<u>Responses to the first reviewer's comments on the preprint</u>

"Diachronic assessment of soil organic C and N dynamics under long-term no-till *cropping systems in the tropical upland of Cambodia"*

1. Reviewer's Expression & General comments

Comment: *I have read "Diachronic assessment of soil organic C and N dynamics under long-term no-till cropping systems in the tropical upland of Cambodia." The manuscript describes a study where soil organic carbon (SOC) mass fractions ("concentrations"), stocks, and particulate/mineral pools were measured at a ten-year interval across different crop types (maize, soybean, and casava) and management practices (monocrop with conventional till without cover crop, monocrop with no till with cover crop, and two phases of crop rotations with no till and cover crop). The authors report that SOC concentration, SOC stocks, and SOC pools generally increased near the surface under no-till treatments, but generally showed fewer changes at depth. N concentrations and stocks generally increased near the surface but decreased at depth under no-till. Space-for-time sampling ("synchronic") generally underestimated SOC stock changes relative to longitudinal sampling ("diachronic"). The authors conclude that no-till cover crop systems may help to increase SOC, but more work is needed to understand N dynamics.*

The dataset is comprehensive, the topic is of general interest, and manuscript is generally well-written. However, I have some suggestions for improvement.

Response: We sincerely appreciate the time and effort that you have dedicated to provide feedback and comments on our preprint. We are grateful for your insightful comments to improve our paper. We have taken into account all your comments and suggestions in our detailed responses.

Comment: *The manuscript is too long, primarily because of the details provided in the results text. The figures and tables contain the details that the reader can reference, and the text should serve to bring attention to the important findings. Therefore, it is not necessary to repeat in the text every result shown in the figures and tables. I would also recommend combining the maize, soybean, and casava results into one section (for both the results and the discussion), first pointing out the similarities in the results (there are many), then pointing out the differences. This would not only reduce the amount of text but also improve the flow.*

Response: Thank you very much for pointing this out. We agreed that our manuscript is quite long due to the number of experiments (3) and the number of cropping systems. Following your advice, we have reshaped the result and discussion sections by concisely describing the most important and unexpected findings across the three experiments, and avoiding repetition of the results shown in the tables and figures.

Comment: *Related to the last point, the authors could reduce the number of tables and figures in the main text by focusing on specific questions. Right now, there are five tables and six figures, and many of the figures are multipaneled. Tables 2 and 5 seem like they could easily be moved to the supplemental. If the manuscript's focus is "storage," "stocks," and "accumulation," as indicated in the first three sentences of the abstract, then it also seems like it is unnecessary to report the C and N concentrations in the main text (i.e., Figures 1 and 2 could be moved to supplemental).*

Response: Thank you very much for your suggestion. We agreed to move Table 2 and Table 5 to the supplementary materials. However, we prefer to keep Figures 1 and 2 in the main text. As also suggested in the title "Soil Organic C and N Dynamics," we are also interested in C and N concentrations, not only stocks. We think it is important to show concentrations as well, to clearly show that SOC stock increases are due to an increase in C concentrations and not to a change in bulk density. By moving two tables to the supplementary materials and shortening the text in the result section, we believe we have significantly reduced the length of the manuscript, so it should now be easier to read.

Comment: *Under each crop type (maize, soybean, and casava), the conventional till system does not have a cover crop whereas the no-till systems have cover crops. Therefore, the effects of no-till and cover crops are confounded. This should be corrected throughout the manuscript when referring to "no-till" effects, including in the title.*

Response: Thank you for your comment. We agree that no-till systems have cover crops, and in some case rotations. It is clearly explained in the description of the systems in the Materials and Methods section. The title refers to "no-till cropping systems". We think this is valid. The title does not say changes in SOC or N are due to no-tillage. "No-till cropping systems" always include cover crops and, for some treatments, rotations. It just says these treatments are under no tillage, but it is not exclusive. But in order to avoid confusions for readers, we have now modified the title to "*Diachronic assessment of soil organic C and N dynamics under long-term conservation agriculture cropping systems in the tropical* *upland of Cambodia*", and in the text we now refer to conservation agriculture (CA) systems instead of no-till systems throughout the treatment description in the main text.

