

Response to **Reviews of “Positive tipping points for accelerating adoption of regenerative practices in African smallholder farming systems: What drives and sustains adoption.”**

Dear Editor

We thank you for considering our manuscript and the two reviewers for their positive and constructive feedback. We have made several revisions to the manuscript to incorporate their suggestions and provide our point-by-point responses below.

We have put significant further thought into addressing Reviewer 1’s seven remaining concerns. We acknowledge that there had been insufficient clarity and signposting in the various parts. We have revised our manuscript and included new and revised text to improve clarity, better introduce and link the material. Our point-by-point response is provided below.

We thank Reviewer 2 for their positive endorsement of our study and their insightful suggestions to improve the manuscript. We have fully incorporated the suggestions in the revised manuscript and provide a detailed explanation of how we have addressed them below.

In our responses below, the reviewers’ comments are in plain black text and our responses in blue text, with quoted additions to the manuscript in italic text. All line numbers refer to the revised manuscript without tracked changes.

Thank you again for your consideration of our manuscript. We look forward to hearing from you.

Your sincerely,

Antony Philip Emenyu

Reviewer 1

Abstract:

‘We present three key insights’ sounds as if those insights were an outcome of the paper. However, these insights are exactly the outcome of Moore’s article. What is the new insight here?

Response 1: Thank you for this critical observation. Since Moore’s article is one of our key building blocks, we embrace its observations and build on them in this paper. We have revised our abstract and conclusion to more clearly articulate how we build on Moore’s work leading to our new conclusions that extend this discourse. To articulate the conclusion from Moore et al., in lines 7-9 in the abstract we write, “*Moore et al. (2015) contended that scaling up, out and deep is essential for wide scale system change but identified a gap in understanding of how to achieve the three-way scaling goal let alone achieve it quickly*”. From lines 12-18 we present our own unique conclusions when we write, “*We present three key insights: (1) it is essential to work with centrally positioned actors capable of and motivated to influence changes in policy and norms towards scaling the intervention such as the smallholder farmers for TIST; (2) these different dimensions of scaling continuously interact, influenced by feedback loops. For sustained scaling it is key to create enabling conditions to trigger reinforcing feedbacks, and; (3) The rate of scaling is a factor of the reinforcing feedbacks at play in a particular location. Therefore, identification of these feedbacks and the appropriate leverage points is key to address location specific scaling challenges thus emphasising the need for context specific data*”.

The revised abstract now reads,

“Mass adoption of regenerative agriculture (RA) practices could improve the resilience and increase productivity of African smallholder farming systems in the face of growing climate change pressures. However, mechanisms to rapidly and sustainably scale-up these RA practices are not yet well understood. Recent research suggests that rapid system transitions towards sustainable practices such as RA can be driven by amplifying feedback loops and if these are sufficiently strong, the system could reach a tipping point of self-propelling change. Moore et al. (2015) contended that scaling up, out and deep is essential for wide scale system change but identified a gap in understanding of how to achieve the three-way scaling goal let alone achieve it quickly. To address this gap, we combine Lenton et al. (2022)’s framework for operationalising positive tipping points with Moore et al. (2015)’s conceptualisation of scaling to understand triggers for rapid scaling in the case of The International Small group and Tree planting programme(TIST) in East Africa. We present three key insights: (1) it is essential to work with centrally positioned actors capable of and motivated to influence changes in policy and norms towards scaling the intervention such as the smallholder farmers for TIST; (2) these different dimensions of scaling continuously interact, influenced by feedback loops. For sustained scaling it is key to create enabling conditions to trigger reinforcing feedbacks, and; (3) The rate of scaling is a factor of the reinforcing feedbacks at play in a particular location. Therefore, identification of these feedbacks and the appropriate leverage points is key to address location specific scaling challenges thus emphasising the need for context specific data”.

