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Gender Differentials in Adoption of Soil Nutrient Replenishment Technologies in Meru South District, Kenya

E.G. Kirumba, D.N. Mugendi, R. Karega, and J. Mugwe

Abstract Understanding gender differentials in adoption of soil nutrient replenishment technologies is critical to their successful implementation by farmers. This study was conducted first to examine gender differentials in choices of technologies adopted at intrahousehold level. Second, to investigate socio-economic, institutional, and demographic factors influencing adoption, and finally to examine gender differences in the frequency of participation in project activities. The results indicated gender differences in the choice of cattle manure and inorganic fertilizer. Gender differentials were also observed in the frequency of participation in project activities. A logistic regression model developed revealed that different factors influenced adoption at intrahousehold level. In male-headed households, adoption was positively influenced by the number of cattle owned, the access to credit, the number of adults working on farm, and farmer group membership. For female-headed households, adoption was positively influenced by the area under cash crops, the number of goats owned, the number of adults working on farm, participation in project activities, and farmer group membership. There is a clear need for strategies and policy to address gender disparities in adoption of soil improvement technologies and to encourage women's participation in agricultural training activities.

Keywords Adoption · Choice · Gender · Participation · Technologies

Introduction

Soil fertility depletion on smallholder farms has been cited as the fundamental biophysical root cause responsible for the declining per capita food production in Africa (Sanchez et al., 1996). Studies of soil nutrient balance across countries in Africa show evidence of widespread nutrient mining leading to severe nutrient deficiencies across ecological zones. Soil fertility decline is made all the more alarming, given that recurring devaluations and removal of subsidies have made inorganic fertilizers unaffordable to most small-scale African farmers (Mukhopadhyay and Pieri, 1999).

In the Central Kenya Highlands, farmers themselves have persistently expressed that low soil fertility is a major constraint to food crop production (Sanchez and Jama, 2000). One of the major factors contributing to this decline is soil impoverishment caused by continuous cropping without adequate fertilizers and/or manure, mostly due to lack of readily available resources to replenish the soil. As a result, deliberate efforts by scientists have led to the introduction of several soil nutrient replenishment technologies that integrate nutrient management which encompasses organic materials and mineral fertilizers. These technologies have been found to be both technically feasible and socially acceptable (Sanchez and Jama, 2000).

Despite these impressive advances over the last three decades, soil improvement projects commonly

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suffer from inadequate rates of adoption and/or abandonment soon after adoption (Franzel et al., 2002). To address this situation, Sanchez (1995) highlighted "the need to develop a predictive understanding of how farm households make decisions regarding land use," as others argued for more socio-economic research on adoption of soil improvement technologies. Understanding the factors affecting farmers' adoption of improved technologies is vital to the success of implementing soil innovation programs. An important factor affecting adoption is gender.

The criticality of gender issues in adoption of soil innovations is increasingly gaining global recognition and there is a strong call for its integration in development projects and programs (Gladwin, 2002). Several studies have reported the existence of gender disparities in adoption of soil improvement technologies (Fort, 2007; Mwangi et al., 1996). For example, Franzel and Scherr (2002) found that gender differences in adoption of innovations reflect men and women's differential ability to independently decide on how resources will be used and allocated. The power differentials between men and women lay the foundation for gender bias from the household-level decisions to policy-level decisions.

Further, research indicates that participation in project activities related to dissemination of knowledge on soil improvement technologies encourages adoption. However, women have been found to participate in lesser numbers compared to men. The reasons why women do not participate include lack of time, lack of self-confidence, lack of information, or misunderstanding of project goals (Sarin et al., 2006).

Past research work in the study area primarily focused on biophysical aspects of adoption with limited work on socio-economic factors influencing adoption. However, there has been very little mention of gender differentials in adoption of soil improvement technologies at household level. Also lacking is the information on the choices of technologies for adoption between male- and female-headed households and the socio-economic, institutional, and demographic factors influencing adoption. Further, information was limited on how the frequency of participation in project activities varied among male and female farmers. This study focused on addressing these concerns. As such, the analysis will not only be helpful in predicating choices of technologies adopted by gender, factors influencing adoption but also provide gender-disaggregated data frequency of participation in project activities. These results could inform gender-sensitive policy making and enhance gender targeting in technology dissemination.