Comment: *I found the descriptions of the experiments and the treatments to be insufficient. I had to reference several of the previous publications from this study to understand that 1) the maize, soybean, and casava treatments were "separate" experiments at the same site and, 2) NT2 and NT3 are the two phases of a rotation, and 3) the site has been in various agricultural uses since 1937. These are important details that must be explained sufficiently in the text. There are still some questions that I have about the experimental design that I list in the specific comments below.*

Response: Thank you very much for pointing this out. The description of the experimental design and history of the experimental site was reshaped to provide sufficient information. The following sentence "*Briefly, the site was the natural tropical rainforest, which was then converted to perennial cropland in 1937. The crops included cashew, coffee, mango, mulberry, avocado, and rubber, which were planted soon after forest clearance. Because of the civil war (Khmer Rouge) between 1970 and 1982, the area was abandoned and taken over by several tree species, such as Tetrameles nudiflora R Br., Nauclea officinalis, Cassia siamea Lam., and Leucaena leucocephala (L.) Benth., which grew naturally. The farming was resumed, and cotton (Gossypium hirsutum L.) and banana (Musa acuminata spp.) were planted from 1982 to 2000. From 2000 to 2009, successive annual crops per year of cotton, followed by mung bean, and sesame, followed by soybean, were rotated under plough-based management before the establishment of the three experiments. Mineral fertilizers such as NPK (15-15-15), ammonium phosphate (16-20-0), and potassium chloride (0-0-60) were applied to the crops without lime application. The soil of the study site is classified as a red Oxisol (USDA, 1999) or a ferralsol in the world reference base (WRB) for soil resources (IUSS Working Group WRB, 2015), with 1.3% sand, 28.6% silt, and 69.8% clay in the 0–20 cm and gradually increasing with soil depth to 78% clay at 20–100 cm. The clay fraction is mainly made of kaolinite (Hok et al., 2015). The research site's climate is defined as tropical monsoon, corresponding to the Am Köppen climate classification, with two main seasons: the wet season from May to November and the dry season from December to April. The mean annual temperature from 2009–2021 was 27.5°C, while the average annual minimum and maximum temperatures were 22°C and 35°C, respectively. The annual rainfall during the last 13 years ranged between 1,650 and 2,000 mm.*" was added to the study site description in the main text in L181.

Furthermore, we reshaped the description in experimental design, treatment description and crop management section, and the paragraph in L191-207 was removed and replaced by the following paragraph "*The detailed experimental design, description of the treatments, and fertilizer application were reported in Hok et al., (2015) and Pheap et al., (2019). Our study covers three separate experiments located on the same site, which were implemented in 2009. The three experiments include (i) maize (Zea mays L.) (which was a former rice (Oryza sativa L.)-based trial from 2009 to 2019 and shifted to a maize-based trial in 2020), (ii) soybean (Glycine max L.)-based trial, and (iii) cassava (Manihot esculenta Crantz)-based trial, hereafter called MaiEx, SoyEx, and CasEx, respectively. These three experiments represent the most important annual upland crops in Cambodia as well as in some Southeast Asian countries. Each experiment is arranged in a randomized complete block design (RCBD) with three replicates. The elementary plot dimensions are 8m x 37.5m, equivalent to 300 m^2. Each experiment consists of four (4) treatments: (i) monocropping of the main crops, i.e., maize (Mz), soybean (Sb), and cassava (Cs) under conventional tillage (CTM) with land preparation done by disc ploughing (CTM-Mz, CTM-Sb, and CTM-Cs); (ii) monocropping of main crops (maize, soybean, and cassava) are cropped under conservation agriculture systems (CAM) along with the use of cover crops (CAM-Mz, CAM-Sb, and CAM-Cs); (iii) and (iv) bi-annual rotation of the main crops under CA systems (CAR1 and CAR2), respectively, along with the use of cover crops. CAR1 and CAR2 represent the two phases of the rotation. The main crops, i.e., soybean and cassava, in SoyEx (CAR1-Sb, CAR2-Sb) and CasEx (CAR1-Cs, CAR2-Cs), respectively, were grown in a bi-annual rotation with maize, while in the case of MaiEx (CAR1-Mz, CAR2-Mz), the maize was grown in a bi-annual rotation with soybean. The detailed history of the crop sequences in each treatment and experiment is presented in Table 1 in the supplementary materials.*"

