

## ***Interactive comment on “Increased nitrogen enrichment and shifted patterns in the world’s grassland: 1860–2014” by Rongting Xu et al.***

**Anonymous Referee #2**

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Dear editors, dear authors,

Xu et al. presented a very important contribution fully in the scope of ESSD. The spatialized allocation of manure and synthetic fertilizers has been the Holy Grail for the researchers budgeting nutrients in agroecosystems of the world. The dataset presented here that is ready to be used open access represents a relevant step. I agree with the authors and there is still much work to do to improve accuracy and to solve many difficulties but this dataset is itself very valuable. I therefore recommend the publication of this manuscript-dataset in ESSD.

I have, anyhow, some generally minor comments that, in my opinion, should be considered by the authors before the work is ready for publication.

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To strength the message I miss some extra figures:

- 1) To complement Figure 3 it would be nice another figure with the evolution of total surface of grasslands and also split into pasturelands and rangelands
- 2) Figure 5 should be completed with an equivalent extra figure (3 panels) including the inputs per ha in order to see the evolution of the intensification.

An uncertainty that for me is very important and it is not clearly highlighted is that inside a grassland cell we have pasture and rangelands with different livestock density and for sure different deposition rates. The final manure N deposition would be highly affected by the proportion of each type of management in the cell. Disentangling this point is relevant and, in my opinion, it is an important task for further research. Authors could remark this need for the future.

Other comments:

In the abstract please clarify “manure deposition by grazing animals”, I am very used to prepare N soil budgets were the term “deposition” is used for atmospheric deposition and this clarification will improve the reading at a first sight.

Please, along the paper when you cite several papers, the order should be chronological (in the references section alphabetical)

L38 not only air but also nitrate leaching to water bodies

L48 not only meat but also dairy products (e.g. Bai et al. 2018 Global Change Biol)

L67 I am conscious that this dataset was probably developed for GHGs estimation but it will be useful for a wider audience (nutrient budgets in agricultural systems including ammonia emissions, leaching. . .)

L93 In supplements please include a table including the countries per region

L138-140 To help the reader please explain briefly the FAOSTAT methodology to esti-

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mate “manure applied to soils”. Is NH<sub>3</sub> emission discounted? Is manure dumped into the rivers discounted? (e.g. China, see Gu et al. 2015 PNAS).

In the results section please maintain the same order as in methods (i.e. manure deposition before application, or the other way around but consistently).

For the 3 inputs you provide the 5 top countries in terms of total input, I recommend to do the same with the input/ha to detect countries with a generalized high level of intensification.

L281-282 Please be careful when saying “total reactive N production of 217 TgN yr<sup>-1</sup>”), important part of the manure production has an origin in the synthetic fertilizer applied to feed crops or pasturelands, therefore is the same N recirculated into the system. You could say total “resulting in a total input of 217 TgN yr<sup>-1</sup> and considering that it is in part recirculated” (or something similar with that message).

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