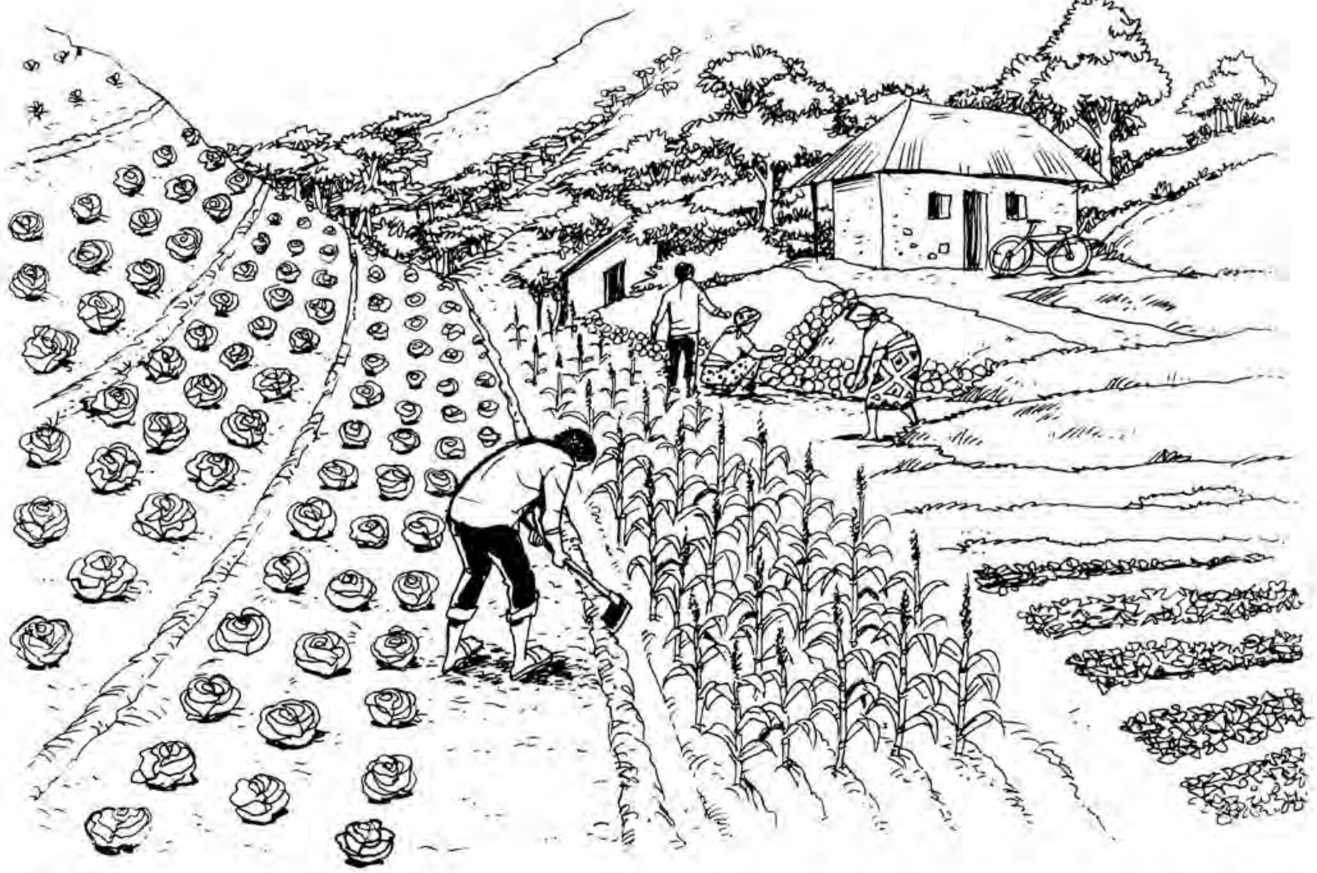
The Role of Sustainable Land Use Management to Achieve Effective Water Use



The agriculture sector of the Tanzanian economy contributes about 24.1% of gross domestic product, 30% of export earnings, and employs about 75% of the total labor force. Given the low level of agricultural development, the current average agricultural growth rate of 4.4% is insufficient to lead to significant wealth creation and poverty alleviation. To reduce poverty, annual agricultural growth rate must range from 6 to 8% (URT, 2013).