Comment: *The authors use the equivalent soil mass (ESM) approach to calculate changes in SOC and N stocks, which is robust assuming that there are no losses or gains of mineral soil. However, the authors also mention that erosion is an issue in this area, which would cause ESM (and the fixed-depth approach) to be inaccurate. The authors should address this issue, either by providing assurance that significant erosion does not occur at the site, or providing an approximation of erosion rates (and thus the uncertainty of stock change estimates). Also, the C and N concentrations and POM/MAOM values were not calculated using ESM, but these could also be affected by changes in bulk density. I recommend using ESM for these values in addition to the stocks.*

Response: Thank you for raising this important point. In the general introduction section, we mentioned soil erosion, which is one of the main mechanisms that causes soil degradation in Cambodia. However, there is low soil erosion at the research station, the land is flat. In this regard, we added a sentence to the "study site description" of the manuscript to emphasize that the land of the site is flat and soil erosion is negligible at the site.

Regarding the values of C and N in POM and MAOM, we calculated again the C and N stocks in these fractions based on ESM approach, presented them in the same format of stacked bar graphs, and replaced the existing Figures 4 and 5 in the manuscript, along with the modifications to the captions of Figures 4 and 5, and the results and discussion related to C and N in POM and MAOM fractions.

2. Reviewer's specific comments

Comment: *L35-38: The results given at the end of the abstract indicate that the NT system contained cover crops, but that is not mentioned here. A better description of the systems is necessary.*

Response: Thank you very much for pointing this out. We modified the sentence "*... comparing conventional tillage (CT) to NT monocropping and NT crop rotation systems using a diachronic….*" to "*... comparing conventional tillage monocropping (CTM) to CA monocropping (CAM) and bi-annual crop rotation under CA systems (CAR) with the use of cover crops using a diachronic …*"

Comment: *L40-41: It is not necessary to list all the depth increments here, as they are not reported in the abstract.*

Response: We have removed the list of the depth increments: "*at 7 depths: 0–5, 5–10, 10–20, 20–40, 40–60, 60–80, and 80–100 cm" from the main text. The sentence now reads: "Soil samples were collected in 2021 down 1 m depth, 10 years after the first sampling in 2011*."

Comment: *L48-50, and throughout the manuscript: If the results are not significant, then do not calculate the percent change.*

Response: Thank you very much for your recommendation. We have removed the values in percentages where the results are not significant throughout the manuscript.

Comment: *L61: This implies that diversity was explicitly tested in this experiment, which it was not. If diversity is of interest, then it should be tested in the analysis.*

Response: We have modified the sentence from "*Our findings suggest that adopting NT cropping systems with diverse crop and cover crop species and high biomass C inputs...*" to "*Our findings suggest that adopting CA systems with the use of cover crops ...*"

Comment: *L76, elsewhere: The word "inappropriate" could be changed to something more specific like "intensive."*

Response: Thank you very much for your suggestion. The term "inappropriate" was corrected to "intensive."

Comment: *L81-82: Please provide a citation.*

Response: As suggested by the reviewer, we have provided the citation: "*Cambodia, located in the tropical region of Southeast Asia, is one of the highest land degradation hotspots in the world, and about 55% of the country's population resides in these hotspot areas (UNCCD, 2018).*"

Comment: *L96: The fate of eroded SOC is difficult to assess. See Sanderman and Chappell 2013 (doi:10.1111/gcb.12030).*

Response: We agree with this comment. The sentence "*Erosion induces soil degradation and SOC loss (Polyakov and Lal, 2004)*" has now been clarified to "*Erosion induces soil degradation and a loss of SOC for eroded fields (Polyakov and Lal, 2004).*"

Comment: *L99-100: Please provide a citation.*

Response: As suggested by the reviewer, we have provided the citation: "*SOC serves as the foundation of soil physical, chemical, and biological processes that sustain essential ecosystem functions, and it is the reservoir of plant nutrients and energy for biota (Lal, 2015).*"

Comment: *L101: The term "SOC content" is ambiguous, as it is sometimes used to describe stocks and sometimes used to describe mass fractions ("concentration"). Please be explicit.*

Response: As suggested by the reviewer, we have replaced the term "SOC content" to "SOC stock."

