

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/377968976>

Anticipating social differentiation and unintended consequences in scaling initiatives using GenderUp, a method to support responsible scaling

Article in *Agricultural Systems* · January 2024

DOI: 10.1016/j.agsy.2024.103866

CITATIONS

0

READS

41

4 authors, including:



C. Leeuwis

Wageningen University & Research

375 PUBLICATIONS 16,231 CITATIONS

[SEE PROFILE](#)



Anne Rietveld

Bioversity International

48 PUBLICATIONS 505 CITATIONS

[SEE PROFILE](#)

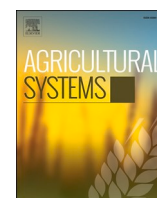


Béla W. E. Teeken

International Institute of Tropical Agriculture

48 PUBLICATIONS 690 CITATIONS

[SEE PROFILE](#)



Anticipating social differentiation and unintended consequences in scaling initiatives using GenderUp, a method to support responsible scaling

Erin McGuire^{a,b,c,*}, Cees Leeuwis^{a,d}, Anne M. Rietveld^{a,b,e}, Béla Teeken^f

^a CGIAR Research Program on Roots, Tubers and Banana, Avenida La Molina 1895, La Molina Apartado 1558, Lima 12, Peru

^b The Alliance of Bioversity International and International Center for Tropical Agriculture (CIAT), Viale Tre Denari, 472, 00054 Maccarese-Stazione RM, Italy

^c University of California, Davis, One Shields Drive, Davis, CA 95616, the United States of America

^d Knowledge, Technology and Innovation (KTI) group, Wageningen University and Research, Hollandseweg 1, 6706 KN Wageningen, the Netherlands

^e Farming System Ecology (FSE) group, Wageningen University and Research, Droevendaalsesteeg 4, 6708 PB Wageningen, the Netherlands

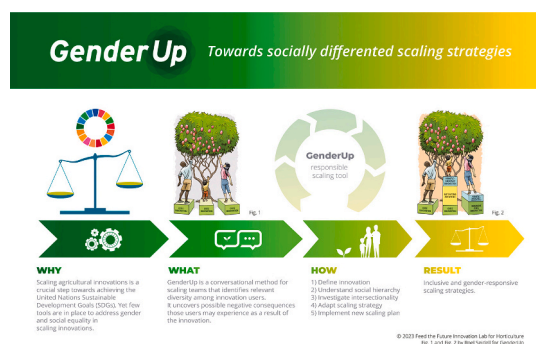
^f International Institute of Tropical Agriculture (IITA), PMB 5320, Oyo Road, Moniya, Ibadan, Oyo State, Nigeria

HIGHLIGHTS

- Research for Development actors increasingly rely on achieving Sustainable Development Goals through scaling innovation.
- Gender and social equity are global priorities, but tools for addressing social differentiation in scaling are lacking.
- Based on Responsible Research and Gender studies, GenderUp is a method for more equitable agricultural innovation scaling.
- GenderUp guides innovation teams through five stages emphasizing conversations, learning, reflexivity, and integration.
- GenderUp fosters a socially responsible scaling strategy, helping to advance gender-positive and socially equitable outcomes.

GRAPHICAL ABSTRACT

GenderUp Methodology.



ARTICLE INFO

Editor: Laurens Klerck

Keywords:

Responsible research and innovation
Scaling
Innovation
Gender
Equity
Social inclusion
Agriculture research for development

ABSTRACT

CONTEXT: A key strategy in progressing towards the Sustainable Development Goals (SDGs) is scaling innovations to improve livelihoods of marginalized populations globally. Consequently, there has been a heightened emphasis on Agriculture Research for Development (AR4D) innovation teams' ability to swiftly identify innovations that can be scaled for broad impact. However, insufficient attention has been paid to the equitable distribution of benefits among different demographic groups, leading to documented unintended consequences affecting some of the most marginalized communities. To effectively contribute to the SDGs and avoid harm to specific groups, AR4D innovation teams must conscientiously consider various dimensions of diversity, including gender and other relevant factors.

OBJECTIVE: Our objective is to introduce GenderUp, a new conversational method for responsible scaling, oriented to making scaling initiatives more inclusive and anticipatory of socially differentiated trade-offs. This

* Corresponding author at: University of California, Davis, One Shields Drive, Davis, CA 95616, the United States of America.

E-mail address: Ejmcguire@ucdavis.edu (E. McGuire).

<https://doi.org/10.1016/j.agsy.2024.103866>

Received 13 September 2023; Received in revised form 19 December 2023; Accepted 8 January 2024

0308-521X/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

new AR4D scaling tool seeks to ensure that scaling efforts not only contribute effectively to the SDGs but also consider and mitigate unintended consequences for marginalized communities.

METHODS: This paper describes a new socially responsible scaling tool. Starting with a defined innovation, GenderUp helps: i) identify relevant diversity and intersectionality among intended innovation users; and ii) re-direct scaling strategies to better anticipate and mitigate unintended consequences for specific social groups. Through a series of five stages, a GenderUp facilitator guides teams through discussions, learning activities, and practical integration to develop a socially responsible scaling strategy. We provide details about each stage and reflect on the results of two early pilot experiences.

RESULTS AND CONCLUSIONS: There is a need for increased recognition of the distribution of innovation benefits based on dimensions of diversity. GenderUp is proposed as a new method to systematically address social differentiation in the scaling of AR4D innovation. GenderUp supported two different innovation and scaling teams to rethink their scaling strategies. Both innovation teams identified at-risk intersectional profiles and made adjustments to their scaling strategies to ensure these groups were not harmed by the innovation or scaling activities. These promising examples suggest that GenderUp provides a simple ex-ante analysis that can reduce unintended consequences more broadly within AR4D.

SIGNIFICANCE: Although gender and social equity are prioritized globally there are very few experts, tools, and systems in place to achieve these cross-cutting goals. While GenderUp only addresses innovation at the scaling stage, it is a step towards systemizing responding to social differentiation within AR4D to at least do no harm, and at best improve social outcomes.

1. Introduction: the need for gender responsible scaling

This paper discusses the development and testing of a new scaling support method, ‘GenderUp,’ a conversational method for responsible scaling. The scaling of innovations is a key requirement and challenge for any initiative or organization that aims to have societal impact. Agricultural Research for Development (AR4D) organizations are among those that have a formal mandate to help realize Sustainable Development Goals (SDGs) and thus have a professional interest in fostering incremental or radical change. To effectively achieve such goals, which are often focused on social transformation, AR4D organizations are increasingly recognizing the need to consider gender and other forms of social differentiation within their AR4D programs. As has been advocated by feminist scholars (Pearce, 1978; Hooks, 2015) redressing inequality and opening up opportunities for marginalized groups requires setting objectives beyond incremental problem solving, and instead employing strategies that support ‘gender transformative change’ and ‘food system transformation’ (Gaitán-Cremaschi et al., 2019; Hall and Dijkman, 2019; Leeuwis et al., 2021; McDougall et al., 2021; Njuki et al., 2022; Wigboldus et al., 2022; Woltering et al., 2019). ‘System transformation’ never arises from an isolated innovation or change, but involves the uptake of multiple interdependent changes across different actors, levels and spheres (Glover et al., 2016; Hall and Dijkman, 2019). Therefore, AR4D organizations, activists and grassroots initiatives with transformative objectives need to engage with multiple scaling processes and partners simultaneously to achieve desired change. These processes can include ‘scaling up’ which involves the establishment of conducive institutional arrangements and policies for the uptake of innovations, ‘scaling out’, which refers to the spreading and replication of innovation use across wider geographical landscapes and contexts, ‘scaling deep’, which involves the reframing of cultural repertoires and roots, and also the undermining and ‘scaling down’ of the pre-existing practices that the innovation replaces (Moore et al., 2015; Schut et al., 2020; Wigboldus et al., 2020). The scaling of innovations to realize meaningful change implies the disruption and combatting of prevailing socio-technical ‘regimes’ (Geels, 2011) including the (often gendered) institutional configurations (Scott, 2014; Hall and Dijkman, 2019) that tend to reproduce the existing order and the undesirable outcomes that inspire the call for transformative change (Leeuwis et al., 2021).

Integrating gender and social differentiation into agricultural innovation systems has proven to be challenging (Sánchez Rodríguez et al., 2021). This integration can involve various approaches, such as designing innovations with a stronger gender focus, achieving greater equity in the upstream AR4D space by balancing bio-physical and social

science elements, or increasing regional expert involvement (McGuire et al., 2024, *forthcoming*). It’s worth noting that achieving “social transformation,” as mentioned earlier, is a distant objective without substantial transformation of innovation systems (Quisumbing et al., 2019). Currently, actors in the AR4D field, like those within organizations such as CGIAR or USAID, often introduce innovations that have undergone some proof of concept, without gender or social considerations, and then attempt to scale them. However, this approach tends to overlook a significant portion of the innovation system and factors that influence an innovation’s impact on different groups of people. GenderUp was specifically designed to operate within the “scaling” continuum of the innovation pipeline. Its primary objectives are not aimed at a total transformation but rather, at a minimum, to prevent harm and, ideally, to contribute to positive social outcomes. Fig. 1 situates GenderUp in a simplified (linear) continuum of innovating and scaling. These processes are anything but linear (see McGuire et al., 2022; Fig. 1), but we hope to provide a clear understanding of where GenderUp was built to be used and where we see future applications.

The process of innovation requires AR4D to make many decisions, for instance, what are the most pressing challenges within a community? What type of innovations will be best suited to address these challenges? How will we know if the solution works and for whom? Similarly, the process of scaling requires an equal amount of decision making and analysis, what path to scale is best: public or private? How will the innovation be acquired and maintained? What groups of people might be displaced by this innovation? We consider innovation and scaling to be the dynamic and overlapping processes in which AR4D actors develop innovations and aim to increase their use. AR4D actors, at least initially, have control over these processes. The innovations and their implementation at scale are the products and activities they manage, with the aim of achieving positive effects on a larger scale.

To address the complexity of scaling, several approaches and methods have been developed within in the agricultural sector (Jacobs et al., 2018; Sartas et al., 2020; USAID, 2018). In the context of AR4D, scaling initiatives often commence with the ambition to scale a particular innovation or solution that is assumed to contribute to bringing about desirable change (often referred to as ‘impact’). However, given the involvement of multiple actors and changes, scaling is also likely to affect multiple development outcomes and objectives. This multidimensionality poses challenges and introduces trade-offs, as often outcomes may be positive in one domain (e.g., productivity, profit) but negative in others (e.g., biodiversity, gender equity) (Mausch et al., 2020). Moreover, such trade-offs may vary across different segments in society as certain groups in society are likely to be better positioned to reap the benefits of the innovations that are being promoted than others,

while there may also be groups in society who can be indirectly affected by the use of an innovation by others. In this context it is relevant to note that studies focusing on innovation uptake in agriculture typically focus on benefits for those who have adopted, and not on the consequences for those who did not (Bouwman et al., 2021; Doss, 2006).

Table 1 provides an overview of the types of scaling challenges, trade-offs, and negative impacts that have been reported in scientific literature in connection with the scaling of innovations. The examples underscore that differential consequences of scaling are frequently linked to gender differences, and that women and other marginalized populations are often confronted with negative outcomes (see also McGuire et al., 2022). Research that considers socially differentiated outcomes of innovation and scaling innovation reveal common threads of types of challenges, trade-offs, and negative impacts. These include unintended outcomes such as loss of income and increased labor for women (Badstue et al., 2020; Schroeder et al., 1993) and exacerbated community and household power dynamics such as increased violence towards women (Bullock and Tegbaru, 2019; Farnworth et al., 2020; Sleghe et al., 2013).

The prevalence of these examples within the literature demonstrates the variety and complexity of the processes and mechanisms at work and suggests that negative consequences are frequently not anticipated by the teams that design innovations and take decisions about scaling strategies. This may be associated with the composition of such teams (e.g. insufficient expertise on social differentiation) and with the processes through which they engage with stakeholders (e.g. no feedback and countervailing power from prospective users or intermediaries). These examples also point to a systematic lack of integration of well-established social theory, which we discuss further in section 2.3 on relevant diversity. While we acknowledge that the outcomes and consequences of innovations can never be fully predicted, it is also clear that there are patterns and processes (e.g., uneven access, shifting workloads, unequal distribution of benefits, growing differences in wealth, etc.) that could be anticipated in advance if more effort was directed to discussing earlier experiences and possible implications of diverse constraints and opportunities among potential users and indirectly affected others. While gender focused research in this area is most robust, the literature points to social differentiation in general being a mechanism that will affect the success of a scaling initiative (e.g., reduced poverty, reduced inequity).

