International NGO Journal Vol. 3 (4), pp. 068-073, April, 2008
Available online at http:// www.academicjournals.org/INGOJ
ISSN 1993–8225 © 2008 Academic Journals

Article

Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania

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Accepted 14 April 2008

Declining soil fertility is recognized as one of the major biophysical constraints affecting agricultural production in sub-Saharan Africa. "Improved fallows" technology, a leguminous trees-based soil replenishment technology was introduced in smallholder farming system in Tanzania to address this problem. The objective of this study was to identify the factors that influence the adoption of the technology among smallholder farmers in western Tanzania. The results revealed that lack of farmer awareness of the technology, inability of farmers to wait for two years before obtaining direct benefits from the technology were the major constraints to planting improved fallows. The study identifies farmer training through workshops and seminars, enforcement of village by-laws on animal grazing, and facilitation of farmers' access to credit as the major approaches to enhance the adoption of the technology.

Key words: Agroforestry, leguminous trees, soil fertility, sustainable agriculture, Tanzania

INTRODUCTION

The continued threat to the world's natural resources is exacerbated by the need to reduce poverty and unsustainable farming practices. A significant proportion of the rural population in sub-Saharan Africa is food insecure and malnourished. Food security is one of the main global concerns in many developing countries (FAO, 1996; IFPRI, 1996). Food insecurity is most acute in sub-Saharan Africa, where the attainment of food security is intrinsically linked with reversing agricultural stagnation and safeguarding the natural resource base (Cleaver and Schreiber, 1994). Declining soil fertility and low macro-nutrient levels is recognized as one of the major biophysical impediment to agricultural growth of African agriculture (Nye and Greenland, 1960; FAO, 1971; Pieri, 1989; Yates and Kiss, 1992; Vanlauwe and Giller, 2006). The low soil fertility arises due to (i) breakdown of the erstwhile traditional natural fallow sys-tem that used to be the means of replenishing soil fertility and (ii) continuously cultivation of crops without external fertilization due to the high costs of mineral fertilizers. The need to improve soil fertility management in the continent has become a very important issue in the development policy agenda (Scoones and Toulimin, 1999) because of the strong linkage between soil fertility and food insecurity on one hand and the implications on the economic well being of the population on the other (Ajayi et al., 2003).

Improved fallows technology has the potential to improve soil fertility through the maintenance or increase of soil organic matter and biological nitrogen (N_2) fixation from nitrogen fixing tree species (Young, 1997). Researchers in southern Africa have introduced improved fallow as a sustainable option to replenish soil fertility within the shortest possible time (Kwesiga et al., 1999). Improved fallow involves planting of fast growing plant species that produce easily decomposable biomass. The major leguminous tree species that have been found to be suitable for improved fallows in western Tanzania are *Sesbania sesban* (L) Merr, and *Gliricidia sepium* (Jacq.) Walp. Agroforestry species have the potential to reverse soil fertility decline thereby increasing crop yields

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(Thangata and Alavalapati, 2003). Various studies have shown the potential of agroforestry as an approach to sustainable agriculture production and soil management, especially in the tropics (Maghembe and Prins, 1994; Nair et al., 1999). There are some technologies that can replenish soil fertility and provide other needs such as fuel wood, hence become integral part of the household subsistence needs. Improved fallow technology is a sustainable agricultural system with potentials to improve food security, and is being promoted in most parts of Tanzania. However, adoption of the technologies among small-holder farmers has generally been low (ICRAF, 1997). Investigation of why some technologies are more readily adopted than others requires key information about the socio-economic and biophysical interactions that affect farmers in making decisions (Thangata and Alavalapati, 2003) Franzel et al.(2001) noted that higher adoption rates of improved fallows in Zambia were associated with proper and effective diagnosis of farmers' problems their participation in programmes and encouragement to innovate. One of the reasons why some agroforestry development projects failed was lack of attention to socio-economic issues in the development of the systems as well as in the extension of technologies (Mercer and Miller, 1998).

