Remarks Anonymous Referee #3

R3.1: This paper provides extensive research involving multiple methods on the anthrosols formed in the terraced agricultural systems in the Andes. The paper provides extensive data covering soil survey results, phytolith analysis, radiocarbon dating, and more. I believe that this paper would provide a firm base for future studies to understand the past human activities and soil in the region. The paper is also well-written and interesting to read, and I believe that it ultimately deserves to be published.
A3.1: Thank you for your kind words and for recognizing the importance of our work and suggesting it for publication. We hope our study will contribute to a better understanding of past human activities and soil conditions in the region.
R3.2: One thing that I would like to specifically comment on is the smart way that the authors dealt with the chronology of these soils. Dating soils can be very technically challenging, and this is especially the case when applying radiocarbon dating. The authors chose not to use the radiocarbon dates as the main source of establishing the chronology but as a supplement to existing archaeological interpretations and climatic data, which I think would be the most reasonable way with the current data. There have been some recent advances in dating the soil formations using ramped pyrolysis or luminescence dating, so the authors may consider applying these methods and see if there is any new information that can be obtained in future research.
A3.2: We value your positive feedback. Your words motivate us to continue our research and to maintain a close interdisciplinary collaboration with our colleagues in archaeology, palaeobotany and archaeometry. To better understand the chronological development of terrace soils in the southern Peruvian Andes, we plan to incorporate additional dating methods, such as OSL, in future work.
R3.3: There is also one thing that I would like to know what the authors think. The authors conclude that the anthrosols do not show indicators of severe soil degradation despite the elongated agricultural practices. The authors mention the consistent application of organic manure in the terraces (Section 5.2.3.), which I think the authors point out as the main strategy to prevent soil degradation. If so, what was the source of organic manure and how was it acquired? I am also curious about what the authors think about the impact on soils by the acquisition of manure on a landscape scale. It is a frequent case in the Eurasian context that the acquisition of organic manure, usually originating from the dung of livestock, may

cause soil degradation within a wider landscape, so I am curious about this case in the Andes.

A3.3: Thank you for these intriguing questions, which are of great interest to us as well. We will delve into them further in the revised version of the manuscript. We conclude that maintaining a consistent level of organic matter through intentional organic manuring played a crucial role in preserving soil health. Based on the results, where tracing the addition of organic nitrogen sources (e.g., urea or compost) is challenging and phytolith assemblages indicate a broad range of plant elements (e.g., maize leaves or glumes, particularly cobs) from typical crops, we can attribute the fertilizer source to a plant component at this stage of investigation. The broader range of maize plant components, which could only be distinguished in the Santa María system, suggests a deliberate application of mulch material to the soil surface. A combined strategy benefits from in situ biomass, available at higher rates than in natural vegetation, as well as allochthonous organic matter applied as needed by intensive cultivation requirements.

To extend this conclusion to a broader landscape scale, the potential role of organic fertilizers of animal origin (e.g., camelid dung) needs systematic exploration in future research; their use is plausible. As noted, Handley et al. (2023) suggest that the Chicha Sora terrace system likely received regular maintenance through the addition of camelid dung, which is known to be less prone to accelerated soil erosion than later-introduced cattle, thanks to its adaptation to topography and native vegetation. The Laramate area provides an opportunity to approach this phenomenon from various angles. A substantial number of circular structures (Soßna, 2015), now utilized seasonally as corrals, remain well-preserved; their quantification using GIS techniques forms a starting point for model development. Studies on domestic animal densities in an archaeological context, utilizing oribatid mite concentrations as indicators, such as those conducted in the Patacancha Valley in Cuzco by Chepstow-Lusty et al. (2007), could offer valuable insights.

R3.4: Line 270: “Twenty-eight samples were collected …” to “Twenty-eight samples for physico-chemical soil analyses”. I think it would be better to address what samples are they for firsthand. The following sentence can be modified accordingly.

A3.4: Thank you for your pertinent observation. We agree with your suggestion. An alternative sentence could read as follows: "A total of twenty-eight samples for soil physico-chemical analyses were collected from seven soil profiles (Supplementary Table S1). The samples were analysed at the Laboratory of Geomorphology and Geoecology, Institute of Geography, University of Heidelberg."

R3.5: Table 1 & 2: I am doubtful whether this is the right place to present this data since this is the section for Materials and Methods. I believe this fits more with the Results section, in which the authors are presenting the contents of the tables in the forms of figures and text. The authors may consider presenting the tables as supplementary material.

A3.5: Thank you for your valuable suggestion. We will consider making adjustments for the benefit of the reader. Our intention was to include this information in both the Methods and Results sections without overloading the Results chapter. However, in the revised manuscript, we will place Table 1 in the Results chapter and Table 2 in the Supplementary Materials section.

R3.6: Section 4.1: Also, this section seems a bit out of place to me, since I think that the "Results" section should reflect the results of the methods that the authors employed. I think this section may be a perfect follow-up for Section 2.6, scaling down from an introduction to the region to the actual sites that have been investigated in this research.

A3.6: Thank you for your valid comment. This section is primarily based on the cited literature, with only a few minor observations. We therefore agree to move this section to chapter 2.7 of the study site, so that the reader can concentrate on the findings of the study in the results chapter.

References:

Chepstow-Lusty, A. J., Frogley, M. R., Bauer, B. S., Leng, M. J., Cundy, A. B., Boessenkool, K. P., and Gioda, A.: Evaluating socio-economic change in the Andes using oribatid mite abundances as indicators of domestic animal densities, Journal of Archaeological Science, 34, 1178–1186, https://doi.org/10.1016/j.jas.2006.12.023, 2007.

Handley, J., Branch, N., Meddens, F. M., Simmonds, M., and Iriarte, J.: Pre-Hispanic terrace agricultural practices and long-distance transfer of plant taxa in the southern-central Peruvian Andes revealed by phytolith and pollen analysis, Vegetation History and Archaeobotany, https://doi.org/10.1007/s00334-023-00946-w, 2023.

Soßna, V.: Climate and settlement in southern Peru: the northern Río Grande de Nasca drainage between 1500 BCE and 1532 CE, Dr Ludwig Reichert, 2015.