The Influence of Soil and Water Conservation Technologies on Household Food Security among Small-Scale Farmers in Kyuso Sub-County, Kitui County, Kenya

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ABSTRACT

This paper examines the influence of soil and water conservation technologies on household food security among small scale-farmers in Kyuso Sub-county, Kitui County, Kenya. The Sub-County suffers from food insecurity due to declining agricultural productivity. The government of Kenya has continuously promoted dryland farming technologies in this region. Despite these efforts food insecurity has been rampant. The purpose of this study was to determine the influence of soil and water conservation technologies on household food security among small-scale farmers in Kyuso Sub-County. The soil and water conservation technologies examined were terraces, log lines, stone lines, grass strips and earth bunds. The study was carried out in Kamuongo Division using the descriptive survey design. Structured interview schedule was used to collect data from a sample size of 140. Multiple linear regression model was used to analyze data. The results revealed that, at 5% level of significance soil and water conservation technologies did not significantly influence household food security in Kyuso Sub-County.

Key words: Kyuso sub-county, household food security, dryland farming, soil and water conservation.

INTRODUCTION

Crop production in dryland areas must be improved to help meet the requirements of the growing world population. A major contribution to this improvement will be the capture and use of a greater portion of the limited and highly variable precipitation in dryland areas. Dryland farming technologies including water and soil conservation and management can increase water use efficiency, thus increasing yields and reducing the likelihood of crop failure (Food and Agriculture Organization [FAO], 2008).

The majority of the population in sub-Saharan Africa make their living from rain-fed agriculture. In Kenya 85% of her population derive their livelihood from rain-fed subsistence agriculture (Rockström, 2000). More than three-quarters of Kenya’s land is arid or semi-arid with 3.2 million food insecure affected marginal farmers and agro pastoralists living in the arid and semi arid Sub-Counties of eastern Kenya (Food and Agriculture Organization [FAO], 2009). Jan (2007) contends that if agricultural research is to help the small-scale farmer, there must be a selective emphasis on technology appropriate for the typical small-farm situation of scarce financial resources and poor access to information (Jan, 2007).

Kenya’s agriculture in arid and semi-arid areas is predominantly small-scale. Production is carried out on farms averaging 0.2-3 ha and without irrigation. Farms are generally small, and in most cases are suffering from a degradation of resources and the environment (GOK, 2010).

Land resource is a major input in agricultural production whether in dry or humid areas. The major purpose of dryland farming technologies is to conserve soil, water and nutrients for the purposes of crop production (Gichuki, 2000). Soil erosion is the process of detachment of soil particles from the top soil and transportation of the detached soil particles by wind and / or water. The agents causing erosion are wind and water. The detaching agents are falling raindrop, channel flow and wind. The transporting agents are flowing water, rain splash and wind (Mutunga et al., 2001). According to Douglas (1994) when land suffers from soil erosion and degradation, it loses its productivity. He explains soil degradation as the decline in...
the productive capacity of the soil as a result of soil erosion and changes in hydrological, biological, chemical and physical properties. Gichuki (2000) states that land degradation can result from inappropriate land use and poor land management. He adds that investments in soil management can be justified on the basis of sustaining and improving land productivity. Soils in semiarid areas are generally fragile and of low inherent producing capacity. The objectives of soil management are to maximise the limited water supply, maximise plant nutrient supply, minimise erosion, and maintain or improve soil fertility and soil physical conditions (Mati, 2006). Water and soil nutrient management form a critical component of agricultural production. In the drylands water and nutrient conservation are dictated by the need for water harvesting and conservation and the available technology (Mutunga et al., 2001).

In the arid and semiarid areas dryland farming technologies are key to achieving food security. Degradation of the land resource and the environment has been identified as a major problem inflicting small scale farmers in Kyuso Sub-County. Though the Ministry of Agriculture and other stakeholders have over the years been sensitizing and training small-scale farmers on various dryland farming technologies, Kyuso Sub-County has remained food insecure. Many small scale farmers in the Sub-County depend on food aid for their survival. Lack of proper soil and water conservation structures and failure to harvest rain water could be some of the major causes of food insecurity in the Sub-County.

The objective of the study was to examine the influence of soil and water conservation technologies on household food security of small scale farmers in Kyuso Sub-County. From the objective of the study, the following null hypothesis was derived and was the basis for the investigation: There is no significant influence of soil and water conservation on household food security among small-scale farmers in Kyuso Sub-County.