Population growth is one of the factors that add pressure on available natural resources such as land. This has given rise to increased demand for land on which to live and develop livelihoods. This results in land degradation, which, in turn, threatens agriculture and food security. It is therefore important for farmers to adopt sustainable land management approaches, which include sustainable farming technologies and natural resource management practices, including physical, cultural, and biological measures for increasing agricultural productivity, ensuring food security, and improving incomes.

Sustainable land management (SLM) can be defined as the use of land resources such as soil, water, animals and plants for the production of goods to meet changing human needs while assuring the long- term productive potential of these resources and maintaining their environmental functions. Herweg *et al.* (1998). On the basis of this understanding, this paper focuses on SLM as a way of engaging in water-smart agriculture in order to improve soil health, resulting in production increases alongside increases in water use efficiency, and ultimately leading to greater farm income.

Objectives

The general objective of the study is to examine the role of sustainable land use management practices in enhancing water-smart agriculture.

Specific objectives

- To describe existing sustainable land use management practices for water-smart agriculture
- To document costs and benefits of various SLM practices, determine social benefits accruing from adoption of SLM practices, and describe the challenges facing smallholder farmers in implementing SLM.
- To propose approaches to address challenges in the implementation of SLM practices.

Methodology

Description of study area

Uluguru and Pare mountains are part of a chain of mountains in eastern Africa collectively called the Eastern Mountains. The area is characterized by a mountainous and hilly landscape consisting of extensive cliffs, rocky outcrops, and steep and deep valleys. While the Uluguru mountains are located in Morogoro and Mvomero districts, the Pare mountains are located in Same District. The mountains are sources of many streams. For example, the Uluguru mountains has tributaries contributing to Ruvu River, which is the major source of water for people living along the river within Morogoro, Dar es Salaam and the coastal regions.

The districts are divided into three ecological zones—the upland middle, and lowland plateau. The upland plateau has an altitude of 1,100 and 2,462 m asl, and annual rainfall of 1,250 to 2,000 mm. In the middle zone, altitude is 900 – 1,100 m asl, and annual rainfall is 800 – 1,250 mm. The lowland plateau zone has an altitude of 500 – 900 m asl, and annual rainfall of 500 – 800 mm. The Uluguru mountains rise to 2,630 m altitude. Climatically, the Uluguru inland from the Indian Ocean and the east-facing slopes are especially wet, with rainfall estimated at more than 3,000 mm per annum, with some rain falling every month.

Review of documents

Various documents with information related to sustainability of water-smart agriculture were reviewed. These included project documents from CARE offices, reports from UMADEP/SUA, and other relevant literature, including those downloaded from the Internet.

The document review showed that the Uluguru and Pare mountains have experienced rapid population growth, resulting in higher food demand and greater need for more agricultural land. For example, a study by Chamshama *et al.* (2009) observed that the root causes of anthropogenic threats that the Uluguru Forest Reserve faces include widespread poverty growth. As a result, agricultural sustainability in these areas continues to be threatened.

In an effort to sustain agricultural activities, a number of sustainable land management (SLM) practices are being promoted in the Uluguru and Pare mountains. These are physical measures, such as bench terraces, stone terraces and *fanya juu* terraces; cultural measures such as ridges, borders, and pits; and biological measures such as grass strips, cover crops, mixed cropping, crop rotation, mulching, and trash lines. Other practices are agro-forestry, application of organic manure (farmyard manure and compost), double digging, and contour strip cropping (Malisa, 2009; CARE, 2014). These practices enhance water-smart agriculture—they improve soil health, resulting in production increase and they increase water use efficiency, leading to higher farm income.