Comment: *L112: NT is part of CA, should "NT" can be removed from this sentence.*

Response: As suggested by the reviewer, "NT" was removed from the sentence.

Comment: *L121-122: The introduction should have more information about this. Some of this could be moved from the discussion, e.g., L793-796.*

Response: Thank you very much for your suggestion. We have included the sentences from L793-796 in the L121 which can be seen in the main text as followed: "*Particulate organic matter (POM) and mineral-associated organic matter (MAOM) are the two main fractions of the SOC pools. They differ in physical and chemical characteristics as well as their turnover rates. POM is more sensitive to soil tillage and land use than MAOM and total SOC (Blanco-Moure et al., 2013; Kan et al., 2021). Therefore, documentation of SOC fractions is desirable for a better understanding of SOC dynamics and stabilization processes (Lavallee et al., 2020).*"

Comment: *L153-168: This seems out of place. It should come earlier in the discussion because it is part of the "big picture."*

Response: We understand the reviewer suggests moving this paragraph earlier in the introduction, not in the discussion. We have split the paragraph (L153–168) into a few parts, reshaped some phrases, and merged "*Cambodian soils are seriously threatened by intensive agricultural systems. The returns on taking actions against land degradation are estimated at 3 US dollars for every dollar invested in restoring degraded land in Cambodia (UNCCD, 2018). Therefore, taking actions to reverse the trend of soil degradation through restoration and adopting sustainable agricultural management practices highlights the positive economic benefits of combating soil degradation in the country (UNCCD, 2018)*." into L98.

The phrase "*Since 2004, CA research for development program has been initiated in Cambodia by the joint collaboration between the General Directorate of Agriculture (GDA) and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France*." was incorporated into L112.

The phrase "*CA have been promoted to smallholders in various agroecosystems of Cambodia since 2009. The early effects of CA cropping systems on soil health and SOC sequestration have been reported in several studies (Hok et al., 2015, 2018, 2021; Pheap et al., 2019; Suong et al., 2019; Sar, 2021; Koun et al., 2023); however, information on the impact of long-term CA systems on the changes in SOC stock remains scarce in the country as well as in Southeast Asia. There is a need to document the long-term changes in SOC stock under CA cropping systems to fill in the knowledge gaps as well as provide robust evidence* *to land use planners and policymakers. This could be profitable not only for Cambodia but also for the whole region*.” was merged to the main text in L153.

Comment: *L171-173: What is the hypothesis regarding the POM and MAOM?*

Response: Thank you for pointing this out. We have developed and incorporated “*In addition, the continuous supply of diverse biomass-C inputs by cover crops and low soil disturbance under CA systems could contribute to increased C in particulate and mineral pools over time.*” as the hypothesis of the SOC fractions into the main text.

Comment: *L173-174: This isn’t so much a hypothesis as it is a test bias.*

Response: This is indeed not a hypothesis, rather a general presentation of the method used in our work, we decided to remove it.

Comment: *L180: What is the slope of the site?*

Response: The land on the site is flat, the land slope (< 1%). It has now been added to the Materials and Methods.

Comment: *L201-207: The treatment abbreviations for the systems (especially the NT systems) could be improved to better convey similarities and differences. For example, CTM (conventional till monoculture), NTM (no-till monoculture), NTR1 (no-till rotation phase 1), and NTR2 (no-till rotation phase 2).*

Response: Thank you very much for your insightful suggestion. We have replaced **CT, NT1, NT2,** and **NT3** by **CTM, CAM, CAR1,** and **CAR2**, respectively, as the new treatment abbreviations throughout the whole manuscript.

