DOI: https://doi.org/10.1007/s11213-018-9458-7

Multi-disciplinary North-South collaboration in participatory action research on food value chains: A German-Tanzanian case study on perceptions, experiences and challenges

Graef, F. [1], Mutabazi, K.D. [2], Sieber, S. [3], Asch, F [4], Bashir, M. [5], Bonatti, M. [3], Brüntrup, M. [6], Gornott, C. [7], Herrmann, L. [8], Herrmann, R. [6], Kaburire, L. [9], Kahimba, F. [10], Kimaro, A. [11], Kuntosch, A. [12], König, H. [1], Lagwen, P. [5], Lana, M. [1], Lambert, C. [13], Levy, C. [14], Löhr, K. [3], Maeda, C. [15], Mbwana, H. [16], Mchau, D. [17], Mnimbo, M.T. [18], Munder, S. [19], Mwinuka, L. [2], Ngwenya, P. [20], Nickson, E. [21], Nkonya, E. [22], Saidia, P. [10], Schäfer, M.P. [23], Schindler, J. [1], Silayo, V. [10], Uckert, G. [3], Wambura, J. [3], William, L. [24]

Corresponding author: graef@zalf.de Tel.: +49-33432-82162

[1] Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Land Use Systems, Müncheberg, Germany
[2] Sokoine University of Agriculture, Department of Agricultural Economics & Agribusiness, Morogoro, Tanzania
[3] Leibniz Centre for Agricultural Landscape Research (ZALF), Institute for Socio-Economics, Müncheberg, Germany
[4] University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Stuttgart, Germany
[5] Agricultural Research Institute (ARI)- Ilonga, Tanzania
[6] German Development Institute, Department II Competitiveness and Social Development, Bonn, Germany
[7] Potsdam Institute for Climate Impact Research, Climate Impacts and Vulnerabilities, Potsdam, Germany
[8] University of Hohenheim, Institute of Soil Science and Land Evaluation, Hohenheim, Germany
[9] Consultant, Dodoma, Tanzania
[10] Sokoine University of Agriculture (SUA), Department of Agricultural Engineering & Land Planning, Morogoro, Tanzania
[11] World Agroforestry Centre (ICRAF), ICRAF-Tanzania Country Programme, Dar es Salaam, Tanzania
[12] Humboldt-Universität zu Berlin, IRI THESys and Faculty of Life Science, Dep. of Agricultural Economics, Unter den Linden 6, 10099 Berlin, Germany
[13] University of Hohenheim, Institute of Biological Chemistry and Nutrition, Stuttgart, Germany
[14] Universität Kassel, International Center for Development and Decent Work (ICDD), Kassel, Germany
[15] The University of Dar es Salaam, Dept. of Economics, Dar es Salaam, Tanzania
[16] Sokoine University of Agriculture, Morogoro, Department of Food Science and Technology, Tanzania
[17] Agricultural Research Institute (ARI), Makatupora, Tanzania
[18] Sokoine University of Agriculture, Development Studies Institute, Tanzania
[19] University of Hohenheim, Institute of Agricultural Engineering, Germany
[20] German Institute for Tropical and Subtropical Agriculture, Witzenhausen, Germany
[21] MVIWATA Tanzania, National Network of Farmers' Groups in Tanzania
[22] International Food Policy Research Institute, Washington, USA
[23] Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Landscape Hydrology, Müncheberg, Germany
[24] Agricultural Council of Tanzania, P.O. Box 14130 Dar es Salaam, Tanzania

Abstract:

Upgrading local food value chains is a promising approach to invigorating African food systems. This endeavour warrants multi-disciplinary North-South collaboration and partnerships through participatory action research (PAR) to help leverage appropriate upgrading strategies (UPSs) with a focus on local stakeholders.

The more disciplines, cultures, and partner institutions that are involved, the more a project will present challenges in terms of communication and coordinating activities. Our aim was to determine the costs and investigate whether PAR with a multi-disciplinary approach was feasible in rural Tanzania with over 600 local stakeholders and more than 100 scientists. This article presents a self-evaluation of the collaboration and communication of project scientists during their research activities.

Despite the overall high satisfaction, the more complex and complicated PAR activities required more cooperation, instructions and communication among the project scientists than had been anticipated in this multi-disciplinary, multi-cultural, and multi–institutional context, resulting in greater tension and dissatisfaction. The findings indicate that this type of large multi-disciplinary PAR is challenging in terms of flexibility in the planning of research activities, the administration of finances, and cross-cultural communication. Potential avenues to overcome these obstacles include a) more communication on PAR activities across cultures to develop a shared vocabulary; b) developing other modes of shared responsibility for a more horizontal collaboration; and c) more face-to-face cross-cultural activities to overcome cultural, disciplinary and geographical distance.

Keywords: *participatory research; food security; food value chains; communication; Tanzania; multi-cultural context.*

1. Introduction

Since the Sahel food crisis of 2011 and 2012, research and development (R&D) projects have more strongly focused on entire food systems and increasing food security (CGIAR 2012) while using region-specific stakeholder-oriented participatory action research (PAR) approaches. Enhancing entire food systems requires large projects that involve a multitude of disciplines and related topics, institutions, teams, and persons, which increases transaction costs (Schmid et al. 2016). Such collaboration also requires highly complex research management and organizational structures and agreements to facilitate decision-making and communication (König et al. 2013), particularly in a North-South context, where cultures and perceptions differ greatly (Cooke and Kothari 2001; Shore and Cross 2005; Popescu et al. 2014). This condition is particularly applicable if the scientists represent a combination of conventional, in contrast to action, research and natural, in contrast to social, science.

The core features of PAR that are identified by Bradbury-Huang (2010) include "its orientation towards taking action, its reflexivity, the significance of its impacts and that it evolves from partnership and participation". Hence, in PAR, the research methodology and activities are context oriented and iterative in terms of how both scientists and local stakeholders select research methods, generate data, and reflect on how change efforts unfold and the impact of the intervention (Chambers 1994; Prowse 2010). Furthermore, linking a PAR approach with innovation systems thinking is beneficial to encompass a comprehensive analysis of a problem situation at different scales and institutional levels (Carlsson et al. 2002).

Reflexivity and iterative advancement are particularly challenging in large, multi-disciplinary and multi-cultural PAR project settings because they require greater effort to reach agreement on joint milestones and products; defining activities, responsibilities and protocols; and information and communication management (Schmid et al. 2015; Shore and Cross 2005). This greater communication burden somewhat contradicts reflective and iterative procedures as well as the action research philosophy of conducting a "work in progress" (Brydon-Miller et al. 2013). As Gustavsen et al. (2007) stated, "the direct influence from action research on human practice is constrained to the small group". However, a number of large-scale PAR projects or programmes have been successfully conducted. These projects were primarily carried out in the Northern context, for instance, on community food security (Pelletier et al. 1999) or regional workplace development (Gustavsen 2006). Other large-scale studies, for instance, those conducted by Waddel et al. (2015) and Waddel (2018), investigated large systems' (regional to global) societal changes and their driving forces, typologies, and supporting activities across disciplines. However, existing literature on large-scale PAR rarely covers inter-cultural contexts and potential collaborative implications.

The large interdisciplinary PAR-based German-Tanzanian project that we studied here (Graef et al. 2014) experienced various management and communication challenges. In this project, 10 food value chain (FVC)-upgrading strategies (UPSs) were selected and implemented through a participatory process (Kaburire et al. 2015) that involved 600 local subsistence farmers and more than 100 scientists. The project included 25 different departments or institutions representing eight nationalities and operated mainly in Tanzania and Germany. As such, it qualifies as a large multi-cultural PAR project (Rodrigues et al. 2014; Sarala 2010). This PAR approach was novel in its complexity and focus, as it targeted the entire FVC, it was participatively planned and carried out starting from the conceptual phase (Bradbury-Huang 2010), it involved many types of stakeholder-scientist interactions, it was characterized by high but balanced North-South cultural diversity and responsibility distribution, and it included an inherent conflict management unit with a sensitized awareness of cultural and institutional differences (Löhr et al. 2016).

The PAR approach developed here facilitated a deeper understanding of how local stakeholders make their food systems work. Furthermore, this strategy was key in jointly learning from the individual drivers and limitations of stakeholders when choosing and implementing a UPS. Stakeholders in this PAR were considered to be partners and co-generators of knowledge with concerns that are valuable to their local settings and as co-pilots of the PAR processes (Bradbury-Huang 2010; Prowse 2010).

