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COMMUNITIES' PERCEPTION ON THE CONTRIBUTION OF SOIL AND WATER CONSERVATION MEASURES IN IMPROVING LAND PRODUCTIVITY IN THE DRY-LAND AREAS OF TANZANIA: THE CASE OF TERRACE, "FANYA JUU" and DOUBLE DIGGING IN SAME DISTRICT

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ABSTRACT

Soil and Water conservation (SWC) measures play significant role in improving land productivity. The study assessed contribution of soil and water conservation measures/techniques in land productivity in dry-land areas of Same District, Tanzania. The study investigated the relevance and effectiveness of SWC measures such as bench terrace farming, double digging and "Fanya juu[1]/Fanya chini". Qualitative and quantitative approaches were used to gather information for this study whereby a range of methods including Key Interviews, Focus Group Discussion, literature review and field observations were employed. The findings revealed that appropriate implementation of the SWC measures has significant impact in terms of increased crop yield, checking soil erosion and retaining soil moisture. The findings further revealed that Bench-terrace and "Fanya juu/Fanya chini" terrace farming were perceived by community members to have remarkably contributed in improving crop yield in the upland areas while application of double digging was commonly used and much better in improving land productivity in the low land areas of Same District. The findings showed cases where maize production was perceived to have increased from 8 to 18 bags per acre prior to and after application of the double digging technique respectively. The study concludes that if applied judiciously, SWC measures are instrumental in improving land productivity and could be potential in improving community livelihoods and they are thus, worth replicating to other dry land areas across the country.

[1] Terraces made by digging a trench along the contour and throwing the soil uphill to form an embankment. The embankments are stabilized with fodder grassed. The space between the embankments is cultivated. Overtime the "Fanya juu" develops into a bench terrace. *Fanya juu* literally means throw soil up hill in Swahili

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Keywords: Soil and water conservation, perception land productivity, dry land areas, efficiency effectiveness

1. INTRODUCTION

This paper looks more strongly at perception of local communities on techniques promoted to produce crops in unfavourable climatic condition that affect agriculture sector in semi-arid areas. These areas have low agricultural productivity which is exacerbated by hash climatic condition characterised by low and erratic rainfall patterns and recurrent droughts (Vohland and Barry, 2009). Such areas are also characterised by intra-seasonal dry spells which can happen in critical stages of crop growth (Rockström et al., 2003). This variation in climatic condition not only affect plant growth but also species capacity to adapt, and reduction of potential biomass in particular area. This emanates from the fact that water that falls is too little for crops because the amount is too little (small) to penetrate the soil sufficiently, some run through the porous soil too quickly, and much of it flow downstream as run-off. As a result of these factors, agriculture in area is affected severely; hence low crop yields are experienced. Under such situations, agricultural techniques lengthen time that water stay in the soil for plant growth and development are imperative.

Same District presents a compelling case of these unfavourable factors; the area is characterised by long drought spells, low rainfall with high variability. In this situation the literature suggest measures to deal with these major challenges such as planting trees, practicing conservation agriculture, use of micro-dam rainwater harvesting for irrigation, and use of terraces to reduce run-off, soil erosion and increase soil water infiltration rate (Liwenga et al., 2012). Techniques like these in Same district have been introduced by different organisations like the Sokoine University of Agriculture, the Same Agricultural Improvement Trust Fund (SAIPRO), CARE International and the government. Now the question here is “how do farmers perceive these techniques?” Ground observation has shown that smallholder farmers in Same use agricultural techniques which are soil and water conservation (SWC) measures.

Apparently, Soil and Water Conservation (SWC) measures/techniques are widely acknowledged as effective and relevant measures for improving land productivity. Despite being laborious bench terrace farming (as one of these measures) for instance is consistently commended for improving soil characteristics, checking soil erosion and improving crop yields. Several studies (Unibraw (1986) in Carson (1990); Siebert et al (1990) concurs that bench terraces can greatly reduce erosion, increase infiltration and make the land more easily managed during normal agricultural operations. In their study Siebert et al (1990) go further and provide statistics that as compared to unterraced field under the same cropping pattern bench terraces can reduce soil erosion by 70%. Other SWC measures such as traditional no-till (TNT), shallow tillage (ST) and

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ridging tillage (RT) are reported to play a remarkable role in improving crop yield, improving soil fertility, reducing weed infestation and soil moisture retention in the water scarce areas/dry-land areas (Shemdoe et al; 2009). While there is an increasing body of literature on SWC measures particularly terracing and double digging about their effectiveness, challenges and so on, the insights provided has been in its generality and not much is known about the workability of these measures in the dry-land areas. It was thus deemed necessary to undertake this study in one of the semi-arid/dry-land areas as a contribution to the existing literature is so far as the role SWC measures in improving land productivity are concerned.

