FARMER GROUPS' MEMBERS' HOUSEHOLD FACTORS INFLUENCING SELECTION OF SOIL FERTILITY TECHNOLOGIES IN THE CENTRAL HIGHLANDS OF KENYA

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ABSTRACT
This second study assessed the influence of farmer groups' socio-economic factors on the selection of the technologies. Household variables that influenced selection of manure include: HH size (p=0.001), benefits of manure (p=0.011), land tenure (p=0.056), HHH education (p=0.075), TLU (p=0.036), and land under food crops (p=0.014). Variables that influenced selection of fertilizer included: HHH education (p=0.033), land under food crops (p=0.012), HHH occupation (p=0.041) and availability of on-farm income (p=0.012). Variables that influenced selection of a combination included: HHH education (p=0.001), land under food crops (p=0.041), TLU (p=0.011) and the most effective method to teach combination (p=0.001). This results could be helpful to the groups, researchers, policy makers, farmers' training designers and other stakeholders in natural resource management programmes.
Key words: *Farmers group members, Household characteristics, Animal manure, Inorganic fertilizers, Selection*

INTRODUCTION
Smallholder farmers in Sub-Saharan Africa (SSA) face severe soil fertility crisis (Gonsalves et al., 2005). A survey in Kenya showed high amount of soil nutrient deficiencies caused by continuous cereal cultivation with limited use of fertility inputs (Gonsalves et *al*., 2005). Research on soil fertility improvement in Central Kenya highlands has generated recommendations for improving soil fertility on smallholder farms (Mugendi *et al*., 2006). For instance, some herbaceous legumes, leguminous shrubs, cover crops, biomass transfer, and cattle manure technologies applied alone or combined with inorganic fertilizers have been identified as potential soil nutrient replenishment technologies due to their costs, effectiveness, appropriateness, simplicity, and multipurpose nature in meeting the needs of the resource poor farmers (Franzel *et al*., 2002; Mucheru, 2003). Despite the obvious benefits of these soil fertility enhancement (SFE) technologies, the adoption rate has been slower than anticipated by the researchers as observed by Adiel (2004). Causes of low adoption may be attributed to the extension methods/approaches used in the dissemination of the soil fertility enhancement innovations among other reasons.

Farmers' groups is one of the approaches that has been used successfully to catalyze the participation of farmers as partners in research and development activities (CIAT, 2003; Sanginga *et al*., 2005), and target technology to specific groups (Reddy *et al*., 2010). Farmers' groups are community-based and their joint activities therefore have an out-scaling effect on the community (Wennink and Heemskerk, 2006). The small-scale farmers form these farmers' groups, which are key to up scaling of technologies and they have self-monitoring mechanisms to enforce collective actions through collective activities of the group (Bingen *et al*., 2003). For example, Peterson *et al*. (2004) found out those group members who were not successful with their first attempt to test soil nutrient replenishment technologies (SNRT) continued to use the technologies after visiting other farmers and getting convinced. Kiptot (2007) however showed that the use of the village committee approach was misapplied as the approach assumed that groups are fully appropriate vehicles for technology development and dissemination.

The success of farmer groups depends on various factors which include small group sizes, group maturity and internal factors (common interests, group commitment and trustworthy leadership). Others are external factors (extension agents, researchers) , structural social factors (roles, rules, procedures, social networks) and cognitive (norms, values, attitude and trust) social factors (Ostrom, 1992; Baland and Platteau, 1996; Uphoff and Wijayaratna, 2000; Agrawal, 2001; Haan, 2001; Johnson *et al*., 2002; Place *et al*., 2002; Jones, 2004). However, the cumulative effects of these factors and their direct influence on selection of SFE technologies have not been well understood. For instance, Agrawal (2001) found that, group size alone gave different results on group's success. Therefore, there is a need for more social-economic research to understand how farm households view and understand the technologies (Misiko, 2007; Kiptot *et al*., 2007). This calls for a study that focuses on factors that influence selection of SFE technologies at household and group levels.

