

# ***Interactive comment on “Soil fertility along toposequences of the East India Plateau and implications for productivity and sustainability” by Peter S. Cornish et al.***

## **Anonymous Referee #1**

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### GENERAL COMMENTS

In this work authors address a crucial issue for the agricultural production and in this specific case for the rice cultivation in different areas of East India Plateau: the soil fertility along the toposequence. Indeed, the manuscript develops on the hypothesis that toposequence position affects soil fertility and aim at providing basic information for future research on the management of soil fertility and plant nutrition. Authors also attempt to provide technical recommendations on fertilizer use. Accordingly, this contribution falls within the scope of Soil Journal.

While acknowledging the effort put by authors in developing this work, which can con-

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tribute to better understand the dynamics underlying the creation and the maintenance of soil fertility, some shortcomings have been detected in the manuscript. First, the title is promising to analyze the soil fertility implications in terms of sustainability. Nevertheless, this very important concept is never addressed in the paper and it is not clear in which terms sustainability is taken into consideration in this work. Besides, the rice productivity, another concept included in the title, is slightly addressed and is indeed limited to only few yield data that are mainly mentioned in the discussion. Yet, a description of the rationale backing the selection of the analysed soil parameters is missing. To this regard would be necessary to briefly explain the influence/contribution of each soil parameters to soil fertility. Such rationale would allow readers to better understand the discussion and the recommendations about soil fertility raised by the authors. Finally, this work mainly aims at providing a picture of the variability of the soil parameters between the different land classes. Accordingly, the figures depicting the final results should clearly show such soil parameters variability when instead now is limited to differences between Rice areas and No Rice areas. This work has been well written in a very good English. Nevertheless, in few circumstances the manuscript is not very clear. However, this paper needs to be improved with a major revision before being published in this Journal. Following, specific comments are provided hoping that these can be of help to improve the manuscript.

## SPECIFIC COMMENTS

From Line 98 to Line 101: The definition of the land classes is a bit confusing. Are the three categories of upland land-classes? In case, please specify.

Line 99: By definition Homestead includes land that is cropped. Should (i) be "land belonging to the homestead. . .", rather than "land near to the homestead. . ."?

Line 99: Please, could clarify what the sentence "to which harvested materials are generally taken" means?

Line 103: Can authors be more specific briefly explaining why "Non-degraded non-

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arable uplands provide an indication of inherent soil fertility”?

Line 106: To make reader to understand the representativeness of the soil samples, the average size of field and the main characteristics of transect (e.g. length and/or distance between the four locations) applied for sampling should be mentioned.

Line 111: It is not clear why the authors refer to unpublished data that furthermore refer to a site that is not under analysis in this work. If this set of data should substantially contribute to the understanding of this work, then should be clearly stated and explained in the text.

Line 120: "A small number of our samples. . ." Could be more specific by indicating the total number of samples and what small number means?

From line 125: It seems that from this line to Line 133, the text is devoted to explain the "statistical analysis". It is suggested to include this part in an independent paragraph or sub-paragraph (2.3.1) of soil analysis.

Line 140: The minimum values of the pH depicted in Figure 2a for non-rice and rice fields seems to be different when in the text the two type of soils have the same value, i.e. 4.4.

Lines 148, 152, 155: the Purulia District is often mentioned in this work notwithstanding it is not amongst the District under analysis. Authors should clarify the role of this District in this work (comment linked to Line 111).

Lines 161 and 162: Because of the relevance of this topic especially in this work, it is suggested to provide more recent literature in addition to Peverill et al. 1999 and Kay and Angers 1999.

Line 164: It would be interesting to know the value of "potential yield based on rainfall". This would contribute to better understand the discussion about rice productivity.

Line 169: Can authors specify why homestead land “being the destination for all har-

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vested materials including crop residues” was expected to have a higher OC content?

Line 172: §3.3 Cation exchange capacity. Although the Fig. 4 provides readers with very interesting correlations between CEC and OC and pH, it is suggested, in addition, to display box plots as already done for OC and pH (further following the suggestion “Lines 155 (Fig. 2), Line 165 (Fig. 3), etc.” reported in section “Figures” of this review).

Line 182: Please, more recent reference(s) in addition to Peveril et al., 1999, is/are desirable.

Line 204: “. . .may be less than a third of potential”. Also in this case it would be useful to have some data (please, see comment Line 164).

Line 210: §3.5 Extractable soil potassium. Please, refer to the suggestion raised for Line 172.