The introduction has been clearly improved. Especially the connection between the Moore and the Lenton framework is now clear. However, the positive tipping process by Lenton is not introduced in the revised version. Fig 1 does not really show the elements of a tipping process and a reader without previous knowledge about social tipping will not understand the connection between Fig 1 and Lenton’s framework. For example, the connection between enabling conditions and Lenton’s framework is not described in the text. Social tipping needs a clear introduction.

Response 2: Thanks for pointing out this observation. We have added the following text in the last introduction paragraph (from lines 72 – 81) to introduce the positive tipping points elements, “*This framework proposes that under certain enabling conditions, some actions can trigger rapid and self-propelling adoption of sustainability innovations driven by reinforcing feedback processes in social-technological or social-ecological systems (Lenton et al., 2022). Economic competitiveness, performance and accessibility of innovations to users, the prevailing cultural and social norms and users’ capability can all be key enabling conditions for systemic tipping points, and will vary according to context. Reinforcing feedback processes that may drive scaling of adoption include*

social contagion, increasing returns to adoption, network effects, information cascades, percolation, co-evolution, ecological positive feedbacks, and social-ecological positive feedbacks. Key intervention areas to strengthen reinforcing feedbacks or create enabling conditions include policy and regulation, private finance and markets, innovation and technology, education and information, behavioural nudges and monitoring and accountability mechanisms”.

The entire paragraph now reads,

“In this paper, we draw on the framework for operationalisation of positive tipping points proposed by Lenton et al. (2022) to explore enablers and processes that could accelerate scaling.

This framework proposes that under certain enabling conditions, some actions can trigger rapid and self-propelling adoption of sustainability innovations driven by reinforcing feedback processes in social-technological or social-ecological systems (Lenton et al., 2022). Economic competitiveness, performance and accessibility of innovations to users, the prevailing cultural and social norms and users’ capability can all be key enabling conditions for systemic tipping points, and will vary according to context. Reinforcing feedback processes that may drive scaling of adoption include social contagion, increasing returns to adoption, network effects, information cascades, percolation, co-evolution, ecological positive feedbacks, and social-ecological positive feedbacks. Key intervention areas to strengthen reinforcing feedbacks or create enabling conditions include policy and regulation, private finance and markets, innovation and technology, education and information, behavioural nudges and monitoring and accountability mechanisms. We combine theories of scaling and the Positive tipping points framework to explore the adoption of RA in sub-Saharan Africa.

Specifically, we examine Moore et al.’s three dimensions of scaling to identify the potential role of feedbacks between the spread of adoption between individuals, changes in governance and institutions, and changes in culture, values, and behavioural norms. We draw on literature from various regenerative farming interventions across Africa, using The International Small group and Tree planting programme (TIST) in East Africa as a case study”.

Figure 1 was design to illustrate the interaction between the reinforcing feedback loops and the dimensions of scaling rather than the various elements in the framework for operationalisation of tipping points. For this reason, we thought introducing the tipping elements in the figure could potentially dilute our intended message.

Amplifying feedback are adopted from Lenton et al (2022) who use the term ‘reinforcing feedbacks’ and include social contagion, increasing returns to adoption, network effects, information cascades, percolation, co-evolution, ecological positive feedbacks and social-ecological positive feedbacks.

Why do the authors here only include social contagion and social-ecological feedback in Fig 1?

Response 3: Social contagion and social-ecological feedbacks were introduced here only as examples of possible reinforcing feedbacks. Since we have now introduced multiple reinforcing feedbacks in the previous paragraph, we have omitted the examples from the diagram to minimise chances of possible miss-interpretation (see the revised Figure 1 below).

