FACTORS AFFECTING ADOPTION OF AGROFORESTRY FARMING SYSTEM IN TURIANI DIVISION, MOROGORO RURAL DISTRICT

BY

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ABSTRACT

A study to identify factors affecting the adoption of agroforestry (AF) farming system in Morogoro Rural District was conducted in Turiani Division so as to recommend strategies for improvement of the prevailing farming systems. A cross sectional research design was adopted so as to collect information at a single point in time. In data collection a structured questionnaire was administered to a sample of 180 farmers, ensuring equal number of adopters and non-adopters of AF innovations. The data were analysed using the statistical package for social sciences (SPSS) computer software.

The results have shown that the most common AF system practised in the study area was the homegarden. In the homegardens, trees or shrubs and agricultural crops were found to interact with livestock thereby enhancing sustainability of the system. Dairying was significantly ($P<0.001$) associated with AF adoption. Therefore, dairy cattle keepers were found to play a key role in environmental protection by planting a variety of fodder trees thereby contributing greatly to sustainability of the homegardens. Farmers' awareness and the innovation's benefits were identified as the major motivating factors in adoption of AF. Major benefits that were found to gear adoption include simplicity of the innovation, control of termites and the provision of such items as fuelwood, livestock fodder, construction materials, fruits and nuts.

The major factors, which were found to limit adoption of AF innovations, include lack of awareness and land scarcity. Lack of motivation and inadequate extension services are among the reasons causing poor participation of farmers in AF practices. It was also

observed that, limited access of women to household decision making and ownership of resources and farm benefits discouraged participation of women in AF practices.

Strengthened and gender-equity extension education, promotion of sunflower production and more research on the components of homegardens are among the recommendations given.

DECLARATION

I, **ADOLF FOKAS MAKAUKI** do hereby declare to the Senate of Sokoine University of Agriculture that the work presented here is my own original work and has not been nor is it concurrently being submitted for a similar degree award in any other University.

Signature .....

Date 17/07/2000

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DEDICATION

Everyone who trusts in him will never be put to shame. The same Lord is Lord of all and richly blesses all who call on him, for, everyone who calls on the name of the Lord will be saved (Rom. 10:11, 12b, 13).

This work is dedicated to my parents, Fokas and Margaret, who in their love, sacrifice and patience brought me to what I am; to my wife, Venosa and our children Margaret-Mashao, Kelvin-Fokas and Johnson-Baraka who suffered various consequences but remained my richest source of encouragement and above all, to the Lord, Jesus Christ whose blessings gave me physical, mental and moral strength to accomplish this important task.

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ABBREVIATIONS AND SYMBOLS

AF	Agroforestry
DANIDA	Danish International Development Agency
e.g.	For example
ENRECA	Enhancement of Research Capacity
et al.	And others
etc	And so on (*et cetera*)
FA	Female adult
FAO	Food and Agriculture Organisation of the United Nations
FC	Female children
GAF	Gender Analysis Framework
HIT	Heifer In Trust
HPI	Heifer Project International
i.e.	That is
km	Kilometre
MA	Male adult
MAC	Ministry of Agriculture and Co-operatives
MC	Male children
MU	Makere University
n	Number of respondents
Na	Not applicable
NRC	National Research Council

NS	Not significant
P	Probability
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
SURUDE	Foundation for Sustainable Rural Development
TAS	Tanzanian Shilling
USA	United States of America
USD	United States Dollar
vs.	Against
>	Greater than
<	Less than
0	Degree
'	Minutes
%	Percent

CHAPTER ONE

INTRODUCTION

1.1 Background information

Most people in Sub-Saharan Africa live in rural areas and earn their living from agriculture (Makundi, 1996). Thus, the majority (85 %) of Tanzanian rural people virtually depend on agriculture particularly small scale farming for their food and other basic needs (Bagachwa *et al*, 1995). The productivity of traditional production systems practised by these farmers is generally low causing low standard of living. Lack of modern knowledge of farming to the farmers has probably been one of the factors perpetuating the low productivity of the agricultural land through lack of proper soil conservation. The source of problems can not be said to be farmers although it is true to argue that how a country's land is managed and used depends upon the perceptions and actions of individual farmers, pastoralists, foresters and other land users. Incorrect land use and management by small farmers are not done intentionally but are the result of ignorance, socio-economic, socio-cultural and political pressures (Rutatora, 1993).