Controversial discussions during multi-disciplinary meetings on PAR activities among teams and single scientists led to the idea of a joint self-evaluation not of the PAR approach but of how the management, collaboration and communication were perceived among the scientists during the course of the project. It was found to be necessary to systematically identify and assess the challenges that were experienced by the project consortium to learn from them and obtain data to inform future projects. Hence, the authors decided to investigate their perceptions of the various PAR activities that were undertaken over three years. Given previous studies on complex, multi-sectoral projects (Hardy et. al. 2017; Popescu et. al. 2014; Stauffacher et. al. 2008) and on the dynamics of North-South collaboration (Cooke and Kothari 2001; Ochieng and Price 2010), we chose to implement a critical self-evaluation (Čagran and Grmek 2013). Furthermore, we aimed to anchor the findings and learn from alternative, possibly more effective and successful, large-scale approaches

(Gustavsen 2006; Gustavsen et al. 2007; Pelletier et al. 1999; Waddel et al. 2015). Methodologically, we chose to analyse and systematically evaluate both qualitatively and quantitatively the scientists' perceived needs for instructions and communication, their satisfaction, and the number of conflicts that they experienced after carrying out specific PAR activities. We assumed that their perceptions would differ depending on discipline, type of activity undertaken, and nationality.

2. Methodology

2.1 Consortium organizational structure

The organizational structure of the research consortium is complex (Figure 1). The project is coordinated by a four-person team with two coordinators based in Germany and two in Tanzania. The overall PAR management and budget control personnel are based in Germany, suggesting a tendency towards "supporting change" as termed by Waddel et al. (2015), where "power-holders use their resources to realize change, convinced it is for the broader good". Most research activities, however, are decentralized, with each German and Tanzanian partner having its own budgetary responsibilities (Graef et al. 2014; Figure 2). Hence, in terms of power distribution, this project aims at "co-creating change through collaborative strategies" (Waddel et al. 2015) with multiple stakeholders. The scientific aims and agendas of the PAR process are defined by both Tanzanian and German coordinators and lead scientists, while the decisions on which UPS to implement are made in collaboration with local stakeholders. The research level is composed of over 100 scientists and non-scientists who are affiliated with 25 different research units or institutions and cooperate with over 600 local stakeholders, most of them subsistence farmers.

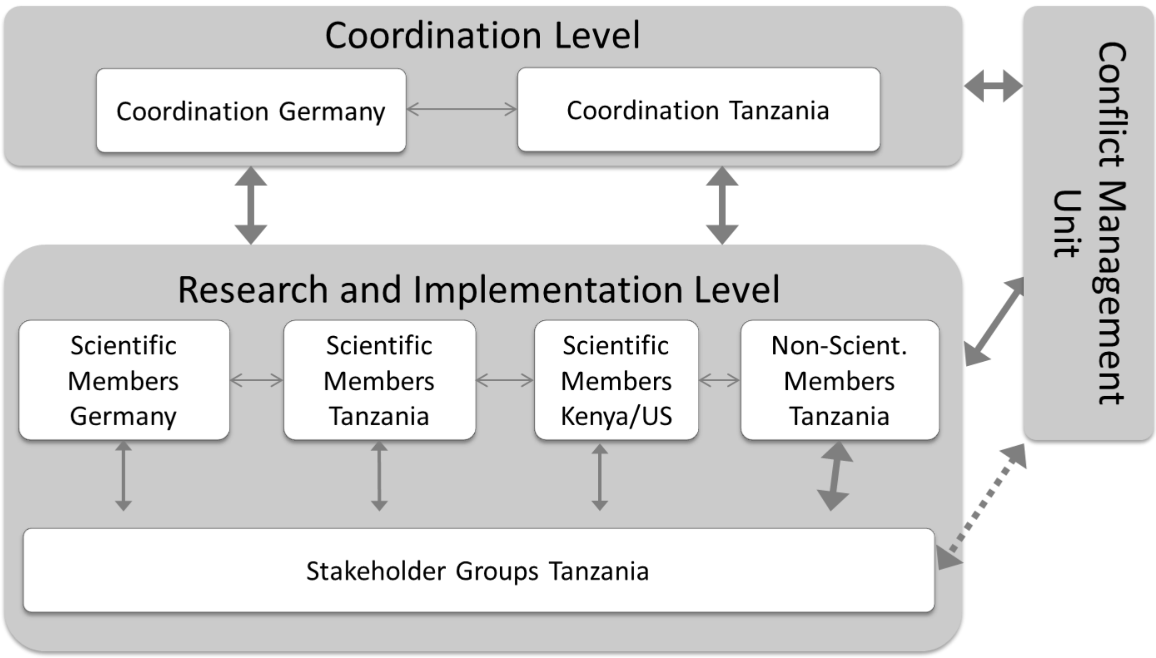

Figure 1: Trans-SEC organizational structure

The 13 German research units include universities and research centres. The ten Tanzanian research units or institutions include five university departments, two research centres, and three NGOs. Two international research centres from Kenya and the US are part of the consortium. Local stakeholder involvement and knowledge co-generation during implementation, testing and assessment of the UPS are primarily coordinated and carried out by Tanzanian scientific and non-scientific partners. A conflict management unit is integrated to minimize conflict potential among the scientific and non-scientific project partners and to moderate in case of conflict (Löhr et al. 2016).

2.2 PAR framework and activities undertaken

Stakeholder[1] participation using different methodologies was an integral part of most of the analytical steps in the project (Figure 2; Stauffacher et al. 2008). In fact, the inclusion and co-generation of stakeholders' and scientists' knowledge at different intensity levels (Table 1) (Bradbury-Huang 2010) iteratively shaped most of the methodologies described below.

(1) Mapping stakeholders across the FVC: the identification of all key relevant and grassroots-level stakeholders and their functions along the FVCs on local, regional, and national scales (Grimble and Chan 1995).

(2) Inventorying FVC constraints and strategies: the priority commodities and FVC constraints on rural farmers at four case study sites (CSSs) were inventoried (Mwinuka et al. 2015).

(3) Identifying local food security criteria: the food security criteria for assessing the impact of UPS were identified using the existing literature as well as local focus groups and panel discussions (Schindler et al. 2016). The criteria were validated by, and adapted to, the local stakeholders' perceptions of food security.

(4) Identifying 3-5 UPSs per FVC component: potential UPSs of priority commodities among each FVC component to enhance food security were screened and described in detail using fact sheets, and an inventory was established for the CSSs, the target regions, and beyond. This procedure was conducted using jointly defined selection criteria (Riisgaard et al. 2008). The components were then jointly analysed in depth among the scientists with regard to their selection criteria, for instance, their expected positive impacts on food and livelihood security, knowledge and the data availability of previous implementations, and practicality (Graef et al. 2017). Finally, 3-5 UPSs were selected by the scientists for subsequent prioritization by the CSS stakeholders.

(5) Prioritizing UPSs in CSSs for testing: the UPSs were first presented to the farmers by the scientists using visual material. Then, the participants worked in small, moderated working groups on a SWOT analysis for each UPS. Each group presented the results to the other participants, and 2-3 UPSs per FVC component were prioritized in a secret voting by groups of 9-13 representative stakeholders for final field implementation in all four CSSs. The scientists accepted a number of additional UPSs for implementation and merged a few UPSs, attaining 6-7 of the most promising UPSs per CSS, and overall, 10 UPSs were selected (Mwinuka et al. 2015).

(6) UPS groups formation: 6-7 UPS farmer groups per CSS, with group sizes that ranged from 10 to 50 members, were formed from a household panel survey sample of 150 HH per CSS.

(7) UPS implementation, testing, adaptation: the 10 prioritized UPSs were implemented and tested in the CSSs. This step included different processes such as bi-monthly monitoring missions with recurrent feedback and adaptation activities between local stakeholders and scientists that extended from several months to one year.

(8) Co-creation of potential future scenarios: these scenarios were developed with researchers and Tanzanian meteorologists. The task here was to prove whether future climate conditions would alter the performance of a UPS. Therefore, the UPS-specific conditions were demonstrated with bio-physical simulation models for large climate datasets. The output of these simulations will be communicated back to farmers and researchers with no meteorological background.