2. MATERIALS AND METHODS

This study was conducted in Same District which is one of the dry-land/water scarce areas in Kilimanjaro region, Tanzania. The study involved five villages of Vudee, Bangalala, Mwembe, Mgwasi, and Ruvu Jiungeni (Figure 1). These villages were selected because they are the ones in which Soil and Water Conservation (SWC) techniques are practiced. Important also is that the villages were selected based on their agro-ecological zones and characteristics: For instance Vudee is a mountainous village experiencing high rains, Bangalala, Mwembe and Mgwasi are located in middle, a semi-arid area relying on farming and livestock keeping while Ruvu Jiungeni is a lowland village reliant on farming entailing both rain-fed and irrigated farming.

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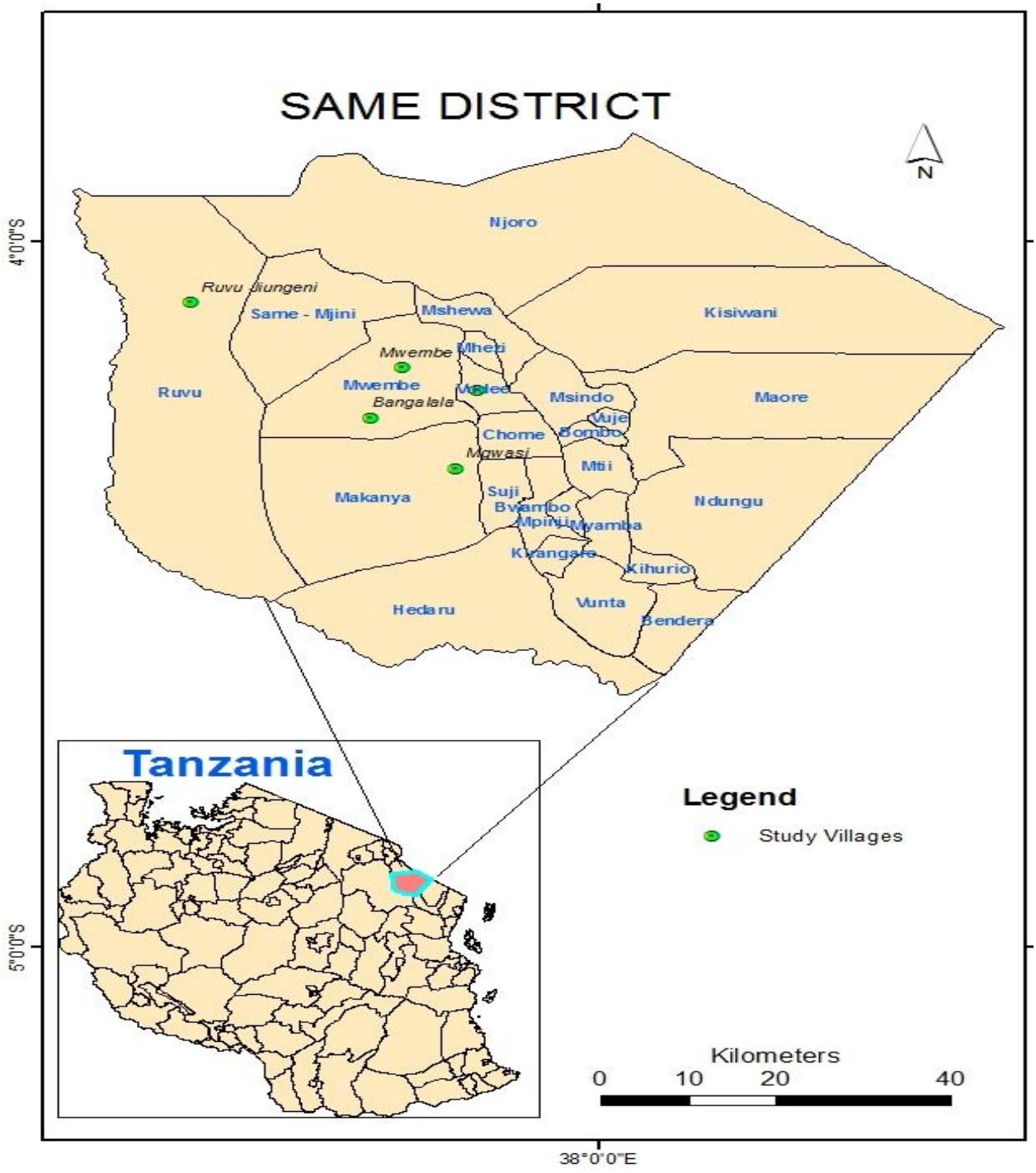

