CABI Agriculture and Bioscience

COMMENTARY

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Transformative adaptation: from climate-smart to climate-resilient agriculture

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Abstract

In response to the climate crisis, there has been much focus on climate-smart agriculture (CSA); namely, technologies and practices that enhance adaptation, reduce greenhouse gas emissions, and contribute to food security; the so-called triple win. Success has tended to be measured in terms of the number of farmers adopting CSA with less focus given to the impacts especially on human development. CSA can inadvertently lead to 'maladaptation' whereby interventions reinforce existing vulnerabilities either by benefitting powerful elites or by transferring risks and exposure between groups. Such maladaptive outcomes often stem from overly technical adaptation programming that is driven by external objectives and discounts the social and political dynamics of vulnerability. Increasingly a more nuanced picture is emerging. This reveals how a failure to contextualize CSA in relation to the structural socio-economic dynamics associated with agricultural systems that render some categories of farmer especially vulnerable to climate change, undermines CSA's contribution to reducing rural poverty and increasing equity. In response, there is a growing focus on transformative orientations that pursue a more deep-seated approach to social, institutional, technological and cultural change in order to address the structural contributors to vulnerability and differential exposure to climate risk. Addressing these questions requires a robust consideration of the social contexts and power relations through which agriculture is both researched and practiced. For agriculture to be transformative and contribute to broader development goals, a greater emphasis is needed on issues of farmer heterogeneity, the dangers of maladaptation and the importance of social equity. This entails recognizing that resilience encompasses both agro- and socio-ecological dimensions. Furthermore, practitioners need to be more cognizant of the dangers of (i) benefiting groups of already better off farmers at the expense of the most vulnerable and/or (ii) focusing on farmers for whom agriculture is not a pathway out of poverty. The success of these approaches rests on genuine transdisciplinary partnerships and systems approaches that ensure adaptation and mitigation goals along with more equitable incomes, food security and development. The greater emphasis on social equity and human well-being distinguishes climate-resilient from climate-smart agriculture.

Keywords Transformative adaptation, Climate-smart agriculture, Climate-resilient agriculture, Resilience, Adaptive capacity, Transdisciplinary networks, Inter-disciplinary research

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Background

The agricultural sector is at the forefront of the climate crisis in terms of being a significant source of greenhouse gas emissions while also being adversely impacted by rising temperatures, droughts and floods. Much agricultural research seeks to mitigate the impacts of climate-related risk and to enhance resilience in the face of climate variability and extremes. One area of focus has been the development and scaling of climate-smart agriculture (CSA) that reduce greenhouse gas emissions, enhance adaptation, and contribute to food security, the triple win (Lipper et al. 2014). CSA encompasses a broad array of agricultural technologies and practices, including: stress-adapted crop germplasm e.g. drought-tolerant maize varieties; conservation agriculture (Andersson and D'Souza 2014); agroforestry (Coe et al. 2014); and soil and water conservation (Partey et al. 2018). Once the seemingly correct technologies and management practices are identified, then the challenge comes to scale them up through widespread dissemination among target populations (Westermann et al. 2018), a challenge that has been readily taken up by international organizations such as the Food and Agriculture Organization (FAO) and numerous NGOs (FAO 2019).

Parallel to this emphasis on adaptation through climate-smart agriculture, the Intergovernmental Panel on Climate Change (IPCC) Working Group 2 report, Climate Change 2022: impacts, Adaptation and Vulnerability highlights the danger that climate responses can inadvertently lead to detrimental impacts upon vulnerable groups (IPCC 2022). Echoing an older literature on the unintended consequences of development (Long and Long 1992). Recent scientific studies refer to this outcome as 'maladaptation' (Schipper 2022; Eriksen et al. 2021). Climate adaptation projects can reinforce existing vulnerabilities either by promoting adaptation interventions that benefit powerful elites or by transferring risks and exposures between groups rather than alleviating them (Blythe et al. 2018; Schipper 2020). In other cases, actions undertaken in the name of adaptation create new risks and sources of vulnerability, often by neglecting the unintended outcomes of project activities (IPCC 2022; Eriksen et al. 2021). Such maladaptive outcomes often stem from overly technical adaptation programming that is driven by outside objectives and knowledge and insufficiently considers the social and political dimensions of vulnerability (Schipper 2020).

