Smallholder farmers decision to adopt and utilize ISFM technologies in Tororo District, Uganda

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Abstract

Soils in Tororo district like in other parts of Uganda are of low inherent fertility, which is declining due to low use of external inputs by farmers and poor management. Integrated Soil Fertility Management (ISFM) offers considerable promise for increasing food production. However it is unclear whether ISFM techniques are easily adopted by smallholder farmers. The study focus was on smallholder farmers' adoption and utilization of ISFM technologies in Tororo district. Soil management technologies were introduced, fine-tuned and disseminated in the study area using participatory approaches by the National Agricultural Research Laboratories of the National Agricultural Research Organization, Africa 2000 Network and government extension. The objectives of the study were to examine household factors that influence adoption of ISFM; to assess the methodologies used to disseminate ISFM technologies; to establish the level and nature of adoption of ISFM by smallholder farmers; and to examine the effects of structural and ecological factors on farmers’ decision to adopt ISFM technologies. Research results indicated that farmer wanted the price for ISFM technologies to be reduced; farmers lacked enough training for efficient use of ISFM. Technology use was affected by farm size, farmer educational knowledge and age, economic and institutional support characteristics and farmer’s perceptions. The three most effective dissemination methodologies/approaches in descending order were trainings, farmer field schools and demonstration farms. Respondents revealed that trainings played a greater role in teaching farmers about fertilizer use. The major problematic aspects were technology accessibility and labour constraints. Strengthening of advisory services and facilitation of inputs delivery by the government through private sector supply would play a critical role in soil fertility replenishment in Uganda. These findings raise important questions as to whether ISFM and related techniques are really affordable to smallholder farmers, so the government should encourage input facilitation such as credit and microfinance to farmers through the private sector in order to facilitate the use of soil management inputs.

Key words?

Introduction

Agricultural sector in African economy is the most important sector because of its contribution towards economic development of the region. First, the agricultural sector in sub-Saharan Africa employs more than seventy percent of the active population in the region. Second, it contributes more than forty-six percent to the gross domestic product (GDP). Third, it remains the main source of foreign exchange earnings. In Uganda, the contributions of the agricultural sector are as follows: the agricultural sector is the main export revenue earner; it contributes ninety percent of the export earnings (World Bank 1994). Agriculture is the largest employer of most Ugandans employing over seventy-three percent of the labor force as compared to manufacturing at four percent and services at twenty three percent (Ministry of Agriculture, Animal, Industry and Fisheries (MAAIF) 2010/11). It is the source of raw materials for the industrial sector through forward and backward linkages with the service and industrial sector (World Bank 1994). Therefore, development programs need to put into consideration the agricultural sector it being the backbone of the Ugandan economy.

Despite the contributions of the agricultural sector, agricultural development remains a challenge in Uganda with little attention to the challenges facing agricultural sector. There has been a noTable

Decline in food production, increase in poverty levels, high malnutrition levels and vulnerability to shocks (Mugwe, Thomas, Isaac, and Minde 2009). The above challenges can therefore be attributed to the following reasons: limited land for cultivation due to high population pressure (Arellane and lee 2003, FAO 2001), insecure land tenure system that has limited farmers from acquiring land for cultivation (MAAIF 2010/2011), poor climatic conditions (Ajayi, Oluyedde Clifford 2009), low soil fertility (Mugwe, Thomas, Isaac, and Minde 2009).

Low soil fertility has become a matter of concern by development workers, researchers and soil scientists and it has been identified as a major constraint to food production in Uganda (Matata, Oluyedde, Ajayi, Oduol and Agumya 2010). Adoption of integrated soil fertility technologies then appear to be the most appropriate way of responding to declining soil fertility in Uganda (National Agricultural Research Laboratories- Kawanda 2009). Integrated soil fertility management (ISFM) refers to making best use of inherent soil nutrient stocks, locally available soil amendments, and inorganic fertilizers to increase land productivity whilst maintaining and enhancing soil fertility and improving efficiency and nutrient and water use (Ajayi oluyedde Clifford, 2009). The agro ecological zones (AEZ) of eastern Uganda are characterized with low organic matter and nutrient contents (NARL 2009). The problem of low organic matter in the soil and declining soil fertility has been worsened by limited or no use of external inputs such as use of organic and inorganic fertilizers, nutrient mining, soil erosion and land fragmentation in some parts of Uganda.

