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Chapter 14
A Participatory Approach to Assessing the Climate-Smartness of Agricultural Interventions: The Lushoto Case

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14.1 Introduction

In 2010, Tanzania's agricultural sector accounted for approximately 28% of gross domestic product and 24% of exports (Msambichaka et al. 2009). The sector employed around 75% of the population and is regarded as important for the economic growth of the country (Mnenwa and Maliti 2010). Agriculture in Tanzania is characterised by small-scale farms, whose average land area for cultivation is less than 3 ha (Sarris et al. 2006). Smallholder farmers produce both crops and livestock that are used mainly for subsistence (Amani 2005). Tanzanian agriculture depends on rain as the main source of water, while women contribute a large proportion of the labour force in the sector. In Tanzania, maize is the most widely produced crop followed by rice, sorghum, millet and wheat (Rowhani et al. 2011).

Climate change has affected the living standards of people as well as the performance of important sectors of the Tanzanian economy (Tumbo et al. 2011). It has been estimated that there will be an increase in average daily temperature of 3–5 °C and average annual temperature of 2–5 °C in most parts of the country by the year 2050 (Tumbo et al. 2011). Rainfall is expected to decrease in most parts of the southeastern highlands and central parts of the country, whereas an increase of rainfall is expected in most parts of the northeastern highlands as well as the Lake Victoria Basin (Mwandosya et al. 1998). This variation in temperature and precipitation poses a major threat to cereal crops; with a temperature rise of 2 °C, by the

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year 2050, causing the following estimated yield reductions: maize 13%, sorghum 8.8% and rice 7.6% (Rowhani et al. 2011). Already, as a result of warming, a decrease in crop yield has been observed in recent years (Lobell et al. 2011). Droughts have been experienced in many parts of the country, and the disappearance of pasture and water in Sukumaland of the Lake Zone region is well documented. This has resulted in pastoralists travelling long distances in the search for grasses and water to nourish their animals (Kangalawe et al. 2007).

In response to the challenges climate change will present, the concept of climate-smart agriculture (CSA) was brought forward by the Food and Agriculture Organization (FAO) of the United Nations (2013). CSA aims to: (a) sustainably increase food production and income; (b) adapt and build resilience to climate variability; and (c) mitigate/reduce and/or remove greenhouse gas emissions from agricultural practices (FAO 2013). Under the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), agricultural practices that are climate-smart have been promoted in seven villages in Lushoto District, Tanzania. As part of this programme, 14 farms are implementing improved forages; 21 farms are introducing improved drought-tolerant varieties; 6 are employing terracing; 5 are using composting; 15 others are testing tree planting; and 11 more are benefitting from indigenous knowledge of weather forecasting.

There are no interventions that are climate-smart per se. An intervention's climate-smartness depends on whether it leads to food security, adaptation and mitigation benefits in the specific local climatic, biophysical, socio-economic and developmental context (Williams et al. 2015). In the absence of any assessment of the impact of CCAFS's work in Lushoto, this study aimed to assess the climate-smartness of these interventions.

We developed a participatory protocol for assessing the climate-smartness of innovations at farm level. This evaluates the contribution of newly introduced practices to the productivity, resilience and mitigation of agriculture. Our protocol assesses the food security and adaptation pillars only, for two reasons. Firstly, these pillars are deemed the most important by farmers, and are recognised by many stakeholders as the priority in developing countries; while mitigation is often seen as a potential co-benefit. What's more, the impacts of interventions, across food security and adaptation indicators, are easily observable/measurable/estimable by farmers. Measurements of greenhouse gas (GHG) emissions, on the other hand, are costly and difficult to implement. We, therefore, don't expect farmers to be able to make assessments of mitigation potential so, if this is deemed important within CSA evaluations, participatory assessments should be complemented by researcher-led measurements or modelling exercises.

The protocol was specifically designed for ease of adaption and implementation across a variety of regions and farming systems. It can be applied in a monitoring, evaluating and learning process and allows for the better prioritisation of interventions. This chapter describes the protocol and the lessons learned from its pilot in Lushoto.

14.2 Materials and Methods

A literature review resulted in an early list of suitable farm-level indicators for each of the three CSA pillars. The list was then discussed with extension officers of Lushoto District and experts from CIAT and the Selian Agricultural Research Institute before a final list of indicators was agreed upon.