(9) UPS monitoring and impact assessment: the implementation and testing of the UPS were monitored using generic and specific parameters that were collected during both UPS focus group discussions and visits to all of the involved households. Once per year, the UPS groups met to provide feedback to the scientists on the expected (ex-ante) and/or experienced (ex-post) UPS impact on food security.

(10) UPS results dissemination: during the process of selecting, testing and assessing the UPS, the lessons learned were prepared for dissemination and outreach. This step was completed through the research

[1] The term stakeholder, as it is used in our context, refers to a) individuals who are directly affected by decisions and actions such as local farmers and b) key informants from groups and organizations that have power to influence the outcomes of these decisions, for instance, NGOs or local, regional, and national governments (Freeman 1984; Figure 1).

network (scientific papers, home page, movies) and within stakeholder organizations through policy briefs and capacity-building workshops at the policy, extension and farmer school levels (Riisgaard et al. 2008).

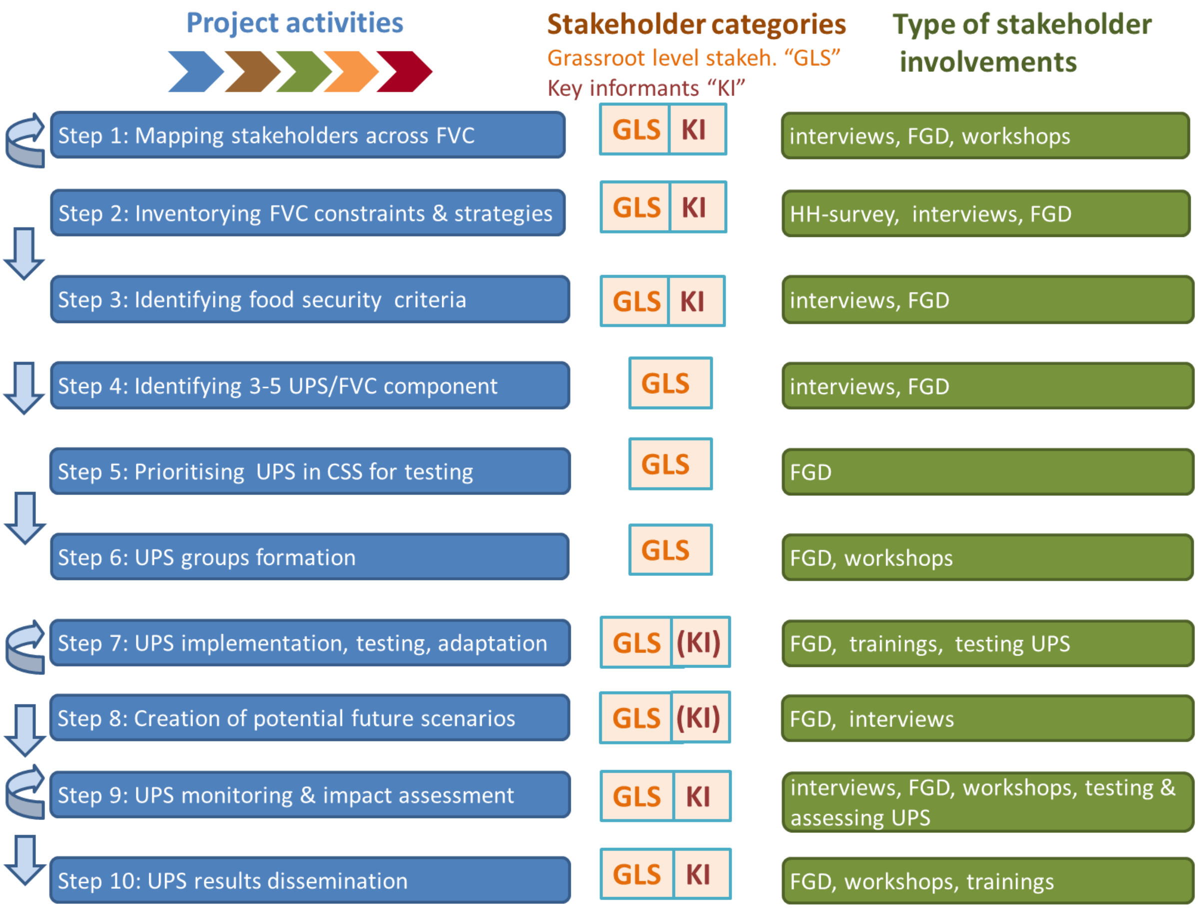

Figure 2: PAR steps, stakeholder categories involved, and types of stakeholder involvements (FGDs: focus group discussions; CSS: case study site; UPS: upgrading strategy; FVC: food value chain), with some steps being recurrent leading to iterative changes of the following ones.

2.3 Evaluation approach

The idea of a critical self-evaluation on how scientists perceived the communication between coordination levels and research levels during the course of the PAR project was initiated and developed by the scientists themselves as a reflexive activity. This process aimed to provide an exchange across multi-disciplinary and organizational boundaries and to enable learning alongside the PAR process and experience, thereby supporting improved preparation for and the informing of future large PAR projects of this type. The UPS implementing stakeholders were excluded from this evaluation because our main focus was on understanding the scientists' perceptions from differing disciplines and North-South working cultures and because the local stakeholders were less involved in a few of the 10 steps.

Based on these considerations, a core team of Tanzanian and German scientists discussed and defined a) the levels of participation (Arnstein 1969); b) the information, guidance and instructions that were provided in each step (Table 1, upper part); c) the indicators for assessing the communication, certain selected process features and satisfaction or dissatisfaction; and d) the assessment scale for evaluating communication along the analytical steps that were carried out. The discussions reflected the concepts of Stauffacher et al. (2008), who investigated differences in participation intensity based on information, consultation, cooperation, collaboration and empowerment (decision-making power). Because efficient communication was found to be the backbone of such a multi-disciplinary participatory setting, a particular emphasis was placed on assessing communication (who, how, where, and with whom) and the scientists' (dis)satisfaction experienced during the project.

It was finally agreed that eight indicators would be assessed and scored using either a 5-point Likert scale (0: none; 1: low; 2: medium; 3: high; 4: very high) (Harpe 2015) or an estimated percentage (Table 1). These indicators were related to communication (*need for more instructions by coordination level; communication requirements among partners during this activity);* selected process features (*complexity/multi-disciplinarity of activity; degree of stakeholder participation; percentage of task accomplished);* and satisfaction or dissatisfaction *(project partner satisfaction during the process; final project partner's satisfaction after >2 years; the amount of conflict/tension experienced).* The Kruskal-Wallis test was used to analyse the stepwise differences of the Likert scale assessments.

The assessment task and procedures were shared by email as a Microsoft Word file with 39 project scientists who were deeply involved in all of the PAR steps, while the scientists with only partial participation were excluded. Each research step was assessed and rated by Northern and Southern scientists from both the coordination level and the research level using the abovementioned indicators. The scientists were asked to provide feedback according to their own personal experiences and perceptions and to provide specific observations, narratives, descriptions of critical shortcomings or bottlenecks, and recommendations. We received 19 responses from Tanzania and 12 from Germany, with eight female and 23 male respondents, all of whom were non-anonymous. The information was analysed qualitatively and quantitatively using IBM SPSS Statistics 22.

3. Results

Altogether, 31 project members who were involved with the PAR activities evaluated the 10 different participatory research steps and provided their perceptions and assessments.

3.1 Guidance/instructions provided by coordinators and team leaders

Based on the different types, content and complexities of the analytical steps, the guidance and instructions varied largely, as did the number of the involved scientists and stakeholders (Table 1, upper part). Some of the participatory research steps were particularly complex and involved many scientists. This was true of steps four (Identifying 3-5 UPS per FVC component), seven (UPS implementation, testing, adaptation), and nine (UPS monitoring and impact assessment). These complex activities were also consistently linked to higher stakeholder participation intensity levels (cooperation, collaboration, and empowerment) and required more instructions from the coordinators and team leaders and a distinctly higher level of cooperation among scientists. Here, knowledge co-generation was also exceedingly highly iterative and provided guidance for most of the PAR steps. Although these complex PAR activities demanded, and were given, more time by the project coordinators, they were regularly followed by considerable delays before the activity was finalized. These activities triggered particularly high numbers of reminders (up to 20) from project leaders before they could be finalized. Higher numbers of the involved stakeholders did not necessarily require a higher degree of cooperation among the project members.

