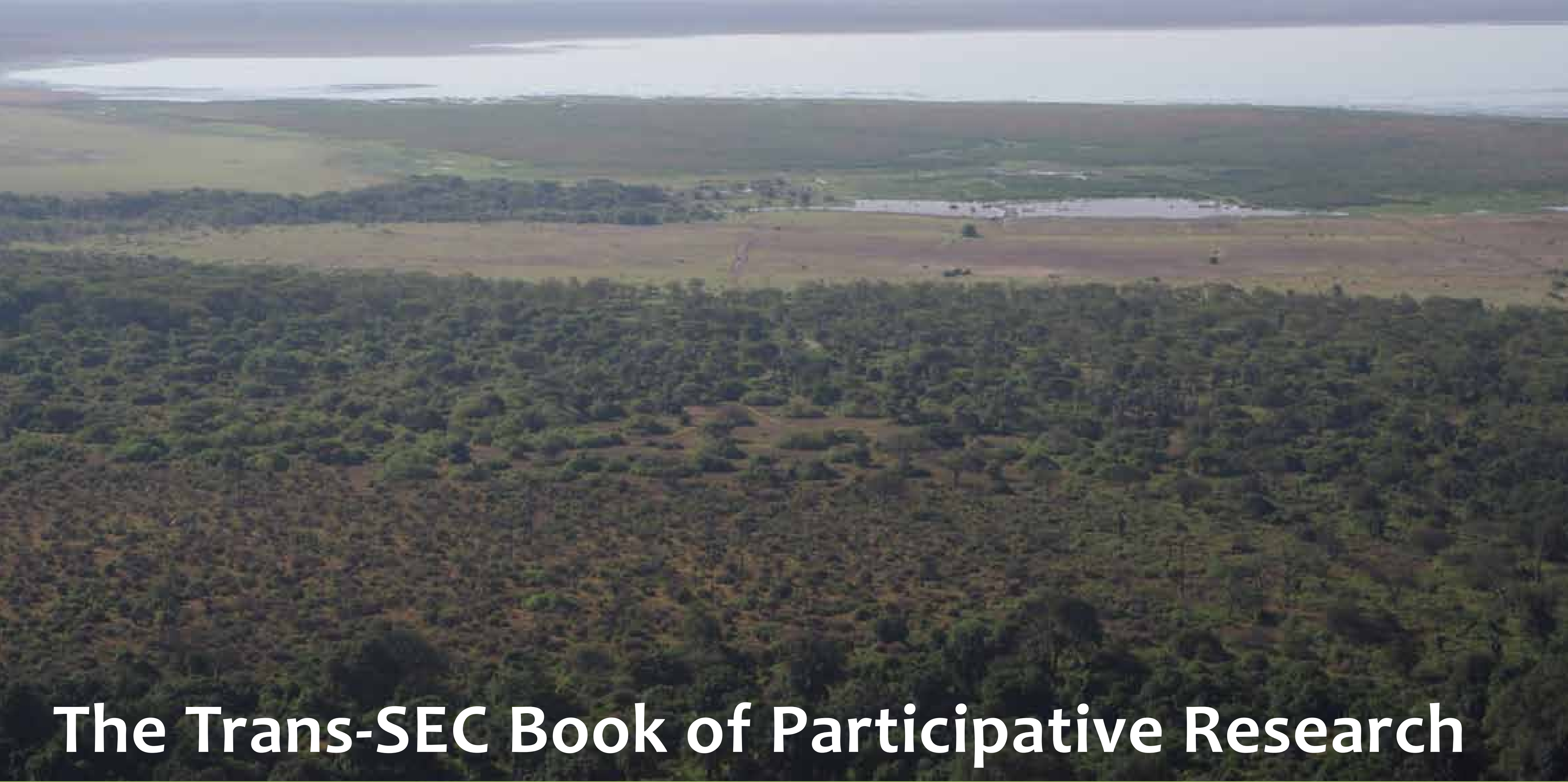

The Trans-SEC Book of Participative Research

Approaches for implementing food securing upgrading strategies

Dr. Götz Uckert, Dr. Katharina Löhr, Dr. Frieder Graef, Dr. Stefan Sieber

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Editors
Dr. Götz Uckert, Dr. Katharina Löhr, Dr. Frieder Graef, Dr. Stefan Sieber

Ordering address
Leibniz Centre for Agricultural Landscape Research (ZALF)
Dr. Götz Uckert
Eberswalder Straße 84
15374 Müncheberg (Germany)
Telefon: +49 33432 82225
Telefax: +49 33432 82308
E-Mail: uckert@zalf.de

Design
www.quad-media.com

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EUV: European University Viadrina Frankfurt (Oder) (Germany)
HU: Humboldt-University Berlin (Germany)
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IFPRI: International Food Policy Research Institute (USA)
IUW: Leibniz University Hannover (Germany)
MVIWATA: Mtandao wa Vikundi Vya Wakulima (National Network of Small-Scale Farmers' Groups) (Tanzania)
PIK: Potsdam Institute for Climate Impact Research (Germany)
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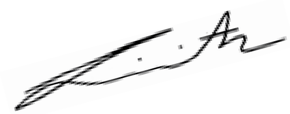
„It will require the commitment of scientists and scientific methods throughout the world ... to bring the benefits of science to all.“ Kofi Annan’s words have lost none of their significance or validity since he uttered them. Thus, the German Federal Ministry of Education and Research (BMBF) and the German Federal Ministry for Economic Cooperation and Development (BMZ) specifically support research projects at the intersection of between research, development cooperation, and society. Several aspects are characteristic of such research projects: they are designed and executed by larger research consortia; they are interdisciplinary in their approach, requiring close cooperation and exchange between international researchers; and they include the intensive participation of local population expert groups in a transdisciplinary approach.

The GlobE call initiated several developing research networks investigating how to effectively improve African food security. Within these networks, the collaborative research project of Trans-SEC, “Innovating Strategies to safeguard Food Security using Technology and Knowledge Transfer: A people-centred Approach,” sought to improve the food situation for the most-vulnerable rural poor population in Tanzania. The project identified successful food securing upgrading strategies and promising innovations along local and regional food value chains. These were tested and adapted to site-specific, sustainable settings. Thus, they were tailored toward successful concepts that could be disseminated across Tanzania. Now, after the project lifetime, Trans-SEC outcomes are being implemented at different levels of policy, extension, and research.

This booklet provides an overview on the strategies implemented, the participatory action research approach, as well as examples of the many methodologies employed by the Trans-SEC project. Additionally, this booklet presents successes and challenges for adoption, as well as reasons for non-adoption during implementation. Thus, it provides sound policy recommendations that have the potential to positively affect change. It also offers entry points and opportunities for further projects at the interface between research and development cooperation. The BMBF hopes that this publication will become a useful tool for both policymakers and researchers.



Dr. Eva Leiritz

Projektträger Jülich (PtJ), Bioökonomie, Agrarforschung (BIO5)

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Tractor ploughing, Tanzania 2018

Trans-SEC, the “Innovating Strategies to Safeguard Food Security Using Technology and Knowledge Transfer: A People-centred Approach” research project addressed food security challenges in Tanzania. Over five years, between 2013 and 2018, strategies to upgrade the local rural food value chains (FVC) were explored. By screening and identifying existing upgrading strategies for food security (UPS), Trans-SEC did not seek to reinvent the wheel, rather, using a participatory approach, it selected promising strategies for testing, adaptation, and implementation in four case studies sites (CSS) in the semi-arid Dodoma and sub-humid Morogoro regions.

Participative Research, using many approaches, is a longstanding research tradition. This book contributes to questions regarding evidence, where participative research contributes to increasing the effectiveness and efficiency of system changes. Against the background that traditional agricultural approaches, like consulting and extension services, need to be improved in order to have a meaningful impact on the food security of the poorest and least well-educated farmers in rural communities. Clearly this idea is not new, but the strength of the process – incorporating an active multi- and trans-disciplinary stakeholder board in Germany and Tanzania – is unique. It resulted from an existing longlasting and deep collaboration between the Sokoine University of Agriculture (SUA) and the Leibniz Centre for Agricultural Landscape Research (ZALF) and its project partners.

By combining multi stakeholder processes and value chain approaches, the Trans-SEC project addressed change and improved the livelihood strategies of rural communities. Installing an overarching innovation system and collaborating with local institutions - taking into account their existing and ongoing efforts to implement new measures – resulted in strengthening the resilience of agricultural systems. By involving farmer groups and designing a way for knowledge to be exchanged well beyond the lifetime of the project, the achievements of Trans-SEC should resonate for years to come. Regular meetings and workshops, across all levels of involved researchers, policy makers, and farmers, called for careful evaluation of the perceptions regarding achieved benefits or still pressing challenges. During the final stage of the project, the book will review the findings derived from the scientific research process as well as the action research approach applied by Trans-SEC. The achievements were discussed under careful consideration of the implementation process via action research.

Emphasizing ex-ante identification of bottlenecks, avoidance/risk of failure, and sustainability impact pathways, these study results are captured as chapters within the book that you are holding. The designed conceptual framework of Trans-SEC included a participative action research (PAR) and research approach tes¬ting within a time frame of six years. The PAR process to implement the identified innovations in the area of small-scale agriculture emphasized to include novel elements. Trans-SEC researchers and partners not only worked on the core research questions, but also made significant advancements with respect to innovative new methodologies. A comprehensive list of all the Trans-SEC work and results is beyond the scope of this book. In this publication, a sample of the unique methods and tasks applied during the Trans-SEC project is presented. Moreover, this book comprises lessons learned, reasons for non-adoption, and recommendations for the benefit of future research projects.

Locating the project

Dodoma Region, Tanzania 2015

Farmers in Tanzania and elsewhere in sub-Saharan Africa (SSA) find it challenging to sustain or increase their food production. Climate change and food security are strongly interlinked. Unstable weather conditions can reduce the stability of food supplies throughout the year, affecting food security. Tanzania was selected to test and spread agricultural strategies and innovations that expand the production and availability of food, not just against the background of small-scale farming and poverty, but also against the effects of climate change. For about 70% of Tanzania's population, small-scale farming is the main source of income, whereby most of it is rainfed (> 95%) resulting in farmers depending highly on prevailing climatic conditions. One-third of Tanzania's rural population lives below the basic needs poverty line and 11% are estimated not to meet the minimum food requirement of 2200 kcal per day. Given this low buffer capacity, farmers are strongly exposed to the negative impacts of climate change, both in the short-term through more extreme weather events and in the long-term through changing temperatures and precipitation. Not only are increasingly unpredictable rainfall patterns seen, but the United Nations' Intergovernmental Panel on Climate Change (IPCC) predictions for the East African region, including Tanzania, estimate an increase in mean annual temperature of between 1 °C and 3.1 °C by 2100.

Definition of food security

Food security is defined as "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" (FAO 1996). The four dimensions of food security are i) food availability, including production, distribution and the exchange of food; ii) food access that relates to affordability, allocation, and personal preferences; iii) utilization of food, including issues referring to both nutritional quality and quantity as well as social value and food safety; and iv) stability of food provisioning over time.

Selection criteria for case study villages

The Trans-SEC project was implemented in the Morogoro and Dodoma regions of Tanzania. Four villages were selected: Changarawe and Ilakala in the Kilosa district, Ilolo and Idifu in the Chamwino district (Figure 1). The case study villages were purposively selected based on their location in different, as well as widely spread and representative, agro-ecological conditions within Tanzania. Selection criteria included the distance that each village was from markets. Market distances represent the differing ability to exchange goods and ideas. As road and transport infrastructure is generally poor (rough gravel roads, non-tarmac), being closer to markets was assumed to generate linkages - resulting in not just increased opportunities to buy and sell, but also more challenges triggered by competition and changes of perspectives. The villages of

Changarawe and Ilolo are expected to have better access to markets due to the shorter distances to Kilosa and Mwumi, respectively, thus allowing farmers to reach the market by foot within in a few hours. Farmers and households in Idifu and Ilakala must undertake longer journeys to reach markets. Trans-SEC looks at subsistence farming and market production, as well as the transition process from one system to the other. As the backdrop and reference frame for changes, another two villages, Ndebe and Nyale, one per region neighboring the Trans-SEC villages, were also included in a overall Trans-SEC household survey (N=900) conducted at the beginning and end of the project.

Site conditions of case study villages

The case study villages are located in two regions of Tanzania: Morogoro and Dodoma. Morogoro is largely sub-humid, with 600–800 mm annual rainfall, with farming systems characterized by maize, legumes, rice, and sesame as the main crops and with little livestock and varying levels of food security. Dodoma is predominantly semi-arid, with 350–500 mm annual rainfall, with its main crops consisting of sorghum, millet, groundnut, and sunflower. Food insecurity is more pronounced in Dodoma and livestock is an integral part of the livelihoods of households. The study areas (figure 1) are found in two districts comprising the selected two agro-ecological focal regions: Kilosa district (Morogoro region) and Chamwino district (Dodoma region). Trans-SEC included the two reference villages of Nyali and Ndebe of the both districts to allow cross checking of strategy impacts. The study villages represent 70–80% of the farming system types found in Tanzania, thus offering ideal sites to study the livelihood strategies of smallholders, their interactions with traditional agricultural value chains, and associated welfare, such as food security. The farming system is characterized by mixed cropping e.g. the mixing of maize and pigeon pea, or the mixing of pearl-millet and sunflower in the same field. Most of what farmers grow is consumed within their household, which implies that the rural food value chains are short. Therefore, Trans-SEC focused on multi-commodity value chain analysis in semi-arid and semi-humid agro-ecological zones and several crops, whereby some are mixed cropped and others mono-cropped.

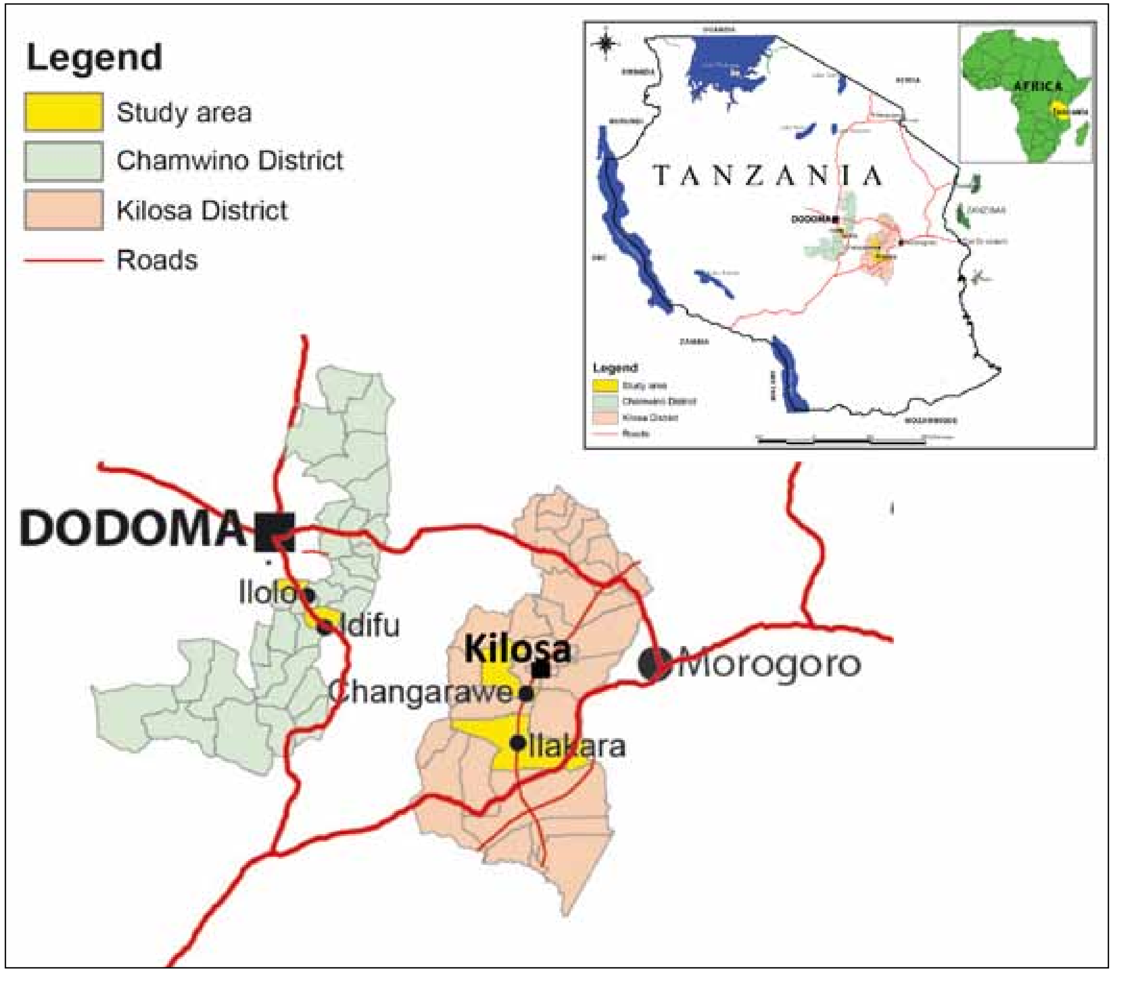


Figure 1: Trans-SEC case study villages

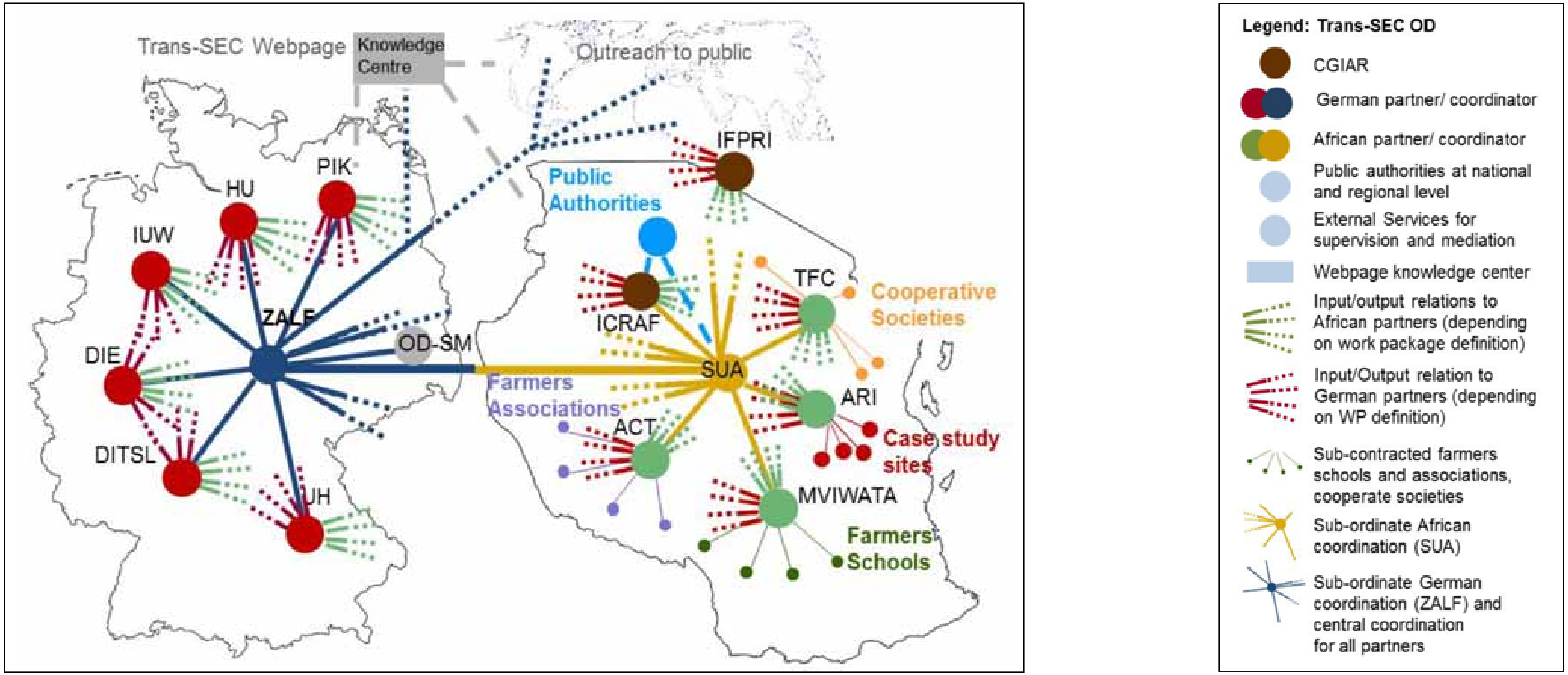


Figure 2: Organizational Structure Trans-SEC

Trans-SEC setting

Trans-SEC aimed to improve the food supply for the most-vulnerable poor rural population in Tanzania, while focusing on the entire food value chain (FVC). Members of Trans-SEC include about 100 researchers/scientists and nongovernmental professionals from 14 partner organizations with altogether 25 different working units. These organizations include research institutes and NGOs from Germany, Tanzania, and CGIAR-centres. From the beginning, a participatory action research (PAR) process was an integral part of Trans-SEC.

Organizational structure of Trans-SEC

Trans-SEC developed a system of intra- and inter-organizational structures, crossing hierarchies, regions, and all stakeholders. The organizational structure of the research consortium was complex. Figure 2 maps the multiple actors of the Trans-SEC project, showing its complex set-up across countries and institutions. Information input/output flows were facilitated across partners by a) a central coordination (ZALF) and b) a Tanzanian sub-coordination (SUA) for operational and scientific management. ZALF and SUA each coordinate their national partner cluster. ZALF and SUA do the overall planning for involving stakeholders at local, regional, and national levels.

The project was coordinated by a four-person team with two coordinators based in Germany and two in Tanzania. The overall PAR management and budget control personnel were based in Germany. Most research activities, however, were decentralized, with each German and Tanzanian partner having their own budgetary responsibilities. Hence, in terms of power distribution, this project aimed at "co-creating change through collaborative strategies" with multiple project partners including local stakeholders. The scientific aims and agendas of the PAR process were defined by both the Tanzanian and German coordinators and the lead scientists, while the decisions on which UPSs to implement were made in collaboration with local stakeholders. The research level was composed of over 100 scientists and non-scientists affiliated with 25 different research units or institutions, all of whom cooperated with over 600 local stakeholders, most of them subsistence farmers.

The 13 German research units included universities and research centres. The ten Tanzanian research units or institutions included five university departments, two research centres, and three NGOs. Two international research centres from Kenya and the US participated. Local stakeholder involvement and knowledge co-generation during implementation, testing, and assessment of the UPS were primarily coordinated and carried out by Tanzanian scientific and non-scientific partners. The Trans-SEC management team also integrated a conflict management system in the project design in order to prevent misunderstandings between team members and to actively facilitate smooth cooperation.

On the national scale, policy actors from the Tanzanian ministries (Ministry of Agriculture, Food and Cooperatives and the Ministry of Industry, Trade and Marketing) cooperated with the NGOs Agricultural Council of Tanzania (ACT) and the Tanzanian Federation of Cooperatives (TFC), while the process was backstopped by the research organizations (German and international research centres). At the regional level, policy actors from the governmental organizations and NGOs collaborated not just with researchers from the international research centres International Food Policy Institute (IFPRI), World Agroforestry Center (ICRAF), Germany, and Tanzania, but also with local scientists and extension officers from SUA and ARI, plus regional authorities.

By involving Agricultural Research Institutes (ARI) and the National Network of Small-Scale Farmers' Groups (MVIWATA), the national farmer's group association, further stakeholder participation was enabled. ARIs and MVIWATA were responsible for local to regional stakeholder involvement, and TFC and ACT for knowledge transfer from regional to national level and the according stakeholder involvement. The German partners approached stakeholders through SUA, ARI, and with the other Tanzanian partners. All Tanzanian partners had ownership to disseminate Trans-SEC results; for instance, among farmer associations and schools as well as cooperative societies, public authorities, and ministries. The science/policy network of actors at the local level included field officers, village extension officers, and various grassroot level stakeholders. In Trans-SEC, stakeholders were organized in stakeholder groups by MVIWATA. MVIWATA conducts its collaboration processes based on methods and education of group processes derived from their long-time experience.

River in Kilosa, Tanzania 2013

Stakeholder level of involvement

Trans-SEC consortium partners conducted all work packages and tasks with a broad set of stakeholders at all scales of interventions. The consortium's project partners carefully selected all stakeholders as a primary network activity. To achieve best results, work package activities were dedicated under responsibilities of partners according to scale and level of expected impact and capacities needed.

The Trans-SEC project conducted participatory action research (PAR). This approach was novel in its complexity and focus, as it targeted the entire FVC. Participation was imbedded from the planning stage, with many stakeholder-scientist interactions taking place starting from the conceptual phase. The process was characterized by high, but balanced, North-South cultural diversity and responsibility distribution.

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 an upgrading strategy. Stakeholders were considered to be partners and co-generators of knowledge. Their concerns were valued: their local knowledge made them co-pilots throughout the PAR processes. In Trans-SEC the FVC stakeholders are distinguished into two groups: first, grass-roots actors who keep the FVC running, including farmers (and pastoralists), processors, millers, stockiest, traders, middlemen, transporters, and consumers; and, second, actors attached to the enabling environment of the FVC, including interested organizations, institutions, and key informants, like policy makers, extension agents, service providers, NGOs, churches, and more.

Farmers and other local stakeholders implement the strategies at local level. In the Trans-SEC project villages, they were chosen via a randomized sampling process. The principle of a randomized selection of households has pros and cons: Its pros include allowing it to by-pass the biases that would be introduced via the frequently used selection process in this region: asking village heads. Accordingly, the randomly selected households tend to mirror higher differences between households because there is no discrimination or pre-selection based on unknown criteria. The main drawback is that the sampled households included some respondents who appeared to be unwilling to participate in the research, either because they were alone in a single household or because they were older with no kids or support. Also it was likely that some important innovators from the villages were not present.

Participatory action research process

In the beginning, information was shared between scientists and stakeholders from the national to the regional level in order to screen and select upgrading strategies (UPSs). The inclusion and cogeneration of stakeholders' and scientists' knowledge iteratively shaped most of the methodologies, as shown in figure 3. Selection was accompanied by expert ex ante evaluation of each UPS regarding requirements and sustainability dimensions. The process of ex-ante evaluation was initially done with the sustainability impact assessment tool for project evaluation (ScalA), developed at ZALF, and the ScalA-FS tool to sensitize the project members for possible bottlenecks in implementation.

The second step focused on adjusting the selected UPSs to the case study sites and discussing needs with farmers. This task involved focus group discussions (FGDs) and workshops with all 150 grass-roots stakeholders across each case study site (CSS). These were farmers who already participated in the baseline survey. The activity aimed to help stakeholders self-select the appropriate UPS and organize farmers into strong and sustainable groups around each prioritized UPS in order to ensure better and easy coordination, accessibility, monitoring, and training of members on specific aspects related to the respective UPSs. At each CSS, a two-day workshop was organized for farmers to share information on the prioritized UPS for each specific component of the food value chain (like production, processing, etc). For better decision making in the meetings, criteria for UPS selection were generated and applied. Each group was allowed to select a maximum of 2 UPS. This resulted in the formation of 27 UPS groups across the villages: 7 in Ilakala, 7 in Changarawe, 7 in Ilolo, and 6 groups in Idifu. After formation of UPS groups, MVIWATA organized workshops to facilitate the formalization of UPS groups in all CSS by establishing its leadership structures and ensuring that they can manage their own group activities and business by strengthening their capacities This capacity building involved trainings on leadership skills, group dynamics, and simple business models to improve the feasibility of single UPS. All UPS implementations were supervised by ARI centers and PhD students.

