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RESEARCH ARTICLE

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

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Abstract

This study was done in Kyuso Sub-County which is located in Kitui County, Kenya. The Sub-County suffers from food insecurity which is linked to declining agricultural productivity. The government of Kenya, through the Ministry of Agriculture, and other development partners have, continuously promoted on-farm soil fertility improvement technologies. Despite these efforts food insecurity has been rampant in the Sub-County. The purpose of this study was to determine the influence of soil fertility improvement technologies on household food security among small-scale farmers in Kyuso Sub-County. Soil fertility improvement technologies examined were farmyard manure, compost manure, application of mineral fertilizers, fallowing, crop rotation and crop residues. The study was carried out in Kamuongo Division of Kyuso Sub-County using the descriptive survey design. Structured interview schedule was used as the main tool of inquiry to gather data from selected households within the division. Questionnaires were administered to a sample 140 farmers through face-to-face interviews. The multiple linear regression model was used to analyze data. The results revealed that, at 5% level, soil fertility improvement technologies did not significantly influence house hold food security in Kyuso Sub-County.

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 soil fertility improvement, 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. They depend to a large extent on small-scale, subsistence farming for their food security. 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 even after decades of modern agricultural research, the small-scale farmer in most parts of Kenya is still poor. He adds that the small scale farmer still operates a largely traditional technology to meet subsistence needs. 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).

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). 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).

The food supply situation in Kenya has been a cause for concern. According to the Ministry of Agriculture [MOA] (2009), over 10 million people suffer from chronic food insecurity and poor nutrition. It is estimated that at any one time, about two million people in the country require food assistance (MOA, 2009). The long rains season in Kenya (March-May), which normally accounts for 80 % of total annual food production, has been failing over the years leading to severe drought, and widespread crop failures in the arid and semi arid areas of Eastern and North Eastern counties of Kenya (Kaloi, Tayebwa, & Bashaasha, 2005). Kyuso Sub-County lies in Kitui County in the drylands classified as arid and semiarid lands and receives low and unreliable rainfall of between 250 and 780 mm per year (Government of Kenya [GOK], 2009). The Sub-County suffers from food insecurity which is linked to declining agricultural productivity and general poverty. Drought as a natural cause is the main problem. Kyuso Sub-County has been under relief emergency operation from 2004 to date, with varying proportions of the population, as a result of either crop failure or low crop production.

The agriculture sector remains the engine of growth of the Kyuso Sub-County economy. Over 85% of the Sub-County population is engaged in activities in the agriculture and livestock production subsector, making the sector the largest employer and by extension the largest contributor to household incomes. Specifically, an estimated 98% and 93% of households are respectively engaged in crop farming and livestock rearing in the Sub-County (GOK, 2009). The agriculture and livestock production activities in the Sub-County are dependent on rainfall, which is inadequate and unreliable, often resulting to droughts. This explains why the Sub-County has continued to be vulnerable due to climatic shocks, food insecure and characterized by high level of endemic poverty. The Ministry of Agriculture has made efforts to promote dryland farming technologies in Kyuso Sub-County (MOA, 2011). These technologies include soil and water conservation, water harvesting, soil fertility improvement through compost and farmyard manure application and use of ecologically correct crop varieties (Mati, 2006). The crop varieties promoted in the Sub-County include: pearl millet, sorghum, green grams, cowpeas and pigeon peas (MOA, 2011). Often farmers face acute food shortage due to failure to harvest in consecutive seasons during which period most farmers rely on relief food for sustenance. Whereas food aid has played a key role in saving lives in the Sub-County during times of extreme drought and famine, it has had a negative impact of creating a dependence syndrome among farmers (GOK, 2009). Dependency syndrome is known to limit creativity and hence maintain the status quo of food insecurity.

In the arid and semiarid areas dryland farming technologies are key to achieving food security. Degradation of the land resource and the environment, leading to low soil fertility, has been identified as a major problem inflicting small scale farmers in Kyuso Sub-County. The Ministry of Agriculture and other stakeholders have over the years been sensitizing and training small-scale farmers on various dryland farming technologies, such as soil fertility improvement. However, Kyuso Sub-County has remained food insecure. Declining soil fertility could be one of the major causes of food insecurity in this Sub-County.

The objective of the study was to investigate the influence of soil fertility improvement 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 fertility improvement on household food security among small-scale farmers in Kyuso Sub-County.