An overview study of scaling approaches across different fields signals that none of the 20 frameworks studied have an explicit strategy to enable socially inclusive scaling (Sánchez Rodríguez et al., 2021). This is also true for current methodologies to support scaling initiatives in AR4D (Schut et al., 2020; Woltering et al., 2019; USAID, 2018). Thus, existing approaches are not well equipped to deal with socially differentiated effects of scaling, anticipate longer term negative consequences

or trade-offs associated with scaling, and/or assist in successfully achieving positive outcomes across different social groups. Further evolved bodies of literature, such as Responsible Research and Innovation (RRI; Owen et al., 2012; Stilgoe et al., 2013) are oriented to making upstream technological science more inclusive, reflexive, responsive and anticipatory with the aim of preventing the emergence of undesirable consequences and/or to make upstream research contribute to positive societal impact. Thus, we argue that RRI needs to be complemented with more clear guidance on ‘Responsible Scaling’ (see also Wigboldus et al., 2020). That is: methodological support to making scaling initiatives more inclusive, reflexive, responsive and anticipatory regarding issues pertaining to social differentiation and trade-offs (ibid.). Such support should also include attention to mitigating the effects of scaling activities for marginalized groups, as well as reflection of innovation and scaling teams on their own positionality and resulting decision making lenses (McGuire et al., 2022). As AR4D organizations and others aim to scale innovations for social transformation, practical attention must be given to gender and its intersectionality with other relevant diversity (Tavener et al., 2022). If not, scaling initiatives risk evoking unintended consequences that exacerbate social inequities – an anti-goal of AR4D. This motivated us to develop GenderUp, a conversational method for responsible, and effective, scaling. While the method pays special attention to social inclusion along lines of gender differences, it emphasizes the need to consider other forms and dimensions of social differentiation as well. Thus, gender is used as an entry point to discuss social inclusion in general.

GenderUp guides innovation and scaling teams through complex social interactions in heterogenous landscapes by employing prescriptive structural exercises and facilitated discussion and reflection. Through a series of learning modules, team activities, and discussions, innovation and scaling teams are sensitized to understand how their innovation and scaling activities might negatively or positively effect different groups of people. The method builds on the call by Sánchez Rodríguez et al. (2021) to foster learning and critical reflection in scaling initiatives about social inclusion. While Sánchez Rodríguez et al. (2021) propose a range of generic questions that scaling initiatives can usefully consider in order to navigate challenges related to inclusive scaling (Carter et al., 2018), GenderUp invites critical reflection and adaptation of scaling strategies that are specific to the context of AR4D. As will be elaborated in the next section, one specific circumstance in AR4D is that it is often not clear from the outset what intersectional groups may face negative consequences in scaling trajectories, as this is highly innovation and context dependent. A unique feature of GenderUp in this respect is therefore that it supports scaling initiatives to first discover relevant diversity and intersectionality, and then redesign scaling strategies to ensure more inclusive outcomes. Another key tenet of GenderUp is the ability to think through possible consequences of

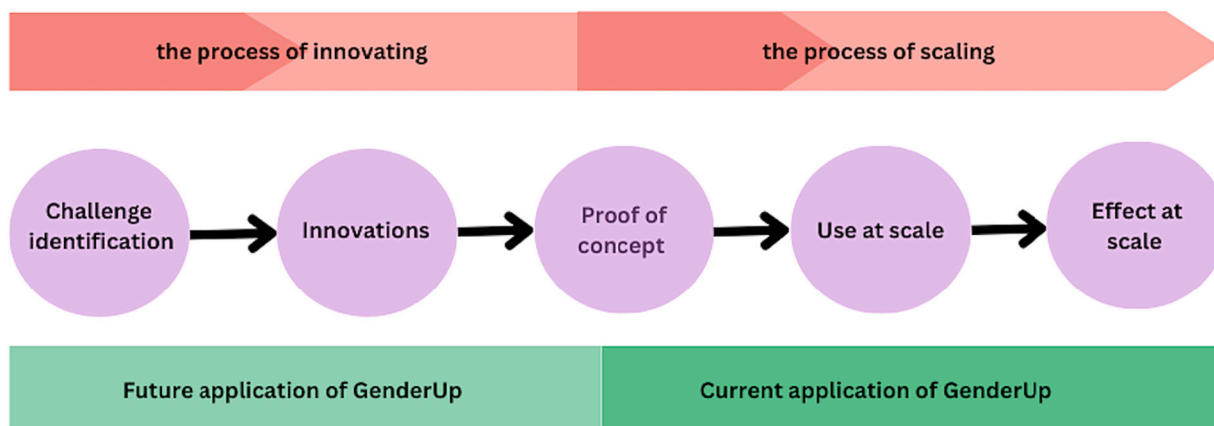


Fig. 1. Situating the current use of GenderUp.

Table 1
Scaling Challenges and unintended consequences.

Scaling Challenge	Underlying Cause	Unintended Consequence	Example found in the literature
Innovation design favours particular groups and cannot usefully be adopted by others	Innovation team composition neglects intersectionality, disregarding the social and contextual parameters of different gender, ethnicity, and class groups.	Intended users or sub-groups of intended users, often from marginalized communities, cannot benefit from innovation, perpetuating existing inequalities.	Kansanga et al. (2019); Kawarazuka et al. (2018); Polar et al. (2017)
Extension and communication approaches are biased towards specific groups	Dominant power structures influence communication strategies, focusing on hegemonic groups and neglecting or marginalizing others.	Continues the marginalization and exclusion of specific groups, often those without social or economic power, from accessing innovations.	Norton and Alwang (2020); Kristjanson et al. (2017); Quisumbing et al. (2014)
Resources needed for use of the innovation cannot be accessed by particular groups	Structural barriers, rooted in classism or systemic economic inequalities, prevent the equitable distribution of resources across various social groups.	Creates barriers for specific groups to utilize the innovation, leading to inequality in its benefits and possibly widening social divides.	Rola-Rubzen et al. (2020a, 2020b); Petesch et al. (2018a); Cohen et al. (2016)
Scale up of a certain innovation requires the scale down of another, simpler innovation	Technocentrism leads to an emphasis on complex innovations at the expense of simpler solutions that might be more accessible or profitable for specific contexts or populations.	Non-adopters, often representing marginalized or less educated groups, are harmed, widening the technology gap and perpetuating existing inequalities.	Paris and Chi (2005); Sánchez Rodríguez et al. (2021); Hackfort (2021)
Scaling up of certain innovations cause environmental harm, further marginalizing certain populations	Agricultural policies and practices prioritize efficiency and short-term yield, reflecting an economism perspective that undervalues ecological diversity, resilience, and indigenous or local cultural practices and knowledge.	Degradation of soil health, increased dependence on chemical inputs, and a loss of ecosystem resilience, leading to potential long-term declines in productivity and harm to surrounding environments.	Assan (2023); Ludwig and Macnaghten (2020); Rietveld and van der Burg (2021)

certain scaling activities and mitigate potential negative outcomes. The conversational method has been designed as a complement to other scaling support approaches in AR4D and has been specifically tailored to be used in combination with Scaling Readiness (Sartas et al., 2020), an approach that is currently being institutionalized within the CGIAR.

Below we outline the concepts and principles that underpin GenderUp, which includes insights from AR4D literature and social theory concerning scaling, gender, relevant diversity, and ex-ante analysis. We then present the set-up, rationale, and practical application of GenderUp and provide examples of how two different innovation and scaling teams have used GenderUp to foster greater responsibility in scaling interventions. Finally, we reflect on the overall experience and conclude on the way forward.

2. Concepts and principles

In this section we further detail how, in the design of GenderUp, insights on innovation and scaling are enriched with perspectives from gender studies, feminism and sociology.

2.1. Systems perspective on innovation: scaling innovation happens in configurations

The development and use of innovations in agriculture cannot be usefully looked at in isolation (Hall and Dijkman, 2019; Woltering et al., 2019). Choices and investments in research, development, and innovation promotion tend to be informed by prevailing political and economic interests, priorities and problem frames, and hence are not neutral (Boon et al., 2008; Klerkx and Rose, 2020; Polar et al., 2017). This is equally true for large research establishments and grassroots initiatives, and hence it is not surprising that we frequently witness contestation about proposed directions for change and innovation. At the same time the actual use of innovations induces or co-evolves with other changes at various levels, ranging from the field, the farm, the community, the regional and/or the (inter)national sphere. For example, labor scarcity or demands for higher wages for farm labor may, in a given context, induce processes of mechanization. This in turn might lead to redundancy and out-migration of farm laborers, as well as contribute to significant modification of rural economies and infrastructures in view of newly fostered dependencies (e.g., on credit, technology distribution and maintenance, etc.). While some of those changes may be intended and foreseen, other consequences are likely to be unintended (e.g., reduction of rural populations due to scale enlargement, loss of incomes for non-users, or closure of local schools). Thus, society and innovation mutually shape or configure each other in intended and unintended manners (Bijker and Law, 1992; Leeuwis, 2013), and this clearly has implications for initiatives that endeavor to create positive societal change by the scaling of a particular innovation.

This kind of systems and configurational thinking has led to the recognition that the scaling of a particular innovation cannot be solely understood with the help of frequently used theories on individual adoption (e.g. Rogers, 2005; Venkatesh and Davis, 2000) since the use of such an innovation is dependent on the simultaneous scaling of other practices and innovations that are outside the sphere of control of individuals since they involve other actors which may operate at different levels (Hall and Dijkman, 2019; Sartas et al., 2020; Leeuwis and Aarts, 2021). The successful scaling of a new potato variety, for example, is likely to be dependent on additional changes at farm level, e.g., adaptation of pest management strategies, weeding practices and labor organization, as well as on changes in the broader environment, e.g., novel seed multiplication facilities or a pro-poor credit arrangement. The introduced innovation, together with the necessary changes in a range of systems, human behavior, and the environment to use the innovation, can be referred to as an ‘innovation package’ (or innovation bundle) that consists of ‘core’ and ‘complementary’ innovations (Barrett et al., 2020; Sartas et al., 2020). As introduced by *Scaling Readiness*, a scaling method developed within the CGIAR (Sartas et al., 2020), core innovations (e.g. the new potato variety mentioned above) are regarded as the main driver of change and expected to contribute most directly to the realization of particular development outcomes. Complementary innovations are those that are necessary to support the use of the core innovation, such as a required adaptation of pest management practices and/or a multiplication and licensing system that enables widespread access to the new potato variety. ‘Mitigating activities’ are often employed in addition to and connected with the innovation package, to either enable more positive, or mitigate negative, effects at the micro-local level or for (as this paper argues), different groups of people.

One and the same core innovation can be ‘packaged’ in different ways. Besides the maturity of elements in the package, the composition of the package determines who is likely to be able to use the innovation

and/or reap the benefits in a given context. In the above example on a new potato variety, the absence or presence of a well-functioning micro-credit scheme may determine which wealth classes of farmers can gain access to the core innovation. Moreover, packages may need to differ across locations and contexts. The potato variety may for instance be well-adapted to various agro-ecologies or regions, but if seed distribution systems vary across these, radically different complementary innovations are required to allow for scaling to happen (Sartas et al., 2020).

Core innovations and innovation packages can differ in the extent to which they challenge and transform prevailing socio-technical regimes (Geels, 2011) and the dominant institutional set-ups and power configurations that characterize them (Scott, 2014). Especially when the purpose is to improve the position of marginalized groups it is likely that complementary innovations need to include the adaptation or re-design of the rules, policies, norms and modes of thinking that actually have contributed to marginalization in the first place (Carter et al., 2018; Mausch et al., 2020; Leeuwis et al., 2021). Thus, socially inclusive scaling is likely to be a social struggle as it tends to disrupt the status-quo, and it usually requires that attention is directed at establishing complementary innovations and changes of an institutional nature (Hall and Dijkman, 2019; MacLachlan et al., 2019), as well as at the undermining and down-scaling of existing arrangements.

2.2. Scaling components as a part of a scaling strategy: Importance of a multi-faceted approach

The ‘packaging’ of a core innovation in a broader innovations package can be seen as one element in a broader ‘scaling strategy.’ The term scaling strategy refers to a range of choices that scaling initiatives need to make regarding why, where, for whom, and how an innovation package is to be scaled. Thus, scaling strategies include (explicit or implicit) decisions on several aspects or components (Jacobs et al., 2018; Leeuwis, 2004; Sartas et al., 2020; Wigboldus et al., 2022; Woltering et al., 2019). Negotiated decisions in scaling strategies are for instance about:

- *Purpose of scaling:* Why something could be worth scaling; that is, to what development outcome(s) scaling of innovations is expected to contribute.
- *Intended users:* What group(s) of people are supposed to use the core innovation, and who are supposed to (directly or indirectly) benefit.
- *Context and resources:* Scale and geography where the scaling is supposed to happen, and what resources are made available to support the scaling strategy.
- *Intermediaries and partnerships:* Partners that may help realize scaling, including intermediaries that can be used to connect with intended users.
- *Communication and training methods:* Media and communication methods that are used at different stages (see e.g., Rogers, 2005) in the process of communicating with potential users. Training on an innovation is a very common information dissemination method.
- *Complementary innovations:* Activities or innovations that make the use of a core innovation possible. This can be additional resources, higher-education, tools, or mechanisms to gain access to the core innovation or resources necessary to benefit from the core innovation, such as the provision of credit or arrangements to guarantee market access.
- *Team composition:* Expertise and skills needed to develop and foster responsible and effective scaling strategies.