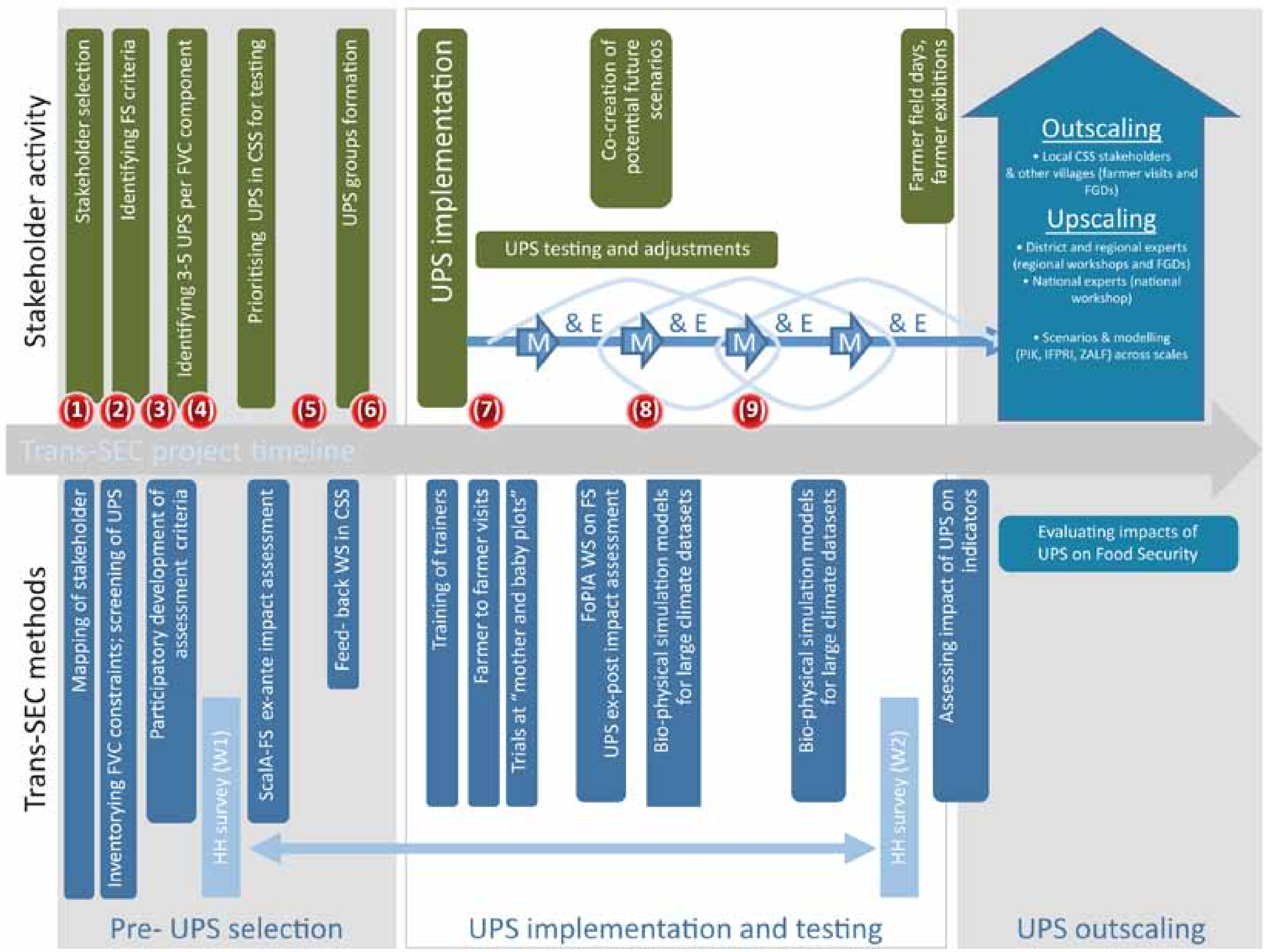


Figure 3: Timeline of Trans-SEC PAR activities

The main PAR activities included the following:

(1) Mapping stakeholders across the FVC identified all relevant key and grass-root level stakeholders and their functions along the FVCs on local, regional, and national scales. The exercise involved visiting stakeholders at their locations and asking for information through focus group discussions (FGDs), interviews, or workshops. Following consultation, eight stakeholder groups were formed based on their activities: local producers, agro-dealers, processors/millers, buyers/traders/exporters, manufacturers, service and marketing providers, and non-governmental organizations.

(2) Inventorying FVC constraints and strategies within the priority commodities was relevant for rural farmers at all four CSSs. This was accomplished through FGD and interviews, with household survey providing complementary information. Stakeholders included 15 -20 key informants and farmers from each CSS.

(3) Identification of local food security criteria to assess the UPS impact was based on the existing literature as well as local focus groups and panel discussions. Criteria were validated by, and adapted to, the local stakeholders' perceptions of food security. In the process, local focus groups and panel discussions were held. Discussions with stakeholders in each CSS pinpointed food security criteria based on community understanding. The resulting criteria were used to assess sustainability dimensions of UPS in the Scala (ex-ante assessment) and the local FoPIA sessions.

(4) Identifying 3–5 UPSs per FVC component: After screening potential UPSs of regional priority commodities (main crops, etc.) among each FVC component, an inventory to enhance food security was established for the CSSs, the target regions, and beyond. This procedure was conducted using jointly defined selection criteria. The FVC components were then jointly analysed by the scientists with respect to their selection criteria, for instance, the expected positive impacts on food and livelihood security, knowledge and data availability of previous implementations, and practicality. Detailed fact sheets were generated for each UPS. Finally, 3–5 UPSs were selected by the scientists for subsequent prioritization by the CSS stakeholders and this was assisted by UPS experts' impact assessment (ScaLA-FS).

(5) UPS were prioritized at CSSs for testing following their discussion among stakeholders and scientists. The participants then worked in small, moderated working groups on a strength/weaknesses/opportunities and threats (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 vote 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, retaining 6–7 of the most promising UPSs per CSS. 10 UPSs were selected overall.

(6) UPS groups formation of 6–7 UPS farmer groups per CSS, with group sizes that ranged from 10 to 50 members. All members belonged to one of the 150 household panel survey sample participants in each CCS. During group formation, some individuals joined a group without fully understanding what the UPS required. This led to some members dropping out or shifting groups.

(7) UPS implementation, testing, and adaptation of the 10 UPS prioritised in the CSS included processes with recurrent feedback and adaptation activities between local stakeholders and scientists lasting from several months up to a year. Some adaptation required trials and error that consumed time and resources before being accepted by the involved stakeholders.

(8) Co-creation of potential future scenarios were developed with researchers, stakeholders from the CSS, and Tanzanian meteorologists. The challenge was to determine if future climate conditions would alter the performance of the UPS. Thus, biophysical simulation models and large climate datasets are used to test the UPSs. The output of these models provided new insights that were communicated back to the farmers and researchers with no meteorological background.

(9) UPS monitoring & impact assessment: the implementation and testing of the UPS was monitored using generic and specific parameters collected during focus group discussions and household visitations. Regular monitoring was weekly, monthly, and quarterly, depending on the implementation stage of the UPS. Annually, all UPS groups jointly met to provide feedback to the scientists on the expected (ex ante) and/or experienced (ex post) UPS impact on food security and sustainability. There were four types of monitoring: 1) Household surveys (HH survey waves 1 and 2); 2) UPS intensive weekly – monthly monitoring; 3) UPS groups quarterly monitoring; and 4) UPS annual impact assessment (FoPIA). All monitoring data are collected and stored in a systematic project repository at SUA.

Objective of FVC integration of UPS

Trans-SEC sought integration of UPSs into the value chains at the case study sites using a set of specific methods. The upgrading strategies (UPSs) sought to strengthen the food value chains by improving economic situations and, thus, the livelihoods of poor target groups. The process of upgrading should enable farmers and FVC actors to acquire the technological, institutional, and market capabilities needed to move into higher-value activities. To upgrade the basic living conditions of rural poor people, Trans-SEC investigated food securing upgrading strategies along the food value chains under sufficiently comparable and, at the same time, diverse environmental and socio-economic conditions. Furthermore, the research design specifically sought UPSs with large up-scaling potential. Therefore, the selected strategies were tested over three growing seasons to identify those that successfully improve food value chains and also have a high potential for scaling up - to be disseminated through a German-Tanzanian Research & Development & Information (R&D&I) network.

Within the Trans-SEC research project, 42 possible (UPSs) were identified as promising and feasible for each case study site, thus becoming the focus of further research. The 13 UPSs ultimately selected address the food value chain components of Natural Resources, Food Production, Food Processing, Markets, and Consumption; with an additional one addressing Waste Management/ Recycling.

Final decision making on UPS for implementation in each CSS

This task involved FGDs with local stakeholders in the CSS. All UPS, including information on their local constraints and requirements, were presented by scientific experts to local stakeholders in all CSS in order to enable them to decide on UPSs for local testing during the Trans-SEC project. The decision making process included ex-ante participatory impact assessments of each UPS. Altogether 10 UPSs were selected. This decision making was followed by a series of stakeholder workshops at the CSS level to widely share (with 150 HH per CSS) the UPSs prioritized for implementation. This was done in order to receive feedback and inputs for subsequent implementation from all 150 participating farmers.

Farmers role in UPS selection and decision

The most important group of stakeholders were farmers who implemented the strategies at local level. The selected farmers chose the UPS to be implemented. Farmers only chose two UPS per household maximum. This focus on one or two UPSs eased both the implementation and adjustments of the innovations, and decreased in the potential bias of ex post analyses due to mixed effects of UPSs.

Further information available online:
http://project2.zalf.de/trans-sec/public/factsheet

Table 1: UPS selected by stakeholders

FVC component of "natural resources and production":	
UPS no.	1) In-situ rainwater harvesting combined with:
	a. Fertilizer micro-dosing
	b. Optimized weeding
FVC component of "post-harvest processing, biomass and energy supply":	
UPS no.	2) By-products for bioenergy
UPS no.	3) Mobile maize shelling and millet threshing machines
UPS no.	4) Improved wood supply
UPS no.	5) Improved cooking stoves
FVC component of "improved market linkages":	
UPS no.	6) Sunflower oil production including
UPS no.	7) Optimized market orientated grain storage-systems
UPS no.	8) Poultry-crop integration
UPS no.	9) Market information access system (m-IMAS) b
FVC component of "consumption":	
UPS no.	10) Household nutrition education and Kitchen garden implementation

UPS No. 1: Rainwater harvesting and fertilizer micro-dosing

Objectives

Rainwater harvesting (RWH) was chosen for smallholder farmers in order to improve sole and intercrop yields under a rain-fed farming system. The technology conserves soil moisture in the field and increases crop production in sub-humid and semi-arid areas. By reducing runoff and soil erosion, it supports sustainable soil fertility management and crop productivity. Rainwater harvesting (RWH) technologies promote crop production and have been used for generations in Tanzania. Trans-SEC introduced in-situ types of RWH technology: Rainwater is harvested either directly as it falls on the field or as runoff water collected with dams and concentrated in basins within the fields, thus reducing soil erosion at the same time. It includes technologies like tied-ridges, infiltration pits, micro-basins, ripping, deep tillage, and mulching.

Description

Rainwater harvesting was done tied righting the plots. Tied ridges of 75-80cm between ridges and 20cm high, as well as cross-ties 1.5m apart and 15cm high were constructed to create mini-basins. During light rainfall, the water remains and accumulates in the mini-basins and slowly infiltrates into the soil. When rainfall is heavy, the water runs off, flowing over the cross-ties along the contour, because the cross-ties are lower than the furrow ridges and the furrows are built at an angle to the contour. Thus, overtopping, i.e. excess water flowing over the ridges, is prevented. The cross-ties reduce the speed of the water flow within rows. The technology is suitable for a wide variety of soil types, except easily eroded sandy soils. Annual crops, such as maize, sorghum, and millet, are well suited to this technology; perennials and deep-rooted crops less so.
In combination with tied ridges, Trans-SEC experts recommended fertilizer micro-dosing to increase yields under sole and intercropping systems for rural stakeholders. Micro-dosing of fertilizers will improve crop yields with a minimal external input requirement for resource poor farmers in sub-humid and semi-arid areas. It is part of sustainable soil fertility management, where the soil nutrient status will be maintained or improved.

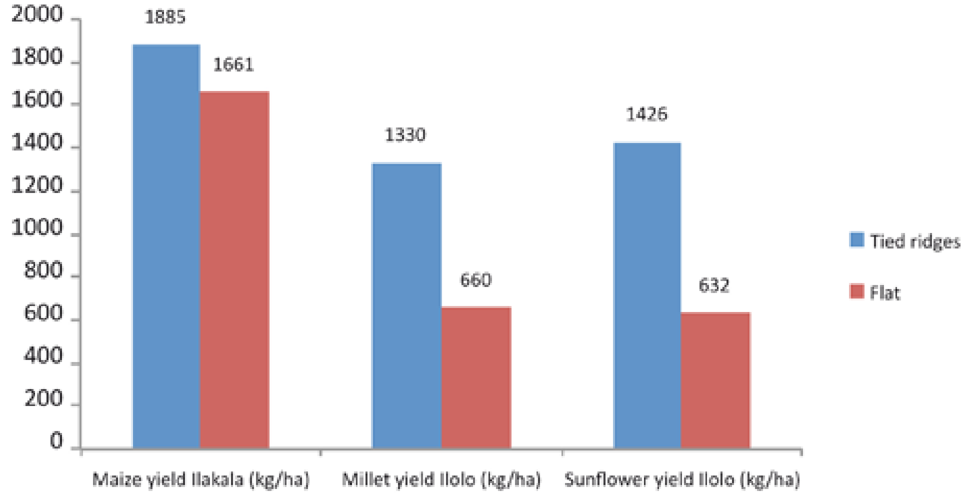


Figure 4: Effects of tied ridges on maize, millet and sunflower grain yields in sub- humid (Ilakala) and semi-arid (Ilolo) Tanzania

Micro-dosing involves the addition of small doses of fertilizers to crops during sowing in cereal crops - P fertilizers are added as DAP and TSP, while N fertilizers are added as Urea during the fourth to sixth leaf stage. This farmer-oriented technology is designed to improve fertilizer use efficiency via localized application. Micro-dosing increases uptake and reduces the investment risk in comparison to broadcasting. When integrated with organic matter and other ISFM practices, like improved seed variety and pest control, the micro-dosing has strong potential to intensify farming systems while sustaining soil health and land productivity. Micro-dose technology is an entry point to boosting crop yields while using affordable or low risk fertilizer rates. Subsequently, later farmers may move to a higher rate as they understand the benefits of applying fertilizers.

Key lessons

Tied ridges are good at conserving soil moisture during short term droughts, ranging between one and three weeks. Using fertilizer micro-doses at 25% of recommended rates results in increased yields, is economical, and reduces risks of weather variability. Integrating in-situ rainwater harvesting and fertilizer micro-dosing is an alternative way to increase the food security of pro-poor farmers in sub-humid and semi-arid areas.

UPS No. 2: Pyrolysis for energy and biochar production in rural areas

Objectives

This UPS contributes to combating inadequate management of waste processing and nutrient cycling. Often, inadequate utilization of crop waste products (e.g. maize cobs) leads to haphazard disposal of such by-products and, ultimately, environmental pollution. Therefore, the process of pyrolyzing crop residues, crop wastes, and by-products into useful energy and other products is a way to adding value to the crop production subsector.

Description

On-farm crop residues are not efficiently used: typically, it is left to decompose or, sometimes, used by livestock in-situ. Crops residues are available in parallel with animal manure where crops and livestock production are integrated. The main crops grown in the project area include maize and sesame in the Kilosa district, while millet, sorghum, and sunflower are in the Chamwino district. These crops, primarily processed at both household and peri-urban centers, generate by-products that can be utilized in various ways, including cooking. The same applies to secondary processing, where the resulting by-products have some limited use, but are often left unutilized, resulting in pollution through decomposition into uncontrolled emission of marsh gases and proliferation of disease-causing agents, such as mosquitos and flies. Although such products could be burned, there are other alternative decomposition methods useful to society. Promoting use of these products will add value to the FVC, reduce use of fuelwood, and save the environment from being polluted by such waste. Residues from primary processing, especially from threshing and shelling, are usually high in highly lignified structural components and, therefore, suitable for thermo-chemical conversion. Among decomposition methods, pyrolysis of these (already dry) residues will provide thermal energy for cooking applications as well as biochar production, which can be used as an energy carrier or for soil amendment. Simple pyrolysis for charcoal making can be done, but for low density materials like maize cobs it may not be feasible. Therefore, an improved pyrolysis method can produce cooking fuel and biochar.

Test results from the UPS farmers group in Ilakala showed that pyrolysis for about two hours on 15 kg of maize cobs yielded about 4.4 kg of biochar (29%). Water boiled 35 minutes after starting pyrolysis process. However, during testing farmers observed some challenges including its relatively tall height, high reactor wall temperatures, and messy production of smoke affecting the operators. This led to the suggestion of reducing its height, insulating the surface and redirect the smoke away. It also resulted in the addition of a second depression on the top lid to accommodate a second cooking pot. Therefore, the overall height of the reactor was reduced, the exit pipe end bent to redirect the combustion products away, and the reactor wall was insulated with 2 cm layer of rice ash encapsulated in the mild steel outer sheet.

Key lessons

Maize cobs are converted into more useful material (biochar) for soil structure amendment through use of TLUD-reactors in rural areas.
Low temperature cooking is achieved through use of a TLUD-reactor.

Pyrolyzer, Tanzania 2015

UPS No. 3: Improved maize sheller and millet thresher machines for reducing human labor in rural areas

Maize and maize sheller, Tanzania 2015

Objectives

The UPS will improve the livelihood of farmers by introducing machinery that increases the efficiency of shelling maize and threshing millet at their location. To overcome post-harvest processing of agricultural products by smallholder farmers characterized byy low income and highly intensive human labor needs.

Description

Primary processing by smallholder farmers in Tanzania is still largely performed directly in the field or with technically insufficient devices. As maize shelling and millet threshing is performed in a labor-intensive way, the products are of poor quality and polluted with dust, animal waste, and insects. Awareness of better and more efficient shelling and threshing methods is lacking at the case study sites.

Appropriate technologies to address the aforementioned challenges are available and focused on by numerous projects. In Tanzania, both manufacturers and traders are present and are willing to sell the machinery to stakeholders in the CSSs. Discussions about the advantages, disadvantages, and possible benefits of mechanizing both maize shelling and millet threshing took place between stakeholders and researchers, including scientists from SUA and MVIWATA. The stakeholders in question were farmers in the Kilosa district for maize shelling and farmers in the Chamwino district for millet threshing. Later, business models were developed by SUA researchers to help stakeholders purchase the machinery, while MVIWATA was involved with the machine procurement process. These machines can be powered by engines or electrical motors. Since electricity is a challenge in the CSSs, machines were powered by diesel engines.

Key lessons

Maize shelling and millet threshing efficiency and effectiveness can be improved in rural areas by introducing mechanized shelling and threshing.
The role of gender is changing, with men now more involved in shelling and threshing activities than they were before.
Maize shelling and millet threshing machines have the possibility of creating employment in the community.

UPS No. 4: Improved wood supply on-farm, education, and tree planting: Wood supply and environmental sustainability in rural communities

Objectives

This UPS was designed to address cooking energy and land degradation problems by integrating fast growing tree species in order to supply wood and improve soil fertility. Over 90% of rural households in Tanzania rely on biomass energy for heating and cooking. Native forests are limited and facing increased pressure as wood is extracted for fuelwood, construction materials, and other wood products. There is an acute shortage of cooking energy in semi-arid regions like Dodoma. To cope with this problem, farmers often use crop residues and livestock manure as a source of cooking energy. Recently in Ilolo, residents started up-rooting the woody biomass from felled trees; an action that especially disrupts the nutrient cycling processes.

Description

This UPS focused on building the capacity of farmers to produce tree seedlings and plant trees that provide alternative sources of wood biomass for the supply of cooking energy (especially firewood), fodder, other wood products (e.g. poles), and for the provision of environmental services (e.g. improving soil fertility, carbon sequestration, and soil erosion). One of the main challenges for tree planting is the availability of a sufficient number of high quality tree seedlings. In order to address this challenge during and after the Trans-SEC project, community-based tree nurseries were established. This activity started by mobilizing farmers into groups (Mazengo and Jamhuri) to facilitate training. These groups have a total of 31 members, with women forming 74% of the group. Training lasted three days per group and covered site selection, seed source, selection and collection, potting mixture and pot filling, nursery management, as well as silvicultural treatments of seeds and seedlings at the nursery. Group members were also trained on tree planting techniques. After training, farmers participated in nursery establishment activities, including pot filling and seeding. Tree seedlings were planted in various niches in the fields, including farm boundaries. Suitable species like Gliricidia sepium were integrated to the farm as trees intercropped on plots, or in highly degraded sites not suitable for crop production, as woodlots or pure stands. ARI Hombolo and ICRAF staff conducted regular monitoring of trees in the nursery and farmer fields in order to get feedback from farmers on the progress and challenges encountered as well as to assess the survival and growth of the seedlings. Data collected was used to calculate preliminary estimates of biomass yields to demonstrate the extent to which agroforestry technologies may meet household cooking energy demand, improve crop production, and reduce land degradation.

Key lessons

On-farm wood supply offers great potential to meet household fuelwood needs. This approach also reduces the substantial amount of productive time that is spent on firewood collection. This productive time can be diverted to other economic activities that improve rural livelihoods and environmental sustainability.

Tree nursery, Tanzania 2015

UPS No. 5: Using improved firewood cooking stoves and its implications for rural livelihoods in Tanzania

Objectives

The UPS established a technology that reduces the demand for fuelwood, improves the economy of rural citizens, and ensures environmental sustainability. This UPS contributes to sustaining natural resources by addressing forest degradation and deforestation. Improving the cooking efficiency of stoves reduces the demand and high reliance on wood fuel (fuel wood & charcoal) as the main source of energy. The Improved Cooking Stoves (ICS) improves the utilization of fuel-wood by improving cooking efficiency, while also improving health via reduced smoke and saving time.

Description

Different ICS types were explored in field trials. An ICS built from easy available materials was chosen as most appropriate for rural areas. The stove design was selected because it could achieve remarkable and visible advantages in a short time. The aim was to combine smoke reduction, higher efficiency in firewood consumption due to better insulation, and enhanced handling of cooking procedures. We used a low-cost mud stove model from a Ugandan stove program, originally developed by the Aprovecho Research Center. This model was also adopted by an EU Project in a neighboring village, "Chololo Eco Village," which is close to the case study site (CSS) in Chamwino, Dodoma region. Three Chololo Eco Village women experienced in ICS construction became our trainers for the first training sessions. They taught lessons while a Swahili ICS construction manual was written to ensure documentation of technological knowledge. Training was conducted in groups of 3 to 8 individuals from each sub-village. The ICS group members were trained on how to construct stoves, prepare firewood (storage and drying), and how to provide stove construction services to other households. During dissemination, ICS were further manufactured by experienced trainers from the UPS groups within the village and abroad. The design and functionality was supposed to be constantly improved and adapted, thus "improving the improved stoves." The training of trainer concept was established to share, disseminate, and sustain knowledge among village households.

Key lessons

ICS technology is economically viable, socially acceptable, and environmentally friendly as it efficiently uses firewood and reduces time consumption. It also reduces greenhouse gases.

Improved cooking stove (Ilolo small version), Tanzania 2016

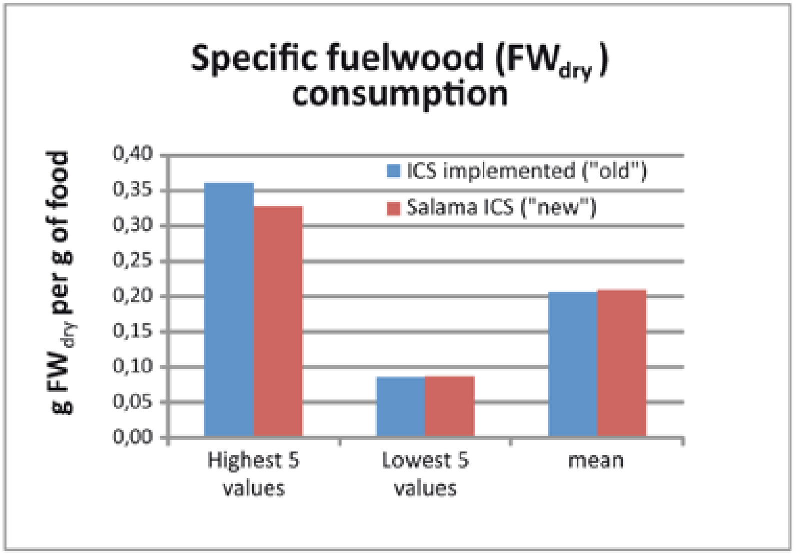


Figure 5: Improved Cooking Stoves: Difference of combustion performance (Controlled Cooking Test) due to stove design, „Implemented" ICS (N=25) vs. „modified" ICS (N=35), Idifu village.

UPS No. 6: Sunflower processing for high quality cooking oil

Objectives

This UPS improves the livelihood of farmers by introducing oil expelling technology that is more efficient, with benefits accruing to the community through less expensive, high quality, oil. Traditional sunflower oil extraction is typically an inefficient oil expelling technology. Furthermore, there is a lack of ecology standards. Limited R&D on planting materials, diseases, and pests poses a serious risk to the growth of the industry. In terms of marketing, despite its potential, there are no initiatives at the national level to support the seedcake export market. Financially, rural sunflower producers have limited access to financial services in the CSSs (i.e. Ilolo and Idifu); if available often including stringent credit terms, excessive interest rates, or tough repayment requirements.

Description

Sunflower oil production has great potential in Tanzania because the raw materials are widely available and its market for sunflower oil is growing. SMEs involved in sunflower oil production seek to increase the production of good quality, safe, oil for consumers who are becoming more health conscious. Across Tanzania, cooking oil has been produced for millennia using traditional technologies; processes that are often very slow, extract a small percentage of the available oil, and use a considerable amount of energy. Improved extraction technologies can increase oil yields, reduce fuel consumption, and enable higher production rates. The success depends on the processors' ability to pay for the improved technology and on having facilities for local maintenance and repair of equipment. It especially depends on the value that can be added to crops by processing, the skills of the processor to make good quality oil, and effective enterprise management.
Sunflowers were highlighted as an oil crop with high potential for contract farming in the regions studied by Trans-SEC. Here, farmers and processers have to agree on terms for supply and demand before production and harvest was carried out. SUA researchers produced a participatory business plan with farmer groups from Ilolo and Idifu in order to determine the potential of the sunflower oil processing business. This exercise was a result of the discussion with actors during field visits to different potential producing areas in Dodoma region, especially Mvumi ward where most sunflower producing farmers and processors of sunflower oil are located.

Key lessons

Optimization of mechanical oil extraction should take three elements – oil production, extraction efficiency, and energy requirement – into consideration. The optimal process could be based on either maximizing oil production or the specific energy input to produce one kilogram of oil.

Based on this knowledge, up-scaling the capacity of the machine or investigating the machines available in Tanzania using a similar method should be conducted in order to increase the oil yield while simultaneously maintain the oil quality.
Efficient sunflower processing can be can be improved in rural areas by introducing mechanised shelling and threshing, thus improving rural livelihoods.

Sunflower seeds, Tanzania 2016

UPS No. 7: Optimized storage for earning better prices and for improved grain quality

Grainpro storage bag, Tanzania

Objectives

The major constraints addressed through optimized market-oriented storage include: reducing post-harvest grain losses in storage, reduced quality of stored grains, to limit stress selling immediately after harvest when prices are overly low, and smooth temporal food availability for food security. In most countries, grains are among the most important staple foods. However, they are seasonally produced and, in many places, there is only one harvest a year, which itself may be subject to failure. This means that in order to feed the world's population, most of the global production of maize, wheat, rice, sorghum, and millet must be stored for periods varying from one month to more than a year. Thus, grain storage occupies a vital place in the economy of individual households, especially in rural areas.

Description

The main function of storage in the economy is to even out fluctuations in market supply, both from one season to the next and from one year to the next, by taking a product off the market during surplus seasons and releasing it back during lean seasons. This, in turn, smooths out fluctuations in market prices. The desire to stabilize the prices of basic foods is a major reason why governments try to influence the amount of available storage, if not directly undertaking storage themselves. This UPS aimed at building the capacity of individual farmers regarding market-oriented storage practices in order to engage them in profitable and sustainable storage. The improved, proper, storage facilities will help increase the volume of supply and quality of grains, thus enabling farmers to obtain competitive prices during lean seasons. The bags are applicable for grains, especially those that are easily infected by pests and insects, such as maize, rice, cowpeas, and pigeon peas, among others.

Key lessons

Proper post-harvest handling measures, particularly grain storage, in the improved bags can offer a wide range of benefits to pro-poor farmers. Quality produce can be available for household food, potential markets, and farm seeds. Moreover, most farmers have objectives of meeting household food requirements and, therefore, are willing to invest in storage technology, regardless of its economic returns.

UPS No. 8: Poultry-crop integration for enhanced rural income and food security

Objectives

The need to improve poultry production was identified by the farmers as an alternative income source, especially during harvest time when the prices of crops are too low. This UPS aimed to enhance FVC participation of production (better integration of crop-livestock systems for improved livelihoods and markets (better utilization of by-products from both the livestock and crop sectors produced under integrated livestock-cropping system) and increased utilization of poultry manure for improving crop production and the use of crop by-products as animal feed). For the sustainability of this UPS, farmers were trained in poultry management, feed ration formulation, chicks broodiness, and marketing. The main objective of this UPS was to increase household income and nutritional security through the optimized integration of poultry-cropping systems at the household level.

Description

The majority of rural communities regard chickens as "a walking bank" because they are a ready source of petty cash in times of need. Chickens are primarily raised under free-range management systems that permit minimal or no care in terms of health, breeding management, housing, or supplemental feed given to the birds. The Trans-SEC baseline survey observed that majority of farmers in the study area spend the income from their poultry enterprise on basic-home needs. Very few use the same income to purchase farm inputs or to re-invest in poultry and other non-farm activities.

Following the Trans-SEC baseline survey, the knowledge gap and materials needs were identified to encourage rural farmers to exploit the potential of poultry-crop integration in order to improve their income and food security. Specifically, the project developed different packages suitable to the project area and traditional management system. The types of resources to improve chicken fodder rations include cereals (such as maize, wheat and sorghum), crop by-products (maize bran, rice bran, wheat bran, cotton seed cake, sunflower cake), cow pea, cassava and cassava leaves, soya, as well as animal by-products like fish meal, bone meal, and blood meal.

Key lesson

Improved poultry production can be a potential alternative source of immediate income and nutrition.