For the food security and adaptation pillars, the indicators were weighted, scored and finally combined into aggregated indices using a weighted sum of the indicators. Weights and scores were elicited via a survey carried out among a selection of CCAFS project farmers. The data collection protocol involved pairwise ranking and scoring, according to a Likert scale. The weights for each indicator were established through pairwise comparison following the Analytic Hierarchy Process outlined in Saaty (1980). Comparisons of the importance of the indicators were entered into a matrix with a 1–9-point scale. Following this, a consistency ratio was calculated for each pillar. When the consistency ratio was greater than 0.10, all comparisons were reviewed and the inconsistent ones re-evaluated (Saaty 1980). The weight of each indicator from each pillar was calculated using a normalised comparison matrix in which each value present in the matrix was divided by the sum of its column.

Based on these weights, the aggregated food security and adaptation indices were calculated following a three-step process. Firstly, the intervention was scored for each indicator within the food security and adaptation pillars. Farmers were asked to assess whether there had been an increase in the indicators since the beginning of the intervention. The scoring of the indicators was performed using a Likert scale, with scores ranging from 0 to 5—a score of 1 meaning that the farmer strongly disagrees, and 5 meaning that the farmer strongly agrees that the indicator has increased since s/he began the intervention. Secondly, these scores were translated into values ranging between −1 and +1, where: 0 means ‘no contribution’; −1 means ‘reduces overall score strongly’; −0.5 means ‘reduces overall score’; 0.5 means ‘increases overall score’; and 1 means ‘increases overall score strongly’. The final step resulted in a weighted sum per CSA pillar.

Through this process we achieved a farmer-centric evaluation of the interventions. The establishment of indicator weights, based on the farmer’s perspective, ensures that the assessment takes into account the indicators that are most relevant to the farmer in his/her own context. The scoring of the indicators is based on the changes the farmers observe on their own farms as a result of the improved practice and allows for a comparison with the farmers’ previous or ‘business-as-usual’ practice.

The protocol was tested among 72 farmers in the climate-smart village of Lushoto. The data was analysed using Microsoft Excel and different CSA interventions assessed for their contribution to adaptation and productivity.

14.3 Results and Discussion

14.3.1 Suitable Farm-Level Indicators

In the literature review and subsequent discussions with extension staff and experts, we identified a total of 14 indicators relevant to CSA in the Lushoto farming community as listed in Table 14.1. The food security pillar of CSA focuses on strategies that aim to ensure food productivity, food availability, food accessibility and food utilisation. In the assessments in Lushoto, we included the following indicators: food production, animal production, income, and consumption. The adaptation pillar of CSA points towards risk reduction, technological adjustments, and information support for environmental management sustaining the proper growth and development of crops and/or animals. In the Lushoto assessments, we included the following ten indicators in the adaptation pillar: skills and knowledge, access to information, crop adaptation, crop diversity, animal diversity, soil protection, income from farm productivity, stability of farm productivity, income stability, and animal adaptation.

Table 14.1 Indicators selected by extension staff and agricultural experts for the food security and adaptation pillars

Pillars	Indicators	References
Food security	Food production	Nambiar et al. (2001), Yegbemey et al. (2014), Rasul and Thapa (2004), Kamanga et al. (2010), López-Ridaura et al. (2002), and Mittal and Bajwa (2015)
	Animal production	López-Ridaura et al. (2002), Chigwa et al. (2015), Descheemaeker et al. (2011), Herrero et al. (2010), Mittal and Bajwa (2015), and Altieri (1999)
	Income	Hayati et al. (2010), Altieri (1999), and Mittal and Bajwa (2015)
	Consumption	Yegbemey et al. (2014), Kamanga et al. (2010), and Smith et al. (2015)
Adaptation	Skills and knowledge	Kimaru-Muchai et al. (2013)
	Access to information	Smith et al. (2015), Hoang et al. (2006), and Odini (2014)
	Crop adaptation	Vignola et al. (2015)
	Crop diversity	Horrigan et al. (2002), Rasul and Thapa (2003), Nambiar et al. (2001), Valet and Ozier-Lafontaine (2014), and Zhu et al. (2000)
	Animal diversity	Nambiar et al. (2001)
	Soil protection	Lusigi (1995), and Snapp et al. (2010)
	Farm productivity	Meul et al. (2012), and Van Passel and Meul (2012)
	Stability of farm productivity	Organisation for Economic Cooperation and Development (2001)
	Income stability	Mishra and Sandretto (2002), and Dose (2007)
	Animal adaptation	Vignola et al. (2015)