Above mentioned choices are not always fully clear and explicit at the outset and are almost entirely dependent on the composition and contributions of the innovation team. As with innovation packages, the design of the scaling strategy is likely to affect who, in each context, will be reached by the initiative and gain effective access to the innovation

and its benefits, and who is not. Thus, to achieve positive AR4D outcomes, responsible and effective scaling requires that scaling strategies are adapted (or created) to account for social differentiation, with an emphasis on avoiding increased system and population inequity (Carter et al., 2018; Sánchez Rodríguez et al., 2021). For example, by prioritizing marginalized social groups most at risk of not benefiting from the innovation or that might be negatively impacted.

Several scaling tools have been developed to support AR4D actors in the field. These tools include Scaling Readiness, Scaling Scan, Agricultural Scaling Assessment Tool, among others (Gebreyes et al., 2021; Jacobs et al., 2018; Sartas et al., 2020; USAID, 2018). However, while they address various challenges such as (lack of) regulatory conditions, market access, institutional support, and partnerships, they often overlook how innovations may affect different groups of people.

For instance, CGIAR’s Scaling Readiness primarily focuses on scaling bottlenecks, mainly from the perspective of innovation usage and readiness. Centro Internacional de Mejoramiento de Maíz y Trigo’s Scaling Scan provides a checklist of relevant considerations, including environmental, and USAID’s ASAT emphasizes sustainable scaling through a client driven lens. These tools are valuable for helping innovation teams navigate the complexities of increasing innovation adoption but generally do not center on the outcomes of use or the potential displacement or negative impacts on specific groups of people. GenderUp was designed to address the lack of gender and social differentiation in these existing tools. Integrating GenderUp with these existing tools facilitates the creation of scaling approaches that consider gender and other social factors, thus enhancing the overall impact and inclusivity of scaling.

2.3. Relevant diversity and scaling: Access to benefits of innovation depends on interacting social factors

While social theory themes prominently feature in much of the AR4D literature that explores gender and social disparities in agricultural innovation and their outcomes, these effects receive less attention in mainstream innovation and scaling processes. Consequently, although social group differences impact nearly all innovation and scaling processes, there has been limited systematic integration of social theory throughout these processes, from inception to implementation (McGuire et al., 2024, forthcoming). Notable social theories, among others, that can be effectively incorporated include feminism, the feminization of poverty, intersectionality, critical race theory, and decolonization (Crenshaw et al., 1995; Offen, 1988; Pearce, 1978; Quijano and Ennis, 2000; Yosso and Solórzano, 2005). GenderUp actively considers these theories and how they have been applied in AR4D literature to better comprehend the identification of pertinent diversity in scaling agricultural innovations.

Social identity, social factors, and geographical location affect who can use and benefit from certain innovations (Rietveld and van der Burg, 2021; Glover et al., 2019; Badstue et al., 2018). Women’s and men’s opportunity spaces, cultural roles, decision-making power, and social networks can be very different and influence how they interact with innovation (Kawarazuka and Prain, 2019; Polar et al., 2017; Rola-Rubzen et al., 2020a, 2020b), whereby patriarchal structures and norms frequently pose limits to women (Hooks, 2015; Petesch et al., 2018a, 2018b; Rietveld et al., 2020). Further, women and other socially identified groups are not homogenous within the group, and different categorizations and identities are interconnected and may foster overlapping and interdependent systems of discrimination or disadvantage (Crenshaw, 2005; Rietveld et al., 2020).

Such intersectionality may also affect the distribution of benefits and risks associated with an innovation. For example, gender intersects and is shaped by other dimensions of diversity such as age, wealth, occupation, ethnicity, land tenure, and religion (Colfer et al., 2018; Kabeer, 2014). While low-income groups may all suffer from the same detriments of poverty, such as limited resources, men and women often have

different responsibilities, cultural expectations, and legal rights that impact how they experience poverty (Petesch et al., 2018a, 2018b). Thus, an essential condition for responsible scaling is that innovation packages are or become adapted not only to different ecological contexts, but also to socially differentiated populations within a particular context (Glover et al., 2019; Sartas et al., 2020; Teeken et al., 2021). Given high levels of social heterogeneity, it is often not self-evident what dimensions of diversity are relevant in relation to an innovation and specific scaling initiative at the outset. Through the GenderUp journey, “at-risk intersectional profiles” are created by sorting through relevant dimensions of diversity and considering potentially negative impacts of an innovation given social parameters within a landscape. Table 2 provides an overview of core concepts and the process in which GenderUp considers these concepts to build at-risk intersectional profiles.

Relevant diversity is innovation and innovation package specific (and vice versa) - The relevant dimensions of diversity may vary depending on the core and/or complementary innovations considered. What is ‘relevant’ diversity is related to the specific features of an innovation, and how they link to the contextual rationales that food system actors may have to appreciate or use them or not (Leeuwis, 2004). Based on insights from the literature, dimensions of diversity specifically pulled out in GenderUp include, among others, geography, age, ethnicity, wealth status, education, land ownership, marital status, household structure, religion, the occupation(s) other than farming that are performed by the innovation users, mobility, migrant status, people with disabilities, age and mobility. Innovations that have labor saving features may be more interesting for smaller households than for large households. The acceptance of pesticides may differ significantly between Buddhist farmers and those of other religions. Migrant farmers that farm on tenanted or rented land may not have sufficient land security to invest in perennial crops or measures and innovations that restore soil fertility (Adjei-Nsiah et al., 2007; Van Schoubroeck and Leeuwis, 1999). Innovations that require access to credit (e.g., hybrid seeds) may be less accessible to low-income women farmers (Rietveld and van der Burg, 2021). These examples demonstrate that different categories of food system actors may experience different constraints and opportunities and see different advantages and disadvantages in

Table 2
Definitions and examples of core concepts in understanding relevant diversity.

Dimension of Diversity	Categories within the Dimension	Intersectionality Impact	At-risk Intersectional Profile
Social identities, factors, or bio-physical conditions along which people differ that affect impact	Categories or groups within a diversity dimension that further affect innovation impact	How these dimensions intersect with gender and other social groups to further affect innovation impact	Intersectional group most vulnerable to negative innovation impacts
Eg. Geography	rural, peri-urban, urban	Rural men may be better positioned to access markets than rural women, even if they are both far from cities	Rural women
Eg. Age	young, old, child-bearing age	High-income older farmers may be more mobile than low-income older farmers	Low-income older farmers
Eg. Ethnicity	indigenous, migrant	Highly educated indigenous people may have more access to capital than less educated indigenous people	Less educated indigenous people

relation to using a specific innovation (see also Mudege et al., 2018). Moreover, when designing innovation packages for certain social outcomes, relevant dimensions of diversity should be considered when determining the necessary components of the innovation package. Since there are often multiple components in and to a package, different dimensions of diversity and segments may be relevant at the same time, and thus intersectionality (Crenshaw, 2005) must be considered when designing interventions for an at-risk focus population.

Different social categories of people, and intersectional profiles of these different categories, influence how individuals and communities will be impacted (or not). Innovation relevant dimensions of diversity can be associated with three spheres.

- **Access to resources needed to use the innovation:** What resources, including education and awareness, are required to use the innovation? What social groups have access to these resources, and which do not?
- **Individual level effects of the innovation on users and non-users:** What social groups have decision making power to use the innovation? How will intra-household power dynamics shift? How are risks distributed among household members?
- **Community level effects of the innovation on users and non-users:** What will the innovation be replacing, what group of people will lose income? What groups of people will have power to apply and change the innovation?

To understand and highlight specific relevant dimensions of diversity within these three spheres, GenderUp poses a range of anticipatory questions, as discussed below.

Relevant diversity may depend on the scaling objective –The relevance of dimensions of diversity and associated segmentations of groups depends on the eventual scaling objective (Sartas et al., 2020). It makes a difference whether new seed varieties are promoted mainly to boost food production and reduce food insecurity in the cities, or whether they are seen as an instrument to reduce poverty in rural areas. In the first instance, scaling initiatives may be inclined to argue that it is less relevant to anticipate the consequences and implications for resource-poor farming households in rural communities, while clearly the difference between resource-poor and resource-rich cannot be ignored if the scaling objective relates to poverty reduction. In either example, it is possible that low-income women lose out because they do not have access to credit, and these social inequities are exacerbated even though the main scaling objectives are achieved. We hold the opinion that each scaling initiative, especially when initiated in the public sector, should be socially inclusive and should assess its objectives accordingly. A responsible scaling approach needs to foster critical reflection on whether the defined priorities and the trade-offs in scaling initiatives are indeed justifiable (Woltering et al., 2019; Sánchez Rodríguez et al., 2021).

Relevant diversity is communication related – Food system actors are likely to differ regarding whether and how and through whom scaling initiatives can get in touch with them (Leeuwis, 2004). Migrant farmers may be part of different social networks than natives, and these groups may be inclined to value and respect the views of other people in their communities regarding the innovation at hand. Similarly, women farmers may tend to visit different types of gatherings than men, tune in to different radio programmers, or prefer altogether different media for communication (Mudege et al., 2017). All this is relevant when it comes to selecting intermediaries, partners or contact farmers, and for deciding on which media and venues to use where and when. In essence, scaling initiatives need to connect with different groups of farmers in different ways if they want to raise their interest in an innovation and take subsequent steps.

Relevant diversity may vary across time – What constitutes relevant diversity may also depend on the time horizon that is considered. In the early stages of a scaling trajectory, it may be useful to distinguish

between men and women farmers because they face different constraints in accessing the innovation, while at a later point in time (i.e., when the innovation is actually used and implemented) it may be useful to distinguish between farmers and farm-laborer's who are affected differently by the uptake of e.g., labor saving technologies. The massive scaling of certain innovations (e.g., fertilizers or pesticides) may over a longer time horizon result in negative consequences with regards to, for instance, biodiversity or soil fertility. Certain community members may experience / suffer more from these ecological consequences than others because of their geographical location or their capacity to be resilient. In addition, community members with more social power are likely to have an increased ability to change or take ownership over the innovation over time.

Overall, we see that there is no simple and single dimension of diversity or categorization into segments that bears relevance to innovation in general. Instead, we must conclude that relevant diversity is context specific, and shaped by the features of the innovation, innovation package, communication networks, intervention goals and the time horizon considered. This implies that multiple dimensions of diversity and intersectionality must be first discovered and then acted-upon when the aim is to strengthen and support responsible scaling. Current frameworks and lines of questioning to support socially inclusive scaling are not explicitly geared towards this discovery dimension and seem to assume that it is more-or-less self-evident what groups are marginalized and at-risk (Sánchez Rodríguez et al., 2021). Once relevant diversity has been identified, it can be used to make existing scaling support approaches more sensitive to social differentiation. When used in combination with Scaling Readiness, for example, it becomes possible to systematically identify innovation packages, bottlenecks and scaling strategies that are specific to the groups that have been identified with GenderUp (see Sartas et al., 2020).

2.4. Anticipatory Questions: Future-based discussions grounded in lessons learned are critical to mitigating negative consequences

To become more responsible and effective (i.e., inclusive, responsive, reflexive, and anticipatory) scaling initiatives need to consider relevant diversity and social differentiation in society and consider possible and/or likely consequences and implications of scaling for different intersectional segments of people over time. Achieving this is a complex task, and it is unrealistic to expect a detailed prediction of all potential consequences and implications. Even with the best planning, societal developments are often capricious, emergent, and can be coincidental (Leeuwis et al., 2021). As is the case with RRI we feel that it is important to strengthen and support critical reflection and discussion on these matters, and a key mechanism for doing so can be found in posing anticipatory questions that stimulate a conversation about desirable futures (MacNaghten, 2016). With the help of such conversations parties involved can explore different perspectives, develop mutual understanding and common ground, and agree upon strategies, activities and task divisions that contribute to responsible scaling.

GenderUp uses anticipatory questions to uncover relevant diversity, anticipate possible and likely consequences, and offers practical guidance to critically answer these questions when information is not known. Relevant questions to enhance responsible scaling were identified through literature reviews on the relation between gender, social differentiation and agricultural innovation, and methods in which to anticipate different outcomes (McGuire et al., 2022). The questions posed as part of GenderUp invite reflection on how use of the core innovation may be linked to resource requirements and access to resources; practice change and household level implications; community level consequences and distributional effects, and landscape level consequences. These combined with possible information sources and methods used to collect data, such as participatory rapid rural appraisals, resource mapping and the Women's Empowerment in Agriculture Index, generated literature grounded questions that GenderUp

guides innovation teams through, to consider future outcomes.

In their effort to answer such questions, innovation teams can gather additional knowledge and information, and insights gained are then discussed and used to adapt their scaling strategies to become more inclusive and effective and anticipate and prevent, as good as predictable, and mitigate negative consequences.

In sum, GenderUp is built on the concept that innovations are scaled within systems, through scaling strategies that include several components. How that innovation and the associated scaling strategy will affect different groups of people differs. To mitigate unintended consequences and ideally ensure that as many groups of different people as possible have access to the benefits of an innovation, innovation teams must think through the different dimensions of relevant diversity. They need to come up with additional complementary innovations and mitigating activities for different segments of at-risk users and add these to the scaling strategy. Fig. 2. below depicts the challenge of unequal access to the benefits of an innovations, and how GenderUp can help innovation teams arrive at a more responsible, effective scaling strategy.