There is much literature that heralds the success of CSA, but the focus has tended to be on the climate change adaptation and mitigation benefits to agriculture rather than those related to human development (Hellin and Fisher 2019). Across the various institutional discourses and narratives around CSA, there is seldom sufficient emphasis on societal concerns, including attention to social norms or issues of inequality, power and justice (Karlsson et al. 2018; Taylor 2018; Chandra et al. 2017) and the types of farmers who many benefit from agricultural interventions at the expense of more vulnerable and marginalized farmers (Hellin and Fisher 2019). The climate response has tended to be primarily technical in nature based on the premise that the climate challenge can best be resolved through the application of expert knowledge. CSA has typically been portrayed as a process of identifying and disseminating improved technologies and practices that can simultaneously advance the aforementioned triple-win goals, especially adaptation and mitigation. Pointedly, it is precisely this notion of advanced technical innovation that provides the basis for putting the 'smart' in climate-smart agriculture.

Increasingly a more nuanced picture is emerging, one that demonstrates that a failure to contextualize CSA in relation to the structural socio-economic and power dynamics associated with agricultural systems, which render some categories of farmer especially vulnerable to climate change, undermines CSA's contributions to reducing rural poverty and may increase inequalities (Karlsson et al. 2018). Resilience encompasses both agro- and socio-ecological dimensions and can be enhanced by embedding social equity in agricultural interventions. There is a need for transformative orientations that better incorporate social analysis and that foreground social equity concerns (Hellin et al. 2022). This new emphasis typically argues for adaptation initiatives to pursue a more deep-seated approach to social, institutional, technological and cultural change in order to address the structural contributors to vulnerability and differential exposure to climate risk. Such approaches empower the effected communities (Kinley 2017; Ajulo et al. 2020). Addressing these questions requires a robust consideration of the social contexts and power relations through which agriculture is both researched and practiced.

In our view, it will be impossible to create transformative change without bringing social equity issues to the fore and tackling the issues of power relationships and decision-making within agricultural development. The aforementioned IPCC report (IPCC 2022) highlighted this with its emphasis on transformative adaptation and the need to tackle the root causes of vulnerability to climate change. The greater emphasis on social equity and human well-being distinguishes climate-resilient from climate-smart agriculture. Transdisciplinary partnerships and systems approaches are needed to realize climate-resilient agriculture and ensure that agricultural interventions achieve adaptation and mitigation goals along with more equitable incomes, food security and development.

In this Commentary, and based on our experiences from South Asia, Sub-Saharan Africa and Latin America, we elaborate on these themes and demonstrate their importance for reorienting the climate response from climate-smart to climate-resilient agriculture. The following section on a more nuanced approach to determining success and failure highlights the danger of maladaptation and benefiting groups of already better off farmers at the expense of poorer and more vulnerable farmers. The section on farmers' livelihood trajectories then highlights that for some farmers agriculture is unlikely to be a pathway out of poverty. This means that agricultural interventions need to be better targeted. Finally, the section on climate-resilient agriculture unpacks the word 'resilience', and argues that pathways to climate-resilient agriculture rest on researchers and practitioners applying a social equity lens to agricultural research and development.

A more nuanced determination of 'success' and 'failure'

A conspicuous feature of much institutional promotion of CSA has been the reliance on a 'success story' approach to identifying and scaling up valued innovations. Many of these success stories stem from farm-level interventions. The literature on CSA is replete with accounts of success stories, often a list of anecdotes of successful innovations that are held to exemplify the virtues of CSA and establish its practicality on the ground (FAO 2013). One of the drawbacks of an anecdotal approach promoting 'what works' is that it reduces reflection and learning from nuanced experience, or indeed from robust research, often downplaying failure and limitations.

In-depth studies typically demonstrate a more nuanced pattern of success and failure (Taylor and Bhasme 2021; Glover et al. 2021; Clay and Zimmerer 2020). A good example is the controversy around the virtues (or otherwise) of conservation agriculture and smallholder farming in Africa (Giller et al. 2009). Despite this, agricultural research often continues to be predicated upon determining 'what works' as a largely frictionless, technical process of applying scientific methods to determine superior technologies and practices, and then scaling them. The trouble with this notion is that the question of 'what works' needs to be complemented with other questions, i.e. 'what works, for whom, in what social and agro-ecological conditions, and according to whose criteria' (Sumberg 2017). Indeed, the issue of 'what works' is highly context-specific, both spatially and temporally. Even within superficially homogenous farming populations, social distinctions and hierarchies across such target populations greatly shape farmers' differential ability to successfully adopt CSA.