3.2 Assessments of the participatory process by involved consortium members

The project members' assessments showed great differences among both the research steps and the evaluated parameters (Table 1).

Need for more instructions: The *need for more instructions* was generally rated medium to high by most of the project members. In particular, the more complex activities (for instance, research steps, (2) inventorying FVC constraints and strategies, (4) identifying 3-5 UPSs per FVC component, (9) UPS monitoring and impact assessment, and (10) UPS results dissemination) would have required, or still require, more instructions, having *"lacked communication explaining the task between the scientific partners in Germany and Tanzania".* This demand for instructions is also linked to the number of project teams and members who were involved and, to some extent, to the activity delays that occurred. We also found higher rating disunities (high SDs) among the members, implying that they were unequally informed or involved.

Complexity/multi-disciplinarity of activity: All of the activities except (1) mapping stakeholders were given high ratings for *complexity/multi-disciplinarity of activity,* which indicates the multiple tasks and challenges that this type of participatory research presented to the project members. The involved colleagues noted that "*discussion processes lacked interdisciplinarity*" and "*seemed [too] complex for task teams"*.

Communication requirements among partners during this activity: The *communication requirement* for all the activities was perceived to be high to very high, which reflects the need for continuous and/or repeated exchanges through different communication pathways. Particularly high ratings were received for (3) Identifying food security criteria; (4) identifying 3-5 UPS per FVC component; (5) prioritizing UPS in CSS for testing; (9) UPS monitoring and impact assessment; and (10) UPS results dissemination. These were activities that specifically involved many project members. Specifically, (5) prioritizing UPSs according to scientists after a long PAR process of approximately 15 months "*compromised interests of [some] PhDs whose objectives were set before the* UPSs were prioritized" or "were selected against the interest of respective [senior] researchers". This finding suggests that the allocation and timing of budget and personnel in this type of PAR project would need increased flexibility. Other PhDs were able to adapt their work to the local stakeholders' decisions. Interestingly, the respondents all agreed (low SD) on *communication requirements*.

Degree of stakeholder participation: The ratings on *degree of stakeholder participation* differed largely between the research steps and ranged from medium to very high, with significant differences. A low *degree of stakeholder participation* was also reflected by the number of stakeholders who were involved. A particularly high *degree of stakeholder participation* was reported for activities where few (80-200) stakeholders were involved, for instance, for (2) inventorying FVC constraints and strategies, (3) identifying food security criteria, and (5) prioritizing UPSs in CSSs for testing.

Percentage of Task accomplished thus far: The assessment for percentage of *Task accomplished thus far* differed significantly and ranged from 30% to 97% depending on the type and schedule of activities. While some of the activities were still ongoing (such as (7) UPS implementation, testing, adaptation; (8) creation of potential future scenarios; (9) UPS monitoring and impact assessment; and (10) UPS results dissemination), other activities, such as (1)-(6), were fully completed. Interestingly, we found disunity as to whether the final outcome had been obtained.

3.3 Perception of satisfaction and tensions experienced

Project partner satisfaction during the activity: The ratings for proj*ect partners' satisfaction during the activity,* despite the challenges noted above, ranged in score from medium (a few) to high (many). Higher satisfaction was linked with higher degrees of stakeholder participation, for instance, with the activities of (3) identifying food security criteria and (5) prioritizing UPSs in CSSs for testing. Lower satisfaction was observed for (8) creation of potential future scenarios and (10) UPS results dissemination, which are activities that are highly demanding in terms of time and desk work requirements. In this regard, the scientists complained that "*decision-making was not balanced to some extent. Some partners dominated others so that some actions were imposed instead of using a consensus-building and negotiation approach"*.

Final project partners' satisfaction after 1-2 years: The ratings for *final project partners' satisfaction* differed greatly and ranged from few medium to many high or very high ratings. The final satisfaction ratings differed only slightly from those for *partners' satisfaction during the activity.* This finding indicates that a possibly inconvenient setting during an activity could only partially be overcome during the activity's finalization. It was specifically reported that *"interests of some PhDs and scientists were compromised [due to the 18 month PAR period until UPS selection]".* The relevant takeaway here is that pre-defined disciplinary assignments are highly risky and need more flexibility in an action research-based large multi-disciplinary food system setting. High satisfaction was found for activity (3), identifying food security criteria, which was reported to be *"linked to intensive interaction with and participation of stakeholders"*.

Amount of conflict/tension experienced: The *amount of conflict/tension experienced* was perceived to be low to medium and differed significantly among the steps *(*$p < 0.01$; Kruskal-Wallis test). Most of the tensions were perceived to be related to activities (4) identifying 3-5 UPS/FVC components, and (9) UPS monitoring and impact assessment. Both activities were considered to be *"complex and multi-disciplinary, requiring a high degree of cooperation among project partners".* Both also had a high need for more instructions, high communication requirements, a high degree of project partner and stakeholder participation, as well as requiring a large number of reminders before finalizing the activity. It is clear that this type and size of multi-disciplinary and multi-cultural PAR setting reached its limits.

3.4 Scientists' narratives

This section draws on the narratives of 21 respondents (10 from the North and 11 from the South). Despite the limited number of respondents, the assessment of the narratives provides insights into the above findings (Table 1). It also informs the relational strands of the interactions and the collaboration process among the Northern and Southern scientists through their personal perceptions of and convictions about the PAR steps.

The respondent researchers' narratives across the 10 steps were segmented into eight blocks of narrative constructs (Figure 3). The intensity of the responses across the steps indicates that more researchers (15 counts) from the North felt that the PAR activities "*were complex, sluggish and fuzzy*". In contrast, most of the researchers from the South (12 counts) had a positive view of how the PAR activities were iteratively implemented, being more familiar with this PAR approach, and stating for instance that "the *approach is good and its objectives address the real needs of rural communities*". Tensions and disagreements were similarly rated among both nationalities (six counts). The researchers from the North felt that at least some of the PAR steps "*lacked interdisciplinarity/holism and were intransparently coordinated*" and required "*more instructions*" (Table 1). Compared to their counterparts from the North, the Southern researchers perceived that the scientific coordination across the PAR activities was not problematic; however, *"some partners dominated others so that some actions were imposed instead of using a consensus approach"*. The Northern researchers were relatively more concerned with poor communication than were those from the South (five versus three counts), and they identified "*heterogeneities in expectations, institutional and personal agendas, and professionalism"*. More of the researchers from the North, who were less involved with local field activities, felt that the *"processes and outcomes of some PAR activities were poorly communicated"* and that "*project duration is too short to truly assess an impact".*

Overall, the narratives coupled with the assessments and perceptions (Table 1) exhibit clear North-South differences in overall PAR process satisfaction, in communication, and in the cultural differences in resolving disputes. In spite of all efforts to co-create a balanced inter-cultural PAR, this finding indicated that scientific, political and cultural domination to some extent underlay the scientists' behaviour.

