Soil and Water Conservation Practices and their Potential for Outscaling in Semiarid Areas of Tanzania

Shortage of water for agriculture causes food insecurity among populations living in semiarid areas, (those characterized by low and erratic rainfall) worldwide (Barry *et al.*, 2008). This has serious implications in sub-Saharan Africa (SSA), where poverty is rampant and agricultural production is primarily rainfed (Sanga *et al.*, 2013). The region's vulnerability to food insecurity is underscored by the severe droughts experienced in the Horn of Africa, which killed human and livestock in 2011 (Sarr, 2012). To reverse the situation, the use of soil- and water-conserving (SWC) practices (bench terraces, grass strips, *fanya juu,* double digging, cover crops, micro basins and mulching) that have been proven scientifically to be water-smart agricultural practices with double dividends, reducing soil erosion and retaining soil moisture, is emphasized. However, the outscaling (i.e., increasing the number of users) of these technologies is quite low, despite the important role they play in the lives of smallholder farmers in semiarid areas (Oduol *et al.*, 2011; Ndjeunga and Bantilan, 2005). For example, in East Africa, outscaling is less than 10% of the farming communities living in semiarid areas (Kangai *et al.*, 2002).

Tanzania presents a compelling case, especially in semiarid areas where crop failure due to drought is severe and the use of water-smart agricultural technologies is very low (less than 6% of the farming communities are adopters) (Hatibu *et al.*, 1995). As a result, smallholder farmers in these areas are poor and suffer from food insecurity (Hatibu *et al.*, 2000). Realizing this grave situation, many programs geared toward increasing the use of SWC practices have been initiated and implemented since the colonial era (Tenge *et al.*, 2004; Hella, 2002). Yet, the outscaling of practices has continued to be low and the SWC structures, which are already in place, are not well-managed by smallholder farmers.

Considering the need to improve food security and livelihood of the people living in these areas, CARE International, through GWI2, initiated a project designed to advocate investment in water-smart agricultural practices from the rural to the national level. The project seeks to outscale the use of these practices by engaging key stakeholders in supporting smallholder farmer practices (CARE, 2012). Therefore, a study on the actual factors limiting outscaling is imperative. It involves gathering scientific evidences at local levels and getting farmers' point of view and using them to build consensus at the local and national levels.

Objectives

The paper aimed to present evidence on factors that prevent smallholder farmers from adopting SWC technologies and to evaluate the potential for outscaling them.

Specifically, the study aimed to

- Investigate factors limiting smallholder farmer adoption of SWC at the farm level in Same District.
- Identify opportunities for outscaling the use of SWC in the area.

Research approach and methodology

Study location

Same District is situated between 4°S to 4°45´S and 37°5´E to 38°5´E. The district is divided into three ecological zones: highlands, middle lands, and lowlands. These zones differ in topography, availability of water for agriculture, and use of water-smart (i.e., soil- and water-conserving) farming systems.

The highlands

The highland plateau zone lies between altitudes 1100 and 2462 m above sea level and is densely populated with 650 people per square km. The area receives between 1250 and 2000 mm of rainfall per annum. The temperature ranges from 15°C to 25°C. Because of reliable rainfall, the arable land in this area is fully utilized for agriculture. The crops grown in this zone include coffee, timber trees, banana, maize, beans, cardamom, and fruits such as pear, pawpaw, and avocado. The zone is also famous for producing vegetables such as tomato, onion, spinach, lettuce, okra, and pepper.

The middle lands

The middle lands lie between altitudes of 900 m and 1100 m above sea level. The area is relatively densely populated, with 250 people per square km. Rainfall is between 800 mm and 1250 mm per annum. Temperature ranges from 25 °C to 39 °C. Most crops produced in this zone include maize, coffee, and timber trees.