Kuroiler chickens, Tanzania 2015

UPS 9: Mobile integrated market access system (m-IMAS)

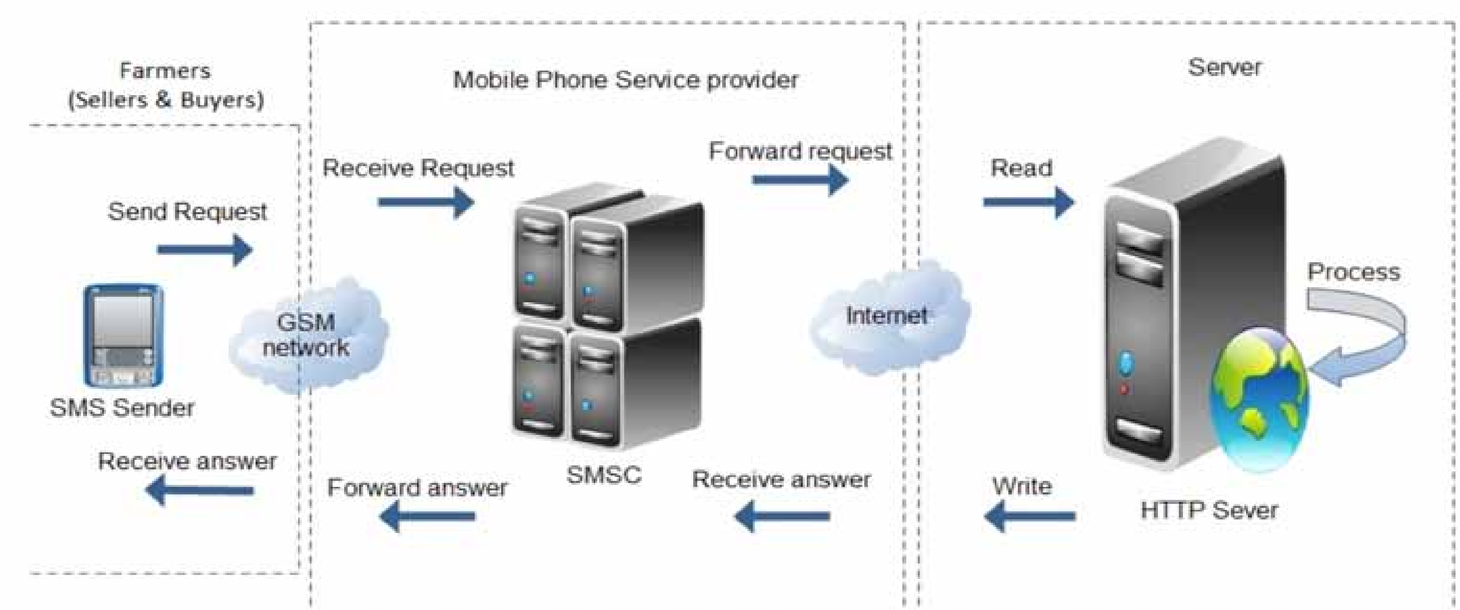


Figure 6: Model process of the m-IMAS system

Objectives

The UPS will improve the market access of smallholder farmers through increased access to market information. The system is designed to link smallholder farmers to other farmers and to food markets via an mobile phone app. Local middlemen might be bypassed. The m-IMAS will enable farmers to increase market access by linking buyers and sellers of commodities in the villages with traders outside the village through the telephone and internets based system. Increase marketing of agro-products through m-IMAS whereby farmers market their produce and buyers bid for the same via mobile phones.

Description

The system registers and provides full information about the sellers and buyers, including their location, contacts, quantity offered, and prices. After the system matches the requests of buyers and sellers, it notifies them by sending text messages.

Preliminary observation shows that the system works in villages with a strong network signal, a large number of traders, and for farmers knowledgeable about mobile texting. When operating the database using free mobile services alerts, the mobile phone network companies deliberately slow the system response time (robotic response control).

Key lessons:

This UPS depends on mobile phone functionality and network operations. While some farmers do not own mobile phones, the majority of farmers who own a mobile phone are not familiar with mobile texting. Furthermore, there is limited power reliability and access to network signals. Although it is not used for market purposes, users are required to have an airtime bundle in order to access the system. Last, but not least, during testing with farmers, it was noted that mobile network providers were actively slowing text message response times, thus extending waiting time for replies.

It is recommended to consider requirements and criteria before UPS up-scaling

- Strength of network signals;
- Mobile phone ownership;
- Establishment of a pooled phone resource center for farmers who cannot access or use mobile phones;
- Source of power/electricity for charging phones;
- Familiarization of farmers with text messages on mobile phones;
- Size of the village and the number of people participating in the market;
- Purchasing power and willingness of farmers to pay for airtime bundles; and
- Awareness among traders of nearby markets within the system.

UPS No. 10: Household centered nutrition training and kitchen gardens of green leafy vegetables for improved dietary diversity and family health

Objectives

Rural areas in Tanzania face a number of nutrition problems, including poor nutritional knowledge, inadequate consumption of micronutrient green leafy vegetables, stereotypes about vegetables, low dietary diversity, inadequate domestication efforts for vegetables, as well as the low use of vegetable cultivation during the off-season. Therefore, the main objective of this UPS was to improve food consumption patterns, nutrient intake, and the dietary diversity of rural household family members. Kitchen gardens address household malnutrition by promoting increased consumption of the available diverse, nutrition. In addition, as home gardens are predominantly managed by women, they can also play an important role in ensuring the proper diets of women and children, especially in rural areas.

Description

Implementation was in both semi-arid (Ilolo and Idifu) and sub-humid (Ilakala and Changarawe) villages. A baseline survey assessed needs in order to identify the nutritional needs of the population. Nutritional training materials were developed based on the knowledge gap and needs identified from the baseline survey. Household nutritional training was provided to both male and female household members. In rural areas where water is scarce, the introduction of pocket/bag gardens is feasible because they require very little water compared to conventional ground gardens. Typically pocket gardens are on the doorstep, thus ensuring the immediate availability of vegetables. Pocket bag demonstrations were conducted at one central household close to the seedling nursery bed. Materials required to start pocket gardens include manure, sand, soil, pebbles, pocket bag, water, spade, and buckets. Another type of gardening that was implemented was the ‘tray’ garden, where a plastic material is inserted into a square hole then filled with pebbles, dry grass and a mixture of soil, sand, and manure. Crops are planted on top. This type of kitchen garden does not need any additional economic resources, using only locally available planting materials and own labor. It can grow year-round, ensuring a sustainable supply of vegetables, thus providing direct access to high quality vegetables that can be harvested, prepared, and fed to household members, often daily. These gardens can raise micronutrient rich green leafy vegetables like Chinese cabbage, spinach, collard greens, swiss chard, amaranth, sweet potato leaves, pumpkin leaves, African eggplants, and hot peppers, among others. The nutrition training covers are wide range of nutrient rich foods that need to be consumed.

Key lessons

This UPS recognizes positive impacts of home gardens on addressing inadequate food diversity and under-nutrition.
Additional benefits, such as increased small income and livelihood opportunities for resource-poor families, are also provided.
There is a need for local governments to promote kitchen gardens and nutritional education to ensure that the community achieves the dietary diversity necessary to improve family health and income.

Kitchen garden nursery of leafy vegetables, Tanzania 2015

Expert ex-ante food security assessments of UPS: the ScalA-FS tool

Frieder Graef, Götz Uckert,
Jana Schindler, Stefan Sieber

Motivation

Upgrading strategies (UPS) need to be context- and site- specific since they may be affected by various factors at different temporal and/or spatial scales. ScalA-FS (Scaling up Assessment Tool for Food Security) was jointly and iteratively developed by and for experts in order to assess the potential success and challenges of selected UPS. This was accomplished by (i) using local food security assessment criteria developed by agricultural scientists and local farmers in a participatory process and (ii) using suitability and requirement criteria for a successful sustainable implementation.

Description

Adapting the scaling up assessment tool ScalA, ScalA-FS was designed to serve both the food security dimensions (availability, access, utilization, and stability) as well as the social, economic, and environmental pillars of sustainability. These criteria, grouped by the three sustainability dimensions, are listed below; their respective indictors are shown in parentheses.

a) social sustainability criteria: food diversity (sufficient, safe, and nutritious food), social relations (socio-cultural acceptance), and working conditions (working hours and work quality);
b) economic sustainability criteria: production (agricultural yield), income (household income), and market participation (surplus sold at markets or input purchase); and
c) environmental sustainability criteria: soil fertility (soil chemical properties), available soil water (for plants over the growing season), and agro-biodiversity (number of crops and wild species).

Furthermore, ScalA-FS provides an overview on the general suitability and local institutional requirements to assist the successful implementation of a UPS. A pretest with four persons from the pool of UPS implementing consortium members was carried out to identify shortcomings and adapt the tool. ScalA-FS and fact sheets describing all the UPSs in greater detail were then distributed to the other 50 Trans-SEC consortium members who were experts in Sub-Saharan agriculture to assess the UPS. Sixteen Tanzanian and 16 German project members carried out the UPS assessment, with 21 male respondents and 11 female. They were affiliated to eight international, German, and Tanzanian institutions. A diversity of respondents was found to be important since both nationality and gender determine individual assessments. Respondents only answered questionnaire items if they thought they had appropriate expertise for the UPS. As a result, individual questions had between 13 and 22 respondents.

Outcome and practical implications

The ScalA-FS assessment results on the potential impact of the UPS differed strongly between the UPS and the social, economic, and environmental assessment criteria. Impact assessments for the semi-arid and sub-humid regions differ only slightly, with gender showing a limited effect. The positive impacts of food securing UPSs centered on productivity and income generation. Rain water harvesting, fertilizer micro-dosing, optimized weeding, and kitchen garden promotion were expected to have the greatest impacts after implementation. The implementation requirements for the selected UPS were assessed as generally low to medium, while the projected suitability in most cases was high. Regarding local knowledge and education (human capital) as well as visible success after a short time, high requirements for UPS implementation were indicated. Hence, ScalA-FS was useful in assessing the UPSs, identifying whether they were adaptable, applicable, and likely to succeed in the food security and development context.

Recommendations

ScalA-FS is recommended for creating a knowledge base using experts from across nationalities and across genders to identify potential impacts and bottlenecks that need to be addressed during the implementation of a UPS. It can help identify entry points where more efforts and/or other participatory actions with local stakeholders are needed to assure successful implementation and adoption. Therefore, it is expected to be applicable to other rural poor cropping regions and to a broad range of environments. ScalA-FS should be applied early in the implementation process of UPSs in order to support adaptations and a successful upscaling at other locations.

References

Graef, F., 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 9(6): 1255-1270.

Graef, F., et al. (2018). „Systemising gender integration with rural stakeholders' sustainability impact assessments: A case study with three low-input upgrading strategies." Environmental Impact Assessment Review 68: 81-89.

Schindler J., Graef F., König H. and Mchau D. (2017). "Developing community-based food security criteria in rural Tanzania." Food Security (9)6: 1285–98.

Schindler J., Graef F., König H., Mchau D., Saidia P. and Sieber S. (2016). „Sustainability impact assessment to improve food security of smallholders in Tanzania". Environmental Impact Assessment Review 60: 52–63.

Sieber, S., et al. (2015). „Integrated assessment of sustainable agricultural practices to enhance climate resilience in Morogoro, Tanzania." Regional Environmental Change 15(7): 1281-1292.

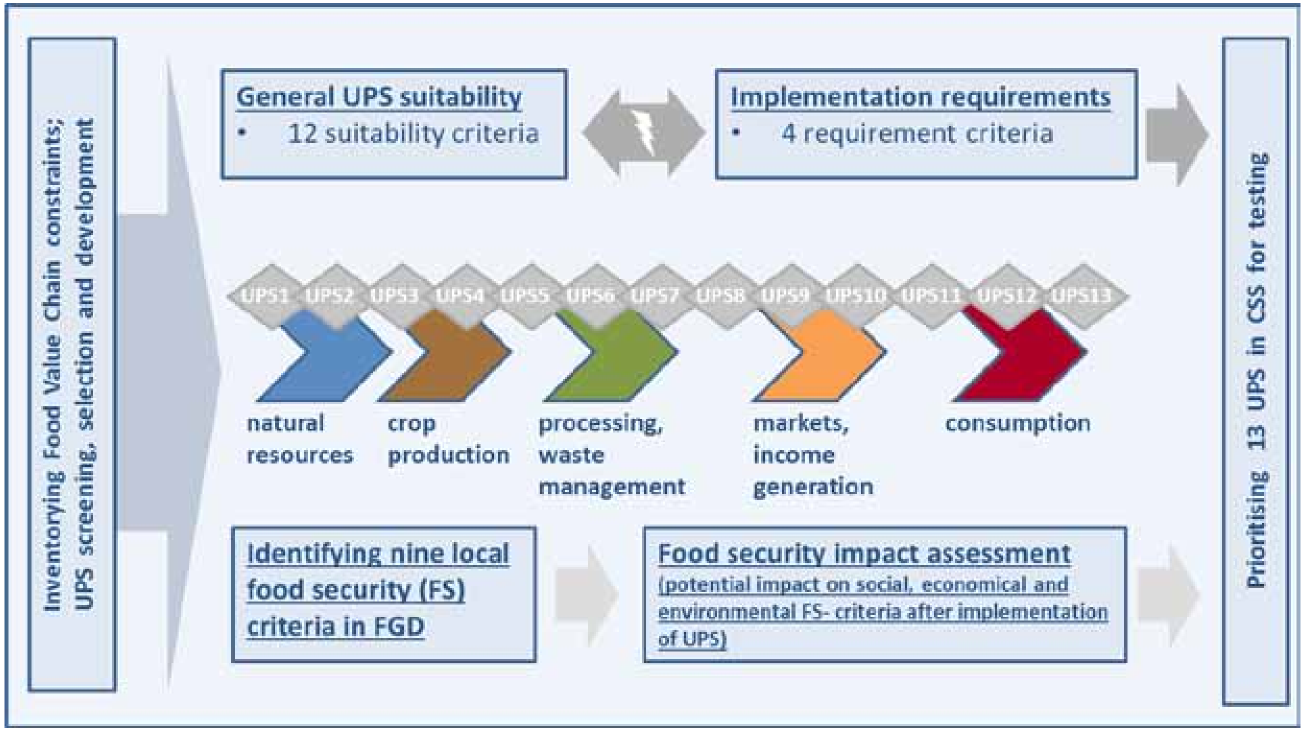


Figure 7: ScalA-FS ex-ante assessment of local food security, suitability, and local requirements for successful implementation and dissemination of single UPSs.

Framework for Participatory Impact Assessment (FoPIA)

Jana Schindler, Hannes König

Introduction

Impact assessment is used to assess the outcome of a defined action, frequently for project and policy assessments. This section outlines the Framework for Participatory Impact Assessment – or FoPIA – a participatory impact assessment method used to conduct ex-ante and ex-post impact assessment of different food securing upgrading strategies in rural Tanzania. Food security remains a major challenge in Sub-Saharan Africa. Sustainable agricultural development is fundamental for food security and poverty alleviation, especially in developing countries. Several development initiatives focus on enhancing the agricultural production of smallholder farmers. Because smallholder livelihoods are fragile, assessing the impact of development initiatives prior to implementation is critical, with the primary goal of increasing the probability that these initiatives will improve the livelihoods of impoverished people in the respective project regions, as well as avoiding negative impacts. Ex-ante impact assessment is a process that identifies and explores the consequences of a possible future development – the likely effects of the intended action. Thus, it is frequently and widely used as part of planning processes; for example, during policy implementation processes. There is a growing demand to anticipate the suitability, outcome, and sustainability of planned projects and programs, whereby assessing this requires appropriate methods.

An impact assessment framework used under the label of “sustainability impact assessment” should be future-oriented toward ensuring a positive contribution to reaching a desired goal. Furthermore, it should consider multiple sustainability dimensions, equally accounting for economic, social, and ecological needs. The interlinkages and interdependence of ecology, economy, and society must be respected, with trade-offs analyzed and minimized, while encouraging the stakeholders to learn the new knowledge.

FoPIA

The approach applied within Trans-SEC was based upon the Framework for Participatory Impact Assessment (FoPIA) after Morris et al. 2011. FoPIA, in its original form, was developed to ex-ante assess policy impacts of land use changes at the European level was applied and tested in different transition and developing countries and later adapted to conduct an ex-ante assessment during the last part of the planning phase prior to the implementation of agricultural upgrading strategies (FoPIA-FS).

By applying FoPIA-FS, the aim was to systematically incorporate farmers’ knowledge into the knowledge generation process and to identify the positive and negative impacts of proposed food securing upgrading strategies, then, if necessary modify and adapt them prior to implementation. The modified FoPIA comprises two main parts: 1) an analysis of the food security contexts and 2) ex-ante impact assessment through focus group discussions of local food security upgrading strategies. The following methodological steps follow a series of successive participatory stakeholder workshops.

In a first step, the food security context was analyzed together with the farmers. The farmers defined, to their understanding, food security in their context. The research team then interactively discussed with the local population the key challenges influencing their local food situation, which were later conceptualized and translated into a set of food security criteria, presented in Table 2. These criteria cover the three dimensions of sustainability (economic, environmental, social), while simultaneously representing the four food security dimensions (availability, access, utilization, stability), showing that rural communities think holistically, considering multiple criteria and dimensions related to food security. The farmers were asked to individually score the perceived importance of each criterion for their food security, thus providing an overview of individual preferences and regional relevance.
In step 2, alternative food security upgrading strategies were presented to the farmers by the research team. During moderated focus group discussions, farmers were asked to elaborate the strengths and weaknesses of each proposed agricultural upgrading strategy in small groups. The farmers identified positive and negative sustainability impacts of the upgrading strategies based on the food security criteria. Thereafter, based upon these two steps, farmers chose their preferred upgrading strategies for implementation in their village.

Subsequently, an impact assessment followed, with farmers ranking the assumed impacts of each selected upgrading strategy on the food security criteria.

In a final presentation, the results were discussed with village elders and authorities. The stakeholders were asked for their feedback and the add-on activities necessary for the successful implementation of the selected upgrading strategies. Finally, a plan for the timing and distribution of responsibilities for implementing the upgrading strategies was shared.

Lessons learned

FoPIA-FS enabled a quick and transparent identification of the trade-offs between upgrading strategies and prioritizing food security criteria at all four case study sites. The results of two regional (Dodoma/Morogoro) impact assessments in four selected villages (2 x Dodoma / 2 x Morogoro) demonstrate the benefit of actively involving local stakeholders during impact assessment. By applying this approach, locally-relevant food security criteria were elaborated in a constructive and interactive way. The results show the benefit of the active involvement of local stakeholders during impact assessment. By applying this approach, locally-relevant food security criteria were elaborated in an interactive way.

Furthermore, FoPIA-FS helped identify possible impacts and facilitated insights into the socio-environmental context of each local community. The results of the sustainability impact assessments were considered valuable, helping to recognize adaptations to the intended development interventions required by specific localities in order to reduce the assessed potential negative impacts. This research shows that impact assessment results cannot simply be transferred from one locality to another, even if the distance between the case study sites is very minimal, given that each locality has its own characteristics and particularities.

Criterion	Sustainability Dimension	Farmers' definition	Food Security Dimension
Food diversity	Social	Sufficient number of meals (=3) per day offering a diversified and balanced diet	Access, Utilization
Social relations in the community	Social	Community support during family need (i.e., drought, family incidences such as illness, death) and share of workload (i.e., for field ploughing)	Access, Stability
Social relations in the family	Social	Family support and understanding of decision making about household resources	Access, Stability
Working conditions	Social	Access to appropriate technology/equipment and agricultural practices, reducing working hours, and workload	Access
Agronomic education	Social	Knowledge on best practices along the whole food value chain: natural resource management, production, processing, marketing, and consumption	Access, Utilization
Yield	Economic	Amount of food produced and available for family consumption and for selling	Access, Availability
Income	Economic	Family financial resources earned from agricultural production and off-farm activities	Access, Stability
Loan access	Economic	Existence of reliable and trustful institutions for loan provision for agricultural activities	Access, Stability
Market participation	Economic	Selling and buying agricultural products and other needs; knowledge of market prices for improved negotiation power of farmers toward buyers	Access, Stability
Land access	Economic	Sufficient land size and ownership of agricultural land	Access, Availability
Soil fertility	Environmental	Quality of the soil for agricultural production	Availability, Stability
Soil water availability	Environmental	Soil water availability for agricultural production	Availability, Stability
Agrodiversity	Environmental	Cultivation of crop variety for family consumption and for selling; risk management in case of crop failure	Availability, Stability

Table 2: Food security criteria

Framework for Participatory Impact Assessment

Phase 1: Analysis of the geographical and food security context

- First step: Definition of food security context
- Second step: Identification and analysis of food security criteria

Phase 2: *Ex ante* impact assessment of local food security upgrading strategies (UPS)

1) First step: Presentation and participatory selection of UPS
2) Second step: UPS impact assessment
3) Third step: Presentation of results and stakeholder feedback

Figure 8: Adapted schema of FoPIA

We used FoPIA-FS with farmers and a similar approach (ScalaFS) with scientists. The interlinkage of local stakeholders' knowledge and scientific knowledge provides a more comprehensive understanding of complex and dynamic systems and processes, producing more relevant and effective practices. As shown in our research, farmers and scientists had considerably different views on the positive and negative impacts of proposed agricultural interventions. While scientists mostly focused on direct causal impact chains, the farmers considered indirect linkages that take into account their complex livelihoods. Furthermore, the FoPIA-FS was found to be a social learning tool that initiates structured thinking and knowledge exchange among participating farmer groups as well as between researchers and farmers. This research shows that sustainability impact assessment is a critical step prior to project implementation, enabling adapting upgrading strategies to the local context and providing real benefits to local communities.

References

König, H. et al. (2013). "Regional impact assessment of land use scenarios in developing countries using the FoPIA approach: Findings from five case studies". Journal of environmental management, 127, Suppl S56-64.

Morris J. B., Tassone V., Groot R. de, Camilleri M. and Moncada S. (2011). "A Framework for Participatory Impact Assessment: Involving Stakeholders in European Policy Making, a Case Study of Land Use Change in Malta". E&S 16.

Schindler J., Graef F. and König H. (2016). "Participatory impact assessment: Bridging the gap between scientists' theory and farmers' practice". Agricultural Systems, 148: 38–43.

Schindler J., Graef F., König H. and Mchau D. (2017). „Developing community-based food security criteria in rural Tanzania". Food Security, 9(6): 1285–98.

Schindler J., Graef F., König H., Mchau D., Saidia P. and Sieber S. (2016). „Sustainability impact assessment to improve food security of smallholders in Tanzania". Environmental Impact Assessment Review, 60: 52–63.

Potential of tied-ridging as a management strategy to increase water productivity of pearl millet and sorghum

Angela Schaffert, Felista Mpore, Isack Francisco Teya, Alexandra Schappert, Jörn Germer, Folkard Asch

Introduction

Water shortage is a key factor that limits crop growth in the semi-arid Dodoma region in Tanzania. The 30 year average rainfall amount of 500 mm during the rainy season (based on weather data recorded at Dodoma airport from 1980-2010) indicates that in many growing seasons water supply is sufficient for the crops to mature. However, intra-season variability in rainfall and generally low rainfall amounts frequently cause drought-induced yield losses in smallholder crop production systems. In contrast, floods caused by erratic rainfall events also impose a great challenge for smallholder farmers. Micro basins, formed by ridges and cross ties, could reduce surface run-off and increase infiltration (see photo p50). Hence, tied-ridges offer the potential to improve water productivity of the crops, which, in turn, results in more stable yields. Therefore, it is a management strategy that can mitigate the effects of insufficient rainfall distribution and extreme weather events.

As Tied-ridging was identified as an upgrading strategy (UPS) to enhance food security by farmers in co-operation with scientists and other stakeholders involved in the Trans-SEC project this technology was tested in-depth. One researcher-managed mother plot in each village served as a demonstration for the farmers. In turn, farmers tested the technology on their own plots, the so called baby plots, which reflect diverse farming conditions. Thereby, the ability of tied-ridging to conserve water and stabilize yields of the target crops with respect to different rainfall patterns was determined.

Material and methods

On-station field trials were conducted at ARI-Makutupora (S05°58.543, E035°46.118, ca. 1100 m.a.s.l.) in the Mjini district of Dodoma. The semi-arid climate of Dodoma is characterized by a unimodal and erratic rainfall pattern, with a rainy season from November/December through April. .

During the rainy seasons (RS) of 2015 and 2016, pearl millet (Pennisetum glaucum var. okoa (L.) R.Br.) and sorghum (Sorghum bicolor var. macia (L.) Moench) were grown on two fields (Field A and B); both soil types classified as Rhodic Luvisol (loamic, ochric). Rainfed plots with tied-ridging (TR) were compared with rainfed plots (R) on flat terrain. A fully irrigated (FI) treatment was included on field A in order to reveal the potential yield under no water and nutrient limitations. These plots were irrigated via drip irrigation whenever rainfall was insufficient for the crop water requirements. All treatments were tested with 4 replicates.

The experiment used a randomized block design. Ridges were 0.8 m apart, equivalent to the planting distance, and 0.25 m high. Cross ties connected the ridges at 0.6 m distance and were 0.15 m high. The seeds were sown on top of the ridges.

All plots received a mixture of fertilizers at the recommended rate of 60 kg N ha-1, 13.1 kg P ha-1, 24.9 kg K ha-1 via Yara Mila complex fertilizer (23-10-5), potassium nitrate (13-0-46), triple super phosphate (0-44.5-0), and urea (46-0-0). Yara Mila, potassium nitrate, and triple super phosphate were placed in each planting hole at sowing and covered with some soil before the seeds were added (placed fertilizer application). Urea was side dressed 4-6 weeks after emergence over all treatments.

Water collected in micro basin, Tanzania 2015

Field A [mm] between sowing and harvest	Total rainfall amount	Effective rainfall amount
Rainy season 2015	252	221
Rainy season 2016	537	439

Table 3: Total amount of rainfall [mm] and effective rainfall amount [mm] of the crop cycles on field A.

A weather station (WS-GP1, Delta-T) was installed on the experimental site at ARI-Makutupora. The observed precipitation differed notably between the two seasons. In the 2015 rainy season, only 252 mm of rain fell between sowing and harvest (Table 3). In contrast, in 2016, the crops received 537 mm of precipitation on field A. In order to estimate the effective rainfall amount, the potential surface run-off was computed from daily rainfall amounts. The approximated effective rainfall amounts are displayed in Table 3.

Results

The potential yield, obtained from the fully irrigated (FI) treatment, was 4.1 ± 0.8 t ha-1 for pearl millet and 3.5 ± 0.3 t ha-1 for sorghum. As expected, there were no significant differences between the FI grain yields in 2015 and 2016 (Figure 9, Figure 10).

In 2015, the grain yield of pearl millet on field A was significantly higher on plots with tied-ridging (TR) than those with flat cultivation (R), where the crops hardly produced any grain (Figure 10). However, a wide gap remained between the yields of TR and the potentials yields, which were obtained for FI from field A. Under the prevailing climatic conditions, the evapotranspiration for pearl millet is approximately 524 mm and for sorghum 543 mm (calculation based on the guidelines of the FAO-56 methodology). This underlines that the rainfall of 252 mm between sowing and harvest caused severe suffering to the plants. The greatest susceptibility to water stress was observed during the flowering stage.

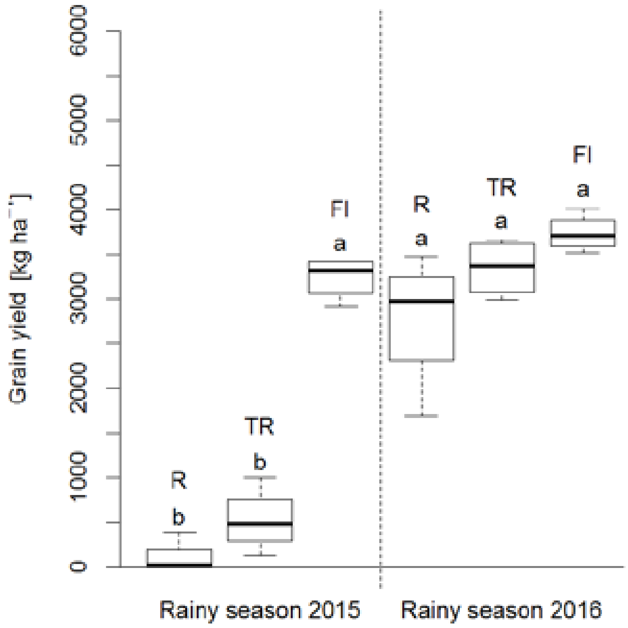


Figure 9: Sorghum on field A, N=4. Grain yield [kg ha-1] of sorghum at 13 % grain moisture on the experimental field (A) in the rainy seasons 2015 and 2016. R = rainfed, TR = tied-ridging, FI = full irrigation. N indicates the number of replicates per treatment. Different lower-case letters indicate a significant difference among average yield data (Kruskal-Wallis-test, Mann-Whitney-U-test, p = 0.05).

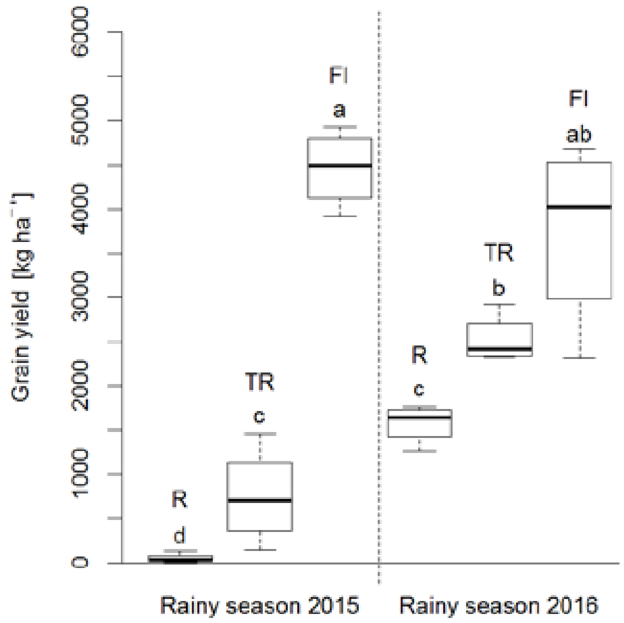


Figure 10: Pearl millet on field A, N = 4. Grain yield [kg ha-1] of pearl millet at 13 % grain moisture on the experimental field (A) in the rainy seasons 2015 and 2016. R = rainfed, TR = tied-ridging, FI = full irrigation. N indicates the number of replicates per treatment. Lowercase letters indicate significant differences (Kruskal-Wallis-test, Mann-Whitney-U-test, p = 0.05).