The question of 'what works' is also power-laden, flowing from particular interpretations on the role of human agency in environmental change (Leach et al. 2015) As Huff and Naess (2022, p. 7) note "*'Solutions' based in control and scaling-up technical interventions can obscure latent possibilities and alternative pathways, hiding contestation and power relations. This can close down spaces for debate and 'lock in' a single pathway as if it were the only possible course of action*". In effect, received wisdom on climate change shapes the framing of problems and solutions, obscuring plurality and carrying the danger of flawed policy prescriptions (Leach and Mearns 1996). In contemporary terminology, such flaws can stimulate 'maladaptation'.

A fundamental issue with CSA interventions is that often they underplay social distinctions and divisions within target populations, coupled with how these divisions are underpinned by inequalities bound to local power relations. Indeed, the extent to which interventions like CSA reflect and meet the priorities and needs of diverse farming populations is often ignored (Glover et al. 2016; Kyeyune and Turner 2016). What is often missing is how any given technology can be practically incorporated into farmers' practices and farm-level realities within diverse farming systems, including both agronomic and social dimensions (Sinclair and Coe 2019). Using a new technology can have unintended impacts upon other aspects of farm management, including a loss of flexibility within cross-farm or cross-seasonal cultivation strategies and their associated divisions of labor (Vanclay and Lawrence 1994). Research needs to identify the opportunities and constraints smallholders face in synergizing CSA within their wider cropping systems (Coe et al. 2019). Socio-economic differences in access to inputs including land, labor, water, and credit can create sharply diverging—and gendered—farmers' experiences and impacts (Cavanagh et al. 2017).

We have direct experience from South Asia and Latin America of these diverging, gendered and inequitable outcomes and impacts. In one case in southern India (Taylor and Bhasme 2021), a program to expand rainwater harvesting empowered more affluent farmers by building infrastructure on their strategically-placed land. These farmers were able to diversity into higher value vegetable crops while simultaneously selling water to less affluent farmers for a third of their final crop (a form of sharecropping based on water not land). The result was growing inequality between the wealthier and more powerful farmers and marginalized farmers who were unable to benefit from the promotion of rainwater harvesting.

In another example, Taylor and Bhasme (2019) highlighted strong divergence in outcomes within a project in south India to promote the system of rice intensification

(SRI) among smallholder farmers. SRI is an alternative method of cultivating rice that can simultaneously increase productivity, reduce water requirements, and lower methane emissions (Glover 2011). The benefits of SRI rest on the synergistic interaction of four combined alterations to cultivation practices (i) transplanting of very young seedlings (ii) widely spaced grid formation combined (iii) alternate wetting and drying (AWD) irrigation and (iv) use of a mechanical weeder that aerates the soil. Many southern Indian state governments have promoted SRI (Basu and Leeuwis 2012).

Taylor and Bhasme (2019) report on farmers' uptake of SRI in six villages in the state of Telangana. Farmers' ability to work with SRI was strongly determined by class, caste and gender. Despite farmers' recognition that SRI increased yields and decreased aggregate water usage, only a minority of relatively well-resourced farmers persisted with the practice. SRI requires a choreography in which transplanting, weeding and irrigation follow a precise timeline to attain optimal yield benefits. Much depends on labor availability at specific stages, a requirement that did not match the social dynamics of labor markets that are shaped by gender and class dynamics (Pattenden 2018). More affluent farmers offered higher wages and supplemental benefits, such as food, to attract workers. Furthermore, as providers of informal credit and land rentals to less affluent households, they were able to ensure that labor groups composed of local women prioritized their lands. In contrast, less affluent farmers sent mainly female household members to work for the larger farmers. Subsequently they missed the optimal transplantation timings for SRI, leading to negative impacts upon yields.