The lowlands

The lowland zone lies between 500 m and 900 m above sea level and receives 400–600 mm rainfall per annum. This zone is semiarid and is dominated by pastoralists with farming activities conducted in areas where irrigation is possible. Water is diverted from the Pangani River or harvested from runoff from the uplands. Crops that are commonly grown in this area include paddy, maize, cotton, sisal, vegetables, sesame, millet, sorghum, groundnut, beans, sunflower, sugarcane, and fruits. This zone is also characterized by the development of rapid urban settlement.

Data collection

The study benefited enormously from both secondary data collected through review of related literature and primary data collected through focus group discussions (FGDs) and structured questionnaire surveys. The FGDs were meant to gather general information on the current situation of soil- and water-conserving farming practices in the area, the actual limiting factors to adoption of the systems, and conflict lines among the various smallholder farmers. Participants in the FGD were selected purposively based on their experience and knowledge regarding soil- and water-conserving farming systems in the area. To get information with historical quality, people aged 40 years and above and who have lived in the village for more than 10 years were selected and involved in the FGDs. Six people (three men and three women) were chosen in each village.

Other primary data were collected through a household survey that was conducted in seven villages (Vudee, Bangalala, Mgwasi, Mwembe, Makanya, Ruvu Jiungeni, and Ruvu Mferejini). A total of 210 small-scale farmers were randomly selected from the seven villages and interviewed by using a structured questionnaire.

Results and discussion

Soil- and water-conserving practices

The survey results indicate eight main soil- and water-conserving practices commonly used in the area. Figure 1 indicates that bench terraces and fanya juu terraces are practiced more in the upper and middle zones, while micro-basins, double digging, and ridges are practiced more in the lowlands. According to Hatibu *et al.* (2000), the distribution of these structures is influenced by topography. The upper and middle zones are characterized by steep slopes, which require structures that can serve two purposes at a time: reducing runoff and conserving soil moisture. The lower areas have gentle slopes and flat plains, a feature that favors micro-basin, double digging, and ridges. Such structures hold water for a relatively longer period and allow it to percolate slowly.

Cover crops and mulching are not popular in the area; very few are found being practiced in the highlands and middle zones. This can be attributed to the fact that the area is semiarid, receiving low rainfall per annum, and that many varieties of cover crops need enough rain; the upper and middle areas receive relatively more rain than the lower zone. Nonetheless, mulching is also not popular in the area because the area does not produce much litter and the dead plants, mainly grasses, are used as animal feed.

Factors limiting outscaling of SWC structures

The shortage of land suitable for construction of SWC structures emerged as the main factor limiting outscaling of soil- and water-conserving practices in the upper and middle zones. This can be attributed to these zones' undulating topography, with very small areas that are good for constructing soil- and water-conserving farming systems, rapid population growth and in-migration, especially in the lower zones. Lack of labor and tools needed to build the structures are the other constraints. Figure 2 indicate that