Methodology

The Study Area and Background

The study was carried out between November 2006 and January 2007, in 14 villages in Mukuuni location, Chuka division, Meru South District. The area is located in upper midland 2 and 3 (UM2 and UM 3), a predominantly maize growing area, which is also referred to as a coffee agro-ecological zone (Jaetzold and Schmidt, 1983). The altitude is 1200–1600 m above sea level with an annual mean temperature of 20°C. Annual rainfall varies between 1200 and 1400 mm. The rainfall pattern is bimodal, falling in two seasons, with the long rains between March and June and short rains between October and December. The soils are mainly Humic Nitisols (Jaetzold and Schmidt, 1983). The farming system in the area is characterized by integration of both crops and animals. A wide variety of species and breeds of livestock, which include cattle, goats, sheep, and poultry, are found in the area. The major cash crops grown in the area are coffee (*Coffee arabica*) and tea (*Camellia sinensis*) and food crops like maize (*Zea mays*) and beans (*Phaseolus vulgaris*).

Maize is the main staple food, which is cultivated from season to season (Muriu, 2005, Farmers decision making process in their preference for soil nutrient replenishment technologies in the Central Kenya Highlands, unpublished masters thesis presented to Kenyatta University). As a result of soil fertility decline leading to low yields and food insecurity, a project was initiated in the area in 2003. One of the objectives of this project was to promote adoption of newly introduced soil fertility improvement technologies through participatory approaches. To start with, a demonstration trial was set up and the technologies were demonstrated to farmers during field days, which were organized every growing season. The demonstration trials comprised of soil fertility improvement technologies, which were those technologies that farmers had been introduced to with a view to improving soil fertility and food security. They included adoption of *Tithonia diversifolia*, *Calliandra calothyrsus*, *Leucaena trichandra* and improved management of inorganic fertilizers and cattle manure. By the time the study was conducted in November 2006, the farmers had visited the demonstration plots eight times during the short and long rain seasons. During field days, village training workshops and nursery groups, farmers were taught on how to implement the technologies on their farms by scientists and extension agents. The farmers also exchanged information and technologies among themselves.

Sample Selection

A sampling frame of all 350 households in the area was obtained from the provincial administration office and availed by the area chief. All the households in the area practice farming as the major economic activity. Ninety of the households were female-headed households while 260 were male-headed households. A sampling frame of adopters already existed in the project records. From these records, 160 households had adopted at least one of the technologies by the time the study was conducted. When crosschecked against the chief's list, it was found that 108 male-headed households had adopted at least one technology while 152 had not adopted any. Fifty-two female-headed households had also adopted at least one technology, while 38 female-headed households had not adopted any of the introduced technologies. Male-headed households were sampled by the use of simple random sampling while female-headed households were purposively sampled because they were fewer in number. The sample size comprised of 140 households, 70 who were adopters and another 70 who were non-adopters. Of the 70 adopters, 35 were male-headed households while another 35 were female-headed households. Of the 70 non-adopters sampled, 35 were male-headed households while another 35 were female-headed households.

Data Collection

The study relied on both primary and secondary sources of data. Primary data were obtained by the use of semi-structured interview schedules, which were administered to the 140 respondents. The interview schedules generated information on the frequency of participation in project activities and choices of technologies for adoption by gender, demographic, institutional, farm, and socio-economic factors influencing adoption. In all households, household heads were interviewed. Secondary data were obtained from journals, text books, and periodicals.

Analytical Approaches and Empirical Model

The data collected were analyzed using the statistical software for social scientists (SPSS). Data summary was done by the use of descriptive statistics and presented as frequencies and means. Chi-square tests ($p < 0.05$) were run to determine significant statistical relationships between categorical variables. Independent sample *t*-tests ($p < 0.05$) were run to test for equality between two means.