Comment: *L205-207: This makes it sound like the NT2-Sb, NT3-Sb, NT2-Cs, and NT3-Cs do not have cover crops, but I don’t believe that is correct.*

Response: As stated in the response to the earlier comment of the reviewer, we have reshaped the treatment description paragraph from L199 to 207, and the following phrase was incorporated into the main text “*Each experiment consists of four (4) treatments: (i) monocropping of the main crops, i.e., maize (Mz), soybean (Sb), and cassava (Cs) under conventional tillage (CTM) with land preparation done by disc ploughing (CTM-Mz, CTM-Sb, and CTM-Cs); (ii) monocropping of main crops (maize, soybean, and cassava) under conservation agriculture systems (CAM) along with the use of cover crops (CAM-Mz, CAM-Sb, and CAM-Cs); (iii) and (iv) bi-annual rotation of the main crops under* *conservation agriculture systems (CAR1 and CAR2), respectively, along with the use of cover crops. The main crops, i.e., soybean and cassava, in SoyEx (CAR1-Sb, CAR2-Sb) and CasEx (CAR1-Cs, CAR2-Cs), respectively, were grown in a bi-annual rotation with maize, while in the case of MaiEx (CAR1-Mz, CAR2-Mz), the maize was grown in a bi-annual rotation with soybean. The detailed history of the crop sequences in each treatment and experiment is presented in Table 1 in the supplementary materials.*"

Comment: *L221-222: Why weren't the root inputs estimated, for example, by using a root-to-shoot ratio?*

Response: We did not include the estimation of C-input from roots in this manuscript because root-shoot ratio is largely uncertain, and we prefer to stick to measurements for this study. However, we fully agree root inputs matter a lot. The assessment of belowground biomass input is ongoing for the different crops and cover crops at the study site, using both excavation (pits) and soil cores. The sampling will be completed at the end of 2024 and a dedicated paper will be written on it. We made this choice, as the current manuscript is already long as pointed out by the reviewer.

Comment: *L253: Pyrophosphate is a more common term; otherwise thermophosphate as one word.*

Response: Thank you very much for your correction. The term "thermo phosphate" was replaced by "thermophosphate."

Comment: *Table 1: While this table is very comprehensive, it is very difficult to interpret because there are so many different types of crops. I would recommend making it easier for the reader to understand by putting the crops into categories. For example, main crop could be bolded, cash crop could be underlined, and cover crop could be italicized.*

Response: Thank you very much for this great suggestion. We have now modified the font styles, all the main crops are bolded, cash crops are underlined, and cover crops are italicized.

Comment: *Table 2: It seems like this can be supplemental information that is referenced in the text where appropriate.*

Response: We agreed with your suggestion, and we have removed the Table 2 from the main text and placed it in the supplemental materials with clear referencing in the main text.

Comment: *L282: A 20-year-old coffee plantation with otherwise identical history to the experimental treatments does not seem like appropriate "reference vegetation." Reference vegetation would be an old growth forest (e.g., 100 years old) or remnant forest (never cultivated). Readers might assume that the "reference vegetation" contains the maximum SOC stock possible, which is highly unlikely in this case. Moreover, the SOC stock in the "reference vegetation" was only measured to 20 cm deep. I suggest that the reference vegetation data and Figure 3 are removed.*

Response: We agree with the reviewer that the use of "reference vegetation" might be ambiguous. Thank you for this very relevant comment. However, we think that it is very useful to show these long-term dynamics of SOC and N at the site, even if only to a depth of 20 cm. Therefore, instead of completely removing the Figure 3 from the manuscript, we removed the data of "reference vegetation (RV)" from Figure 3, and keep only the data of pre-experiment (PE) in 2009 and the data of the four treatments in 2011 and 2021 (so keep Figure 3 without data of RV). We run the statistical analysis again with the dataset of PE in 2009, and tested treatments in 2011 and 2021. We also modified the caption of Figure 3, replacing it with the following: "Figure 3. Changes in SOC and N stocks (Mg ha^{-1}) at 0−20 cm depth from pre-experiment (PE) in 2009, 2011, and 2021 under different cropping systems. CTM: monocropping under conventional tillage; CA: conservation agriculture; CAM, CAR1, and CAR2 refer to different cropping CA systems as described in Table 1. Lowercase letters inside the brackets indicate a significant difference between PE and the treatment(s) in 2011 and uppercase letters inside the brackets indicate a significant difference between PE and the treatment(s) in 2021 (Tukey's test; $P < 0.05$)."