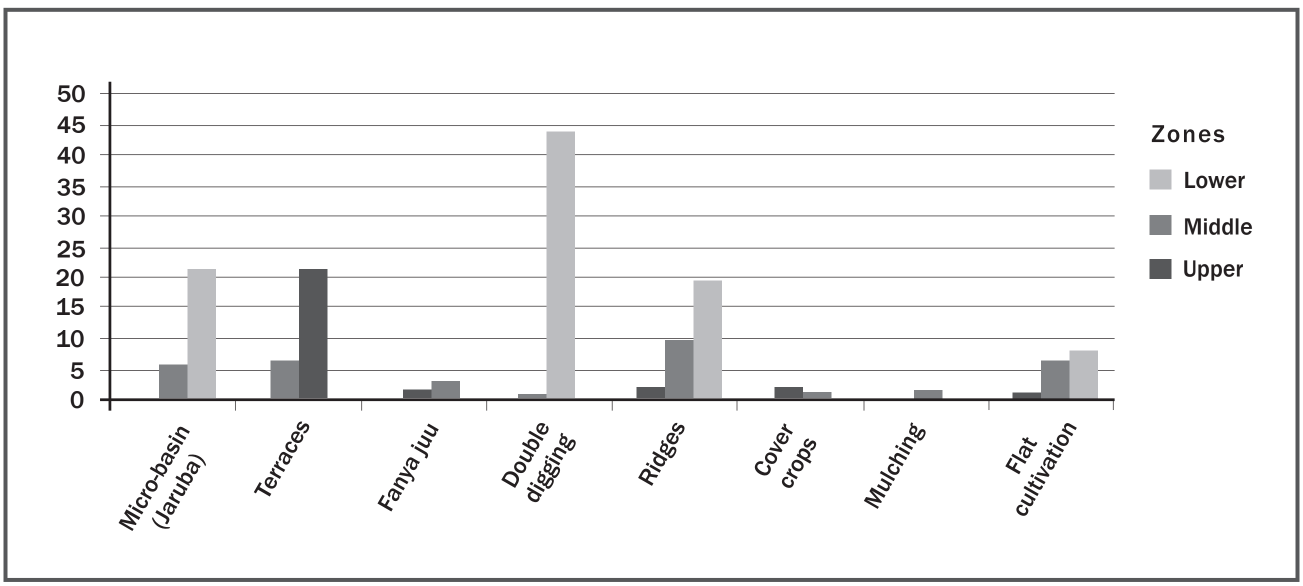

Fig. 1. *Distribution of SWC structures currently available in the project area.*

these are the major limiting factors in the upper and middle zones. Topography and type of soil pan also present problems. Many parts of these zones have rocks and hard pan; therefore, much labor is needed (a maximum of 40 man-days for an acre) to break the rocks and the pan to get to a level suitable for construction of the structures.

Equally important was the less priority given by weak governing institutions. In these areas, there are no regulations that force a household to practice soil and water conservation on its farm plot. Observations on the ground and testimonies from key informants and FGD participants also corroborated these results. It was pointed out that use of soil- and water-conserving structures is an individual decision. Therefore, smallholder farmers make decisions mutually exclusive of each other, something that leads some farmers not to practice SWC.

Lack of knowledge on how to build the structures is another limiting factor to outscaling in all the three agroecological zones. Smallholder farmers revealed that the currently used approach of selecting and training a few farmers is not effective in spreading the knowledge. Those involved in the program fail to disseminate the knowledge they have acquired to others due to lack of resources and platforms for training others. Finally, the lack of funds for constructing and maintaining the structures also hindered outscaling activities (Fig. 2). Some SWC structures such as bench terraces are too costly for a single smallholder farmer to construct and maintain, given his or her limited resources.

Lessons learned

- The potential for outscaling SWC practices that constitute water-smart agriculture exists in the area. Smallholder farmers are aware of the importance of SWC technology on their livelihood, and they know the factors that constrain them.
- Unstable land tenure arrangements and labor and tool unavailability are disincentives to smallholder farmers, thus hampering outscaling efforts.
- Weak governing institutions and lack of regulations that govern households as to WSC practice limit the outscaling of SWC technologies in the area.