3. GenderUp, conversational method for gender responsible scaling

GenderUp is meant to be used by a team of people (usually a group of AR4D staff and key scaling partners) that have previously arrived at a shared ambition to scale a particular (technical, nature-based or institutional) innovation, and which has an interest to reflect on the inclusiveness of their scaling initiative. GenderUp guides such innovation teams to; i) identify relevant diversity and intersectionality among intended innovation users from a social and gender perspective; and ii) to create a more inclusive and gender responsive scaling strategy which also anticipates foreseeable unintended (negative) consequences for specific social groups and allows for their adequate mitigation. Spread out over one to three workshops, it includes five distinct stages that guides the innovation team through conversations, reflection exercises and learning activities. This process is meant to be supported by a GenderUp facilitator who has followed training on the use of the method. The workshops can be held live or online, and the total time invested in them amounts to about one full working day per participant. The learning activities take the form of video-clips, live presentations of slide-decks, and reflection questions.

GenderUp requires teams to consider their own positionality, and during preparatory discussions with initiators it is strongly encouraged that those participating in the GenderUp workshops constitute a diverse team in terms of expertise and gender. Ideally, representatives from biophysical and social sciences should be equally represented as well as partners that represent intended users and implementers of the innovation to be scaled. Through the GenderUp journey innovation teams may learn that they have a specific expertise missing from the conversation, and thus can add new members and organizations to the effort during this process. Learning and sensitization activities embedded in the GenderUp journey focus on gender in agricultural systems, team composition, relevant diversity, intersectionality, and mitigating activities. GenderUp recognizes that innovation team members may not have considered gender issues and how gender may intersect with other social dimensions exacerbating disadvantages in relation to the innovation. The learning activities are designed with that in mind - they are short and directed at raising awareness and stimulating discussions, rather than at providing a comprehensive lecture on a particular issue. It is assumed that completing a GenderUp journey may strengthen the capacities of the participating organizations to navigate responsible scaling in other settings as well.

Fig. 3 highlights the flow of each stage and the guiding principles. GenderUp is housed on a web-platform that guides a facilitator through the different learning activities, a survey and facilitated discussions using guiding questions and virtual collaboration boards. In case of a face-to-face workshop the online collaboration boards can be turned into

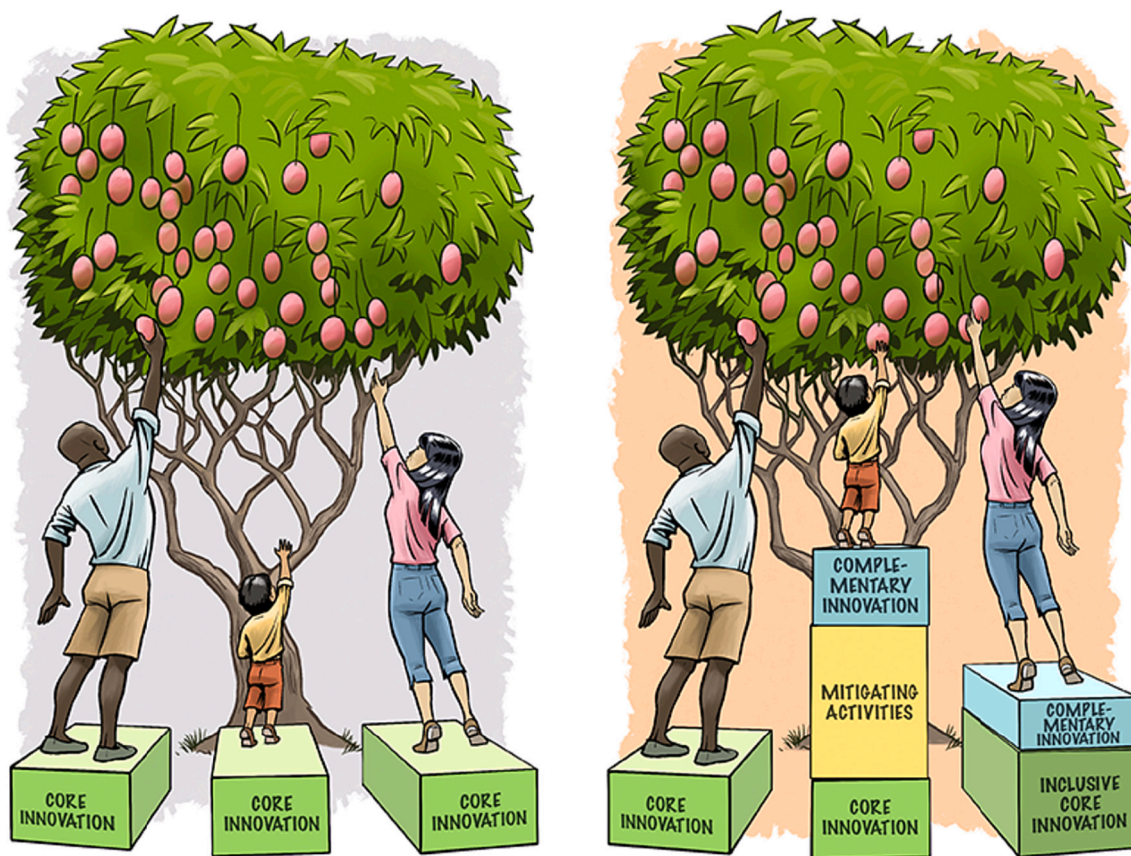


Fig. 2. GenderUp strives for more equitable scaling strategies.

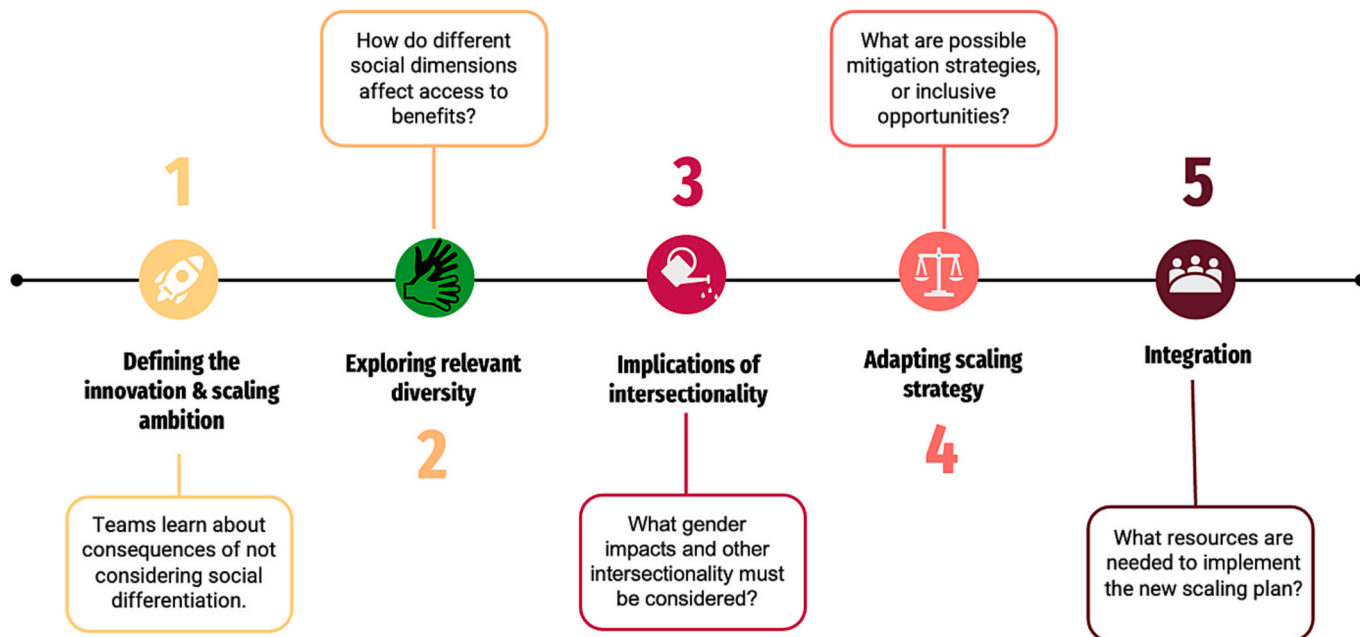


Fig. 3. The flow of GenderUp.

a physical version, e.g. using flipcharts and post-it's on the walls of the venue.

3.1. Stage 1: Defining the innovation and eliciting the current scaling strategy

The objective of stage 1 is to understand the innovation that will be scaled, the intended goals, and the current scaling strategy. This serves

as a baseline against which the new, more socially inclusive and gender responsible scaling strategy could be compared or evaluated at the end of stage 4. At this stage, the innovation team provides information about current partners within scaling activities and any complementary innovations already considered. Importantly, it also zooms in on the context of the scaling project and what kind of activity the innovation will be replacing. This centering around the innovation and scaling activities allows the innovation team to make their -sometimes rather implicit- thinking and assumptions about scaling explicit and will make the team think about how the scaling strategy may affect the lives of users and non-users.

The conversation in Stage 1 is facilitated with the help of two interrelated collaboration boards. The questions posed and answered in these boards are listed in Table 3; see Fig. 4 for an visual impression of a board.

After the guided discussions, participants are offered learning materials about the relation between gender and innovation and the importance of team composition. These sensitizations are deliberately placed after eliciting the currently existing scaling strategy, so that we maximize the chance that participants report what is currently in place. Providing earlier guidance could amplify socially desirable or projective answering of questions, which would reduce the value of using it as a qualitative 'baseline' against which the team can mirror the adapted scaling strategy that is developed later in Stage 4. However, it's crucial to introduce the team composition assessment early in the GenderUp journey. This step helps innovation teams recognize the absence of certain perspectives at the table. Being mindful of this is essential because critical viewpoints or data may be overlooked if specific expert groups or perspectives are not represented on the innovation team, which can impact the outcomes of the GenderUp journey. In the end, identifying the "right partners" who can complement any expertise or perspective gaps should be a result of a revised scaling strategy.

3.2. Stage 2: Exploring relevant dimensions of diversity

The objective of stage 2 is to identify dimensions of relevant diversity (see Table 2) that are important in achieving a particular scaling outcome or that could negatively impact certain sub-groups in the short or long run. At the start of Stage 2, the participants are offered several learning materials on possible dimensions of diversity, the contextual relevance of such dimensions and on intersectionality. To explore relevant dimensions of diversity and intersections between them in their

Table 3

Questions posed in Stage 1 collaboration boards.

Stage 1a: Defining the innovation and scaling ambition
<ul style="list-style-type: none"> - What is the core innovation you are aiming to scale? - Describe which problem the innovation is solving. - Describe which development goals the innovation is contributing to. - What is the purpose of scaling? What ends do you aim to achieve? - Are there other innovations that you are promoting at the same time? - Describe the context where the innovation will be launched (social, geographical, agricultural) - Describe what your innovation will replace. - Describe on which scale you want to have an impact: in the community, regionally, or nationally?
Stage 1b: The current scaling strategy
<ul style="list-style-type: none"> - What is the core innovation you are aiming to scale? (copy from 1a) - What is the purpose of scaling? What ends do you aim to achieve? (copy from 1a) - What kind of training is planned and who is providing it? - Who is communicating the innovation and through what media? - What else are you doing so people can use your innovation? - Which partners are you working with? - How will end-users benefit from this innovation? - Do you have specific users or beneficiaries in mind?

particular case, the innovation team members are subsequently asked to individually take a survey and then discuss the results as a team. The questions in the survey are organized into four categorical blocks, including what resources are needed to use the innovations and how access to these may differ across segments of people. Subsequent blocks focus on possible and likely consequences for different people as individuals and for the communities they live. For example, the questions explore whether use of the innovation is likely to lead to an increased labor burden for different groups of people, or whether it could shift the balance of intra-household decision making power and access to resources. By thinking through the innovation's impact within a larger community, users and non-users of the innovation are considered. The results of the surveys are presented in several automatically generated summary tables that can be accessed by the participants (see for a fictitious example Table 4).

Stage 2 ends with a facilitated discussion of the survey results using a next collaboration board (See Table 5). The survey results serve as an entry point for the discussion about relevant dimensions rather than as a fixed result.

3.3. Stage 3: Understanding implications of intersectionality

The objective of stage 3 is to deepen the discussion about relevant diversity and to identify the specific categories and intersectional groups that require special attention to enable responsible scaling. During this process the innovation team identifies gender impacts and other intersectionality that is relevant to use and access the benefits of the innovation. Emerging from this stage are at-risk intersectional profiles of people that the innovation team prioritizes to advance positive development outcomes or mitigate negative impacts. For example, if wealth has been identified as a dimension of diversity that is relevant to the use of the innovation, then what group within that dimension is vulnerable to not receiving access to the benefit of the innovation? And if the conclusion is that a low-income group of people is at risk, how does the risk or opportunity change at the experiential intersection of a low-income woman. Stage 2 starts with a learning activity that deepens the understanding of intersectionality, and provides examples on how this may play out in agricultural settings. The discussion is then continued with the help of a collaboration board. Table 6 provides the questions that guide the conversation in this step, and Fig. 5 provides a visual image.