2. Soil Fertility Improvement

Soil fertility refers to the capacity of soil to produce crops by providing adequate supply of nutrients in correct proportions, resulting in sustained high crop yields (Bationo et al., 2006). Most drylands soils have been depleted in soil organic matter due to inappropriate cultivation, overgrazing and/or deforestation in the past, causing a decline in soil quality. In order for farmers in these areas to achieve food security they must embrace soil fertility management as an integral part of dryland agriculture.

Trials done in Arusha, Arumeru and Babati Sub-Countys of Tanzania on the performance of different dryland farming technologies showed that water harvesting alone does not give the strongest yield increase. It was only when soil fertility management was combined with water harvesting that the full effect of conservation farming was felt (Benites, Vaneph, & Bot, 2002).

In Kenya, soil fertility depletion and soil degradation present the most serious problems. According to an FAO study (FAO 2001), Kenyan soils lose an annual average of 48 Kg/ha of nutrients, the equivalent of 100 Kg/year of fertilizer. To compensate for this loss, they receive an average of only 10 Kg of mineral fertilizer, compared with a global average of 90 Kg (Gichuru et al., 2003). According to Mati (2006) the declining per capita food production in Kenya is associated with declining soil fertility in small-scale farms. This is because nutrient capital is gradually depleted by crop harvest removal, leaching and soil erosion. The use of crop residues by farmers as fodder, and none or shorter fallow periods due to a shrinking land resource base, should be balanced by addition of chemical fertilizers and organic manure, which most small-scale farmers in the semiarid areas cannot afford. There is, therefore, a need to develop appropriate soil nutrient and cropping systems that minimize the need for chemical fertilizers and also find ways to integrate livestock into the farming system (Mati, 2006).

Maintaining or increasing soil fertility is one of the most important things farmers have to do to increase output. In doing so, farmers have to know the characteristics and constraints of their soils and use sustainable agricultural practices and methods for conserving them and making them more fertile. These include fallowing, using compost, farm yard manure, crop residues, agroforestry, intercropping legumes with cereals and including the principles of conservation agriculture. Conservation agriculture includes crop rotation, ensuring permanent cover for the soil and no disturbing of the top soil layer. Soils have to be nourished and cared for, and allowed to rest from time to time (Gichuru, et al., 2003). In many small-scale farms, crop residues are harvested and fed to livestock, and very little is returned to the soil to replenish lost nutrients. The depletion of organic matter thus exacerbates this condition. Efficient farm management practices should result in greater stimulation of activities of soil organisms, nutrient additions to the soil, minimal nutrient exports from the soil and optimal nutrient recycling within the farming system (Mati, 2006).

Enhancement of soil productivity through the improvement of soil organic matter is essential for sustained agricultural production systems. This is particularly important in arid and semi arid areas (ASAL) where rainfall is erratic and soils are low in most of the major nutrients needed by plants, and continuous cultivation with little or no external soil fertility inputs is a widespread practice (Bationo et al., 2006). A study done in Machang'a in Mbeere Sub-County, Kenya indicated that the annual manure application had positive response to crop dry matter (DM) production. Cumulative mean crop DM production after 20 seasons from 5 tons ha-1 and 10 tons ha-1 manure application did not differ significantly and therefore a recommendation was put forwards to ASAL farmers to apply 5 tons ha-1 manure in erosion free continuously cultivated lands (Micheni, Kihanda, & Irungu , n.d.).

In the sub-humid highlands of Kenya, soil fertility management among small-scale farmers is quite widespread. For instance, in Embu Sub-County, 99 percent of farmers use mineral fertilizers, 91 percent use farmyard manure and 74 percent do crop rotations, while in Vihiga, western Kenya, 75 percent use compost manure, 79 percent use green manure and cover crops, 91 percent use farmyard manure and 93 percent use crop residues (Amudavi, 2005). In arid and semi-arid areas use of farm yard manure in cereal farms is low. A study done in Mbeere Sub-County, Embu County , Kenya only 7% of farmers practice composting with the majority applying low quality manure directly from the cattle boma (Onduru et al., 2008). In Kyuso Sub-County the most common methods of soil fertility improvement is through intercropping of cereals with legumes. Organic and inorganic fertilizers are also used but to a lesser extent (GOK, 2009).

3. 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 km^2 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-Countys in Kenya receiving an average annual rainfall ranging from 250-780mm.

The study adopted a descriptive survey design. This design was appropriate because it enabled the description and exploration of the soil fertility improvement technologies used by farmers in the selected study areas and determined the household food security in the Sub-County (Kathuri & 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 fertility improvement 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 consisted all the 2,629 households in Kamuongo Division of Kyuso Sub-County, the study area (KNBS, 2010). The average farm holding is about 2ha. Mixed farming is practiced. 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 rain water harvesting 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 & Mugenda, 2003).