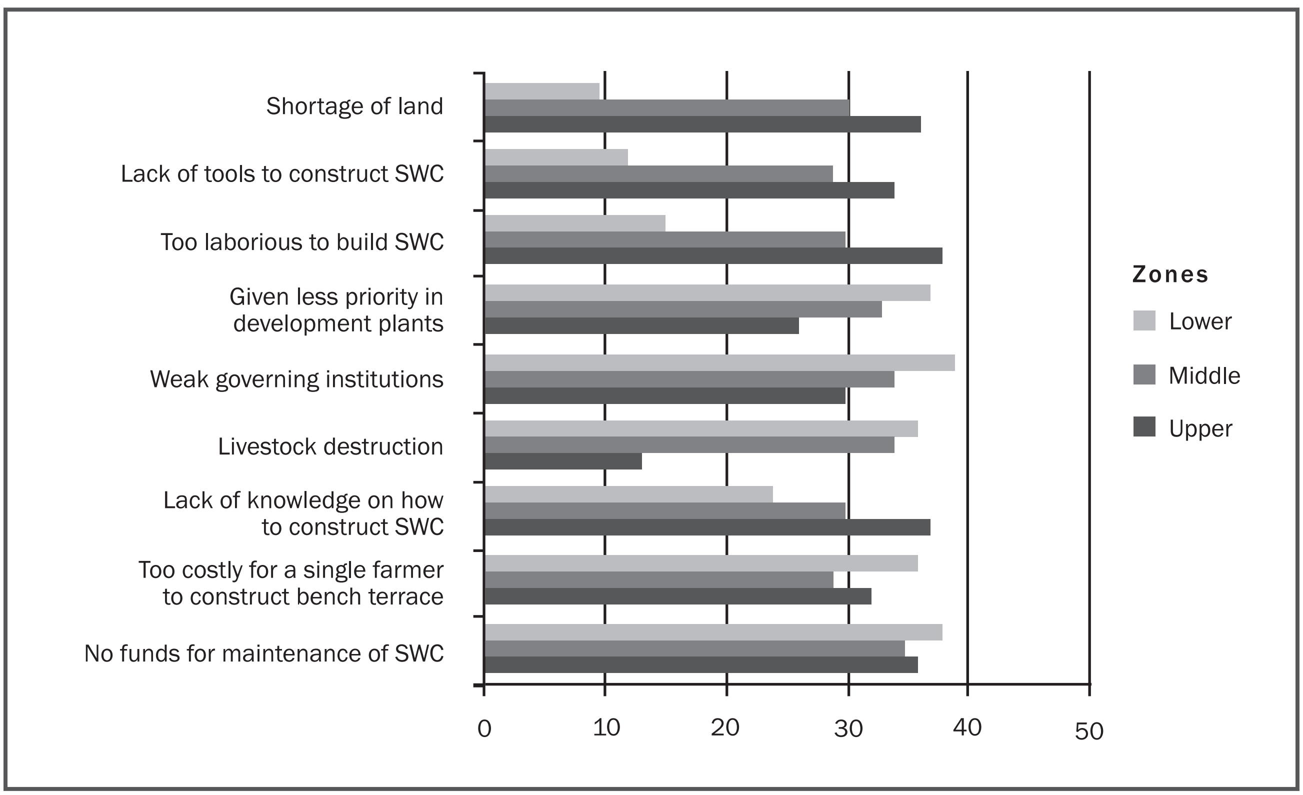

Fig. 2. Factors limiting outscaling of soil- and water-conserving structures in the project area.

Conclusions and recommendations

Outscaling SWC practices is the centerpiece of water-smart agriculture in semiarid areas. Therefore, understanding the factors that prevent smallholder farmers from adopting SWC practices is imperative. Results have shown that smallholder farmers in the area are aware of the practices and of barriers to adoption at a wider scale. The awareness angle not only creates the potential for outscaling but also identifies the focus of intervention. Poverty, lack of knowledge about WSC structures, high labor demand, and poor governance are important areas to focus on in order to achieve successful outscaling of the practices.

Policies play a vital role in the adoption of SWC practices. Results have shown that a weak legal system operates. In the lower zone, laws are not enforced, especially those that prohibit grazing of livestock in farmland.

Land, labor, and tools for constructing SWC structures are critical in the outscaling of SWC practices. Land shortage here means two things: tenure and availability. Insecure land tenure discourages a smallholder farmer from adopting SWC practices. Similarly, a household that has inadequate labor and no means of hiring labor will not adopt these technologies. Finally, implementation of SWC requires appropriate tools and equipment. Majority of smallholder farmers are too poor to afford these tools and this becomes a big constraint to adoption.

In view of these findings, the following recommendations are made:

- Establishing SWC structures is laborious and can be too much for a single farmer; an approach that promotes working together should be emphasized and strengthened among smallholder farmers.
- Tools and technical knowhow need to be available to smallholder farmers; the local government, through the Department of Agriculture, should be able to ensure this.
- Laws that can be used to settle disputes among smallholder farmers, enforce the practice of SWC technology, and maintain already existing structures should be established.

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