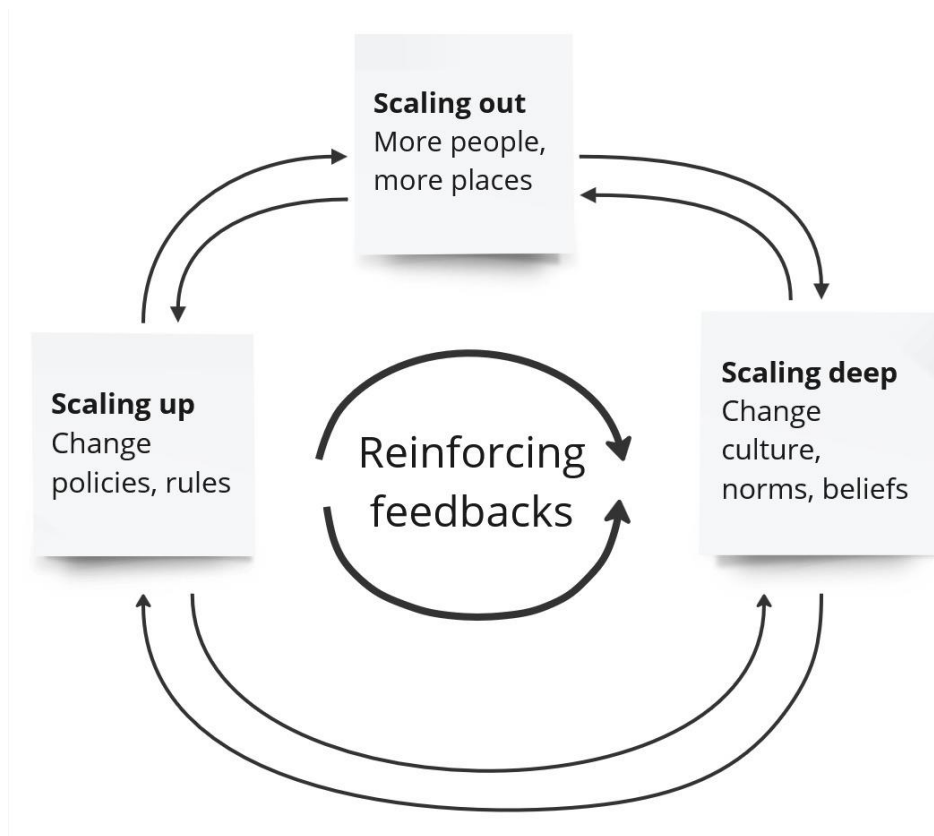


Figure 1. The interaction between the different dimensions of scaling driven by reinforcing feedback processes. Different reinforcing feedback processes can be involved at one time. The reinforcing feedback processes act within and across multiple spatial scales (from local, national to international) and influencing changes to the scaling within and across those levels in the process.

The section ‘enabling conditions’ needs an introductory sentence. Now, the different parts seem like a random list of terms and it is unclear that cost, desirability etc are subsections to ‘enabling conditions’.

Response: We have taken note and introduced a few sentences (lines 118-128) to introduce the section under the heading “**Enabling conditions and feedback processes for successful adoption of RA in Africa**” in line 114. In lines 115 – 125 we write, “*Enabling conditions are thresholds in system parameters such that small further interventions may trigger rapid, self-propelling change. For example, if an innovation outperforms the incumbent system on key metrics (price, labour costs etc.), adoption is more likely to become self-propelling. Some of these conditions relate to the innovation itself, such as price and quality. These can be partly addressed at the design stage, but may also be affected further by system dynamics including feedbacks (e.g. prices may be lowered and quality improved through increasing returns to adoption) . Others such as complementarity and performance, desirability and symbolism, accessibility and convenience, information and social networks depend on how the innovation fits within the environment in which it is to be implemented (Lenton et al., 2022). These conditions are highly dynamic, continuously adjusting in response to the actions taken and the feedback processes triggered and modifying the intervention environment. To keep up with these dynamics, implementors have to be highly proactive and adaptive in their response*”.

Regarding response 6: I cannot see any figure that substitutes the original fig. 2.

‘Enabling conditions and amplifying feedback processes in the scaling of TIST’: The authors only provide details about TIST regarding the enabling conditions that were introduced before. How is this linked to amplifying feedbacks?