MATERIALS AND METHODS

Research Site

The study was carried out in Mbeere South and Maara sub counties. These sub counties were selected because research and dissemination on soil fertility had been done in the area. Mbeere South lies in the Agro-ecological Zone (AEZ) Lower midland 4 and 5 (LM 4 and LM 5), with an altitude of about 800m above sea level (Jaetzold *et al*., 2006). The average rainfall is between 600-800 mm per year, in a bimodal regime, where long rains come from mid March to June and the short rains from late October to December. The annual mean temperature is between 21.7 to 22.5^{o}C.The soils are predominantly Ferralsols and Acrisols (Jaetzold *et al*., 2006), and the predominant land uses are dry land farming and livestock production.

Maara sub-county lies in the Agro-ecological Zone (AEZ) Upper Midland (UM2-UM3) (Jaetzold *et al*., 2006) on the eastern slopes of Mount Kenya, with an altitude of 1500 m above sea level. It receives an average rainfall of 1200-1400 mm per annum with a bimodal regime where long rains come from March to June and short rains from October to December. The mean temperature is 20^{0}C. Two cropping seasons are experienced in a year. The district is predominantly maize/coffee growing zone with some dairy enterprises, with smallholdings ranging from 0.1 to 2 ha and an average of 1.2 ha per household (Jaetzold *et al*., 2006). The soils are mainly humic Nitisols.

Research design

Primary data was collected through face to face interviews with individual farmers. The study aimed at collecting information from the individual farmers who were members of farmer groups on the household factors that enhanced uptake of various soil fertility management technologies. Both primary and secondary sources of data were used. Primary sources of data were questionnaires and interview schedules while secondary sources included journal articles, Government reports, theses and dissertations.

Sampling strategy

The category of interviewee that was targeted for data collection through questionnaires was individual farmers who were members of farmer groups. A total of 218 farmers were sampled. The sample size calculated was based on the groups' household population of 1200 by applying 95% confidence level and 6% confidence interval. The population was derived from the total number of farmers who had participated in the previous soil fertility activities. Individual farmers were randomly selected from the single gendered groups, but purposively selected from mixed gendered groups in order to capture gender in the mixed groups.

Data collected

A pre-test was done before the main survey. This was conducted in order to check for face, content and criterion validity of the farmers' interview schedules. It also helped to ascertain the amount of time needed to administer the tools. A sample of 7 farmers from each site were randomly selected and interviewed. The data collected included: (i) Household characteristics, (ii) group activities, (iii) group trainings, (iv) soil fertility and technologies' use.

Data Analysis

Data cleaning and close examination was done to ensure completeness and consistency in the questionnaires. The questions were coded, managed and stored in MS Excel. SPSS, version 12 software, was used for data analysis. Descriptive statistical analysis was applied, involving the use of means, frequencies, percentages, standard deviation. For categorical variables, cross tabulation was carried out while for quantitative variables, Pearson correlation was done. In the regression analysis, the household and socio-economic variables were independent (explanatory) variables while the dependent variables were the individual farmers SFE technology selection (Table 1). Results were presented in form of tables.

For logistic analysis, various factors were regressed upon the dependent variable "group membership" in a binary logistic model. Such models are used when response variables are binary; that is, they have only two possible outcomes (Agresti & Finlay, 1997). The generic terms for the two possible outcomes are success and failure, and the "odds" equal the probability of success divided by the probability of failure (Table.1). As the outcome (in this case, participation in a group) increases from 0 to 1, the odds increase from 0 to infinity. This model tests the probability that the independent variable X has no effect on the dependent variable Y (Agresti & Finlay, 1997). The independent variables consisted of both categorical and continuous variables and were coded accordingly (Table 1). In the logistic regression model, B is the estimated coefficient with standard error S.E. The ratio of B to S.E., squared, equals the Wald statistic. If the Wald statistic is significant (i.e less than 0.05) then the parameter is useful to the model. Exp(B) is the predicted change in the odds for a unit increase in the predictor. When Exp(B) is less than 1, increasing values of the variable corresponds to decreasing odds of the event's occurrence and when Exp(B) is greater than 1, increasing values of the variable correspond to increasing odds of the event's occurrence.