### SOIL AND WATER CONSERVATION IN DRYLAND FARMING

Soil and water conservation form part of the wider aim of conservation of natural resources, which covers also the conservation of other resources including water, forest, pasture and wildlife (Mollison, 2008). As the world’s population grows; improving living standards without destroying the environment is a global challenge (Hinrichsen, 2000). In all arid regions a major challenge is to manage water appropriately. The purpose of such management is to obtain water, to conserve it, to use it efficiently, and to avoid damage to the soil (Creswell and Martin, 1998). Conservation of the environment and sustainable utilization of natural resources are major issues of concern within the international community (Li et al., 1999). Land degradation is a serious environmental problem worldwide and a major threat to the sustainability of agriculture and economic development (Xiao-Yan Li, 2000). Different systems of soil and water conservation are practiced both in Kenya and other parts of the world. Since the economy of Kenya is heavily dependent on agriculture it is critical that soil and water resources are properly managed to sustain this important sector (GOK, 2010). Improving agricultural productivity is central to achieving Millennium Development Goals in the country. However wide spread land degradation, exemplified by erosion and declining soil fertility, which in turn leads to falling production remain a big challenge in the country (Swallow et al., 2003).

Field investigations in the 1980s gave different estimates of the benefits of conservation on small-scale farms in Kenya. In Nandi Sub-County it was found that the average yield of maize and beans was 62 and 77% higher respectively on land where conservation had been done. Similar work done in Machakos, found that the yield of maize was on average 47% higher on terraced land than on non-terraced farms (Kimaru and Jama, 2005).

Early conservation programmes in the country emphasized building of physical barrier to control run off. These measures tended to target the symptoms of land degradation rather than the immediate underlying causes such as poor land management, overstocking and overgrazing which may themselves result from other factors (GOK, 2010). Good management of land under crop with improved practices are the best measures to reduce erosion on crop land. Good management practices such as contour cultivation, strip cropping, grass strips or building of terraces will break up the flow patterns and increase the infiltration rate. Clearing of steep slopes, above 12%, for crop cultivation without providing for erosion control measures greatly accelerates the erosion rates on these slopes (Biamah and Nhlabathi, 2003).

Soil and water conservation can be described as activities that reduce water losses by runoff and evaporation, while maximizing in-soil moisture storage for crop production, but the same could be said of rain water harvesting. The two are differentiated by the fact that under soil and water conservation, rainwater is conserved in-situ wherever it falls, whereas under water harvesting, a deliberate effort is made to transfer runoff water from a “catchment” to the desired area or storage structure (Mati, 2006). The important thing is that both systems complement each other, and under rain-fed agriculture in dry areas, both are necessary nearly all the time.

Indigenous and innovative technologies in soil and water conservation abound in Kenya (Reij and Steeds, 2003). In-situ soil and water conservation systems are by far the most common. From a development perspective the argument for the promotion of soil and water conservation measures have been to control soil erosion. This involves managing the negative side-effects of water (Mutunga et al., 2001).
In Kenya the famous *Fanya Juu* terraces, which are made by digging a trench, normally along the contour, and throwing the soil upslope to form an embankment, has had a very significant effect on reducing soil erosion in semi-arid areas with relatively steep slopes (< 20%) (Thomas, 1997). According to Tiffen et al., (1994) adoption of *Fanya Juu* terraces played an important role in reducing land degradation in Machakos Sub-County over a period from the 1930s – 1990s when population increased more than fivefold. Similar widely spread techniques are the *Fanya Chini* (soil thrown down slope instead of upslope), stone bunds, and trashlines (successfully promoted through extension in dry areas of South-eastern Kenya) (Rockström, 2000).

In Kyuso Sub-County various soil conservation technologies have been promoted and adopted to varying degrees. Such SWC technologies include "*Fanya Juu*" terraces, retention ditches, cut-off drains, stone lines, trashlines, grass strips and agroforestry (MOA, 2011).

**MATERIALS AND METHODS**

This study was conducted in Kyuso Sub-County located in the Kitui County of Kenya. The Sub-County covers an area of 2,509 km² with a population of 64,224 people and 12,378 households (Kenya National Bureau of Statistics [KNBS], 2010). It is one of the arid and Semi-arid Sub-Counties in Kenya receiving average annual rainfall ranging from 250-780 mm.

The study adopted a descriptive survey design. This design was appropriate because it enabled the description and exploration of the soil and water conservation technologies used by farmers in the selected study areas and determined the household food security in the Sub-County (Kathuri and Pals, 1993). The variables under the study were not manipulated. According to Mugenda and Mugenda (2003) this research design seeks to obtain information that discloses existing phenomena by asking individuals about the soil and water conservation technologies, their level of implementation, status of crop production and the existing household food security.