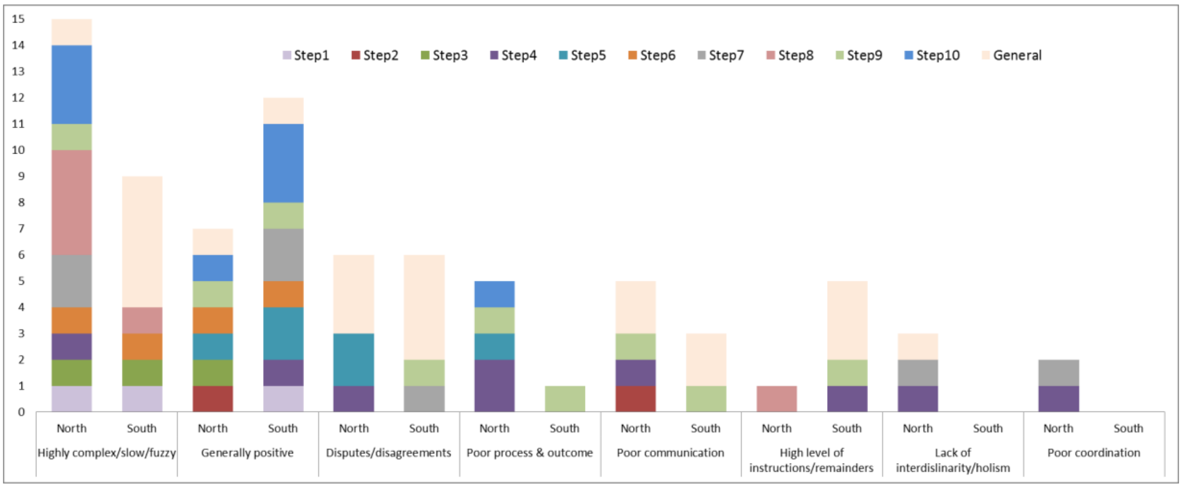

Figure 3: Distribution of response counts of respondents' narrative constructs across PAR steps

4. Discussion

4.1 PAR in a large multi-disciplinary project

In action research literature, there is most often qualitative but very little quantitative analysis. In our study, the number of 31 respondents out of 39 project members who were involved with the PAR activities was considered to be statistically sufficient to derive conclusions (Graef et al. 2017; Schindler et al. 2016). The eight features of guidance and/or instructions that were provided by the coordinators (Table 1, upper part), the eight indicators that were assessed by the involved project members (Table 1, lower part), and the categorized narratives (Figure 3) quantitatively depict most of the characteristics, effort, complexities, and perceptions that were experienced by the participants while they conducted PAR in such a large and complex multi-disciplinary and multi-cultural project (Dant 2004; Hofstede 2018; Pelletier et al. 1999; Popescu et al. 2014, Prowse 2010; Zscheischler et al. 2014). Those findings were supported by the qualitative single narratives.

Scientists' uncertainty, particularly among the Germans, regarding their research topics and activities was particularly high during the first research steps, which included (2) inventorying FVC constraints and strategies; (4) identifying 3-5 UPS per FVC component; and (5) Prioritizing UPS in CSS for testing (Figures 1, 3), concurring with observations by Hofstede (2018).This uncertainty was indicated by a need for more instructions, the complexity and/or multi-disciplinarity of the activity, the communication requirements among the members during this activity, the somewhat lower project member satisfaction, and the amount of tension that was experienced (Table 1). This trend was also reiterated through the narratives (Figure 3). The first six steps leading to the decision on what UPS to implement were performed by local stakeholders and took 18 months, which was longer than expected. Therefore, these steps were perceived to be major bottlenecks that required exceptional patience and flexibility among the involved institutions because they entailed various institutional-administrative impediments for the involved staff (Pelletier et al. 1999).

As indicated in Table 1, and in the respondents' narrative constructs, the PAR parameters are highly interlinked. For instance, more complex activities with higher stakeholder participation intensity (Table 1; Figure 4) required a high degree of cooperation among the project members, a high need for more instructions, greater communication, and a high degree of project partner and stakeholder participation. The project members also required a high number of reminders before finalization, which was linked to higher dissatisfaction (Table 1) and ultimately less transformation into action of the knowledge that was gained (Schmid et al. 2016). This finding may lead to the assumption that the higher the complexity and number of persons involved in such a PAR project, the lower the responsibility and actual engagement will be, as is also indicated by the study's low response rate of 80%, which shows low connectivity (Hardy et al. 2017). Formation of smaller sub-groups of 3-10 members with higher budgetary and personnel autonomy and responsibility, as shown by Pelletier et al. (1999), could alleviate this shortcoming. The narratives indicated that numerous misconceptions were present with regard to the research agenda, decision-making, and timing between the different nationalities, field staff, and scientific disciplines such as natural, engineering, and socio-economic fields. For instance, the value of having researcher-managed versus farmer-managed trials required repeated discussion.

While some of the PAR steps were determined to be sequential by input-output relations (Figure 1), other reflective PAR activities, for instance, UPS implementation, impact assessment and monitoring, were recurrent and resulted in bottom-up adaptations of the PAR (Graef et al. 2014). This process, in turn, required higher degrees of participation (Grimble and Chan 1995; Stauffacher et al. 2008) and more scientist-to-stakeholder and North-South communication and commitments than previously expected. The roadmap, intensity levels of participation and methods of participation (Arnstein 1969) during the PAR steps were not previously fully defined and communicated. However, they were iteratively defined and adapted through successive activities with high degrees of reflexivity and experiential learning (Bradbury-Huang 2010). This approach resulted in the requirement of post hoc definitions, discussions and meta-communication (Zscheischler et al. 2014), which led to some tension (Table 1), particularly across the different cultures (Hofstede 1983; Popescu et al. 2014). Here, the German scientists, possibly due to underlying economic and political domination but also higher uncertainty avoidance (Hofstede2018), tended to be more determining than were their Tanzanian counterparts in some cases. This dynamic was representative of the North-South dilemma as described by Cooke and Kothari (2001). Figure 4 illustrates the levels of participation that were experienced in this project. The levels of cooperation, empowerment and participative collaboration were underestimated by most of the scientific project members, as indicated in the respondents' narratives.

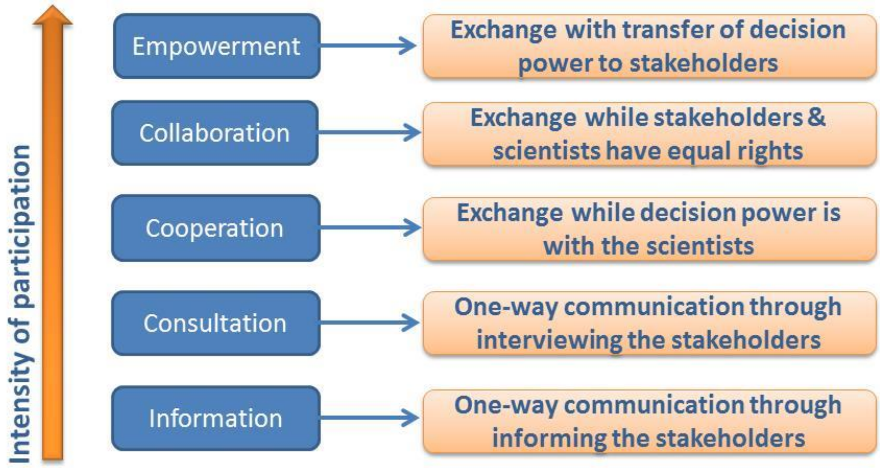

Figure 4: Intensity levels of participation (Stauffacher et al. 2008, modified)

In particular, the less locally involved German members had to be introduced to, and informed about, participative methodologies and (sometimes inconvenient) local decisions that were made on site in Tanzania (Shore and Cross 2005). The PAR process, among other factors, led to perceptions of highly complex, slow and poorly defined activities, and poor communication (Figure 3). Here, putting more emphasis on trust, inter-relationships, and cross-cultural communication would have been beneficial (Ochieng and Price 2010). Furthermore, the modes of inviting researchers to participate and integrating them in joint PAR activities, as is indicated in the narratives, were not satisfactory to some of the respondents. How did the researchers respond to participative integration? Did they actively participate and communicate, or were they not able or prepared to do so, as discussed by Cooke and Kothari (2010)? The provision of more instructions, as indicated in Table 1, may be one answer. More intensive participation and time for development is another (Figure 4). Further, more – or more efficient – North-North, North-South, and South-South communication (Stahl et al. 2010) and PAR theory and practice thinking (Brydon-Miller et al. 2003) could also be of value.

The data triangulation in Trans-SEC, for instance, for assessment of the impacts of UPSs on food security, required different methodological activities to be conducted by distributed multi-cultural and multi-disciplinary investigator teams to arrive at balanced and solid results (Hofstede 1983; Popescu et al. 2014). However, was this truly cross-disciplinary co-working? Did, for instance, the natural and social scientists truly work together and produce joint results? The answer is "yes, in most cases", for instance, with activities such as joint research planning to conduct and produce research results, as was presented by Mwinuka et al. (2015) and Schindler et al. (2016). However, with increasing complexity, there was also a decreasing level of successful North-South collaboration. There was also a gap between knowledge acquisition, co-learning and shared vocabulary development on the one hand and transforming knowledge into actionability on the other, i.e., the UPS implementation (Bradbury-Huang 2010; Schmid et al. 2016).