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

$$n = \frac{(1.96)^2 (.50) (.50)}{(.05)^2}$$

$$= 384$$

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 & 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 soil fertility improvement technologies had 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 & 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.

Table 1

Proportionate Sample Size and Number of Households per Location in Kamuongo Division

Location	Number of households	Proportion	Household Heads
Kamuongo	719	0.27	38
Itivanzou	882	0.34	47

Tyaakamuthale	1028	0.39	55
Total	**2629**	**1.00**	**140**

Source: Kenya National Bureau of Statistics (2010)

Two instruments were be used to collect data in the study area. A focus group discussion guide was used to collect data about the soil fertility improvement technologies practiced 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 fertility improvement 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, Manion, & Morrison, 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 (Kvale & Brinkmann, 2009). The instrument collected data on the soil fertility improvement 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 researcher 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 fertility improvement technologies in this case, together predict a given depended variable (household food security in this study). The hypothesis was to be either rejected or accepted at 5% ($\alpha = 0.05$) level of significance.

4. Results and Discussions

Poor soil fertility is an inherent problem in arid and semi arid soils. Making effort to improve farm soil fertility is essential in order improve crop production and hence household food security. Table 2 shows soil improvement technologies cited by farmers as the ones they practice.

Table 2

Methods of Soil Fertility Improvement n=140

Soil Fertility Improvement Technology	Frequency	Percentage
Make and apply compost manure	9	6.4
Application of farm yard manure	100	71.4
Application of mineral fertilizers	2	1.4
Use of fallow method	7	5.0
Crop rotation	39	27.9
Crop residue	18	12.9
Tractor ploughing	1	0.7
Making terraces	4	2.9
Do nothing	17	12.1

The most popular method of soil fertility improvement in the Sub-County is farm yard manure. Out of 140 farmers interviewed 71.4% indicated that they apply farm yard manure as a way of improving soil fertility in their farms. The second most common method is crop rotation accounting for 39%. Use of crop residue incorporation in the soil is done by 12.9% while a paltry 1.4% applies mineral fertilizers. It was noteworthy that 12.1% of the respondents made no effort at all in improving soil fertility of their farms.

Table 3

Soil Fertility Improvement Frequency n=140

Method	Once a year	Twice a year	Not regular	Never
compost manure	2.20	0	0	97.80
Farmyard manure	58.70	15.90	1.40	23.90
Mineral fertilizer	0	2.90	0	97.10
Use of fallow	2.90	0	0	97.10
Crop rotation	13.90	19.00	0	67.20
Crop residue	5.30	21.20	5.30	68.40

Most farmers in Kyuso Sub-County who used soil fertility improvement methods did so regularly either once or twice a year. Table 10 shows that 58.7% of the farmers who applied farm yard manure did so once a year while 15.9% applied farm yard manure in their farms twice a year.

Table 4

Rating Effectiveness of Soil Fertility Improvement Methods n=140

	Percentage Rating on technology effectiveness in improving production			
Technology	Not effective	Slightly effective	Highly effective	Very highly effective
Compost manure	33.3	0.0	66.7	0.0
Farmyard manure	0.0	31.5	59.3	9.3
Mineral fertilizer	0.0	20.0	80.0	0.0
Use of fallow	0.0	60.0	40.0	0.0
Crop rotation	2.2	84.4	13.3	0.0

Crop residue	0.0	60.0	40.0	0.0

The method accepted by most farmers and rated as being very highly effective and highly effective in improving farm production was farm yard manure at 9.3% and 59.3% respectively. Compost manure is quite similar to farm yard manure and 66.7% of those who had used the technology rated it as being very effective in improving farm production. Eight percent of farmers who had used mineral fertilizer rated it as having been very effective in improving farm production. During focus group discussion farmers were asked why not many of them were using mineral fertilizers. Their response was that they feared their farms would become unproductive during the subsequent seasons.

Table 5

Constraints in Soil Fertility Improvement n=140

Constraint	Frequency	Percentage
Farm yard manure inadequate	88	62.9
Ferrying FYM too cumbersome	65	46.4
Shortage of labour	38	27.1
High cost of labour	44	31.4
Composting skills lacking	5	3.6
High cost of inorganic fertilizer	11	7.9
Not aware of inorganic fertilizer application	3	2.1
Soil erosion washing away applied nutrients	12	8.6
Lack of farm tools	8	5.7
Ignorance	6	4.3
Fear of weeds	5	4.3
Manure increase termites and chaffer grabs	2	1.4
Lack of knowledge on how to apply manure	2	1.4
Poor health	2	1.4
Farm too large	1	.7
Inadequate rainfall	1	.7
Trampling of farm by animals	1	.7

Whereas farmers agreed that farmyard manure application was important in improving crop production not many of them were applying to the maximum. When asked what constraints they faced 62.9% said they did not have adequate supplies to apply to their farms. Some 46.4% found it cumbersome to ferry and apply farm yard manure while 27.1% faced shortage of labour. 31.4% had problems with high cost of labour.