The logistic regression model was used to analyze the gender differences in factors influencing adoption of soil nutrient replenishment technologies. The logistic regression model is a non-linear regression model that has a binary response variable. As such, it has a binomial distribution with parameter (probability of success). According to Pampel (2000), the model equation is as follows:

$$\mathrm{Logit}(E[Y]) = \mathrm{Logit}(P) = X^{\mathrm{T}}\beta$$

The model is based on the binomial logistic probability function. The $\mathrm{Logit}(E[Y])$ is the binary response variable. It represents the probability of the number of events being successful. It is an index reflecting the combined effects of factors that predict adoption. The $\mathrm{Logit}(P)$ is the natural log of the odds of success. It is defined in the open unit interval (0,1). $X^{\mathrm{T}}\beta$ is the product of the transpose of the column matrix X of explanatory variables and the unknown column matrix β of regression co-efficient. The logistic regression model accounts for both categorical- and dichotomous-dependent variables and has been widely used in adoption studies (Wekesa et al., 2003). The dependent variable was a dichotomous variable depicting adoption of a technology and took the value of 1 if the farmer had adopted at least one technology and 0 if none. The independent variables included demographic, socio-economic, farm characteristics, and institutional factors and are as described in the following section.

Demographic Factors

HHSIZE was a continuous variable that depicted the size of the household. Labor constraints often limit farmers' use of soil improvement innovations. Due to the high labor demand of biomass transfer technologies such as *T. diversifolia* (Gladwin et al., 2002), it was expected that the larger the household size, the greater the labor availability. As such, it was hypothesized that the household size would be positively related to adoption.

AGE, a continuous variable, indexed the age of the household head. Age may or may not affect potential adoption. Rogers (1983) observes that age has no definite direction on adoption whereas Obonyo (2000, The adoption of biomass transfer technology in Western Kenya, unpublished MSc thesis, Kwame Nkrumah University of Science and Technology, Ghana) reported a positive relationship between age and potential adoption of *Tithonia* biomass transfer technology. Consequently, the net effect on age could not be determined a priori.

Farm Characteristics

FARMSIZE was a continuous variable referring to the variable on the size of the farm in acres. Farm size dictates the amount of crops grown and input levels. Small farms have a greater likelihood of adopting improved varieties as they are more intensively managed (CIMMYT, 1993). Farm size has been found to influence adoption decisions positively (Sullivan, 2000, Decoding diversity: strategies to mitigate household stress, unpublished master's thesis, University of Florida). Accordingly, it was anticipated that farm size would have a positive influence on adoption.

FOODCROP indexed the area of land under food crops in acres. Wekesa et al. (2003) reported that a larger area under maize is considered to increase a farmer's interest in new technologies and therefore area under food crops was hypothesized to be positively related to adoption. CASHCROP was a continuous variable that indexed the area of land under cash crops. Irungu et al. (1998) in a study conducted among dairy farmers in Kenya found that the higher the household income, the greater the financial ability to adopt. As a result, it was conjectured that the area of land under cash crops would have a positive influence on adoption.

CATTLE indexed the variable on cattle ownership. It takes on the value of 1 if the farmer owns cattle and 0 if otherwise. GOATS indexed the variable on ownership of goats. It took the value of 1 if the farmer owned goats and sheep and 0 if otherwise. SHEEP refers to the variable on the number of sheep owned. It took the value of 1 if the farmer owned sheep or 0 if otherwise. Fodder tree technologies were more likely to be adopted by households with cattle, goats, and sheep (Neupane et al., 2002). It was thus postulated that ownership of cattle, goats, and sheep was likely to influence adoption positively.

Socio-economic Factors

EDUCATION measured the farmer's level of education. The variable took the value of 1 if the farmer had an education and 0 if otherwise. A higher level of education increases a farmer's ability to obtain, process, and use adoption information (Ouma et al., 2002). Education was thus posited to be positively associated with adoption.

ACCLAND indexed access to land resources. The variable took the value of 1 if there was access and 0 if there was no access. CONTLAND indexed control of land resources. The variable took the value of 1 if there was control and 0 if otherwise. According to Sanchez (1995), ability to access and control resources is likely to influence adoption positively. It was therefore predicted that access to and control of land were likely to influence adoption positively.

PARTCPTN was a dichotomous variable that indexed the variable on participation in project activities. The variable took on a value of 1 if the farmer participated and 0 if otherwise. It was hypothesized that participation would be positively related to adoption as it exposes farmers to information about the soil fertility improvement technologies (Kariuki and Place, 2005).