In 2016, the results regarding a yield increasing effect of tied-ridging is ambiguous. The outcome differs across the two fields and crops. On field A, pearl millet performed significantly better on TR plots compared to R (Figure 10). A better performance of the TR treatment was also found for sorghum (Figure 9), but not significantly. There was sufficient water, even for the flatly cultivated crops, to meet crop water requirements. Consequently, some flat plots of pearl millet and sorghum yielded within the range of the potential yields (Figure 9, Figure 10).

Conclusion

Results demonstrate that tied-ridges have only a yield increasing effect within certain threshold levels of water availability. The contrasting rainfall amounts in 2015 and 2016 offer an orientation of the precipitation range in which the establishment of tied-ridges has a positive effect on the yield of the target crops. At very low rainfall amounts, tied-ridging could be the primary reason that the crop produces grain at all. This was the case in 2015, when most flat cultivation plants died, while the plants in tied-ridging plots preserved the limited rainfall and provided a basic grain yield.

The maximum threshold value is reached when the effective rainfall amount is adequate for meeting the crop water requirements. At this point, there is no benefit of tied-ridging in terms of yield compared to flat cultivation. This was the case in 2016 for sorghum on field A, with 537 mm of rainfall, crops grown with tied-ridging had better yields. Economically, the point of no return is very likely to be reached quickly due to the high work load needed to establish and maintain this technology. Installing tied-ridging requires 266 labor hours per hectare compared to 60 labor hours per hectare for flat cultivation. This high work load is an obstacle for farmers since the increase in yield could be little or none in seasons with high rainfall. Farmers in Ilolo and Idifu offered one approach to solve the problem: establishing tied-ridges on only one acre per season. Further, diversification not just of cultivation techniques but also crops could minimize the risk of no return and keep the workload at an acceptable level for the farmers.

References

Mdee, O.J. (2015). “A study of rainwater harvesting practice in semi-arid areas in the Dodoma region, Tanzania: Planning phase”. ARPN Journal of Earth Sciences, Vol. 4(2).

Reinhardt, N., Schaffert, A., Capezzone, F., Chilagane, E., Swai, O., Rweyemamu, E., Germer, J., Asch, F., Herrmann, L. (n.d). „Soil and landscape affecting technology transfer targeting subsistence farmers in central Tanzania”. Submitted at Experimental Agriculture, Cambridge Core.

Swai, O.W., Mbwambo, J.S., Magayane, F.T. (2012). “Gender and perception on climate change in Bahi and Kondoa Districts, Dodoma Region, Tanzania”. Journal of African Studies and Development, Vol. 4(9): 218-231.

Sunflower trial (ARI Makutopora), Tanzania 2015

Extensive module on food security in questionnaire design

Kathleen Bruessow, Luitfred Kissoly, Anja Faße,
Ulrike Grote

Introduction

For Tanzania, two target regions were identified: Morogoro and Dodoma. The Morogoro region contains areas with a variety of different levels of sensibility regarding food security sensitivity levels. Dodoma, in contrast, features a predominance of high food insecurity areas. With regard to the natural environment, both regions together account for 70–80% of the farming systems types found in Tanzania.

Within the target regions, the selected CSS should be able to represent the large variability of farming systems in the region. Hence, the main criteria for selecting the CSS are (a) similar climates; (b) differing market access; (c) differing rainfed cropping systems, possibly integrating livestock; and (d) village sizes with 800–1500 households. If possible, villages are chosen where the Tanzanian smallholder farmer association, MVIWATA, is active and there are no other large R&D projects active. Other selection criteria include the number of stunted children younger than 5, as an indicator of food insecurity, available logistics, infrastructure and facilities, differing wards, soil types, and population density. In addition to each CSS consisting of at least one local market place and the surrounding 2–3 sub-villages, it has at least partial access to markets for cash crops. This creates a design with comparable, yet diverse, environmental and socio-economic conditions.

This design enables the investigation of food security upgrading strategies throughout the different FVC components. The design of the household sur¬vey is depicted in Figure 11.

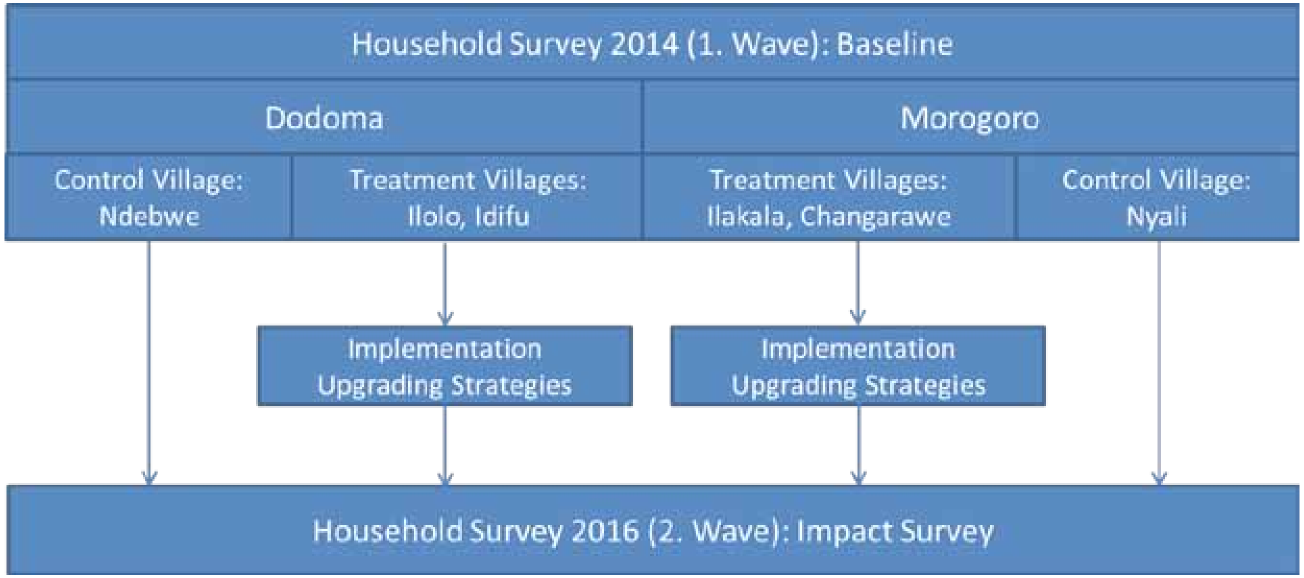


Figure 11: Structure of the household survey

In both Dodoma and Morogoro, three case study villages were selected. Since Trans-SEC sought to implement upgrading strategies (UPS), in each region two villages were chosen for implementation of upgrading strategies (UPSs), the so-called "treatment villages," while one control village did not implement any UPSs. This enables to evaluate possible impacts on income and food security over time (wave 1 versus wave 2 survey results) and across treatment and control groups in both regions. The villages were selected after a scoping study. The treatment villages are Ilakala and Changarawe in Morogoro and Ilolo and Idifu in Dodoma. The control villages are Nyali in Morogoro and Ndebwe in Dodoma. The households were randomly selected from household lists provided by ARI Kilosa and ARI Hombolo. The lists contained information on the name of household heads and the sub-village they live in. After sorting the lists alphabetically for each sub-village, 150 households were selected randomly from each village, making for a total of 900 households.

The baseline survey, wave 1, was conducted in 2014, while the follow up survey was in 2016, following implementation. The overall objective was to collect representative data on smallholders and their integration in agricultural food value chains and possible related challenges. Therefore, the questionnaire consists of different sections designed to capture different aspects.

The objective of the survey is to generate various food security indicators representing the four dimensions of food security. This supports a more in-depth evaluation of households´ welfare in terms of food security status before and after the innovations/UPS. Therefore, the focus of the questionnaire is to collect detailed information on income generating activities, expenditures, and food security on the household level. To depict the household activities, different indicators, such as income (per capita and total household income), expenditure, assets, and food security indicators, can be derived, whereby the latter are of particular interest to the project

Specific description

The overall objective is to collect representative data regarding smallholders' integration in the agricultural value chain and possible related challenges, income activities (farm and off-farm), food and non-food expenditures, use of natural resources, and risk awareness in the study regions. Food consumption data are of special interest and are captured with a variety of indicators.

The questionnaire included an extensive module on food security, covering the four dimensions of food security according to FAO (1996), i.e.

(1) the availability of food;
(2) economic and physical access to food;
(3) stability of food provisioning over time / seasonality of available food; and
(4) utilization of food.

The data then were used to calculate different food security indicators to assess the food security status of the households in order to account for the four food dimensions (table 4):

- Food consumption score (FCS)
- Household Food Insecurity Access Scale (HFIAS)
- Household Hunger Scale (HHS)
- Coping strategy index (CSI)

Outcome/ Added Value and practical implication

Each UPS can affect different dimensions of food security through different impact pathways (e.g. higher yields, high quantities of produce sold, more consumption, better knowledge of how to utilize food during cooking). For example, the introduction of a kitchen garden in a household will not directly affect income, i.e. the economic access to food, but it can substantially improve the nutritional outcome of family members as they now have the chance to regularly take in more nutritious food than before. Thus, indicators for utilization and stability of food provisioning are more likely to show an effect. A household that started using a millet thresher can sell their produce at a higher price, thus improving income. This is quantifiable in the dimension of economic access to food.

Trans-SEC is uniquely positioned to analyze the adoption of a variety of UPSs; the existing literature only analyses one innovation strategy at a time (e.g. improved seeds, or storage, or irrigation, or market access). Kissoly et al. (2017) show that food security is generally higher (higher FCS and lower CSI) for smallholders who use either improved inputs, stored for selling, or participated in collective action than for those who did not. In a further analysis of the effects of agricultural value chain activities on household food security, the effects of exclusively using improved inputs or storing for selling and using both improved inputs with storing for selling were compared to households who were involved only in production. Participating in both the use of improved inputs and storage for selling raised households' FCS and lowered CSI by even more, thus indicating that participation in two UPSs reaps greater benefits than participating in just one. These results underline the need to not just focus on one single upgrading strategy but rather to take the entire value chain into account in order to explore the potential multiplying effects of implementing more than only one strategy.

Indicator	Description	Dimension	Source
FCS	Food consumption score (average/ year 2013)	Access/ Utilization	WFP 2008; Wiesmann et al. 2009
Caloric intake	Total kcal consumed by adult equivalent per week	Access	Wiesmann et al. 2009; Jones et al. 2013
Protein intake	Total protein consumed by adult equivalent per week in g	Access/ Utilization	Wiesmann et al. 2009; Jones et al. 2013
CSI	Coping Strategies Index (average/ year 2013)	Stability	Wiesmann et al. 2009; Coates 2013
MAHFP	Months of adequate HH food provisioning (year 2013)	Stability	FAO 2008a; Coates 2013
HH income	Household annual net income (PPP US$, year 2010)	Access	FAO 1996
HH crop value	Household annual net income from crop production (PPP US$, year 2010)	Availability	FAO 1996; di Falco et al. 2011; Lema et al. 2014

Table 4: Food security indicators and dimensions (Bruessow 2017)

Referenzen:

Brüssow, K., Faße, A. and Grote, U. (2017): Implications of climate-smart strategy adoption by farm households for food security in Tanzania, Food Security, 9(6): 1203-1218.

Kissoly, L., Fasse, A. and U.Grote (2017): The integration of smallholders in agricultural value chain activities and food security: evidence from rural Tanzania, Food Security, 9(6): 1219-1235.

UPS groups and implementation: participatory monitoring and evaluation

Monitoring task, Tanzania 2016

Phlorentine Lagwen, Devotha Mchau, Bashir Makoko, Elirehema Swai

Introduction

Within Trans-SEC, the Agricultural Research Institutes (ARI-Centers) managed and facilitated the monitoring of UPSs at the household level. This involved 600 UPS implementing farmer households, 300 in each region of Dodoma and Morogoro - Dodoma representing semi-arid climates and Morogoro representing humid agro-ecologies. The ARI Center of Kilosa tested, supervised, and monitored a total of seven upgrading strategies (UPSs) in Kilosa District, Morogoro. The ARI center of Hombolo did so for six UPSs in Chamwino District, Dodoma.

To fast track group dynamics and UPS implementation status, challenges, and propositions, the "Participatory UPS group monitoring and evaluation" tool was developed and deployed.

The objectives of Participatory UPS group monitoring and evaluation were:

- In-depth understanding of group performance and dynamics;
- Synchronized decision on adjustments and adoption;
- Centralized UPS platform; and
- Gender inclusion and involvement.

Methodology

In order to determine if the implementation of a development program is going as planned or if the program requires adjustments, monitoring and evaluation is crucial. Trans-SEC included regular monitoring and evaluation that specifically incorporated the active participation of all stakeholders. Monitoring and evaluation exercises were planned to cover two phases, namely tri-monthly monitoring and household monitoring. The tri-monthly monitoring was conducted at three-month intervals and used structured questionnaires designed for each UPS group. Household monitoring was conducted monthly using a checklist. During tri-monthly monitoring, household UPS group members were invited to participate in a focus group discussion (FGD) with at least three-quarters of group members present. Group membership sought equal numbers of men and women, while both youth involvement and economic status (poor, medium and wealth) were also considered. At the household level, it was carried out monthly. It was designed to capture an overview of how the technologies being tested were performing, thus providing feedback to the researchers, who could then work with the farmer-stakeholders to identify potential modifications. This regular monitoring allowed the farmers who were testing the upgrading strategies to directly witness the progress of the project and to share their feelings regarding the benefits they are accruing from participating in various activities.

The regular group monitoring used focus groups discussions facilitated by a structured guide, that incorporated stakeholder developed indicators. Household monitoring consisted of personal interviews of household members using a checklist guide. In both settings, the information collected sought to measure the effectiveness of upgrading strategies and of stakeholder engagement in the implementation processes, thus providing quick feedback to all stakeholders for further adaptive actions. The monitoring efforts had two main objectives: group dynamics and technical details. Furthermore, weekly monitoring is accomplished through observation and informal discussions.

Outcome and practical implications:

- UPS implementation challenges identified and rectified in a timely fashion;
- Room for collective decision (group) and implementation easily reached;
- Easy feedback and discussion during FGD;
- Early adjustments and modification of UPS to reflect community needs and resources implemented; and
- Innovation ownership and awareness easily attained.

Such comprehensive monitoring simplified the implementation and allowed for quick adjustments. The upgrading strategies each needed a number of adaptations in order to improve implementation. This including coping with specific community situations, like cultural aspects, climate factors, technical setups, household knowledge, financial capacity, and providing compensation for expenses incurred.

Throughout this process, trade-offs were identified, including limited resources, production factors, gender-related issues, and cultural requirements, among others. These resulted in adjustments. Finally, this task helped generate knowledge that supported capacity building and decision making at different levels of implementation. Thus, knowledge generated from beneficiaries' practical experience helped to improve performance of the upgrading strategies and influenced the rate that UPSs were adopted by fellow community members. Regular monitoring enabled researchers to understand the differing adoption rates across upgrading strategies and across case study sites. Practical knowledge was gathered from different groups of beneficiaries, whereby the reasons for dropouts, dormant members, and adopters were shared throughout the processes. Since the process was participatory, farmers used these monitoring and evaluation sessions to assess their goals and expectations based on the previously developed indicators, making adjustments to their choices for upgrading strategies. Further, this information allowed researchers to see clearly the performance of different upgrading strategies more quickly and to make decisions as to whether a particular upgrading strategy for a specific case study site should be dropped or not.

Recommendations

- Participatory monitoring and evaluation allows for all stakeholders to share a common understanding and simplifies technical adjustments during implementation processes. Furthermore, it is provides a sense of ownership of the technology to the beneficiaries and makes the adoption processes smoother.
- The tri-monthly and monthly monitoring allows regular follow-ups, while enhancing familiarity and understanding between stakeholders. It is important to have a synchronized back up system that is available to partners in order to simplify data access and prevent work repetition.
- Regular monitoring and evaluation can help save the project money through proper, quick, adjustments and decisions.
- The combination of group discussions every three months and household interviews every month provides complementarities of information.
- Organized project monitoring and evaluation allows for fast-tracking activities and identifying both unintended side effects and implementation challenges.
- Structured questionnaires and checklists provide important information, allowing for early adjustments to embrace stakeholder needs.

A Gendered Analysis of Crop Value Chains in Tanzania

Scoping, Tanzania 2015

Justin K. Urassa, Tatu Mnimbo Said

Introduction

Although gender issues fundamentally shape the totality of production, distribution, and consumption within an economy, they are often overlooked in crop value chains. Generally, women and men participate at multiple levels in value chains, often in different tasks and with different opportunities for upgrading. In Africa, women and men's participation in agriculture is critical to production, poverty reduction, food security, and nutritional security. However, there is a limited understanding of the gender dynamics related to crop value chains. While women and men may face similar constraints to upgrading in crop value chains, their capacities and incentives to overcome them often differ. Therefore, understanding these gender dynamics can help provide the right incentives to the right actors to promote women's, men's, and the youth's position in crop value chains. Moreover, what matters is not simply the level of income derived from value chain activities, but rather a combination of factors related to the perception of ownership or management of a particular commodity.

Methodology

To better understand women's and men's participation in crop value chains, a cross-sectional study was carried out in Chamwino and Kilosa districts, Tanzania. Specifically, the study aimed at analyzing the influence of gender roles in upgrading strategies on multiple-commodity food value chains, assessing the gendered impact on food securing upgrading strategies using different gender tools, analyzing gender in asset ownership and participation in market oriented crop value chains, as well as determining pathways of addressing gender based constraints for equitable and sustainable participation in profitable crop value chains. A mixed methods approach was used to collect information from 595 respondents. Content analysis was used to analyze qualitative data obtained through focus group discussions and key informant interviews, while SPSS was used for quantitative data analysis.

Findings

The findings show that crops commonly grown in the two districts are maize (Zea mays) and sesame (Sesamum indicum) (Kilosa), bulrush millet, and groundnut (Chamwino). The results further show that in Kilosa there are no differences between women and men in relation to upgrading strategies related to natural resources. As the gendered analysis of the crop value chains shows that women and men engage differently in the value chain nodes, value chain analysis is important when it comes to introducing upgrading strategies. In addition, most of the challenges observed in relation to crop value chain upgrading strategies are associated with natural resources and production; 95% and 53 %, respectively. Male farmers are more concerned with natural resources than female farmers; this difference is statically significant (p = 0.05). On the other hand, female farmers were more into processing (maize shellers and millet threshers); those in Chamwino district differed significantly (p = 0.05) from their male counterparts. Women's preference for the processing UPS is no surprise as they are traditionally involved in processing activities.

A gendered analysis of crop preferences for Cham¬wino and Kilosa districts showed that generally, there is no gender difference in food crops preference in Kilosa. However, in Chamwino the women and youth differed from the men in relation to maize versus sorghum as the secondary food crop. Men preferred sorghum over maize because of its drought tolerance and contribution to households' food security. Women disliked sorghum due to its taste and susceptibility to storage pests: men ranked maize poorly because it lacks tolerance to drought. In Kilosa, women and men preferred rice as a food crop over cassava, which the youth preferred due to its drought resistant characteristics. In addition, cassava requires less labor than rice, thus giving the youth time to engage in other things, including leisure. Furthermore, women and the youth preferred crops that consume less time, especially during weeding: in Chamwino district, women opted to grow Roselle (Hibiscus sabdariffa), which requires little care and has multiple functions (making local brew and traditional medicine).

Commercialization of food crops differences were observed between male (MHH) and female (FHH) headed households in both Kilosa and Chamwino districts. Whereas in Kilosa MHH commercialized more than FHH, in Chamwino district it was the other way round. FGD participants in Chamwino district pointed out that FHH higher commercialization was based on crop choice; women produced sorghum, which is drought resistant, while MHH concentrated on maize, which performs poorly due to lack of enough moisture and is, hence, low productivity.

Practical Implication

The study shows the need for a gendered analysis of crop value chains before innovations and technologies are introduced to communities with similar socio-cultural and agro-climatic conditions to those of the study area. At a broader analytical perspective, this study illuminates an analytical gap in rural development economics based on the gender-sensitive value chain framework.

Recommendations

Projects, NGOs, and the government all need to conduct gendered assessments of innovations and technologies that are brought to farmers for better achievement of intended outcomes in food securing approaches. This is crucial as some technologies do not work for both sexes and, thus, are gender-biased. For example, some production technologies (rainwater harvesting and shelling/threshing machines) are very physical and thus proved challenging to women; thereby reducing adoption rates. There is need for a study on physical attributes and how women and men participate in crop value chains.

References

Barrientos, S., Dolan, C. and Tallontire, A. (2003). "A gendered value chain approach to codes of conduct in African horticulture". World Development, 31(9): 1511 – 1526.
Barrientos, S., Gereffi, G. and Rossi, A. (2010). "Economic and social upgrading in global production networks: Developing a framework for analysis". International Labor Review, 150(4): 319 – 340.
Njuki, J., Kaaria, S., Chamunorwa, A. and Chiuri, W. (2011). "Linking smallholder farmers to markets, gender and intra-household dynamics: Does the choice of commodity matter?". The European Journal of Development Research, 23(3): 426 – 443.

Lessons learned on the horizontal and vertical linkages of farmers and markets

Luitfred Kissoly, Raoul Herrmann,
Khamaldin Mutabazi, Anja Faße, Ephraim Nkonya

Motivation

Integrating smallholder farmers into food value chains (FVC) is thought to be a main pathway out of rural poverty and food insecurity in Tanzania and other Sub-Saharan African (SSA) countries. With increasing domestic food demand a result of growing populations, urbanization, and an expanding middle class, there are opportunities for smallholder farmers and small-scale traders. Yet, access to these opportunities are limited: import competition, demand for higher product quality and volume, especially in emerging urban prime markets, along with continuing poor input and output market infrastructure and services.

Vertical linkages in FVC, such as contract farming or outgrower schemes, which are commercial agreements over production and sale of agricultural products, are often viewed as innovative approaches to improve high-value market access, access to credit, technical advisory services, and inputs. However, these opportunities may be limited to only better-off farmers who have the necessary resources and skills. Horizontal linkages among producers via collective action arrangements, such as cooperatives and farmer groups, may help farmers achieve the minimum quantity, quality, and frequency of supply demands necessary to participating in higher-value markets and contract farming schemes.

Against this background, one Trans-SEC research stream focused on identifying and examining innovative institutional arrangements in food value chains (horizontal and vertical linkages) to understand their potential for smallholder FVC integration as well as their implementation and up-scaling challenges. In accordance with the Trans-SEC approach, the research combined different empirical methods, using participatory action-research methods as well as expert interviews and analyses of project- and national-level household survey data.

Description

To understand the extent, modes, and impacts of market participation in the FVC in the project regions and more broadly in Tanzania, two household survey data sets were analyzed: (i) a nationally representative farm household data, the National Panel Survey 2012-13 of the National Bureau of Statistics; and (2) project case study data from the Trans-SEC farm household survey and trader survey of the case study villages. Using these two data sets allowed for understanding the status of market participation and impacts on different levels, from the case study regions to the national level.

In addition, a participatory action-research process was implemented to identify potential upgrading strategies (UPSs) that would improve smallholder market participation in the project districts, thus contributing to food security. In an iterative and participatory process, Trans-SEC researchers, farmer organization representatives, and villagers identified, and developed jointly, a variety of market-oriented upgrading strategies, including chicken businesses involving collective procurement and marketing, small-scale sunflower oil presses, a maize shelling business, as well as a mobile phone based market information system. Furthermore, using expert interviews and a review of the literature, market supporting and hindering policies and regulations in Tanzania were analyzed.

Outcome and practical implication

The national-level analysis suggests that market access for smallholder farmers in Tanzania is still weak. Although nearly three-quarters of crop farmers sell at least some of their produce, most is for home consumption, with an average of only 30% of crop production sold at the market. Less than one-third sell more than half of their production. Most sales take place on spot markets, with only 16% of farmers reporting to market through contract farming (vertical linkages) or cooperative arrangements (horizontal linkages). However, the role of cooperatives differs between zones and crops, with 20% of farmers reporting to sell via cooperates in Coastal and Northern Zone, compared to only 5-10% in Southern Highlands and Lake Zone. Only six crops are responsible for more than 90% of sales through cooperatives: cashew nuts, coffee, cotton, tobacco, sesame, and pigeon pea.

The Trans-SEC project data analysis for Kilosa and Chamwino districts, suggests a similar picture. Smallholders are only weakly integrated in FVC activities. Only around 21% of households use improved inputs. Very few farmers (4%) report having oral and verbal contracts with a regular buyer to sell products. With respect to horizontal linkages, around 18% pursue some of their agricultural activities in groups, though mainly in small and informal groups. Only 4% of agricultural activities in groups relate to collective selling. Cluster analysis shows substantial differences between groups, with some households being highly integrated in FVC activities (input purchase, processing, storing), while a majority are only weakly integrated, indicated by low links to input markets, short storage periods, and high subsistence shares of around 65%. While 30% of traders mention having horizontal linkages and 16% vertical linkages, few – 6% -- are involved both.

Despite their low integration into the FVC and limited use of horizontal and vertical linkages, the research here finds high potential for improving smallholder welfare, especially for more resource poor farmers. The project data shows that poorer and less food secure households are particularly more likely to be active in collective activities in the case study villages, using more informal groups. Participation in these groups requires only the opportunity costs of the farmers, allowing even poorer smallholders to join. However, these households rarely use the improved inputs that would increase their productivity and incomes, highlighting the struggles of poor farmers to significantly improve, even with these informal groups. The national-level data, which focuses on more formal collective action arrangements, such as cooperatives, instead shows a more positive association between horizontal linkages and household income, indicating the potentials of more formal collective action arrangements. These results suggest that smallholder households in Kilosa and Chamwino are constrained from participating fully in the FVC and benefiting from collective action arrangements that would significantly improve their wellbeing.

These findings informed the action research component to identify, develop, and assess FVC-UPSs that could improve vertical and horizontal linkages for smallholder farmers. Selected UPSs included market information system solutions, basic processing machines (maize sheller and sunflower oil press), innovative storage bags, and group-based chicken businesses.
The development of the UPSs was based on assumptions that greater coordination between small-scale farmers (horizontal linkages), with regard to production and marketing, enables them to access higher-value markets and generate higher incomes. Thus, newly formed groups were trained in group processes. Although most UPSs proved to have high potentials to enhance livelihoods, there were a number of implementation challenges. For the case of „improved chicken keeping and marketing," although the UPS helped link farmers horizontally to establish vertical linkages with suppliers and buyers, many farmers continued to operate individually. Trust issues resulted in a reduced willingness to act collectively, especially with respect to sales. A lack of entrepreneurial capacities was the main challenge for developing village-level sunflower processing. Overall, the underdeveloped knowledge and skills at the levels of production, purchasing, and marketing point to future challenges and adjustments when implementing such UPSs.

Recommendation and implication for other projects

Tanzania is one of many SSA countries seeking to support the horizontal integration of farmers by reviving cooperatives and encouraging private sector investments in order to build effective market linkages. Opportunities for such enhanced vertical and horizontal linkages lie in the increasing presence of supermarkets, rising urbanization, and formulating policies that promote cooperatives.

The research on horizontal and vertical linkages to integrate smallholder farmers in the FVC reveals a number of important insights. The analyses shows that only a few farmers are well integrated into the FVC, with very fewer farmers involved in the more rewarding vertical upgrading strategies -- access to improved inputs or contractual arrangements with buyers – and few farmers involved in cooperatives, making formal collective action agreements. The research finds that these more formal vertical and horizontal linkages are associated with higher household welfare.

The results suggest that improving input and output market access can be achieved by building horizontal and vertical linkages through farmer groups, cooperatives, contract farming, and other means. Policies that help smallholders' access to agricultural technologies while removing institutional and infrastructural limitations can be important for improving smallholder productivity and reducing high transaction costs and other market barriers. More importantly, the design of policies to effectively integrate smallholders in the FVC needs to take into account the overall spectrum of activities in the FVC and the participation of very poor farmers. Nevertheless, the action-research shows the high complexities of supporting external smallholder integration in the FVC and reveals challenges for establishing group capacities to operate sustainable businesses after external support ends.

Street markets, Tanzania 2013

Mapping and GIS technologies to support knowledge-based decision schemes in R4D projects

Soil mapping, Tanzania

Ludgar Herrmann, Siza Tumbo,
Nadja Reinhardt, Karsten Vennemann

Motivation

The Trans-SEC project sought to develop specific agricultural value chains in Tanzania using participatory and trans-disciplinary approaches. In doing so, it is equally important to develop the knowledge value chain. In many developing countries, basic data, e.g. on natural resources in sufficient resolution, either do not exist or are not accessible. Further, it is important that the knowledge chain is not disrupted by sophisticated researcher terminology. Therefore, methodologies, research schemes, and GIS technology that are simple, easy to understand, and broadly applicable beyond the Tanzanian context are developed.