Figure 1: Map of Same District showing study Villages

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The study mainly employed both qualitative and quantitative approaches entailing a range of methods to collect data including Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), Field observations and literature review. Both KIIs and FGDs were used to solicit and capture information from respondents on their perception about performance of the SWC measures being implemented in the study villages particularly in terms of their relevance, effectiveness and impact and particularly in connection to yield change. Similarly the researcher visited farms of different respondents to observe SWC measures including bench terrace farming, double digging, "Fanya juu"/"Fanya chini" that they implement in order to get first hand information about these measures (plat 1.).

In terms of literature review, a range of documents, research reports, policy documents and published papers on SWC measures in Tanzania, district development plans and other materials related to economic activities in the dry-land areas and other places across the World were reviewed to get more insights and link them with the ones being implemented in the study villages. Some 25 Key informants were interviewed; five were from Same District Council, one from Water User Association (WUA) based in Same town and the rest were from the respective study villages. The size of the groups ranged from 6-8 members involving both males and females. Table 1a & b shows location and number of keys informants and number of members of discussion groups conducted.

Table 1a: Number of interviewed of Key Informants

KEY INFORMAT INTERVIEWS	
Department/Village involved	***Number of informants***
District Community Development	2
District Agriculture &Irrigation	2
District Water Resources Management	1
Pangani Water Users Association (WUA)	1
Mwembe village	4
Vudee village	5
Bangalala Village	4
Mgwasi village	3
Ruvu Jiungeni Village	**3**
Total Number of Key Informants	**25**

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Table 1b: Number of interviewed of Key Informants

FOCUS GROUP DISCUSSIONS			
Location	***No. of males***	***No. of females***	***Total group members***
Mwembe village	2	4	6
Vudee village	1	4	5
Bangalala Village	3	4	7
Mgwasi	1	5	6
Ruvu Jiungeni	2	6	8
Total	**9**	**23**	**32**

3. RESULTS AND DISCUSSION

3.1. Agro-economic conditions of the study villages

The selected villages for this study reflect a wide range of agro-climatic conditions in upland land, mid land and lowland areas of Same district. To a large extent farmers in these villages and Same district in general depends on agriculture as their main source of livelihoods with high dependence on rainfall (Mother Nature). However, rainfall varies significantly across the district with "reliable" rains experienced more in the Mountainous areas. Clearly, this is supported by Liwenga et al (2012) who observes that local agriculture is highly dependent on local rainfall, either directly or via local irrigation systems, which shows a high degree of variability and unpredictability. Worse still recurrent droughts experienced in the area makes the situation even stiffer to the smallholder farmers. Water shortages attributed to higher temperatures and stronger winds are also among the factors affecting farming in the study villages as they translate directly to the impacts on crop and livestock production and food security. In this case irrigation is key practice that ensures agricultural production in the study area. Irrigation is however being limited due to various reason but the main one is limited water sources in Same district. |The main and reliable source of water for irrigation is Pangani river which passes Ruvu Jiungeni in the lowland areas.

