Response to comments and suggestions by Editor/Reviewers

Reviewer #1: 'Comment on soil-2021-17', Paul Hallett, 30 Mar 2021

This is an extremely valuable paper. The authors provide a strong argument about socioeconomic drivers that have resulted in large increases in vegetable production. The environmental impacts are enormous, and it is clear that best farming practices are not being followed. A particularly useful aspect of this study is the use of commercial farms so that information is gleaned on both practice and impacts. The spatial coverage is impressive, providing a valuable dataset for a large body of potential follow-on research.

A general comment, which may complicate the study, is that the variability between farms is not described or discussed. The Tables could benefit from including either the range or statistical error in fertilizer application rates and soil properties. Are some farmers using much less fertilizer but achieving similar yields? Are some farmers using fertilizer application rates that are much higher than the averages presented, and what are the impacts?

Response: Thank you for your review and comments. We agree with you and have added the standard deviation in the Table 1 and Table 2, respectively. Additionally, because of the productivity differences caused by farmers' agronomic practices and soil properties, both of the scenarios you point out exist. Please see the following Figure. Although some farmers use much less fertilizer but achieve similar or higher yields, on average, the low regional vegetable yields and high levels of fertilizer input remain common. Our manuscript mainly describes the impacts from the change response of soil properties in vegetable fields. Currently, open-field vegetable-cropping practices in southwest China result in significant soil degradation and potential environmental pollution after conversion from a paddy rice-oilseed rape rotation system. Wang et al (2018b), who investigated the status quo of pepper production in the same subtropical region of China, indicated that not only nutrient management (in particular, decreasing application of N, P fertilizer), but also crop management (mainly planting density)

affected pepper yield. We have added these further discussion details to the Discussion section, please see Line 247-252.

Again, thank you very much for your attention and valuable comments.

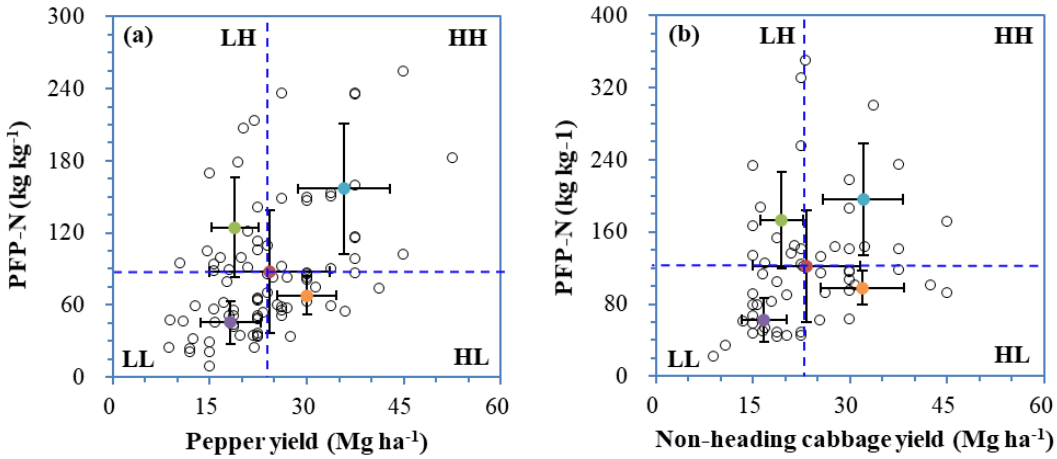

Figure Relationships between nitrogen fertilizer production efficiency (**PFP-N, calculated as yield/N application rate**) and pepper yield (in fresh weight, **(a)**), non-heading Chinese cabbage yield (in fresh weight, **(b)**) in southwest China, respectively. The blue dotted lines represent the average production yield and PFP-N of all farmers surveyed. To analyze the effect of farm management on the environmental effects of pepper and non-heading Chinese cabbage production, the data on yield vs. PFP-N were divided into four groups: a low yield and low PFP-N group (LL); a low yield and high PFP-N group (LH); a high yield and low PFP-N group (HL); and a high yield and high PFP-N group (HH). Each hollow circle represents the data from one farm, and each solid circle represents the mean (with 95% confidence intervals) of the yield and PFP-N in each group.

There are some specific comments to address below, but this is generally a very well-prepared paper that is also extremely valuable.

Response: Many thanks. We appreciate these comments and suggestions from you, and we have revised the manuscript carefully, addressing all your comments and suggestions.

Specific Comments:

Unnecessary use of acronyms. Referring to the treatments as Vegetable and Paddy-Rape would be easier to follow.

Response: We agree, and we have revised the full text accordingly.

The survey, which is an important and novel component of this paper, is not mentioned.

Response: Thank you for this kind reminder. As the focus of this paper is the quantitative evaluation of changes in soil properties in vegetable fields, we did not include details of the farmer-based survey. However, as you and other reviewers' have suggested, we have provided additional detail of the survey methodology. Please see Line 17 and Line 97-103. Additionally, in term of the factor analysis in changes of soil carbon and pH, we have specifically analyzed the impact of farmers' agronomic practices. Please see Table 1 and 3, and Figure 2A and 2B.

Line 20 – is it due to decreased residue incorporation of lack of paddy cycle?

Response: Yes, it is one of the major reasons. Compared with the Paddy-Rape cropping system, the organic C input in the vegetable system decreased by 26% (Figure 2A). In addition, the higher frequency of tillage operations in vegetable production was another important impact factor because frequent tillage generally results in the break-up of soil macro-aggregates, soil structure damage, and an increase in soil aeration, which promotes microbial decomposition of SOC (Figure 2B).

The comparison between paddy and vegetable is not clear at the end of the Abstract.

