frontiers | Frontiers in Sustainable Food Systems

TYPE Methods
PUBLISHED 24 May 2023
DOI 10.3389/fsufs.2023.1112532

Check for updates

# Making the sustainability hotspot analysis more participatory—experiences from field research in Zambia

Klaus Droppelmann[1*†] and Carolin Müller[2†]

[1]Picoteam Ltd., Johannesburg, South Africa, [2]Independent Scholar, Berlin, Germany

OPEN ACCESS

EDITED BY
Wolfgang Bokelmann,
Retired, Berlin, Germany

REVIEWED BY
Thomas Aenis,
Humboldt University of Berlin, Germany
Fabio Pachón,
Universidad Nacional de Colombia, Colombia

*CORRESPONDENCE
Klaus Droppelmann
✉ klaus.droppelmann@picoteam.org

†These authors have contributed equally to this work

RECEIVED 30 November 2022
ACCEPTED 19 April 2023
PUBLISHED 24 May 2023

CITATION
Droppelmann K and Müller C (2023) Making the sustainability hotspot analysis more participatory—experiences from field research in Zambia.
*Front. Sustain. Food Syst.* 7:1112532.
doi: 10.3389/fsufs.2023.1112532



Food value chains constitute a core element of food systems. Along any value chain, several bottlenecks, and obstacles negatively affect the sustainability of the entire chain. Therefore, the identification and assessment of such sustainability hotspots is a vital step in the process towards higher levels of sustainability. Over the past few decades food value chains have been supported as part of development cooperation to help alleviate poverty and ensure food and nutrition security. However, so far, a suitable methodology to assess aspects of sustainability along such food value chains was not available. Therefore, we have adapted the sustainability hotspot analysis, originally developed by the Wuppertal Institute, and enhanced it with a participatory approach, thereby making it suitable for application in the context of development cooperation. In this paper, we present a step-by-step overview of the entire assessment process by using examples from its application in Zambia's dairy and groundnut value chains. The developed methodology allows, through participatory means, the identification and assessment of sustainability aspects by stakeholders themselves, with the validation and amplification of assessment results by locally-based value chain experts. We demonstrate that results from this participatory hotspot analysis are aligned with the principles of agroecology promoted by the FAO, and are geared towards supporting transformative food system change processes. Our key findings from the application of the participatory hotspot analysis showed that sustainability hotspots occur in the social, economic, and ecological dimensions of sustainability along both value chains. It also became clear that hotspots are frequently interconnected, requiring a holistic approach based on a solid understanding of strong sustainability when designing solutions. We conclude that our participatory hotspot analysis provides a user-friendly methodology that generates action-oriented recommendations, and provides an ideal starting point in the development process for co-learning and co-creation of knowledge aimed at generating sustainability-enhancing innovations. The application of the participatory hotspot analysis reveals information on aspects that threaten the sustainability of value chains from a stakeholder perspective. Knowledge of these perspectives is essential, especially for development practitioners tasked with designing implementation strategies to improve the sustainability of value chains.

KEYWORDS

**food value chains, sustainability, hotspot analysis, smallholder agriculture, participatory, knowledge co-creation**

## 1. Introduction and objectives

Poverty reduction and food security remain high on the agenda of international development cooperation. To date, value chain (VC) development has been one of the most widely used tools to achieve these development goals. Despite this, in recent years, the number of people suffering from hunger or malnutrition has been increasing once again. At the same time, the number of people affected by obesity, diabetes, or other noncommunicable diseases is also increasing (WHO, 2022). The reasons for this are manifold and complex. However, one thing is clear—our current food systems are already failing us. This is evident not only from current trends in poverty, hunger, and malnutrition, but is also underlined by the alarming trends of soil degradation and the loss of biodiversity due to more and more land clearing for agricultural activities, that go far beyond planetary boundaries. Social distress and economic insecurity are alarming consequences of these developments (Allen and Prosperi, 2016; Ruerd et al., 2021). Therefore, a shift towards a system that allows for the availability and accessibility of healthy food to meet current food needs is required. This must occur while respecting planetary boundaries to help maintain healthy ecosystems and provide food and ecosystem services for future generations (Allen and Prosperi, 2016). In a food system, food production plays a central role. However, the importance of what Ruerd et al. (2021) refer to as the 'food environment' should not be overlooked: "The food environment incorporates all the infrastructure, public and private, institutional regimes and governance frameworks that guide food availability, accessibility, quality, safety, sustainability, reliability, and affordability. There are structural imbalances and disconnects that prevent the delivery of desired outcomes for nutrition, inclusion, and environmental sustainability." Therefore, it is important to acknowledge that food value chains (VCs) constitute the core element of food systems and are themselves complex systems.

To date, little attempt has been made to connect food VCs to the systemic and multi-dimensional understanding of sustainability. Existing instruments for sustainability assessment along VCs either completely disregard the multi-dimensional nature of sustainability, or are too complex and time-consuming to be broadly used by practitioners. Consequently, a suitable methodology is lacking to assess sustainability issues along food VCs in a holistic fashion. Furthermore, definitions of sustainability are mostly pre-defined by academia, and not based on the understanding and realities of the people engaged in the promoted VCs. Oftentimes, the lack of involvement of the target groups is one of the reasons why development projects, especially VC support interventions, are not successful in achieving their desired outcomes (Stoian et al., 2012). Our objective was to design a robust, scientifically based methodology that employs a participatory approach to assess sustainability aspects along food VCs. The assessment results aim to inform management decisions in food VC governance to enhance the multi-dimensional sustainability of the VC, and contribute to the transformation of the entire food system it is embedded in. This paper will introduce a newly designed participatory HotSpot Analysis (pHSA), as a combination of the Wuppertal Institute HotSpot Analysis (WU-HSA) (Bienge et al., 2009), and the adaptive MAnagement of vulnerability and RISk at COnservation sites (MARISCO) methodologies (Ibisch and Hobson, 2014).

## 2. Existing sustainability assessment and participatory approaches

Based on a literature review we identified the hotspot analysis developed by the Wuppertal Institute of Climate, Environment and Energy (WU-HSA) as a suitable starting point for the design of a new sustainability assessment methodology. In order to take the living situation of smallholder farmers in a development context into consideration we decided to introduce participatory elements which we adapted from the MARISCO methodology.