The identification and selection of an appropriate set of indicators forms the basis of any useful impact assessment. Often-cited weaknesses include incomplete coverage of many different factors, including: issues, key considerations, processes, and the causes and effects of the interlinked trends (Van Cauwenbergh et al. 2007). To avoid these, the scope of our literature review covered not only CSA, but also sustainable intensification and organic agriculture. In addition, a thorough scrutiny of potential indicators, in terms of measurability, relevance and practicability, was conducted on those that made the long-list (Lebacq et al. 2013; Van Cauwenbergh et al. 2007; Nambiar et al. 2001; Brown 2009). Narrowing down the long-list with local stakeholders ensured that the final list of indicators is grounded in the local context, and relevant to the challenges being faced and the vision for development in the region. The recent efforts by, for example, CCAFS (Quinney et al. 2016) and the World Bank (2016) to review and guide the selection of suitable CSA indicators are likely to further facilitate this process.

14.3.2 Importance of Indicators in the Food Security and Adaptation Pillars

Figures 14.1 and 14.2 present the importance of different indicators as assessed by the Lushoto farming community. Overall, food production was deemed most important in the food security pillar with a weight of 0.39. This was followed by income and consumption with 0.27 and 0.22 respectively. Animal production scored lowest in this pillar, with a weight of 0.11.

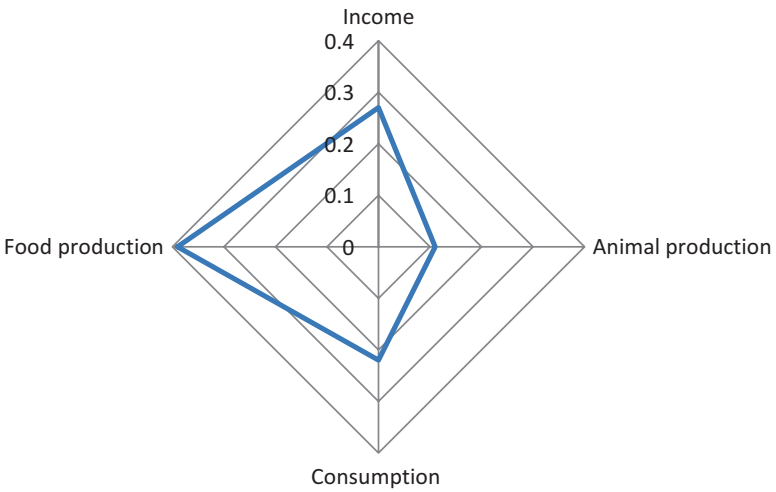

Fig. 14.1 Importance of food security indicators according to small-scale farmers in Lushoto District. Blue line represents indicator weights

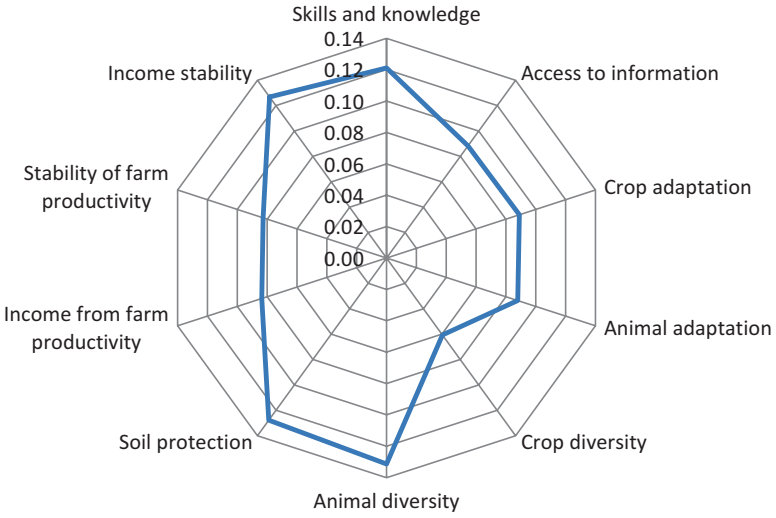

Fig. 14.2 Importance of adaptation indicators as assessed by small-scale farmers in Lushoto District. Blue line represents indicator weights