Similarly, Brydon-Miller et al. (2003) described project participants who struggled to construct broader PAR initiatives. Learning from large-scale PAR experience, Gustavsen et al. (2006) found that deriving lessons learned from a case (here the Tanzanian FVC with over 600 rural stakeholders in four CSS and involved Tanzanian institutions) demands continuous access to the case. He stated that "this is a chief reason why long-distance learning from cases is at best difficult". In particular, this is due to the mainly virtual type of collaboration. Hence, a multi-disciplinary and multi-cultural PAR project of this kind requires high awareness of potential cultural, technical, administrative, and scientific challenges as well as very careful planning and implementation.

4.2 Communication challenges: causes, levels and types

As illustrated in Figure 5, conflict indicators are influenced by three major clusters that correlate with one another: (A) conflict-triggering factors and levels of differences due to cultural diversity, for instance, regarding communication and cultures of dispute; (B) conflict levels, for instance, regarding institutional constraints such as contract assignments; and (C) conflict types, for instance, due to professionalism, personalities or process disunities. This principle applies to all of the activities that were undertaken during our action research (Table 1) and was particularly mirrored in the respondents' narratives that are presented above (Figure 3).

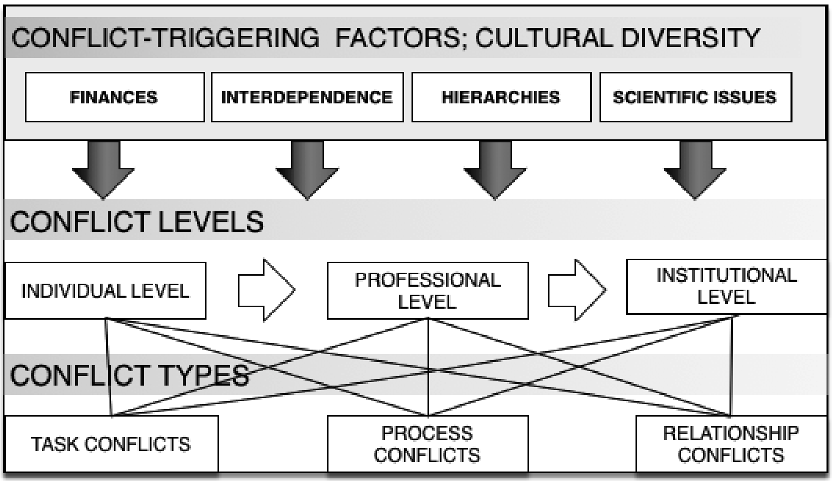

Figure 5: Factors, levels, and types of conflicts encountered in Trans-SEC

Cultural backgrounds of those engaged in joint projects can lead to positive (Popescu et al. 2014), negative (Zander and Butler 2010), and a number of concealed consequences (Cooke and Kothari 2010). Misunderstandings or disagreements are common in such large multi-disciplinary and participatory projects (Löhr et al. 2016; Shore and Cross 2005 et al. 2014). Cultural diversity, as an umbrella factor for tension (Figure 5), requires knowledge of the underlying aspects (Kaushal and Kwantes 2006; Ochieng and Price 2010;) and the extent to which these aspects influence issues such as finances, hierarchies, interdependencies and scientific approaches (Cooke and Kothari 2010; Hofstede 1983; Sarala 2010). Inspired by the conflict types reported by Greer et al. (2011), the types of challenges within this PAR project that are expressed in the respondents' narratives include task challenges (task goals or outcomes), process challenges (logistics of task accomplishments) and relationship challenges (personal clashes over topics or team performance) (Figure 3).

Communication and good connections among the project members were crucial during project implementation and required facilitation via meta-communication (Farrell et al. 2013; Zscheischler et al. 2014; König et al. 2013). However, North-South communication learning, despite technical and practical instructions, was "*at best slow, maybe even stagnant*". Gustavsen (2008) found similar results from a large-scale PAR, suggesting that more emphasis should be put on face-to-face meetings, planning events (Ochieng and Price 2010; Pelletier et al. 1999), and direct communication by Skype or phone (own observations; Stahl et al. 2010). Optimally, existing PAR "networks involve people who can communicate without having to cross large communicative gaps, be it in terms of distances or language", reported Gustavsen et al. (2006). The networks also develop mutual trust because they are better able to control each other. In our case, we experienced communicative gaps both in terms of distance, language (German, English, Swahili), and communication technology, suggesting the need for more frequent exchange of information face to face. Furthermore, cases of domination of discussions or decisions experienced by few individuals indicate the need for enhanced moderation of these activities (Löhr et al. 2016; Ochieng and Price 2010; Pelletier et al. 1999).

The conflict management programme implemented was a novelty in this type of PAR (Figure 5). Our experience indicates a need for this type of support structure, which continuously accompanies the consortium and does not operate only on demand when a conflict has occurred (Löhr et al. 2016). Preventive measures such as workshops on conflict and cultural awareness and communication proved to be valuable for supporting the PAR, as they provided a platform for reflection and exchange and thereby resulted in a more open communication culture. However, as good working relationships with stakeholders are crucial in a PAR, measures on conflict prevention and management should also be offered to the local stakeholders (Löhr et al. 2016). Here, we find that PAR theory was adopted in the service of our practice and further amended throughout the process of the project and experiential learning (Brydon-Miller et al. 2003). Interestingly, and in spite of the conflicts experienced (Figure 3), the project member satisfaction 1-2 years after activity completion was high throughout most activities (Table 1), suggesting that preventive measures, conflict moderation, and project outcome were successful.

4.3. Linking innovation systems thinking and participatory action research

The PAR theory assumes that the non-adoption of innovations is due not to an inability of farmers to adopt but, rather, to imperfect implementation processes, environmental settings, and poorly adapted technologies (Bradbury-Huang 2010; Dant 2004; Myers 1997). Action research strongly focuses on the co-learning of the people involved (local stakeholders and scientists) and seeks to solve real-world problems at the local stakeholders' level (Prowse 2010; Schmid et al. 2016). The respondents' narratives showed that the challenges that were encountered in the project's PAR included the non-consideration or underestimation of the wider research and administrative environment, complexity and cultural setting in which the PAR activity was taking place (Table 1, Figure 3) and in which the innovations were embedded, for instance, within an FVC (Riisgaard et al. 2008). Therefore, investing in time to learn a shared language is fundamental because both the local stakeholders and the scientists only have their specific modes of perceiving their environment. A "search conference" (Pelletier et al. 1999) for in-depth joint language finding and co-creation of goals and activities is a promising approach. In our project, annual and semi-annual meetings were undertaken in this respect.

Adding to PAR theory through our multi-disciplinary FVC approach, we found that an innovation systems focus would facilitate the consideration of problems from different perspectives and scales and aid in the anticipation of challenges. Furthermore, locally adapted FVC solutions should be targeted, as intended, towards more local settings (Chambers 1994; Nygren 1999; Riisgaard et al. 2008) because case studies in the social field cannot be expected to follow the same logic as bio-physical experiments and be simply extrapolated to other regions (Gustavsen et al. 2007). Gustavsen (2006) further suggested increasing the involvement of research in development and innovation processes on a regional level. Other existing literature on large-scale PAR and programmes recommends multi-stakeholder, public engagement and social labs (Waddel et al. 2015); better integration among research, development and education in interdisciplinary research, and initiatives based on local cooperation (Gustavsen 2006; Zscheischler et al. 2014); enhancing the awareness among leaders of cultural variation and of the challenges of creating "*effective cross-cultural collectivism, trust, communication and empathy*" (Ochieng and Price 2010; Shore and Cross 2004); and more detailed insight into major cultural dimensions and preparation to address differences in power distance, uncertainty avoidance, individualism, and long-term orientation between two different cultures (Hofstede 1983). In Tanzania, for instance, the power distance is considerably higher than in Germany (Hofstede 2018).

Larger-scale challenges, as noted by Brydon-Miller et al. (2003), require different approaches such as large system changes recognizing the complex adaptive systems in which change is continuous, but directions can be supported through change actions (Waddell et al. 2015). Larger-scale, cross-cultural PAR projects should also address and manage potential aspects of domination (Cooke and Kothari 2001; Gustavsen 2008; Sarala 2010; Shore and Cross 2004). In particular, power imbalances between members through one-way budget control could be overcome through shared budget control and other shared responsibilities (Greer et al. 2011; Schmidt et al. 2016; Zander & Butler 2010). Gustavsen et al. (2006) stressed "that scope (regional impact) was most efficiently reached […] in horizontal collaboration […] because then learning is mutual". For our project, these findings suggest that more frequent cooperation activities between scientists and local stakeholders of both German and Tanzanian nationalities would have possibly been beneficial.

