GENERAL COMMENTS

The authors present an interesting and complete assessment on Global Warming Potential (GWP) and greenhouse gas intensity (GHGI) during three years in a rice-wheat rotation. The number of crop seasons, as well as the complete overview the sustainability of the agro-ecosystem (soil GHG emissions, SOC, CO2 equivalents from inputs and operations, and crop yields) are, from my point of view, the main strengths of the this study, which fits well into the scope of the journal. Conversely, the manuscript requires additional details and explanation before it can be considered for publication. Moreover, I do not understand why the authors did not set some variables (e.g. Zn fertilization -which has been reported to influence crop yields and GHG emissions- plant density, water management…). That would have simplified the discussion and maybe would have allowed obtaining some conclusions about management techniques (and not only about the overall scenarios) and the possibilities of combining scenarios. The authors should also improve the Materials and Methods section, explaining much better the GWP calculations and other issues of major interest.

The conclusions are adequately presented: since each scenario is a combination of several management techniques, the authors cannot recommend any single practice, only the full scenario. Conversely, ALL the management factors that could have influence the measured variables (yields, GHG fluxes, GWP) should be briefly discussed.

SPECIFIC COMMENTS

Abstract, lines 19-23. It seems that treatments only differ in N rate, and that is not true. Please indicate briefly other parameters that were different between treatments.

Lines 82-84. Include, if available, the information on clay, silt and sand contents and soil texture.

Lines 84-86. Please indicate the annual precipitation and mean temperature in each campaign. Were “normal years” with regard to these parameters, compared to the average values (15.5°C and 1038 mm)? In any case, I think that this information fits better in the results section.

Lines 88-98. What was the N source applied? What were the dates (or phenological stages) of N application in rice -4 split applications in some treatments-? What about the wheat? When was the N applied?

Please indicate that Zn and Na_2SiO_3 fertilization, plant density and the use of an organic amendment were also management techniques for improving rice yield and NUE.

Did you consider the N supplied through rapeseed cake manure for NUE calculations (you should!)? In any case, please indicate in this section the composition of this residue, at least the C and N contents and C:N ratio.

Lines 99-104. What amount of irrigation water was applied during the rice growing season in each campaign? Was it different between scenarios (as could be deduced from line 329)?

Please describe briefly the residue management at the end of rice and wheat growing season.

Line 116. To my knowledge, it is not possible to measure N2O with a flame ionization detector. Was not your GC equipped with an ECD detector? Please, clarify this crucial point.

Line 125. Can you reference this equation?

Lines 131-149. This section needs to be significantly improved. I recommend the authors to summarize the information in a DETAILED Table, indicating for each variable that is included in GWP calculations: Amount/number of labors/inputs, unit cost (kg CO2 equivalents) and a reference.

The information on fertilizer rates is enough, but you should indicate the number of farm operations (labor passes, seeding, fertilizing, harvesting, irrigation –and amount of water applied-) in each treatment. Were the ZnSO4 and Na_2SiO_3 considered for the GWP? (They should!)

What does the Ei involve? Only inputs application? Application + manufacture and transport?

What are the CO_2 equivalents for N_2O and CH_4 emissions? Please, indicate (with a reference).

Lines 151-157. Were the normal distribution and variance uniformity checked? Did you use any non-parametric test for non-normally distributed data? If affirmative, please indicate how.

Line 167-168. I don't know what you meant here. According to Table 2, significant increases were observed… If this statement is referred to average wheat-rice values, please add "data not shown" in brackets.

NUE: See my comment on lines 88-98 for NUE calculations in N3 and N4 scenarios (with rapeseed cake manure). Correct NUE for these cultivation patterns if the N from rapeseed was not considered.

Line 175-176. Please include this sentence "current ISSM strategy was only designed for rice production, not wheat production" in Materials and Methods.

Line 187-188. Avoid as possible the subjective statements (e.g. "due to the combined application of inorganic and organic fertilizers") in the results section. This sentence (from my point of view) fits better in the discussion.

