**Response to the reviewers**

Manuscript: "Soil health-based business models: value perspectives and policy implications"

Dear Editor and Reviewers,

We sincerely thank both reviewers for their careful and constructive assessments. Their comments helped us sharpen the manuscript's conceptual positioning, clarify its terminology and connect the proposed value perspectives more explicitly to the soil security literature. We have made targeted revisions while preserving the manuscript's original structure, argument and policy focus.

The principal revisions are as follows:

- We now define field-scale soil health in relation to the condition dimension of soil security and position the framework as a contribution to the capital dimension.
- We explicitly identify Total Economic Value (TEV) as a policy-relevant but non-neutral framework rooted in neoclassical environmental economics.
- We clarify that TEV can organise distinct value dimensions without requiring their aggregation into a single monetary value.
- We define insurance value more precisely and explain resilience as the temporal dimension of future production and ecosystem-service delivery.
- We distinguish anthropocentric non-use value from intrinsic value independent of human preferences.
- We substantially strengthen the social perspective by addressing labour, power, tenure, dispossession, distribution and the risks associated with market-based environmental instruments.
- We add spatial soil-capital assessment and the genosoil–phenosoil comparison as examples of operationalisation, while clarifying that these tools cannot measure all six perspectives.

Below we respond point by point. All additions and replacements in the revised manuscript are shown in blue to facilitate review.

**Reviewer 1**

We thank Reviewer 1 for challenging the manuscript's theoretical assumptions and for drawing attention to the differences between neoclassical environmental economics and political economy. These observations led to major revisions in Sections 2 and 3.

**Comment 1: The framework disguises neoliberal assumptions about value**

Reviewer comment: The paper appears to take a neoliberal perspective for granted, particularly by translating different soil values into prices and tradable exchange values. Market instruments such as carbon credits may produce technically deficient outcomes and harm local communities.

Response: We agree that the original manuscript did not state its theoretical position clearly enough. We now identify TEV explicitly as rooted in neoclassical environmental economics and acknowledge that its use of willingness to pay and market-compatible concepts is neither neutral nor exhaustive. We retain TEV because it is influential in environmental finance, stewardship policy and investment design. However, we clarify that it is used as a structured policy vocabulary rather than as a complete account of soil value. We also add a political-economy boundary condition: market valuation must be complemented by attention to rights, labour, power, tenure and distribution.

Revision in the manuscript: A short methodological clarification has been added to the opening of Section 2. The social perspective now states that soil values are co-produced through inherent properties, human labour, management history and institutions, and acknowledges unequal ownership, enclosure, colonial dispossession and contemporary land appropriation. In Section 3, the Kariba REDD case suggested by the reviewer is cited to illustrate why market-based projects require safeguards against restrictions on customary land uses and inequitable benefit distribution.

**Comment 2: Aggregation into an overall output value**

Reviewer comment: The manuscript appears to assume that qualitatively different values can be aggregated into an overall output value, although this is highly questionable.

Response: We agree that aggregation into a single monetary measure is contested and should not be assumed. Our intention is to use TEV as an organising vocabulary, not to claim that all value dimensions are commensurable or should be collapsed into one figure.

Revision in the manuscript: The introduction and Section 2 now state explicitly that the framework identifies distinct value claims and that TEV neither requires nor justifies their aggregation into one monetary figure. Section 3 further clarifies that standardisation does not make carbon, biodiversity, water and social values fully substitutable.

**Comment 3: Insurance value is insufficiently defined**

Reviewer comment: “Insurance value” is introduced without a proper definition, and the verb “reflect” does not explain the relationship between soil condition and this value.

Response: We agree and have replaced the vague formulation with a precise definition grounded in the cited environmental-economics literature.

Revision in the manuscript: Section 2 defines insurance value as “the value of maintaining soil’s capacity to continue delivering production and ecosystem services under uncertainty and disturbance.” The policy discussion then connects this capacity directly to the potential losses faced by farmers, lenders, insurers, processors and the public.

**Comment 4: Use value and non-use value conflict with political-economy terminology**

Reviewer comment: The manuscript’s use of “use value” and “non-use value” conflicts with established meanings in classical political economy and is therefore confusing.

Response: We appreciate this terminological warning. We have retained the terms because they are standard categories within TEV, but we now flag explicitly that their meaning differs from classical political economy. This clarification prevents readers from interpreting the categories through an incompatible conceptual tradition.

Revision in the manuscript: At the beginning of Section 2, we explain that TEV use value covers benefits obtained through direct, indirect or possible future use and is commonly expressed through willingness to pay. We simultaneously acknowledge that this is a specific neoclassical convention rather than a universal definition of value.

**Comment 5: Resilience is a temporal dimension, not a separate value category**

Reviewer comment: The resilience perspective mainly concerns future productivist or ecosystem-service values and should not be presented as fundamentally different from those categories.

Response: We agree with the conceptual point. The revised manuscript now explicitly describes resilience as a temporal property of productivist and ecosystem-service values. We nevertheless retain it as a separate perspective because doing so makes uncertainty, discounting, contract duration and long-term stewardship visible as distinct policy problems. Integrating it entirely into the first two perspectives would obscure these issues.