To solve the problem of declining soil fertility in Eastern Uganda, association for strengthening agricultural research in east and central Africa (ASARECA) project in collaboration with national agricultural research organization (NARO) has taken part in encouraging farmers in Tororo district to adopt integrated soil fertility management technologies (ISFM). This project was introduced in Tororo district in 2009; one of the project main objectives is to develop appropriate methodologies for uptake and scaling up of soil fertility management technologies among smallholder farmers. In order to enhance declining soil fertility and increase crop production among smallholder farmers, NARO Uganda developed a number of soil fertility management technologies in Tororo district. Some of the types of technologies developed by NARO include inorganic fertilizers such as Triple super phosphate (TSP), dis-ammonium phosphate (DAP), Urea) and organic fertilizers such as animal manure and Green manure. Smallholder farmers have provided a number of dissemination methodologies to promote the use of the technologies. Examples of the methodologies include, farmer field schools, farmer groups, field days and trainings, mother baby trials and demonstration farms (learning centers), and knowledge sharing products like brochures and posters (NARO 2009). However, there is still need for further information on how effective such techniques are in changing farmers’ traditional practices and attitudes and whether or not there is local farmers’ participation in the program.

Significance of the Study
Adoption and utilization of integrated soil fertility management technologies is believed to be the best solution in arresting declining soil fertility. However, adoption and utilization of soil fertility management technologies has been problematic by smallholder farmers yet little research has been done on this problem and there is an information gap on the factors that influence smallholder farmers’ decision to adopt and utilize ISFM technologies. The study findings will help cover the gaps in the previous research done on soil fertility technologies. Study findings will also guide policy makers to formulate appropriate policies on agricultural based activities for smallholder farmers. The findings will also help in enhancing soil fertility, increased crop production and reduction of poverty levels among smallholder farmers. The findings will help ASARECA project and other international organizations to identify an appropriate approach for disseminating the technologies to smallholder farmers.

Scope of the study
The study was conducted in Tororo district. Tororo district was chosen because according to NARL-NARO, Progress report January to May 2010, there was a noticeable decline of the fertility of the soil in

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Tororo district which is the main reason for low crop production in the area. The study was carried out in three sub-counties of Kisoko, Usukuru and Petta sub-counties. Two parishes were selected from each sub-county. The study populations were the smallholder farmers and other key stakeholders such as the district agricultural officer and extension workers in the implementation of the project. Tororo district is one of the most densely populated, maize producing districts bordering western Kenya. Extensive research has been conducted in western Kenya on the use and profitability of soil improvement strategies. It is likely that there are spillover effects to neighboring Eastern Uganda. Furthermore, soils in Tororo have been characterized as poor in nutrient status. The study was confined on factors influencing small holder farmer’s decision to adopt and adapt soil fertility management technologies. The key themes under this study are: smallholder characteristics and needs, ISFM project implementation methodology, the nature of technology structural and ecological set up. The data collection exercise was carried out in a period of one month, during which the researcher collected enough data that was used to provide answer the study objectives.

Materials and methods

Study design

The research mainly used a cross sectional design and was implemented for the purpose of assessing the process of smallholder farmer’s decision to adopt and utilize integrated soil fertility management technologies. The cross sectional study research design was selected because allows one to conduct in-depth investigations on the study in question. The study employed both qualitative and quantitative research methods. Qualitative method was used to establish in-depth issues that smallholder farmers consider important to adopt and utilize ISFM technologies. These issues included farmer’s attitudes and the reasons behind farmer’s attitudes and perceptions, reasons why farmers are limited to utilizing recommended fertilizer technologies and recommendations for such challenges. Qualitative method was also used to get key people’s views in the study like extension workers who have participated in the implementation of the ASARECA project in Tororo district.

Description of the study area

The study was conducted in Tororo district (Eastern Uganda) located between latitudes 33°45'-34°15' East and 0°30'- 1°00' North. Tororo is bordered to the southeast by Kenya, northeast by Mbale, the northwest by Pallisa, and Bugiri, southwest by Iganga and to the south by Busia. The district has a population of 555,574 people, 88.5% of who reside in the rural areas (Rwabwoogo, 1996). Eighty percent of this population derives their livelihood from agriculture. Annual crops such as cassava, finger millet, sorghum, maize, beans, and other crops are grown in this area with cotton grown as the major cash crop. The animals kept are cattle, goats and sheep. Industrial activity includes the manufacture of corrugated iron sheets, inorganic fertilizers, fungicides, cassava starch, cotton ginning, and oil milling.