3.4. Stage 4: Mitigating consequences and embracing opportunities

The objective of stage 4 is to create a revised scaling strategy that considers what the innovation team has now identified as the most relevant diversity and prioritized at-risk intersectional profiles. The discussion is centred around preparing and planning to prevent, mitigate, or redirect the intervention strategy to enhance scaling and avoid potentially harmful unintended consequences. Mitigation strategies may include defining complementary innovations and measures as part of the innovation package, additional partnerships, changes in team composition, wrap around programs, long-term education programs, etc. At the end of stage 4, the innovation team has identified a more gender responsible and socially inclusive scaling strategy.

Stage 4 starts with learning materials about the importance of complementary changes and innovations that may be required to create a responsible innovation package, and which thus should be part of a responsible and equitable scaling strategy. This is followed by a facilitated discussion about how the original scaling strategy that was formulated in Stage 1b may be adapted. The questions raised in the collaboration board are presented in Table 7.

The last question posed in the collaboration board is meant to foster reflection on whether the innovation can be scaled responsibly at all. If the answer is 'no' for one or more intersectional groups the team may discuss whether or not to abandon efforts to scale the particular



Fig. 4. Visual impression of online collaboration board Stage 1b: currently existing scaling strategy.

innovation altogether, and redirect the attention to more promising innovations.

3.5. Stage 5: Integration into project management

The objective of stage 5 is to streamline GenderUp discussions and new gender responsible scaling activities into the work plans and management tools of the scaling project. In doing so the innovation team identifies critical resources and partnerships that are necessary to achieve and enact the newly developed scaling strategy and make decisions on concrete activities and task divisions. These discussions can be done with a small group of innovation team leaders and the facilitator of GenderUp and could take place a few weeks after the completion of Stage 4.

In summary, GenderUp leads innovation teams to look at their innovation through a new lens, one that considers differentiated experiences of different groups of people. In doing so innovation teams gain insight into how an innovation’s benefits are distributed (or not) among potential innovation users. This allows the team to reflect on scaling activities, rethink priorities, and to be more inclusive.

4. Early experiences with GenderUp pilots

Below we present how scaling strategies were adapted in two initial pilots where GenderUp was used. In addition, we highlight some qualitative observations and feedback we received from participants about insights they obtained regarding gender responsible scaling. The process, discussions, and outcomes of the two pilots were documented in detail through the online collaboration boards, and the facilitators recorded observations and made notes about the discussions that evolved. In addition, we organized discussions with the innovation teams at several points during the GenderUp journey to reflect on the process. The GenderUp creators initially served as facilitators during the early implementations of GenderUp. However, in our pursuit of a comprehensive understanding of GenderUp’s effectiveness, we deliberately refrained from influencing the outcomes of the GenderUp “journey” for innovation teams. To the best of our ability, we simply provided guidance throughout the process, akin to the support offered by a trained GenderUp facilitator. The adjustments in scaling strategy emerged organically from the discussions among innovation teams themselves. In any case, this should not be interpreted as a systematic evaluation or assessment of GenderUp, but rather as early indications of whether and how GenderUp may contribute. A rigorous assessment of GenderUp should be conducted by an outside research team when more cases are available.

GenderUp was piloted in 2021–2022 with two innovation teams that each participated in three online workshops of 3.5 h within a two-week period. The first pilot was an innovation team focused on the ‘DryCard,’ a simple innovation used to determine whether agriculture products have been dried enough for long-term storage. This scaling team of entrepreneurs was producing and selling the DryCard for profit. The second pilot was based at the CGIAR and was piloting a cassava ‘Flash Dryer,’ a more elaborate, medium sized machinery setup in a building that is meant to dry large quantities of cassava relatively quickly to produce high-quality cassava flour (Tran et al., 2022). The pilots were recruited through the networks of the authors and agreed to function as learning experience for the developers of GenderUp. The innovation teams consisted of 7 to 8 AR4D project staff and partners and were diverse in terms of expertise and gender.

4.1. Evolving scaling strategies

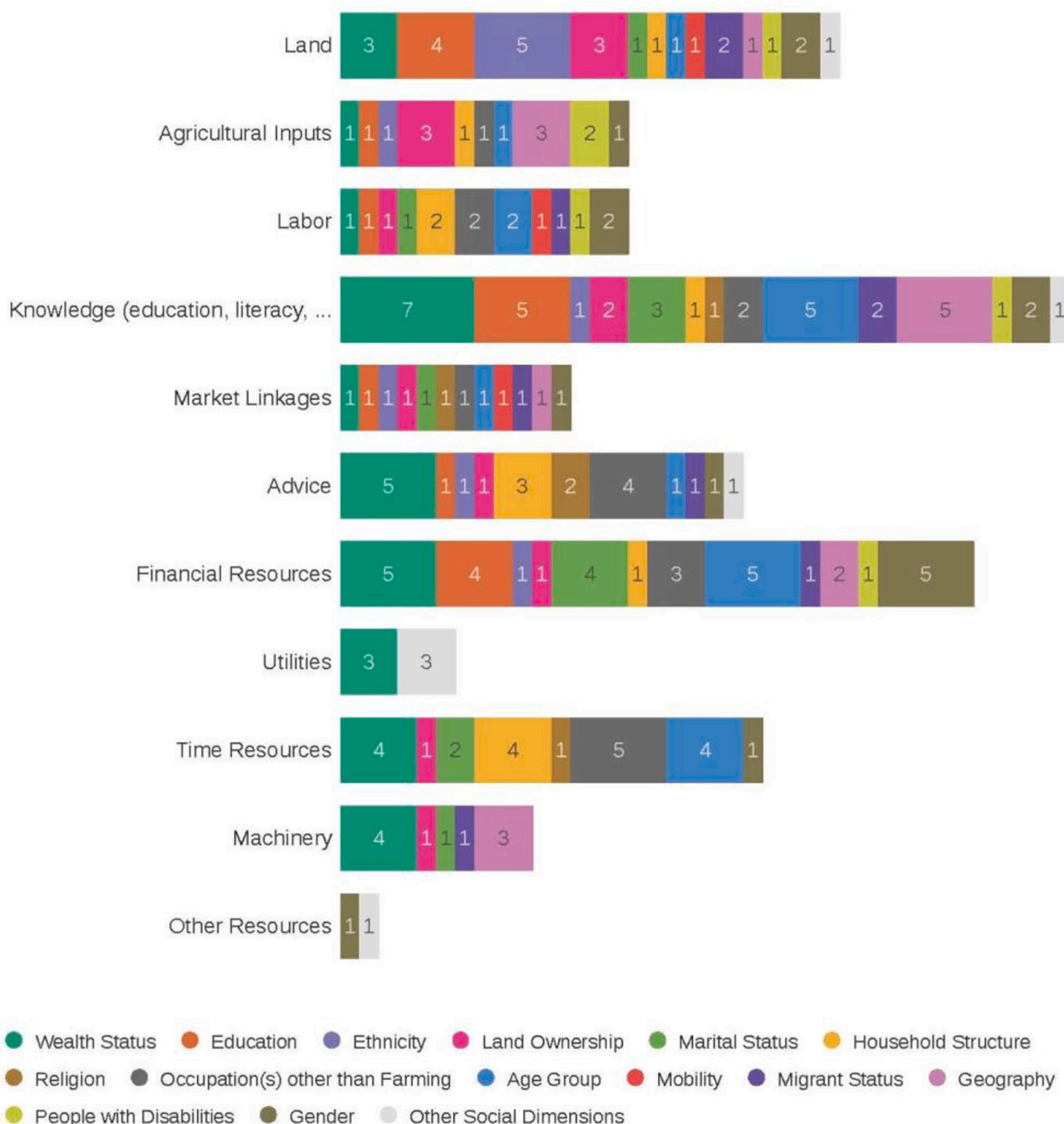
After the workshops, both innovation teams considered more and different types of users, other than standard community archetypes and specifically shifted their focus to ‘at-risk’ users. The ‘at-risk’ users consisted of marginalized and non-users that had been left out of the initial scaling strategies of both teams. When innovation teams realized that this exclusion might contribute to exacerbating existing inequality, they responded by incorporating mitigating activities and more user-specific complimentary innovations into their strategy. As a result, the pilot teams were both able to design more inclusive, gender-responsive and responsible strategies. Table 8 below highlights the differences between the innovation teams’ original scaling strategy and the improved strategy proposed at the end of the GenderUp journey.

For instance, in the initial scaling strategy, both innovation teams had plans for generic training that centered around how the innovation worked and the benefits of using it, and a compilation of complimentary innovations aimed at ‘users.’ However, after considering relevant diversity and its intersection with gender, new strategies emerged. For example, the DryCard innovation team identified low-income women as an at-risk profile, as a result the innovation team re-imagined trainings in regions where low-income women live, provide per diem to account for time away from their work, and offer trainings in relevant languages. This demonstrated an increased awareness of low-income women’s experiences and the necessary complementary innovations to provide access to the benefits of the DryCard. Additionally, when considering women who do not have a lot of power within the household, the DryCard team identified the need to also train men on their attitude towards their partnerships with women. As they put it: “There should be trainings for men too because sometimes they are the ones who put down their wives

Table 4

Example of a summary table that presents the survey results, in this case about issues pertaining to access.

For each of the following resources selected, what are the social dimensions that may impact access to that resource?



and cause them not to have enough confidence to get involved in those innovations or anything else that can provide the women with more income. There should also be trainings for women on how to be more confident so that they would stand up for themselves.”

Similarly, the Flash Dryer team identified unique constraints that women might have. For instance, the team realized that women living further away from the Flash Dryer unit would be less likely to benefit from it because they would struggle to cover transport costs and to find

Table 5
Questions posed in Stage 2 collaboration boards.

-
1. Ability to make use of an innovation
 - What are the 3–5 most important resources (e.g. land, labour) that are required to use the innovation? In case you mentioned other resources, which ones do you mean?
 - What social dimensions (e.g. wealth status, education, religion...) are most influential in determining access to these 3–5 resources?
 - For which of these dimensions does being a man or woman also make a significant difference in whether or not one has access to these 3–5 resources?
 2. Individual consequences of using the innovation
 - What are the 3 most important potential consequences for individuals, according to the survey results?
 - What social dimensions (e.g. wealth status, education, religion...) are most influential in determining which individuals may face positive or negative consequences?
 - Is there a difference in the way men and women experience the effects of these dimensions?
 3. Community benefits and consequences
 - What are the 3 most important potential consequences at community level, according to the survey results?
 - What social dimensions (e.g. wealth status, education, religion...) are most influential in determining who in the community may face positive or negative consequences?
 - Is there a difference in the way men and women experience the effects of these dimensions?
-

Table 6
Questions posed in Stage 3 collaboration board.

-
- Stage 3: understanding implications of intersectionality.
- PRIORITY DIMENSIONS: What are the 3 most important social dimensions that we need to take into account in our further discussion?
For each dimension the following questions are asked:
 - What segments of people within this social dimension may not be able to use or benefit from the innovation or be likely to face negative consequences?
 - For which of these segments of people might other social dimensions (e.g. being a man or a woman) also make a significant difference in whether one is able to benefit from the innovation, or face positive or negative consequences?
 - What are the negative (or positive) individual and/or community level consequences for those who belong to the at-risk segments or intersectional groups? (see Stage 2)
 - What are the immediate causes of these consequences? What bottlenecks, norms or interaction patterns play a role in limiting access or causing negative or positive consequences?
 - Which segments or intersectional groups are most at-risk given the likelihood and severity of the negative consequences that can emerge?
-

the time to travel back and forth. They noted differences in how intra-household power dynamics would play a role in who could invest or have control over the innovation. Importantly their notion of who the innovation users were shifted from not only including direct users (the entrepreneurs that can afford to buy and build the flash dryer) but also including secondary innovation users: the farmers that supplied the flash dryer with roots.

GenderUp guides teams through a process that helps identify at-risk intersectional profiles (see Table 4). At-risk means that they are in danger of being negatively impacted by the innovation or the scaling process. “Intersectional” can in theory be countless elements of diversity. GenderUp facilitators aim for two dimensions, often an at-risk dimension as it intersects with gender, and the innovation team can choose what other elements of diversity are important and relevant to each at-risk intersectional profile. Through the GenderUp process innovation teams identify who is most at risk by considering what resources are needed, and what changes could occur at the individual or community level. The above are examples of how innovation teams responded to the at-risk intersectional profiles that emerged through this process.

Originally, the GenderUp journey was completed by the end of stage 4. Our assumption was that innovation teams would implement their

new strategy autonomously. Implementing an inclusive, gender-responsive and responsible scaling strategy proved difficult however and therefore, based on feedback from the pilot teams, a fifth “Integration” stage was added to the GenderUp journey. In this stage, the innovation teams, with the support from the facilitator, develop an actionable plan with which to exit GenderUp.