Description

Three highlights include (i) a new rapid soil resource mapping approach; (ii) a spatial upscaling procedure including soil information to derive resource-based recommendations; and (iii) a GIS-based resource inventory and decision tool for non-advanced applicants.

i. The rapid soil resource mapping approach combines indigenous knowledge on soil resources with a simple radiometric measurement (see photo p52) that is based on the natural radioactivity of the local soils. While farmers bring their field experience and local terminology, gamma-ray spectrometry allows for spatially separate soil mapping units - in theory without drilling.

ii. The soil maps derived from the preceding activity are then used to design field testing schemes for agricultural innovations. So far, agricultural extension services tend to distribute blanket recommendations without considering the specific local resource conditions. Once a local resource map is created, the spatial mapping units are used to identify which innovations are appropriate for each type of terrain. To give an easy example: as volcanic soil is naturally rich in potassium, it is not necessary to apply potassium-based fertilizer.

iii. However, in agricultural reality, it is not just the soil that influences crop performance. Other factors, like climate, infrastructure, and pests, etc., also influence site performance. Therefore, high resolution information on these factors is indispensable. Thus, the easy-to-use Tanzania Food and Land Productivity Information System was created, with its two critical components: (a) the Tanzania Food Security Monitor and (b) the Land Evaluation Tool, as shown in figure 12. The food security monitor is an automatic long-term early warning system for food production shortage addressing Tanzanian politicians and administrations. The land evaluation tool allows for estimating the performance of a potential innovation in Tanzania through five simple, guided, steps on the basis of self-selected information.

Outcome and recommendations

All people working in agriculture know that the spatially varying resources determine its performance. Combining the indigenous knowledge and gamma-ray-based soil resource mapping procedure allows for enhanced planning that is specific to an area rather than a blanket recommendation for the entire country.
Furthermore, mother plots (on farms, but researcher managed) covering the full diversity of soil and terrain types need to be established. The best way to do so is to have researcher-managed trials on the spatially dominant soil type (representativeness). Then, because not all farms have this soil type, demonstration plots on other soil types must be established. In this way, a sound proof-of-concept is established. In order to include the socio-economic reality, simplified large-N trials on farmer-managed fields are also necessary. The land evaluation tool then allows for out-scaling proven innovations by searching for areas that exhibit similar environmental and socio-economic conditions.

References

Reinhardt, N. and L. Herrmann (2017). „Fusion of indigenous knowledge and gamma spectrometry for soil mapping to support knowledge-based extension in Tanzania". Food Security, 9(6): 1271-1284.

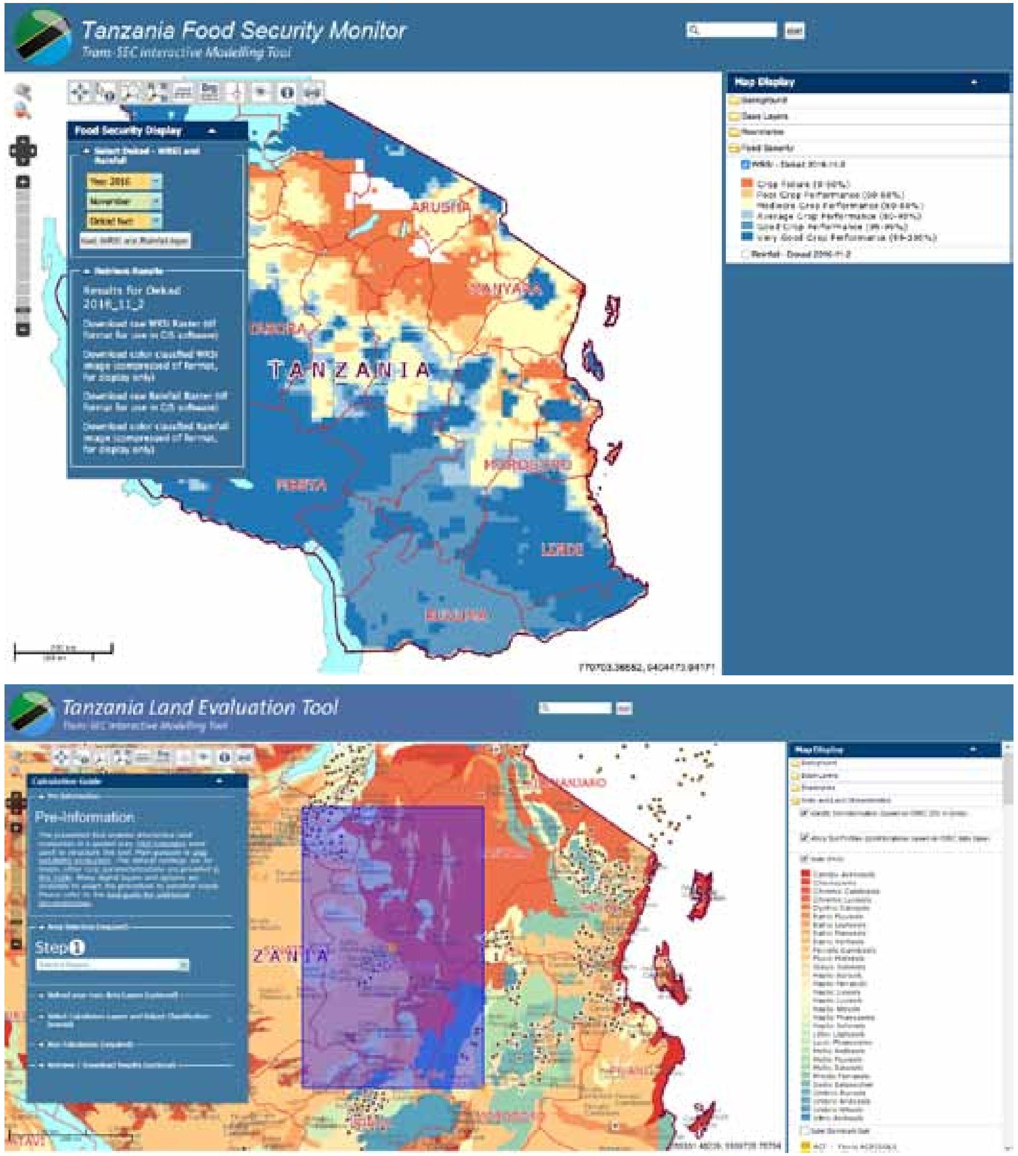


Figure 12: (a) The Tanzanian Food Security Monitor and (b) the Land Evaluation Tool of the Trans-SEC webGIS. Both are found at: http://sua.terragis.net/transsec/Welcome.html

Anthropogenic impacts on water resources in Tanzania

Frank J. Wambura, Ottfried Dietrich, Frieder Graef

Motivation

The sustainable use of water resources in a river basin requires proper planning and management. Typically, hydrological models are used to analyze the impacts of anthropogenic activities before planning and managing water resources in a river basin. Thus, it is very important to understand the hydrological behavior of a river basin prior to hydrological modelling in order to improve the reliability of predictions for sustainable water uses. However, large regions of sub-Sahara Africa lack the detailed data required for any modelling approach. This research addresses this challenge in a data-scarce setting. It aims to analyze anthropogenic impacts on water resources in the Wami River basin in east-central Tanzania using a distributed hydrological model.

Study area

The Wami River basin, with an area of approximately 41,170 km2, is located between 5o00’- 7o27’ S and 36o00’- 39o00’ E in east-central Tanzania (Figure 13). The topography of the river basin ranges from 0 to 2360 meters above sea level. The river basin is separated into two major parts by the Eastern Arc Mountains (EAMs), comprised of the Rubeho, Ukaguru, Nguru, and Nguu mountain ranges. The predominant soils in the river basin are loam and sand-clay-loam soils (FAO-ISRIC, 2003). The land use classes are predominantly bushland, woodland, and grassland (FAO, 1997). The ranch, cropland (under small-scale farming), and irrigation areas cover about 10% of the river basin.
In the Wami River basin, the average rainfall ranges between 692 and 1388 mm per annum. There are two major rainfall zones in the basin: a unimodal rainfall zone with one heavy rainfall season from October to April in the upstream part and a bimodal rainfall zone in the downstream part. The bimodal rainfall zone has two rainfall seasons, light rainfall between October and December and heavy rainfall between March and May. The average daily temperature in the river basin ranges between 24 and 31oC. The average actual evapotranspiration (ET) in the river basin ranges between 368 and 1614 mm/year.

Methodology

In analyzing the hydrological behavior of the river basin, the study makes efficient use of readily available extensive remote sensing data of actual evapotranspiration (ET). Via principal component analysis of the time series of images of remotely sensed ET, the prevailing spatial patterns of ET during different boundary conditions are identified. These spatial patterns inferred information about the effects of different soil textures and land use classes, about shallow groundwater areas, and about land cover change in the river basin. This information was used to improve the Soil and Water Assessment Tool (SWAT) of the river basin that was set up and calibrated based on it. The improved SWAT model was used to model in-field rainwater harvesting (IRWH), land use change (LUC), and water use change (WUC).

IRWH was modelled by fragmenting rainwater harvesting areas from the croplands and assigning them as potholes for water impoundment. The LUC was implemented by modifying both land use types and parameters in computation units. The LUC scenario used the National Land Use Framework Plan (NLUFP) 2009-2029 as the proposed future land use (MLHHSD, 2009). The projected water demands were used to model WUC in the river reaches.

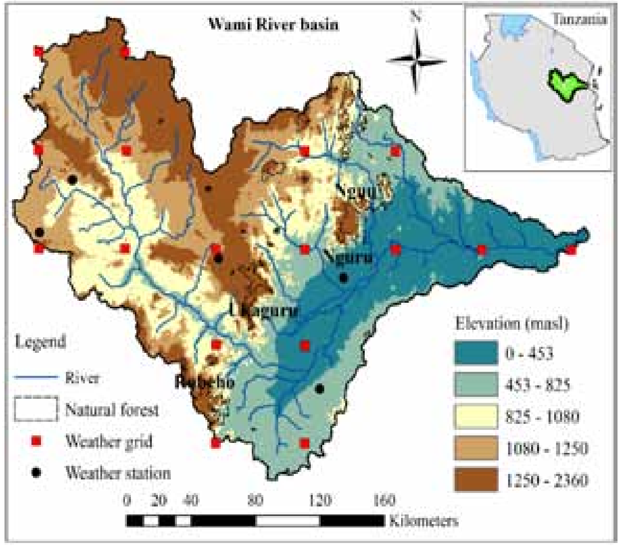


Figure 13: The Wami River basin showing elevation, rainfall stations and grid points (Wambura et al. 2017).

Practical implications

The improved SWAT model was tested against observed streamflow at 1G2-Mandera gauge. The calibration and validation performance of the improved SWAT model was satisfactory (Figure 14). Therefore, the improved SWAT model was appropriately constrained for the analysis of the impacts of anthropogenic activities).

The applications of LUC, WUC, and IRWH were tested with respect to simulated ET, soil water content, percolation, and streamflow. In the impact analysis,

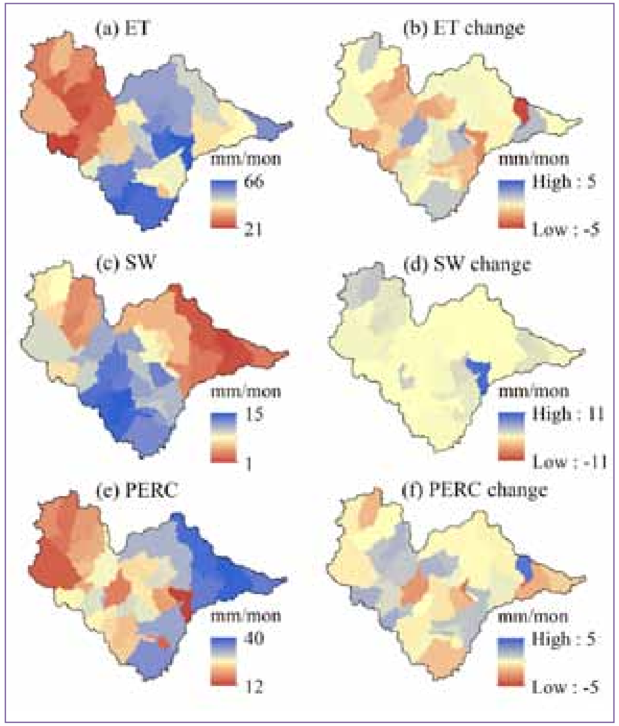


Figure 14: Mean monthly variables of the baseline between the year 2001 and 2010 (left), and changes due to either LUC or LUC and WUC (LWUC) application (right). ET, SW and PERC stand for evapotranspiration, soil water content, and percolation, respectively.

the applications of IRWH on the current croplands are found to have very huge changes on the local hydrologic cycles in those areas. The IRWH led to the increase of soil moisture, which in turn might also lead to the increase of crop production, especially during dry years. Nevertheless, the change in the average annual streamflow was very small, even after the IRWH was implemented at 50% of all current croplands in the river basin. Therefore, using the IRWH application as the upgrading strategy for improving food security in the river basin is recommended.

The application of LUC led to substantial changes in ET, soil water content, and percolation across the river basin (Figure 15). It also had minor impacts on the average annual streamflow (-1%). In contrast, the application of LUC and WUC (LWUC) led to a very huge decrease in the average annual streamflow (-26%), thus indicating that WUC has very huge impacts on the river basin. The results also show that the impacts of LWUC outweigh those of the IRWH. Therefore, further study on the eco-hydrology of the river basin under various water use scenarios before the NLUFP 2009-2029 proposal is fully implemented in the Wami River basin is recommended.

Recommendations

Our findings can be used by stakeholders in the Wami River basin in Tanzania for planning and managing the sustainable use of both land and water resources. They can also be used as baseline information for further eco-hydrological studies of this river basin. Since threats of increasing anthropogenic activities of land and water resources do not only affect this river basin, these findings also implicitly indicate the status of resources and ongoing trends of anthropogenic impacts in other river basins in the region.

This research also demonstrates the applicability for analyzing hydrological behavior, improving distributed hydrological models, and assessing the anthropogenic impacts in data-scarce environments. It can be used as the blue print for analyzing anthropogenic impacts on land and water resources in any river basin.

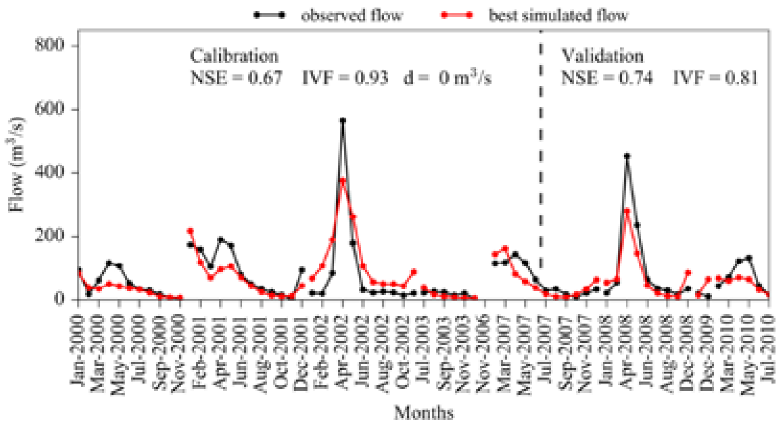


Figure 15: Calibration and validation performances at 1G2-Mandera for the optimal simulation. The dashed line separates the calibration and validation periods (Wambura et al. 2018b).

References

Mu, Q., Zhao, M. , Running, S.W. (2011). "Improvements to a MODIS global terrestrial evapotranspiration algorithm". Remote Sens. Environ. 115(8): 1781–1800.

Wambura, F.J., Dietrich, O., Lischeid, G., (2017). „Evaluation of Spatio-Temporal Patterns of Remotely Sensed Evapotranspiration to Infer Information about Hydrological Behaviour in a Data-Scarce Region". Water, 9(5): 333.

Wambura, F.J., Dietrich, O., Graef, F., (2018). „Analysis of infield rainwater harvesting and land use change impacts on the hydrologic cycle in the Wami River basin". Agric. Water Manage., 203: 124-137.

Wambura, F.J., Dietrich, O., Lischeid, G., (2018) „Improving a distributed hydrological model using evapotranspiration-related boundary conditions as additional constraints in a data-scarce river basin". Hydrol. Process., 32(6): 759-775.

Conflict Prevention and Management System in Transdisciplinary Research Collaborations

Katharina Löhr, Christian Hochmuth, Stefan Sieber

Motivation

Measures of conflict prevention and management (CPM) were an integral part of the Trans-SEC project. Large-scale international collaborative research projects are complex systems and their management is challenging. Such projects tend to be international, inter-organizational, interdisciplinary, virtual, temporary, and third-party funded. These types of projects also tend to be transdisciplinary, with substantial stakeholder involvement in the process.

Lean management structures with limited financial and personal resources allocated to overall coordination and management are typical in scientific research collaborations. A decentralized structure prevails, with relatively flat hierarchies between the partnering organizations and responsibilities split between project members. Project managers have limited decision and sanctioning power and are usually scientists by profession. Typically, they are not specifically trained in project, human resource, or conflict management.

Conflicts are inevitable in such complex settings and can lead to project failure if it is not managed well. For example, 79.3 % of Trans-SEC project members reported having personally experienced some type of conflict in the project (Löhr et al., 2017b). It is at this point that CPM-measures come into play, to support and help overcome crucial points.

Escalation of conflict in research projects can have damaging effects, potentially risking project failure. Few resources are available to cope with conflict costs, such as delays in delivery, poor data, staff absenteeism, replacement of staff, and extensive conflict management processes. In addition, well-known coping mechanisms, such as budget top-up or time extensions, are difficult to obtain from third-party funding.

CPM Structure in Trans-SEC

Based on previous work experience, Trans-SEC management delegated the design of a Conflict Prevention and Management System (CPM-System) to a Coordination Unit based in Germany. During the initial three years, a set of mechanisms and activities were designed and implemented to both prevent conflict escalation and provide support in cases of conflict. Accounting for the project's structure, a decentralized CPM-System was established with organizational conflict contact points appointed at each partner organization and a national CPM coordinator elected for Tanzania. Various activities and mechanisms were implemented: Conflict prevention measures and activities such as teambuilding and team supervision, workshops on intercultural awareness, communication, and conflict management, coaching, and a reflective jour-fixe for project coordination. If needed, individuals could contact any conflict contact point they wished. An external consultant was also put in place, offering moderation of processes with high conflict potential, such as board meetings, as well as coaching and mediation on demand. Continuous evaluation of the CPM-System ensured documentation, with project members regularly updated via the website, e-mails, and conference presentations.

Outcome and practical implication

The majority of Trans-SEC members reported a positive impact of the CPM component on communication, intercultural understanding, levels of trust, as well as prevention of conflict escalation. A substantial 80% of project members recommended including such support measure in all international and interdisciplinary research projects. The large majority of those members who participated in workshops on communication and conflict management stated that CPM improved their conflict handling skills and that the workshops gave them knowledge and skills that they can use beyond the project.

First spill-over effects support the positive findings. Project members report the transfer of knowledge to the stakeholder level by applying new skills in case of conflict between stakeholder groups. Conflict management structures were set up in home institutions, as in the case of the Tanzania Federation of Cooperatives (TFC), which works with farmers groups across the country. Project members requested additional CPM workshops at their home institutions and integrated CPM in subsequent projects.

The Viadrina component model on conflict management (PWC/EUV, 2011; 2013) served as the conceptual frame for the CPM-System in Trans-SEC. The model, developed based on conflict management practices in the German business sector, had positive results. The implementation of CPM measures included a scientific evaluation of its effectiveness. It was found that conceptual adaptations of the Viadrina model are needed in order to fit the research environment. Key findings are, first, the need to decentralized conflict management structures to account for the project's organizational set-up and, second, the integration of a conflict prevention component to keep levels of conflict low and prevent escalation. An adapted model of conflict prevention and management for international and interdisciplinary projects was derived, which can serve as conceptual model for future projects (Figure 16). To facilitate the implementation of conflict prevention and management measures in other projects, a guide book was published and is available for free download in German and English. Further, peer-reviewed publications on CPM were published and a film produced for public outreach.

References

Löhr, K., Graef, F., Bonatti, M., Mahoo, H., Wambura, J. & Sieber, S. (2017a). „Conflict management systems for large scientific research projects". International Journal of Conflict Management, 28: 322-345.

Löhr, K., Weinhardt, M., Graef, F. & Sieber, S. (2017b). „Enhancing collaboration and effectiveness in collaborative research projects through conflict management systems: Analyzing the case of a food security project". Organizational Dynamics.

Löhr, K., Hochmuth, C. & Sieber, S. (2017c). Conflict Prevention and Management Systems in Collaborative Research Projects: A guide for design and implementation, Müncheberg, ZALF.

PwC and Viadrina (European University Frankfurt-Oder) (2011). Conflict Management- From the Elements to the System, Frankfurt (Oder).

PwC and Viadrina (European University Frankfurt-Oder) (2013). Konfliktmanagement als Instrument werteorientierter Unternehmensführung, Frankfurt (Oder) and Frankfurt am Main.

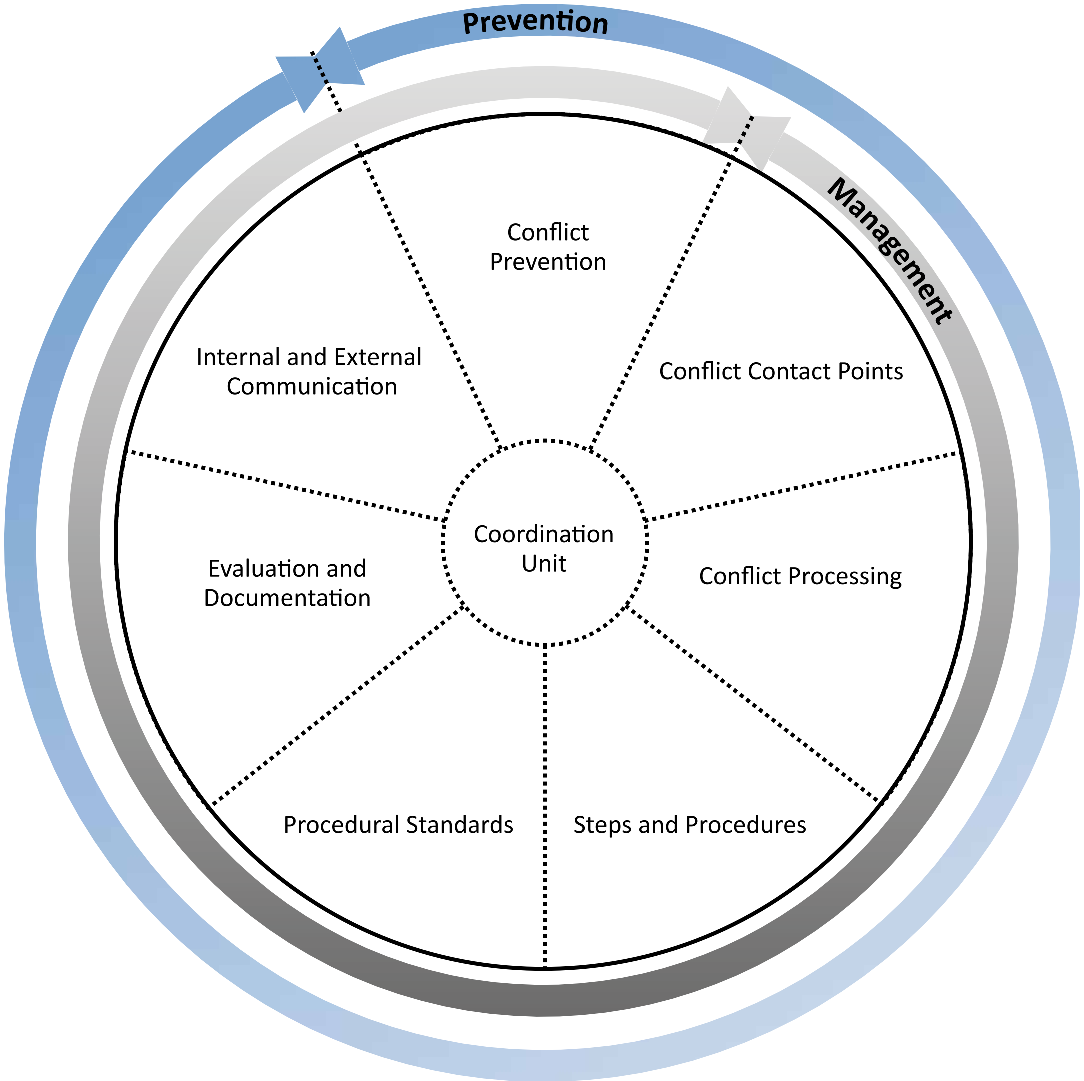


Figure 16 Model of Conflict Prevention and Management System for International and Inter-organizational Research Projects (CPM- System) (Adapted Viadrina Component Model; (PwC and Viadrina, 2011, 2013) (Löhr et al., 2017a)

Outcome, practical implications and recom¬mendations

Anett Kuntosch, Bettina König

Motivation

The innovative capacity of farmers, individual decisions for adopting or rejecting a specific innovation, as well as the diffusion rate of specific innovations, does not just depend on individual adopters, rather it can also be explained by numerous dynamic processes and interactions among various actors in an innovation system. To understand the making of food security innovations in such multi-level and multi-actor, wicked-problem settings, an innovation systems approach was used. It assists understanding the broader system of arrangements in which Trans-SEC related innovation processes for food security in Tanzania are embedded. Given the system setting in Tanzania; what are the conditions under which the project´s food security innovations can be successfully implemented, thus enhancing food security at the case study sites? What do our findings mean for future interaction research for food security?

First, the aspects the work package focused on more in detail, were e.g.: national and regional policy regulations (relevant for food security), competitive activities (on national, regional, or local levels), available knowledge and knowledge sharing mechanisms, as well as interest groups, actors, or organizations involved in decision making processes with regard to food security. Additionally, the approach facilitates a better understanding of the personal decisions underlying the adoption or rejection of specific innovations, at a certain time and locality, thereby opening “the black-box” of the innovation process.

Thus, the system approach provided us with a fairly comprehensive picture of system arrangements by describing innovation processes and activities that are often not evident at first glance, but that influence adoption behavior on the ground; as well as decision making at higher levels.
Starting from this “comprehensive picture,” a detailed baseline study is outlined, then used to deduce important site- and innovation-specific adoption obstacles. These were laid out in the impact study, which focused on analyzing five specific Trans-SEC UPSs (poultry keeping, kitchen gardens, improved cook-stoves, fertilizer micro-dosing, and thresher machines).

Description

A two-step research framework was developed, based on the sectoral innovation systems and diffusion of innovations literature. The first was used to describe the overall system arrangements (including all actors, interactions, knowledge, technology, demands, policy settings, and environmental settings) across scales. The latter gives more specific insights into food security innovation processes on the ground. The methods used were: literature review, semi-structured expert interviews, and farmer group discussions with Trans-SEC farmer groups from three project case study sites (CSS). Additionally, comparative farmers groups not affiliated with the project were examined. Lastly, both new adopters from the village and drop-outs from the Trans-SEC groups were interviewed. The results from the field were presented and discussed in a validation workshop with scientists, policy makers, and practitioners from all CSS and several different UPSs.

Outcome and practical implications and recommendations

In the Baseline Study, how the interactions between different actors in the system are perceived by farmers and experts, and how those interactions can become obstacles to innovation are shown. More precisely, the focus was on interactions with regard to knowledge sharing and learning among the actors involved. Figure 17 shows our two main findings: It shows that the transmission of knowledge between relevant actors was disturbed, resulting in two separated spheres of knowledge evolving. This disturbance prevents sufficient feedback loops and joint learning processes in the system from functioning.
In the Impact Study for each of the five selected Trans-SEC UPS conditions that enhance the success of the innovation processes are identified. The identified conditions could either be described as “internal” (self-controlled by actors) or “external” (externally controlled by the national and district system levels). Specific aspects that are “internalized” in the process and that come with the Trans SEC project setting but would otherwise be external or internal are identified.
Summing up, it was specified what makes food security a wicked problem across innovations and system levels. These problems are “complex social - environmental issues and cannot be solved with existing modes of inquiry and decision making”. Enabling more food security offers various entry points for purposeful intervention according to our results. Therefore, any search for right or wrong “solutions” might not be targeted and problem-solving. Finally, any activity that addresses these problems also requires more systems thinking ap-

proaches that include innovation, but also require:

- Changing existing behaviors, routines and mechanisms (at different system levels);
- Working across internal and external boundaries and system levels;
- Developing more systemically thought innovations, comprehensive, learning by doing using experience, and feedback-loops;
- Carefully justifying the target level for intervention. Some of the examined innovations can be implemented by individual subsistence farmers but can also be a business model (e.g. kitchen gardens). Both strategies need to be supported keeping in mind the different goals. When introduced as business models only, the question of “picking the winners” may arise because subsistence farmers will often not have the means to participate in the business model approach; and
- Targeting specific groups for each intervention will better contribute to food security goals being achieved.

These findings might challenge some traditional approaches of policy making and program implementation, simultaneously encouraging a debate between stakeholders and including the local level in the quest for more purposeful program design, interaction modes, and exit strategies.