We associate the first figure with the farmers' priority on allocating resources, where a large proportion of land is allocated for food crops. Likewise, the farmers' priority towards the income indicator was associated with the large proportion of income spent on food items. The importance of the consumption indicator was associated with its direct correlation to food security. The farmers' responses around the animal production indicator points to the higher importance of crop production than livestock for most farmers. A study carried out by Lyamchai et al. (2011) in Lushoto District indeed suggested that 100% of the food crop is produced by smallholder farmers and that crop agriculture is the dominant sector in the area. The findings of this study are also in line with a characterisation survey carried out in western Kenya in which food production was deemed most important by farmers followed by income (Waithaka et al. 2006). Moreover, the study of Shikuku et al. (2016) reported that income and yield were deemed the most important CSA indicators by both male and female farmers in Mbeya, Tanzania. Yet, the study did not specify whether yield is coming from the production of crops and/or animals.

In the adaptation pillar, soil protection, income stability, skills and knowledge were deemed the most important indicators with weights of 0.13 each (Fig 14.2). Our findings concur with those of a study conducted by Shikuku et al. (2016) in the uplands and lowlands of Mbarali and Kilolo Districts, Tanzania in which soil fertility, together with skills and knowledge, were deemed the most important. Surprisingly, regardless of the observed diversified cropping pattern, crop diversity was deemed less important by farmers. Our result in this indicator differed with the study performed in Malawi in which crop diversity was deemed most important by farmers (Cromwell et al. 2001).

The framework incorporates input from farmers through a pairwise comparison of indicator importance and indicator scoring, which involves the careful process of allocating weights (Notenbaert et al. 2010). Here farmers were responsible for allocating the weights of the indicators. In particular, the process represents a challenge when farmers are unable to count and translate their assessments into a 1–9-point scale. This problem necessitated frequent repetition to ensure an acceptable consistency ratio for each pillar. Calculations of the consistency ratio for each pillar were carried out with an expert during the process.

14.3.3 Performance of CSA Interventions Across Two Pillars

Of the six different interventions that were implemented as part of CCAFS's projects and assessed by farmers in terms of their impacts on food security and adaptation, only composting, improved drought-tolerant varieties and improved forages interventions represent true win-win scenarios. This means that they contribute significantly to food security through their ability to increase productivity while ensuring adaptation to climate variability and change. As a result, the Lushoto farmers valued these interventions because they contributed to improving soil fertility and structure, reducing surface runoff, and reclaiming degraded land due to their positive impact on yield and off-season crop agriculture. This result is corroborated by Nyasimi (2017) who mentioned that improved crop varieties and composting were the most commonly implemented CSA interventions by the smallholder farmers.

On the other hand, a clear trade-off is observed between the two pillars when implementing tree planting (Fig. 14.3). According to the farmers, tree planting failed to contribute to food security. This is in contrast with several studies (Murthy et al. 2016; Verchot et al. 2007) which have shown that a combination of beneficial trees on farms tends to increase soil fertility and farm production, while protecting crops from climate risk. In addition, the continued use of these interventions ensures the diversification of farmers' incomes as well as minimising monetary risk. The fact that such evidence is not taken into account by the farmers, points to a weakness in this type of participatory assessment. It is potentially biased as a result of social conditioning and basing results on anecdotes instead of hard evidence (Sen 1999). Participatory assessments, however, elicit the views of the actual beneficiaries and, therefore, ensure the use of locally relevant indicators as well as the assessment of context-specific impacts. It also increases the likelihood of longer term buy-in and farmer-to-farmer promotion of positively assessed interventions. In addition, it can contribute to capacity-building and the empowerment of smallholder farmers in relation to choosing suitable CSA interventions (Williams et al. 2015). In addition, the approach can have broader implications in managing trade-offs in the perceptions of smallholder farmers and policymakers.

The scarceness of win-win interventions, on the other hand, raises a question around whether every activity undertaken by every farmer in every field should generate double or triple wins. According to the FAO (2014), the short answer is no.