Lines 189-196. The description of the N2O evolution should be improved. You should indicate how many peaks or increments (if any) were reported in each crop, and if they were reported after fertilization events. Comparing emissions (CH4 and N2O) between crops (wheat versus rice) would be interesting.

"Correlations between seasonal cumulative N2O emissions and fertilizer N application rates were also calculated": that should be indicated in Materials and Methods (Statistical Analysis section, in which you only explain that "linear relationships were determined"). About this regression, the N rate was not the only variable that could have influenced N2O emissions, since other variables were not fixed. Moreover, the N rate in N3 and N4 is not correct (you have not considered rapeseed manure). Therefore, I recommend removing this figure.

“Relative to the FP plot, the N1 and N2 scenarios decreased the annual N2O emissions by an average of 41% and 22%, while the N4 scenario significantly increased it by 46% although there was no significant difference between N3 and FP plots ($P < 0.05$)”. This sentence is so confusing for me. Is this statement referred to wheat? If affirmative, please indicate and check the percentages of abatement/enhancement (looking at Table 2, average 2011-2013, I think there are some mistakes). You should describe also the results for the rice (in spite of the lack of significant differences between fertilized treatments). If these percentages are based on information of Table 2, please refer to this Table.

“With respect to the N application effect, the annual cumulative N2O emissions in all four ISSM scenarios were significantly higher than in NN ($P < 0.05$)”. In what crop? In wheat? Please indicate, because this is not observed for rice (Table 2, Average 2011-2013 fluxes).

Line 202- 203. “Although N fertilizer increased annual CH4 and N2O emissions, they also increased SOC sequestration in this cropping system”. Please change “N fertilizer” by “fertilized treatments”. The idea that N fertilization can increase SOC sequestration is speculative, particularly in the Results section.

Lines 206-207: “CO_2 equivalents from machinery used for Ei (2449–4192 CO2-eq ha−1 yr−1) were higher than Eo (1285–1697 CO2-eq ha−1 yr−1) of the fertilized plots”. The word “machinery” is confusing form me since you explain (in lines 123-133) that the Ei component accounted the CO2 emissions from agrochemical inputs.

Lines 211-212: “Consequently, the lowest NGWP was achieved under the N1 scenario for the ISSM.” The NGWP in N1, N2 and FP was statistically similar. Please remove or correct this sentence.

General comments on Discussion section: the Discussion should be significantly improved. First of all, the document (and particularly this section) should be reviewed by a native speaker. As explained above, each scenario is a combination of several management techniques, and even though authors cannot recommend any single practice (only the full scenario), ALL the management factors that could have influence the measured variables (yields, GHG fluxes, GWP) should be discussed:

- Fertilization: Not only different N rates were tried, but also different P, K, silicon and Zn. This fact may have directly affected crop yields, and also N_2O emissions indirectly (i.e. the more a crop grows, the more N is uptaken and the less N is likely to be lost as N2O). Particularly, Zn has been reported to influence CH4 and N2O emissions (Glass and Orphan, 2012) and yields in some crops, e.g. rice (Hossain et al., 2008). The effects of silicon in rice physiology have also been described (Kabata-Pendias and Mukherjee, 2007).

Hossain, M. A., Jahiruddin, M., Islam, M. R., & Mian, M. H. (2008). The requirement of zinc for improvement of crop yield and mineral nutrition in the maize–mungbean–rice system. Plant and soil, 306(1-2), 13-22.

Glass, J. B., & Orphan, V. J. (2012). Trace metal requirements for microbial enzymes involved in the production and consumption of methane and nitrous oxide. Frontiers in microbiology, 3.

Kabata-Pendias, A., & Mukherjee, A. B. (2007). Trace elements from soil to human. Springer Science & Business Media.

- The rapeseed cake manure is also an important variable. This organic amendment can substantially modify CH4 and N2O fluxes thorough the release of C and N. You should indicate the composition of this residue (C and N contents) and discuss better its influence on GHG emissions (Thangarajan et al., 2013) and C sequestration. Moreover, the residues from Brassicaceae have been reported to inhibit nitrification, thus affecting N_2O losses (Subbarao et al., 2015).