In both cases, resources to broaden the scaling strategy to be more inclusive were limited. Additionally, it became apparent that several vulnerable groups did not stand to benefit from the innovation, due to structural barriers including socio-cultural norms. This led to broader conversations among the innovation teams around the gendered differences in a landscape, and whether the innovation and/or the scaling activities had enough scope and resources to take on broad-level social transformation. Innovation teams had to confront how gendered, or otherwise socially differentiated, the benefit of an innovation was. There were honest realizations among team members that some groups of people would still be left behind, considering the innovation’s limitations and the project’s limited resources to include mitigating activities so that marginalized populations could access the benefit of the innovation.

4.2. Observations and feedback from team members about their perspective on gender responsible scaling

As part of the GenderUp process the innovation teams were being introduced to new concepts concerning gender responsible scaling, such as intersectionality, relevant diversity, complementary innovations and mitigation strategies. Below we report and reflect on some typical statements and comments that we recorded as part of the process, or in response to explicit requests for feedback by the facilitators.

Some insights captured were very straightforward, such as, “*I have gained more knowledge about gender inequalities in the use of innovations. Agricultural innovations can transform gender relations in negative & positive ways.*” Other innovation team members integrated this new knowledge and applied it to their innovation and expressed the difficulty of putting in practice these new insights. One innovation team member noted: “*We work in a resource-limited environment, sadly. Shifting resources to these keystone technologies to ensure gender responsible scaling will have downstream effects. Gender and socially marginalized groups should be considered in all scaling endeavors, but in those instances where resources may limit outreach to at risk groups, an expert is needed to consider gender and socially marginalized groups. A neutral, or male dominated approach to scaling would have broad ramifications and consequences.*”

In each case, the discussion between team members, instigated through learning activities and facilitated questions, seemed to be the most effective mechanism in fostering new insights. The learning activities and (survey) questions appeared instrumental in evoking these discussions. Observations indicate that the time and resources that innovation teams dedicated to thinking through gendered components of their innovation and scaling strategy allowed team members with biophysical and social science backgrounds to better understand and engage with one another. This may have contributed to a more nuanced understanding of gender and social inclusion and greater recognition of the complicated nature of social experiences, and the importance of considering and incorporating these nuances into scaling strategies for effective development outcomes. While it is too early to know if these teams followed through with their new gender responsible scaling plans, the depth of the conversations coupled with the application of the gender concepts provided hope that innovation teams will be able to integrate this new knowledge more routinely in their scaling pursuits.

5. Analysis and discussion

Below, based on the piloting process, several preliminary observations are highlighted regarding the gender responsive and socially inclusive scaling ambitions that GenderUp stresses.



Fig. 5. Visual impression of (part of) online collaboration board Stage 3: Understanding implications of intersectionality.

Table 7
Questions posed in Stage 4 collaboration board.

<p>Stage 4: Mitigating consequences and embracing opportunities: your adapted scaling strategy</p> <p>What are the segments / intersectional groups to which we will pay special attention when adapting our scaling strategy?</p> <p>For each segment / intersectional group the following questions are asked:</p> <ul style="list-style-type: none"> - What risks or negative consequences need to be mitigated for this group? What positive consequences can be promoted for them? (see Stage 3) - What needs to be changed in the training plan? - How should communication strategies and media-use be changed? - What arrangements (i.e. complementary innovations) need to be in place (a) to foster access to relevant resources, and/or (b) to mitigate risks or ensure positive consequences? - What new partnerships do we need to established in view of our changing scaling strategy? - Is it possible and realistic to expect that scaling has positive consequences for this group of people?

Systemic issues: One of the prominent and challenging realizations for the pilot innovation teams was that their innovation, which may scale well within a certain context for certain people, may unintentionally underscore or exacerbate social inequities. This is often true as those with power and resources within a community can afford taking risk and ultimately benefit from innovation. Developing complementary innovations or mitigating activities to undo or work around the systematic and structural inequities within the social landscape is daunting – and oftentimes not (fully) feasible within the boundaries, mandates, and available budgets that innovation teams are confronted with. Our early experiences indicate that teams found it difficult to determine who should be responsible for mitigating activities. Some stakeholders, such as private sector, may feel they are not responsible for this. Socially motivated groups, such as NGOs, may not have the resources. Those with the most resources, such as policy makers, tend to have a myriad of competing interests. Thus, it may be particularly challenging, or impossible, to simply ‘re-package’ innovations to make them more inclusive, once the innovation has been developed or introduced without prior consideration of these social groups.

Navigating systems thinking for social transformation: Given the above reflection on systemic challenges, developing and designing innovations from the start with the intention to achieve social transformations that benefit marginalized groups may be a more direct path to meaningful social change. This strategy requires innovation teams to

maintain focus on high-level social goals concerning gender and social equity from the beginning on an innovation development process. GenderUp is based on a systems perspective, thinking in terms of packages and making existing innovations more transformative. However, by taking existing innovations as the point of departure, the risk is that the proposed innovations may simply reproduce current social inequities. That is, scaling innovation for social transformation must navigate a tension between innovating to disrupt the current social and cultural landscape; and scaling that adapts to the existing context and strives to enhance the prospects for marginalized groups by stretching some of the contextual boundaries.

This is a tension in the set-up and rationale of GenderUp, that is arguably reflective of the context in which it has been developed, notably the CGIAR research establishment that needs to demonstrate impact to donors that often have a strong belief in scaling of technologies as part of market-based development pathways (see Cummings et al., 2022; Leeuwis et al., 2018). Even so, there is no solid reason to assume that the scaling of innovations that have been developed from the start with transformative ambitions will not be accompanied by unanticipated effects and unequal opportunities to benefit. Thus, GenderUp can potentially be a useful method to enhance the conversation about social differentiation in projects and programs to be used at different stages of their execution.

Integrating gender and social awareness: Our first pilots indicate that GenderUp may push boundaries in the sense that innovation teams became aware of the limitations of their current ambition and strategy, but these experiences also suggest that GenderUp cannot immediately alter the status quo logic within which such teams work. One might assume that the earlier a gender and socially inclusive lens is applied the better and more cost-effective resources, partners, iterative processes, and project plans can support the distribution of the innovation’s benefits. Additionally, the earlier a gender-lens is applied the more open innovation teams may be to choosing a different innovation that achieves the same development goal but is more socially inclusive. Broader experiences with AR4D organizations suggest that innovation teams can become dedicated to particular innovation, particularly after years of resources spent working on them, which can make it difficult to re-direct despite new information. In summary, it is likely that the stage at which GenderUp (or another social reflection method) is applied will affect how successful an innovation team can be in achieving their social goals and/or not causing harm to already marginalized populations.

Scaling team’s composition matters: Being gender aware and

Table 8
Shift in scaling initiatives from baseline to adapted scaling strategy in Case 1 and 2.

Scaling components	DryCard baseline scaling strategy	DryCard mitigated scaling strategy	Flash Dryer baseline scaling strategy	Flash Dryer mitigated scaling Strategy
Purpose for scaling	Improved nutrition, increased income	Equitable distribution of increased incomes	Yield and income	Equitable access to the benefits of the flash dryer
Original intended users /adjusted at-risk profiles	Farmers that produce for the market	Rural, low-income women who may not have decision making power in their homes	Engineers and cassava aggregators	Producers who are rural, low-income women who may not have high-level of cassava expertise
Resources needed to use innovation	Hermetic storage bags, glass jars	Pictorial dry card instead of written text	Credit system to purchase necessary inputs	Increase awareness about available government subsidies for inputs; Increase awareness about the distribution of improved varieties; access to credit through innovative means (contract farming)
Training	Benefits of the Innovation and why it is important	Trainings for men and women on household dynamics, build confidence of both parties to use DryCard; Trainings in appropriate regional language	Engineering/technical training needed to ensure smooth running of machine/factory.	Training when women are available and in an accessible location (in terms of care work, space, and proximity); Training focused on skills necessary to understand and implement quality standards. (e.g. don't just teach quality standards, teach how to use moisture measurements, how to store appropriately)
Media / communication methods	Printing of training materials; extension officers; agro-dealers	Use (relevant) cooperatives, who can help recruit relevant groups of people	Virtual workshop with general public (stakeholders/decision-makers) to discuss the cassava value chain in general, and how this technology can improve the value chain	Radio ads, using existing trade and media outlets, partnering with micro-finance institutions and other NGOs.
Other complementary innovations	Bundle innovation with other dry chain technologies, more demonstration on how innovation and marketing can work.	Decision trees for producers; Follow-up curriculum; Evaluation of curriculum and success of training for women	Market products as socially inclusive / building communities	Women farmer-to-women farmer training - including quality standard certificates of completion; Subsidies for complementary inputs through government programs; connect/partner with local NGOs that have experience working with some of the poorest households, and particularly women

socially inclusive means being willing to think through challenging questions with not-exact answers. GenderUp provides a methodology to systematically think through questions about a group of people that many on the innovation team might not identify with. In this context it is likely that the rigor in conversations towards an informed understanding of the possible negative consequences or challenges to experiencing the benefit of an innovation is dependent on the experiences and expertise of participants. As a result, GenderUp puts a premium on who is at the table for these discussions. In connection with this, team dynamics and outcomes (i.e., the gender informed scaling strategy) may well be affected by possible power relationships related to different disciplines, gender, backgrounds and positions of the team members.

This stresses the need to invest time and effort in assuring that a representative team is chosen to participate in the GenderUp sessions. An existing team that presents itself will have to be extended or recomposed to allow GenderUp to bring out optimal insights, and extra effort may be needed to identify stakeholders and experts knowledgeable on the country or region a scaling team operates in, to join the team. Bringing together a transdisciplinary team however does not guarantee success as they have to engage with each other in a meaningful and non-hierarchical way (Phillips, 2017), hence the need for a GenderUp facilitator trained in creating such an interactive environment.

In connection with team composition, it is relevant to note that potential end-users or indirectly affected groups were not represented in the early GenderUp pilots. At the same time, it is clear that tapping into their perspectives and experiences would be relevant, also because the first experiences with GenderUp make clear that current team members cannot always answer all questions posed in the GenderUp process. Thus, GenderUp serves to articulate what the team members do not yet know about how and what social differentiation matters in their scaling context. Such knowledge gaps could be remedied in part by direct involvement of potential users, or by building in an extra step and period of information collection halfway through the process.

Prospects in development and evaluation: GenderUp is currently tailored to innovation teams that already have a specific innovation that they feel is worth scaling. In future work, we want to expand the method to include agenda and priority setting for research and innovation design. GenderUp could be restructured to be used at the onset of an innovation team's endeavor, that is, in the initial scaling phase where aspirational and desired outcomes and corresponding innovations are defined, chosen and created in order to foster more socially equitable outcomes.

The lines of questioning and exploration in GenderUp are currently geared towards farm-level innovations, but the pilots indicate that innovation packages may well involve other elements and users such as non-rural actors. Moreover, there exist numerous innovations that are directed at different types of end-users than farmers (e.g. local food processors), even though farmers are eventually supposed to benefit as well. The initial experiences with GenderUp suggest that the way in which questions are phrased may need to be adapted to the different types of end-users involved, and we strive to incorporate this complexity in a more systematic way in the future.

GenderUp has received promising feedback in its initial pilots. However, to gain a comprehensive understanding of its impact on a larger scale, more thorough testing is required. For example, there is a need for more substantial evidence to confirm that the tool can effectively influence innovation teams to avoid negative consequences for marginalized populations over extended periods. In the short term, GenderUp should strive to demonstrate its capacity to influence scaling plans and prompt innovation teams to adjust their strategies accordingly for implementation. Conducting a greater variety of case-studies will also allow for a rigorous assessment of whether the conversational method does indeed contribute to redirecting scaling trajectories towards greater inclusiveness, and of how the GenderUp process can be improved. Additionally, while we have so far piloted GenderUp in projects that involved outside intervention and funding, more

experience should be obtained in the field and with community-led-grassroots innovation development.

To enable the more widespread use of GenderUp several facilitators' trainings have been conducted, and there are plans to translate the web-based facilitator guide and materials in other languages. GenderUp is also useful as combined with other scaling tools, such as Scaling Readiness or the Scaling Scan. GenderUp, as noted previously, was created in response to a lack of gender or other relevant social differences present in other scaling tools. Thus, GenderUp should be used with these tools to enable innovation teams to avoid unintended consequences for marginalized populations. Considering this, as Scaling Readiness expands within the CGIAR in its current format as the *Innovation Platform for Scaling Readiness* (Kangethe et al., 2023), GenderUp can similarly extend with its presence throughout the system.

6. Conclusion

Innovation is critical to achieve development goals that are focused on social transformation, and scaling of innovation that aims to improve livelihoods of key populations is essential to realize these development outcomes. While many innovations exist within the AR4D space, and scaling tools are available to help researchers and practitioners assess and strategize their increased use, very few tools assist researchers in understanding the distributed effects of an innovation. GenderUp responds to this gap and has been designed to support initiatives in making their scaling efforts more inclusive and responsible.