### 2.1. The Wuppertal hotspot analysis

The WU-HSA aims to identify priority areas for interventions relating to sustainability (i.e., sustainability hotspots) along food VCs (Bienge et al., 2009; Liedtke et al., 2010; Rohn et al., 2014). Briefly put, the WU-HSA assessment is carried out over three steps. In the first step, the VC in question is separated into distinct phases, e.g., production, aggregation, processing, retailing, and consumption. In the next step, external and internal VC experts are invited to assess the relevance, or criticality, of each of these VC phases in relation to the sustainability of the entire chain by assigning values from 1 (low) to 3 (high). In the final step, sustainability aspects in each of these phases are identified, evaluated, and again assigned a value of 1 (low) if this aspect does not indicate a sustainability failure, to 3 (high) if it threatens the sustainability of the entire VC. On completion, the two values are multiplied. If the product for a specific sustainability aspect within a specific VC phase is 6 or larger (up to 9), this aspect is considered a sustainability hotspot. Bienge et al. (2009) provided an example of this calculation: if the social aspect 'general working conditions' were to be assigned a relevance of 3 in the production phase, and a relevance of 2 in the processing phase, while the VC phase 'production' is assigned a relevance of 3, but 'processing' only 1, then the aspect 'general working conditions' becomes a hotspot in production ($3 \times 3 = 9$), but not in processing ($2 \times 1 = 2$). While the WU-HSA takes a multi-dimensional and holistic approach, it has not been adapted to be applied in a development context, where the prime target population of support interventions is usually a large group of resource-constrained, smallholder farmers in a rural setting. Moreover, the WU-HSA relies mostly on expertise from academics, external experts (i.e., not directly involved in the VC), and managers and operators from downstream stages of the VCs in question. Although the procedure is straightforward, quick, and easy to implement, we found it lacking in two respects: the level of detail of the analysis, and the lack of participation of the primary target group in the analysis.

### 2.2. The MARISCO approach

To add a strong participatory element suitable to engage with smallholder producers, we adapted specific elements of the MARISCO methodology (Ibisch and Hobson, 2014). MARISCO was developed to support management decisions on risks and vulnerabilities experienced by communities living in and around conservation sites, such as national parks and reserves. The MARISCO methodology takes a holistic and systemic livelihood-based approach to the planning process. We adapted its livelihood-centered approach and simplified the evaluation process to suit the requirements for sustainability hotspot assessments in a development context. The specific elements are (1) the listing of resources (MARISCO uses the term attributes) necessary for a successful participation in the dairy and groundnut value chains, (2) the steps to identify services and systems that provide or maintain these resources and their related sustainability aspects (for an illustration also see Figure 1 below), and (3) the process to assess the functionality of these systems by identifying and evaluating threats to these sustainability aspects.

## 3. Designing the participatory HotSpot analysis

The pHSA takes a multidimensional approach to assessing VCs encompassing economic, social and ecological aspects of sustainability. This holistic approach is targeted towards identifying high-priority areas throughout all phases of the VC, by evaluating aspects that go beyond the economic dimension of sustainability. In general terms, and following Bienge et al. (2009), we refer to such high-priority areas as sustainability hotspots. In the specific context of our study, sustainability aspects are evaluated using a set of criteria to arrive at a numerical value. Above a certain threshold we assume the sustainability of a specific aspect threatened, which is then defined as a sustainability hotspot. Thus, the results of the hotspot analysis help identify action points that will result in the highest impact. This is achieved by taking the livelihood of small-scale farmers engaged in food VCs as a point of departure, and integrating their understanding of sustainability and their value perceptions into the analysis. Due to its participatory nature the pHSA may offer the additional benefit to initiate processes of knowledge co-creation and co-learning in order to enable the discovery of innovations necessary to address identified sustainability hotspots. This paper presents the steps taken to develop the pHSA and provides examples of its implementation on the ground. The method has been applied in a pilot trial in the groundnut and dairy VCs in Zambia. To ensure, as much as possible, the broad applicability of the pHSA an animal-based and a plant-based food value chain were chosen.

### 3.1. The pHSA methodological approach—step-by-step

#### 3.1.1. Preparatory phase—literature review

To prepare for the sustainability assessment it is useful to familiarize oneself with the entire VC to be investigated and the concept of agroecological principles and transformative food system change. This may include scientific literature as well as grey literature, like project reports, newsletters etc. Detailed knowledge about the VCs is critical to establish the context of the study and may later on feed into the science-based verification of results. If further adaption to pHSA methodology appears necessary, it is helpful to gain a basic understanding of the WU-HSA and MARISCO methodologies.

Our preparatory phase included the conceptual development of the pHSA methodology based on intensive literature reviews of the WU-HSA and MARISCO methodologies, as well as literature on AEPs and the specific VCs we intended to analyze in our study. We collected as much information as possible on critical sustainability aspects of the VC from both a global and country perspective. Information about stakeholder groupings along the VC stages, and the identification of the target population for the study, was also crucial to ensure all analysis results will be relevant, representative, and transferable beyond the actual scope of data collection. For example, in a development context, the target group may be limited to participants of VC support programs, as was the case for us, while the objective of a purely research-oriented project might be to draw more generalized conclusions for an entire sector or a country level. The latter requiring a larger sample size that allows for statistical analysis.

#### 3.1.2. The pHSA for the production phase

To capture the different living realities within a smallholder community, the study participants should be disaggregated by gender and age. Thus, focus groups may be formed of senior women, senior men, and male and female youths—each of 4–6 members per sub-group. At the start of the focus group discussions (FDGs), participants should be asked to identify the basic resources they need to engage and maintain their successful participation in the VC. Employing 'free-listing' (Quinlan, 2018), all resources are collected, documented on moderation cards, and then placed in a

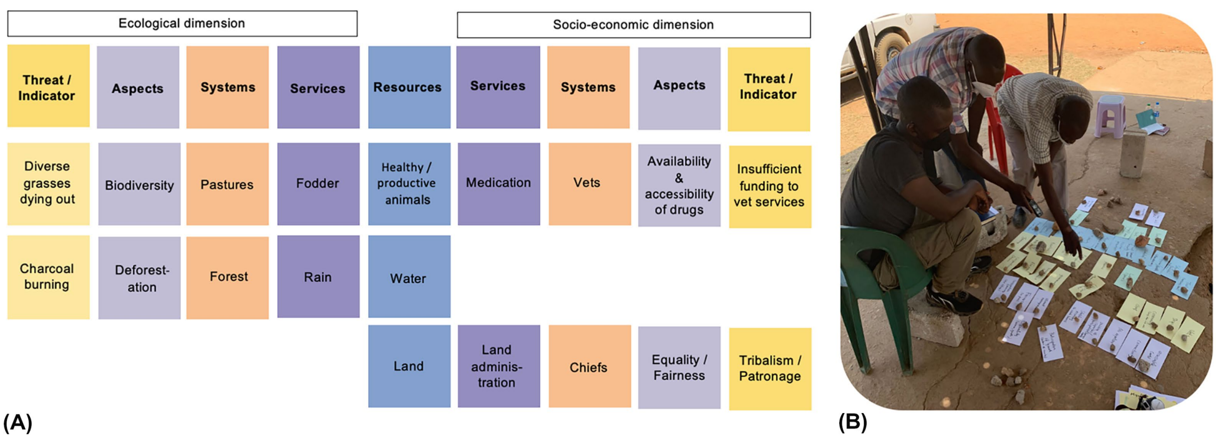


FIGURE 1
Stylized example of an pHSA sustainability assessment matrix **(A)** and an actual example from a FGD in Monze **(B)**.