The above SRI example illustrates the potential for maladaptation to emerge whereby CSA benefits groups of farmers at the expense of the most vulnerable. Indeed, addressing climate risk through adaptation can reinforce inequity in the creation of winners and losers, with resilience building shaped by existing inequalities. CSA projects often embed themselves within and entrench rural hierarchies in order to scale. Taylor and Bhasme (2021), reporting on a climate-resilient village project in Karnataka, India, show how power relations greatly shaped project outcomes. The project relied heavily on collaboration with village elites with whom they had pre-existing relationships. Elite farmers were able to use their influence to jump-start projects, ensure local participation, and therein help demonstrate rapid "success". The unreported outcome, however, was that these farmers benefited most from the CSA project thereby exacerbating extant inequalities. Elite farmers readily benefited from subsidies to promote agroforestry because they had more extensive landholdings, direct ties to extension officers, and the financial security to manage the transition from annual crop production to the longer-term income cycles of agroforestry. Project evaluations only documented the overall area of agroforestry operations rather than the distribution of benefits.

Farmers' differential livelihood trajectories

CSA often does not take into account small-scale farming households' different capacities for livelihood transformation within processes that include both agricultural and non-agricultural livelihood pathways. CSA programs often implicitly assume that productivity increases are in farmers' best interests and will contribute to farmers escaping poverty. Farmer abandonment of CSA interventions demonstrate the importance of a social analysis to understand 'what works and why' for different categories of smallholder farmers in the context of differential livelihood trajectories.

The reality is that for many small holder farmers grappling with poor soil quality and minimal land holdings, agriculture per se may not represent a pathway out of poverty (Dorward 2009; Dorward et al. 2009; Harris and Orr 2014; Harris 2018). As Gassner et al. (2019) note, while "*technologies already exist that can raise smallholder farmers' yields 3 or 4 times, even under rainfed conditions, the small size of land available to them limits how much can be grown and the per capita income from agriculture is insufficient to allow people to move above the current World Bank-defined poverty line of US$1.90 per day*". For these farmers, resilience and livelihood security is more likely achieved by pursuing non-agricultural pathways (Hellin and Fisher 2018) and/or being supported by social protection, such as cash transfers.

There may be an uncomfortable disconnect between a world of agricultural research, whose mission has been focused on productivity improvements, and smallholder farmers' realities where agricultural activities are embedded within their lives and diverse livelihoods. In such households, making agriculture 'fit' with a wider spectrum of livelihood activities is paramount. Productivity enhancements are at best one consideration in terms of household investments of capital and labor—including of women's labour—and are not necessarily a priority. Failure to grasp this can lead to stunted agricultural innovation and wasted opportunities.

Taylor and Bhasme (2018) and Taylor (2019) document the example of locally-adapted hybrid rice variety in Southern India that performed well in standard agronomic terms. Almost all farmers that took part in the initial trials stopped using the variety immediately following their completion. Hybrid seed is significantly more costly than seed of standard varieties and requires an extensive fertilizer regime and close management to produce

best results. These demands add to input costs at the start of the year that are frequently covered through informal credit sources at high interest rates. Only more affluent and well-resourced farmers had the necessary assets, knowledge and fiscal reserves to experiment with hybrids.

One example from a village that rejected the variety clearly reveals these complex livelihood dynamics (Taylor 2019). With households prioritizing income streams from members working in local manufacturing or informal commercial activities, agriculture was viewed increasingly as a means of subsistence by which older household members could aid the reproduction of the household through food provision while selling surpluses to the market. For such purposes, a low-input strategy producing a culturally appropriate variety was of paramount importance to reduce risks associated with changing rainfall patterns, shifting market prices for crops, and the high price that indebtedness incurred. For these farmers increased yield through the use of hybrid rice was not the priority. This clearly illustrates that for some farmers, agriculture is not a pathway out of poverty. In these cases other types of development interventions such as social protection and/or non-agricultural income generating sources may be more appropriate.

The evidence that increased agricultural productivity does not offer a route out of poverty for some types of farmers necessitates more focus on targeting i.e. embracing the "*inconvenient truths about the structure of smallholder agriculture and variations in potential between different agricultural environments*"(Harris and Orr 2014). More attention needs to be directed at farmers' livelihood pathways, ones that are shaped by farm household characteristics (e.g. dependency ratios, labor constraints), coupled with farmers' available assets (natural, financial, social etc.), and the cultural, economic, institutional and policy environment that frames opportunities. While commonly used in agricultural interventions, targeting is often based on broad agro-ecological criteria (not to be confused with the holistic agroecology approach to agriculture) rather than detailed socio-ecological ones. Examples include the promotion of conservation agriculture in southern Africa (Andersson and D'Souza 2014). There is an urgent need to recognize and systematically address social differentiation in farming communities at different levels.