A study in Nigeria found that farmers do not plant trees due to lack of farmer involvement and the unattractiveness of income incentives from tree growing com-pared with food crops (Osemeobe, 1990).

Based on a sample survey of 55 small-scale farmers in five villages in Tabora region of Tanzania, the aim of this paper is to understand the process and socio-economic factors affecting the adoption of the improved fallow technology within the context of resource-poor farmers in Western Tanzania. The study highlighted implications for scaling up and scaling out of the technology to other geographical locations.

Overview of western Tanzania (Tabora) and survey methods

Tabora region is located in mid-western part of Tanzania on the central plateau between latitude 4 - 7^o South and longitude 31 - 34^o East. It covers an area of 76,151 km^2, representing 9% of the land area of mainland Tanzania. A total of 34,698 km^2 are forest reserve and 17,122 km^2 are game reserve. Tabora region has a total population of 1,717,908 (NBS, 2002). It has a long dry season of about 5 - 6 months, with temperatures ranging from a mean minimum of 16.6^{o}C in June to mean maximum of 37.7^{o}C in October. Soils are 80 - 90% sand (Ferric acrisol), with low organic carbon ranging between 0.4 and 0.8%. Tabora region lies in the uni-modal upland plateau agro-ecological zone where agro-pastoralism dominates the farming system. The natural vegetation in the region consists of miombo woodlands with mainly *Acacia* and *Cambretum Spps*. Land tenure is public and individual farmers have user rights to be allocated and to cultivate the land (Warner, 1993).

Most of the population in the region (93%) depends on agricultural production and 80% of the regional economy is derived from agriculture, of which 30% is contributed by tobacco cultivation (Ramadhani et al., 2002). Farm holding size averages about 20 ha, most of which is uncultivated (Otsyina et al., 1996). Tobacco is the main cash crop among smallholder farmers; other crops grown for both food and cash include maize as, the main food crop, groundnuts (*Arachis hypogaea* L.), rice (*Oryza sativa* L.) and sorghum (*Sorghum bicolor* L.). About 5% of the farmers own livestock ranging from 1 to 100 (Otysina et al., 1997).

METHODOLOGY

Sampling technique

A total number of 55 farmers (30 adopters and 25 non-adopters) were selected for interview in five districts of Tabora region: Tumbi, Malolo, Isikizya, Kigwa and Magiri in Uyui districts. First, from each district one village was purposively chosen for the study, i.e. a total of five villages. The villages chosen were the pilot sites where agroforestry research and dissemination activities were taking place. In each selected village, a random sampling technique was used to selected farmers based on a sampling frame of farmers which was available in the village extension offices also farmers' focus group was conducted to collect general information about farmers' views regarding the technology. For the purposes of this study, farmers who planted *Sesbania sesban* and *Gliricidia sepium* were regarded as adopters. Farmers who were aware about these species but did not establish any fallow were considered as non-adopters.

Data

Data collection was done through a formal questionnaire that was administered in 2004. The questionnaire had closed and open-ended questions that were posed to collect information on various socio-economic characteristics such as age, household demography, labour availability, education, occupation and policy factors. The Statistical Package for Social Sciences (SPSS) software was used to analyze the data. Frequency distributions and percentages were used to summarize the information.

RESULTS AND DISCUSSIONS

Demographic structure in the study area Results revealed that majority of respondents were married male of the sampled population, (Table 1). The high percentages of married headed families observed in the study suggest that participation of farmers in improved fallow in the

Table 1. Distribution of respondents by type of household

Household head	Frequency	Percentage
Married male	28	70
Married female	12	20
Single	3	1
Widowed	7	3
Divorced	8	7
Total	**55**	**100**

study area depends on the perception of the technology by the male members of the community because most of the women did not own land. This is in agreement with (Phiri et al., 2003), in his study found that proportionately more men planted improved fallow than women primarily because married women need consent of their husbands before planting trees. In sub-Saharan Africa, conventional methods of agricultural extension have traditionally tended to be geared towards men while ignoring women (Saito et al., 1990). The authors noted that the bias against women is manifested in the delivery of the extension message itself. The message is generally provided by male extension agents to men with the implicit assumption that it will “trickle down” to women. The authors also noted that extension messages tend to focus on activities of male farmers while ignoring the wide range of agricultural activities, responsibilities and cons-traints facing women farmers. They pointed out that discrimination against women in agricultural technology generation and dissemination inevitably affected women negatively, leads to inefficient use of resources (as women fail to adopt improved technologies) and lower levels of agricultural production.