TENURE indexed whether the farmer had security of tenure. Security of tenure took a value of 1 if the farmer purchased or inherited land and 0 if otherwise. It is expected that borrowed, rented/leased will be negatively related to adoption, as renting or leasing land is a sign of land scarcity. Inherited or purchased land is likely to be used to take up technologies that include a tree component (Adesina and Chianu, 2002). This may have a positive influence on adoption.

HIRELABOR indexed the variable on the ability of the household to hire labor. The dichotomous variable took on the value of 1 if labor was hired and 0 if otherwise. Studies conducted in West Africa cited labor availability as a major limiting factor to adoption of soil fertility replenishment technologies. Others said that due to labor shortage they have not been able to adopt technologies that require extensive labor investments (Enyong, 1999). Consequently, availability of labor was expected to have a positive influence on adoption.

PERCEPTION indexed whether farmers perceived a soil fertility problem in their farms. It took the value of 1 if yes and 0 if otherwise. If farmers' perceptions are that soil fertility is not a problem, labor and capital resources will not be channeled toward this cause (Nabifo, 2003). As a result, farmers' perception of soil fertility as a problem was hypothesized to have a positive relationship with adoption.

OFFINCOME was a dichotomous variable that indexed the variable on the household's access to off-farm income. It took the value of 1 if yes and 0 if otherwise. Wekesa et al. (2003) reported that an employed household head who was permanently employed had an assured income and was more likely to hire labor and adopt recommended maize technologies. It was thus posited that off farm would influence adoption positively.

Institutional Factors

CREDIT depicted access to credit. The dichotomous variable took the value of 1 if there was access and 0 if otherwise. The statistically significant positive coefficient for access to credit was established in West Africa in a study identifying credit as a major constraint to adoption of planted forages (Elbasha et al., 1999). Access to credit was postulated to affect adoption positively.

EXTENSION was a dichotomous variable that measured if the farmer had contact with extension agents, taking on the value of 1 if there was such contact and 0 if none. Extension services are a major source of technical information for farmers. Njuki (2001, Gender roles in agroforestry: a socio-economic analysis of Embu and Kirinyaga districts, Kenya, unpublished PhD thesis presented to Sokoine University, Tanzania) reports that contact with extension agents is one of the most important factors that determine adoption and hence was expected to influence adoption decisions positively.

GROUP was a dichotomous variable that indexed whether the farmer was a member of any farmers' group, taking on the value of 1 if the farmer belonged to a farmer's group and 0 if he did not belong to any group. It has been found that soil improvement innovations have higher success rates in adoption when soil fertility management projects work through farmers' groups (Adesina and Chianu, 2002). It was thus theorized that membership in a farmers' group would be positively related to adoption.

Results and Discussion

Sample Characteristics

Demographic and Farm Characteristics

Results revealed gender differences in demographic and farm characteristics between adopter and non-adopters (Table 1). In male-headed households, adopters had larger farm sizes, larger household sizes, higher number of adults working on the farms, and higher number of cattle owned than non-adopters. For female-headed households, adopters had larger areas of land under cash crops, more adults working on the farm, and a higher number of goats. The age of the household head, area under food crops, area under cash crops, and the number of goats and sheep owned were not significantly different between adopters and non-adopters for male-headed households. Similarly, for female-headed households, there were no significant differences between adopters and non-adopters in relation to age of household head, farm size, area under

Table 1 Farmers' demographic and farm characteristics disaggregated by gender

Variable	Male-headed households ($N = 70$) Mean Non-adopters	Adopters	T-statistic	Female-headed households ($N = 70$) Mean Non-adopters	Adopters	T-statistic
Farm size (acres)	2.60	3.25	–2.845**	1.89	2.04	0.888 NS
Area under food crops (acres)	1.33	1.56	–1.532 NS	1.04	1.31	1.421 NS
Area under cash crops (acres)	0.46	0.63	–1.599 NS	0.11	0.30	3.199***
Age of HH head (years)	45.23	46.91	0.654 NS	47.51	47.14	–1.49 NS
Household size	3.26	4.86	4.149***	3.51	3.17	–1.249 NS
Number of adults working on farm	1.86	2.66	4.866***	1.23	1.74	4.085***
Number of cattle	2.80	4.11	4.464***	1.89	2.20	1.460 (NS)
Number of goats	9.31	10.91	–1.367 NS	4.09	5.94	–2.706***
Number of sheep	1.60	1.71	–0.344 NS	1.09	1.43	–1.142 NS

Legend: NS = not significant; ** = significant at $p < 0.05$; *** = significant at $p < 0.01$

cash crops, household size, the number of cattle and sheep owned (Table 1).