RESULTS AND DISCUSSION

Socio-economic characteristics of the households influencing decision to select soil fertility technologies

Socio-economic factors influencing the farmers' selection of animal manure

The results of the Logit model developed to determine factors influencing use of animal manure was significant at $p<0.01$ and correctly predicted 67.4% of both users and non users of animal manure with the selection and non selection of animal manure (Table 2). Size of the household ($p=0.096$), farmer's education ($p=0.075$), land with or without title deed ($p=0.056$), land under food crops ($p=0.014$), Tropical Livestock Units on the farm ($p=0.036$) and benefits of animal manures ($p=0.062$) were significant in explaining the selection of animal manure in Embu and Tharaka-Nithi counties (Table 2).

Table 1: Definition of study variables influencing the farmers' selection of animal manure, inorganic fertilizers and manure + fertilizers technologies in Embu and Tharaka-Nithi counties

Dependent variables	Definition
Selection of animal manure, inorganic fertilizer and manure + fertilizer	0 No
	1 Yes
Independent variables	
HH head gender	1 Male
	2 Female
HH head age	Continuous variable
Education	0 Not educated
	1 Educated
Number of months spent on the farm	Continuous variable
Benefits of animal manure	1 Fertile soil
	2 High yields
	3 Water retention
Participation in group activities	0 No
	1 Yes
House hold size	Continuous variable
Total land for the HH	Continuous variable
Total HH land with food crops	Continuous variable
Tropical Livestock Units (TLU)	Continuous variable
Number of donkeys	Continuous variable
Number of groups farmer belongs to	Continuous variable

Land with/without title deed	0 Without title 1 With title
Full / part-time farmer	0 Part-time 1 Full-time
Any on-farm income	0 No 1 Yes
Benefits of fertilizer / combination	1 Fertile soil 2 High yields 3 Early maturity
Source of knowledge of manure, fertilizer and manure + fertilizer	1 Extension 2 Researchers 3 Other farmers
Most effective method to teach manure, fertilizer and manure + fertilizer	1 Demonstrations 2 Meetings 3 Media

Table 2: **Logistic regression estimates of factors influencing selection of animal manure technology in the Embu and Tharaka-Nithi Counties**

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
HH marital status	0.829	0.845	0.964	0.326	2.291
Education	-0.564*	0.316	3.179	0.075	0.569
HH size	0.147*	0.088	2.779	0.096	1.158
Land under food crops	0.397**	0.161	6.081	0.014	1.487
Land with/without title	-0.655*	0.342	3.659	0.056	0.520
Tropical Livestock Units	0.206**	0.099	4.376	0.036	1.229
Animal manure benefits	0.163*	0.087	3.482	0.062	1.177

N=218, **Significant at 5% probability level, *Significant at 10% probability level

HH Head Education

Household head education negatively influenced (β= -0.564, p=0.075) the selection of animal manure (Table 2). This implies that an increase in the household head education did not necessarily increase the chances of selection of animal manure. That means that lack of formal education did not hinder the households from selection of manure. This could be because manual application of manure may just require observation as a demonstrator illustrates the amount to apply, how to apply and the equipment to use. This also means that an increase in education could mean more opportunities to earn off-farm income which could be a dis-incentive in investing in manure. Off-farm income negatively influenced farmer uptake of ISFM as sometimes individuals with higher incomes tend to invest their time, energies and money in non-farm activities at the expense of on-farm activities (Adolwa *et al*., 2010). These results agree with those of Place *et al* (2005) that education was not found to play a major role in the decision to take up technologies. Preparation and application of manure may require practical hands-on management, skills and conceptual understanding (Okoth *et al*., 2006) based on non-formal adult education principles. The study by Kiptot (2006) on sharing seed and knowledge agreed with the results that education has a negative influence by indicating that an increase in the number of years of schooling reduced the probability of giving out seed by 0.16. Mugwe *et al* (2003) also reported that those farmers who had attained their formal education up to secondary level had about 63% higher chances of adopting SRFT than those with tertiary education. This is contrary to what Kariuki and Place (2005) found, that more educated household heads are more likely to have adopted bio-mass transfer than non-educated household heads.