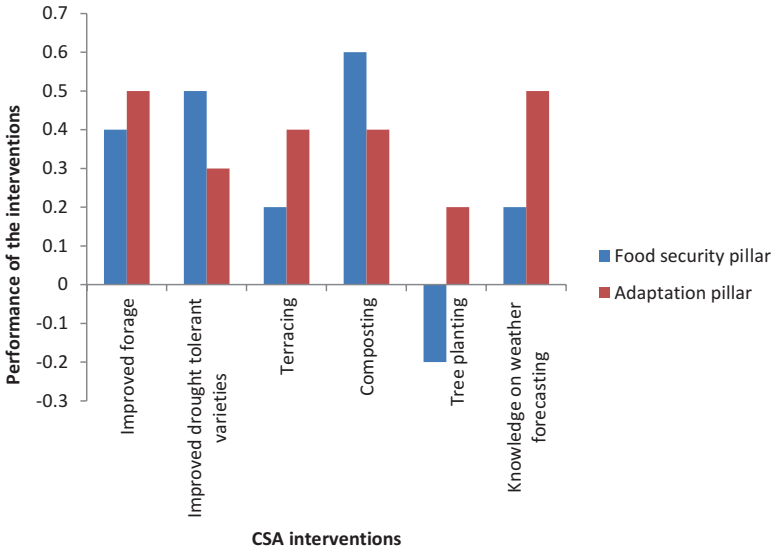

Fig. 14.3 Trade-offs and synergies of the interventions across the two pillars

A CSA policy for agricultural development includes various interventions (on practices, delivery systems/institutions and policies) at various scales (community, landscape, agro-ecological zone, regional and national). The need for adaptation and the potential for mitigation in relation to achieving food security/development vary among these activities and scales and, as a result, so does the ability to capture synergies. Farmers should not only consider CSA as a new set of practices, but also as an integrated approach (Rosenstock et al. 2016; Williams et al. 2015). Likewise, options for an effective combination of interventions would enable smallholder farmers to reap the benefits of both pillars of CSA.

14.4 Implication for Development

Tanzania is experiencing extreme climate change, and the adverse effects have already been reported to affect agriculture and people's livelihoods (United Republic of Tanzania (URT) Ministry of Agriculture 2014, 2015, 2016). As a result, several measures have been taken by the Government to combat the effects of climate change, including the formation of institutions and policies responsible for promoting CSA (Wanzala 2010). These institutions, however, currently lack tools and approaches to assess the performance of the interventions they promote. Our proposed tool could be used as a starting point for assessing the climate smartness of agricultural interventions. Extension officers and other stakeholders can be trained to carry out regular assessments and get insights, based on farmers' opinions on any

interventions. These insights then need to be fed back into the planning process and used to inform adjustments to the current interventions or the design of future investments. The application of such a monitoring, evaluation and learning process has the potential to increase the effectiveness of a wide range of CSA initiatives in the country.

14.5 Conclusion

Around the world, CSA has gained a lot of attention; while a variety of agricultural interventions has been hypothesized to contribute to food security, adaptation and mitigation. Assessment, monitoring and evaluation are integral parts of CSA planning and implementation. They are crucial for making decisions on the use of financial, natural and human resources. CSA options should therefore be assessed for their effectiveness in achieving their intended climate change goals.

However, there is a lack of clear and workable criteria and methods for assessing the actual climate-smartness of these interventions. In addition, often, there is limited inclusion of stakeholders' perspectives and, therefore, little buy-in resulting in a lack of wide scale adoption. This chapter proposes a participatory approach that—unlike many other assessments—involves stakeholders at every stage: from indicator selection, through indicator weighing, to actual intervention evaluation. Its application in Lushoto District, Tanzania, demonstrates that participatory assessment of the climate-smartness of agriculture interventions can be used to provide valuable indication supporting CSA groundwork. The protocol presented ensures the selection of locally relevant indicators and the inclusion of farmers' experiences through participatory monitoring of the interventions' local impact. We recommend its use for eliciting insights on the effectiveness of the on-farm components of CSA initiatives beyond this study. These insights can then inform necessary adjustments of such programmes.

The approach is easy to adapt to different types of interventions in a variety of contexts. We believe, however, that the protocol would be easier to implement with farmers after the adjustment of the quantitative scales used to rank indicators and value interventions according to these indicators. We suggest the use of qualitative descriptions of these scales for future applications.

Our framework deals with two pillars of CSA only, namely food security and adaptation. With its standard indicators and long-term and off-farm impacts, the mitigation potential of the interventions does not lend itself to such participatory approaches. We, therefore, recommend complementing the participatory assessments in terms of food security and adaption with science-led GHG emissions estimations. These could be a combination if ex- and in-situ measurements and modelling approaches. Such complementary studies would add value to the overall assessment of climate-smartness of tested interventions.

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