Despite efforts to promote SLM practices, recent studies (Chamshama *et al.,* 2009; Mussa *et al.* 2012) reveal that land degradation is still one of the main threats to food security in the Uluguru mountains and that adoption of SLM practices is not widespread (Malisa, 2009). The recommended ways to curb this adoption gap include promotion of SLM practices that are profitable (Wamba, 2008; CARE 2014), that can be integrated into existing farming system, and that support soil nutrient and moisture retention (Malisa, 2009). Adoption that enhances the ownership of interventions is necessary.

Results and discussion

Relevance of SLM as a strategy in promoting water-smart agriculture

Experiences from the Uluguru and Pare mountains show that SLM practices are relevant because they result in economic, environmental, and social benefits.

Economic benefits

Investment analysis of three key SLM practices—bench terraces, *fanya juu* terraces, and borders (*majaluba*), done in the Pare mountains using net present value (NPV), benefit cost ratio (BCR), and internal rate of return (IRR), showed that investment in any of the three practices was profitable (GWI-CARE, 2014). Comparing the with and without SLM practice scenarios, the findings showed that farmers not applying any SLM practice experienced loss and that SLM practices resulted in incremental net benefits.

Considering other factors such as technical aspects, it can be asserted that, on flat land or gentle slope, borders are potentially profitable, whereas *fanya juu* and bench terraces are profitable on moderate and steep slopes. The findings also demonstrated that SLM practices were more profitable when integrated with high-value crop production. For example, from the results, two high-value crops, namely onions and tomatoes, had the highest NPV, whereby onions ranked first (NPV of 2,887,660 Tsh) followed by tomato (NPV of 1,375,160 Tsh) (Table 1).

The following are the main considerations and assumptions made for the NPV, BCR and IRR computations:

- Discount rate of 15%, which is assumed to reflect the prevailing opportunity cost of capital
- Farm size considered for each practice is 1 acre (0.405 ha)
- Projection of costs and benefits over a 5-year period: This is based on the fact that agricultural harvesting practices in question have long-term effects (more than 5 years)

A study conducted in the Uluguru mountains by UMADEP and GRET (2014) showed that *fanya juu* terraces, contour strip cropping, bench terraces, and agro-forestry were profitable. They resulted in a positive NPV and a value of BCR greater than 1. In this regard, *fanya juu* terraces had the highest NPV (TZS 2,415,318), followed by contour strip cropping (TZS 1,677,633), bench terraces (TZS 944,698), and lastly, agro-forestry (TZS 725,665). Likewise, with regard to BCR, *fanya juu* terraces had the highest BCR (7), followed by contour strip cropping and bench terraces, (both with BCR value) of (4), and lastly, agro-forestry (BCR value of 2).

Table 1*. Investment analysis of various SLM practices.*

Practice	Criteria	Maize	Lablab	Onion	Tomato
Bench terraces	NPV (TZS) BCR IRR	453,331 1.4 70%	-375,444 0.6 na	748,347 1.3 93%	1,375,160 1.6 577%
Fanya juu terraces	NPV (TZS) BCR IRR	453 331 1.3 59%	na na na	na na na	na na na
Border	NPV (TZS) BCR IRR	862 742 24 na	897 045 2.3 na	2 887 660 3.2 na	na na na
Conventional	NPV (TZS) BCR IRR	168 336 0.7 na	4 820 1.0 na	na na na	na na na

NPV = net present value, BCR = benefit cost ratio, IRR = internal rate of return, NA = not available.

Environmental benefits

- Soil erosion control: In the Uluguru mountains, about 63 ha were converted into terraces by 327 farmers in Kibungo juu ward during the 2009–2012 period.