Fig 3: The examples the figure provides as ‘interventions to amplify feedbacks’ are examples of ‘enabling conditions’, not amplifying/reinforcing feedbacks following Lenton et al (2022).

Response 5: Thanks for the critical observation in Figure 3. We have reviewed the initial heading in

the figure from “Interventions to amplify feedbacks” to “Enabling conditions and linked TIST interventions”. We feel that this also benefits from the introduction of positive tipping elements as you suggested previously. Please see the revised Figure 3 below.

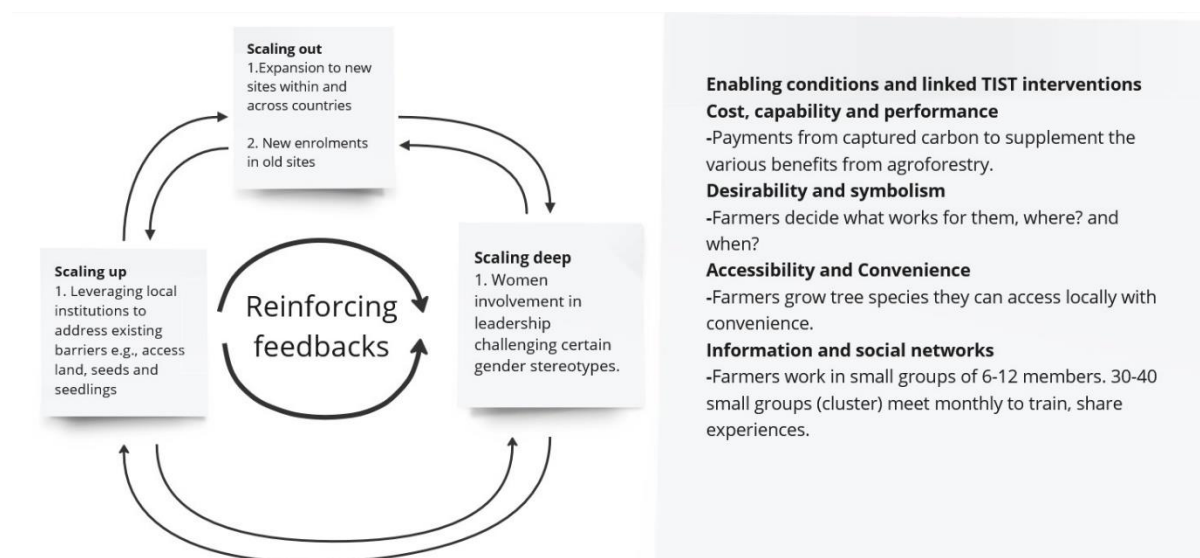


Figure 3. TIST scales up, deep, and out in multiple ways. The interventions activate and contribute to the amplification of feedback processes that drive scaling out, up and deep and the interaction between them.

Why is Fig 4 necessary and how does it link to the focus of the study? ‘Crop diversification’ or ‘carbon finance’ appear in the figure without any contextualization in the main text.

Response 6: Figure 4 illustrates the various pathways in TIST that lead to accumulation of benefits and encourage continued participation. We have introduced the figure in lines 280-283 when we write, “The subsequent section then explains the mechanisms through which these enabling conditions result in scaling with Figure 4 illustrating the interconnected and mutually reinforcing membership benefits which have potential to drive strong feedbacks”. We further reference the Figure in line 305 when we write, “This reduction in cost alongside other ecological and social-ecological reinforcing feedback processes leads to accumulation of benefits thus increasing the returns to participation (See Figure 4)” (lines 303-305).

Response 8 is insufficient. If Fig 4 was developed by the authors, it needs to be better described where, why, with whom etc. From the figure capture I take that it is a reproduction from another study. What’s the benefit of reproducing the figure here, especially as it is not properly explained and contextualized in the main text.