Liwenga et al (2012) also noted that high degree of rainfall variability and unpredictability has caused outmigration local farmers from high and mid lands to other parts of the country to seek for suitable agriculture conditions and also selling their labour for in agriculture or other economic sectors. Others have migrated to urban areas like Moshi, Arusha and also Dar es

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Salaam for other economic activities. This outmigration has caused reduction labour power/forces in the villages hence no or limited crop and livestock production.

3.2. Population, land ownership and land size

For years population in Kilimanjaro region and Same district in particular have been growing steadily. Population density of Kilimanjaro region is 124 persons per square kilometre. This figure is well above other regions in Tanzania mainland except Dar es Salaam and Mwanza. The current population in Same District is estimated to be 269,807 while in 2002 the population was 211,738 people (National Census data 2002, 2012). Clearly, this increase is remarkable and has direct implications as it exerts a lot of pressure on land and other natural resources. The current populations in the study villages are as follows: Bangalala 4,793, Mwembe 3,389, Mgwasi 2,503 while Vudee is 2,079 people far above if compared with the 2002 figures. Coupled with the changing climatic conditions in the district; this demographic situation compel farmers to adopt to alternative land use practices including SWC techniques.

In terms of land ownership and size the study revealed that while the majority of the farmers own land, on average land size is relatively small with the majority having between 1-5acres. Under such conditions therefore practicing intensive rather than extensive farming using improved measures is seemingly more suitable and needs to be promoted. As noted from Everything Connect website (accessed in September 12, 2016 http://www.everythingconnects.org/intensive-farming.html) intensive farming is an agricultural intensification and mechanization system that aims to maximize yields from available land. Intrinsically, intensive farming practices produce more and cheaper food per unit of land and animal to feed a booming human population and may prevent surrounding land from being converted into agricultural land.

3.3. Relevance and impact of Soil and Water Conservation Measures

Generally, Same district faces scarcity of water for both home use and farming. This is due to the fact that the district is a semi-arid experiencing drought with fewer rains. As a way of coping with these harsh climatic conditions; most smallholder farmers in Same district practice traditional irrigation systems which is more practiced in high and mid land areas. successful results of using traditional irrigation systems farmers in Same district through various programs and initiatives have been practicing soil and water conservation (SWC) measures for which this study focused on. This study's focus is important as it is provides comparative solutions towards the issue posed by Mutabazi et al. (no date indicated) on semi-arid areas being less productive in agriculture. At the policy level implementation of these measures notably bench terraces, Fanya juu/Fanya chini and double digging responds well to a range of policies and strategies including National Agriculture policy, Irrigation policy, Vision 2025 and the National climate change

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strategy which promote sustainable land use practices. The findings showed that common measures/techniques being implemented in the study villages are the "bench terrace"[2] framing, "Fanya juu" and "double dinging[3]". Farmers who were interviewed reported that in the course of implementing these techniques they have realized that they are very useful in checking soil erosion, saving water, retaining soil moisture and improving land productivity and crop yield. Evidently there is significant increase in crop production in the project villages. However, the downside is that not many farmers are practicing these measures in the study villages. This situation is due to a number of factors/challenges that will be elaborated in the subsequent sections.

3.3.1. Bench terrace farming and improved crop yield

Bench terrace as a technique used in farming is widely acknowledged as being an effective and excellent method to reduce soil erosion and improving land productivity in the steeply sloping agricultural land in the tropics (Carson;, 1990, Siebert & Belsky, 1990)

The respondents in the study villages, both at the district and village levels reported that use of bench terrace in farming has shown significant positive results in checking soil erosion and eventual increase in crop yield (Table 2 & Fig. 1). Respondents applying bench terrace in Vudee which is the most mountainous village among the study villages noted that application of this technique is fruitful and has significantly changed their mindset towards its implementation. This is substantiated by the testimonies given by several farmers during interviews. For instance a farmer (woman) who is practising this technique in Vudee village gave the following remarks:

> *"Initially my thinking was that bench terrace farming is an impossible undertaking but upon attending training on terrace provided by some NGOs, I was convinced that I can manage. Today the story is different. I no longer sell labour like before, I have my own farm plots with terraces where I grow onions and maize. I am food secure, I sell onions and can pay school fees for my children. I don't think I will refrain from practicing terrace farming".*

Such remarks from a person practicing bench terrace farming is a clear indication that making more farmers know and appreciate the usefulness of this technique could bring about more impact in terms of increased farm production and improved food security in the study villages and Same district in general.

