## **KEY:**

Editor/Reviewer Comments
Author Response
Already in Text
Modified Text
**Comments from Reviewer**

**First Review/Response ()**

Reviewer: 1

Comments to the Author

The paper is much improved and is acceptable for publication. My only suggestion is to limit significant figures on some of the data. Up to 10 significant figures are reported in some instances.

Digit changes made

Reviewer: 2

Comments to the Author

The authors did a nice job addressing the reviewer comments, however there are a couple of things that need to be edited:

In the abstract the authors say there is an increase of 7% per year in P use. Although there is an increase of 349% over 53 years, saying that 349%/53 represents 7% increase yearly is inadequate. Any thing growing at a 7% yearly will have a doubling time of 10 years, with this being said, P use would need to be over 2 billion Mg and its not. The correct rate increase per year with the data presented is 2.43%. Either change the yearly increase or delete the 7%.

Good point. 7% has been deleted.

Line 249-251 the added text reads awkward please revise after you accept the changes.

Revision of this section now reads more clearly.

the same is true for lines 280-282, it reads awkward specially where it says "... at a 0.30m2 resolution obtained at a 1m2 resolution..." not sure what you are trying to say.

Correct, this was not clear and has been modified.

The rest is fine with me. Though I still don't see how the difference method is a more correct estimate of PUE when you apply 70 kg P2O5 ha and recover 70 kg P2O5 ha. To me the true PUE can only be estimated by doing the following math (P concentration in grain \* grain yield per ha)/(Total P2O5 applied per ha). Anyways I think the manuscript will be ready for publication after the few changes suggested are fixed. Nice manuscript

Thanks

Associate Editor: 1

Comments to the Author:

Associate Editor Comments:

Overall this manuscript is interesting, but still needs improvement in structure before it can be considered for publication. Please consider all the comments below.

Abstract

L8-9: odd phrasing, the aren’t the same, this statement is confusing

L11: incorrect, the P from soil is subtracted from uptake according to the equation.

Correct. Changes made

Abstract should be one paragraph

L21: what does “realistic” mean in this context?

Realistic was deleted. This was changed to the specific values found.

Need a conclusion

Also, need to indicate this paper will calculate of PUE and a review of how improvements in PUE could be made.

Change above resulted in a final sentence that better delineates our conclusions

Introduction

Opening paragraph is really choppy; it reads as a series of sentences stating what each person reported in their study. Need some sort of sentence to indicate there is a wide variation in reported reserve estimates.

The opening paragraph was disjointed and has been edited

L92: Need to be clear who you are referring to by “their” earlier work.

Corrected

The ending of the intro seems abrupt. Also, the intro would be better if it included a more thorough description regarding the three methods to calculate PUE (balance, direct, and 32P). And move the discussion in the M&M about the methods to the intro. Then the M&M just be the description of how you assembled the data.

This has been completely altered whereby this is now discussed in the Introduction.

The objective of the paper is beyond estimating parts of PUE – it is also to review these results in context of where there are opportunities for improvement.

The objective has been modified, and clarity added in terms of methods of application

L116: summation of area and production.

Added

L121-122: Need to indicate that you are assuming that P is evenly distributed across all agricultural lands.

If approved, we have left this the same.

It would seem easier to explain the Balance method first and then explain the Difference method and why it would be better. Also, it would be better to discuss the different methods in the Introduction, rather than the M&M as this is a core part of the justification for this paper. The authors should also consider explaining the “direct method” in the intro and then just focus on how they used an average measure from direct method studies to estimate PUE by the difference method.

Balance method has now been delineated first as per your suggestion. The direct method is also better defined.

The Difference method in equation 1 isn’t really what the authors did. They did not subtract values of P from soil, but instead, just corrected the balance method. I think it would make sense to start with the balance method and then explain how they determined a “difference method” value. If all of this is reviewed in the Intro, then this will make a lot more sense here.

Agreed, change made.