vertical row on the ground. In the subsequent steps, the socio-economic and ecological services participants need to access to obtain these resources are identified. In our study, for example, a key resource for a viable dairy enterprise was "healthy and productive dairy animals." To maintain their productivity and health, the dairy farmer has to be able to provide them with quality fodder. Again, the terms or phrases describing such services are written on moderation cards and related to the basic resources row by row. Socio-economic services are arranged to the right of the corresponding resource cards and ecological ones to the left. Participants are then asked to identify systems that provide these services. In our example, productive pastures or rangelands would provide fodder for livestock. Cards, labeled accordingly, will again be placed next to the corresponding service cards. Participants are then asked to identify sustainability aspects that impact those systems—for example, the aspect "biodiversity of grass species" impacts the long-term productivity of rangelands. The aspects are written on moderation cards and placed next to the corresponding systems. In the next step, the participants are asked to identify threats. As threats have a negative impact on these sustainability aspects, we prefer this term rather than the term 'indicator', as used by the Wuppertal Institute. For example, the loss of certain grass species may threaten the sustainable functioning and productivity of rangelands. The threats are discussed and agreed upon by the participants and then documented on evaluation cards, together with the corresponding sustainability aspects. Figure 1 shows a stylized example of an assessment matrix, as well as a picture from an FGD in Monze.

The evaluation of these threats follows a more detailed protocol compared to the WU-HSA approach. We use four criteria to assess individual threats: scope, severity, permanence, and trend. Each of these criteria is evaluated by the FGD participants using the scale: 1 (low), 2 (medium), and 3 (high). As facilitators, it is helpful to note how participants define the criteria levels, thereby allowing a better understanding of their reasoning. To establish the impact of a threat, the values assigned to the first three criteria are added up: (1) scope (i.e., how widespread is this threat?); (b) severity (i.e., how damaging is this threat?); and (c) permanence (i.e., how easily can this threat be addressed?). Adding values for the current trend of this threat—decreasing (1), stable (2), or increasing (3)—provides a measure of the significance of the threat to the sustainability aspect. A significance value of 10 or higher indicates a sustainability hotspot that requires immediate attention. Figure 2 shows an example of an evaluation card that has been filled in. Resources permitting, minor threats to sustainability with significance values of 9 and lower would still be worthwhile addressing at some point. Additional data collection applying participatory research methods is recommended to provide more context for analyzing the hotspot evaluation results. Especially if, along with the hotspot identification and evaluation, potential innovations and underlying trade-offs are to be researched. Figure 2 shows an example of a pHSA evaluation card on the left, and an actual example of the evaluation process during an FGD in Monze district.

### 3.1.3. Additional, optional field data collection

To complement the data collection from the FGDs, we suggest collecting information using participatory research methodologies, including transect walks, seasonal calendars, and Venn diagrams. The objective of this additional data collection is to gain a deeper and more comprehensive understanding of the smallholder farmers' livelihood situation and work environment. This data collection can run parallel to the FGDs, and ideally involves both male and female community leaders and lead farmers. In our case, these exercises proved valuable in identifying and discussing conflicts over resources in the community, potential innovations, and successful or failed communal action projects. These exercises usually took 1.5 to 2 h. Notes were transcribed as soon as possible for later analysis. These additional participatory exercises are not vitally important for assessing sustainability aspects. However, they might be extremely valuable for detailed investigation of innovations developed by pioneering individuals or communities, as well as the in-depth identification of needs for further innovations.

### 3.1.4. The pHSA for downstream VC phases

VC interventions in a development context aim to ensure the fair and just distribution of value addition, thus contributing to the improvement of smallholder livelihoods. Hence, the pHSA is biased towards the production phase. However, to gain a comprehensive understanding of an entire VC, stakeholders from downstream phases must also be included in the evaluation. Typically, these stakeholders will be individual representatives of companies and organizations active in the input, aggregation, transport, processing, and retailing phases. Consequently, we prepared semi-structured interview guidelines customized to each VC phase. As a first step in the key informant interviews (KII), following the introduction, we presented available preliminary findings from the FGD and other KII. Then

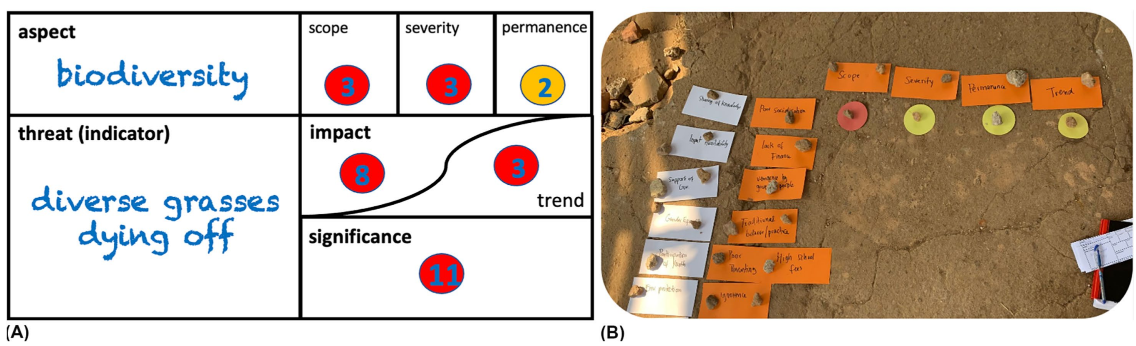


FIGURE 2
Example of a pHSA evaluation card **(A)** and an actual example of the evaluation process during a FGD in Monze **(B)**.

we invited the key informants to provide feedback and verify the identified hotspots. Following that, we asked them to identify additional hotspots along the VC, and evaluate them using the evaluation procedure described above. They were also encouraged to share any observations on potential innovations and trade-offs. Generally, these interviews lasted between 1 and 1.5 h.

