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Interactive comment on "Herbicide weed control increases nutrient leaching as compared to mechanical weeding in a large-scale oil palm plantation" *by* Greta Formaglio et al.

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RC> Abstract: It would be interesting to indicate some values of nutrient losses in plots with conventional management practices.

AR> We agree with the reviewer and decided to add the values in l 28 as follows: "The leaching of total N was the highest with conventional management (73.6 kg N ha-1 yr-1) and the lowest in mechanical weeding with reduced fertilization (32.0 kg N ha-1 yr-1) whereas its yield remained comparable among all treatments".

RC> L32: "Our findings signified that mechanical weeding: : :" should be replaced by

"Our findings suggested that mechanical weeding: : :" because you cannot generalize to Indonesia your results at a single site.

AR> We agree with this comment and we will modify it accordingly.

RC> L71-73: Not always the case, see for example eucalypt plantations.

AR> We agreed that this is not always the case and therefore we will substitute "result" with "can result". See below for a literature review on eucalyptus plantations.

RC> The lysimetry design was suitable for the quantification of leaching losses. You might indicate that, even though the time period for soil stabilization was short in your study (only two months from the installation of the ceramic cups to the start of the soil solution collection and four months from the implementation of the factorial management experiment to the collection of the soil solutions), this period was sufficient because the biological processes are rapid in tropical soils.

AR> Thank you for this observation, indeed the period was quite short but it was enough to show effects on nutrient leaching. However, other soil parameters (e.g. gross N mineralization, soil nutrient contents) did not yet show any treatment effect, probably due to the short period passed between the establishment of the experiment and sampling. Therefore we prefer to not add this in the text to avoid confusion.

RC> You may be interested in two articles that accurately describe the spatial development of roots in oil palm plantations: Plant and Soil 189: 33-48, 1997 and Plant and Soil 190: 235-246, 1997.

AR> Thank you for this comment, I am familiar with these articles but I was not sure where to insert them in the paper. I will insert at l 97 a small sentence to describe root density of the oil palm: "Root uptake is related to root density, which is high inside the palm circle and lower in the inter-row (Jourdan and Rey, 1997; Lamade et al. 1996)" [Jourdan, C. and Rey, H.: Plant and Soil, 190, 235–246, 1997].

RC> More information should be given on the water drainage model. How have you

dealt with run off from one management zone to another?

AR> It's not possible to include this in the water model because the different management zones have to be modelled separately, with no interaction with each other. Nevertheless, we expect the runoff to be small in our plantation based on literature review in oil palm plantations and the lack of slope at our site.

RC> The parameterization of the model is rough, without measurements of root profiles and soil hydraulic parameters in each treatment and management zones. Moreover, the validation from soil water potentials is also rough with only two depths (it would have been interesting to include the depth of 1.5 m where soil solutions are collected) and punctual measurements in only two treatments (only 12 tensiometers). It is important to provide a table (in appendix) showing the values given to all the parameters used in the Expert-N water sub-model for each management zone.

AR> We agree that the parametrization of the water model is rough because of the reasons explained. Unfortunately, we could not find an easily accessible, spatially explicit water model that could account for the spatial variability given by the management zones. The commonly used models estimate root water uptake from an estimation of plant evapotranspiration and root density, and therefore cannot partition the root water uptake among management zones. On the other hand, more complicated models require in-depth knowledge of the processes and a large quantity of data that are often not available in literature. Given the limits in our model parameterization, our modeling approach strongly relied on the calibration of the results with field measurements of soil matric potential. We focused on the top 60 cm of the soil because the majority of roots in oil palm are in the top-50-cm depth, so that this is the main zone where the water is exchanged between the soil and the plant and with the atmosphere. The table with all the parameters used in the Expert-N sub-model will be provided in the appendix as Table A1.

RC> Discussion You might be interested by a recent paper providing values for N

leaching in oil palm plantations. The three management zones were sampled in the field to validate this model and the order of magnitude is consistent with your results: DOI:10.1002/agj2.20109.

AR> Thank you for providing this important reference. I will include that in the manuscript.

RC> The comparison with other perennial tropical plantations is interesting (Table A2). Could you add forest plantations to this appendix (pines, eucalypts, acacias) and rubber plantations if you find data in the literature?

AR> Nutrient leaching losses in rubber smallholder plantations were measured near our study site by our group: annual N leaching losses were 4 kg N ha-1 yr-1 (Kurniawan et al. 2018). These data were not included in the table because these plantations were not fertilized. We couldn't find other data about field-measured leaching losses in rubber plantations or other plantations, just a few data in eucalyptus plantations. Silva et al. 2013 (Forest Ecology and Management 301: 67-78) measured leaching in 2-years-old eucalyptus plantations on sandy soil in Brazil with low fertilization (80 kg N ha-1 in 2 years) and lower annual rainfall than our site (1240 mm). They found relatively low leaching: 5.6 kg N ha-1 leached in 2 years when the fertilizer was applied 4 times over the 2-year study period, and 8.6 kg N ha-1 leached in 2 years when the fertilizer was applied one time at the beginning of the sampling. Another interesting study on nutrient dynamics in eucalyptus plantation is the one of Laclau et al. 2010 (Forest Ecology and Management 259(9):1771-1785) for plantations of different ages in Brazil and Congo, fertilized once with 38 kg N ha-1 (Congo) and 120 kg N ha-1 (Brazil). The leaching fluxes were in the range of 1-6 kg N ha-1 yr-1. Another study by this group, published by Versini et al. 2014 (Geoderma 232-243: 426-436), on 2-years-old eucalyptus plantations in Congo (annual rainfall of 1220 mm and fertilization of 43 kg N ha-1 at planting), measured similar leaching losses, equal to 4.4 kg N ha-1 yr-1. We decided to not include these data on eucalyptus plantations in Table A2 because: 1) the rainfall was much lower than the one at our site 2) the majority of the data were

from young plantations, 3) the plantations were not regularly fertilized.

Silva et al. 2013, soil:Arenosols, precipitation: 1240 mm yr-1, plantation: 2-years-old eucalyptus, N fertilizer: 40 kg N ha-1 yr-1, N leaching: 7 kg N ha-1 yr-1, % fertilizer leached: 17.5%

Versini et al. 2014, soil:Arenosols, precipitation: 1220 mm yr-1, plantation: 2-years-old eucalyptus, N fertilizer: 21.5 kg N ha-1 yr-1, N leaching: 4.4 kg N ha-1 yr-1, % fertilizer leached: 20.5%.

RC> L515-517: not sure that the amounts of Na taken up by soil macrofauna could be sufficient to explain the differences. It has been demonstrated that oil palm can take up Na in addition/substitution to K (Bonneau, X., Boutin, D., Bourgoing, R., Sugarianto, J., 1997. Le chlorure de sodium, fertilisant idéal du cocotier en Indonésie. Plantations, Recherche, Développement 4 (5), 336–346), as also shown recently in eucalypt plantations.

AR> Thank you for providing these interesting references that show that palm and trees in plantations can take up Na from the soil. However, we think that this cannot explain lower Na leaching with mechanical weeding compared to herbicide weeding because it would imply higher Na uptake by the palms with mechanical weeding, which was not investigated.

RC> L329: than in the inter-row.

AR> We will add “in” in the revised manuscript.

RC> L332: dissolved organic N or total dissolved N?

AR> We understand that this may be misleading and we decided to remove “dissolved” in l 332.

RC> L453: higher?

AR> We will change “highest” with “higher” in the revised manuscript.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2020-153/bg-2020-153-AC2-supplement.pdf

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