Household Size

Household size positively influenced (β=0.147, p=0.096) the selection of manure (Table 2). This implies that an increase in the household size increases the selection of manure. This could be because a higher number of household members can provide timely labour that is required to apply manure since manure application is a labour intensive activity. Household labour provision is very important for speeding up implementation of labour intensive technologies such as manure application. This is consistent with Odendo *et al*. (2010) who found out that due to high labour demands for preparation and application of manure, compost and mineral nutrient sources, higher ratio of household members who contribute to farm work is hypothesized to increase the speed of the adoption of all the studied practices because of the low opportunity cost of labour in Western Kenya. Franzel (1999) also reported that labour constraints had a significant impact on the adoption decision, as tree fallows are a relatively labour-intensive activity, and that the ratio of household members who provide farm labour to total household size accelerated the adoption of manure as expected (Odendo *et al*., 2010). At the same time, the household size also can address issues of synergy in SFE technology adoption. This agrees with Kacharo (2007) who found out that the higher number of family members leads to higher decision to take risks for participation in technology packages and this leads to increased chances of getting agricultural information and consequently ISFM knowledge. Mapiye *et al*. (2006) in a study in Chikomba district, Zimbambwe noted that household size influences adoption of soil fertility technologies through increase in knowledge base. Similarly, households with large numbers have more labour and needed more food, both of which increased the tendency to learn more on how to conserve the soil in order to feed themselves (Odendo *et al.*, 2010).

HH Total Land Under Food Crops

Total land under food crops significantly (β= 0.397, *p*=0.014) influenced the selection of manure (Table 2). This implies that an increase in the land under food crops increases the selection of manure. These findings also agree with those of Kebede *et al*. (1990) who in a study carried out in Tegulet-Bulga district, Ethiopia found out that farm size have a significant effect in increasing information and adoption of soil fertility technologies. In addition to providing food security, food crops can also be sources of farm income. Barhama and Chitemi (2008) reported that cereals and legumes are the traditional staple food crops for many smallholders, and that when these staple food crops are grown on a large scale, they offer substantial regional and international market potential. Such food crops can therefore attract attention and enhance the likelihood of selection of inorganic fertilizer and other soil fertility enhancing technologies.

Land With / Without Title Deed

Owning land with title deed negatively influenced (β= -0.655, *p*=0.056) the selection of manure (Table 2). This implied that owning land with title did not necessarily increase the likelihood of selecting manure. This could be because the land with title could be far and with poor communication, or that the crop grown did not attract good market, and therefore not profitable enough to warrant investing in manure. Cramb (1999) in his study found out that success of adoption of conservation technologies was also due to a number of site-specific factors, which included good communications, close community interaction, stable land tenure, increasing accessibility and market link- ages, and the evolution of the farming systems towards new enterprises. Contrary to the results, Lastarria-Cornhiel (1997) reported that individual and private ownership of holdings tends to provide greater security of access and control over land, and without this security farmers may lack incentives to invest. This also contradicts Onduru et al. (2001) who reported that facilitation of the acquisition of title deeds encourages investment in short- and long- term soil fertility management strategies.

Tropical Livestock Units (TLU)

Tropical Livestock Units (TLU) a farmer owns significantly (β= 0.206, *p*=0.036) influenced the selection of manure (Table 2) which implies that an increase in the number of domestic animals increases the likelihood of farmers to make decision to select manure. Ownership of domestic animals is assumed to increase availability of manure and to generate income through sales of the animals or their products and is thus hypothesized to accelerate adoption of manure and mineral fertilizers (Odendo *et al*., 2010). Green (2003) found out that livestock, a proxy for the wealth position of households, positively and significantly related with the likelihood of using inorganic fertilizers and ISFM practices. He added that livestock also has a positive and significant effect on the intensity of use of inorganic fertilizers and stone/soil bunds. Pezo *et al*. (1999) also reported that buffalo numbers remained larger than expected probably due to their ability to utilize crop residues and forage in waste areas and thus continued to have a role as an asset and contributing manure for rice-based systems in the Phillipines.

Manure Benefits

The benefits derived from manure significantly (P=0.011, χ^2=9.008) influenced the selection of manure (Table 2). The results showed that a majority (71.0%) of the farmers that selected manure did so because of its benefit of high yields, while 48.8% selected it because of its benefit of fertile soil. This implies that an increase in the yields as a benefit increases the probability of the farmers' selection of manure. This agrees with Harris *et al*'s (1997) survey that gained the impression from farmers that inorganic fertilizer is for feeding plants (short term response) but manure is required to feed the soil (long term sustainability) (Lekasi *et al*., 2001). Research also has shown that a combination of run off-harvesting and farmyard manure significantly increases grain yields in these semi-arid areas (Jaetzold et al., 2007).