Hypothesis of the study was to test if soil fertility improvement 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 fertility improvement 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 fertility improvement 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 was .198 which was greater than 0.05 we failed to reject the hypothesis $H_{01.}$

Observations during data collection showed that the farmers in the study area were agro-pastoralists. During focus group discussion farmers indicated that, after harvesting, livestock were allowed to graze freely in their farms. This production system greatly reduced availability of organic matter in the soil. Majority of farmers (98%) who applied farm yard manure did not improve quality through composting. 62.9 % of the farmer interviewed did not have adequate supplies of the farm yard manure. In his paper “a search for strategies for sustainable dryland cropping in semi-arid eastern Kenya”, Probert (1992) observed that farmers in Kitui and Makueni Counties experienced problems of declining yields due to low soil fertility. The same paper inferred that manure supplies were inevitably inadequate to prevent yield decline to a low-level equilibrium (Probert, 1992). Probert (1992) further found that farmers often had inadequate knowledge to prevent misapplication of farmyard manure. A similar study was done in Mangwe District, Zibambwe to assess the impact of conservation agriculture on food security and livelihoods. Key among the findings was that while conservation agriculture does improve yields per acreage, the improvement does not necessarily translate to improved food security. This is mainly due to climatic factors, including the poor rainfall experienced in the District (Tshuma, Maphosa, Ncube, Dube & Dube, 2012)

The inability of soil fertility improvement measures to positively influence household food security at 5% level of significance could be due to various reasons. Some of the reasons could be that farmers apply low quantities of poor quality manures, poor methods of manure application and poor rainfall regime experienced. This observation was made during focus group discussion and data collection.

5. Summary, Conclusion and Recommendations

5.1 Summary

Poor soil fertility is a serious problem in Kyuso Sub-County. 95.7% of farmers interviewed indicated they were having the problem of low soil fertility. Methods used by the small-scale farmers to improve soil fertility in Kyuso Sub-County were found to be compost manure, application of farmyard manure, application of mineral fertilizers, use of fallow method, crop rotation and crop residue. The most popular method of soil fertility improvement in the Sub-County was farm yard manure. Out of 140 farmers interviewed 71.4% indicated that they applied farm yard manure as a way of improving soil fertility in their farms. The second most common method is crop rotation accounting for 39%. Use of crop residue incorporation in the soil was done by 12.9% while a paltry 1.4% applied mineral fertilizers. It is noteworthy that 12.1% of the respondents made no effort at all in improving soil fertility of their farms. Most farmers in Kyuso Sub-County who used soil fertility improvement methods did so regularly either once or twice a year. Farmers believed that using either compost manure or farmyard manure could greatly improve farm production. Application of mineral fertilizer was extremely low because farmers feared their farms would become unproductive during the subsequent seasons.

Whereas farmers agreed that farmyard manure application was important in improving crop production not many of them were applying to the maximum. When asked what constraints they faced 62.9% said they did not have adequate supplies for their farms. Some 46.4% found it cumbersome to ferry and apply farm yard manure while 27.1% faced shortage of labour and 31.4% had problems with high cost of labour. The hypothesis that there is no significant influence of soil fertility improvement on household food security among small-scale farmers in Kyuso Sub-County was positive at 5% level of significance ($p>0.05$).

5.2 Conclusion

The findings of this study led to the following conclusions:-

Maintaining good soil cover through retaining organic matter after harvesting could be crucial in enhancing the function of soil fertility improvement technologies. Improved yields per acreage due to soil fertility improvement technologies does not necessarily translate to improved food security. Climatic factors such as poor rainfall often experienced in arid and semi-arid areas hinders soil fertility improvement technologies from having positive influence on household food security.

5.3 Recommendations

Policies developed by Ministries and Departments of Agriculture should lay specific emphasis on quality soil improvement methods. These policies could major on training farmers on how to improve the quality of organic manures through composting and the correct methods of application. Farmers should also be taught about the correct quantities and combination of manures that can influence household food security. Otherwise casual application of soil fertility improvement measures would have little or no impact on household food security.

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