Sample selection

According to Amin (2005), sample selection is the process of choosing elements from a population in such a way that the sample elements represent the population. Two types of sampling procedures were employed in this study namely; stratified random and purposive sampling. Stratified random sampling was used to select smallholder farmers who acted as study respondents and one farmer introduced the researcher to the next farmer after the interview. Purposive sampling was used in the selection of key informants respondents based on their role in the project, in society, and their experience in the area of study. The respondents under purposive sampling were extension workers and the agricultural officers in Tororo district. The type of respondents, methods and instruments that were used are summarized in the Table 1 below.

Sampling procedure

These included Osukuru, Kisoko and Petta sub-counties purposively selected because they host project activities in the district and 3 villages randomly selected per sub-county. From these villages both
adopters and non-adopters were interviewed with only one household member from each household interviewed. The activities that have been conducted include training of farmers through farmer groups, farmer field schools and demonstration farms. During the trainings, different technologies were identified, tested and recommended as best bet technologies by farmers. It was upon this that farmers considered the best bet technologies for increased crop production.

**Data collection**

The study used both primary and secondary data. Primary data were collected using a pre-tested structured questionnaire that was administered to individual farmers to determine the level of acceptance and the farmer’s perceptions of soil improvement practices. The variables that were captured to characterize the determinants of acceptance included socio-economic data such as household size, farm and family size, educational status of the household, participation in farmer organizations, extension-farmer contact, perception of the soil fertility problem and labor requirements of different farming stages. The farmer perceptions and ideas to adopt and utilize ISFM technologies preferred were established from Focus Group Discussions (FGD’s). Secondary data was extracted from text books, agricultural related reports, newspapers and internet related information on agriculture and adoption of soil fertility technologies. However, given the gaps in the literature in terms of time and space, the researcher also collected first hand information from the contact respondents using Interview guides and a review guide that were accompanied by observation and photography. The approach was useful in a way that allowed the researcher to come up with firsthand information about factors that influence smallholder farmers’ decision to adopt and utilize ISFM technologies.

**Data analysis**

Quantitative data was analyzed using SPSS (version 11.0). This computer program was used because it gives simple descriptive statistics easy for interpretation. Data analysis was done through relative frequencies and percentages and cross tabulations at a significance level of 0.05 percent. Descriptive statistics and Logit regression model were used.

**Results and discussion**

Table 4.1 shows that majority 52.1 percent of the respondents who participated in the study were men while 47.9 percent were female, also majority (42.2 percent) of the respondents were less than 35 years, majority (54.3 percent) were married, 12.9 percent were widowers or widows and 28.6 percent were cohabiting. 10.1 percent of the respondents who were interviewed had not attained education at all, 20.9 percent attained lower primary, 35.3 percent attained upper primary, 27.3 attained O-level, 5 percent attained A-level and only 1.4 percent of the respondents attained other educational levels. Farmers with more years of education are likely to have lower probability of adopting ISFM like agro forestry technologies than less educated farmers. This was not expected as educated farmers are likely to be better informed about the improved soil conservation technologies and the adverse effects of land degradation. The likely explanation for these results may be related to higher cost of labor for more educated farmers, which reduces the probability to adopt labor-intensive soil conservation methods.
Increase of farmers’ age has been found to decrease the probability of adoption. It may be that older farmers who have more experience in the use of available soil fertility management technologies are in a better position to assess characteristics of new technologies than younger farmers Michael M. Odera., Kimani, S.K. and Musembi, F.,(2000). However it could be that older farmers are more risk averse than younger farmers and have a lesser likelihood of adopting new technologies (Adesina and Zinnah, 1993). The likely explanation for this is the opportunity cost of labor. Younger farmers are likely to be more educated and with more nonfarm activities (Abdulai and Delgado, 1999), implying that the opportunity cost of the labor is higher. The farmers that had attained above secondary level of education were very few which showed a negative impact of education of household head on probability to adopt ISFM and was also unexpected. Since educated farmers were expected to have a good knowledge of the importance of ISFM technologies and hence the need to adopt the technologies. The reason for these results is the cost of farmers’ labor, which is likely to increase with years of formal education. This would make the labor intensive ISFM technologies too expensive to implement.

**Sex of respondent versus application of fertilizers**

Hypothesis

H₀: Application of fertilizers depends on the gender of the farmer

H₁: Application of fertilizers does not depend on the gender of the farmer

*Significant at α = 0.05.*
When I checked from cross tabulation, the critical value of $\chi^2$ when $\alpha=0.05$ was 0.231. Therefore the chi-square is significant at the 5% level, and therefore this suggests that application of fertilizers does not depend on the sex of the farmer.