L145: Vague statement – how does the calculation influence PUE? Also – good point to elaborate on in Introduction.

This has been corrected

Results and Discussion:

The order should be changed to report on components that lead to PUE (acreage, consumption) and then build to the PUE values.

Acreage and consumption were included in Table 3.

L166: Syers et al. – this seems obvious, were these authors really the first to report why?

Syers et al. (2008) was used here, but we are unsure if they were the first to report this.

L171-173: I’m not sure I understand the point of this sentence. Are the authors calling for a review of removal estimates?

This issue remains important concerning ensuing year estimates of PUE that could “possibly” depend on the rate that was applied. That “rate” on a global scale is the total amount that was the same and that was likely to have been applied in previous years. Because macro data to some extent depends on consistency, it also assumes that the same (or very similar) rates were applied in prior years.

L173-175: What same approach are the authors referring to?

Use of global data (year to year). For use efficiency estimates, these two papers are now somewhat unique.

L180-186: This is really M&M, where the authors need to explain their approach for correcting balance PUE to difference PUE. Then here they can just review the result of their lit review and averaging.

With editor approval, we would like to leave this in the discussion section.

L185-186: If the authors are using small scale estimates to guide global estimates, shouldn’t the values be similar anyway?

Good point. Many of the smaller scale PUE papers (using difference and/or direct methods) have values less than 20%

L192-194: This is already stated and obvious.

Point is still needed in this particular context

L194-196: This is too big of a jump – how can the authors know this? What are max values that can be reached in high PUE systems?

Sentence modified to convey a more modest expectation for improvement

L198: Figure 1 doesn’t show food demand.

Food demand deleted

L199-200: Need to explain more here. Based on what info specifically?

This is a citation that we would like to leave in the document

L203: Why does it matter that consumption was variable in the 80s and 90s?

Reviewer #3 from the first review, asked that this be included

L203: Can crops be sinks? The nutrients in crops get recycled through humans and animals. I suppose in any one year P is trapped in grain, but not even for the entire year. This statement needs clarification.

Use of sinks has been modified to reflect major sources of P removal

L224: Only 12 and 4% of the arable land in Europe experience erosion? There is no way this is true. Are the authors suggesting there is zero soil loss on 84% of Europe’s ag land?

This reference and what they reported has been removed

L227: Is this for Europe or worldwide?

Correct, Europe… and that is now clarified

L228: Is there evidence that PUE is connected to erosion? Surface transport of P is not calculated in your PUE calculations. Is the amount of P uptake related to P loss? I would argue this is too variable.

Citation is now included

The paragraph on risk of P losses is not well connected to PUE in the way that it is calculated in this paper. P loss is driven by many factors other than rate of application (e.g. placement, timing, source, soil test P values).

We do not disagree, and hopefully have properly communicated sources for decreased PUE.

L239: How will adjusting base saturation reduce the amount of P bound by Al and Fe, which are pH driven processes?

This was a citation back to Syers et al. (2008).

The rest of the R&D can be improved by having a clearer outline of practices to improve PUE. Managing pH, source of P, application practice of P, and source of P (again) are all covered in one paragraph, but all have specific benefits. There is more to cover on each of these and concluding points would be clearer if addressed one by one. There is too much vague connection to PUE. For example, L241-242 just states a bunch of general things that can lead to improvement in PUE without providing any specifics.

Several items were delineated in that sentence (…. *Fertilization method, source, rate, time of application and the interaction between these variables can be managed to achieve better PUE*) , but that was immediately followed by detailed discussion/reporting on those variables where PUE could be improved, and that included 9 additional references.

Table 2. Need to include a line in the table that reports the average (rather than subscript).

completed

This manuscript needs a more thorough and sharply written review of practices that will improve PUE. The paragraphs on precision agriculture and soil testing are more developed.

Again, this manuscript has all the components and is highly relevant work, but feel that a restructuring is necessary.

Restructuring completed. Thank you for the excellent review.