Furthermore, we removed all the information, results, and discussion related to "RV" from the manuscript. Thank you again for this suggestion.

Comment: *L286: Can the authors explain the rationale for using a different soil sampling strategy in 2021 compared to 2011?*

Response: Thank you for this question. The sampling strategy was actually quite similar between the two sampling dates, with small modifications due to several reasons. The elementary plots of these long-term experiments are relatively small (37.5m x 8m = 300 m^2), so repeating the same soil sampling procedure as in 2011 would have been too destructive for the experiments. We decided to make the composite samples from soil collected from three sides of the pit and the samples from the four cores to account for the spatial variability within the elementary plot. This was also a way to reduce the costs of analysis. We are confident this did not impact our conclusions as each bulk sample resulted from 7 sampling points and we still have a high number of samples analyzed for C and N (756 samples) along with bulk density.

Comment: *L289: What is the model of the "soil column cylinder auger?"*

Response: We provided the model for the auger, and "The model of the auger is gasoline powered percussion hammer Cobra TT with inner diameter of 85 mm" was added to the main text.

Comment: *L297-301: It appears that SOC and N was measured differently between 2011 and 2021 (different lab, different instrument). Did the authors run any of the samples on both instruments/labs to check for consistency. Or could this difference explain the unexpected decrease in N reported in 2021? For example, a small change in the N calibration between instruments could result in apparent N changes through time.*

Response: Thank you very much for pointing this out. For the first point, it would have been very interesting to conduct this ring test to compare the results between the two labs or instruments prior to the analysis of the whole samples. However, this would not be possible because all soil samples were stored at the State University of Ponta Grossa (Brazil) and we were not able to ship back these samples to Cambodia. In this regard, both labs use the same analyzer (TruSpec CN, LECO), international standard protocols and standard samples for C and N measurement (dry combustion), we are confident the results are correct.

Comment: *L351: "computed" could be "conducted."*

Response: The term "computed" was replaced by "conducted."

Comment: *L367-371, 512-517: This preamble is unnecessary.*

Response: The preambles from L367-371 and L512-517 were deleted from the main text.

Comment: *Figure 1. Figure 2: In general, error bars are necessary for graphs. Also, the description does not mention that text in bold brackets in the 2011 panels (presumably) represents a significant decrease.*

Response: Thank you very much for pointing this out. Initially, we also included the error bars (SE) into those graphs, but this makes the graphs become tedious because readers cannot distinguish the error bars between the treatments, so we decided to remove them from the graphs. All the raw data are freely available in the dataverse mentioned in the manuscript, so we think colleagues interested into standard errors could directly retrieve them for this dataset.

Comment: *Table 3, Table 4: Measurements should have units for error (e.g., standard error).*

Response: Thank you very much for your suggestion. We have added the "values of standard error (+/- SE)" to the Table 3 and 4.

Comment: *L599: The discussion would be stronger if it started with the takeaway messages and significance of the study.*

Response: Thank you very much for the insightful suggestion. We removed the sentence in L599-601 and replaced by "Despite the varied effects among the CA system and the experiments, our study showed that long-term adoption of CA systems with the use of cover crops and high biomass C-inputs significantly increased SOC stock and its vertical distribution across the soil profile (Table 1)."

Comment: *L619-630: These are detailed results that should not be presented in the discussion.*

Response: We have reshaped paragraph, and replaced by this new sentence: "Our study revealed that CA systems significantly increase SOC stock, although there is variability among the CA systems, across the three experiments in the accumulation rate along with its vertical distribution in the subsoil layers."

