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Interactive comment on "Insights on nitrogen and phosphorus co-limitation in global croplands from theoretical and modelling fertilization experiments" *by* Bruno Ringeval et al.

Anonymous Referee #1

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The manuscript by Ringeval et al. presented a theoretical framework to quantify the different formalizations of nutrient interaction (N and P) for global croplands. The authors linked their theoretical framework with the nutrient limitation categories defined by Harpole et al. (2011). The authors then applied the framework with global maps of soil supply and plant demand for croplands to quantify the degree of (co-)limitation, and showed that "a true co-limitation could affect a large proportion of the global crop area if multiple limitation hypothesis is assumed".

The theoretical framework presented here is a great highlight of this study, but the justification as to why it is important, in particular for cropland systems, was not well

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articulated. What I can extracted from the Introduction was that the author attempted to perform a meta-analysis on nutrient interaction effect on global cropland but found out that it was not possible, so they had to switch to a theoretical analysis. I personally don't think that this is a good rationale for this sophisticated work. To start with, why is a meta-analysis needed for global cropland where these managed systems are mostly over-fertilized and subject to human perturbation? Then, I find it hard to convince myself that there is indeed no "cross fertilization experiments" for croplands in general. The authors probably need to spend more time convincing their readers that this is indeed the case – it currently just doesn't convince me. The lack of good justifications for their rationale leave with me the question as to why this work is needed – as it currently stands, I find the application of the theoretical work to cropland not justifying the sophisticated mathematical framework presented in the main text and the supporting materials.

The other major weakness of this study is the Discussion section. It seems that the authors spend the majority of the Discussions discussing the limitations of this work. While it is absolutely needed to acknowledge the limitation of the presented work, I would still like to see more discussion on the findings itself, e.g. how does it compare to other analyses, what are the implications, what knowledge do we get in terms of cropland management, etc.

Specific comments:

L 24: I don't think the citation is needed here. These definitions of nutrient interaction categories existed before Harpole et al. 2011. Also, it is hard to understand what you meant by "the implications". Can you be more specific about on what the implications apply to? Is it productivity, or something else? How does this justify your rationale? It is hard to extract any useful information from this sentence along to justify the purpose of this study (in fact, this also applies to the introduction section).

L 29: What do you mean "the corresponding between most Harpole categories"?

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L 32: what “certain conditions”? Can you be more specific? Basically, up to this point reading the abstract, I learnt nothing.

L 36: The word “true” is misleading here. If co-limitation occurs under a certain assumed hypothesis (i.e. multiple limitation), then it is not a “true” co-limitation, right?

L 38: Again, nothing can be learnt from this sentence.

L 40: Normally croplands are over-fertilized, right? Why is it important to “improve our understanding of nutrient limitation in cropland” then?

L 56: You may need to define what is potential growth really. How is potential growth estimated? Is it only an assumption of nutrient limitation? I doubt that. Light, water, soil physical environment, human management, plant acclimation ability, and genetics are all important between potential and actual growth.

L 74: I find this “conceptual optimum stoichiometry” very hypothetical. I don’t think one can easily estimate this.

L 87: what is a true co-limitation? Have you defined it anywhere yet?

L 89: If plants need to mobilize resources to acquire one nutrient, do you call it a single limitation or co-limitation? I find timescale is an important aspect of nutrient limitation here, which suggest that your study may need to have a more clearly defined temporal scale under which different limitation theories apply to.

L 89 – 90: Unclear what you meant here. Are you trying to categorized each nutrient limitation hypothesis into either LM and MH? Also, the next sentence seems to have a big jump with this current sentence.

L 96 – 97: I find myself hard to follow your logic. If the same fertilizer is applied each year for many years, you can still analyze the current limiting nutrient, no?

L 99 – 101: The way you phrase it makes me feel that you really just wanted a meta-analysis of N and P limitation in croplands. But why is it important? Croplands are

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managed systems where nutrients are added to maximize yield. I would normally expect croplands are over-fertilized, and the amount of fertilizer varies depending on crops, climate, and other factors (e.g. financial). Why do you need to compute a NP limitation meta-analysis for croplands? Even for a meta-analysis, there is the need for some clearly defined rationales. The current narrative gives me no answer, and I keep wondering what is the point for performing such a meta-analysis to start with.

L 120: what about different forms of nutrients?

L 144: What is the symbol in the middle? Is it multiplication? Why? Can to provide some texts to justify these equations?

L 150: Is there any justification of the arbitrary value of 0.75?

L 153 – 155: Any explanation for these results? Similarly, some further explanation of the results showed later would guide the readers to understand your work.

L 258: observed yield for each grid or global mean?

L 298 – 301: So your results start with figures and texts in the supplementary materials?

L 381: Why? Can you explain a little bit more?

L 384 and onward: So from this point forward, you are discussing the limitations of this study. Can you maybe spend a little bit more space describing your results (i.e. implications, significance, comparison to other studies, etc.)?

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