Socio-economic and Institutional Factors

For male-headed households, factors that were significant were participation in project activities, access to credit, and membership in a group. Perception of soil fertility as a problem, ability to hire labor, secure land tenure, access to land, control of land, education, off-farm income, and access to extension services were not significant for both male- and female-headed households. For female-headed households, significant factors were participation in project activities and membership in a group (Table 2).

Frequency of Participation in Project Activities by Farmers in Meru South District

Significant gender differences were found in the frequency of participation in project activities, where men were found to participate in larger numbers than women. Participation in problem diagnosis meetings, field days, and village training workshops was significantly higher among male-headed households in comparison to female-headed households (Table 3). Most female household heads (80%) reported that they had no time to attend project meetings as they were either busy in their farms or performing domestic chores. Njuki (2001, Gender roles in agroforestry:

Table 2 Farmers' socio-economic and institutional factors disaggregated by gender for farmers in Meru South District, Kenya

Variables	Male-headed households ($N = 70$) Mean Non-adopters	Adopters	Chi-square value	Female-headed households ($N = 70$) Mean Non-adopters	Adopters	Chi-square Value
Farmer's perception of soil fertility as a problem	77.1	68.6	0.650 NS	71.4	68.6	0.068 NS
Ability to hire labor	82.9	88.6	0.072 NS	71.4	74.3	0.402 NS
Has secure land tenure	94.3	97.1	0.952 NS	77.1	85.7	0.324 NS
Has access to land	85.7	94.3	1.263 NS	82.9	94.3	0.729 NS
Has control of land	94.3	91.4	0.402 NS	85.7	88.6	0.128 NS
Participates in project activities	51.4	77.1	5.040**	42.9	77.1	8.571***
Has education	97.1	100	0.514 NS	77.1	80	0.701 NS
Receives off-farm income	22.9	31.4	0.348 NS	20	25.7	0.324 NS
Has access to extension	82.9	82.9	0.094 NS	71.4	74.3	0.280 NS
Has access to credit	17.1	57.1	9.130***	20	37.1	2.520 NS
Belongs to a group	74.3	22.9	18.529***	31.4	71.4	20.696***

Legend: NS = not significant; ** = significant at $p < 0.05$; *** = significant at $p < 0.01$

Table 3 Frequency of participation in project activities by farmers disaggregated by gender in Meru South District, Kenya

Project activity	Mean number who participated		
	MHHs ($N = 70$)	FHHs ($N = 70$)	T-statistic
Farmers who attended problem diagnosis (yearly)	0.60	0.41	–2.158**
Farmers who attended field days (twice in a year)	0.96	0.63	–2.673***
Farmers who attended village training workshops (twice in a year)	1.04	0.74	–2.195**
Farmers who attended nursery group meetings (once a week)	1.51	1.54	0.101 (NS)

Legend: NS = not significant; ** = significant at $p < 0.05$; *** = significant at $p < 0.01$.

a socio-economic analysis of Embu and Kirinyaga districts, Kenya, unpublished PhD thesis presented to Sokoine University, Tanzania) reported that the men mainly participate in project activities; thus, women who provide much of the labor do not receive sufficient training required to implement the technologies on their farms.

Choices of Technologies for Adoption Disaggregated by Gender for Farmers in Meru South District, Kenya

The findings indicated significant gender differences in the adoption of cattle manure and inorganic fertilizer (Table 4). Adoption of cattle manure was higher among male-headed households (65.7%) in comparison to female-headed households (40%). Similar results were noted for adoption of inorganic fertilizers: 74.3% for male-headed households and 37.1% for female-headed households. These results coincide with the results reported by Lekasi et al. (2001), who reported women's lack of animal and pasture land limits their access to manure, and although organic fertilizer is important for maize in addition to inorganic fertilizer, women can rarely use it as they lacked animals as well as cash to procure it. However, no significant gender differences were found in adoption of *T. diversifolia*, *C. calothyrsus*, and *L. trichandra*.

