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 system that used to be the means of replenishing soil fertility and (ii) continuous-ly 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 (N₂) 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 falls 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.
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 incentives from tree growing compared with food crops (Osemenebe, 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° South and longitude 31 - 34° East. It covers an area of 76,151 km², representing 9% of the land area of mainland Tanzania. A total of 34,698 km² are forest reserve and 17,122 km² 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°C in June to mean maximum of 37.7°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 (Otsyina 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 select 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

<table>
<thead>
<tr>
<th>Household head</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married male</td>
<td>28</td>
<td>70</td>
</tr>
<tr>
<td>Married female</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Single</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Widowed</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Divorced</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100</td>
</tr>
</tbody>
</table>

**Occupation:** Most of the farmers depended entirely on farming while a 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 fallsows (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 Isikiza village showed that there were no effective by laws against livestock grazing and burning. Results fro
Table 2. Household characteristics

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

NS: not significant.

Table 3. Occupation of the respondent

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming</td>
<td>41</td>
<td>93</td>
</tr>
<tr>
<td>Formal employment</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100</td>
</tr>
<tr>
<td>Off-farm activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horticultural crops</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>Small business</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>Local brew</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4. Factors affecting adoption of improved tree fallows

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Non-adopters (%) N = 25</th>
<th>Adopters (%) N = 30</th>
<th>Chi-square</th>
<th>Significant level</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFOIF</td>
<td>Received information on Improved farming</td>
<td>40</td>
<td>60</td>
<td>13.1</td>
<td>**</td>
</tr>
<tr>
<td>FARMGROP</td>
<td>Membership in farm groups</td>
<td>18</td>
<td>82</td>
<td>20.4</td>
<td>***</td>
</tr>
<tr>
<td>CONTEXT</td>
<td>Has contacts with Extension</td>
<td>39</td>
<td>61</td>
<td>20.3</td>
<td>***</td>
</tr>
<tr>
<td>PART IF</td>
<td>Participated in improved farming</td>
<td>41</td>
<td>59</td>
<td>26.5</td>
<td>***</td>
</tr>
</tbody>
</table>

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

Table 5. Constraints to the planting of improved tree fallow

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of awareness and poor knowledge</td>
<td>33%</td>
</tr>
<tr>
<td>Not willing to plant trees</td>
<td>21%</td>
</tr>
<tr>
<td>Inability to wait two years</td>
<td>18%</td>
</tr>
<tr>
<td>Lack of seeds/seedlings</td>
<td>10%</td>
</tr>
<tr>
<td>Takes long time</td>
<td>9%</td>
</tr>
<tr>
<td>Livestock destruction</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

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-
shops and seminars) for participating and non-partici-
pating 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 stake-
holders 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 falls (Table 6).

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

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

Conclusion

Martial status, formal education and regular of-farm
income had no influence on decisions to plant improved
fallow. According to this study, lack of awareness on
improved falls, 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 adop-
tion. 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 gua-
rantee tree planting and management needs labour
which was formally not planned for tree planting.

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script however do not represent the official views of the
institutions mentioned above

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