[2] An embankment or ridge of earth constructed across a slope to control runoff and minimize soil erosion

[3] A type of strip tillage where farmers use a hand hoe that has been modified to be about one-third the width of a normal hoe, which helps the farmers till a thin strip of soil about 30 inches deep

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Table 2: Change in maize harvest on bench terraces in Vudee village

Farm No.	Land size (acre)	Crop type	Type of SWC measure	Harvest (bags)	
				Before using bench terrace farming	While Using bench terrace farming
Farmer 1	0.25acre	Maize	Bench Terrace	0.6	1.5
Farmer 2	0.25 acre	Maize	Bench Terrace	0	0.5
Farmer 3	0.25 acre	Maize	Bench Terrace	0.5	4.0

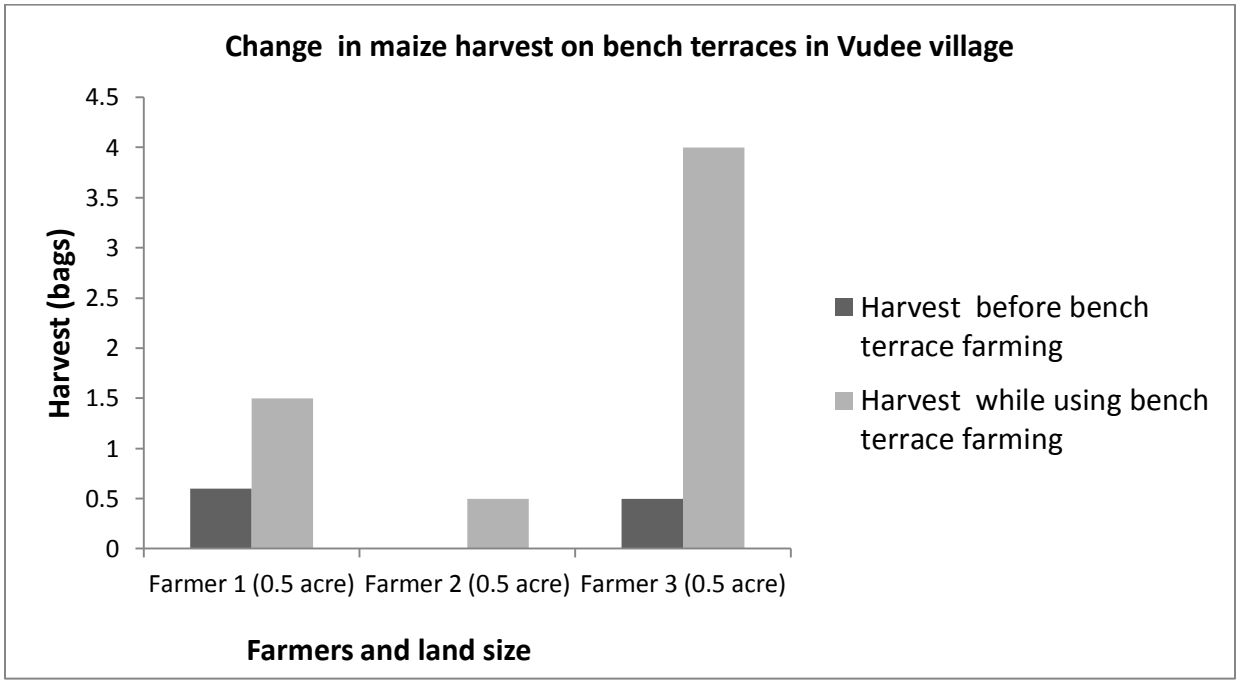

Fig 1: Change in maize harvest on bench terrace in Vudee village

Table 2 and figure 1 demonstrates significant increase of crop production from three different farmers each owning a plot size of 0.25 acres. It was deemed important to know why the same land size among three different farmers but with variation in crop yield and it was established that some of the farmers apply manure in their field while others don't apply manure. It was also revealed that the variation could be attributed to the level of management of the terraces on which crops are grown for instance it was indicated that if a terrace is well maintained by

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growing vetiver grass to ensure he soil is stable it can produce more as compared to a terrace where such practice is not done. Generally, a well managed terrace can yield more yield compared to the one which is not well managed. Such an observation was the same among all farmers practicing bench terrace farming particularly in the mountainous and midland villages. This is also qualified by Wamba (2015) who stipulated that farmers practice or investing in these techniques (bench terrace and fanya juu) in Pare Mountains, Same District have achieved incremental net benefit. The facts provided is that these techniques enhance water availability in the soils, improve soil health, resulting in production increase and they increase water use efficiency, leading to higher farm income.