Thangarajan, R., Bolan, N. S., Tian, G., Naidu, R., & Kunhikrishnan, A. (2013). Role of organic amendment application on greenhouse gas emission from soil. Science of the Total Environment, 465, 72-96.

Subbarao, G. V., Yoshihashi, T., Worthington, M., Nakahara, K., Ando, Y., Sahrawat, K. L., ... & Braun, H. J. (2015). Suppression of soil nitrification by plants. Plant Science, 233, 155-164.

- Plant density, split N application ratio and water regime were not the same in all treatments (I do not know why). Could these changes have modified GHG emissions and crop yields?

For instance, in lines 230-234, you consider that the changes in rice yields in N1 and N2 treatments as opposed to FP are due to changes in N fertilization rate. But the crop density and split ratio were different, and that could have also affected yields. In the reference that you provide (Peng et al., 2006) only the N rate is changed between treatments.

As indicated above, the N supplied thorough the manure should be taken into account for NUE calculations. Therefore, the NUE should be re-calculated and re-discussed.

Lines 239-240: “Possible explanations can be that organic fertilizer supplemented with adequate nutrients in combination with improved rice yield and efficient control of pests and diseases”. As indicated above, many factors could have contributed to this higher yields and must be discussed (i.e. why the organic amendment increase yields? Maybe due to the higher supply of nutrients that you have not considered)… But what about the efficient control of pest and diseases? Were not efficiently controlled in the rest of treatments? This point needs to be clarified.

Lines 248-252. Please split and/or rewrite this sentence for better understanding and be careful with the variables that were not measured (e.g. leaching and volatilization).

Line 277: add a reference for this statement.

Lines 278-279. Likely, the flooded conditions during rice season led to the reduction of N2O to N2 (complete denitrification).

Lines 280-282: add a reference for this statement.

Lines 286-287: as explained above, I recommend removing this correlation analysis.

Lines 325-327: why the fertilized treatments could have increased SOC sequestration? That should be briefly discussed (maybe that could be related to residue management, which you should also explain).

Line 343-344: I suggest adding a figure or table indicating the relative weight of each component in each crop. Were there any differences in Net GWP between years?

Conclusions: you should indicate some results about wheat, not only about rice.

Lines 382-384: I guess that you are referring to one ISSM strategy in particular (N2), please indicate. Since you propose N2 as the most appropriate management strategy, I recommend describe briefly this scenario (10% reduction of N input, no rapeseed manure, no Zn or silicon addition, higher plant density…).

Table 2: please indicate with lowercase letters if there were significant differences between treatments in 2011, 2012 and 2013 (not only in the average).

Table 4: you must add the values for both wheat and rice in each component, and discuss in the text. Additionally, see my comment on lines 343-344.

Figure 2: You should delete figure 2a (this information is given on Table 2) and c (see the comment on lines 286-287). Add the standard errors (or deviations) to the columns in fig. 2b.

Figures 3 and 4. Indicate (e.g. with arrows) the times of N fertilization and the flooding cycles.

TECHNICAL CORRECTIONS

Abstract: A widespread criteria is that non-standard or uncommon abbreviations should be avoided in the abstract. Therefore, you should remove some abbreviations that you only use once, e.g. Ei, Eo and SOC.

Avoid abbreviations at the beginning of the sentence (e.g. K in line 102, CO2 in line 206, CH4 in line 263).

Line 214: The word “Conversely” does not make sense there. Please rewrite the whole sentence.

Line 224: at the beginning of the sentence, change “A” by “The”.

Line 312: Although there were not significant differences…

Lines 314-316: In spite of producing. Change “considerable” by “similar”.

Line 333: per unit OF grain produced.

Line 355: the word “technologies” is repeated twice.

Line 362: the word “increment” is repeated twice.

Caption Table 2: and yields during rice and wheat cropping seasons…

Footnote Table 2: significant differenceS.

Table 3: I guess that you have considered MEAN fluxes and yields during the three cropping seasons (please indicate in the caption).

Caption Table 4: global warming potential (without “s”)

Be careful with the font and size in the figure captions.