Socio-economic factors influencing the farmers' selection of inorganic fertilizer

The results of the Logit model developed to determine factors influencing use of inorganic fertilizer was significant at $p<0.01$ and correctly predicted 70.2% of both users and non users of inorganic fertilizers with the selection and non selection of inorganic fertilizer (Table 3). Four variables: household head education (p=0.014), total land under food crops (p=0.031), availability of on-farm income (p=0.055) and whether the household head is a full-time or part-time farmer (p=0.019) were significant in explaining the selection of inorganic fertilizers in the central highlands of Kenya (Table 3).

Table 3: **Factors influencing selection of inorganic fertilizer technology in the two Counties**

Independent variable	B	S.E.	Wald	Sig.	Exp(B)
HHH gender	-0.105	0.353	0.088	0.766	0.900
Education	-1.070**	0.369	8.382	0.004	0.343
Number of groups one belongs to	0.094	0.220	0.183	0.669	1.099
Land under food crops	0.353**	0.164	4.661	0.031	1.424
With / without title deed	0.126	0.366	0.119	0.730	1.134
Tropical Livestock Unit (TLU)	-0.060	0.105	0.332	0.564	0.941
Any on-farm income	-1.342*	0.701	3.668	0.055	0.261
Benefits of fertilizer	0.399	0.310	1.661	0.197	1.490
Full time / part-time farmer	-1.194**	0.510	5.487	0.019	0.303

N=218, **Significant at 5% probability level, *Significant at 10% probability level

HH Head Education

Household head education negatively (β=-1.070, p=0.004) influenced selection of inorganic fertilizer respectively (Table 3) which implies that inorganic fertilizer selection decreases with increase in education. These results agree with Place *et al*. (2005) who reported that education was not found to play a major role in the decision to take up improved fallows and biomass transfer technologies. Preparation and application of fertilizer may require practical hands-on management, skills and conceptual understanding (Okoth *et al*., 2006) based on non-formal adult education principles. These results disagree with the normal expectation that the education level of the household head to be positively related to productivity per acre since better educated farmers may have improved access to knowledge and tools that enhance productivity (Fatma Gül Ünal, 2008). Kariuki and Place *et al*. (2005) had also found out that more educated household heads are more likely to have adopted biomass transfer than non-educated household heads. These results could therefore be because as long as fertilizer is available, application of it just needs to be demonstrated by an expert and this physical activity can be done even without formal education. Its rates of application can be determined by physical objects such as soda bottle tops. This calls for simplification of technical information by development professionals in order to help support farmers' understanding and communication of complex principles (Kiptot *et al*., 2006). This also agrees with the Place *et al*. (2005) who noted that education was not found to play a major role in the decision of farmers to take up technologies.

HH Land under Food Crops

Land under food crops positively influenced (β=0.353, p=0.031) the selection of inorganic fertilizer (Table 3). This implies that an increase in the size of the land under food crops increases the selection of inorganic fertilizer. In addition to providing food security, food crops can also be sources of farm income. Barhama and Chitemi (2008) reported that cereals and legumes are the traditional staple food crops for many smallholders, and that when these staple food crops are grown on a large scale, they offer substantial regional and international market potential. Such food crops can therefore attract attention and enhance the likelihood of selection of inorganic fertilizer and other soil fertility enhancing technologies. Arifalo and Mafimisebi (2011) also found out that the respondents who applied inorganic fertilizers only, had the greatest yield of maize and yam crops.

