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Interactive comment on "Greater soil carbon stocks and faster turnover rates with increasing agricultural productivity" *by* Jonathan Sanderman et al.

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This manuscript provides compelling data and an important contribution to hoarding vs using SOC. Below are some specific comments.

One general comment is that the empirical results from this study are likely to be site specific. In other locations, there may be tradeoffs between different types of SOC.

Response: This is a fair and likely true point. In response we have added a caveat in the discussion section that these findings may not necessarily be representative of the response of all soils under all climatic conditions, and identify that further research is required to better understand how edaphic properties drive trade-offs between se-

questration and utilization.

Also, I believe there was a somewhat recent editorial published on this topic in Frontiers in Ecology and Environment by Oldfield et al that might be worth reading if the authors have not.

Response: Thanks for the suggestion of this editorial which is a call for quantitative research linking soil organic matter and soil health/food production benefits. In revision, we have now cited this publication in support of the roles SOM plays in soil fertility and crop production.

Line 2: I'm not sure that the belief is that it will offset current emissions as much as it could draw down concentrations. In other words, most of the SOC that could be built up is probably coming from recovering lost C from degraded lands.

Response: We completely agree that the opportunity to sequester SOC comes from the fact that most agricultural land has been degraded. Carbon sequestration is being sold in both ways the reviewer states: 1) people are actively developing carbon offset methodologies and emission reduction markets such as the California cap & trade system are seriously considering including SOC sequestration; and 2) as a negative emission technology which is needed because cutting emissions only at this point will be unlikely to get us to the goal of limiting warming to well under 2 degrees as agreed to at the COP21 in Paris. While politically and socially these are different things, from an atmospheric CO2 standpoint they are the same thing – less CO2 will be in the atmosphere than without improved land management for soil carbon sequestration In response, we have revised this sentence to include both of these needs for SOC sequestration and have included a reference to a recent Pete Smith paper which discusses SOC sequestration as a negative emission technology (Smith, P. (2016). Soil carbon sequestration and biochar as negative emission technologies. Global Change Biology, 22(3), 1315-1324.).

Lines 9-15: I certainly agree with this argument in terms of direct, short-term effects

on crop production. But stabilized, "hoarded" SOC can also have positive effects on productivity through changes in soil structure, water holding capacity, and potential to buffer pH. I don't think there's a good sense of the relative importance of nutrients vs. these other properties to crop production.

Response: This is an excellent point that there are other benefits to having higher SOM levels that should positively impact production. We have modified this paragraph to indicate that the "hoarding" part of locked up nutrients is only one part of the biological utility of SOM.

Lines 16-32: Since this is an empirical, rather than modeling, paper, this paragraph on representing mechanism in SOC models is distracting from the main contribution: testing the using vs hoarding paradigm

Response: We would argue that our paper joins empirical work with modelling, and that consistency of models with empirical data and conceptual/heuristic understanding should always be addressed in publications where possible. We do broadly agree in a sense with the reviewer: modelling papers and empirical papers do sometimes seem unrelated. We would clarify that this is primarily an empirical paper, but we have structured the work to reflect that there is a lot that modelers can learn from well collected empirical data and conversely, empiricists can learn a lot from how modelers think their systems function. This paragraph was included for this reason and we prefer to keep it because the discussion over microbially-explicit models is currently one of the major foci of the soil carbon community and the data presented in this study have a lot to offer this debate.

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