Early experiences with two GenderUp pilots provide indications that facilitated learning activities and conversations can support the actual development of more inclusive scaling strategies. Through more awareness and acknowledgment of differentiated experiences on access to innovations and distribution of benefits, innovation teams were able to identify vulnerable groups and unintended outcomes and come up with possible complementary innovations and mitigating strategies towards more responsible scaling.

The first experiences with GenderUp suggest that the method can invoke meaningful discussion and reflection on how innovations may help or hinder certain groups. This can trigger innovation teams to consider different and specifically marginalized users that would otherwise be left out under their current scaling strategy – thus exacerbating inequities within the cultural landscape. In the pilots, such realizations resulted in new priority, at-risk intersectional profiles, and strategies to reach them. Thus, the conversational method seems to have potential to add value to existing scaling support methods that tend to be blind for gender and social differentiation. At the same time, it effectively complements existing conversational approaches to responsible research and innovation that tend to be used in upstream techno science, enabling us to have meaningful discussions about responsible scaling. Our experience suggests that it may be useful to include elements of upstream responsible innovation into GenderUp to ensure gender responsible development of agricultural innovations at an earlier stage in AR4D activity. This could help avoid that GenderUp is used only for innovations that have poor transformative potential to begin with. Thus, further research should be conducted to understand the usefulness of GenderUp in the development of innovations for social equity and for enhancing the conversation around innovation initiatives taken by grassroots organizations.

The process of developing GenderUp has highlighted a significant need for AR4D organizations and managers to pay closer attention to social differentiation in how they choose and scale innovation. As a 'development' community we are tasked with a significant responsibility to make progress on social experiences, whether it be increased nutrition, income, or empowerment. If we continue to leave the social aspects out of the data we use to provide solutions to these social issues, we will continue to fall short of achieving socially driven SDGs. GenderUp when integrated and used early enough can be an important way to prioritize and target specific users and can be marketed

to donors as a way to provide a realistic overview where to invest for maximal social impact. GenderUp reports can therefore act as a succinct or summarized version of a gap analysis, especially in a context where the CGIAR stresses social impact through the five impact areas that they prioritised: poverty reduction, food and nutrition security, gender and youth inclusion, climate adaptation and environmental protection (CGIAR System Organization, 2021; Donovan et al., 2022).

Funding

The CGIAR Independent Science for Development Council (ISDC) supported the open access of this article. This work was supported by the CGIAR research Program on Roots, Tubers, and Bananas (CRP-RTB) and the Netherlands – CGIAR research program of the Dutch Research Council (NWO), and salary was supported by University of California, Davis; the CGIAR Initiative on Low-Emission Food Systems (Mitigate+) and the CGIAR initiative on Diversification in East and Southern Africa (Ukama Ustawi). We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund.

CRedit authorship contribution statement

Erin McGuire: Conceptualization, Methodology, Resources, Writing – original draft, Writing – review & editing. **Cees Leeuwis:** Conceptualization, Funding acquisition, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Anne M. Rietveld:** Conceptualization, Funding acquisition, supervision, methodology, Project administration, Resources, Writing – original draft. **Béla Teeken:** Conceptualization, Methodology, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

- Adjei-Nsiah, S., Leeuwis, C., Sakyi-Dawson, O., Giller, K.E., Kuyper, T.W., 2007. Exploring diversity among farmers for orienting inter-disciplinary action research on cropping system management in Wenchi, Ghana: the significance of time horizons. *Int. J. Agric. Sustain.* 5 (2–3), 176–194.
- Assan, N., 2023. Socio-cultural, economic, and environmental implications for innovation in sustainable food in Africa. In: *Frontiers in Sustainable Food Systems*, vol. 7. <https://doi.org/10.3389/fsufs.2023.1192422>. Frontiers Media SA.
- Badstue, L., Lopez, D.E., Umantseva, A., Williams, G., Elias, M., Farnworth, C.R., Rietveld, A., Njuguna-Mungai, E., Luis, J., Najjar, D., Kandiwa, V., 2018. What drives capacity to innovate? Insights from women and men small-scale farmers in Africa, Asia, and Latin America. *Journal of Gender, Agriculture and Food Security* 3 (1), 54–81.
- Badstue, L., van Eerdewijk, Anouka, Danielsen, Katrine, Hailemariam, Mahlet, Mukewa, Elizabeth, 2020. How local gender norms and intra-household dynamics shape women's demand for labor-saving technologies: insights from maize-based livelihoods in Ethiopia and Kenya. *Gender, Technology and Development* 24 (3), 341–361. <https://doi.org/10.1080/09718524.2020.1830339>.
- Barrett, C., et al., 2020. Socio-technical innovation bundles for agri-food systems transformation, Report of the International Expert Panel on Innovations to Build Sustainable, Equitable, Inclusive Food Value Chains. Ithaca, NY, and London: Cornell Atkinson Center for Sustainability and Springer Nature, 2020. A brief comment based on the report appears in the December 2020 issue of *Nature Sustainability*.
- Bijker, W.E., Law, J., 1992. *Shaping Technology/Building Society: Studies in Sociotechnical Change*. MIT Press, Cambridge MA.
- Boon, W.P.C., Moors, E.H.M., Kuhlmann, S., Smits, R.E.H.M., 2008. Demand articulation in intermediary organizations: the case of orphan drugs in the Netherlands. *Technol. Forecast. Soc. Chang.* 75 (5), 644–671.
- Bouwman, T.I., Anderson, J.A., Giller, K.E., 2021. Herbicide induced hunger? Conservation agriculture, Ganyu labour and rural poverty in Central Malawi. In: *Journal of Development Studies* 57 (2021), 2.

- Bullock, R., Tegbaru, A., 2019. Women's agency in changing contexts: a case study of innovation processes in Western Kenya. *Geoforum* 105 (July), 78–88. <https://doi.org/10.1016/j.geoforum.2019.07.007>.
- Carter, B., Joshi, A., Remme, M., 2018. Scaling up Inclusive Approaches for Marginalised and Vulnerable People. K4D Emerging Issues Report. Institute of Development Studies, Brighton, UK. Retrieved from. https://assets.publishing.service.gov.uk/media/5b69bf34ed915d2bbc0bb896/Scaling_up_inclusive_approaches_for_marginalised_and_vulnerable_people.pdf.
- CGIAR System Organization, 2021. CGIAR 2030 Research and Innovation Strategy: Transforming food, land, and water systems in a climate crisis. CGIAR System Organization, Montpellier, France.
- Cohen, P.J., Lawless, S., Dyer, M., 2016. Understanding adaptive capacity and capacity to innovate in social-ecological systems: applying a gender lens. *Ambio* 45, 309–321. <https://doi.org/10.1007/s13280-016-0831-4>.
- Colfer, C., Basnett, B., Ihalainen, M., 2018. Making sense of intersectionality: A manual for lovers of people and forests. In: CIFO Occasional Paper 184. Center for International Forestry Research, Bogor, Indonesia.
- Crenshaw, K., 2005. Mapping the Margins: Intersectionality, Identity Politics, and Violence against Women of Color (1994).
- Crenshaw, K., Gotanda, N., Peller, G., Thomas, K., 1995. Critical Race Theory: The Key Writings That Formed the Movement. <https://scholarship.law.columbia.edu/books/101>.
- Cummings, S., Kiwanuka, S., Regeer, B., 2022. The private sector in knowledge brokering for international development: what the experts say. *Inf. Dev.* 38 (1), 52–67. <https://doi.org/10.1177/0266666920977597>.
- Donovan, J., Coaldrake, P., Rutsaert, P., Bänzinger, M., Gitonga, A., Naziri, D., Demont, M., Newby, J., Ndegwa, M., 2022. Market intelligence for informing crop-breeding decisions by CGIAR and NARES. In: Market Intelligence Brief Series, 1. CGIAR, Montpellier. <https://hdl.handle.net/10883/22248>.
- Doss, C., 2006. Analyzing technology adoption using microstudies: limitations, challenges, and opportunities for improvement. *Agric. Econ.* 34, 207–219. <https://doi.org/10.1111/j.1574-0864.2006.00119.x>.
- Farnworth, C.R., Badstue, L., Williams, G.J., Tegbaru, A., Gaya, H.I.M., 2020. Unequal partners: associations between power, agency and benefits among women and men maize farmers in Nigeria. *Genet. Technol. Dev.* 24 (3), 271–296. <https://doi.org/10.1080/09718524.2020.1794607>.
- Gaitán-Cremaschi, D., Klerkx, L., Duncan, J., Trienekens, J.H., Huenchuleo, C., Dogliotti, S., Contesse, M.E., Rossing, W.A.H., 2019. Characterizing diversity of food systems in view of sustainability transitions. A review. *Agronomy for Sustainable Development* 39, 1. <https://doi.org/10.1007/s13593-018-0550-2>.
- Gebreyes, M., Mekonnen, K., Thorne, P., Derseh, M., Adie, A., Mulema, A., et al., 2021. Overcoming constraints of scaling: critical and empirical perspectives on agricultural innovation scaling. *PLoS One* 16 (5), e0251958. <https://doi.org/10.1371/journal.pone.0251958>.
- Geels, F.W., 2011. The multi-level perspective on sustainability transitions: responses to seven criticisms. *Environ. Innov. Soc. Trans.* 1, 24–40.
- Glover, D., Sumberg, J., Andersson, J.A., 2016. The adoption problem; or why we still understand so little about technological change in African agriculture. *Outlook on AGRICULTURE* 45 (1), 3–6.
- Glover, D., Sumberg, J., Ton, G., Andersson, J., Badstue, L., 2019. Rethinking technological change in smallholder agriculture. *Outlook Agric.* 48, 169–180. <https://doi.org/10.1177/0030727019864978>.
- Hackfort, S., 2021. Patterns of inequalities in digital agriculture: a systematic literature review. *Sustainability* 13, 12345. <https://doi.org/10.3390/su132212345>.
- Hall, A., Dijkman, J., 2019. Public Agricultural Research in an Era of Transformation: The Challenge of Agri-Food System Innovation. Rome and Canberra: CGIAR Independent Science and Partnership Council (ISPC) Secretariat and Commonwealth Scientific and Industrial Research Organisation (CSIRO), IX + 67 pp.
- Hooks, B., 2015. *Feminism Is for Everybody: Passionate Politics*, 2nd ed. Routledge.
- Jacobs, F., Ubels, J., Woltering, L., 2018. The scaling scan - a practical tool to determine the strengths and weaknesses of your scaling ambition. PPPlab and CIMMYT. <https://repository.cimmyt.org/handle/10883/20505>.
- Kabeer, N., 2014. Social Justice and the Millennium Development Goals: the Challenge of Intersecting Inequalities, *The Equal Rights Review*, Vol. Thirteen Colfer CJP, Basnett BS and Ihalainen M. 2018. Making sense of 'intersectionality': A manual for lovers of people and forests. Occasional Paper 184. CIFOR, Bogor, Indonesia.
- Kangethe, E., Schut, M., Dror, I., 2023. Innovation Packages: CGIAR's Transformative Strategy for Scaling Agricultural Solutions. CGIAR Blog. <https://www.cgiar.org/news-events/news/innovation-packages-cgiars-transformative-strategy-for-scaling-agricultural-solutions/>.
- Kansanga, M., Andersen, P., Kpienbaareh, D., Mason-Renton, S., Atuoye, K., Sano, Y., Antabe, R., Luginaah, I., 2019. Traditional agriculture in transition: examining the impacts of agricultural modernization on smallholder farming in Ghana under the new green revolution. *International Journal of Sustainable Development & World Ecology* 26 (1), 11–24. <https://doi.org/10.1080/13504509.2018.1491429>.
- Kawarazuka, N., Prain, Gordon, 2019. Gendered processes of agricultural innovation in the northern uplands of Vietnam. *Int. J. Genet. Entrep.* 11, 210–226. <https://doi.org/10.1108/IJGE-04-2019-0087>.
- Kawarazuka, N., Prain, G., Forsythe, L., Mayanja, S., Mudege, N., Babini, C., Polar, V., 2018. Gender in Agricultural Mechanization: Key guiding questions. CIP, Lima, Peru.
- Klerkx, L., Rose, D., 2020. Dealing with the game-changing technologies of agriculture 4.0: how do we manage diversity and responsibility in food system transition pathways? *Global Food Security* 24: 100347, 1–7. <https://doi.org/10.1016/j.gfs.2019.100347>.
- Kristjansson, P., Bryan, E., Bernier, Q., Twyman, J., Meinzen-Dick, R., Kieran, C., Ringler, C., Jost, C., Doss, C., 2017. Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? *International Journal of Agricultural Sustainability* 15 (5), 482–500. <https://doi.org/10.1080/14735903.2017.1336411>.
- Leeuwis, C., 2004. Communication for Rural Innovation. Rethinking Agricultural Extension. Blackwell Science/CTA, Oxford/Wageningen, p. 412.
- Leeuwis, C., 2013. Coupled Performance and Change in the Making. Inaugural lecture. Wageningen University, Wageningen.
- Leeuwis, C., Aarts, M.N.C., 2021. Rethinking adoption and diffusion as a collective social process. Towards an interactional perspective. In: Campos, H. (Ed.), *The Innovation Revolution in Agriculture - A Roadmap to value creation*. Springer press, Cham, Switzerland, pp. 95–116.
- Leeuwis, C., Boogaard, B.K., Atta-Krah, K., 2021. How food systems change (or not): governance implications for system transformation processes. *Food Security* 13, 761–780. <https://doi.org/10.1007/s12571-021-01178-4>.
- Leeuwis, C., Klerkx, L., Schut, M., 2018. Reforming the research policy and impact culture in the CGIAR : Integrating science and systemic capacity development. *Global Food Security* 16, 17–21.
- Ludwig, D., Macnaghten, P., 2020. Traditional ecological knowledge in innovation governance: a framework for responsible and just innovation. *J. Resp. Innov.* 7, 26–44. <https://doi.org/10.1080/23299460.2019.1676686>.
- MacLachlan, M., McVeigh, J., Huss, T., Mannan, H., 2019. Macropsychology: Challenging and changing social structures and systems to promote social inclusion. In: O'Doherty, K.O., Hodgetts, D. (Eds.), *The SAGE Handbook of Applied Social Psychology*. SAGE Publications Limited, Darrin Thousand Oaks, CA, pp. 166–183.
- MacNaghten, P., 2016. The metis of Responsible Innovation: Helping Society to Improve the Conversation between Today and Tomorrow. Inaugural Lecture. Wageningen University.
- Mausch, K., Hall, A., Hambloch, C., 2020. Colliding paradigms and trade-offs: Agri-food systems and value chain interventions. In: *Global Food Security*, vol. 26. Elsevier B. V.
- McDougall, Cynthia, Badstue, Lone Bech, Mulema, Annet Abenakyo, Fischer, Gundula, Najjar, Dina, Pyburn, Rhiannon, Elias, Marlène, Joshi, Deepa, Vos, Andrea, 2021. Toward structural change: Gender transformative approaches. In: Advancing gender equality through agricultural and environmental research: Past, present, and future, eds. Rhiannon Pyburn, and Anouka van Eerdewijk. Chapter 10. International Food Policy Research Institute (IFPRI), Washington, DC, pp. 365–401. https://doi.org/10.2499/9780896293915_10.
- McGuire, E., Rietveld, A., Crump, C., Leeuwis, C., 2022. Anticipating Gender Impacts in Scaling Agriculture for Development Technologies: Insights from the Literature. *World Development Perspectives*.
- McGuire, E., Boa-Alvarado, M., Marina Valencia Leñero, E., Al-Zu'bi, M., Giang Luu, L., Sylvester, J., 2024. X Equity Principles for Social Transformation. *Agricultural Systems (Forthcoming)*.
- Moore, M.-L., Riddell, D., Vocisano, D., 2015. Scaling out, scaling up, scaling deep: strategies of non-profits in advancing systemic social innovation. *J. Corp. Citizsh.* 15 (58), 67–84. <https://doi.org/10.9774/gleaf.4700.2015.ju.00009>.
- Mudege, N., Mdege, N. Putri, Abidin, E., Bhatasara, Sandra, 2017. The role of gender norms in access to agricultural training in Chikwawa and Phalombe, Malawi. *Gender, Place & Culture* 24 (12), 1689–1710. <https://doi.org/10.1080/0966369X.2017.1383363>.
- Mudege, N. Robert, Mwanga, O.M., Mdege, Norita, Chevo, Tafadzwa, Abidin, Putri E., 2018. Scaling up of sweetpotato vine multiplication technologies in Phalombe and Chikwawa districts in Malawi: a gender analysis, NJAS: Wageningen journal of Life Sci. 85 (1), 1–9. <https://doi.org/10.1016/j.njas.2018.05.003>.
- Njuki, J., et al., 2022. A review of evidence on gender equality, women's empowerment, and food systems. *Global Food Security* 33, 100622. ISSN 2211–9124. <https://doi.org/10.1016/j.gfs.2022.100622>.
- Norton, G.W., Alwang, J., 2020. Changes in agricultural extension and implications for farmer adoption of new practices. *Appl. Econ. Perspect. Policy* 42 (1), 8–20. <https://doi.org/10.1002/aep.13008>.
- Offen, K., 1988. Defining feminism: a comparative historical approach. *Signs* 14 (1), 119–157. <http://www.jstor.org/stable/3174664>.
- Owen, R., Macnaghten, P., Stilgoe, J., 2012. Responsible research and innovation: from science in society to science for society, with society. *Sci. Public Policy* 39 (6), 751–760. <https://doi.org/10.1093/scipol/scs093>.
- Paris, T.R., Chi, T.T.N., 2005. The impact of row seeder technology on women labor: a case study in the Mekong Delta, Vietnam. *Gender, Technology and Development* 9 (2), 157–184. <https://doi.org/10.1177/09718524050090201>.
- Pearce, D., 1978. The feminization of poverty: women, work, and welfare. *Urban Soc. Chang. Rev.* 11, 28–36.
- Petesich, P., Badstue, L., Prain, G., 2018a. Gender Norms, Agency, and Innovation in Agriculture and Natural Resource Management: The GENNOVATE Methodology. CIMMYT.
- Petesich, P., Bullock, R., Feldman, S., Badstue, L., Rietveld, A., Bauchspies, W., Kamanzi, A., Tegbaru, A., Yila, J., 2018b. Local normative climate shaping agency and agricultural livelihoods in sub-Saharan Africa. *Journal of Gender, Agriculture and Food Security* 3 (1), 108–130. <https://doi.org/10.19268/JGAFS.312018.5>.
- Phillips, K., 2017. What is the real value of diversity in organizations? Questioning our assumption. In: Page, S. (Ed.), *The Diversity Bonus, How Great Teams Pay Off in the Knowledge Economy*. Princeton University Press, pp. 223–245.
- Polar, V., Babini, C., Velasco, C., Fonseca, P.F.C., 2017. Technology Is Not Gender Neutral, pp. 1–42.
- Quijano, A., Ennis, M., 2000. Coloniality of power, eurocentrism, and Latin America. *Nepantla: Views from South* 1 (3), 533–580. <https://www.muse.jhu.edu/arti cle/23906>.

