps add columns that shows the amount of time for each land use, or say in the caption?

Many of the figure captions are quite long. I think they can be shortened significantly without losing any key information.

Fig. 3. The Y axis wording is a little odd, maybe "Proportion of original C" or similar?

Discussion:

Overall, this section feels a little disjointed and lacks a good flow of ideas from paragraph to paragraph. Restructuring it so that it has a clearer arc and/or follows a similar flow of ideas as the introduction would help make the ideas easier to digest and follow.

Lines 492-497: This is a pretty clear explanation and I think it would be useful to have this much earlier, in the methods. I found it really hard to figure out whether this was the case

from reading the methods section.

Lines 516-517: Rather than saying "trees generated the conservation of the entire prairie-legacy" I would say something like "afforestation did not lead to loss of prairie-C" or "prairie-C was conserved during afforestation".

Line 527: I think it would make more sense to use "climatic" instead of "hydrothermal", and do this throughout the discussion. Could soil texture or aggregation play a role here?

Lines 530-536: What about physicochemical protection mechanisms? SOM fractionation might give additional insights, and I'd suggest that would be another important avenue for future research.

Line 540-541: Change "shown to continually being lost" to "was shown to be lost continually"

Line 541-542: This sentence seems to contradict the prior and following sentences. This makes it sound like not much of the prairie C was lost (only 1.7% of the original prairie C over 55 years is a very small amount). How does this compare to the rate of loss of native prairie C in the cropland? Is it really something to note, or is it a relatively normal turnover rate for old C?

Lines 570-574: This is a nice explanation and something to this effect should be included in the introduction (either move this text there, or introduce the idea there and reiterate it here).

Lines 587, 591, 592: I have only ever seen "MRT" refer to the C itself, never an MRT of soil C accretion or depletion. What does this mean? I think it would make more sense to refer to the rate of accretion/depletion, or average time to xx% of total accretion or something like that.

Paragraph beginning on line 604: I agree with the suggestion of studying different physical pools of C in terms of stability, and I like the ideas introduced here. However, they seem to come out of nowhere given that they have not been introduced earlier in the manuscript. I might suggest including them earlier on in the discussion (e.g. when discussing potential differences in native prairie C turnover between sites) and then coming back to it here to expand on it.

Summary:

The authors state that afforestation is a suitable means to address climate change, but it would be helpful to put their results in context of the amount of area being afforested in these cases. While there was significant C accrual in the soils under the trees, the area being planted to trees seems relatively small, so what is the overall gain from this practice? Is it really very significant given that most of the cropland is not being planted to trees? I think that noting these relative area sizes and total C losses and gains in the croplands vs afforested areas is very important to put the results into larger context.