The dominant age group among the respondents was between 20 - 40 years (57%) while the age group 45 - 70 was 43%. All age groups in this survey were active and had the potential of participating in agroforestry. This is contrary to other studies that young people participate more in agroforestry due to their ability to acquire and use information about new technology faster than old people (Sonii, 1992). Results of this present study reveal that almost all the age groups had equal participation with exception those who were above 70 years of age. Our results also support the findings on the adoption of social forestry in India by (Alavalapati et al., 1995) and live hedge in Burkina Faso (Ayuk, 1997) that younger farmers are more likely to adopt agroforestry.

Education was not a major constraint hindering participation in agroforestry activities in the study area as almost all the farmers interviewed had acquired formal primary education (Table 2). The majority of the respondents had education that could enable them to read and write and eventually follow technical recommendations.

Occupation: Most of the farmers depended entirely on farming while small number was formally employed in rural non-farming sectors. It further revealed that majority of farmers are involved in off-farm income generating activities including production of horticultural crops, small enterprises and local brew making and other miscellaneous activities. (Table 3)

Given that improved fallow technology primarily alleviates the problems associated with the use of high cost fertilizer, the findings that farmers who adopt improved fallow technologies are wealthier than non-adopters are not related. Peterson (1999) found that all farmers who purchased more than 50kg of fertilizers did not feel that their access to fertilizer discouraged them from planting trees. Majority of households who adopted improved farming compared to non-adopters have contacts with extension agent and participated in improved farming programme (Table 4). Farmers who did not plant improved fallow attributed this to their being non-members in farmer groups. Extension contact comprises information such as the farmer’s visit to the extension worker for advice, visits by the extension worker to farms to provide advice, attendance at extension meetings, or a course in the extension planning area. Contact with extension staff is very important in promoting mixed intercropping in Malawi (Thangata and Alavalapatti, 2003). The weak extension delivery system in the study area is one of the key constraints to the adoption of improved fallow in Tanzania.

Constraints facing farmers in participation

Farmers face a number of challenges that hinder them from establishing and using improved fallows (Table 5). Lack of awareness and poor knowledge on improved fallow is most critical compared to other problems. This is followed by lack of interest to plant trees, the long time it takes to realize benefits from trees, as farmers have to wait for two years before getting benefits from improved fallow and lack of seeds/seedlings. Similar study carried out in Zambia revealed that the major constraints to planting an improved fallow were lack of awareness, lack of seeds/seedlings; and unwillingness to wait for two years before realizing of the benefits of the technology (Ajayi et al., 2003).

Peterson (1999) noted that farmers would plant improved fallow if they have resources to do so. These resources’ include patience (ability to wait two years to reap the benefits) In addition farmers mentioned that livestock grazing is becoming a serious problem because of the land tenure system in which land is communally owned and free livestock grazing. Studies from elsewhere (Shiferaw and Holden, 1998; Shiveley, 1997) have shown that insecurity of tenure over land influences the adoption process of agricultural technologies negatively.

Focus Group Discussion (FGD) results which ranged from a group of 5 farmers to 10 farmers at Kigwa and Isikizya village showed that there were no effective by laws against livestock grazing and burning. Results fro

Table 2. Household characteristics

Variable	Description	Non-adopters N = 25	Adopters N = 30	Chi-square	Significant level
EDUC	Education (average school years)				Ns
	1-4 years (%)	57	43		
	5-6 years (%)	70	30		
	7-12 years (%)	50	50		
OFACT	Involved in off-farm activities (%)	83	86		Ns
STATUSM	Marital status				Ns
	Married male (%)	93	57		
	Married female (%)	30	70		

NS: not significant.