Revision in the manuscript: A clarifying passage has been added to the existing resilience perspective stating that resilience is primarily a temporal dimension of productivist and ecosystem-service values. We explain that it is retained separately to make uncertainty, discounting and long-term stewardship visible as policy concerns. Table 1 has been adjusted accordingly, while the original policy discussion has been retained.

**Comment 6: Non-use value versus intrinsic value; use of “warm-glow”**

Reviewer comment: The distinction between non-use and intrinsic value is unclear. The term “warm-glow” may sound dismissive or imply that the value is naïve or disposable.

Response: We agree that the original text did not make the distinction sufficiently clear. Non-use value remains anthropocentric: it concerns the value people attach to existence or preservation independently of their own use. Intrinsic value attributes moral worth to soil and its living community independently of human preferences. Although “warm-glow” is an established technical term in behavioural and environmental economics, we removed it from the revised manuscript to avoid an unintended dismissive connotation and because it was not essential to our argument.

Revision in the manuscript: Section 2 and Table 1 now use the clearer language of existence and preservation values. Section 3 distinguishes public expenditure and intergenerational protection based on non-use preferences from duties and ecological limits based on intrinsic value.

**Comment 7: Human labour, power relations and dispossession**

Reviewer comment: The social perspective should begin from the role of past, present and future human labour and should recognise power relations, enclosure, colonial dispossession and the rift in the metabolic relation between humans and nature.

Response: We agree that the social perspective was underdeveloped. We have expanded the existing paragraph while retaining its original focus. It now treats social and political conditions as a necessary boundary to economic valuation and emphasises that soil value is co-produced through inherent properties, labour, management history and institutions.

Revision in the manuscript: The existing social perspective now recognises inherent soil properties, past and present labour, management history and institutions, as well as unequal ownership, enclosure, colonial dispossession and contemporary land appropriation. The policy paragraph retains its focus on empowerment, tokenism and institutional support, while adding tenure security, bargaining power, transaction costs and benefit sharing.

**Reviewer 2**

We thank Reviewer 2 for identifying the manuscript's potential contribution to the soil security framework and for suggesting practical pathways towards measurement and spatialisation. These suggestions significantly strengthened the paper's positioning.

**Comment 1: Clarifying soil health versus soil condition**

Reviewer comment: "Soil health" lacks a globally agreed definition and is measured inconsistently. The manuscript should relate soil health to the condition dimension of soil security and explain how field-scale improvements connect to regional and national challenges.

Response: We agree. We retain "soil health" in the title and the SHBM terminology because the paper focuses on field-scale management incentives and addresses practitioners and policymakers already using that language. However, the revised manuscript no longer treats soil health as a self-sufficient policy concept. It explicitly anchors soil health in the condition dimension of the broader soil security framework.

Revision in the manuscript: A concise clarification has been added to the introduction explaining that field-scale soil health corresponds primarily to the condition dimension of soil security, which also includes capability, capital, connectivity and codification. The passage cites McBratney et al. (2014, 2026) and Evangelista et al. (2024). The term "soil health" is otherwise retained throughout to preserve the manuscript's focus and accessibility.

Comment 2: Reframing the contribution around soil capital

Reviewer comment: The paper's strongest contribution may be to the capital dimension of soil security. Its six perspectives could translate soil functions, services and threats into economic terms and support treatment of soil as an appreciating or depreciating natural asset.

Response: We appreciate this reframing and have adopted it as a central contribution. At the same time, we avoid renaming SHBMs as Soil Security Business Models because the manuscript remains focused on business models and incentives linked to field-scale soil management. Instead, we position the six perspectives as a way of adding economic and institutional content to the capital dimension within the wider soil security framework.

Revision in the manuscript: The final sentences of the introduction and the final paragraph of section 2 now explain that the framework contributes to the capital dimension by clarifying how soil as a stock creates different flows of value and may appreciate or depreciate through management. A corresponding sentence has been added to the conclusion, noting that the wider soil security framework prevents capital valuation from becoming the sole account of what soils are and why they matter.

Comment 3: Quantifying and spatialising soil capital

Reviewer comment: The manuscript should incorporate practical methods for measuring and spatialising the perspectives, including pixel-level soil-capital assessment and comparisons between genosoils and phenosoils.

Response: We agree that these approaches demonstrate how parts of the framework can become operational. In keeping with the manuscript's perspective format and word limit, we introduce them as illustrative methods rather than attempt a complete spatial assessment protocol. We also clarify their limits: spatial monetary estimates can operationalise selected functions, services and threats but cannot fully measure intrinsic or social value.

Revision in the manuscript: One short paragraph has been added at the end of Section 2. It cites Francos et al. (2024) on spatial estimates of soil management capital and Román Dobarco et al. (2023) on genosoil–phenosoil mapping. It identifies pH-regulation costs, nutrient stocks and available water capacity as examples of measurable indicators and states that these methods should complement rather than replace plural indicators and public deliberation. A full spatial assessment methodology remains beyond the scope and word limit of this perspectives paper.

**Closing statement**

We again thank the Editor and both Reviewers for their thoughtful engagement. We believe these targeted revisions make the manuscript more conceptually transparent, better connected to contemporary soil-security scholarship and more attentive to the political and distributional limits of economic valuation, while preserving its original argument and structure. We hope that the revisions address the concerns raised and make the paper suitable for publication in SOIL.

Sincerely,

Erik Mathijs and Kato Van Ruymbeke