Comment: *L665-679: This would fit better with the discussion of POM and MAOM.*

Response: Thank you very much for your suggestion. We have moved this paragraph to L802 in the discussion section of POM and MAOM: "*During the decomposition process, microbial communities use the rapidly decomposable materials as energy sources, while the recalcitrant and other labile compounds materials act as the glue to bind soil mineral particles together (Witzgall et al., 2021). This process is a pathway for the formation of soil micro aggregates (Bot and Benites, 2005). The continuous supply of biomass C inputs to the soil associated with microbial decomposition without soil mechanical disturbance creates a favorable environment for the emergence of soil macroaggregates (Crews and Rumsey, 2017). Organic carbon inside soil aggregates is physically protected from microbial oxidation as well as strongly associated with the organo-minerals, leading to SOC stabilization over time (Powlson et al., 1987; Lützow et al., 2006). In the same experiments as in our study but after 3 years of CA adoption, Hok et al. (2021) reported that soil aggregation was one of the main* *stabilization mechanisms, providing physical protection to the newly derived C into the soil microaggregates protected by macroaggregates. From our knowledge of the literature, the high SOC accumulation rate recorded under cassava-based CA cropping systems is relatively unique and, in addition to the residues of cover crops and maize under the biannual cropping system, the nature of the cassava residues that was retained into the field with high cellulose and lignin contents may explain this result (Veiga et al., 2016)*".

Comment: *L680: This seems like a separate idea from the prior part of the paragraph*

Response: Thank you very much for your insightful suggestion. We have separated the L679 to create a new paragraph starting from L680-699: "*Considering the challenges faced by smallholder farmers in Cambodia... the continuous C flow and soil structure enhancement under CA systems (Lavelle et al., 2016).*"

Comment: *L707-711: This should be in the results section.*

Response: We appreciate your suggestion; however, we preferred to keep this sentence in the discussion because, as stated in the introduction, our goal is to calculate ESM with a diachronic approach. In addition, we believe that keeping the results of the comparison between the diachronic and synchronic approaches to the SOC stock calculation in perspective offers additional strength to the paper.

Comment: *L714: A major reason why the synchronic method produced lower SOC stock changes than the diachronic results is because the control treatment had increased SOC stocks over time (although it may not have been statistically significant, it was still numerically higher, which affected the calculation).*

Response: Thank you very much for pointing this out. We have added a sentence "*This could also be explained by the increase of SOC stock under CTM with time although at insignificant level (Table 3)*" to the main text.

Comment: *Figure 6: Statistically significant changes (i.e., different from zero) should be noted, for example with an asterisk. Also, it would be helpful to draw a horizonal line on each graph to represent zero.*

Response: Thank you very much for your insightful suggestions. We have added an asterisk to indicate the statistically significant changes from zero on the graph of SOC and N stock change rate. In addition, the horizontal line representing zero was drawn on each graph.

Comment: *L755-764: Could N uptake and/or N priming from the cover crops have resulted in N loss?*

Response: Thank you very much for raising this point. To better understand the N loss observed in our study, samples of various plant materials (root, stem, and grain) from a range of main and cover crop species from the experiments have been sent to CIRAD's lab in France to measure N content and estimate biological nitrogen fixation in the legume cover crops using the ^{15}N isotopic technique. Indeed, N uptake and/or priming effects from the cover crops are possible hypotheses. We have now mentioned in the main text between L754 and L755 with the following paragraph, "*Nitrogen uptake and/or N priming effects from the cover crops, among other factors, could possibly have resulted in N loss in our study. Priming effects are short-term changes in the turnover of soil N caused by the addition of organic or mineral fertilizer, the mechanical treatment of soil, its drying and rewetting (Kuzyakov et al., 2000), and the exudation of organic substances in the rhizosphere by living plants (Kuzyakov, 2002). These effects can occur immediately or very shortly after the addition of a specific substance to the soil and are larger in soils rich in C and N than those in poor soils (Kuzyakov et al., 2000). In our experiments, under CA systems, the soils are year-round protected by the cover crops established through association or succession with the main crops (maize, soybean, and cassava) and continue to grow after the main crop harvest. The stylo (Stylosanthes guianensis), the most common legume cover crops used in the experiments (Table S2 in supplementary materials), is a good example remaining green throughout the dry season with root exudates that may have enhanced the priming effect. In addition, the symbiosis relationship between stylo and rhizobia during the dry season could also be low due to low soil moisture content and thus resulting in high N uptake from the soil by the stylo. Their drought tolerant characteristics allowing these species to cross the dry season, even with little or no rain for more than 4 months in the dry season, their fast-growing characteristics, the species diversity, and a large amount of biomass produced annually and retained in the soil at the termination of the cultivation of the main crops (Table 1 in supplementary materials), may create conditions for the N uptake or N priming effects to happen. Therefore, the measurement of N content and the estimation of biological nitrogen fixation by the legume cover crops using the N^{15} isotopic technique should be conducted to explain the N uptake or N priming effects.*"