Response 7: The section under which Figure 4 is presented discusses how the high benefit to cost ratio in TIST encourages continued participation in the program. Figure 4 illustrates the various pathways through which members could benefit from their participation. In this sense we think the figure adds depth to the discussion in this section, especially given the improved sign posting.

The Figure 4 was reproduced from Figure 4.3.11 in Powell et al. which illustrates the mutually reinforcing feedback processes linked to the benefits of TIST (our specific study case) and has been adapted here to provide similar insights to the reader.

To appropriately signpost figure 4, in the introductory paragraph to the section, lines 280 – 283, we first introduce the figure when we write, “The subsequent section then explains the mechanisms through which these enabling conditions result in scaling with Figure 4 illustrating the interconnected and mutually reinforcing membership benefits which have potential to drive strong feedbacks”. From lines 303 – 305 we link the figure in our discussion of the link between reinforcing feedbacks and TIST benefits when we write, “This reduction in cost alongside other ecological and social-

ecological reinforcing feedback processes leads to accumulation of benefits thus increasing the returns to participation (See Figure 4)”.

See figure 4 and caption below.

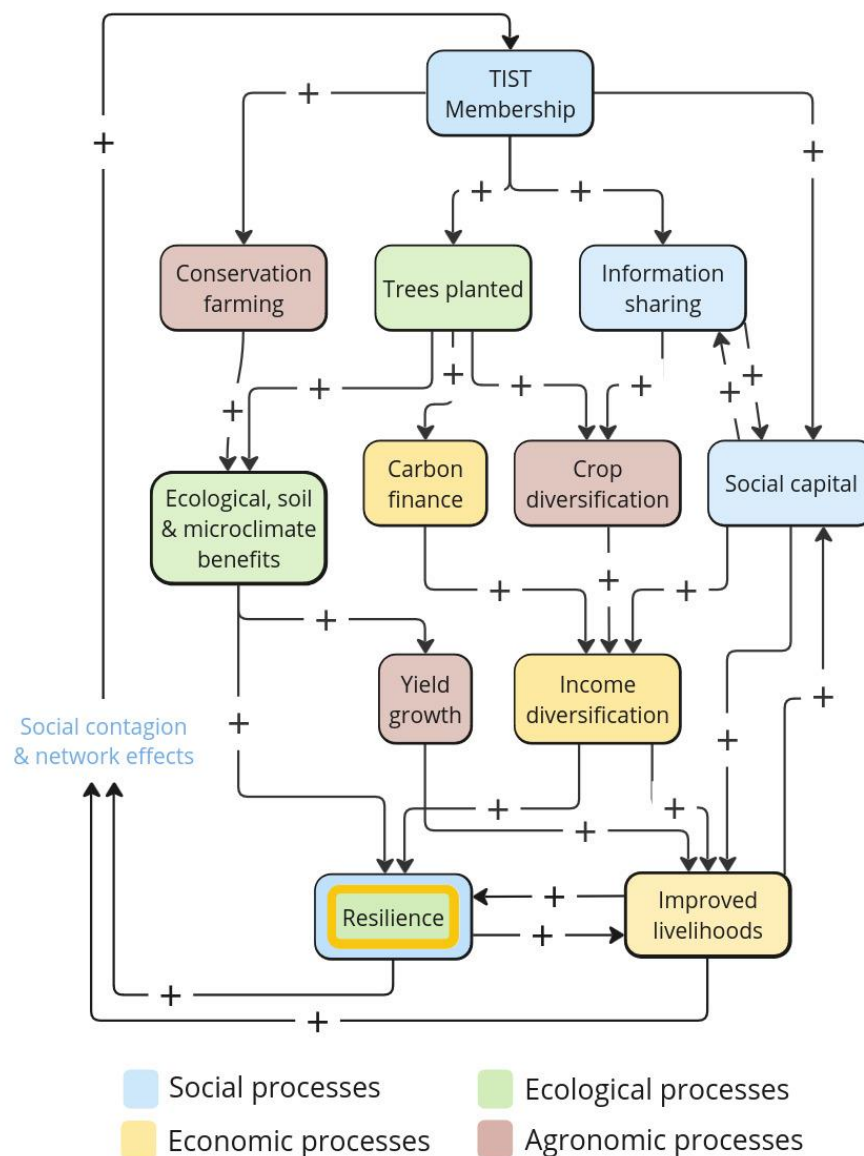


Figure 4. Mutually reinforcing benefits evidenced in the literature are likely to strengthen feedbacks and increase the likelihood of further adoption of TIST at community level. Conservation agriculture and agroforestry improve soil ecological functioning and contribute to improved and more stable yields (Rehberger et al., 2023), while the various tree products along with carbon finance contribute to income diversification and improved livelihoods (Benjamin et al., 2018). Through working in groups, there is better information sharing which in-turn builds and reinforces the social capital. Strong and visible benefits to individual farmers or small groups are more likely to feedback on adoption rates through social contagion. Reproduced from Figure 4.3.11 in Powell et al. (2023, p. 43).

Reviewer 2

In the Section “Enabling conditions and feedback processes for successful adoption of RA in Africa” I miss a framing or explanation of the sub categories presented. It is not entirely clear to me where the

categories come from and what decision led to combining some of the categories. I would suggest adding 1 or 2 sentences on this in the introductory paragraph of this section.

