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Interactive comment on "Global meta-analysis of the relationship between soil organic matter and crop yields" *by* Emily E. Oldfield et al.

Anonymous Referee #1

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The authors use a global data set on maize and wheat yields together with soil and other environmental variables to derive statistical relationships between SOC and yield. The overall value of the study is appreciated. The interpretation of the data and observed relationships is, however, going too far because direct evidence for the postulated effects, as it could be derived from long-term experiments at different SOC levels, cannot be derived and many other influencing factors were ignored.

Title and abstract. In both, SOM is described as the key variable but the study relies on SOC data. This should be reflected in the title and the abstract. This already touches a more fundamental problem – the study does not provide mechanistic insight as to why higher SOC results in higher yields. More SOC is often obtained using more organic inputs, i.e., more macro- and micro-nutrients bound to SOM. A second issue here,

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related to the first one is that, correctly, a higher SOC concentration might reduce the amount of N needed as fertilizer to get the same yield, but it is not discussed how much more N must be fertilized to reach the higher SOC level.

L. 96 and methods. It is not clear why authors only used aridity and latitude as variables related to climate. Yields are strongly related to rainfall and temperature, which are easily available variables.

L. 121. More recent literature suggests that higher yield is not coming along with higher plant residue inputs (e.g., Hirte et al. 2018 Agriculture Ecosystems Environment 265).

L. 141. Authors argue that two thirds of maize and wheat cultivation takes place on soils with less than 2 % SOC. What is, for comparison, the average % SOC of croplands worldwide? Are these two staple crops planted on particularly C-poor soils?

L. 160. Are the authors aware of any long-term field experiment where an increase from 0.5 to 2 % SOC has been observed? This seems unlikely to me. Even a doubling (previous sentence) is ambitious. The following argumentation, that higher SOM soils may supply enough plant available nutrients to sustain crop yields with drastically cutting back N fertilizer input overlooks that these are typical situations of SOM decline, as observed in many long-term experiments, where plant productivity can be maintained at low nutrient input rates only because of SOM decline and the associated release of organically bound nutrients.

L. 193 ff. The first para in section 2.3. belongs largely to the method section and is partially a repetition of that.

L. 215. It is not clear where the yield gap comes from – how was it calculated, was it taken from the literature? Clarification needed.

L. 302. Authors refer to Söderström et al. 2014. I looked up that reference where I could not find a database as key repository but rather a research approach. Should be clarified.

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L. 352. I suggest to use three classes: rainfed, irrigated, unknown.

L. 353. Filling data gaps for soil pH and texture for experimental sites by a global database may introduce large errors and, potentially, biased estimates, given that these soil properties vary much over short distances. I suggest to either exclude those variables as explanatory ones or to ask authors of the studies to provide those data for their sites. Alternatively, these parameters can be categorized and used as categorical variables.

Table 2. I suggest to add a percentage increase in production from an increase in SOC to the table to make the global yield average and the increase in production comparable to each other.

Figure 2. Not clear why the figure relates to maize and yield in line 1114 whereas the caption in line 1115 refers to maize only.

Figure 5. The figure is interesting but results would better be presented as percentage increase in yield, and not as percentage closure of yield gap. The yield gap itself is prone to large uncertainty, both in extent and possible reasons, and these uncertainties are not explicitly included.

Figure 4. The provided interpretation of this results ignores the fact that building up additional SOC requires additional N.

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