Comment: *L765-791: This section doesn't add much in addition to the previous section, especially since the comparison the "RV" was only done to 20 cm and the RV vegetation is not likely representative of the pre-agricultural SOC stocks. I recommend removing this.*

Response: Thank you very much for pointing this out. As stated in the response to the reviewer's early comment, we agreed with the reviewer to remove this section from the manuscript.

Comment: *L796-799: This level of detail should be confined to the results.*

Response: We have reshaped the sentences, and the following phrase was incorporated into the main text: "In all the three experiments, CA systems significantly increase C in both POM and MAOM fractions in the topsoil layer (Fig. 4)."

Comment: *L825-839: This is too much detail for the conclusions. Provide a high-level overview of the results and implications.*

Response: We have reshaped the whole conclusion, and replaced by the new version of the conclusion:

"*The present study showed that, over 10 years, the effects of CA systems on SOC and N stocks and pools varied across the three main crops and the three CA systems. CA systems significantly increased SOC stock in the surface layers in SoyEx and distributed it to deeper soil layers under MaiEx and CasEx. When considering the whole profile (0–100 cm), the annual SOC accumulation rate in CA systems ranged from 0.86–1.47, 0.65–1.00, and 0.70–1.07 Mg C ha^{-1} yr^{-1} in MaiEx, SoyEx, and CasEx, respectively. Similarly, the impact of CA cropping systems on SOC pools was in the topsoil layers in MaiEx and SoyEx, whereas a significant effect on C-MAOM in soils under CA systems was found from 0–40 cm in CasEx. In contrast to SOC stock, N stock under CA cropping systems only increased in the surface layer. Although CA cropping systems increased N in POM in the surface layers, reduction was observed in the subsurface layers. Surprisingly, CA cropping systems caused the depletion of N-MAOM, with significant losses observed below the surface layers in all three experiments. This resulted in significant N stock depletion below 40 cm and in the whole profile, particularly under soybean and cassava CA monocropping systems.*

Overall, our findings reveal that diachronic sampling is crucial for proper measurements of the impacts of CA systems on SOC dynamics with time. Adopting CA cropping systems accompanied by diversified crop and cover crop species significantly increased SOC stock and pools in the tropical red Oxisol of Cambodia. The study highlights the potential of CA cropping systems for SOC accumulation and stabilisation over time, even for cassava, which is known to have severe environmental impacts and soil degradation, but raises questions about soil N dynamics. Further research on N use efficiency, N cycles, and nutrient availability and their stoichiometry relationship by considering deeper layers (> 100 cm) is needed to understand the mechanism driving N loss in CA *systems for making informed decisions regarding sustainable soil fertility management and crop production systems*".

Comment: *L846: In addition to "question about N dynamics," it also raises questions about the sustainability of these systems in general. If the systems are continually losing N, they may not be sustainable. Moreover, SOC has a fixed ranged of C:N, so at some point, C will no longer accumulate if N is being lost.*

Response: Thank you very much for pointing this out. We totally agree that sustainable C sequestration and storage depend on the relative importance of the change in total N, phosphorus (P), sulfur (S). The observation of N loss under CA systems has raised questions about the capability of N supply by the CA systems in our experiments. As mentioned in our conclusion, we plan to conduct further studies to understand the causes of N loss, and then the modifications of the cropping systems and crop management in the experiments will be conducted to substantially increase N availability, which is a major factor supporting long-term C sequestration.