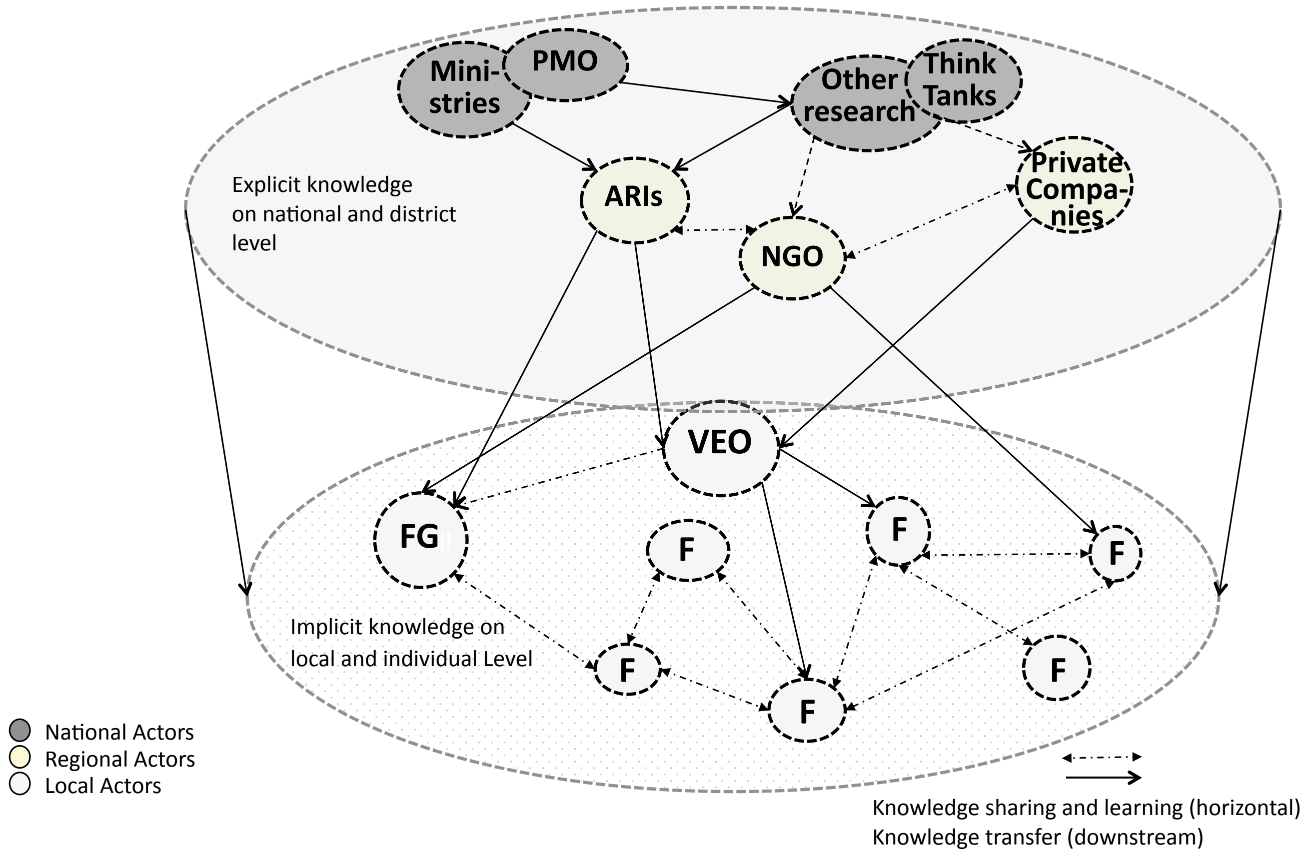


Figure 17 Spheres of knowledge and knowledge sharing mechanisms (own figure, all methods) (F= farmer, FG Farmer Groups)

References

Brown, V. A., Harris, J. A., & Russell, J. Y. (Eds.). (2010). Tackling wicked problems through the transdisciplinary imagination. Earthscan. Washington DC: USA. Fagerberg, J. (2003). Innovation: A guide to the literature. Paper presented at the Workshop: “The many guises of Innovation: What we have learnt and where we are heading”.
Ottawa, Canada, October 2003. Kuntosch, A. and B. König (2018). „Linking system perspectives with user perspectives to identify adoption barriers to food security innovations for smallholder farmers – evidence from rural Tanzania”. Food Security, 10(1).
Malerba, F. (2004). Sectoral Systems of Innovation. Concepts, issues and analysis of six major sectors in Europe. Cambridge, University Press.
Rogers, E., M. (2003) Diffusion of Innovations. 5. Aufl. New York, Free Press.

Horizontal and vertical scaling-up of upgrading strategies for enhancing food systems in Tanzania

Khamaldin D. Mutabazi, Frieder Graef, Stefan Sieber

Introduction

Between 1980 and 2000, Africa is estimated to have spent about US$ 4 billion on agricultural research that generated a wealth of agricultural innovations. However, few of these were widely adopted. This, among other reasons, is a result of poor scaling-out and -up processes for agricultural innovations.

Several decades of Agricultural Research for Development (AR4D) in Sub-Saharan Africa (SSA) have generated various agricultural innovations that could enhance the performance of the food systems. Such innovations span different components of the food value chains– entailing natural resource management, production, processing, market distribution, consumption, and, lastly, management of wastes and by-products.

The major existential question for AR4D is why have the developed agricultural innovations not reached the farmers who desperately need them? Hence, one challenge is to determine how agricultural innovations can be disseminated efficiently and effectively through out-scaling and up-scaling, given varying site conditions and diverse target groups. Out-scaling and up-scaling are defined as horizontal (village to village) and vertical (village to the larger region or country) scaling up, respectively.

Expansion of an innovation must be based on an effective pilot demonstration or other local success (Carter et al. 2018). However, in practice many innovations fail to scale. Analyses criticize externally driven, short-term, and unsustainable efforts to scale up individual interventions that fail to respond to complex local dynamics. Some recommend scaling the processes of learning and adapting to develop solutions rather than the intervention itself, for example by applying a problem-driven iterative adaptation approach.

This chapter shares experiences and lessons of scaling up of food value chains UPSs under the Trans-SEC project. The term innovation is used synonymously for UPS. In this regard, the chapter adds to the landscape of AR4D literature on horizontal and vertical scaling up of agricultural innovations.

Methodology

Horizontal scaling up

In the four Trans-SEC villages, Farmers Field Schools (FFS) hosted pilot demonstrations to encourage spontaneous uptake of food securing innovations. FFS is a participatory approach intended to develop each farmer's individual understanding and decision making capacity regarding the uptake of innovations.

For instance, in each village, a pilot mother plot applied the "rainwater harvesting using tied ridges & fertilizer micro-dosing" innovations as a treatment, comparing against traditional cropping practices as a control. The FFS field trial, termed as mother plot, was cultivated every season – three times over the 5-year lifetime of the Trans-SEC project. Farmers chose tillage and fertilizing technologies of their interest that were tried on their small plots (baby plots) at the beginning for learning before applying them at a higher field scale.

The FFS were conducted over two days in each village. The first day involved farmer-led presentations and demonstrations for an audience that included invited district planners, extension staff, farming communities in the case study village, invited farmers from 3-4 neighboring villages, and the project team. Day two was designed to undertake more detailed farmer self-assessment using a SWOT analysis and the perceived likelihood of uptake of UPSs by farmers from both the Trans-SEC villages and the neighboring villages.

Vertical scaling up

Vertical scaling up included lobbying the policy processes by providing results-backed action points for upgrading the food value chains – at both subnational and national scales. This was done through workshops that were attended by a variety of relevant stakeholders with the capacity and mandate for specific policy change. The workshops offered presentations from the project researchers, group work, and open plenary discussions. The group work addressed specific UPS issues for the stakeholders to suggest policy action points.

Results from scaling up processes

Results from horizontal scaling up process

The empirical lessons drawn from horizontal scaling up are presented in terms of weaknesses and threats derived from a farmer-led SWOT analysis. This is followed by the results of a study of farmer perceptions with regard to their willingness to adopt the innovations. Across a range of value chain upgrading innovations, farmers cited weaknesses revolving around the three aspects of capital and labor intensiveness; poor market access to both input and output markets; and limited technical know-how. The major threats reported by farmers included low and unpredictable rainfall as well as crop diseases and pests. Most farmers indicated that they were highly willing to adopt UPSs.

Results from vertical scaling up process

Some of the critical weaknesses and threats emanating from the lower level became key policy issues for vertical scaling up at subnational and national platforms through planned stakeholder workshops. At these platforms, the stakeholders discussed the research results and recommendations, coming up with key policy issues and action points needed to help adjust the policy processes for upgrading food value chains and the national food system at large. The policy issues raised at both subnational and na¬tional platforms (Table 5) addressed local-level weaknesses and threats to UPS adoption. The policy issues and action points were relevant to different Trans-SEC food value chain upgrading innovations.

Outcome and recommendations

Scaling up of AR4D agricultural innovations in the African context is a complex and multifaceted process. The inherent research design is the very first stage for accelerating or decelerating the scaling up of innovations. The ultimate beneficiaries and/or stakeholders must be in the driver's seat, guiding the innovation generation and uptake process. However, research experts must assist these beneficiaries, supporting local solutions with needed technical input.

SN	Policy issues highlighted at subnational and national workshops	Innovation addressed+++
	Subnational workshops	A,G,H
2	Policy makers should improve regional and rural roads	A,G,H
3	Proper management of district crop levy systems as it affects trade	A,C,I
4	Encourage farmers to produce crops that suit the local climate	A,C,G,H
5	Sensitization of community on proper fertilizer use	A,C,G,H
6	Ensure timely availability of fertilizers in the villages	A,C,G,H
7	Farmers needs subsidized inputs as they are expensive	A,C,G,H
8	Legalize repackaging of fertilizer into affordable packs of 2, 5, 10, 15 and 50 kg	A,C,G,H
9	Promotion of farmer groups for collective access of inputs	A,C,G,H
10	Development of animal driven ridger technology	A,C,G,H
11	Introduce subsidy on airtight grain storage bags to make them affordable	C
	National workshops	
1	Improve quality of oil seeds	H,A
2	Improve machinery quality and train for proper use	H,A
3	Reduce and harmonize fees and taxes, and remove taxes on accessories	H,A
4	Improve availability and affordability of quality packaging material	H,I
5	Promote proper storage and handling of sunflower oil	H,I
6	Improve availability of quality seeds with higher oil content	H,A
7	Improve the efficiency of official seed release by TOSCI	H,A
8	Promote seed bulky import procurement	H,A
9	Fixing maximum price for seeds supplied to farmers	H,A
10	Close monitoring of seed supply agents	H,A
11	Promote and support growth of small local manufacturers of machineries	H,A
12	Promote institutional collaboration and coordination for technology development	A,B,C,D,E,F,G,H,I
13	Promote rainwater harvesting	A,F,H
14	Promote the use of recycled plastics to address the non-durability of the sacks	F
15	Promote use of kitchen gardens in water constrained rural and urban areas	F
16	Incorporate kitchen garden training in skills in school curricula	F

+++ Trans-SEC innovations: A= Improved agronomy package (rainwater harvesting using tied ridges & fertilizer micro-dosing), B= Using a pyrolizer to process by-products into charcoal and biochar as soil amendment, C= Improve airtight storage bags, D= Improved wood supply through tree planting, E= Use of improved cooking stoves, F= Nutrition education and kitchen garden, G= Mechanized grain shelling, H= Sunflower oil processing, and I= Improved rural poultry

Table 5: Policy issues and action points in vertical scaling up process

Protected tree seedling, Tanzania 2015

As an organizing framework, the participatory value chain approach leverages an advantage of bringing actors and supporters of the innovation value creating web to the table. Driving innovations to scale and impact needs requires many actors and supports to consult and collaborate. Farmers are only part of the complex value chain innovation world, with other actors and supporters including input dealers, researchers, traders, financial institutions, planners, and policy makers. There are also global partners in research and development, including donors and international research entities. This collaborative alliance is critical for propelling innovation processes.

In order to make sense to those in need of them – farmers, small and medium enterprises – technological innovations must address the local barriers and challenges to prosperity. Trans-SEC demonstrates that innovations originating from local community needs are relevant and considered at higher planning scales during the scaling up process. Working with the right stakeholders with vested interests around a common policy issue is critical – as they will use the empirical evidence to enhance their advocacy when lobbying for policy change.

References

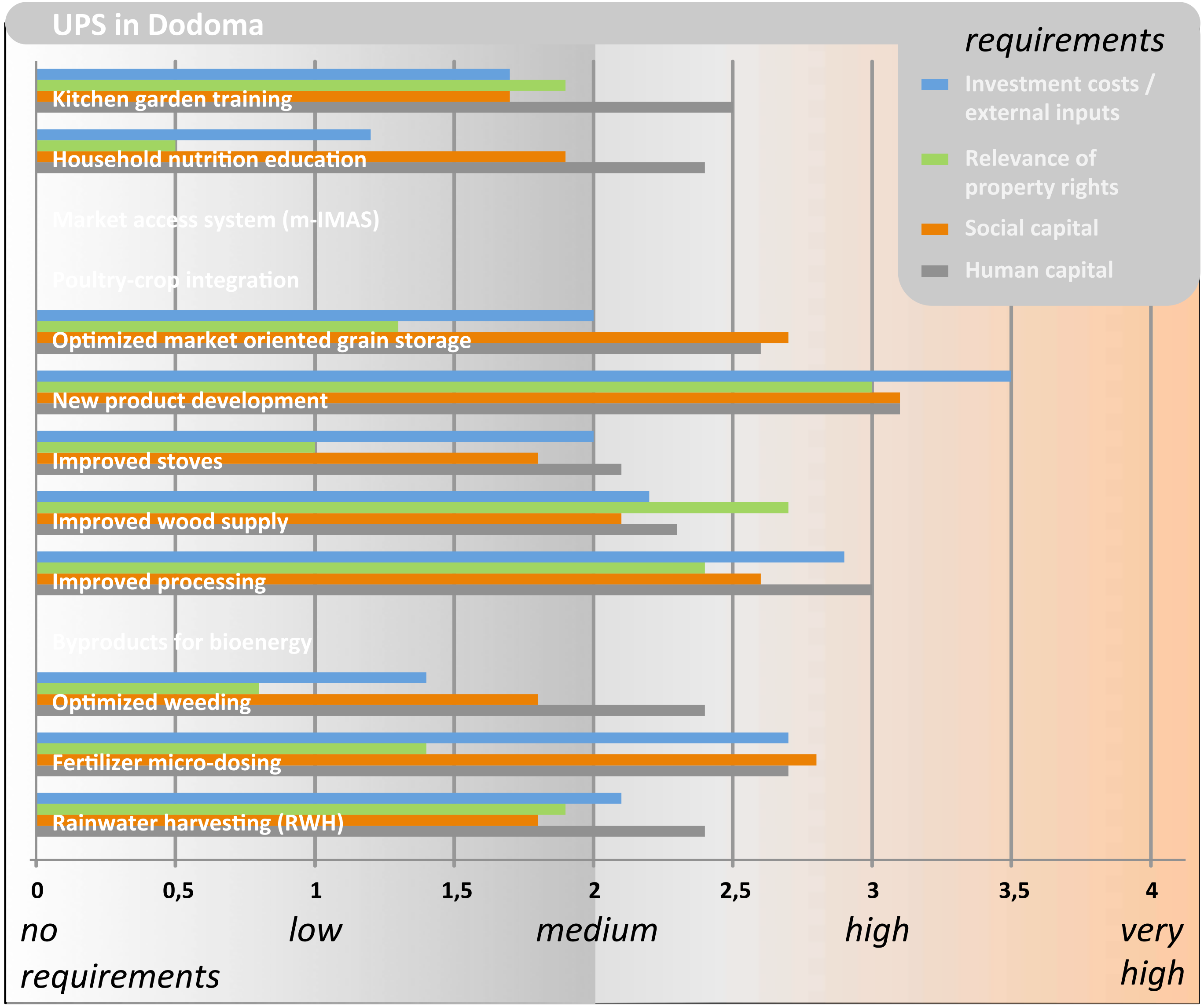
Agapitova, N., & Linn, J.F. (2016). "Scaling up social enterprise innovations: Approaches and lessons". Global Economy & Development, working paper 95.
Senyolo, M.P., Long, T.B, Block, V., & Omta, O. (2018). "How the characteristics of innovations impact their adoption: an exploration of climate-smart agricultural innovations in South Africa". Journal of cleaner production, 172(20): 3825-3840.
Sieber, S., Frieder, G., Amjath-Babu, T.S., Mutabazi, K.D. et al. (2018). "Trans-SEC food security research in Tanzania: from constraints to adoption for out – and upscaling of agricultural innovations". Food Security, 10:775–783.
Tumbo S.D., Mutabazi, K.D., Byakugila M.M. & Mahoo H.FM. (2011). "An empirical framework for scaling-out water system innovations: lessons from diffusion of water system innovations in the Makanya catchment in Northern Tanzania". Agricultural water management, 98: 1761-1773.

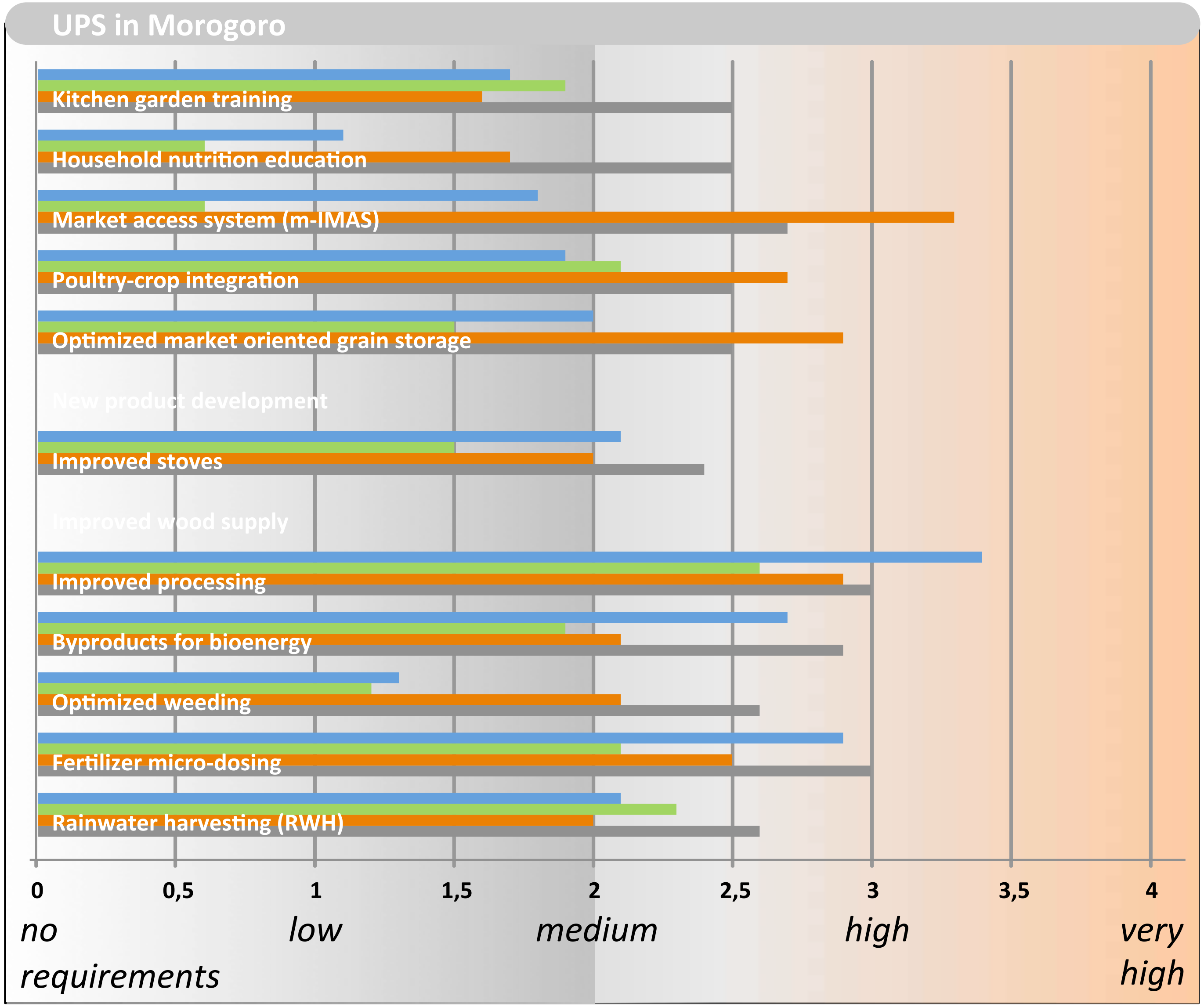
Landscape, Tanzania 2016

Ex-ante analysis of UPS requirements by scientists to guide implementation

To identify bottlenecks in early stages of the project, Trans-SEC scientists were asked to assess the level of local requirements for a successful implementation of the selected UPS in the project regions of Dodoma and Morogoro. Using the ScalA-FS tool, each UPS is evaluated using four different requirement criteria: (1) investment costs / external inputs needed; (2) the relevance of property rights (e.g. land and machinery ownership); (3) the human capital vis-a-vie the required know-how and education among farmers; and (4) the social capital provided through e.g. agricultural services, market information systems, or networks (figure 18). The criteria indicate the potential of a UPS to be facilitated by an enabling environment. Low requirement ratings indicate few challenges and that the UPS is more likely to be successfully implemented.

Human capital requirements produced the overall highest ratings with all UPSs scoring medium to high. The criteria ratings, for social capital, property rights, and investment costs/external inputs, were in general lower than this. As long as the requirements of these criteria were stated to be below medium, the need for action is also low. However, because the rating variability was high it is worth looking at UPSs and their ratings individually. Investment costs/external inputs for some UPSs (fertilizer micro-dosing, improved processing, and new product development) were assessed as extremely important. The maximum rating for improved processing (high to very high) indicates that technology inputs with regard to mechanization are seen as a challenge for





small-scale farmers, with no differences between Morogoro and Dodoma reported. Property rights requirements were most distinctly associated with new product development, improved wood supply, and improved processing. In conclusion, successful UPS implementation primarily requires sufficient education and knowledge among stakeholders. The requirements for this can be ranked according to their importance as follows: special knowledge (human capital) > agricultural service, market information systems, networks, and trainings (social capital) > investment costs > property rights and ownership.

Overall the assessments outlined action points for the project decision makers. They indicate where the need for resources, for example, financial and human, might be beyond the capacity of small producers. Due to careful pre-selection of UPSs, Trans-SEC sought to limit mismatches regarding local feasibility. Still, some UPS faced challenges during implementation.

Figure 18: (both sides) Requirement level of selected upgrading strategies (UPSs) in Morogoro and Dodoma Region. Ex-ante assessments by Trans-SEC experts using the ScalA-FS tool (for statistical details, see Uckert et al. 2018).

UPS adoption and non-adoption - current state and development

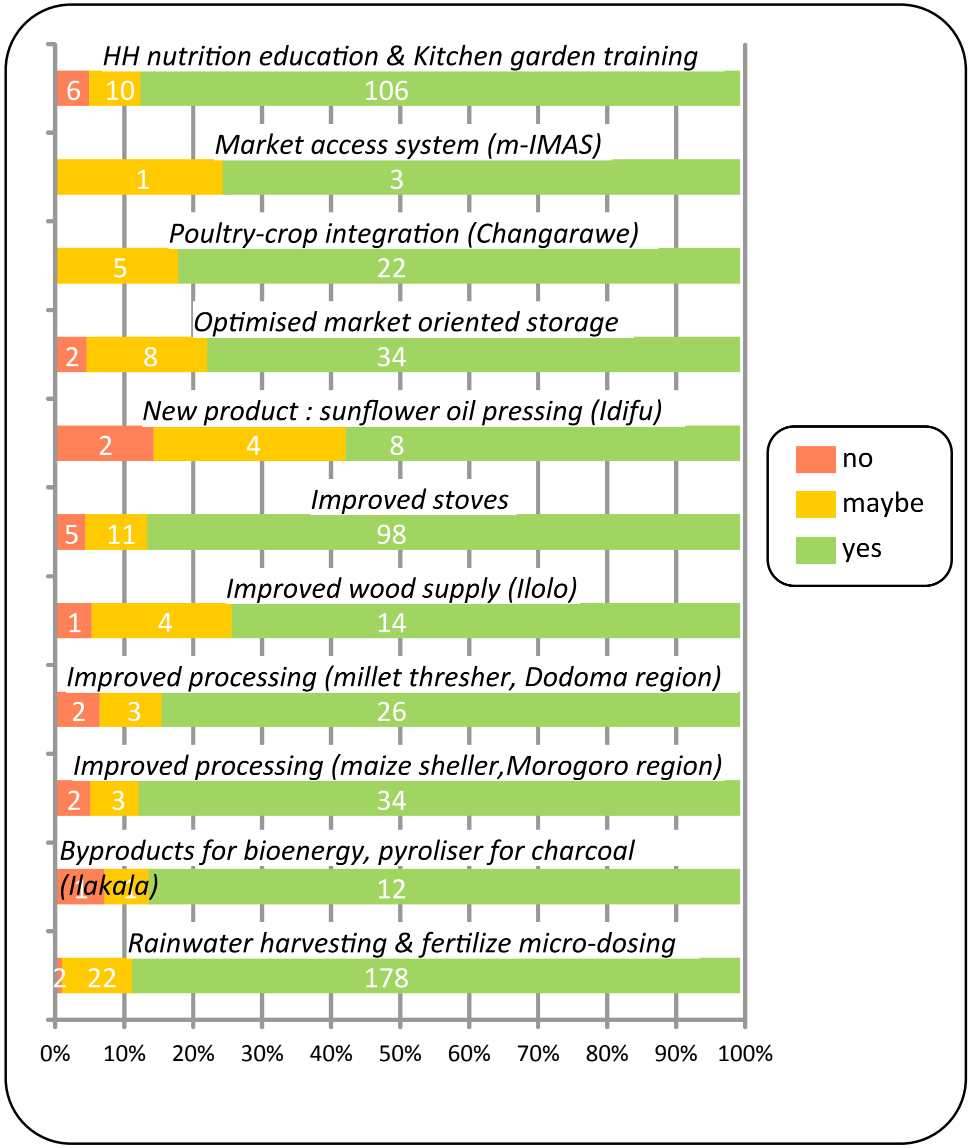
Figure 19 highlights the stakeholders' willingness to continue an UPS. Statistics were derived from the second wave survey. Here members of the farmer UPS groups were asked, if they wished to continue with the UPS after the project ends. Dominating positive answers serve as an indicator of a successful adoption of the practices. Willingness to continue with practice of UPS was found to be high. According to the second wave of farmer household interviews, almost 85 % of the 630 respondents intended to continue, while 11.4 % were not yet sure, and only 3.7 % refused.

This positive survey response with respect to UPS implementation does not match the experiences of project partners engaged in out- and upscaling. When asked for reasons of non-adoption, multiple reasons were given:

Reasons for UPS non-adoption vary in villages. The approach of the Trans-SEC project was intentionally broad. To achieve validity of results, the area of investigation was extended to multiple regions and village characteristics. Therefore, while a one-fits-all solution was not expected, it is worth looking at mismatches.

To look again at the farmer: What does the farmer perspective tell us about the feasibility of the UPS? What kind of villager behavior might indicate "wishful thinking" or disillusioned expectations? Further investigations using the gathered data should note the differences due to village or region characteristics: grouped farmer data, based on their being innovators, followers, or laggards, should be created and analyzed.

Figure 19: Number of farmer households (across all 4 villages) willing to continue a UPS that they have learned about and adopted during Trans-SEC. Results from the second wave household survey, (N=630).



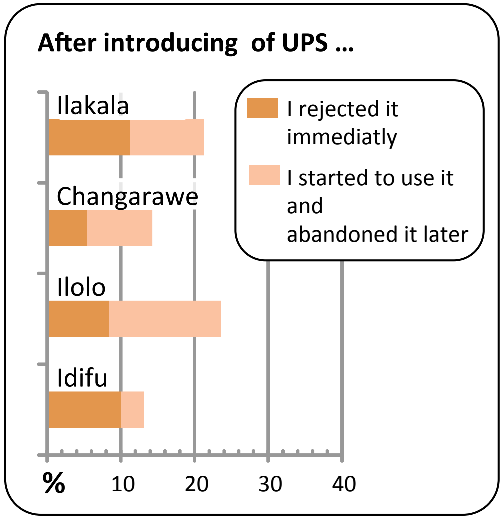


Figure 20: Drop outs per village in percent

As many households in the villages (especially the remote ones) are very poor, Trans-SEC sought to provide UPSs where the adoption potential is not restricted due to high costs or low returns. However, as a comprehensive food value chain approach was aimed for, UPSs with higher costs were provided, e.g. in the processing component of the FVC. Therefore, UPSs needing higher investments were abandoned more frequently and UPSs with low input costs were selected instead. An in-depth analysis of the statistics is outstanding. Questions raised are addressed in the following sections.