Response: Thanks. We have revised part of the Abstract and emphasized on the comparison between paddy and vegetable systems.

Introduction

Line 37 – mixing up % and 'times' in the same sentence, which makes it harder to follow.

Response: Sorry for these errors, we have changed "%" to "times". Please see Line 40.

Line 40-44 – disconnected paragraph

Response: Accepted and addressed.

Line 48 – the impact of paddy production on C storage is not adequately described. There is a major change from this system to upland vegetable production.

Response: Thank you for your valuable suggestion. We have added more background information to carefully describe the innovation of this work: “For instance, because the paddy soil was flooded long-term and had two deep tillage operations per year with high inputs of carbon (Wang et al., 2014), while the vegetable fields generally had three to four deep tillage operations per year, resulting in greater disturbance of the surface soil layer (0-20 cm) in southern China. Wang et al. (2014) also found that the SOC concentration and the C/N ratio of soil in open-field vegetable systems converted from paddy fields decreased by 19.7% and 27.8%, respectively, which was mainly attributable to aggregate fragmentation.” Please see Line 54-59.

Materials and Methods

For this study it is very important to characterize the soils, including their classification, dominant mineralogy and parent material. You should be able to get this from available soil survey data. You have described the soil as an Ultisol, but this is quite general. Readers need to be aware of the capacity of the soils to adsorb nutrients. Shallow soils affect some of this province, but I am not sure about this specific region. An idea of soil depth would help.

Response: We agree. We have revised the information about the regional soil, and added the soil depth details as per your suggestion, like “The main type of soil in this region is a typical Ultisol with loamy clay texture (average of sand 11.5%, silt 43.5%, and clay 45%, respectively) and alluvial parent material based on USDA soil classification system. Soil depth is generally >90 cm.” Please see Line 82-84.

Line 89 – be clear that this is on commercial farms.

Response: Accepted and revised. Please see Line 108-109.

The experiment design and approaches are all good. You need to give details on how

bulk density was measured and be clear whether your 20 cm intervals incorporate the whole depth (which I assume it does) or just an interval defined by a core size.

Response: Thank you for your kind comment and suggestion. The bulk density was measured using the cutting ring method. Each single soil sample in this study incorporates the whole 20 cm depth. Please see Line 114-116.

Results

Although the data are presented clearly, this section could be more compelling. The amount of N application under vegetable production is staggeringly high. You could start by just mentioning N and stating the kg ha^{-1} y^{-1} amounts for different systems first and then use this to introduce high fertilizer use for other nutrients too. Table 1 gives no indication of variability, which is important to understand the commercial practices in place. If some farmers have much lower inputs, this is important to get across.

Response: Yes, annual total input of N in the vegetable cropping was 2.38 times higher than that of paddy-rape rotation, while the inputs of P, Ca, and Mg in the vegetable cropping were also many times greater than the paddy-rape rotation (i.e. 2.97, 4.40 and 7.14 times, respectively). Because all of these inputs are several times greater in the vegetable cropping systems, we have grouped them together and see no merit in separating these out.

Line 160'ish – the downward movement of P & K gives stronger reason to describe these soils more.

Response: Yes, we totally agree, and have provided additional soil descriptions as described in previous responses.

Discussion

This is excellent. I really like the start that describes what the farmers, which is then followed by the impacts.

Response: Thank you for your comments.

Line 223 – nice start! This is a good guide on what to do elsewhere to make the paper more compelling.

Response: Thank you so much!

Line 224 – whenever dealing with a soil depth, don't use 'higher' or it can get confusing.

Response: Ok, we understand and we have modified the text accordingly

Line 226 –I think not having a paddy cycle may be a big factor that is not being adequately considered.

Response: We agree with you. However, there was no paddy cycle in the annual vegetable production when converting from the paddy-rape rotation. Thus, the two factors resulting in further depletion of SOC in subsequent years following the conversion from paddy-rape to vegetable production, were low input of organic C from organic fertilizers and crop residues (Figure 2A), and a high tillage frequency (Figure 2B). We also discussed several possible management practices which should be conducted in the future to slow or reverse soil degradation, such as increasing organic inputs, optimizing fertilizer application, decreasing tillage frequency etc. Please see line 354-356 for details.

Line 242 – you are deviating away from vegetable production, where conservation agriculture may be less feasible. Only use practical solutions for the farming system. If CA is ok for vegetable production, you need to cite evidence for this rather than maize. What about better use of residue management from the vegetable crop or other practices? The discussion on alternative management strategies is weak. Can you obtain any further analysis from your data? Are there some farms using much lower fertilizer inputs who are maintaining yield or do they all apply very high rates of fertilizer? Can you do a simple cost-benefit based on the rising cost of N fertilizer vs. yield benefits?

Response: Thank you for your thoughtful analysis and valuable suggestion. Following the advice of Reviewer #3, we have removed this paragraph to retain focus avoid

confusion.

Line 261 – be clear if these studies were for the same region and/or soil type.

Response: Done. These studies were for the same production region. Please see Line 291-292.

Line 274 – Good argument on P impacts to rhizosphere, but do you think in a highly tilled, high nutrient system, AM will feature? You need to include more on the adsorption capacity of the soil in the region.

Response: Thanks. We do not think AM will feature in a highly tilled, high nutrient system. A high level of P enrichment in the soil is detrimental to plant growth because it inhibits the rhizosphere manipulation processes employed by plants to efficiently acquire P, including the colonization of roots by arbuscular mycorrhiza fungi and the exudation of organic acids or phosphatase enzymes. Please see Line 307-309.

Line 287 – remind readers of the pH value.

Response: Accepted and done.

Thank you very much for your consideration.

Kind regards,

(Ming Lu and Dunyi Liu)