Table 3. Occupation of the respondent

Respondent	Frequency	Percentage
Farming	41	93
Formal employment	14	7
Total	55	100
Off-farm activities		
Horticultural crops	16	33
Small business	14	27
Local brew	9	10
Others	15	30
Total	55	100

Table 4. Factors affecting adoption of improved tree fallows

Variable	Description	Non-adopters (%) N = 25	Adopters (%) N = 30	Chi-square	Significant level
INFOIF	Received information on Improved farming	40	60	13.1	**
FARMGROP	Membership in farm groups	18	82	20.4	***
CONTEXT	Has contacts with Extension	39	61	21.3	***
PART IF	Participated in improved farming	41	59	26.5	***

** Significant at 0.01, *** significant at 0.001

Table 5. Constraints to the planting of improved tree fallow

Constraint	Percentage
Lack of awareness and poor knowledge	33%
Not willing to plant trees	21%
Inability to wait two years	18%
Lack of seeds/seedlings	10%
Takes long time	9%
Livestock destruction	9%
Total	**100%**

from a related study carried out in Zambia (Ajayi and Kwesiga, 2003) revealed that the effectiveness of by laws against browsing varies depending on the type of cultural community involved and the level of agro-pastoral farming. Lack of effectiveness of the by laws was due to lack of understanding of the exact provisions of the by-laws by various components of the community (Ajayi and Kwesiga, 2003).

Farmers' opinion on how to improve adoption

Farmers suggested several approaches to enhance the use and adoption of improved fallows by small-scale farmers in Tanzania. It was recognized that the benefits of planting improved fallow are not clearly known to farmers, since most of them were not involved in training and workshops programs conducted in the area. Hence the respondents proposed that training (through work-

Table 6. Farmers' suggestions for enhancing the uptake of improved fallow

Opinion	Percentage
Create awareness and train farmers on improved tree fallow	39
Conduct farmer; seminars and dialogue meetings	20
Enforce existing bylaws on fire and grazing	12
Provide farmers with Gifts/loans	7
Encourage the formation of farmer group	7
Organize regular follow-and feedback session with farmers	5
Emphasize agroforestry in policy decision making	3

shops and seminars) for participating and non-participating farmers should be conducted in order to create awareness. Farmers also raised issues concerning by-laws to control free grazing and browsing by livestock. Village by-laws should be enforced to control grazing. Farmers recommended that the by-laws should be documented which will be a tool to safeguard all stakeholders including livestock and other non-agroforestry farmers. The reviews of credit conditions to enable farmer's access credit were also suggested.

Access to credit could improve farmers' ability to hire laborers to work in improved fallow field especially during the establishment phase before the benefits from the technology accrue to farmers. The formation of farmer groups and policy emphasis to create awareness were also suggested as the way forward to enhance the use of improved fallows (Table 6).

Conclusion

Martial status, formal education and regular off-farm income had no influence on decisions to plant improved fallow. According to this study, lack of awareness on improved fallows, unwillingness and lack of inability to wait two years are the major limiting factors of improved fallow adoption. Lack of access of extension services seems to be a very important factor in agroforestry adoption. Our study supports the findings for (Omoregbee, 1998; Adesina et al., 2001) and (Boahene et al., 1999) that farmers with higher extension contact are more likely to adopt agroforestry technology. The study through discussion with farmers revealed that, the provision of free seeds/seedlings and other equipment might not guarantee tree planting and management needs labour which was formally not planned for tree planting.

ACKNOWLEDGEMENT

The authors would like to thank farmers and extension agents in Tabora Tanzania who availed us their time during field data collection for this study and, to Paul Thangata for his comments on the initial draft of the manuscript. We also gratefully acknowledged the financially support provided by Canadian International Development Agency (CIDA). The contents of this manuscript however do not represent the official views of the institutions mentioned above

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