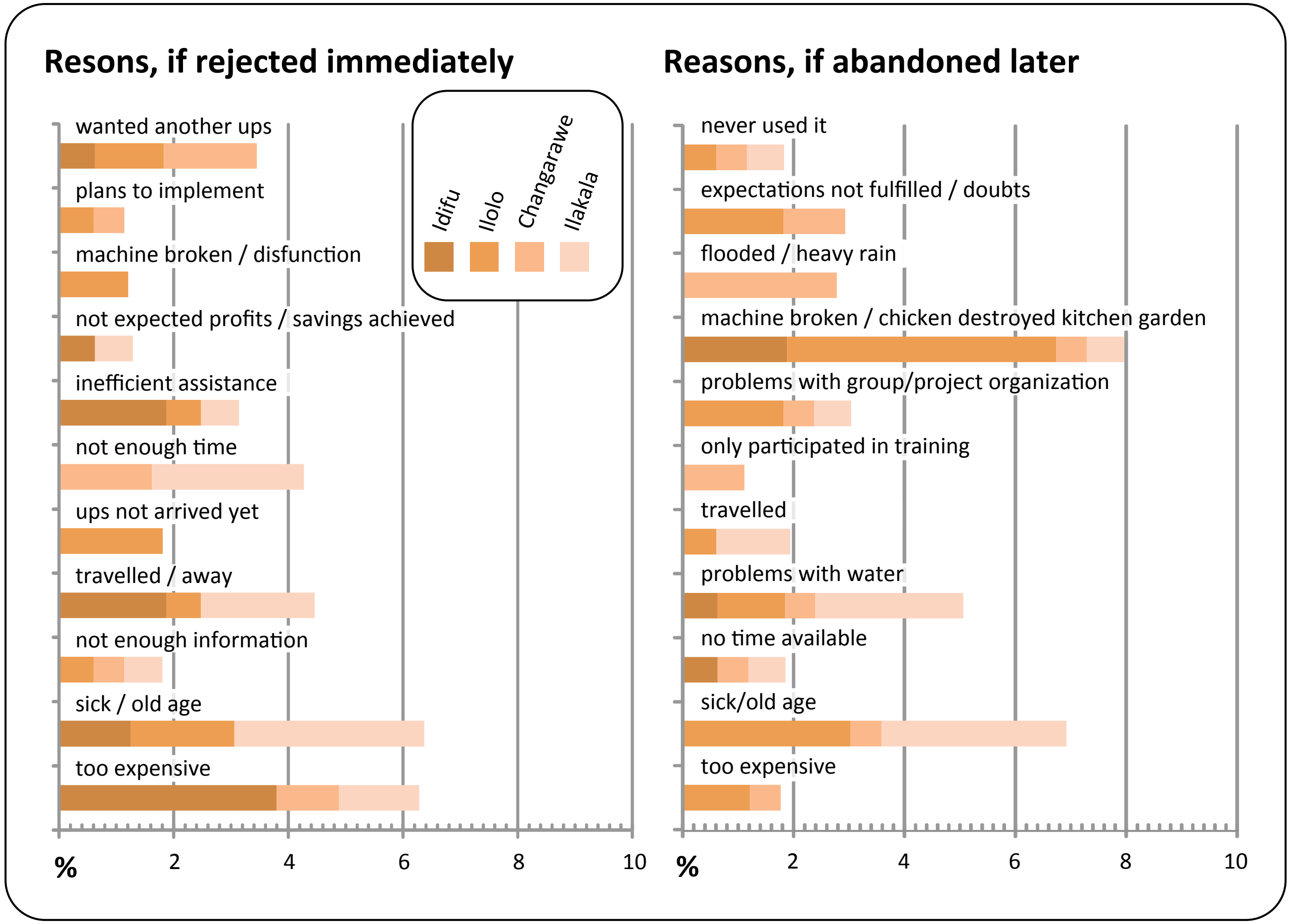


Figure 21: Main reasons for UPS rejection and abandonment by farmers at a later state of the implementation (second wave survey). Cumulative percentage of drop outs from all UPS for all four Trans-SEC villages, (N=662).

Success and temporality of current implementation status and dissemination rates of UPS

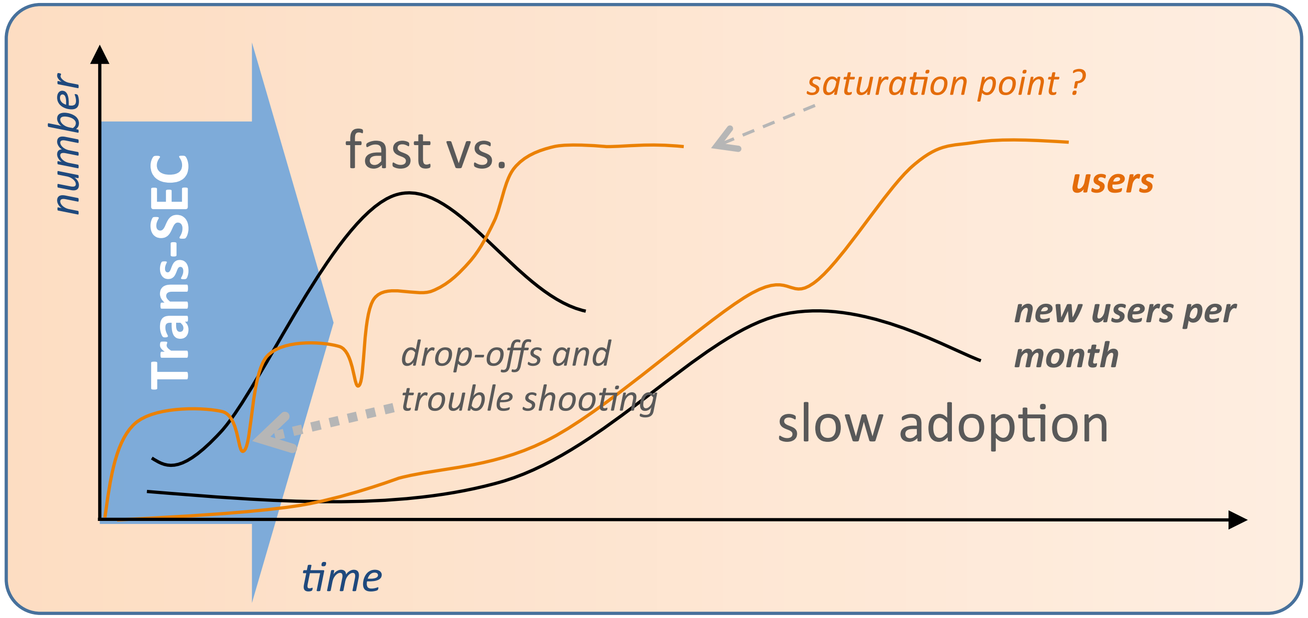


Figure 22: Dissemination rates and adoption of UPS in time: fast vs. slow adoption.

Trans-SEC draws its recommendations from a stage of adoption analysis after implementation – using data collected through several feed-back loops of monitoring, troubleshooting, UPS adjustments, as well as from multiple household surveys and focus group discussions. Whether a saturation point of a certain UPS was reached cannot be answered yet. Nevertheless, based on evidence from implementation processes and knowledge about reasons for non-adoption and adaptations, it is possible to scale up and out from our case study sites to farmers in other villages and regions.

An evaluation of Trans-SEC practices is required when assessing the success of the UPSs, not just in terms of food security enhancement, but also in terms of adoption and dissemination.
The degree of UPS uptake differs across UPSs and CSSs. Have some UPSs already reached a point of saturation?

It is more likely that over 3 years, implementation processes for each UPS resulted in patterns of fast and slow adoption behavior by farmers. Due to the initially installed farmer groups among those farmers who attended the baseline survey, Trans-SEC essentially limited dissemination villagers being part of the project. Therefore, it is assumed Trans-SEC UPSs are in an early stage both in time and in rates of dissemination and, further, that these rates might increase in the future (figure 22). Looking at future development, the main question is, do low or slow dissemination rates indicate that a given UPS is already abandoned? In these cases, not only it should be examined if adaptation was requested but also all reasons for non-adoption should be examined.

Open Questions remaining from the Participatory Action Research (PAR) approach and group membership selection

The initiation of farmer UPS groups at the beginning of the Trans-SEC project was challenging. After selecting one UPS that met their interests and capacities, famers were asked to join a group and become an UPS group member. During implementation, groups fluctuated as members joined, dropped out, and shifted to other groups. Figure 23 displays the increase in UPS group members in single UPS per village. Generally there was a low fluctuation of less than 10 %, but some UPSs in some villages had higher fluctuation: e.g. in the village of Idifu and Changarawe. As farmers were supposed to be a member of only one UPS group, farmer movement toward other UPS groups might indicate the attractiveness of these against the selected one (positively interpreted) or an indication they were not happy with the previous UPS (negatively interpreted). In a limited number of exceptional cases, simultaneous participation in two UPS groups was permitted. Although many farmers joined the UPS groups, they were not part of the baseline and second household survey waves.

However, when working with randomly selected stakeholders, some might be laggards and others might have had (false) expectations. False expectations might jeopardize UPS group performance; if a high share of households dropped out, this might reflect the lack of expectations being fulfilled. It is unclear if such “leakage” jeopardizes the farmer groups? Further, if leading UPS group members found new persuasive arguments when talking with the laggards, then spillover effects of knowledge are found.

For those cases where UPSs were adjusted at the request of new adopters, what was their role in the spillover of knowledge to non-Trans-SEC members?

With respect to the random farmer selection, it needs to be determined if this procedure is able to include a critical mass of innovative farmers who are able to take charge and further develop a technology. What is the role of champion stakeholders for being a farmer in a light house position to achieve further outreach?

Unlike those approaches that identify and use farmers known to be multipliers or innovators, the selection of upgrading strategies and grouping of farmers was constituted by more arbitrary factors. The share of laggards within the groups remained fairly constant, with some farmers not acting due to their old age or due to capacity problems of being a household with just a single member. In these cases, there was no spare capacity available to help with implementing and testing the innovations. However, due to the MWIVATA trainings, the farmer groups developed a systemic solidarity principle among members, regardless of income or age. As the core cell of innovation, the group secures the depth and feasibility of the knowledge gained, and guarantees a higher level of continued performance despite of single farmers being active and powerful at all times.

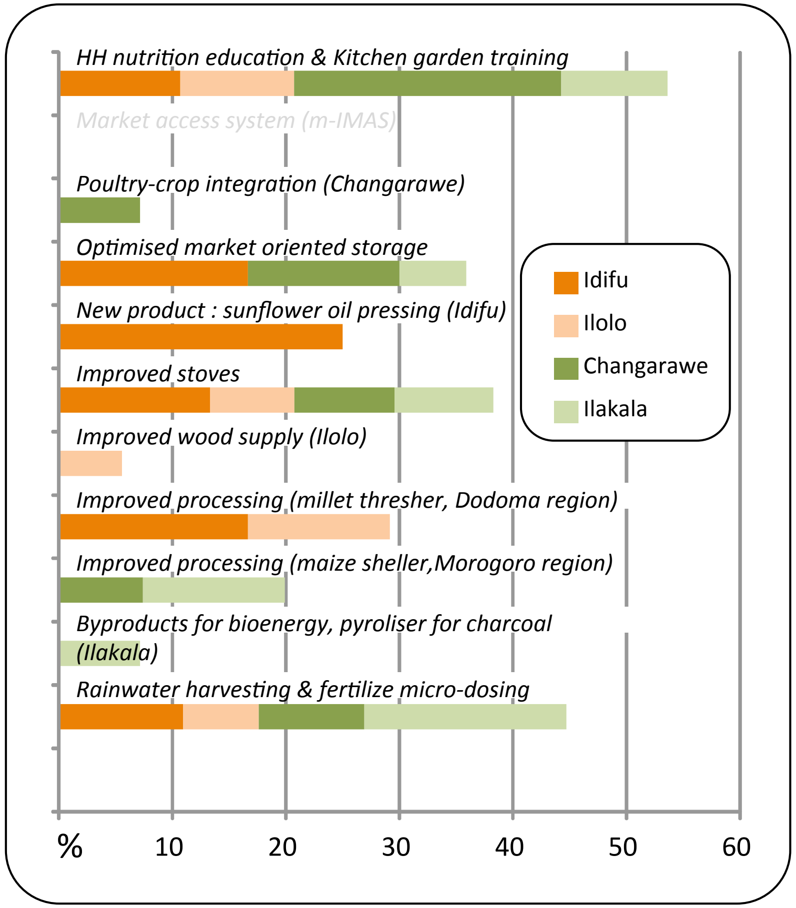


Figure 23: Cumulative percentage of UPS group size increases; result of individuals taking their own initiative to join a group during a later stage of implementation (N=703).

Open questions remaining from the Trans-SEC approach

Knowledge exchange, Tanzania 2014

Starting from a pro poor, low, cost and people centered approach, Trans-SEC implemented a framework of strategy implementation incorporating many methods to strengthen social interaction. The PAR framework foresaw monitoring and recursive adaptations of the UPSs, thus tackling implementation challenges and addressing reasons for non-adoption within the project lifetime. The following figure 24 frames aspects of the participatory action research approach by putting reasons for the non-adoption for each of the selected Trans-SEC UPS at the center of the action.

Reasons for non-adoption of an UPS fall into two broad categories: reasons related to (a) situations where the Trans-SEC approach of “pro poor,” “low cost,” and “people centered” encountered challenges due to social and economic conditions within the villages; and (b) situations where the use of PAR activities failed in creation of an enabling environment for some communities. The experiences and analyzed information on non-adoption are fed-in into information systems and expert networks for further dissemination.

In the further step of up- and out-scaling, the lessons learned will contribute to the goal of systematically analyzing possible synergy effects by combining several UPSs. Future dissemination programs should to ensure that optimal combinations or an advantageous sequential implementation order of the tested UPS are used. Farmers can take advantage of the factor outputs from previous implemented UPS or those occurring due to the combination of UPSs. Therefore, bottleneck factors and constraints need to be outlined specifically for each innovation. Typically, tailored procedures to overcome challenges start by balancing predominant constraints: (1) opportunity costs of labor; (2) the social organization of farmer implementation group; (3) limited resources; (4) technological, process-oriented knowledge; and (5) economic, cultural, traditional and gender reasons.

Transferring ownership and responsibility for created knowledge to the farmer groups was guided by MWIVATA, which supported activities that foster social organization practices. One strategy that might enable future funding from the government was to facilitate the group registering with the Tanzanian government.

As part of the project’s exit strategy, toward the end of the project, all partners and farmers were requested to highlight strategies of out- and upscaling for the further dissemination of the UPSs to other farmers and villages. To promote their UPS, farmers were encouraged to create a self-reliant process of dissemination, e.g. by word of mouth or during organized farmer field days and regional farmer exhibitions.

At all times, scientist, extension agents, and farmers were tasked with analyzing reasons for abandonment, including situations when dissemination slowed or when implementation was not followed with sustained long-term usage. Experience shows that the implementation pathway often needed a phase of empowering the farmers, e.g. by implementing fundamental understanding of the technology. Accordingly, the perspectives of farmers became an important component of Trans-SEC.

Evaluation of PAR components

Participatory action research theory assumes that the non-adoption of innovations is not due to the inability of farmers to adopt, but rather to imperfect implementation processes, environmental settings, and poorly adapted technologies. Therefore, "non-adoption" is likely to happen if the implementation efforts have not addressed the identified requirements completely. The Trans-SEC project addressed these issues and, furthermore, understood successful adoption and sustainable implementation to be defined as the constant adaptation of technologies and a perpetual dissemination process.

During fade out, Trans-SEC must trust that the newly generated knowledge and that the achieved as well as perceived advantages of each individual UPS will incite its sustained usage. The needed trust – after exit of the project - especially applies for those UPSs where adoption is still low and the experimental phase seems to need extension or intensification.

Participatory action research was somewhat new for many scientists, and as well as the majority of farmers, and extension agents on the ground in Tanzania. Through constant and lively cooperation, farmers appreciated the Trans-SEC approach of participative creation of solutions together with those targeted for implementation.

Group work and the training of trainers (ToT) concept followed the step of creating farmer groups. Here the expertise that was generated resulted from the inclusion of indigenous knowledge and a broad discussion incorporating diverse farmer and family interests. Another aspect of social learning systems was the prolonged keeping of knowledge, as many UPS group members who participated can

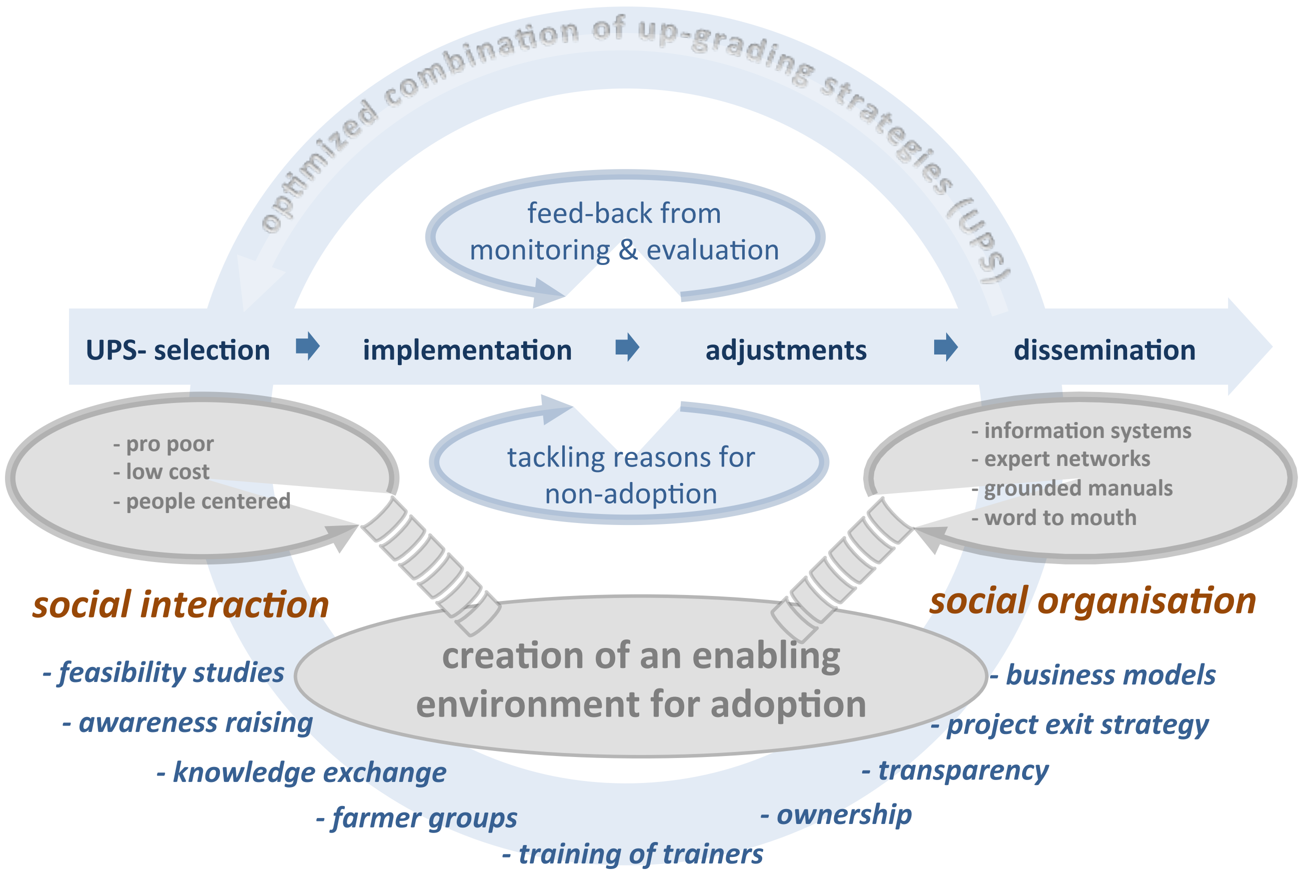


Figure 24: Conceptual PAR framework of Trans-SEC: UPS adaptations were an inherent activity from concept to implementation and back again to increase adoption.

Training farmer groups, Tanzania 2015

share their knowledge with those unable to attend training events. For example, in the case of the improved cooking stove (ICS) UPS, the training abilities of the trainer were reinforced through a 16-fold repetition of stove construction within the group. During the first ICS training events, each group member was asked to take responsibility for each step of the construction process.
The slow and extended training helped the illiterate and low educated farmers understand the process. Although single UPS group members, whether due to age, illness, or being over-burdened with other duties, might not be able to cope with such a slow but still demanding approach, the group still provided an enabling environment that created awareness. Perceptions of the combined benefits of the UPSs were strengthened in the end. Learning a technology step-by-step, along with discussions and adjustments, creates the ownership needed to be convinced and to convince others. Nevertheless, UPSs also rely on the performance participating farmers to have a high level of motivation and an ability to learn quickly. It was also found UPSs that incorporating a business model adjusted for pro-poor clients were more successful.

Implementation processes incorporated continuous monitoring by project experts. From the third month of implementation onwards, monitoring conducted by Master's students, doctoral students, other sci-

entists, and ARI Center extension officers detected issues and addressed them quickly. In the best-case scenario, issues were resolved in partnership with the farmers. As other farmers voluntarily joined the UPS groups, monitoring reports also include reports from non-Trans-SEC farmer households that had not participated in the survey waves. Therefore, the basis of evaluation was broadened.
The monitoring and evaluation procedures of Trans-SEC were important. Farmers and experts prioritized UPSs for implementation. The early adaption of indicators, incorporating feedback by the farmers, was critical. An iterative participatory process before the implementation of UPSs created suitable criteria that represented the needs of farmers for the UPS impact assessments. The process incorporated the ex-ante and ex-post ScalA and FoPIA evaluation tools. For example, as their poor economic status constrain many farmers, developing knowledge that facilitates the understanding of innovations and technologies is equally important as creating feasible indicators that capture their economic perspective.

In Trans-SEC, the bottom-up approach incorporated scientific rigor. Based on community needs and problems, strategies were further developed. Here, special emphasis was put on enhancing the ownership of implemented strategies and to integrate farmer adapted solutions. In the feedback loops between farmers and experts, the content and scope of analyses were substantially enriched, resulting in recommendations that were sharpened for further outreach. The stepwise process of raising awareness and knowledge, through mutual trials and adaptation resulted in deeper adoption of technologies.

Therefore, Trans-SEC highly recommends that the practice of continual adjustments should be incorporated, with all UPS members actively encouraged to come up with their own ideas. For example, during implementation of ICS, several adjustments to the stove were made due to repeated encouragement of farmers and UPS group members: To improve the improved stoves. A subsequent task included observing design shifts, carefully analyzing the quality of the combustion process and providing feedback. The new degree of ownership feeling was reflected in statements that declared the ICS stove was a joint invention of both the farmers and the Trans-SEC project.

Group empowerment became more and more important toward the end of the project. Therefore, after 3 years of intensive UPS implementation practice, Trans-SEC sought a transparent exit strategy. One part was to enable each group to seek formal registration as a farmer group by the Tanzanian government. A second part was to empower the groups to take charge and sustain implementation of the respective UPS, encouraging dissemination both within and outside the village. This was fostered by training and education on business models and basic economic steps to start business.

The PAR process is designed to finally disseminate results from implementation, by up- and out-scaling successful UPSs. The UPSs were developed through a process of selecting, testing, and assessing UPSs, an experience that resulted in lessons about being better prepared for dissemination and outreach being learned. This is accomplished via the research network (scientific papers, home page, movies) and stakeholder organizations. Examples include policy briefs and capacity-building workshops at the policy, extension, and farmer school levels. The scaling out of UPSs has already started through field days and farmers exchange visits with neighboring villages.

Recommendations for future action research

Water transport with oxcarts, Tanzania 2015

This book highlights upgrading strategies for agricultural development with small-holder farming to cope with food insecurity in rural Tanzania. The above collection and evaluation of insights from the implementation of UPSs also sought to identify generic PAR strategies to improve rural livelihoods. Below are a number of recommendations for future PAR projects.

Interventions must incorporate early stakeholder involvement

At the beginning of a PAR project, impact pathways need to be jointly discussed by the scientists, implementers, and other local stakeholders in order to identify an agreed upon development goal. On this basis, strategies can be selected and discussed regarding how an impact could be achieved and measured. The particularly complex and reflective activities, which are often based on narrative constructs and assessments of the PAR activities, require not just sufficient time, but also good cooperation and communication among the scientists and stakeholders.

Establish a more equal partnership characterized by mutual learning

Forming consortia that include both southern and northern institutions and colleagues as equal partners may help with the transition from a one-directional transfer of capacity from north to south into a balanced and open knowledge exchange across cultural, hierarchy, and gender borders.

Comparing our results with those from other large-scale PAR and inter-cultural projects indicates that a) developing a shared vocabulary requires allocating a great deal more time early on in order to communicate PAR theory and PAR activities across cultures; b) modes of shared responsibility in smaller teams are needed for a more horizontal and successful collaboration; and c) overcoming cultural, disciplinary, and geographical distances requires more face-to-face cross-cultural activities.

Use processes of social learning for the improvement of the enabling environment

Given the level of farmer poverty, the adoption of new strategies might be enhanced by using a multi-stakeholder PAR approach. Human capacity constraints are often neglected and need to be addressed before strategy implementation. Here, community-based PAR activities ought to emphasize that the neighborhood peer learning processes should leverage the positive enabling capacities of the social environment.

Implementation need contextualization

Site-specific information and assessments are necessary for identifying suitable sustainable development practices. All site conditions, including climate, physical, economic, cultural, and social are crucial. Strategies to be implemented cannot be a “one-size-fits-all” solution applied across all regions or an entire country. Discussion should identify how strategies contribute to stabilizing and increasing the sustainable use of water, soils, forests, and other natural resources, thus enhancing resource efficiency.

Implementations must account for existing knowledge and capacities

Upgrading strategies need to be based on local societal knowledge and capacities because activities are closely linked to site conditions. This requires a) identifying existing farmer coping mechanisms to deal with challenges that will be addressed by project interventions; and b) identifying strategy components that are able to support these coping strategies and commonly practiced handling of shortages to link local knowledge to the new strategies.

Implementations should be fostered by creating an entrepreneurial environment

The success of adoption might be boosted by components of an innovation that generates a (fast) profit gain. Savings, either in labor or on a monetary basis, that can be linked to the new strategy should be identified and highlighted. Costs and market prices - relevant for implementation of the strategy - should be made transparent at the different transaction nodes. Involve local SMEs early to ensure the availability of services or market related inputs (fertilizer, i.a.) and credits that will be needed to successfully implement the new strategy.

Invest in training to educate upcoming trainers

Farmers benefit from advanced training programs where farmers become trainers themselves. Continued and recursive training measures should allow other farmers to adopt newly introduced technologies when joining existing farmer groups; social and physical heterogeneity among stakeholders should be considered. Experienced farmers trained in new technologies, how to train others, and in the sustained use of the new technologies should be encou-

Water transport with bycicle, Tanzania 2015 raged to share their knowledge of the most important and most common hindering factors.

Here, the most important task of the “strong” farmers or farmer groups is to sustain usage of the new innovations via timely technical assistance in repair and maintenance. The same applies to knowledge support and idea sharing. When adjustments are needed, regular knowledge exchange sessions should be facilitated, if not self-organized by the farmer groups, with reporting, discussions, and feedback loops incorporated.

Project exit strategies must be planned from the beginning

When planning the end of a project, efforts must be made to determine the best way to perpetuate the dissemination of knowledge gained throughout the project, insuring that it is self-sustaining. Thus, further dissemination following fade-out of the project should be based on collaborating local stakeholders who have ownership of the knowledge.
The outstanding success of the project is in creating a self-initiating process of UPS dissemination due to co-generation of knowledge in the farmer groups. Further adaptation was enabled by participating farmers – as users and experts of the new knowledge and technology. The implemented strategies should be integrated into a community-based knowledge system. In village meetings and assemblies, each farmer group should report on the dissemination success of their respective strategy.

Include farmer-to-farmer visits into the up-scaling program

Rural farmers face knowledge, capital, and labor constraints. Other farming communities adopting the strategies will presumably be affected by similar constraints. The intermediate farmers and their social interactions are key when raising the awareness and encouraging adoption of new technologies. Social ties with the trained farmers, the proximity of plots, and visitations increase the likelihood of uptake by neighboring households.

Up- and out-scaling needs to follow successful pathways of tested strategies

To be persuasive in disseminating successful strategies, narratives should build upon the evidence of the improvements experienced by farmers. These narratives of success are based on actual events that happened during the project’s lifetime. UPSs spilled over to non-trained farmers in neighboring rural farming communities. Toward the end of Trans-SEC, farmer-to-farmer visits were facilitated, with farmer field days and knowledge exchange events organized during regional NANE-NANE exhibitions; an annual event that takes place around August 8th – the name is derived from the Kiswahili word for 8, nane; so 8/8.

Further dissemination should include the trained champion farmers. Upcoming projects should take advantage of these lead farmers and their experienced knowledge. Moreover, future projects should support these farmers by supplying training on other promising UPSs and production technologies. The same applies to national outreach organizations and locally operating NGOs, as well as their extension agents. Collaboration with established local networks is a reasonable option for governmental programs seeking to continue technology dissemination.

Introduce measures of meta-communication and conflict prevention to fa¬cilitate collaboration

In PAR activities with high levels of stakeholder participation or north-south cooperation, both increased communication among members as well as more input from project management is required. To create a collaborative environment, early and transparent communication is proven to be critical for multi-disciplinary, cross-cultural work environments. To facilitate the smooth communication, it is important to implement a culturally sensitive environment that also actively works to mitigate conflict. By offering team building and supervision, or training on communication and conflict awareness the development of trust is enhanced, which is crucial for effective team cooperation.