3.3.2. Fanya juu terrace farming and increased crop yield

"Fanya juu" terrace farming was reported to be a relevant and useful intervention in increasing crop yield depending on land size and management of the terraces (plate 1). This was revealed during interviewees with farmers who are practicing "Fanya juu" terrace farming in Mwembe and Bangalala villages. Farmers indicated that they saw a tremendous increase in maize harvest upon starting practicing this improved land use intervention. For instance it was interesting to learn that a farmer who was harvesting 2 bags of maize from 0.5 acres before practicing Fanya juu terrace farming her harvest increased to 5 bags in the same land size and the farmer who used to harvest just 6 bags from his 2.5 acres farm, his harvest doubled to 12 bags upon switching into using "Fanya juu" terrace farming. Similarly, the farmers have indicated that fanya juu terraces improve storage of moistures in the soils to support crops' growth. The statistics are as shown in Figure 2.

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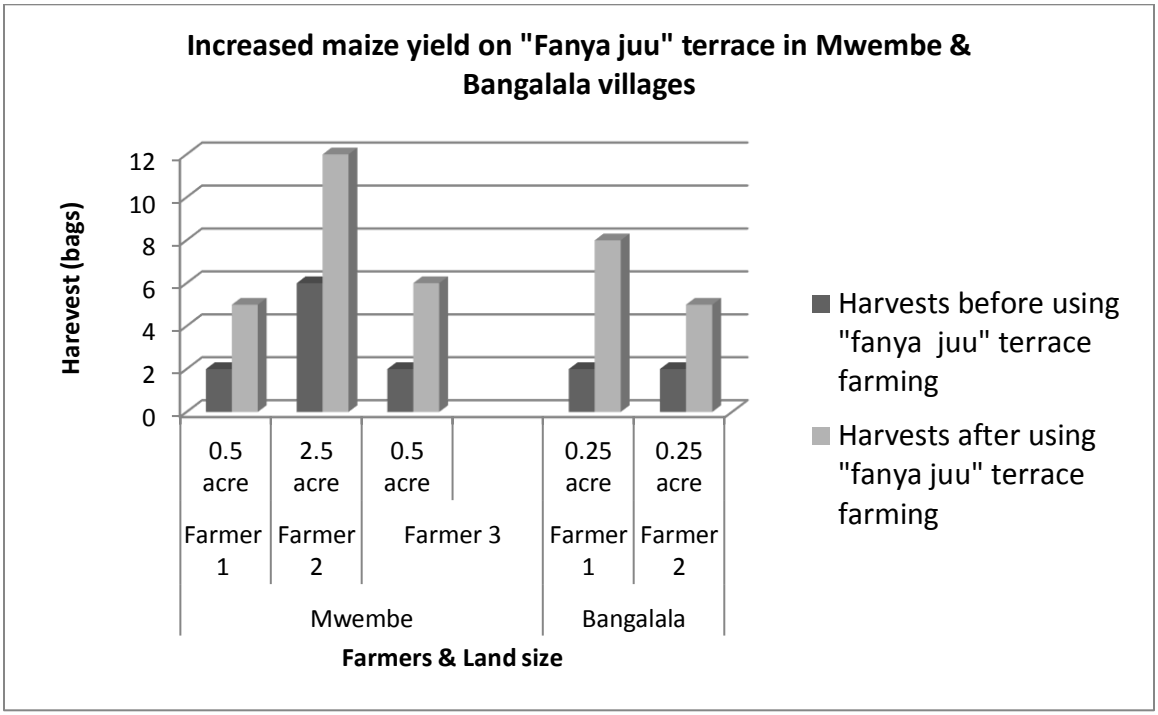