Full/Part-time Farming

Being a fulltime farmer negatively influenced (β=-1.194, p=0.019) the selection of inorganic fertilizer (Table 3). This implies that farmers who spent more time on the farm selected less of inorganic fertilizer. Lack of cash to buy fertilizer could have been the reason of non selection of fertilizer. Ajayi *et al*. (2007) noted that lack of cash to buy mineral fertilizers or non-availability of fertilizer in rural areas at the right time was a constraint in fertilizer adoption. This could also be because they had an opportunity to use other SFE technologies like manure which on the other hand required more time to prepare and apply and at the same time was cheaper than inorganic fertilizer. A fulltime farmer spends more time on the farm and therefore gets more experience on farm activities, including use of new technologies. A greater number of hours worked by the farmer lower the probability of adoption of new technologies (Dorfman, 1996). Odendo *et al*. (2010) found out that relative farming experience retards the adoption new technologies. Edemeades *et al*. (2008) however reported that relative farming experience increased the likelihood of the adoption of different banana varieties in Uganda.

Farm Income Availability

Availability of farm income negatively (P=0.012, χ^2=6.266) influenced the selection of fertilizer (Table 3). Results showed that a majority (68.4%) of the farmers that had on-farm income did not select fertilizer, while 31.6% of the farmers that had on-farm income selected fertilizer. This implies that an increase in the availability of on-farm income does not necessarily increase the probability of fertilizer selection. This could be because the farmers might have preferred to invest in other technology options but not fertilizer. Other times, farmers do not adopt because the technology does not fit with their existing options. Giller *et al*. (2009) in his study reported that farmers' involvement in new technologies requires trade offs with other activities from which they currently generate their livelihood and if the new technology does not fit with them, they will hesitate to take it up. This could also be that possibly the complexities of using fertilizer in terms of types, time of application and rates of application could have discouraged the farmers from selecting it. This agrees with Doss and Morris (2001) who indicated that there are certain technology specific factors that influence the decision to adopt.

3.1.3: Socio-economic factors influencing the farmers' selection of a combination of animal manure and fertilizer

The results of the Logit model developed to determine factors influencing use of a combination of animal manure + inorganic fertilizer was significant at p<0.01 and correctly predicted 75.3% of both users and non users of the combination of animal manure + inorganic fertilizers with the selection and non selection of the combination (Table 4). Household head education (p=0.021), total land under food crops (p=0.058), Tropical Livestock Units (TLU) (p=0.011) and the most effective method to teach combination (p=0.001) were significant in explaining the selection of a combination of animal manure + inorganic fertilizers in the central highlands of Kenya (Table 4).

Table 4: **Factors influencing selection of a combination of animal manure + inorganic fertilizers technology in the Embu and Tharaka-Nithi Counties**

Independent variables	B	S.E.	Wald	Sig.	Exp(B)
Education	1.004**	0.436	5.301	0.021	2.730
Land under food crops	-0.604*	0.318	3.601	0.058	0.546
Land with title deed	0.608	0.454	1.796	0.180	1.836
Tropical Livestock Units	0.441**	0.173	6.538	0.011	1.555
Participate in group activities	1.230	0.830	2.195	0.138	3.422
HH total land	0.258	0.157	2.694	0.101	1.295
Benefits of combination	0.138	0.399	0.120	0.729	1.148
Source of knowledge-combination	0.510	0.463	1.214	0.271	1.665
Effective method teach combination	-0.957**	0.265	13.021	0.001	0.384

N=218, **Significant at 5% probability level, *Significant at 10% probability level

HH Head Education

Household head education significantly (β= 1.004, p=0.021) influenced the selection of manure plus fertilizer (Table 4). This implies that the more educated the farmers, the more likely they are to select manure + fertilizer technology. This is because education exposes the farmers to details of the manure + fertilizer use such as types, application rates, methods and timings, which are critical in productivity. A well-founded knowledge supports well-informed decision-making with respect to resource use and management (Jansen *et al*., 2006). This is as expected that education of the head of the household positively and significantly influenced both the likelihood of adoption and intensity of inorganic fertilizer use (Green, 2003). Conventional methods are complex and difficult to use, particularly for non or semi-literate farmers with little or no formal education (Galpin *et al*., 2000). Higher education also broadens the opportunities of the farmers to engage in off-farms income generating activities which in turn can support investment in on-farm activities including SFE technologies for higher incomes. This agrees with Odendo *et al*. (2010) who found out that higher education level are most likely to obtain off-farm income through employment, hence hasten the adoption. Higher education also provides a well founded knowledge base which may help to distinguish myths from facts, and beliefs from realities as noted by Francisco (2008), and this also helps to support well informed decision making with respect to resource use and management (Jansen *et al*., 2006).