**Age of respondent versus application of fertilizers**

**Hypothesis**

$H_0$: Application of fertilizers depends on the age of the farmer

$H_a$: Application of fertilizers does not depend on the age of the farmer

*Significant at $\alpha = 0.05$.

When I checked from cross tabulation of age and application of fertilizers, the critical value of $\chi^2$ when $\alpha=0.05$ was 0.786. Therefore the chi-square was significant at the 5% level, and therefore this suggests that application of fertilizers does not depend on the age of the farmer.

**Marital status of respondent versus application of fertilizers**

It is hypothesized that

- $H_0$: Application of fertilizers depends on the marital status of the farmer
- $H_a$: Application of fertilizers does not depend on the marital status of the farmer

*Significant at $\alpha = 0.05$.

When I checked from cross tabulation of age and application of fertilizers, the critical value of $\chi^2$ when $\alpha=0.05$ was 0.190. Therefore the chi-square was significant at the 5% level, and therefore this suggests that application of fertilizers does not depend on the marital status of the farmer.

**Education level of respondent versus application of fertilizers**

**Hypothesis**

$H_0$: Application of fertilizers depends on the education level of the farmer

$H_a$: Application of fertilizers does not depend on the education level of the farmer

*Significant at $\alpha = 0.05$.

When checked from cross tabulation of age and application of fertilizers, the critical value of $\chi^2$ when $\alpha=0.05$ was 0.275. Therefore the chi-square was significant at the 5% level, and therefore this suggests that application of fertilizers does not depend on the level of education of the farmer.

**Economic activities undertaken in the community**

The economic activities undertaken in the community are presented in the bar chart below. It is observed from the chart below that smallholder agriculture is the main economic activity in the study area. This implies that addressing factors that affect smallholder agriculture will have significant benefit to the livelihoods of the communities.
Source of income per household
According to Table 4.8 it shows that almost all (99.3 percent) of the respondents who were interviewed got their income from agriculture activities, 29.9 percent of the respondents also got income from salaries as salary earners, 24.6 percent were wage earners, 23.6 percent got their incomes from loans, 4.9 percent were pension earners, 3.4 percent got incomes from their assets like buildings they rented out and got interest while only 0.7 percent of the respondents got their incomes from other activities like mining. Wealth, as indicated by some households that got revenues from more than one avenue had a positive impact on probability to adopt improved land management technologies. Wealth was observed to increase the probability to adopt SFM technologies in Tororo and Uganda at large, probably due to its role in increasing the possibility of hiring labor to implement ISFM practices. Wealthy farmers may also have more land than poor farmers, hence would afford to adopt technologies that compete for land space with crops. As expected, wealth is also predicted to increase the probability to adopt inorganic fertilizer in Uganda.

Land access and utilization
Study findings shows that 93.6 percent of the people in Tororo have enough access to land while only 6.4 percent of the people have no access to enough land. The households that are found not to have enough access to land are the families that were observed to be extended families and yet family size is found to reduce the probability to adopt ISFM most especially agroforestry technologies in Tororo district. The reason for this observation is likely to be related to land scarcity, which is more severe with larger families.

Source of information about ISFM
Study findings shows that 30.5 percent of the respondents got information about ISFM from farmer groups, 37.1 percent got it from farmer field schools, 51.4 percent got it from trainings, 35.2 percent got it from demonstration farms, 19.7 percent got it from posters/brochures or leaflets while 9.3 percent got it from other sources like other farmers, radios and TV talk shows. As indicated in the literature review
and the background of the study, there are a number of implementation methodologies that most researchers have developed to disseminate information to farmers.

**Fertilizer application**

According to the study findings 65.7 percent of the respondents have ever applied fertilizers in their gardens while only 34.3 of the respondents have never applied fertilizers in their gardens.

**Beneficiaries of ISFM technologies**

According to the study results, it shows that 91.3 percent of the farmers who were interviewed and use fertilizers have benefited in using fertilizers while only 8.7 percent of the farmers have not benefited. The farmers who have managed to benefit are the farmers who have been able to use the required amounts of fertilizers in their farms and have managed to get increased crop yield. While the farmers who have not managed to get benefits ever since they started using fertilizers are those who are occasional farmers and have very many others off farm activities that reduce their time on the farms.