Dorward et al. (2009) proposed a simple typology:

- Farmers who maintain current levels of wealth and welfare, in the face of the threats of stresses and shocks, 'hanging in'
- Farmers in a position to increase production and income through diversification, intensification and/or expansion, including via adoption of CSA, 'stepping up'
- Farmers who are able to accumulate assets that lead to higher and more stable returns often via increased off-farm employment or an exit from agriculture, 'stepping out'.

In the case of those farmers who are 'hanging in', it may be the case that productivity increases from CSA do not translate into a pathway out of poverty and an increae in human development (Hansen et al. 2019; Ollenburger et al. 2019). A persistent challenge is how best to identify different types of farmers to determine where to target climate-resilient agriculture. The process ranges from data-heavy, and potentially expensive and time consuming approaches to often faster qualitative ones. The former include the Rural Household Multi-Indicator Survey (RHoMIS). The latter include ethnographic approaches that are based on the premise that predicting farmers' decisions concerning agricultural technologies using conventional economic theories is flawed. Qualitative approaches such as capturing human aspirations (that have a much greater influence on technology choices) may be more effective and efficient (Mausch et al. 2018).

Social equity in climate-resilient agriculture

Even for those farmer types best placed to benefit from agricultural interventions such as CSA, these can (inadvertently) contribute to maladaptation, therein maintaining or exacerbating inequalities. The 2022 IPCC report argues that the climate crisis is so serious that the climate response has to change from incremental to transformative and that there needs to be more focus on the tackling the root causes of vulnerability (IPCC 2022). We believe that a critical step is to revisit what we mean by 'resilience' and subsequently to orchestrate a paradigm shift from climate-smart to climate-resilient agriculture. This is in line with Boyd et al. (2008) who argue that "*a resilience lens may assist development policy to consider pathways towards more successful livelihood transformations in the face of climate change*".

An established body of work on resilience places emphasis, on the one hand, on recovery and return time following a disturbance, and, on the other, on how much a system can be disturbed and still persist without changing its function (Miller et al. 2010). However, studies also encompass concern with how resilience can encompass both adaptation within current development processes, and new development trajectories when older systems are no longer appropriate (Folke et al. 2010; Walker et al. 2004). A first step is to unpack the differences between the social and ecological dimensions of resilience.

Barrett and Constas (2014) make the distinction between ecological and development resilience. The emphasis in the former is on "*persistence and recovery in the face of change and unpredictability*," while development resilience "*concerns individual agents with basic rights as well as aspirations for improved living conditions, that necessitates differentiation from and adaptation of preexisting, systems-oriented uses of the resilience concept in fields like ecology*" (Barrett and Constas 2014, p. 14625). Folke et al. (2010) argue that resilience can be seen variously, in terms of persistence, adaptability and transformability. Persistence is the capacity of a socio-ecological system to change and adapt while remaining within critical thresholds. In the case of adaptability, the system adjusts responses to changing internal processes and external drivers in ways that allow for development along the current trajectory. Transformability is the capacity to transcend thresholds and move into novel development trajectories.

Our argument is that a shift is needed from climate-smart to climate-resilient agriculture, in keeping with the assertion that resilience can be transformative ('transformability'). This paradigm shift means that socio-ecological resilience not only requires the ecological characteristics of persistence and recovery but also the conditions for households to move from one asset threshold and livelihood pathway to another. In the context of climate change, a resilience approach is one that transforms undesirable socioeconomic states, such as inequalities in power and income, into more desirable ones without undermining the integrity of ecological systems that humans depend on (Boyd et al. 2008; Fisher et al. 2022).

As we highlight above, strategies to increase climate resilience may not equally benefit all groups of smallholder farmers (Williams et al. 2020). Dornelles et al. (2020) refer to this as undesirable resilience i.e. the outcome is greater resilience for some farmers and less if any for others i.e. maladaptation. Climate resilient agriculture requires practitioners to embrace issues of social equity and the power dynamics within farming communities. Failure to do so risks perpetuating maladaptive outcomes that benefit (often) the few at the expense of the many. Quoting a recent paper, "*without intentional and consistent attention to ensure equity in planning and implementation of adaptation for marginalized groups, climate change will likely exacerbate and reproduce existing inequities and vulnerabilities in society*" (Araos et al. 2021).