Response 8: Thank you for this critical observation and suggestion. We have taken note and introduced a few sentences (lines 115-125) to introduce the section under the heading “**Enabling conditions and feedback processes for successful adoption of RA in Africa**” in line 114. In lines 115 – 125 we write, “*Enabling conditions are thresholds in system parameters such that small further interventions may trigger rapid, self-propelling change. For example, if an innovation outperforms the incumbent system on key metrics (price, labour costs etc.), adoption is more likely to become self-propelling. Some of these conditions relate to the innovation itself, such as price and quality. These can be partly addressed at the design stage, but may also be affected further by system dynamics including feedbacks (e.g. prices may be lowered and quality improved through increasing returns to adoption) . Others such as complementarity and performance, desirability and symbolism, accessibility and convenience, information and social networks depend on how the innovation fits within the environment it is to be implemented (Lenton et al., 2022). These conditions are highly dynamic, continuously adjusting in response to the actions taken and the feedback processes triggered and modifying the intervention environment. To keep up with these dynamics, implementors have to be highly proactive and adaptive in their response*”.

In line 136-139 provided a few sentences to explain our logic for combining a few categories and write, “*To realistically illustrate the relational dynamics between some of the contextual factors, we have merged certain enabling conditions in the subsequent discussions. Based on this logic resulting categories include cost, performance and capability, desirability and symbolism, accessibility and convenience, information and social networks*”.

The Section “Scaling TIST” consists only of a figure without text. An explanatory text would be helpful here. For example, it is not entirely clear to me how exactly this figure was created and how it is connected to the previous and subsequent sections. In your response to one of my earlier comments, you write, “Under the section of Scaling TIST, we present a TIST-focused adaptation of the conceptual framework introduced in the section on conceptual framing. We then follow through with explanation of the enabling conditions and amplifying feedback potentially contributing to the observed scaling pattern of TIST.” It would be nice if a similar description, perhaps even more detailed, could be found in the respective section of the manuscript explaining the points above.

Response 9: Thank you again for this critical observation and suggestion. From line 279-283, just after the heading “Scaling of TIST” (Line 278), we have added a few sentences to explain Figure 3 and also introduce the rest of the sections that follow. From line 279-283 we write, “*Here we apply the conceptual framework introduced to identify key features of TIST’s success in scaling. In Figure 3, we adapt Figure 1 to illustrate the enabling conditions specific to TIST. The subsequent section then explains the mechanisms through which these enabling conditions result to scaling with Figure 4 illustrating the reinforcing feedbacks linked to membership benefits*”.