Integrate measures for conflict management

Practicing PAR is highly demanding in terms of flexibility in research activity planning, financial-administrative handling, and communication. Practice can differ depending on nationality, hierarchical status, and gender. Transparent and early communication among all the involved members is required, especially in such temporary and heterogeneous work settings. Underestimating these demands is likely to trigger tension and dissatisfaction within and between the different cultures. To prevent (the escalation of) conflicts, implementing measures of conflict prevention, such as meta- communication or training on communication and conflict awareness are particularly important for facilitating good collaboration. However, support measures in the event of conflict, such as coaching and mediation, should be put in place to facilitate conflict management and the continuation of collaboration.

Trans-SEC Consortium, Tanzania 2013

Adeleye, O., Bako, S., Afiemo, O. G., Alli-Balogun, K., Agbo, R. (2015). Role of local innovation in mechanisation of maize shelling: Evidence from Igabi, Chikun and Kajuru Local Government Areas, Kaduna State Nigeria. Journal of Agricultural Extension and Rural Development, 7(5): 170-175.
Adkins, E., Tyler, E., Wang, J., Siriri, D., Modi, V. (2010). Field testing and survey evaluation of household biomass cookstoves in rural sub-Saharan Africa, Energy for Sustainable Development, Volume 14, Issue 3: 172-185.
Alam, M. M., Momin, M. A. (2009). Performance of existing maize shellers in Bangladesh. Progress. Agric. 20(1 and 2): 207 – 220.
Allen, R. G., Periera, L. S., Raes, D., Smith, M. (1998). Crop evapotranspiration (Guidelines for computing crop water requirements). Food and Agriculture Organization of the United Nations, Rome, Italy. FAO Irrigation and Drainage Paper 56.
Bagayoko, M., Maman, N., Palé, S., Sirifi, S., Taonda, S.J.B., Traore, S., Mason, S.C. (2011). Microdose and N and P fertilizer application rates for pearl millet in West Africa. Afr. J. Agric. Res. 6: 1141–1150.
Below, T., Sieber, S., Schmid, J., (2015). Farmers' knowledge and perception of climatic risks and options for climate change adaptation: a case study from two Tanzanian villages. Regional Environmental Change, 15(7):1169-1180.
Belward, A. (2011). "Renewable Energies in Africa", JRC Scientific and Technical Reports, European Commission Joint Research Center, Italy.
Bonatti, M., Homem, L. H. I. R., Graef, F., Mbwana, H. A., Rybak, C., Lana, M., Sieber, S. (2017). Social organization, constraints and opportunities for kitchen garden implementation: ScalA and ScalA-FS assessment tools in Morogoro and Dodoma, Tanzania. Food Security 9(6): 1299-1308.
Bonatti, M., Schlindwein, I. L., Lana, M., Bundala, N., Sieber, S., Rybak, C. (2017). Innovative educational tools development for food security: Engaging community voices in Tanzania. Futures.
Bradbury-Huang, H. (2010). What is good action research? Why the resurgent interest? Action Research, 8(1): 93-109.
Camara, B.S., Camara, F., Berthe, A., Oswald, A. (2013). Micro-dosing of fertilizer- a technology for farmers' needs and resources. International Journal of Agri Science, 3(5): 387- 399.
Carter, B., Joshi, A., Remme, M. (2018). Scaling up inclusive approaches for marginalised and vulnerable people. K4D Emerging Issues Report. Institute of Development Studies, Brighton, UK.
Clough, L. (2012). The Improved Cookstove Sector in East Africa: Experience from the Developing Energy Enterprise Programme (DEEP), GVEP international. London UK.
Codjia, G. (2001). Food sources of vitamin A and pro-vitamin A specific to Africa: An FAO perspective. Food and Nutrition Bulletin 22(4): 357 – 360.
Cosyns, H., Damme, P.V., Wulf, R.D. (2013). Who views what? Impact assessment through the eyes of farmers, development organization staff and researchers. International Journal of Sustainable Development and World Ecology 20 (4):287-301.
Dant, T. (2004). Critical social theory: Culture, society and critique. SAGE Publications Limited.
de Graaff, J., Kessler, A., Nibbering, J. W. (2011). Agriculture and food security in selected countries in Sub-Sharan Africa: diversity in trends and opportunities. Food Security, 3: 195-213.
de Janvry, A., Sadoulet, E., Rao, M. (2016). Adjusting models to the way farmers learn. FERDI Workshop on "Learning for adoption". University of California at Berkeley and FERDI. USA.
Ekop, O.E., Osuji, E.E. (2003). Participatory methodology in information dissemination: A case study of Oyo State Agricultural Development Projects (OYSADEP). in Ogbomosho Zone. FoodAfrica, Internet Forum 31st March–11th April 2003, Internet Paper for Food Security.
Eleri, A., Eleri E. O. (2009). "Rethinking Biomass Energy in Sub-Sahara Africa", Prospects for Africa- Europe's Policies, VENRO (Association of German Development NGOs), German NGO Forum on Environment and Development and ICEED (International Centre for Energy, Environment and Development), Bonn, pp. 20.
Ezezika, O. C., Oh, J. (2012). What is trust?: perspectives from farmers and other experts in the field of agriculture in Africa. Agriculture & Food Security, 1 (Suppl 1), S1.
FAO (2011). The State of Food and Agriculture: Women in Agriculture – Closing the gender gap for development. Rome: FAO.
Fellows, P.J., Axtell, B. (Eds) (2012). Setting up and running a small-scalecooking oil business, Opportunities in food processing series, ACP-EU TechnicalCentre for Agricultural and Rural Cooperation (CTA).
Gómez, M.I., Barrett, C.B., Buck, L.E., De Groote, H., Ferris, S., Gao, H.O., McCullough, E., Miller, D.D., Outhred, H., Pell, A.N., Reardon, T., Retnanestri, M., Ruben, R., Struebi, P., Swinnen, J., Touesnad, M.A., Weinberger, K., Keatinge, J.D.H., Milstein, M.B., Yang, R.Y. (2011). Research Principles for Developing Country Food Value Chains. Science 332: 1154-1155
Gornott, C., Wechsung, F. (2016). Statistical regression models for assessing climate impacts on crop yields: A validation study for winter wheat and silage maize, Agricultural and Forest Meteorology (217), 89–100.
Graef, F., Schneider, I., Fasse, A., et al. (2015). Assessment of upgrading strategies to improve regional food security in Tanzania: Natural resource management and crop production. Outlook on Agriculture 44(3): 159-167.
Graef, F., et al. (2014). Framework for participatory food security research in rural food value chains. Global Food Security 3(1): 8-15.
Graef, F., et al. (2018). Systemising gender integration with rural stakeholders' sustainability impact assessments: A case study with three low-input upgrading strategies. „Environmental Impact Assessment Review 68: 81-89.
Graef, F., Schneider, I., Fasse, A., et al. (2015). Assessment of upgrading strategies to improve regional food security in Tanzania: Food processing, waste management and bioenergy, and income generation, Outlook on Agriculture 44(3).
Graef, F., Uckert, G. (2016). Male and female scientists differ in their suitability assessments of food-securing upgrading strategies. International Journal of Agricultural Resources, Governance and Ecology 12(3): 305-326.
Graef, F., Uckert, G., Schindler, J., König, H. 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 9(6): 1255-1270.
Guidi, D. (2011). Sustainable Agriculture Enterprise: Framing Strategies to Support Smallholder Inclusive Value Chains for Rural Poverty Alleviation. CID Research Fellow and Graduate Student Working Paper No. 53. Center for International Development at Harvard University.
Gura S., Gundula K. (2000). ECART/ASARECA/CTA Workshop on impact assessment 537 of agricultural research in East and Central Africa. GTZ, Eschborn.
Habermehl, H. (2007). Economic Evaluation of the Improved Household Cookstoves Dissemination Programme in Uganda; GTZ, Household Energy Programme-HERA,
Hafner, J., Uckert, G., Graef, F., Hoffmann, H., Kimaro, A. A., Sererya, O., Sieber, S. (2018). A quantitative performance assessment of improved cooking stoves and traditional three-stone-fire stoves using a two-pot test design in Chamwino, Dodoma, Tanzania Environ. Res. Lett. 13 25002
Herrmann, R., Nkonya, E., Brüntrup, M., Mutabazi, K., Maed,a, M., Mwinuka, L., Faße, A. (2017). Institutional and policy analysis of FVC. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/39009624577cb122976d0e3555026413.pdf.
Herrmann, R., Nkonya, E., Faße, A., Maeda, C., Mutabazi, K., Mwinuka, L. (2015). Impact of smallholder farmer horizontal and vertical linkages. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/1030d08db339c02b38e7a9373e58905f.pdf.
Hoffmann, H., Sander, K., Brüntrup, M., Sieber, S. (2017). Applying the Water-Energy-Food nexus to the charcoal value chain. Frontiers in Environmental Science 5, Article 84.
Hoffmann, H., Uckert, G., Sieber, S., Graef, F., Reif, C. (2014). Traditional biomass consumption, the introduction of efficient stoves and its effects on Miombo forest: A case study from Western Tanzania, Regional Environmental Change, Springer.
Ilett, S., Freeman, A. (2004). Improving the diet of toddlers of Pakistani origin: a study of intensive dietary health education. Journal of Family Health Care 14(1): 16 – 19.
Jones, M., Alexander, C., Lowenberg-DeBoer, J. (2011). An initial investigation of the potential for Hermetic purdue improved crop storage (PICS) bags to improve incomes for maize producers In Sub-saharan Africa. Purdue University West Lafayette, Indiana 47907-Working Paper #11.
Kadigi, R., Kadigi, I., Laswai, G., Kashaigili, J. (2013). Value chain of indigenous cattle and beef products in Mwanza region, Tanzania: Market access, linkages and opportunities for upgrading. J. of Agric Res. Vol 1 (8): 145-155
Kahimba F.C., Mbaga, S., Mkoko B., Swai, E., Kimaro, A., Mpanda, M., Liingilie, A., Germer, J. (2015). Rainfed crop, livestock, and agroforestry systems. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/83905803646d86cb3ba323cdc201860b.pdf.
Kahimba, F.C., Mbaga, S., Mkoko, B., Swai, E., Kimaro, A.A., Mpanda, M., Germer, J. (2015). Rainfed crop, livestock, and agroforestry systems in Semi-arid and sub-humid Tanzania: A Baseline report. http://project2.zalf.de/trans-sec/public/product/view/id/37.
Kaminski J., Christiaensen L. (2014). Post-Harvest Loss in Sub-Saharan Africa-What Do Farmers Say? Policy Research Working Paper, No. 6831. World Bank, Washington, DC. © World Bank.
Kanyeka, E., Kamala, R., Kasuga, R. (2007). Improved agricultural technologies recommended in Tanzania. 1st edition. Published by the Department of Research and Training, Ministry of Agriculture Food Security and Cooperatives, Dar es Salaam, Tanzania.
Kaur, M., Bassi, R., Sharma, S. (2011). Impact of nutrition education in reducing iron deficiency anemia in adolescent girls. Indian Journal of Fundamental and Applied Life Sciences 1(4): 222 – 228.
Khairwal, I. S., Rai, K. N., Diwakar, B., Sharma. Y. K., Rajpurohit, B. S., Nirwan, B., Bhattacharjee, R. (2007). Pearl millet: Crop management and seed production Manual. Patancheru 502. Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.
Kimaro, A.A., Mpanda, M., Rioux, J., et al. (2016). Is conservation agriculture 'climate-smart' for maize farmers in the highlands of Tanzania? Nutr. Cycl. Agroecosyst, 105: 217 - 228. DOI: 10.1007/s10705-015-9711-8.
Kimaro, A.A., Timmer, V.R., Mugasha, A.G, Chamshama, S.O.A, Kimaro, D.A. (2007). Nutrient use efficiency and biomass production of tree species for rotational woodlot systems in Semi-arid Morogoro, Tanzania. Agroforest. Syst. 71: 175 - 184
Kimenye, L., Bombom, A. (2009). Best-bet research outputs for enhancing agricultural productivity in Eastern and Central Africa: Abstracts. ASARECA, Entebbe.
Kissoly, L., Faße, A., Grote, U. (2017). The integration of smallholders in agricultural value chain activities and food security: evidence from rural Tanzania. Food Security, 9(6):1219-1235.
Kitalyi, A.J. (1998). Village chicken production system in rural Africa. Household food security and gender issues. FAO Animal Production and Health Paper 142, pp84.
König, H. J., et al. (2013). Regional impact assessment of land use scenarios in developing countries using the FoPIA approach: Findings from five case studies Journal of environmental management 127: S56-64.
König, H. J., Graef, F., Schindler, J., Fasse, A., Mutabazi, K. D., Lambert, C., Ngwenya, P., Uckert, G., Mahoo, H., Hattermann, F. F., Sieber, S. (2017). Combining participatory, qualitative and quantitative methods for impact assessment of food value chains into an integrated framework. Food Security, 9(6), 1309-1321.
Kuntosch, A., B. König (2018). Linking system perspectives with user perspectives to identify adoption barriers to food security innovations for smallholder farmers – evidence from rural Tanzania. Food Security 10(1). DOI: 10.1007/s12571-018-0821-4
Kuntosch, A., Konig, B., Bokelmann, W. (2015). Approaching food security from an innovation perspective. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/826eba091612fdfd58ed8efe1a34d709.pdf.
Lambert, C., Biesalski, H.K., Mbwana, H., Kinabo, J. (2015). Analysing and enhancing food quality and consumption practices. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/5b97b6f87a8164ffd0e7b02a67ef35d4.pdf
Lana, M., Vasconcelos, A.C.F., Gornott, C., Schaffert, A., Bonatti, M., Volk, Graef, F., Kersebaum, K.C., Sieber, S. (2018). Is dry soil planting an adaptation strategy for maize cultivation in a semi-arid region? Food Security, 1-14.
Löhr, K., Bonatti, M., Homen, L., Schlindwein, S., Sieber, S. (2018) Operational challenges in collaborative research projects: Addressing conflict multidimensionality. Kybernetes 47, 6, 1074-1089.
Löhr, K., Graef, F., Bonatti, M., Mahoo, H. F., Wambura, J., Sieber, S. (2017): Conflict management systems for large scientific research projects. International Journal of Conflict Management 28, 3, 322-345.
Löhr, K., Hochmuth, C., Graef, F., Wambura, J., Sieber, S. (2017). Conflict management programs in trans-disciplinary research projects: the case of a food security project in Tanzania. Food Security, 9(6), 1189-1201
Löhr, K., Hochmuth, C., Sieber, S. (2017). Conflict Prevention and Management Systems.) Conflict Prevention and Management Sys¬tems in Collaborative Research Projects: A guide for design and implementation, Müncheberg, ZALF.
Löhr, K., Weinhardt, M., Graef, F., Sieber, S. (2017). Enhancing communication and collaboration in collaborative projects through conflict prevention and management systems. Organizational Dynamics.

Lyimo, C.M., Weigend, A., Janßen-Tapken, U., Msoffe, P.L., Simianer, H., Weigend, S. (2013). Assessing the genetic diversity of five Tanzanian chicken ecotypes using molecular tools. South African Journal of Animal Science 43(4): 499-510.
Lyimo, C., Mwinuka, L., Magomba, C., Lagweni, F.P., Mbaga, S. and Mutabazi, K.D. (2016). Poultry-crop integration. http://project2.zalf.de/trans-sec/public/media/factsheets/Trans-SECfactsheet8.pdf.
Maeda, C., Fue, K., Tumbo, S., Mchau, D., Lagweni, F., Mutabazi, K.D. (2016). Mobile integrated market access system (m-IMAS). http://project2.zalf.de/trans-sec/public/media/factsheets/Trans-SECfactsheet9.pdf.
Maeda, C.R.K. (2018). Smallholder commercialization and agricultural market status in Tanzania. PhD Thesis, University of Dar es salaam.
Maertens, M., Swinnen, J. F. (2012). Gender and modern supply chains in developing countries. The Journal of Development Studies 48 (10): 1412 – 1430.
MAFAP (2013). Review of food and agricultural policies in the united republic of Tanzania 2005-2011, (July). MAFAP Country Report Series, FAO, Rome, Italy.
Magomba, C., Mwinjuka, L., Mutabazi, K., Silayo, V. (2016). Optimized storage. http://project2.zalf.de/trans-sec/public/media/factsheets/Trans-SECfactsheet7.pdf.
Magomba, C., Yustas, Y., Mutabazi, K.D., Mwinuka, L., Mueller, J. (2016a). Sunflower processing. http://project2.zalf.de/trans-sec/public/media/factsheets/Trans-SECfactsheet6.pdf.
Mahoo, H.F., F.C. Kahimba, K.D. Mutabazi, S.D. Tumbo, F.B. Rwehumbiza, P. Reuben, B.P. Mbilinyi, and J.W. Gowing. (2012). Adoption and up scaling of water harvesting technologies in Tanzania. Chapter 6. In: Eds. W. Christley and J. Gowing. Water Harvesting Technologies in SSA: State of the Art. Earth Scan Publishers.
Makumba, W., Jassen, B., Oenema, O., Akinnifesi, F.K., Mweta, D., Kwesiga, F., (2006). The long-term effects of a gliricidia-maize intercropping system in Southern Maliwi, on gliricidia and maize yields, and soil properties. Agric. Ecosyst. Environ. 116: 85–92.
Malinski, B (2008). Impact Assessment of Chitetezo Mbaula Improved Household Firewood Stove in Rural Malawi: Programme for Basic Energy and Conservation (ProBEC) – Malawi.
Mayoux, L., Mackie, G. (2009). 'Making the strongest links - A practical guide to mainstreaming gender analysis in value chain development', ILO.
Mbwana, H. A., Kinabo, J., Lambert, C., Biesalski, H.K. (2017). Factors influencing stunting among children in rural Tanzania: An agro-climatic zone perspective. Food Security, 1-15.
Mbwana, H. A., Kinabo, J., Lambert, C., Biesalski, H. K. (2016). Determinants of household dietary practices in rural Tanzania: Implications for nutrition interventions. Cogent Food & Agriculture, 13, 1–13
Mnimbo, T. S., Lyimo-Macha, J., Urassa, J. K., Mahoo, H. F., Tumbo, S. D., Graef, F. (2017). Influence of gender on roles, choices of crop types and value chain upgrading strategies in semi-arid and sub-humid Tanzania. Food Security 9, 6, 1173-1187.
Mnimbo, T. S., Lyimo-Macha, J., Urassa, J., Graef, F. (2017). Gendered impact assessment on food securing upgrading strategies: results from three methodological approaches. Developing Country Studies 7, 2, 94-112.
Morris, J.B., Tassone, V., de Groot, R., Camilleri, M., Moncada, S. (2011). A Framework for Participatory Impact Assessment: Involving Stakeholders in European Policy Making, a Case Study of Land Use Change in Malta, E&S 16.
Morris, M., Stathers, T., Riwa, W., Mvumi, B., (2005). Doing things differently: technical and institutional options for Post-Harvest Innovation (projects R7034, R8179 & R8460). Livelihood poster, Natural Resources Institute, University of Greenwich, UK. http://www.nri.org/projects/PHILA/reports/Poster-DFID-Zim-Sep05.pdf.
Mutabazi, K., Maeda, C., Nkonya, E., Hermann, R., Bruentrup, M., Fasse, A., Sieber, S., Graef, F. (2015). Assessing commercialization of smallholders. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/5d7cdb548cdfe9cd3a538427ff809f45.pdf.
Mutabazi, K., Sieber, S., Maeda, C., Tscherning, K. (2015). Assessing the determinants of poverty and vulnerability of smallholder farmers in a changing climate: the case of Morogoro region, Tanzania, Reg Environ Change 15: 1243. DOI: 10.1007/s10113-015-0772-7.
Mutabazi, K.D., Amjath-Babu, Sieber, S. (2015). Influence of livelihood resources on adaptive strategies to enhance climatic resilience of farm households in Morogoro, Tanzania: an indicator-based analysis, Reg Environ Change 15: 1259. DOI: 10.1007/s10113-015-0800-7 .
Mwakaje, A. (2010). Information and Communication Technology for Rural Farmers Market Access in Tanzania. J. of Info Tech Impact, Vol. 10 (2): 111-128
Mwinuka L., Mbaga S.H. (2015). Phase I: Baseline Survey Study and Training summary Report. Trans-SEC
Mwinuka, L., Mutabazi, K. D., Graef, F., Sieber, S., Makindara, J., Kimaro, A., Uckert, G. (2017). Simulated willingness of farmers to adopt fertilizer micro-dosing and rainwater harvesting technologies in semi-arid and sub-humid farming systems in Tanzania. Food Security 9, 6, 1237-1253.
Mwinuka, L., Mutabazi, K. D., Sieber, S., Makindara, J., Bizimana, J.-C. (2017). An economic risk analysis of fertiliser microdosing and rainwater harvesting in a semi-arid farming system in Tanzania. Agrekon 56, 3, 274-289.
Mwinuka, L., Mutabazi, K.D., Makindara, J., Stefan, S. (2016). Reckoning the risks and rewards of fertilizer micro-dosing in a subhumid farming system in Tanzania, African Journal of Science, Technology, Innovation and Development, 8(5-6): 497-508.
Mwinuka, L., Mutabazi, K.D., Sieber, S. Makindara, J. (2017). An economic risk analysis of fertiliser microdosing and rainwater harvesting in a semi-arid farming system in Tanzania, Agrekon, 56(3): 274-289.
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
Nyadzi, G.I., Otsyina, R.M., Banzi, F.M., Bakengesa, S.S., Gama, B.M., Mbwambo, L., Asenga, D., 2003. Rotational woodlot technology in northwestern Tanzania: tree species and crop performance. Agrofor. Syst. 59: 253–263.
Parpart, J.L., Rai, S. M., Staudt, K. (eds.) (2002). Rethinking Empowerment: Gender and development in a global/local world, Routledge, London.
PwC and Viadrina (European University Frankfurt- Oder) (2011). Conflict Management- From the Elements to the System, Frankfurt (Oder).
Reif, C., Graef, F., Dietrich, O., Lana, M., Helming, K., Gutzler, C., Sieber, S., (2015). Combining analytical methods and framework scenarios for assessing food security across the food value chain, Outlook on Agriculture 44 No 1.
Riisgaard, L., S. Bolwig, F. Matose, S. Ponte, A. du Toit and N. Halberg (2008). 'A Strategic Framework and Toolbox for Action Research with Small Producers in Value Chains', DIIS Working Paper 2008:17.
Saidia, P.S., Graef, F., Rweyemamu, C.L., Semoka, J.M.R., Kimaro, A.A., Mwinuka, L., Mutabazi, K.D., Sieber, S. (2018). Nitrogen and Phosphorus Fertilizer Microdoses on Maize and Its Effect on Profitability: An Evidence from Sub-humid Farming Systems, Tanzania. Journal of Economics, Management and Trade 21 (9): 1-10. DOI: 10.9734/JEMT/2018/44157.
Saidia, P.S., Rweyemamu, C.L., Asch, F., Semoka, JMR., Kimaro, AA., Germer, J., Graef, F., Lagweni, P., Kahimba, F., Chilagane, E. (2018). Effects of nitrogen and phosphorus micro-doses on maize growth and yield in a sub-humid tropical climate. Annals of Biological Research 9(2): 20 - 35.
Schauberger, B., Gornott, C., Wechsung, F. (2017). Global evaluation of a semiempirical model for yield anomalies and application to within-season yield forecasting, Global Change Biology, 1-15.
Schaefer, M.P., Dietrich, O. (2015). General conditions of water resources. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/3f4a9fbbd6bc6f54127fc03f00c97d5c.pdf.
Schäfer, M.P., Dietrich, O., Mbilinyi, B. (2015). Streamflow and lake water level changes and their attributed causes in Eastern and Southern Africa: a review. International Journal of Water Resources Development (accepted).
Schindler, J. Graef, F, König, H, (2015). A critical examination of sustainability impact assessment methods of farming interventions in developing countries: A Review. Agronomy for Sust. Development 35 (3): 1043-1057.
Schindler, J., Graef, F., König H. J. (2016). Participatory impact assessment: Bridging the gap between scientists' theory and farmers' practice Agricultural Systems 148 38–43.
Schindler, J., Graef, F., König, H. J., Mchau, D. (2017). Developing community-based food security criteria in rural Tanzania. Food Security 9, 6, 1285-1298.
Schindler, J., Graef, F., König, H., Mchau, D., Saidia, P., Sieber, S. (2016). Sustainability impact assessment to improve food security of smallholders in Tanzania Environmental Impact Assessment Review 60 52–63.
Schut, M., Klerkx, L., Kamanda, J., Sartas, M., Leeuwis, C. (2018). Synopsis of Innovation Platforms in Agricultural Research and Development. https://www.researchgate.net/publication/326524614_Innovation_Platforms_Synopsis_of_Innovation_Platforms_in_Agricultural_Research_and_Development/download.
Sererya, O. G. (2016). Economic analysis of improved cooking stove, its implication on the livelihoods and environmental sustainability in Chamwino and Kilosa districts, Tanzania. M.Sc. Dissertation, Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture, 66pp.
Shackleton, S., Paumgarten, F., Kassa, H., Husselman, M., Zida, M. (2011). Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African non-timber forest products. International Forestry Review 13(2): 136 – 151.
Sieber, S., et al. (2017). „Trans-SEC's food security research in Tanzania: principles, research models and assumptions." Food Security 9(6): 1147-1155.
Sieber, S., Graef, F., Amjath-Babu, T. S., Mutabazi, K. D., Tumbo, S. D., Faße, A., Gomez Y Paloma, S., Rybak, C., Ndah, H. T., Uckert, G., Schuler, J., Grote, U. (2017). Introduction to a special issue: regional food and nutritional security in Tanzania - methods, tools and applications (Editorial). Food Security 9, 6, 1143-1145.
Sieber, S., Graef, F., Tscherning, K., Uckert, G. (2015). Food security in the context of climate change and bioenergy production in Tanzania: methods, tools and applications, Regional Environmental Change, Special issue, online first, Springer.
Sieber, S., Jha, S., Amjath, B., Bringe, F., Crewett, W., Uckert, G., Polreich, S., Hycenth Ndah, T., Graef, F., Mueller, K. (2015). Integrated assessment of sustainable agricultural practices to enhance climate resilience in Morogoro, Tanzania. Regional Environmental Change 15(7): 1281-1292.
Tabo, R., Bationo, A., Diallo Maimouna, K., Hassane, O., Koala, S. (2005). Fertilizer micro-dosing for the prosperity of small-scale farmers in the Sahel: Final report. International Crops Research Institute for the Semi-arid Tropics, Niamey, Niger. 28 pp
Tefera, T., Abass, A., Ndunguru, G. T., Matawo, P., Mamiro, P., Mlingi, N., and Makalanag, C. (2012). Improved postharvest technologies for promoting food storage, processing, and household nutrition in Tanzania. International Institute of Tropical Agriculture. https://cgspace.cgiar.org/bitstream/handle/10568/24886/aresa_postharvest.pdf?sequence=1
Torretta, V., Conti, F., Leonardi, M., Ruggieri, G. (2012). Energy recovery from sludge and sustainable development: a Tanzanian case study. Sustainability, 4(10), 2661-2672.
Uckert, G., Graef, F., Faße, A., et al. (2018). ScalA-FS: expert-based ex-ante assessments of local requirements and success potential of upgrading strategies for improving food security in rural TanzaniaFood Sec10: 841. DOI: 10.1007/s12571-018-0789-0.
Uckert, G., Hafner, J., Graef, F., Hoffmann, H., Kimaro, A., Sererya, O., Sieber, S. (2017). Farmer innovation driven by needs and understanding: building the capacities of farmer groups for improved cooking stove construction and continued adaptation. Environmental Research Letters 12, 12, Article 125001.
Uckert, G., Kimaro, A., Gassaya, O., Obed, M., Maseta, Z. (2016). Using improved forewood cooking. http://project2.zalf.de/trans-sec/public/media/factsheets/Trans-SECfactsheet5.pdf.
Uckert, G., Kimaro, A., Gassaya, O., Swamila, M., Yustas, Y., Romuli, S., Elly, N., Mgeni, C., Munder, S., Makoko, B., Silayo, S., Mueller, J. (2016). Final report for additional biomass utilization and UPS implementation. Trans-SEC deliverable 6.3.1. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/ef081586b-13c56171625b71519263e30.pdf.
Walji, A. (2016). Why innovation seldom scales, and what to do about it. In Ramalingam, B., and Bound, K. (Eds.) Innovation for international development: Navigating the paths and pitfalls. London: Nesta.
Wyrod, R. (2008). Between Women's Rights and Men's Authority: Masculinity and shifting discourses of gender difference in Urban Uganda. Gender and Society, 22(6): 799-823.
Yustas, M. Y,Romuli,S.,Elly, N., Munder, S., Uckert G., Silayo, V., Mueller, J. (2016). Testing Report on Waste Management and Nutrient. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/03a0b8b449f7a50a67f000fea5d3f145.pdf
Yustas, Y., Romulli, S., Makindara, J., Kimaro, A., Mpanda, M., Munder, S., Uckert, G., Mutabazi, K., Silayo, V., Mueller, J. (2014). Baseline report on post-harvest. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/a13df82f-1465d7806f279709a912821d.pdf.
Yustas,Y., Romuli, S., Elly, N., MgeniC., Munder, S., Makoko, B., Uckert, G., Silayo, V., Mueller, J. (2016).Testing report on post-harvest processing upgrading strategies. http://project2.zalf.de/trans-sec/public/media/upload/product/pdf/7702f67be69d66d31feb33f4f5f9f263.pdf.

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