Fig 2: Increased maize yield on a "Fanya juu" terraces in Mwembe and Bangalala villages

Plate 1: Maize flourishing on a "Fanya juu" terrace in Mwembe village, Same District

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The interviewed farmers reported that although preparing both bench and "Fanya juu" terraces is a laborious task; they have proved to be more productive as compared to the traditional farming that they used to practice before. On the wholly farmers admitted that the land use techniques that they are implementing have been very helpful in increasing farm productivity, ensuring food security particularly at the household levels and indeed as an adapting strategy to the changing climatic conditions in Same District. Almost all farmers said that terraces enabled them to practice irrigation with little amount of water and also grow high value crops like onions, tomatoes and round potatoes during off and short rain seasons.

3.3.3. Double digging and increased crop yield

The other technique assessed was "double digging" or also known as zonal tillage. This was observed to be mostly practiced in the lowland areas of Same district notably Ruvu Jiungeni village. The study revealed that application of double digging was more effective in increasing crop yield compared to the rest of the techniques. For instance a farmer who was harvesting just

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4 bags of maize in a 1hectre before starting applying this technique, found harvest increasing to 12 bags of maize in the same land size while the other who cultivates "lab lab" indicated that yield increased from 4 to 8 bags before and after using double digging respectively. Famers also noted that using double digging has enabled them to save water for irrigation as described by one of the respondents:

> "*Since I started applying double digging; I have noticed a tremendous saving of water I use to irrigate my farm. Previously I used to irrigate my 2acre plot weekly but with double digging I can stay up to fourteen days before doing another round of irrigation".*

This farmer from Ruvu Jiungeni village also noted that with the use of double digging he has seen significant increase in crop yield. The same was reported by another farmer who noted that through adoption of double digging technique she has witnessed high and quick water infiltration in the soil. She insisted that the benefit of practicing this technique is more dramatic and without those techniques she could not be able to produce enough. For example before application of micro basins – zonal tillage integration she was harvesting average of six bags of maize each with 100Kg capacity but after applying appropriate double digging technique production has increased to 18 bags of maize. Interestingly and more importantly she reported that she is now able to use the same piece of land producing two times per year.

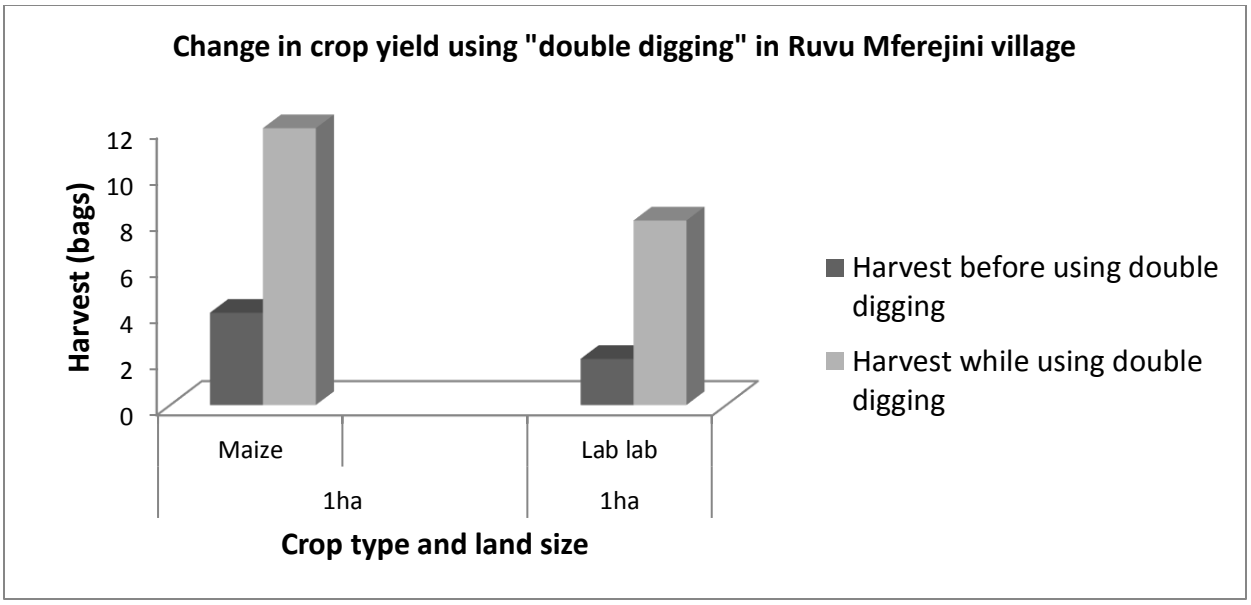

Fig 4: Change in crop yield using "double digging" in Ruvu Mferejini village

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3.4. Some relevant policy issues