5 Conclusions and recommendations

The critical self-evaluation by scientists of their large multi-disciplinary cross-cultural PAR project produced interesting results. The overall satisfaction with PAR activities and the outcome was mostly high. Based on narrative constructs and assessments of the PAR activities, we found that particularly complex and reflective activities required more time, cooperation and communication among the scientists; more instructions from project management; and more overall participation than expected. This increased input was also accompanied by considerable delays, increased reminders before finalization, and higher tension and dissatisfaction. These challenges were perceived to be more severe by the Northern colleagues. A PAR of such a complex, multi-disciplinary nature is highly demanding in terms of flexibility in research activity planning; financial-administrative handling; and North-South, scientist-scientist, and scientist-stakeholder communication. These projects require transparent and early cross-cultural communication among all the involved members. Both North-South and intranational disagreements were common. Adding to the PAR theory, we find that this type of cross-cultural project requires higher meta-communication, conflict management, and preventive workshops on conflict awareness and communication issues than others. Comparing our results with those from other large-scale PAR and inter-cultural projects indicates that a) a great deal more time should be allocated to communicate PAR theory and PAR activities across cultures beforehand to develop a shared vocabulary; b) modes of shared responsibility in possibly smaller teams are needed for a more horizontal and successful collaboration; and c) more face-to-face cross-cultural activities are needed to overcome cultural, disciplinary and geographical distance.

Acknowledgements

This publication is a product of the project Trans-SEC (www.trans-sec.org). The Trans-SEC project was funded by The German Federal Ministry of Education and Research (BMBF) and co-financed by the German Federal Ministry for Economic Cooperation and Development (BMZ). The views that are expressed are solely those of the authors and may not under any circumstances be regarded as representing an official position of the BMBF or BMZ. Thanks to the reviewers for their helpful suggestions.

6. References

Arnstein, S.R. (1969). A ladder of citizen participation, Journal of the American Institute of Planners, 35/4, 216--224.

Brydon-Miller, M., Greenwood, D., & Maguire, P. (2003). Why Action Research? Action Research, 1 (1), 9 – 28.

Bradbury-Huang, H. (2010). What is good action research? Why the resurgent interest? Action Research, 8, (1): 93-109.

Čagran, B. & Grmek, M.I. (2013). Critical Self-Evaluation: An Attribute of Systemic Behavior: Authors of Natural Science Learning Materials as Evaluators. Systemic Practice and Action Research, 26, 537.

Carlsson, B., Jacobsson, S., Holmen, M., & Rickne, A. (2002). Innovation systems: analytical and methodological issues. Research Policy, 31, 233-245.

CGIAR (2012). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). http://ccafs.cgiar.org/commission/reports#final.

Chambers R. (1994). Participatory Rural Appraisal (PRA): Analysis of Experience. World Development, 22, 1253-1268.

Cooke, B. an&d Kothari, U. (Eds.) (2001). Participation: The New Tyranny? New York: Zed Books, 207 pages.

Dant, T. (2004). Critical social theory: Culture, society and critique. SAGE Publications Limited.

Farrell, K., Luzzati, T., & van den Hove, S. (2013). What lies beyond reductionism? Taking stock of interdisciplinary research in ecological economics. In: Beyond Reductionism: a passion for interdisciplinarity, edited by Farrell, K., Luzzati, T. and van den Hove, pp. 36-75. Routledge.

Freeman, E.R. (1984). Strategic Management: A Stakeholder Approach. Pitman, Boston MA, USA.

Graef, F., Sieber, S., Mutabazi, K.D., et al. (2014). Framework for participatory food security research in rural food value chains. Global Food Security, 3, 8-15.

Graef, F., Uckert, G., Schindler, J., et al. (2017): Expert-based ex-ante assessments of potential social, ecological, and economic impacts of upgrading strategies for improving food security in rural Tanzania using the ScalA-FS approach. Food security, DOI: 10.1007/s12571-016-0639-x

Greer, L. L., Caruso, H. M., & Jehn, K. A. (2011). The bigger they are, the harder they fall: Linking team power, team conflict, and performance. Organizational Behavior and Human Decision Processes, 116–128.

Grimble, R. & Chan, M.-K., 1995. Stakeholder analysis for natural resource management in developing countries. Natural Resources Forum 19, 113-124.

Gustavsen, B. (2006). Learning organization and the process of regionalisation . International Journal of Action Research, 2(3), 319-342.

Gustavsen, B., Hansson, A., & Qvale, T.U. (2007). Action research and the challenge of scope. In P. Reason & H. Bradbury (Eds.), Handbook of action research (2nd edn, pp. 63-76). London: SAGE.

Hardy, L.J., Hulen, E., Shaw, K., Mundell, L., & Evans, C. (2017). Ripple effect: An evaluation tool for increasing connectedness through community health partnerships. Action Research, DOI: https://doi.org/10.1177/1476750316688512

Harpe, S. E. (2015). "How to analyze Likert and other rating scale data." Currents in Pharmacy Teaching and Learning, 7(6), 836-850.

Hofstede, G. (1983). Cultural dimensions for project management. Project Management, 1 (1), 41-48.

Hofstede (2018). In: Hofstede Insights [Internet]. Country comparison Germany, Tansania. https://www.hofstede-insights.com/product/compare-countries/ Cited 22nd March 2018.

Kaburire, L., Graef, F., Mutabazi, K., Makoko, B., & Swai, E. (2015). Multistakeholder Platforms for Sustainable Upgrading Agri-food Value Chains in Rural Tanzania: Creating a Space for Empowerment and Effective Engagement. Plant2030 status seminar, Berlin 4th-6th March 2015.

Kaushal, R., & Kwantes, C. T. (2006). The role of culture and personality in choice of conflict management strategy. International Journal of Intercultural Relations, 30(5), 579-603.

König, B., Diehl, K., Tscherning, K., & Helming, K. (2013). A framework for structuring interdisciplinary research management. Research Policy 42, 1, 261-272.

Löhr, K., Hochmuth, C., Sieber, S., Graef, F., & Wambura, J. (2016). Conflict Management Programs in Transdisciplinary Research Projects: The case of a Food Security Project in Tanzania. Food Security 8(6*):*1053-1068.

Mwinuka, L., Schneider, I., Maeda, C., et al. (2015). Comparing stakeholder views for mutual acceptable food value chain upgrading strategies in Tanzania. African Journal of Agricultural Research, 10(12), 1376-1385.

Myers, M. D. (1997). Qualitative Research in Information Systems. MISQ Discovery, May. Retrieved from http://www.qual.auckland.ac.nz

Nygren, A. (1999). Local Knowledge in the Environment--Development Discourse From dichotomies to situated knowledges. Critique of Anthropology, 19(3), 267–288.

Ochieng, E.G. & Price, A.D.F. (2010). Managing cross-cultural communication in multicultural construction project teams: The case of Kenya and UK. International Journal of Project Management 28 (5), 449-460.

Ondersteijn, C.J.M., Giesen, G.W.J. & Huirne, R.B.M. (2003). Identification of farmer characteristics and farm strategies explaining changes in environmental management and environmental and economic performance of dairy farms. Agricultural Systems 78: 31–55.

Pelletier, D.L., Kraak, V., McCullum, C. Uusitalo, U., Rich, R. (1999). Community food security: Salience and participation at community level. Agriculture and Human Values (1999) 16: 401

Popescu, A.-D., Borca, C., Fistis, G., & Draghici, A. (2014). Cultural Diversity and Differences in Cross-cultural Project Teams. Procedia Technology, 16, 525-531.

Prowse, M. (2010). Integrating Reflexivity into Livelihoods Research. Progress in Development Studies, 10(3), 211–31.

Riisgaard, L., Bolwig S., Matose F., Ponte S., du Toit, A., & Halberg N. (2008). A strategic framework and toolbox for action research with small producers in value chains. DIIS, Copenhagen.