According to the Kenya National Bureau of Statistics (2010) Kyuso Sub-County has 12,378 households. This constituted the target population. The accessible population consists of all the 2,629 households in Kamuongo Division of Kyuso Sub-County, the study area (KNBS, 2010). The average farm holding is about 2 ha. Mixed farming is practised. Farmers keep goats, sheep and cattle and also plant crops such as maize, sorghum, pearl millet, cowpeas and green grams. Horticultural crop production is practised along seasonal river valleys. The horticultural crops grown are mangoes, pawpaws, tomatoes, kales and onions (MOA, 2011).

A sample of 12 to 15 individual farmers were selected purposively from each location in the study area for the initial focus group discussion (FGD) planned for the study. The criteria for their selection were gender, age, education, and marital status. One sublocation was selected randomly from each location to be a site for FGD.

Kyuso Sub-County has 4 divisions. One division, Kamuongo, was selected purposively because the Ministry of Agriculture had in the past promoted soils and water conservation technologies in the division. There are 12,378 households in the Sub-County. In social science research, the following formulae can be used to determine the sample size:

\[ n = \frac{z^2pq}{d^2} \]

Where: \( n \) = the desired sample size (if the target population is greater than 10,000), \( z \) = the standard normal deviate at the required confidence level, \( p \) = the proportion in the target population estimated to have the characteristic being measured.

\[ q=1-p \]

\( d \) = the level of significance set.

Where, \( 0<p,x<1 \), according to Mutai (2000) confidence level 95%, the level of accuracy of 10% \( z = 1.96 \) from normal distribution may be used when very strong evidence is not required, if there is no estimate available of the proportion in the target population to have the characteristic of interest, 50% should be used (Mugenda and Mugenda, 2003).

Since the target population is more than 10,000 the formulae applies:

\[ n = \frac{(1.96)^2 (0.5) (0.5)}{(0.05)^2} = 384 \]

With a large sample, the researcher is confident that if another sample is taken of the same size, findings from the two samples would be similar to a high degree (Mugenda and Mugenda, 2003).

A sample size of 140 was selected. This sample size was adequate as Kathuri and Pals (1993) and Denscombe (2007) recommend a minimum of 100 subjects as ideal for a survey research in social sciences. The extra 40 was necessary to take care of none response and attrition. This extra number of farmers also assisted in giving meaningful representation in the study area.

Out of the four administrative divisions of Kyuso Sub-County, Kamuongo was purposively selected. This is because dryland farming technologies have been promoted in the division over time (MOA, 2011). It was thus a representative of the population. Divisional and Locational extension officers were used to draw a list of all the household heads in the study area.
Proportionate random sampling was used to determine the number of respondents for a given location while systematic random sampling was then used to obtain the actual respondents from the location. For each location the target population was divided by the proportionate sample size to obtain the sampling interval for the location. The starting point was blindly selected using table of random numbers (Mugenda and Mugenda, 2003). Respondents were picked from that determined starting point and following the sampling interval. This formula was applied to all the three locations until the sample size of 140 was obtained. The specific sample sizes for the selected locations are as shown in Table 1.

Two instruments were used to collect data in the study area. A focus group discussion guide was used to collect data about the soil and water conservation technologies practised by the small scale farmers in Kamuongo Division. It was also used to collect data on the status of food crop production as a result of these technologies, extent of household food insecurity among the small scale farmers and the soil and water conservation technologies that influence the small scale farmers’ food security in the study area.

A structured interview schedule was used to collect data from household heads involved in the study. A structured interview schedule was chosen because of the ease of administration and scoring of the instruments besides being readily analyzed (Cohen et al., 2007). It was also useful in that the type of response to items facilitates consistency across the respondents (Denscombe, 2007). This type of instrument is useful in that it allows participation by illiterate people and allows clarification of any ambiguity in addition to minimizing discrimination of the less articulate (Leung, 2001; Kvale and Brinkmann, 2009). The instrument collected data on the dryland farming technologies practised by small-scale farmers in Kyuso Sub-County. It was also used collect information on the crops grown and the food situation status. Challenges faced by farmers as they implement the soil and water conservation technologies were explored.

The instrument was subjected to peer examination in the Department of Agricultural Education and Extension and colleagues in the Ministry of Agriculture. Secondly academic experts looked at its contents and determined its ability to measure what it was intended to measure. In addition appropriate sampling procedures were be used to eliminate or reduce validity threat due to selectivity. A built in theoretical framework in the proposal was used to assess compliance to construct validity. For focus group discussion instrument validity was ensured by having colleagues and experts discuss it and ensured that all aspects of interest were covered. The researcher himself who had thorough understanding of the subject moderated the discussions. In order to follow deliberations and to avoid losing track the researcher was assisted by another person in recording proceedings.