- Land cover restoration: In Kibungo juu ward, over 300,000 timber tree species (*Grevillea robusta, Khaya anthotheca, Afzelia quanzensis, Markhamia lutea)* and fruit trees were planted from 2009 to 2012. Total land planted with trees under agroforestry and reforestation programs is about 370 ha belonging to 873 farmers (477 male, 396 female).

- Improved water quality: According to CARE Tanzania (2012), there has been a significant decrease in sediment load in Mfizigo River as a result of SLM interventions (Fig. 1).

Social benefits

Improved food security: A survey conducted in 2012 in eastern Uluguru mountains showed that farmers got higher crop production and productivity per unit of conserved land (*fanya juu* and bench terraces) due to improved biological and chemical properties of the soil (Table 2).

By linking farmers with markets, Kibungo juu farmers managed to generate a high income of Tshs 19,500,000 ($13,000) through the sale of cabbage, tomato, and onion (CARE, 2012). This has improved the community's access to social services such education, health, and housing.

Challenges

The challenges facing smallholder farmers in SLM implementation include lack of tools and inputs, destruction of water-harvesting structures by livestock, incidence of crop pests and diseases, and high establishment cost and labor requirement. Other issues include worn-out irrigation infrastructure, poor market access, and lack of collective action against environmental degradation.

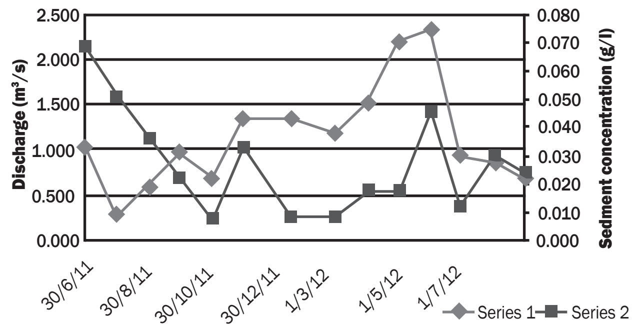


Fig. 1. *Relationship between discharge and suspended sediment in Mfizigo River.*

Table 2. *Changes in crop production.*

Crop	Baseline (2008)	(May 2012)
Maize	< 400 kg/acre	>1,600 kg/acre
Beans	< 120 kg/acre	≥ 950 kg/acre
Cabbage	Nil	≥ 9,600 pcs/acre
Tomato	Nil	≥ 9,000 kg/acre
Union	Nil	≥ 4,000 kg/acre

Source: (CARE, 2012)

Conclusion and recommendations

Adoption of SLM practices is necessary if we are to achieve water-smart agriculture. SLM practices relevant to water-smart agriculture include bench terraces, stone terraces, *fanya juu* terraces, borders, cover crops, mixed cropping, crop rotation, mulching, and trash lines. Other practices are agro-forestry, use of organic manure, double digging, and contour strip cropping. These are relevant in the sense that they control soil erosion, increase crop production, improve farm income, and are sustainable.

For wider adoption of SLM practices that promote water-smart agriculture, the following recommendations are made:

1. As SLM benefits not only land users but also society in general (e.g., through downstream effect), this justifies the use of incentives.

For continued adoption, incentives should be accompanied by creating awareness among beneficiaries as to why they receive the incentive and when it ends.

2. Establish rules and set mechanisms to enforce compliance with SLM agreement.
3. Champion farmers or paraprofessionals need to be identified and trained, especially on the use of technical aspects of SLM and general agriculture. This is to be accompanied by provision of line level for plot measurements.
4. Interventions that involve primary and secondary schools must be done to inculcate environmental stewardship among the young generation.
5. Micro-finance institutions must be promoted in the project area to improve access to capital.
6. SLM practices should be promoted together with irrigation improvement, use of high-value crops and linkage of farmers to markets. For SLM practices to be widely adopted, they should be profitable.
7. Ensure regular field follow-up and evaluation of ongoing activities.

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