#### 3.1.5. The pHSA approach to validate preliminary results

After data entry and cleaning, preliminary findings and observations can be generated and presented to a select group of locally based experts for validation. We organized a validation workshop, with attendees mainly recruited from VC-supporting and -enabling agencies [see Springer-Heinze (2018) for definition and details], along with some VC operators based in Lusaka. Such a group of stakeholders is particularly well suited to provide an impartial perspective on the challenges of the entire VC and its contribution to the whole food system. As with the key informant interviews, our preliminary findings from both VCs were presented and put up for discussion. To handle the large amount of information, and to collect the feedback from the participants in an efficient manner on the identified hotspots, we used Mentimeter[1]. Following this exercise, participants discussed and identified innovations and trade-offs along the VCs in smaller working groups. At the end of the workshop, rapporteurs from the individual working groups presented the results of their discussions to the plenary. This validation of our preliminary data ensured the appropriateness, robustness, and comprehensiveness of our field data collection.

## 3.2. Equipment and resources needed for applying the pHSA

The pHSA is a qualitative research methodology for which no special materials or equipment are necessary. For the facilitation of focus group discussions and validation workshops, standard participatory rural appraisal (PRA) materials will be needed, e.g., markers and cards for moderation and evaluation. Flip chart stands and pin boards might be useful but are not essential. For the documentation of additional PRA exercises (e.g., Venn diagrams, seasonal calendars, and/or transect walks), PRA handbooks provide good guidance. To document key informant/expert interviews, we used paper notebooks and semi-structured interview guidelines. Consent, whether in written or oral form, from all participants needs to be obtained in order for them to participate in the research study. In our opinion, the use of recording devices and their subsequent analysis is not necessary, since preliminary summaries or conclusions should be generated by the participants themselves and agreed with them before documentation. To capture results from the focus group discussions (i.e., evaluation cards), we used simple data spreadsheets (e.g., Microsoft Excel). In these spreadsheets, the responses were coded using a combination of deductive and inductive approaches. For example, facilitators and researchers may form a set of coding categories upfront based on agroecological principles (AEPs) (FAO, 2018; HLPE, 2019). This is in line with a deductive approach. Additional categories are added to these categories based on participant responses that were not adequately covered by the AEPs, which is consistent with an inductive approach. Thereafter the analysis is straightforward. The categories assigned the most hotspots—sustainability aspects rated 10 and higher—represent the most pressing areas to enhance sustainability along the VC in question. Local research collaborators are strongly recommended to be involved when applying the pHSA. Firstly, to ensure the study approach is firmly rooted in the local context, and secondly, to facilitate communication with participants in vernacular. In rural areas, some participants may find it easier to open up and express themselves more comfortably if they can use their local dialect or language.

## 3.3. Scale of assessment, data collection, and sampling methodology

In 2021, the Green Innovation Centers (GIC) of Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) supported about 3,500 dairy farmers, of which 21% were female farmers, organized into 24 cooperatives within 7 districts of the Southern Province. The coop members sold their milk into the formal market through milk collection centers. In 12 districts of the Eastern Province, the GIC supported about 107,000 groundnut farmers, of which 54% were female farmers, organized into 54 cooperatives (GIZ-GIC 2021). These coops were linked to the social enterprise COMACO, through which they marketed their produce. In total, we conducted 9 FGDs with farmers from these two groups. Table 1 provides an overview of our entire data collection. In the dairy sector, we conducted 5 FGDs, while in the groundnut sector, we conducted 4 FGDs. As we began testing our methodology in the first FGD with participants from the dairy sector, and then applied most of the *ad-hoc* adjustments in subsequent data collection sessions, we conducted an additional FGD in this sector. Volunteers for transect walks and seasonal calendars were recruited on the spot from communities in which the FGDs were conducted. The identification of participants for the FGDs was facilitated by the staff of GIZ-GIC and their partner COMACO. We perceived any selection bias or conflict of interest to be negligible. Participants for the key informant interviews and the validation workshop were identified by purposive sampling.

## 3.4. Data processing and analysis

The information from the evaluation cards, notes, and FGD participants (e.g., gender and location) were transferred to Excel spreadsheets for analysis. We coded the responses from the FGDs using deductive and inductive methods to strike a balance between ensuring some degree of standardization, and thus allowing a comparison to be made between results from different FGDs and the AEPs, as well as accurately capturing the livelihood situation of our participants. For example, we checked which AEP covers a particular sustainability aspect identified by our participants. If that AEP fitted well, we used that term as a code for the sustainability aspect. If not, we defined a new code term for that issue based on input from the participants. Then, the identified and evaluated sustainability threats were assigned to corresponding sustainability aspects. All aspects that

1 Free online audience engagement platform - https://www.mentimeter.com.

TABLE 1 Summary of data collection activities and participants.

| Method | Focus group discussions | | | Transect walks & seasonal calendar | Key informant interviews | Validation workshop |
|---|---|---|---|---|---|---|
| Value chain | Women | Men | Youth | | | |
| Dairy | 23 | 38 | 29 | 3 | 16 | 19 |
| Total | 90 | | | | | |
| Groundnuts | 31 | 32 | 26 | 6 | 19 | |
| Total | 89 | | | | | |

Own data.

received one or more threats with a score higher than 10 were treated as a sustainability hotspot and reported on in Tables 2, 3. No statistical analysis was undertaken.

## 4. Results from the dairy and groundnut VC case studies in Zambia

Tables 2, 3 provide a summary overview of the sustainability aspects that participants identified, and the number of threats rated as sustainability hotspots relating to those sustainability aspects. In the dairy VC, participants identified 19 sustainability aspects compared to 15 in the groundnut VC. However, the number of threats rated as hotspots was almost double in the dairy, compared to the groundnut VC—60 and 33, respectively. Nevertheless, the identified sustainability aspects in the social, ecological, and economic dimensions were very similar or the same in both VCs. For example: "Knowledge sharing" and "knowledge and adoptions of CA" in the social dimension; "stable rain patterns" and "environmental protection" in the ecological dimensions. In the economic dimension, quality issues—such as "product quality," "quality standards," and "quality monitoring," as well as issues around "profitability" and "viability of the VC," were shared concerns in both VCs. It is worth noting that under "environmental protection," the "cutting of trees" for charcoal production, and resulting deforestation, was an equally strong concern—rated five times as a hotspot in each VC. However, participants in the dairy VC included the threat of "weak governments/chiefs" as a concern. The sustainability aspects "access to inputs, land, capital," and issues around alternative economic opportunities—e.g., "economic diversification" and "employment opportunities," were also identified in both VCs.