- Quisumbing, A., Meinzen-Dick, R., Malapit, H., 2019. Gender equality: Women's empowerment for rural revitalization. In: In 2019 Global Food Policy Report. International Food Policy Research Institute, pp. 44–51.
- Quisumbing, A.R., Meinzen-Dick, R., Raney, T.L., Croppenstedt, A., Behrman, J.A., Peterman, A., 2014. Closing the knowledge gap on gender in agriculture. In: *Gender in Agriculture*. Springer, Netherlands, pp. 3–27. https://doi.org/10.1007/978-94-017-8616-4_1.
- Rietveld, A.M., van der Burg, M., 2021. Separate and joint interests: understanding gendered innovation processes in Ugandan farm systems. *Frontiers in Sustainable Food systems* 5, 666051. <https://doi.org/10.3389/fsufs.2021.666051>.
- Rietveld, A.M., Van der Burg, M., Groot, J.C.J., 2020. Bridging youth and gender studies to analyse rural young women and men's livelihood pathways in Central Uganda. *Journal of Rural Studies* 75, 152–163. <https://doi.org/10.1016/j.jrurstud.2020.01.020>.
- Rogers, E.M., 2005. *Diffusion of Innovations*, 5th edition. Free Press, New York.
- Rola-Rubzen, M.F., Paris, T., Hawkins, J., Sapkota, B., 2020a. Improving gender participation in agricultural technology adoption in Asia: from rhetoric to practical action. *Appl. Econ. Perspect. Policy* 42 (1), 113–125. <https://doi.org/10.1002/aapp.13011>.
- Rola-Rubzen, M.F., Paris, T., Hawkins, J., Sapkota, B., 2020b. Improving gender participation in agricultural technology adoption in Asia: from rhetoric to practical action. *Appl. Econ. Perspect. Policy* 42 (1), 113–125. <https://doi.org/10.1002/aapp.13011>.
- Sánchez Rodríguez, A.M., MacLachlan, M., Brus, A., 2021. The coordinates of scaling: facilitating inclusive innovation. *Syst. Res. Behav. Sci.* 38 (6), 833–850.
- Sartas, M., Schut, M., Thiele, G., Proietti, C., Leeuwis, C., 2020. Scaling readiness: science and practice of an approach to enhance impact or research for development. *Agr. Syst.* 183, 102874.
- Schroeder, R.A., Geography, E., Oct, P., 1993. Shady practice : gender and the political ecology of resource stabilization in Gambian garden / orchards shady practice : gender and the political ecology of resource stabilization in Gambian ~ a r d e n l ~ r c h a r d s. *Environment* 69 (4), 349–365.
- Schut, M., Leeuwis, C., Thiele, G., 2020. Science of Scaling: Understanding and guiding the scaling of innovation for societal outcomes. *Agricultural Systems*. 184, 102908.
- Scott, W. Richard, 2014. *Institutions and Organizations: Ideas, Interests, and Identities*. Sage Publications (fourth edition).
- Slegh, H., Barker, G., Kimonyo, A., Ndolimana, P., Bannerman, M., 2013. "I can do women's work": reflections on engaging men as allies in women's economic empowerment in Rwanda. *Gen. Dev.* 21 (1), 15–30. <https://doi.org/10.1080/13552074.2013.767495>.
- Stilgoe, J., Owen, R., Macnaghten, P., 2013. Developing a framework of responsible innovation. *Res. Policy* 42 (9), 1568–1580.
- Tavener, Katie, Crane, T., Bullock, R., Galiè, A., 2022. Intersectionality in gender and agriculture: toward an applied research design. *Gender, Technology and Development* 26 (3), 385–403. <https://doi.org/10.1080/09718524.2022.2140383>.
- Teeken, B., Garner, E., Agbona, A., Balogun, I., Olaosebikan, O., Bello, A., Madu, T., Okoye, B., Egesi, C., Kulakow, P., Tufan, H., 2021. Beyond "women's traits": exploring how gender, social difference and household characteristics influence trait preferences. *Frontiers in Sustainable Food Systems, land livelihood and food security* 5, 740926. <https://doi.org/10.3389/fsufs.2021.740926>. <https://www.frontiersin.org/articles/10.3389/fsufs.2021.740926/abstract>.
- Tran, T., Abass, A., Taborda Andrade, L.A., Chapuis, A., Precoppe, M., Adinsi, L., Bouniol, A., Ojide, M., Adegbite, S.A., Lukombo, S.S., Sartas, M., Teeken, B., Fotos Kuate, A., Ndjouenkeu, R., Moreno, M., Belalcázar, J., Becerra López-Lavalle, A.B., Dufour, D., 2022. Cost-effective cassava processing: Case study of small-scale flash-dryer reengineering. In: Thiele, G., Friedmann, M., Campos, H., Polar, V., Bentley, J. W. (Eds.), *Root, Tuber and Banana Food System Innovations*. Springer, Cham. https://doi.org/10.1007/978-3-030-92022-7_4.
- USAID, 2018. *Guide to the Agricultural Scalability Assessment Tool for Assessing and Improving the Scaling Potential of Agricultural Technologies*.
- Van Schoubroeck, F., Leeuwis, C., 1999. Enhancing social cognition for combating the Chinese citrus fly in Bhutan. In: Leeuwis, C. (Ed.), (1999). *Integral Design: Innovation in Agriculture and Resource Management*. 145–171. Mansholt Institute / Backhuys Publishers. Wageningen / Leiden.
- Venkatesh, V., Davis, F.D., 2000. A theoretical extension of the technology acceptance model: four longitudinal field studies. *Manag. Sci.* 46 (2), 186–204.
- Making scale work for sustainable development: a framework for responsible scaling of agricultural innovations. In: Wigboldus, S.A., Klerkx, L.W.A., Leeuwis, C., Adenle, A. A., Chertow, M.R., Moors, E.H.M., Pannell, D.J. (Eds.), 2020. *Science, Technology, and Innovation for Sustainable Development Goals: Insights from Agriculture, Health, Environment, and Energy*, 1 ed. Oxford University Press, New York, pp. 518–543.
- Wigboldus, S., McEwan, M.A., van Schagen, B., Okike, I., van Mourik, T.A., Rietveld, A., et al., 2022. Understanding capacities to scale innovations for sustainable development: a learning journey of scaling partnerships in three parts of Africa. *Environ. Dev. Sustain.* <https://doi.org/10.1007/s10668-022-02394-4>.
- Woltering, L., Fehlenberg, K., Gerard, B., Ubels, J., Cooley, L., 2019. Scaling – from "reaching many" to sustainable systems change at scale: a critical shift in mindset. *Agr. Syst.* 176, 102652.
- Yosso, T.J., Solórzano, D.G., 2005. Conceptualizing a critical race theory in sociology. In: Romero, M., Margolis, E.L. (Eds.), *The Blackwell Companion to Social Inequalities*. <https://doi.org/10.1002/9780470996973.ch7>.