Rodrigues, J. S., Costa, A. R., & Gestoso, C. G. (2014). Project planning and control: Does national culture influence project success?. Paper presented at the Procedia Technology.

Sarala, R. M. (2010). The impact of cultural differences and acculturation factors on post-acquisition conflict. Scandinavian Journal of Management, 26(1), 38-56. doi: http://dx.doi.org/10.1016/j.scaman.2009.07.001.

Schindler, J., Graef, F., Königm H.J., & Mchaum D. (2016). Developing community-based food security criteria in rural Tanzania. Food Security: The Science, Sociology and Economics of Food Production and Access to Food.

Schmid, J.C., Knierim, A., & Knuth, U. (2016). Policy-induced innovations networks on climate change adaptation – An ex-post analysis of collaboration success and its influencing factors, Environmental Science & Policy, 56, 67-79.

Shore, B., & Cross, B.J. (2005). Exploring the role of national culture in the management of international science projects. International Journal of Project Management, 23, 55-64.

Stahl, G.K., Mäkelä, K., Zander, L., Maznevski, M.L. (2010). A look at the bright side of multicultural team diversity. Scandinavian Journal of Management 26, 439-447.

Stauffacher, M.; Flüeler, T.; Krütli, P. et al. (2008). Analytic and dynamic approach to collaboration: A Transdisciplinary Case Study on Sustainable Landscape Development in a Swiss Prealpine Region. Systemic Practice and Action Research 21/6, 409-422.

Waddell, S., Waddock, S., Cornell, S., Dentoni, D., McLachlan, M., & Meszoely, G. (2015). Large Systems Change: An Emerging Field of Transformation and Transitions. Journal of Corporate Citizenship 58, 5-30.

Waddell, S. 2018: NetworkingAction – Organising for the 21st century. https://networkingaction.net/2014/10/from-change-initiatives-to-change-systems/

Zander, L., & Butler, C.L. (2010). Leadership modes: Success strategies for multicultural teams. Scandinavian Journal of Management, 26(3), 258-267.

Zscheischler, J., Rogga, S. & Weith, T. (2014). Experiences with Transdisciplinary Research. Systems Research and Behavioral Science 31 (6), 751-756.

Table 1: In-depth evaluation by involved project scientists of selected analytical steps undertaken across participatory research actions (Steps (1) Mapping stakeholders across FVC; (2) Inventorying FVC constraints & strategies; (3) Identifying food security criteria; (4) Identifying 3-5 UPS per FVC component; (5) Prioritizing UPS in CSS for testing; (6) UPS groups formation; (7) UPS implementation, testing, adaptation; (8) Creation of potential future scenarios; (9) UPS monitoring & impact assessment; (10) UPS results dissemination)

Guidance/instructions provided by coordinators	**Step 1**			**Step 2**			**Step 3**			**Step 4**			**Step 5**		
No. of involved scientists	9			8			10			22			14		
No. of involved stakeholders	120			80			120			0			200		
Stakeholder participation intensity levels***	1			1			0;1;2			0			0;1;4		
Amount of instruction provided by coordination level and team leaders (0-4)*	1			2			1			4			3		
Degree of cooperation between WP & Tasks (No. activities and institutions) (0-4*)	1			1			3			4			4		
Time period estimated and allocated by coordination level (No. of days)	45			30			90			60			60		
Delay (No. of days)**	90			45			30			60			10		
No. reminders before finalizing actions	5			2			1			15			2		
Indicators assessed by involved project scientists															
	mean	SD	(N)	mean	SD	(N)	mean	SD	(N)	mean	SD	(N)	mean	SD	(N)
Need for more instructions by coordination level (0-4)*	1,2	± 1,0	(6)	2,6	± 1,0	(7)	2,1	± 1,6	(7)	2,7	± 1,3	(19)	2,2	± 1,4	(11)
Complexity/multidisciplinarity of activity (0-4)*	2,3	± 1,0	(6)	2,7	± 0,8	(7)	3,1	± 0,9	(7)	2,8	± 1,1	(20)	3,0	± 1,0	(11)
Communication requirements among members during this activity (0-4)*	3,4	± 0,9	(5)	3,2	± 0,8	(6)	3,5	± 0,6	(6)	3,5	± 0,7	(19)	3,5	± 0,7	(10)
Degree of stakeholder participation (0-4)*	3,3	±0,5	(6)	3,9	±0,4	(7)	3,6	±0,5	(7)	1,8	±1,1	(20)	3,6	±0,5	(11)
Percentage of task accomplished so far (%)	75%	±28	(6)	88%	±9	(6)	96%	±6	(6)	90%	±15	(17)	97%	±6	(10)
Project member's satisfaction during process (0-4)*	2,8	±1,0	(6)	2,8	±0,6	(7)	3,3	±0,5	(7)	2,5	±1,0	(20)	3,2	±0,4	(11)
Final project member's satisfaction after 1-2 years (0-4)*	2,6	±1,1	(5)	2,8	±1,0	(6)	3,5	±0,6	(6)	2,5	±0,9	(19)	3,1	±0,6	(10)
Amount of conflict / tension experienced (0-4)*	0,5	±0,8	(6)	1,1	±1,5	(7)	0,7	±0,8	(7)	1,5	±1,2	(20)	1,3	±1,1	(11)

* ratings: 0: none; 1: low; 2: medium; 3: high; 4: very high; ** accumulated No. of days for one step; *** Stakeholder participation intensity levels: 0: information; 1: consultation; 2: cooperation; 3: collaboration; 4: empowerment (Figure 4)

Table 1: continued

Guidance/instructions provided by coordinators	Step 6			Step 7			Step 8			Step 9			Step 10		
No. of involved scientists	12			28			12			28			55		
No. of involved stakeholders	550			560			-			580			2000		
Stakeholder participation intensity levels***	2;3;4			3;4			0;1			1			0;1;2		
Amount of instruction provided by coordination level and team leaders (0-4)*	2			3			2			3			2		
Degree of cooperation between WP & Tasks (No. activities and institutions) (0-4*)	2			4			2			4			2		
Time period estimated and allocated by coordination level (No. of days)	45			150			60			900			750		
Delay (No. of days)**	40			100			60			60			120		
No. reminders before finalizing actions	2			20			5			8			6		
Parameters assessed by involved project scientists															
	mean	SD	(N)	mean	SD	(N)	mean	SD	(N)	mean	SD	(N)	mean	SD	(N)
Need for more instructions by coordination level (0-4)*	2,1	± 1,5	(10)	2,1	± 1,3	(23)	2,5	± 1,3	(15)	2,6	± 1,1	(22)	2,8	± 0,8	(17)
Complexity/multidisciplinarity of activity (0-4)*	2,6	± 1,4	(10)	2,6	± 1,1	(23)	2,8	± 0,9	(15)	3,0	± 1,1	(22)	2,7	± 1,0	(18)
Communication requirements among members during this activity (0-4)*	2,9	± 1,1	(9)	2,9	± 0,8	(22)	2,9	± 0,9	(14)	3,5	± 0,7	(21)	3,4	± 0,7	(17)
Degree of stakeholder participation (0-4)*	3,0	±1,3	(10)	3,0	±1,0	(23)	2,0	±1,1	(15)	3,2	±0,9	(22)	3,0	±0,9	(18)
Percentage of task accomplished so far (%)	82%	±31	(9)	82%	±16	(21)	65%	±26	(12)	54%	±23	(20)	30%	±22	(16)
Project member's satisfaction during process (0-4)*	2,9	±0,6	(10)	2,9	±1,0	(23)	2,0	±1,0	(14)	2,4	±0,7	(22)	2,1	±0,7	(15)
Final project member's satisfaction after 1-2 years (0-4)*	3,0	±0,7	(9)	3,0	±1,0	(22)	2,0	±1,1	(13)	2,5	±0,9	(22)	1,9	±0,8	(16)
Amount of conflict / tension experienced (0-4)*	1,3	±1,1	(10)	1,3	±1,1	(23)	0,3	±0,6	(15)	1,6	±0,9	(22)	0,9	±0,9	(18)

* ratings: 0: none; 1: low; 2: medium; 3: high; 4: very high; ** accumulated No. of days for one step; *** Stakeholder participation intensity levels: 0: information; 1: consultation; 2: cooperation; 3: collaboration; 4: empowerment (Figure 4)