The National Agriculture Policy of 2013 accepts that inappropriate land husbandry practices are among the main causes of low soil productivity in the country; indicating further that this is aggravated by inadequate enforcement of land laws, regulations and by-laws (ibid.).

The policy also highlights low productivity of land and underdeveloped irrigation potential as setbacks to the agriculture sector. Similarly the Policy has specific objectives on addressing challenges facing agriculture sector including creating enabling environment to attract youths to participate effectively in agricultural production. Despite such acknowledgement on challenges facing the agriculture sector; the policy doesn't put much emphasis on the SWC measures in connection to their effectiveness in improving land productivity.

4. CHALLENGES OF IMPLEMENTING SWC MEASURES/TECHNIQUES IN SAME DISTRICT

Farmers implementing SWC measures in the study villages stated that, although these techniques seem to be promising, they are associated with a range of challenges. Firstly, they said establishment of terraces is a laborious and time consuming task and as a result not many people are interested in practicing terrace farming and for that the uptake of this technology is seemingly slow. Expectedly the youth would contribute more in implementing these methods; however they seem to desist from doing so as they search for quick and less laborious and time consuming income-earning activities. Secondly, the interviewed farmers named lack of timely and adequate guidance from extension officers. This is attributed to huge shortage of extension officers and other local government officials in the study villages. In some villages for example Vudee village; the extension officer was found assuming responsibilities of the Village Executive officer, hence lacking adequate time to attend to his core responsibilities that includes guiding and advising farmers on the suitable farming practices. More so, there were cases where due to shortage of staff; one village extension officer is compelled to attend the whole ward. Thirdly; for the farmers who are aged; not energetic, to construct terraces on their own they are compelled to hire people to construct terraces for their own. However, not every farmer can afford to meet the required costs. The other challenge that farmers face is difficulties in securing water for irrigating their crops. This is partly due to the increased use of water but also poor irrigation infrastructures especially poor furrows which results into water loss. This is confirmed by the study on water use efficiency which assessed Canals flow and revealed that only 4% of the released water from the source reached the terminal point of the main canal with more than 80% percent lost between 0 and 360m chainage.

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5. CONCLUSIONS AND RECOMMENDATIONS

This study was undertaken to ascertain the general claim that SWC measures plays significant role in improving land productivity. It was specifically conducted in Same district to represent dry-land areas in Tanzania. The findings has revealed that the Soil and Water Conservation (SWC) measures/techniques being implemented in the study villages in Same district are effective in terms of improving land productivity and crop yield and eventual improved food security in the study villages. However, not many farmers are practicing these measures and this is attributed to a number of factors as indicated in the previous sections. It is important therefore that awareness creation sessions on the usefulness of these techniques are organised and conducted so that more farmers are aware and are sensitized to practice these intervention measures. The fact that bench terrace farming and "Fanya juu/Fanya chini "are labour-intensive; farmers should be encouraged to work in groups/associations. This makes the work of constructing terraces much easier. More so, to be more impactful SWC measures being practiced in the study villages should be scaled-up. This could be achieved through sensitization and awareness programmes and where possible these techniques should be replicated to other dry land areas in Tanzania. Farmers should also be encouraged to practice other relevant and even cheap and easy to establish SWC measures such as vegetative strips. More extension officers should be recruited and deployed to these areas so that farmers can have access to reliable extension services for appropriate implementation of these measures/techniques. There is a need for lining the irrigation furrows/ canals in the study villages to address the problem of water loss. This should go hand in hand with promotion and implementation of rain-water harvesting methods in the study villages to make more water available to crops.

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