From Line 236 to Line 245: In this part of the text, authors state that in contrast to other authors (Fuwa et al 2007), the fertility decreases down the toposequence and that the higher fertility of lowlands claimed by farmers is likely due to a higher water availability that overweighs the very low P and K content. Nevertheless, the lowlands have registered also an higher OC and CEC that are key drivers for determining soil fertility just as confirmed by this work in which these elements were carefully taken into consideration. To avoid confusion in the interpretation of the results, authors must provide (possibly in the Introduction) a clear definition of what soil fertility is in this work and to which extent the different elements (OC, CEC, K, etc.) taken into consideration contribute to its setting up.

Line 248: Since the “underlying geology” seems to play a crucial role in this work, some key detail about the geology of the analysed EIP watersheds should be provided to readers.

From Line 251 to Line 252: “Our findings will likely apply. . .”, then what raised for Line 248 become very important.

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From Line 257 to Line 259: These are relevant recommendations (i.e. the 'test strips', the 'omission trial'). Nevertheless, they are only mentioned and referenced but an interesting discussion is missing. Authors should spend some word to briefly explain their recommendations. Some detail about the learning process is also desirable.

Line 262: Although the meaning of Nutrients is well known, probably it would be more clear to specify which nutrients are taken into consideration in this discussion.

Line 266: "...and animal carcasses are a significant sink". Please, can clarify? Besides, animal carcasses are not included in Fig.7 (the category "Old cows burnt, buried or sold" does not contribute to the flows).

Line 270: imported in fertilizer or imported with fertilizer?

Line 275: "...farmers prioritise rice for their compost... This is an important statement and would be desirable to support it with some reference.

Line 283: Some data about low yields and rice yield in general in the EIP should be provided.

Line 283: Should "In rice..." be "In rice land.."?

Line 294: "...rice requires 15-20 kg N t<sup>-1</sup>", please specify what tons refer to (grain?).

From Line 293 to Line 310: The assumptions and related calculations made in these lines seem to be approximate. From line 293, authors refer to a direct correlation between the quantity of N fixed, the average quantity required by the crop and its yield. Nevertheless, the various "destinies" of the Nitrogen in soil (i.e. leaching, denitrification, immobilization, etc.) seem to be neglected. Same consideration applies for P and K. This part should be carefully revised.

Line 313: "...sustainable crop production..." Sustainable in which terms?

Line 315: As previously commented (Lines 257-259), test strips and omission trials should be briefly described.

To make effective the interesting discussion that authors raised from line 318 to line 331, it is suggested to include a paragraph/table (maybe in material methods) in which the main fertilization techniques (type of fertilizer, quantities and timing) currently adopted by farmers are summarized. This would allow readers to better understand the discussion and the authors' recommendations.

From Line 323 to Line 325: A major cause of soil acidification is the use of ammonium-based fertilizer. . . Please, make clear if this is a general statement or specifically refer to the soils under analysis. For instance, it is not clear if DAP is used in the fields under study and if the related applied quantities can actually determine the acidity of such soils.

Line 345: "The present cropping system is clearly unsustainable. . ." In which terms is unsustainable?

## - REFERENCES

Please, format the references according to the Journal requirements.

Please, verify "Kay and Angers", 1999 in the text, 2000 in References.

## - FIGURES

Captions should be self-explanatory avoiding to send the reader to the text (e.g. Fig. 7).

The quality of the Figures layout should be improved. It is currently low.

A figure/map depicting the sites would be appreciated.

Figure 1. Whether possible, it would be helpful to include also the homestead in this figure, making clear its position along the toposequence.

Line 42: Figure 1. Should (after Cornish et al., 2015a) be (Modified from Cornish et al., 2015b)?

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Lines 155 (Fig. 2), Line 165 (Fig. 3), Line 201 (Fig. 5): In order to appreciate the influence of the toposequence to soil fertility, authors identified six land classes. To this regard, it would be effective to show the variability of the analysed soil characteristics/properties (pH, OC, etc.) between the six land classes (e.g. one figure depicting one box plot for each land class) in addition to that between the No-rice and Rice areas (Figures 2a, 3a, 3b, 5a and 5b).

Figure 4 and Figure 6: Please, specify what the depicted correlation points refer to (are they the samples collected in the 252 fields?).

## - TABLES

Brief but explanatory captions should be included.

For the sake of a better understanding, Tables from 1 to 5 should be set with the same schematic logic displayed in Figure 1 where the toposequence goes from the higher to the lower level moving from left to right.

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