Factors Influencing Adoption in Female-Headed Households

The logistic regression model was significant at $p < 0.05$ and correctly predicted 84.3% for both adopter and non-adopter female-headed households. This implies that the model predicted 84.3% of the total variations in adoption of soil nutrient replenishment technologies and was therefore very reliable. The exponential beta (β) or odds ratio indicated the proportion with which adoption could occur, while the beta (β) sign predicted whether the variable influenced adoption decisions positively (+) or negatively (–). The results indicate that adoption by female-headed households was significantly influenced by the number of goats owned, membership in a group, area under cash crops, participation in project activities and the number of adults working on the farm.

The number of goats owned influenced adoption positively. The model predicted that a unit increase in the number of goats owned by a female household head was 1.37 times likely to increase adoption of soil nutrient replenishment technologies. This may have been so because most female household heads could not afford cattle and mainly fed their legume technologies to goats. Goats were cheaper to purchase and more risk averse. A study of high-potential areas in Kenya showed that on small farm sizes where farmers had no access to credit and inputs, dairy goats were

Table 4 Choices of soil nutrient replenishment technologies for adoption by farmers disaggregated by gender in Meru South District, Kenya

Technology adopted	Frequency of adopters (%)		
	MHHs ($N = 35$)	FHHs ($N = 35$)	Chi-square value
Cattle manure	65.7	40	4.644**
Tithonia	82.9	80	0.094 NS
Leucaena	22.9	17.1	0.357 NS
Calliandra	71.4	54.3	2.203 NS
Inorganic fertilizer	74.3	37.1	9.785***

Note: NS = not significant; ** = significant at $p < 0.05$; *** = significant at $p < 0.01$

more profitable and less risky than dairy cattle (IFAD, 2007). Generally, men and women tend to own different animal species. In many societies, cattle and larger animals are usually owned by men, while smaller animals, such as goats and backyard poultry which are kept near the house, are more women's domain (Fort, 2007).

A farmer's members into a group increased the chances of adoption. The more farmer's that joined groups, the higher the possibility of taking up technologies. This may have been because farmers were able to access legume seedlings and also receive adequate training and skills in groups. These results were supported by Adesina and Chianu (2002), who found that soil improvement innovations had higher success rates in adoption when soil fertility management projects work through farmers' groups.

Farmers with larger areas of land under cash crops were more likely to adopt than those with smaller areas. Indeed, a unit increase in the area of land under cash crops was 23.16 times likely to increase adoption. This may have been because income generated from cash crops could be used to hire labor and purchase required inputs. Wekesa et al. (2003) also found that the area of land under cash crops dictated a farmer's income and thus his ability to invest in soil fertility improvement technologies.

Farmers' participation in project activities significantly and positively influenced adoption. This could be attributed to the fact that through participation, farmers became aware of the technologies, were trained, and also could visit demonstration plots to learn more. These results are corroborated by Njuki (2001, Gender roles in agroforestry: a socio-economic analysis of Embu and Kirinyaga districts, Kenya, unpublished PhD thesis presented to Sokoine University, Tanzania), who reports that farmers who participate in farmer training courses are more likely adopters than those who do not.

An increase in the number of adults working on the farm was likely to have a resultant increase in adoption. This was probably given that most households in the area relied on family labor and with the free primary education initiative by the government; labor from children was unreliable as more children enrolled in schools. These results coincide with Mwangi et al. (1996), who found that households with a higher number of adults working on farm were more likely to adopt compared to those with fewer adults (Table 5).

Logistic Regression Results for Male-Headed Households

The logistic model estimate was significant at $p < 0.05$ and correctly predicted at 90% for both adopter and non-adopter male-headed households, suggesting that the model's precision in prediction was very high at 90% and was thus dependable. The results revealed that the number of adults working on farm, access to credit, member in a farmer's group, and the number of cattle owned significantly and positively influenced adoption.