The structured questionnaire instrument was pilot-tested in Kyuso Division, Gai Sublocation which has similar subject, climatic and agroecological characteristics as the study location. Twenty households were surveyed during the pilot test. The piloting of the instrument helped to assess its appropriateness and aided in further refinement based on its reliability coefficient. The reliability of the instrument was estimated after the pilot study using the Cronbach’s alpha procedure. A reliability coefficient of 0.795 was obtained which is above 0.7 adopted as the minimum threshold as recommend by Fraenkel and Wallen (2000) and Boermansab and Kattenbergb (2011). The tool was therefore good and was used for data collections.

Data collection included Focus Group Discussion with key informants and self administered questionnaire instrument to the 140 sampled household heads. Data and summaries from the Focus Group Discussions were analyzed using descriptive statistics namely percentages and frequencies to capture categories and patterns of interest.

Data from the questionnaire was transcribed, coded and synthesized by study objective. Data entry in the computer then followed after which analysis of quantitative data was done, using the statistical package for social sciences (SPSS).

The objective was analyzed using descriptive statistics namely percentages and frequencies and multiple linear regression was used to determine the relationship between the independent and the dependent variables. Multiple linear regression inferential statistic was the most suited for analyzing data in this study because it attempts to determine whether a group of independent variables, soil and water conservation technologies in this case, together predict a given depended variable (household food security in this study). The hypothesis was either rejected or accepted at 5% (α = 0.05) level of significance.

## RESULTS AND DISCUSSION

Soil erosion and absence of soil moisture could be a major constraint in crop production in the arid and semi-arid areas. Farmers overcome this challenge by using technologies that can conserve both soil and water. Table 2 shows soil and water technologies that farmers indicated they use in the study area.

The soil and water conservation technologies practiced in Kyuso Sub-County are shown in Table 2. The most popular technology is *fanya juu* terraces whereby 90% of the respondents indicated that they use the technology. *Fanya chini* or retention ditches is the second most used technology with 55% of the farmers interviewed indicating that they practise the technology. The other technologies indicated by the respondents are trash lines (32.9%), grass strips (13.6%), stone lines (6.4%), log lines (2.9%) and earth bunds (1.4%).

Hypothesis of the study was to test if soil and water
conservation measures had any influence on household food security among small-scale farmers in the study area. The following null hypothesis was stated: There is no significant influence of soil and water conservation on household food security among small-scale farmers in Kyuso Sub-County.

The hypothesis was tested using multiple linear regression by running the model in the SPSS. The independent variables were soil and water conservation technologies while the dependent variable was household food security measured by grain cereal and grain legume production from one acre of land. The hypothesis was tested at confidence interval $\alpha = 0.05$. Since $p = 0.346$ which is greater than 0.05 we fail to reject the hypothesis $H_0$. Soil and water conservation alone do not necessarily positively influence household food security. During focus group discussion farmers indicated that only about 30% of the households in the study area could be regarded as being food secure. This was despite implementing soil and water conservation technologies at various levels. Reasons advanced were that there were frequent prolonged rainfall failures and poor agronomic practices. This agrees with Mati (2006), who observed that in arid and semi-arid areas, low productivity is usually associated with prolonged and recurrent drought and dry spells. The same results were obtained in India by Bouma and Scott (2006) who found out that in the semi-arid areas of India watershed development does not show a significant effect on dryland crop yields under prolonged drought conditions. Farmers indicated that they expect more benefits in good rainfall years.

**Conclusion**

Soil and water conservation technologies practiced by small scale farmers in Kyuso sub-county were found to be *fanya juu terraces, fanya chini / retention ditches, log lines, stone lines, grass strips, trash lines and earth bunds*. The most popular technology was *fanya juu terraces* where by 90% of the respondents indicated that they use the technology. *Fanya chini* or retention ditches is the second most used technology with 55% of the farmers interviewed indicating that they practice the technology. The other technologies indicated by the respondents are trash lines (32.9%), grass strips (13.6%), stone lines (6.4%), log lines (2.9%) and earth bunds (1.4%). The influence of soil and water conservation on household food security among small-scale farmers in Kyuso Sub-County was found to be insignificant at 5% level of significance ($p > 0.05$).

The findings of this study led to the conclusions that soil and water conservation technologies alone do not necessarily positively influence household food security. Frequent and prolonged rainfall failures and poor agronomic practices are some of the important factors that deny farmers the full benefits of soil and water conservation technologies.

**Recommendations**

(i) In addition to promotion of soil and water conservation technologies, governments and other stakeholders in arid and semi-arid regions should empower their extension staff
to train farmers on good agronomic practices, early planting and choice of appropriate crop varieties.
(ii) In arid and semi-arid regions it is important for the governments and non-governmental organizations to invest in irrigation infrastructure development. This will ensure that during seasons of inadequate rainfall supplementary irrigation is done in order to bring crops to maturity and thus prevent crop failure.

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