While there were shared concerns about sustainability aspects in both VCs, there were also distinct differences. As already alluded to, participants in the dairy VC had a much greater focus on the role of government. About a quarter of all hotspot threats in the dairy VC related to governmental service delivery, ranging from extension—such as poor accessibility and having to pay transport and lunch allowances to staff, to political marginalization, general funding constraints, and poor maintenance of transport infrastructure. While for groundnut farmers, only the latter point was mentioned in relation to the impact of government on their VC.

The other aspect that clearly stood out in the VC dairy farmers' hotspot assessments were gender relations issues—such as gender equality and youth empowerment. In addition to high prices for land acquisition, gender inequalities and customs were highlighted in the dairy VC as an aggravating factor regarding "access to land." Groundnut farmers also identified "access to land" as a problem, but the factors leading to this differ and do not relate to gender issues; instead, "overpopulation" and a lack of available suitable arable land are cited as causes. The gender bias within the two VCs is also reflected in the different ratios of male to female farmers engaging in the dairy and groundnut VC. As mentioned above, there was 21 and 54% female farmer participation in the dairy and groundnut VC, respectively. Also of significance was "jealousy," which was rated as a hotspot by participants in both VCs. However, it came up in somewhat different contexts, i.e., under different sustainability aspects, namely "knowledge sharing" in the dairy VC and "community cooperation" in the groundnut VC.

## 5. Discussion

### 5.1. Performance of the pHSA in our case studies

Sustainability is a very broad and multi-layered topic, and its definition is intensely and controversially discussed in academic and political circles (Tulloch and Neilson, 2014; Elkington, 2018; Bruckmeier, 2020). To engage in a meaningful way with smallholder farmers in sub-Saharan Africa on the many aspects of sustainability, one must break this complex issue down to the living realities of the people concerned, and start addressing real-life problems (Fraser et al., 2006; Stoian et al., 2012; Frank et al., 2022). We aimed to do that by placing emphasis on the basic resources farmers require to engage in dairy or groundnut production successfully. By taking the necessary resources as a point of departure for the sustainability assessment, farmers, i.e., our FGD participants, quickly became aware of the ecological, social, economic, and political systems surrounding them. Importantly, they also recognized the conditions for their continued functioning. Therefore, participants gained a holistic understanding of the interdependencies between different dimensions of sustainability and the situation as it related to their livelihoods.

The pHSA allows facilitators flexibility, which has proven useful in this step, as it allows participants to define terms in their own words and according to their understanding. This prevents later misunderstanding or confusion and, according to Bezner Kerr et al. (2019a), promotes reflection, discussion, and active participation. The fact that pHSA goes hand in hand with the goals of PAR (Participatory Action Research) is reflected in the principles that both approaches follow. Namely, people's interests come first, and the goal is specifically to include people's perspectives on a given issue, thereby empowering them to actively change a situation (Frank et al., 2022).

This is also supported by Fritz and Meinherz (2020), who discuss the value of participatory approaches in sustainability assessments in

TABLE 2 Sustainability aspects, threats, and hotspot rankings in the dairy value chain.

| Phase | Dimension | Sustainability aspect | # of threats rated as hotspots |
|---|---|---|---|
| Production | Social | Government extension services | 12 |
| | | Gender equality | 4 |
| | | Youth empowerment | 4 |
| | | Rent seeking by government authorities | 2 |
| | | Knowledge sharing | 1 |
| | | Community empowerment | 1 |
| | Ecological | Stable rain patterns | 8 |
| | | Environmental protection (forests) | 5 |
| | | Biodiversity | 1 |
| | Economic | Access to input | 7 |
| | | Access to capital | 5 |
| | | Access to land | 2 |
| | | Economic diversification | 1 |
| Aggregation | Social | Governance at MCC | 1 |
| | Economic | Milk quality | 2 |
| | | Transport | 1 |
| | | Economic viability | 1 |
| Processing | Economic | Milk quality | 1 |
| | | Participation of local value chain | 1 |
| Total social hotspots in the entire value chain | | | 25 |
| Total ecological hotspots in the entire value chain | | | 14 |
| Total economic hotspots in the entire value chain | | | 21 |
| Total hotspots in the entire value chain | | | 60 |

Data from FGDs and KIIs.

TABLE 3 Sustainability aspects, threats, and hotspot rankings in the groundnut value chain.

| Phase | Dimension | Sustainability aspect | # of threats rated as hotspots |
|---|---|---|---|
| Input | Social | Access to land | 2 |
| | Ecological | Quality seed | 3 |
| Production | Social | Community cooperation | 6 |
| | | Knowledge and adoption of CA | 3 |
| | Ecological | Environmental protection (e.g., forests, soil, water) | 5 |
| | | Stable rain patterns | 2 |
| | Economic | Employment opportunities | 2 |
| | | Demand | 2 |
| | | Access to capital | 1 |
| Aggregation | Economic | Mobility | 2 |
| | | Honesty | 1 |
| Processing | Economic | Quality standards | 1 |
| | | Storage capacities | 1 |
| | | Quality monitoring | 1 |
| Marketing | Economic | Profitability | 1 |
| Total social hotspots in value chain | | | 11 |
| Total ecological hotspots in value chain | | | 10 |
| Total economic hotspots in value chain | | | 12 |
| Total hotspots in entire value chain | | | 33 |

Data from FGDs and KIIs.

facilitating a shift from "power over" (i.e., coercion and manipulation, – such as external experts prescribing solutions), to "power to" (i.e., resistance and empowerment—such as the political process helping marginalized societal groups gain the ability to act), and eventually create the opportunity for "power with" (i.e., cooperation and learning, such as co-creation of knowledge). Our field study is a good example of inherent power structures that can prevent participatory approaches from reaching their potential—if they are not adequately recognized and addressed through good facilitation, such as that provided by pHSA. For example, membership in dairy cooperatives (Fritz and Meinherz (2020), and GIZ-GIC 2021), as well as participation in our FGDs (see Table 1, above) was skewed towards men in Southern Province. Interestingly, despite this gender imbalance, gender equality became an important topic of discussion in Southern Province among dairy farmers. In Eastern Province, where gender balance was a lot more pronounced, the topic was less discussed. This underlines once again that it is not enough to increase the number of participants of a marginalized group in the form of a quota in order to address their concerns adequately. Rather, skillful facilitation should be employed to sensitize dominating groups about concerns of marginalized ones, as the pHSA was able to demonstrate in our case study.