A unit increase in the number of adults working on farm was likely to increase adoption by 8.19 times. This may have been due to the fact that most households in the area mainly relied on family labor, which was readily available and cheap. Studies conducted in West Africa cited labor availability as a major limiting factor to adoption of soil fertility replenishment technologies (Enyong, 1999).

Farmers who accessed credit were more likely to adopt than those who did not. This may have been possibly because financial access translated to access to purchasable inputs, including hired labor. Mwangi et al. (1996) reported that access to credit by male-headed households encouraged adoption of improved maize varieties in Tanzania.

Table 5 Logistic regression parameter estimates for female-headed households

Variable	β	S.E.	Wald	Sig.	exp(β)
Number of adults working on farm	2.656	0.832	10.192	0.001	14.246
Farmer belongs to a group	2.116	0.785	7.257	0.007	8.297
Number of goats owned	0.315	0.146	4.665	0.031	1.370
Area of land under cash crops (acres)	3.142	1.683	3.486	0.062	23.160
Farmer participates in project activities	1.447	0.721	4.030	0.045	4.251
Constant	–7.938	2.009	15.615	0.000	0.000

Table 6 Logistic regression parameter estimates for male-headed households

Variable	β	S.E.	Wald	Sig.	exp(β)
Number of adults working on the farm	2.103	0.754	7.777	0.005	8.190
Access to credit	2.475	1.100	5.061	0.024	11.880
Farmer belongs to a group	3.107	1.075	8.347	0.004	22.355
Number of cattle owned	1.323	0.437	9.180	0.002	3.754
Farm size in acres	0.307	0.440	0.488	0.485	1.359
Farmer participates in project activities	1.387	1.005	1.907	0.167	4.005
Constant	−13.336	3.419	15.212	0.000	0.000

A farmer's membership into a group was a motivation for adoption. A unit increase in group membership was found to possibly increase the adoption by 22.4 times. The reason for this may have been that farmers who were group members could access legume seedlings and receive training and short loans with which they could purchase inputs. These findings are supported by Kariuki and Place (2005) who found that a farmer's membership in a group increased adoption as farmers exchanged information and obtained resources through groups.

Farmers who owned more cattle were likely adopters in comparison to those who did not own as many. The explanation for this could probably be that cattle ownership is a sign of wealth and thus well-to-do farmers could also afford to buy other inputs and also hire labor. Sullivan (2000, Decoding diversity: strategies to mitigate household stress, unpublished master's thesis, University of Florida) found that the number of cattle owned influenced adoption decisions in male-headed household. Farm size in acres and participation in project activities influenced adoption positively though not significantly (Table 6).

Conclusions, Implications, and Recommendations

This study affirms the need for gender consideration in adoption of soil nutrient replenishment technologies. The choices of technologies for adoption were differentiated by gender, with female-headed household adopting fewer technologies than male-headed households. Significant gender differences were observed in the choices of cattle manure and inorganic fertilizers for adoption, with female-headed households using these technologies at lower levels in comparison to male-headed households.

Factors significantly influencing adoption in male-headed households were found to be access to credit, membership in a farmer's group, the number of adult household members working on farm, and the number of cattle owned. Those that significantly influenced adoption in female-headed households were found to be the following: participation in project activities, membership in a farmer's group, area of land under cash crops, the number of goats owned, and the number of adult household members working on farm. Further, significant gender differentials were also noted in the frequency of participation in project activities such as village training workshops, field days, and problem diagnosis meetings. There is a clear need for researchers to target technologies by gender to encourage adoption by both male- and female-headed households.

Further, successful implementation of projects will need to take into account the equal participation of women and men in all project activities. Interventions targeted at women need to consider women's available time, not only for new activities but also for participating in meetings and committees. Based on the fact that adoption by male- and female-headed households is influenced by different factors, it is vital that these factors are considered as a reference point when conducting studies on adoption and gender. In addition, future researchers need to investigate gender differentials at interhousehold level and also determine whether farmers who participated in project activities disseminated the knowledge acquired to their spouses and community members. Finally, gender literacy for policy makers and project implementers requires immediate attention.

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