Furthermore study findings indicate that there is limited access to agricultural extension services on ISFM. The proportion of households reporting to have received agricultural training in the Tororo district is low (39.7 percent) because Tororo district has just started getting programs and organizations that train on ISFM. This could be the reason for limited knowledge of soil fertility technologies by farmers in Tororo district.

According to findings most of the farmers (37.7 percent) get extension services through trainings. As expected the number of visits by extension agents positively affects the probability to use SFM technologies in Tororo. Study findings show that majority of the respondents (65.1 percent) get extension services once in three months. In addition the results indicate that there is limited satisfaction with the extension services provided to farmers about ISFM. The findings shows 41 percent of the respondents are satisfied with the nature of extension services. This is because majority of the services given to the people of Tororo do not come in time because of the long distances from the suppliers and the weather roads that link to these farmers. And some extension service agents do segregate between the farmers leading to hatred between the farmers.

From the cross tabulation findings it can be noted the p-value =0.45 is greater than 0.05 it implies that there was no a significant relationship between extension services and application and adoption of fertilizers at the 5 percent level, and therefore this suggests that application and adoption of fertilizers doesn’t depend on the extension services received by farmers on SFM. This implies that extension services have no relationship with farmer’s decision to adopt and utilize soil fertility management technologies. Farmers with or without extension services have the ability to adopt and utilize soil fertility technologies.

**Type of extension service received versus application of fertilizers**

Study results in the Table 2 indicate that a big number of the respondents (82.6 percent) who received fertilizers from the extension workers applied the fertilizers in their gardens and a relatively smaller number of respondents (68.2 percent) who had only received trainings on soil fertility had not applied any fertilizers in their gardens. The likely explanation could be related to the fact that provision of fertilizers reduces on the costs of applying fertilizers hence encouraging farmers to apply fertilizers.

<table>
<thead>
<tr>
<th>Category</th>
<th>Ever applied fertilizers</th>
<th>Never applied fertilizers</th>
<th>Number of farmers (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training</td>
<td>68.2%</td>
<td>31.8%</td>
<td>44</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>82.6%</td>
<td>17.4%</td>
<td>23</td>
</tr>
<tr>
<td>Farm visits</td>
<td>76.5%</td>
<td>23.5%</td>
<td>34</td>
</tr>
</tbody>
</table>
Markets
Study findings shows that low market prices for the produce is the major constraint affecting marketing of farmers produce. This is in addition to poor transport due to lack of feeder roads in the villages yet it over rains during the rainy seasons cutting off the farmers from the town areas meaning they are not able to get farm requirements and linking to the market places during the rainy seasons.

Access to credit
Study result show that most of respondents interviewed lack collateral security to present to financial institutions to access loans to invest in their farming activities with a 61.9 percent, while others face problems with the procedures involved in getting bank accounts and processing loans. Access to credit may help to reduce poverty and hence land degradation and also increases the probability to adopt agro forestry technologies in Uganda. This is consistent with the findings of Pender, Gebremedlin, Benin and Etui (2001) who observed that access to credit increased the probability to plant trees and live fences

Study results shows that, SACCO’S are the major (81.8 percent) sources of loans for the farmers in Tororo district. The findings also reveal that there is limited access of funds from commercial banks by smallholder farmers. The high proportion of respondents receiving credit from Microfinance Institutions (MFIs) may be related to the success of microfinance institutions (MFI) in Uganda. It is estimated that there are about 500 MFIs in Uganda with 550,000 active customers who save about pound 370 million.

Conclusion and recommendations
It can be concluded that the variables that significantly increased the adoption of ISFM were group membership, in form of farmer groups and farmer field schools, access to off-farm income, access to fertilizers, fertilizer knowledge in terms of types of fertilizers and knowledge on fertilizer measurements and access to practical knowledge through participating in technology evaluation on demonstration farms or learning centers. Adoption of organic fertilizers like manure was more associated with the farmers who expressed limited sources of income.

However it should also be noted that the major constraints to usage of fertilizers were the high prices of the fertilizers and lack of enough fertilizers in the region, though other factors like low incomes, low producer prices and others also constrained fertilizer usage while lack of security also mainly contributed to failure to acquire loans from micro-finance institutions.

The adoption and utilization of soil fertility management technologies is likely to increase with higher levels of education to farmers, secured farm ownership, profitable crops, availability of information, availability and affordable technologies. There is a need to identify and integrate socio-economic characteristics of farmers and integrate in plans to promote the uptake and utilization of soil fertility management technologies. Important characteristics are personal characteristics, resources availability and institution factors.

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References – Where are the list of references used in the text?