We argue that this method can shed light on the understanding and perception of sustainability of those people who are to be the focus of the analysis, as well as on the complexity and multidimensionality of sustainability itself. We assume this is necessary to understand the complexity of the underlying problems and adapt interventions accordingly. Or in the words of Fraser et al. (2006): "Since it is impossible to ensure that indicators chosen by 'development experts' will be relevant to local situations, local input is necessary to ensure indicators accurately measure what is locally important." Furthermore, the early involvement of local actors may help strengthen their agency and empowerment. In fact, evidence shows that local engagement helps strengthen the community's ability to address future problems (Fraser et al., 2006).

The importance of bringing in different perspectives, how existing intrinsic power relations function, and how sensitively they have to be taken into account in the interaction with stakeholders, became particularly clear in one example from the field study. On this particular occasion, the participants of a youth focus group discussion from the dairy VC were initially apprehensive about sharing their experiences and discussing their challenges with the facilitators. The reason given by the participants was that they were neither listened to nor taken seriously by the older male farmers, nor did they receive support from them in the form of knowledge sharing. This initial reluctance was only overcome through gentle yet persuasive encouragement, and the creation of a safe space in which they could share their experiences with peers. A lively debate ensued, with valuable insights gained by both participants and researchers. In addition, such experiences can help strengthen self-esteem and a sense of community within the group (Droppelmann et al., 2022). The feedback from a lead farmer of a groundnut farmer group we interacted with in Eastern Province offers another example of participants' appreciation for the pHSA approach. Over and above the usual courtesy and multiple 'thank-yous' at the end of the FGD day, this lead farmer sent a note to the COMACO area coordinator, saying how helpful the day was. He specifically appreciated the opportunity to discuss sustainability challenges in his community, and create awareness of potential underlying interdependencies between sustainability aspects (Droppelmann et al., 2022).

In their review, Utter et al. (2021) point out that: "farmer-centered processes encourage knowledge co-creation that captures the interests and needs of farmers. This is important in terms of equity, and because farmers are key agents and critical actors in defining the interventions, resources, and new knowledge they need for sustainable livelihoods." The authors extend this argument even to cases in which co-creation was not explicitly planned at the outset of the process, such as Bezner Kerr et al. (2019b)—recommending the inclusion of AEPs that have local relevance in the farmer-researcher co-creation efforts. Fraser et al. (2006) also conclude that: "The process of engaging people to select key [sustainability] indicators provides a valuable opportunity for community empowerment and education. It is not necessary that this process be initiated from the bottom-up, but it is important that local stakeholder input be allowed to drive the process." The application of the pHSA in the field study has demonstrated that this approach offers the opportunity to achieve all these conditions.

Our results also demonstrate that farmers perceptions across the different dimensions and about specific aspects of sustainability do correspond to the AEPs as set out by the HLPE (2019). This thereby ensures their transferability to and comparability with similar assessments of other VCs—even within different countries. The pHSA takes the perspectives and perceptions of all actor groups along a VC into account. The validation of preliminary results from the FGDs and key informant interviews by local experts from supporting agencies and governing institutions, ensures the comprehensiveness, relevance and validity of the assessment from a local perspective.

## 5.2. Application of the pHSA in the context of development projects

In support of the Millennium Goals and, subsequently, the Sustainable Development Goals, numerous development agencies, donors, and governments adopted the VC development approach to achieve poverty alleviation goals among vulnerable rural populations (Neilson, 2014). However, successful smallholder participation in VCs has proven to be notoriously challenging, for which Stoian et al. (2012) offer the following explanation: rural smallholder households usually follow diversified livelihood strategies, which place smallholders in conflict with VC approaches that require following specialized investment and production strategies. Similarly, a number of critical challenges revolve around community organization and collective action (Perret and Stevens, 2006; Ortmann and King, 2007). In our study, these include the management of communal rangeland (e.g., fodder production) and forest resources (e.g., charcoal burning), as well as water management issues (e.g., erosion control). All these issues play out at a landscape scale and require community, not individual, responses. Hence, VC support interventions need to be designed in a manner that dovetails with the overall livelihood strategy of participating individual smallholder households, while also fostering communal action. In this regard, the pHSA proved to fit in well with participatory approaches frequently applied in a development context. In particular, the level of detail the pHSA offers in identifying specific threats or indicators to monitor sustainability failures may support the identification and design of corresponding innovations in response to such challenges. Therefore, the actual potential of the pHSA may go beyond its application solely as an analytical tool. When it is used as part of a transformative VC development approach, it can lead towards effective co-learning and co-creation. Thus, it would also make a meaningful contribution to a sustainable transformation in food systems. South African experiences show that: "encouraging farmers to participate in technology development, taking account of local knowledge and making sound institutional arrangements are some ways to foster better integration of technology and innovation" (Ortmann and King, 2007). Utter et al. (2021) postulate that: "A farmer-centered approach is fundamental in achieving sovereignty in the agrifood system." However, farmers are not the only actors and stakeholders in a VC. To achieve a truly transformative change within the food system, all relevant groups need to be brought into the processes of sustainability assessment and co-creation of knowledge. This will eventually lead to the design of sustainability-enhancing innovations along the entire VC. The foundation of a successful co-creation process is the respectful interaction, commitment, credibility, and trust between involved parties—attributes that take time to nurture and build (Cash et al., 2003; Carolan, 2006; Hegger et al., 2012). The pHSA offers a starting point for such a process within a development context. Building the foundations for what Frank et al. (2022) refer to as a crucial factor for successfully applying newly gained knowledge. Namely, the guided experimentation that allows for the testing of contextualized ideas that have been gained through constructive communication forums of experience sharing and action-oriented practices. Therefore, follow-up measures need to be devised that bring these diverse actors and stakeholders together on a longer-term basis, and ensure the incorporation of scientific evidence in the design of innovations. This goes beyond the current scope of the pHSA.

## 5.3. Limitations of the pHSA

To guarantee the soundness of the recommendations based on the analysis of the results from the pHSA, as described so far, verification against available scientific evidence appears necessary. For example, at no point in our research study was the issue of methane release from large ruminants and their contribution towards climate change mentioned (IEA, 2021). This issue is a global concern, and while its relevance may appear negligible to local VC stakeholders, VC support interventions geared towards sustainable development cannot ignore such facts. Another consideration is the high demand for water in dairy production and processing. In the case of Southern Province in Zambia, one has to ask: Can water resources be sustainably managed to sustain dairy production in the foreseeable future (Arndt et al., 2019)? Therefore, verifying recommendations from the participatory assessment against available scientific evidence is crucial. If necessary, steps should also be taken to broaden the perspective to different scales of space and time. Furthermore, knowledge co-creation and facilitation processes for sustainability assessments, such as the pHSA, need to consider potentially unbalanced power relations among the various stakeholder groupings along a VC (Pohl et al., 2010), and must have the tools and capacity to mediate between these.