HH Land under Food Crops

Land under food crops negatively influenced (β= -0.604, p=0.058) the selection of a combination of manure plus fertilizer (Table 4). This implies that an increase in the size of the land under food crops decreases the selection of a combination of manure plus fertilizer. This could be because of the labour involved since the use of combination requires a lot of labour for both preparation and application. Women provide a significant share of labour for farm activities (Dixon, 1982) and are important as primary producers of food crops (FAO, 1985; Weekes-Vagliani, 1985). A NALEP-SIDA evaluation report (Cuellar *et al*., 2006) showed that women comprise of 70% of the members of CIGs that are food crops and small livestock production based. In most cases, high costs prohibit farmers from applying both manure plus fertilizer although they know that the resulting yields are high.

Tropical Livestock Units

Total livestock unit (TLU) owned by the household significantly (β= 0.441, p=0.011) influenced the selection of the combination (Table 4). Results showed that the households that selected the combination had a TLU mean of 2.5 while those that did not select it had a mean of 2.4. This implies that an increase in the TLU in the household increases the probability of selection the combination. This could be because owning domestic livestock is considered as a source of wealth through the sales of the animals and their products like milk which can facilitate buying of fertilizers, while the animals themselves produce manure to be used in the combination. The findings agree with Odendo *et al*. (2010) who found that ownership of cattle is assumed to increase availability of manure and to generate income through sales of the cattle or its products and is thus hypothesized to accelerate adoption of manure and mineral fertilizers. Pezo *et al*., 1999) reported that buffalo numbers remained larger than expected probably due to their ability to utilize crop residues and forage in waste areas and thus continued to have a role as an asset and contributing manure for rice-based systems in the Phillipines. Birds (poultry) are also not only seen as a source of wealth but also manure providers. Mugwe *et al*. (2006), in Mugendi *et al.* (2006) reported that poultry manures contain sufficient nutrients in 1 to 2 tonne per hectare, compared to at least 10 tonnes per hectare from crop residues for a 2 tonnes per hectare maize crop.

Teaching Method Used for Combination

The most effective method of teaching combination significantly (χ^2=47.532, P=0.001) influenced the selection of a combination (Table 4). Results showed that a majority (78.4%) of the farmers that selected combination were taught through demonstrations, while 27.5% of them that selected combination were taught through meetings. This implies that use of demonstrations as a teaching method increases the probability of farmers to select combination. Demonstration methods are participatory, involving logical description and explanation through experiments and at the same time, the farmers' involvement is high. According to Knowler and Bradshaw (2007), the use of group approach in technology uptake and transfer has emerged as an important strategy of extending or introducing new technologies in developing countries. Odendo *et al*. (2000) attested to this by reporting that a larger number of farmers should be involved in technology testing and field days should be held to disseminate the technology. Mburu *et al*. (2008) during his study in Eastern Kenya Highlands agreed with the use of group approaches, but cautioned that they are costly, although the costs are mainly borne by the members of the groups. Pretty (1995) reiterates that farmers do learn from what they see than just what they are told. Makaya (1999) also noted that accelerated impact can only be achieved by selecting the most effective means of dissemination of the technology.

CONCLUSIONS

The third objective was to determine the influence of household characteristics of the farmers who are members of the groups, on selection of SFE technologies. The characteristics that were found to positively influence the use of manure include; household size, Tropical Livestock Units, total land under food crops, and benefits of manure. On the other hand, household head education and land ownership with title negatively influenced the use of manure. On the likelihood of households' socioeconomic factors influencing the use of fertilizer, total land under food crops, household head education, availability of farm income and the time spent on the farm were identified as possible predictor factors likely to influence the use of manure. On the likelihood of households' socioeconomic factors influencing the use of manure plus fertilizer, total land under food crops, household head education, and Tropical Livestock Units were identified as possible predictor factors likely to influence the use of manure plus fertilizer. These results imply that in order to enhance the uptake of the soil fertility enhancement technologies in the Central Highlands of Kenya, the identified factors should be put into consideration.

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