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Interactive comment on "Global and regional phosphorus budgets in agricultural systems and their implications for phosphorus-use efficiency" *by* Fei Lun et al.

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Dear Editors and Reviewers: Thank you for your letter and for the reviewers' comments concerning our manuscript entitled "Global and regional phosphorus budgets in agricultural systems and their implications for phosphorus-use efficiency". Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied comments carefully and have already made the revision. The revised portions are marked in red in this reply. The main corrections in the paper and the responds to the reviewer's comments are as flowing:

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Discussion paper

Reviewer: 1 First of all, thank you so much for your great comments, and I have revised all of them as follows: Comments 1: P4 Line 74-79 “Previous research mainly focused on cropland while P fluxes in pasture and livestock production systems received less attention (McDowell and Condron, 2004)”. This sentence is not precise and was supported by a literature in 2004 (morethan 10 years ago). Actually there are a lot of studies including pasture and livestock production and the terms “agriculture” and “food production system” also include livestock production system in most cases (please see selected reference blow). With the diet change, more attention is attracted to the livestock production system. The logic of the long sentence needs to be further clarified. Do the authors mean “the differences in methodologies, system boundaries, and data sources hamper the assessment of (or make it difficult to assess) PUE”? Reply: We have rewritten this part and made it further clarified as follow: “Previous research mainly focused on cropland, and P fluxes in pasture and livestock production systems have also received more and more attention recently, especially due to diet change. The differences in methodologies, system boundaries, and data sources have made it difficult to assess the differences in the phosphorus use efficiencies (PUEs) among agricultural sectors and to extrapolate regional findings to the global scale”.

Comment 2: There are some problems in the Figure 1 (P6). The biggest problem is that the Human system should not be part of agricultural system. Detergent is not only for agriculture. There are some industrial uses for P, although the fraction is small. Most sludge is produced from urban life and should be in the agricultural system either. Reply: Thank you so much for your good suggestions. In our revised manuscript, we have re-drawn the Figure 1 and Figure 2. For these new figures, the “Human system” and “detergent and other uses” are not include in the agricultural system, as you suggested. Besides, we have also updated related parts.

Comment 3: The authors used fertilizer for chemical fertilizer, which is not appropriate and will raise a lot of confusions. The term fertilizer includes all kinds of nutrient used into the soil including organic fertilizer. In P6, figure 1, the fertilizer box should be

chemical fertilizer. In P9, Line199-201. The dependency indicator can be the ratio of imported chemical fertilizer to the P in all chemical fertilizer or all fertilizer, which both make sense but have different policy implications. Reply: According to your great suggestions, we have revised all these parts by "chemical fertilizer" replacing "fertilizer", including figures and texts.

Comments 4: Table SI-2. The authors need to polish the crop categories. There are some inappropriate sorting and overlaps for different types of crops. For example the maize and the silage (maize) have overlaps. Popcorn, to my understanding, is the processed maize, but the authors sort it into other cereal. Reply: Thank you so much for your good comments. In our study, we divide crops into maize, rice, wheat and other cereals. In the FAO statics, they put forage and silage (maize, grasses nes, alfalfa and so on) into other crops, and here we also put them into the type of "other crops". For popcorn, we have checked it, and then deleted. In our future research, we will research on much more detailed categories.

Comments 5: It will be good if the authors can reorganize the text a little bit and highlight the most important results and conclusions. Reply: We have rewritten the conclusion part and highlight the most important results as follows (Line 775-796): The results reveal P from phosphate fertilizers was the largest single input flux into the agriculture system, while one half flowed into waters and 1/3 of them accumulated in soil. Chemical fertilizer inputs, P loss to the environment and P harvested in crops presented significantly increasing trends. Global significant imbalanced P budgets in cropland and pasture mask large regional differences, and there also existed differences between cropland and grassland. Compared with cropland, a slightly larger proportion of the total global pasture area had a net annual soil P deficit. The hot spots of cropland P budgets shifted from increasing P accumulation in Eastern Asia countries to increasing soil P deficits in African countries, while European and North American pasture had significant soil P deficit. There presents great differences among the values of PUE for or cropland, pasture, livestock, and food at global, regional, and national scales, and

livestock subsystem generally had the lowest PUE. PUE decreased exponentially with increasing input; that is, P was used most efficiently at low application rates; meanwhile, P in harvested crops increased exponentially with increasing P inputs, but the response slowed at high P inputs. International trade played a significant role in P redistribution among countries, and near one fifth of total harvested crop P entered into international trade. Population increases and dietary changes are requiring higher P inputs in cultivated land and increased mining of P ores, and human dietary shifts may have been responsible for half of the increase of P ore mining. It can mitigate regional P imbalances in agricultural soils, by optimizing phosphate fertilizer application and recycling P. Again, special thanks to you for your good comment and correction in our manuscript, which are all valuable and very helpful for revising and improving our paper. We have studied comments carefully and have made correction and improvement according to the reviewer's suggestion. These changes will not influence the content and framework of the paper. We appreciate for Editors/Reviewers' warm work earnestly. We hope that the correction will meet with approval for publication, and look forward to hearing from you at your recent convenience.

Yours sincerely, Fei Lun on behalf of all co-authors

Please also note the supplement to this comment:
https://www.earth-syst-sci-data-discuss.net/essd-2017-41/essd-2017-41-AC1-supplement.pdf

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