In addition, special attention must be paid to terms such as 'indigenous knowledge' or 'local knowledge', which are also known to be key elements of agroecology. What researchers or practitioners have in mind when using these terms may differ greatly from what local farmers think. As a result of agricultural reforms, neocolonial practices, and economic models, local farmers have adapted to a form of agriculture characterized by monocultures, high use of chemicals, and profit maximization—often damaging the environment for lack of alternatives. Bezner Kerr et al. (2019a) highlight that when it comes to recovering knowledge about traditional practices which may have been lost or forgotten in the wake of these developments, sensitivity, respect, and recognition of inherent power imbalances and contradictions are required.

## 6. Concluding remarks

We developed and field-tested a participatory approach to the hotspot analysis in two VCs in Zambia. We incorporated agroecological principles and elements, as well as participatory methods, to capture the perspectives of all relevant stakeholders on sustainability aspects. We conclude that our participatory hotspot analysis, the pHSA, is a user-friendly sustainability assessment tool that provides an ideal starting point in the development process for co-learning and co-creation of knowledge, with the capacity to generate sustainability-enhancing innovations and actionable recommendations. Drawing on Heron and Reason (2008) and Frank et al. (2022), it should be stressed that shared learning and desired changes in action are more likely to occur when the knowledge gained is based on stakeholders' own experiences, and is properly understood as the result of a collaborative assessment process. The application of the pHSA enables the incorporation of stakeholders' own experiences, and thus provides insight into aspects that threaten the sustainability of VCs from a stakeholder perspective. Knowledge of these perspectives is essential, especially for development practitioners tasked with formulating implementation strategies to improve VC sustainability. To further strengthen the transformation process of the food VC, we recommend that the impact evaluation of innovations—developed through the use of the participatory hotspot analysis—also be aligned with AEPs of co-creation of knowledge.

López-García et al. (2021) call for: "a more complex and renovated approach to agroecological, participatory research." To that end, field-testing the pHSA demonstrated its potential to become a valuable element in such an approach. It also proved its applicability in a development context. It produced robust, transferable results in line with AEPs, and offers a starting point for the co-creation of knowledge in support of transformative food VCs. Through the pHSA methodology, all relevant actor groups along a specific VC, as well as other stakeholders—such as supporting agencies and governing institutions, are involved in the sustainability assessment. The in-built validation and verification through subsequent scientific 'review loops' ensure that recommendations based on the assessment are locally grounded and scientifically based. We recommend the application of the pHSA as part of the planning process of VC development support interventions. We further recommend building on the participatory processes initiated by the pHSA in co-learning and co-creation of knowledge around sustainability-enhancing innovations. Doing so will ensure the full potential of the pHSA to contribute towards transformative food system change can be realized. Thus, sustainability assessments applying the pHSA could not only help achieve levels 1 to 3 of Gliessman's (2016) proposed agroecological transformation (i.e., efficiency, recycling, regulation, diversity, synergies, and resilience), but also contribute towards realizing levels 4 and 5 (i.e., co-creation of knowledge, culture and food transition, circular economy, human and social values, and responsible governance).

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

## Funding

This work was undertaken as part of the NAMAGE Research Project (Sustainability of Modern Agri-Food Systems) funded by the federal ministry of economic cooperation and development (BMZ). The funding source was not involved in the conduct of this research and the preparation of this article. The authors are grateful for the financial support.

## Acknowledgments

The participatory HotSpot Analysis (pHSA) methodology presented in this paper was developed and field tested as part of a Joint International Research Project (JIRP) by the Seminar für Ländliche Entwicklung (SLE) in 2021. This study focused in more detail on the assessment results along the two value chains and its results were published in a separate publication. We like to express our gratitude for the committed work of the participating German and Zambian researchers. The study was embedded in a broader research project called NAMAGE (German acronym for Nachhaltigkeit Moderner Agrar- und Ernährungssysteme), commissioned by the BMZ, and conducted from September 2020 to December 2022. We like to express our gratitude to the entire NAMAGE team, specially to Markus Hanisch and Aicha Mechri, for their insightful inputs and excellent collaboration. Further, we would like to thank the editor and the two reviewers for their constructive criticism and suggestion which helped to improve this paper.

## Conflict of interest

KD was affiliated to Picoteam Ltd at the time this manuscript was prepared.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

## References

Allen, T., and Prosperi, P. (2016). Modeling sustainable food systems. *Environ. Manag.* 57, 956–975. doi: 10.1007/s00267-016-0664-8

Arndt, C., Chinowsky, P., Fant, C., Paltsev, S., Schlosser, A. C., Strzepek, K., et al. (2019). Climate change and developing country growth the cases of Malawi, Mozambique, and Zambia. *Clim. Chang.* 154, 335–349. doi: 10.1007/s10584-019-02428-3

Bezner Kerr, R., Hickey, C., Lupafya, E., and Dakishoni, L. (2019b). Repairing rifts or reproducing inequalities? Agroecology, food sovereignty, and gender justice in Malawi. *J. Peasant Stud.* 46, 1499–1518. doi: 10.1080/03066150.2018.1547897

Bezner Kerr, R., Young, S. L., Young, C., Santoso, M. V., Magalasi, M., Entz, M., et al. (2019a). Farming for change: developing a participatory curriculum on agroecology, nutrition, climate change and social equity in Malawi and Tanzania. *Agric. Hum. Values* 36, 549–566. doi: 10.1007/s10460-018-09906-x

Bienge, K., Geibler, J., Lettenmeier, M., Adria, O., and Kuhndt, M. (2009). Sustainability hot spot analysis: a streamlined life cycle assessment towards sustainable food chains. 9th European IFSA symposium. Vienna. pp. 4–7.