Social equity frameworks can bring to the fore historically-rooted inequalities including those linked to gender and ethnicity, and assist practitioners to feed these insights into climate adaption planning and governance (Hellin et al. 2022). Practical steps include paying greater attention to the extent to which different types of farmers needs and voices are heard and respected and ultimately, the degree to which they influence decision-making. A social equity lens also lends itself to determining the costs and benefits of climate adaptation efforts are how these are distributed between different groups of farmers. In the fields of resilience and vulnerability, researchers often chose qualitative and quantitative tools, stakeholder engagement, and social learning (Miller et al. 2010). Fostering climate-resilient agriculture, hence, requires inter- and trans-disciplinary responses that bring together networks of researchers, practitioners, and policy-makers (Cundill et al. 2019). This is accompanied by shift from output-directed to process-oriented research during which these diverse actors co-produce knowledge (Miller et al. 2010).

Inter- and transdisciplinary approaches allow for a greater understanding of farmers diverse needs and aspirations by encouraging practitioners to address key questions such as *'Whose knowledge counts?', 'Who is the expert?', and 'Who can speak for whom*?' (Huff and Naess 2022, p. 4). Addressing these questions is fundamental to the shift from climate-smart to a more transformative climate-resilient agriculture. A shift that brings to the fore issues such as unevenly distributed power relations, existing networks of control and influence and climate justice (Newell 2022). There will be agricultural researchers and practitioners who do not feel comfortable with an overtly more political economy focus to their work, but in the absence of such an approach, transformative adaptation will remain largely elusive.

Conclusions

CSA approaches have tended to downplay the danger of maladaptation, a consequence that often builds on extant inequalities and power relations within farming communities. CSA narratives are often ambiguous as to the procedural aspects of identifying, testing and disseminating the innovations considered to achieve triple-win outcomes. There is often an implicit emphasis on 'success stories' that can be scaled up without due consideration of how social differences within target populations strongly shape who can benefit and how from such practices. Research on climate adaptation must therefore seek to address core issues of whose priorities count. In particular, researchers need to be explicit about the extent to which they, extension agents and smallholders themselves converge on the priority areas for change and innovation. Secondly, they need to explicitly consider how priorities diverge across smallholder populations in accordance with differences in asset holdings and gendered roles and responsibilities.

For approaches to be transformative, what is required is a broader and more comprehensive understanding and appreciation of farmers' realities and the changes needed to foster large-scale transformation in their livelihood trajectories while avoiding or mitigating the dangers of maladaptation. This means that the climate response has to involve those from numerous disciplines across the natural and social sciences. Furthermore, it has to ensure that it is embedded in transformative adaptation with more focus on tackling the root cause of vulnerability and giving more emphasis to human development. The focus necessarily shifts more to social equity governance and policy and less on technologies per se.

To do so effectively, farming activities must be seen as one element of broader livelihood strategies, and the appropriateness of interventions within agriculture should be measured in that context. Equally, it also requires greater attention to the active participation of farmers and farmer groups in defining the key challenges they face and discerning what might be appropriate innovations in response. This is key to avoid the production of maladaptive outcomes resulting from overly centralized and top-down approaches. A paradigm shift from climate-smart to genuine climate-resilient agriculture allows for this because of its systems approach, emphasis on adaptive capacity and above all its social equity focus.

Acknowledgements
This work was carried out with support from the CGIAR research project *Building Systemic Resilience against Climate Variability and Extremes* (ClimBeR). We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund (https://www.cgiar.org/funders/). Eleanor Fisher also acknowledges the financial support of the Nordic Africa Institute. The authors are also very grateful to two anonymous reviewers who provided invaluable comments on an earlier version of the manuscript.

Author contributions
JH led writing of the manuscript; all authors contributed material to the manuscript; all authors read and approved the final manuscript.

Funding
This work was carried out with support from the CGIAR research project*Building Systemic Resilience against Climate Variability and Extremes(ClimBeR).*

Availability of data and materials
Not applicable.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 2 March 2023 Accepted: 21 August 2023
Published online: 28 August 2023

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