Bruckmeier, K. (2020). "The policy context of the sustainability discourse," in *Economics and Sustainability*. Cham: Palgrave Macmillan, 2, 3–37. doi: 10.1007/978-3-030-56627-2_1

Carolan, M. S. (2006). Sustainable agriculture, science and the co-production of 'expert' knowledge: the value of interactional expertise. *Local Environ.* 11, 421–431. doi: 10.1080/13549830600785571

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., et al. (2003). Knowledge systems for sustainable development. *Proc. Natl. Acad. Sci.* 100, 8086–8091. doi: 10.1073/pnas.1231332100

Droppelmann, K., Bangwe, N., Hähnle, J., Klingler, R., Krüger, C., Kückes, J., et al. (2022). "From method to action—designing a participatory hotspot analysis to assess sustainability in Zambia's groundnut and dairy value chains" in *Humboldt-Universität zu Berlin, SLE postgraduate studies on international cooperation for sustainable development, Publication Series S288* (Berlin. Germany)

Elkington, J. (2018). 25 year ago I coined the phrase "triple bottom line." Here's why it's time to rethink it. Harv. Bus. Rev. Available at: https://hbr.org/2018/06/25-years-ago-i-coined-the-phrase-triple-bottom-line-heres-why-im-giving-up-on-it (Accessed April 15, 2022).

FAO. (2018). The 10 elements of agroecology: guiding the transition to sustainable food and agricultural systems. Available at: www.fao.org/agroecology (Accessed January 27, 2022).

Frank, M., Amoroso, M. M., Propedo, M., and Kaufmann, B. (2022). Co-inquiry in agroecology research with farmers: transdisciplinary co-creation of contextualized and actionable knowledge. *Agroecol. Sustain. Food Syst.* 46, 510–539. doi: 10.1080/21683565.2021.2020948

Fraser, E. D. G., Dougill, A. J., Mabee, W. E., Reed, M., and McAlpine, P. (2006). Bottom up and top down: analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *J. Environ. Manag.* 78, 114–127. doi: 10.1016/j.jenvman.2005.04.009

Fritz, L., and Meinherz, F. (2020). "The politics of participatory sustainability assessments: an analysis of power" in *Sustainability Assessment of Urban Systems*. eds. C. Binder R and E. Massaro (Cambridge: Cambridge University Press), 87–122.

Gliessman, S. R. (2016). Transforming food systems with agroecology. *Agroecol. Sustain. Food Syst.* 40, 187–189. doi: 10.1080/21683565.2015.1130765

Hegger, D., Lamers, M., van Zeijl-Rozema, A., and Dieperink, C. (2012). Conceptualising joint knowledge production in regional climate change adaptation projects: success conditions and levers for action. *Environ. Sci. Policy* 18, 52–65. doi: 10.1016/j.envsci.2012.01.002

Heron, J., and Reason, P. (2008). "Extending epistemology within a co-operative inquiry" in *The Sage Handbook of Action Research: Participative Inquiry and Practice*. eds. P. Reason and H. Bradbury (London, United Kingdom: Sage), 366–380.

HLPE (2019). Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. *Food Agri. Org. United Nations* 14, 1–162.

Ibisch, P. L., and Hobson, P. (2014). *MARISCO: adaptive management of vulnerability and risk at conservation sites. A guidebook for risk-robust, adaptive and ecosystem-based conservation of biodiversity*. Eberswalde, Germany: Centre for Econics and Ecosystem Management.

IEA. (2021). Methane tracker 2021. International energy agency. Available at: https://www.iea.org/reports/methane-tracker-2021 (Accessed March 12, 2022).

Liedtke, C., Baedeker, C., Kolberg, S., and Lettenmeier, M. (2010). Resource intensity in global food chains: the hot spot analysis. *Br. Food J.* 112, 1138–1159. doi: 10.1108/00070701011080267

López-García, D., Cuéllar-Padilla, M., Azevedo Olival, A. d., Laranjeira, N. P., Méndez, V. E., Parada S, P. Y., et al. (2021). Building agroecology with people. Challenges of participatory methods to deepen on the agroecological transition in different contexts. *J. Rural. Stud.* 83, 257–267. doi: 10.1016/j.jrurstud.2021.02.003

Neilson, J. (2014). Value chains, neoliberalism and development practice: the Indonesian experience. *Rev. Int. Polit. Econ.* 21, 38–69. doi: 10.1080/09692290.2013.809782

Ortmann, G., and King, R. (2007). Agricultural cooperatives I: history, theory and problems. *Agrekon* 46, 18–46. doi: 10.1080/03031853.2007.9523760

Perret, S. R., and Stevens, J. B. (2006). Socio-economic reasons for the low adoption of water conservation technologies by smallholder farmers in southern Africa: a review of the literature. *Dev. South. Afr.* 23, 461–476. doi: 10.1080/03768350600927193

Pohl, C., Rist, S., Zimmermann, A., Fry, P., Gurung, G. S., Schneider, F., et al. (2010). Researchers' roles in knowledge co-production: experience from sustainability research in Kenya, Switzerland, Bolivia, and Nepal. *Sci. Public Policy* 37, 267–281. doi: 10.3152/030234210X496628

Quinlan, M. B. (2018). "The freelisting method" in *Handbook of Research Methods in Health Social Sciences*. ed. P. Liamputtong (Springer, Singapore), 1431–1446.

Rohn, H., Lukas, M., Bienge, K., Ansorge, J., and Liedtke, C. (2014). The hot spot analysis: utilization as customized management tool towards sustainable value chains of companies in the food sector. *Agris On-Line Papers Econ. Inf.* 6, 133–143. doi: 10.22004/ag.econ.196583

Ruerd, R., Cavatassi, R., Lipper, L., Smaling, E., and Winters, P. (2021). Towards food systems transformation—five paradigm shifts for healthy, inclusive and sustainable food systems. *Food Security* 13, 1423–1430. doi: 10.1007/s12571-021-01221-4

Springer-Heinze, A. (2018). ValueLinks 2.0. Manual on sustainable value chain development. Available at: https://www.valuelinks.org/material/manual/ValueLinks-Manual-2.0-Vol-1-January-2018.pdf (Accessed February 09, 2021).

Stoian, D., Donovan, J., Fisk, J., and Muldoon, M. (2012). Value chain development for rural poverty reduction: a reality check and a warning. *Enterprise Dev. Microfinance* 23, 54–60. doi: 10.3362/1755-1986.2012.006

Tulloch, L., and Neilson, D. (2014). The neoliberalisation of sustainability. *Citizenship Soc. Econ. Educ.* 13, 26–38. doi: 10.2304/csee.2014.13.1.26

Utter, A., White, A., Méndez, V. E., and Morris, K. (2021). Co-Creation of knowledge in agroecology. *Elementa* 9, 1–16. doi: 10.1525/elementa.2021.00026

WHO (2022): Obesity. Available at: https://www.who.int/health-topics/obesity#tab=tab_1 (Accessed July 18, 2022).