What is discouraging is that, efforts towards soil conservation have proved inadequate to sustain the increasing population pressure on the land (Senkondo and Kihiyo, 1994). This, among other things leads to increased deforestation and environmental degradation which in turn aggravate the social and economic costs associated with the scarcity of fuel wood and construction materials (poles, timbers and withies) to the rural

people. It should be noted that deforestation and environmental degradation have been an alarming problem in Tanzania (Ishengoma, 1994; Senkondo, 1994).

Earlier studies have shown that most agricultural systems in Sub-Saharan Africa are not sustainable (Smaling *et al.*, 1996). The adoption of sustainable development strategies by the respective farmers can be the best alternative in reversing the problem of low productivity of the existing land and the associated problems. Agroforestry as a multipurpose land use system has been suggested as a solution to attain sustainability in land use and as a complement to the existing land use management (Redhead *et al.*, 1983; Senkondo, 1994; Senkondo and Kihiyo, 1994). As defined by the International Centre for Research in Agroforestry, the term agroforestry is a collective name of land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboo etc) are deliberately combined with agricultural crops and/or animals in some form of spatial arrangement or temporal sequence (Moshi, 1997) This farming system was promoted widely as a sustainability-enhancing practice that combines the best attributes of forestry and agriculture (Sanchez, 1995). Agroforestry farming systems have therefore been found to have several advantages. Some of the advantages include its significant contribution in such aspects as control of soil erosion, conservation of soil fertility through nutrient recycling and enhancement of biodiversity (Sanchez, 1995).

Other benefits of agroforestry include increased income from the same piece of land and the provision of fuel wood, fodder, fruits and timber. Some tree species in agroforestry systems have been reported to have medicinal as well as insecticidal values

(Makauki *et al.*, 1999; NRC, 1992). In view of these advantages, it is likely that, the adoption of agroforestry innovations is a strategy for increased household welfare (Isac, 1994 cited by Sanchez, 1995). Additionally, the adoption of agroforestry systems by smallholder farmers holds potential for slowing the rate of environmental decline (Caveness and Kurtz, 1991). The farming system was found to be beneficial as a practice of soil conservation and fertility management in some areas of Tanzania including Mufindi District (Chonya, 1993).

1.2 Problem statement

Although agroforestry has been in use for at least 1300 years with its advantages known (Sanchez, 1995) its potential is not fully utilised in many rural communities of Tanzania. Unlike Kilimanjaro region where farmers benefit from the interaction between trees, coffee, banana, annual crops and livestock (O'Kting'ati and Mongi, 1986), the problem is worse in areas like Turiani where most farmers depend on short lived crops such as rice and maize for food and cash. Some depend on sugarcane as a cash crop. The problem is one of adoption-decision making, probably due to several socio-economic, service related, cultural and political factors. It is agreed that adoption decisions are a product of sequence of influences operating through time (Lionberger and Gwin, 1991). Moreover, it should be noted that at farming systems scale, agroforestry adoption has different impacts for different classes of farmers such as gender (Isac, 1994 cited by Sanchez, 1995). Some of the impacts may make the innovation either adoptable or not adoptable to farmers.

1.3 Justification of the study

Although agroforestry as a multipurpose land use system for rural development has gained a great deal of popularity, technology transfer to the smallholder has been only narrowly examined (Senkondo, 1996) Identifying factors influencing the adoption of this farming system is therefore credited taking into account that adoption of agroforestry interventions can lead to ecologically sustainable systems which are sufficiently productive and profitable to decrease rural poverty (Isac, 1994 cited by Sanchez, 1995).

Several researchers have been directing their efforts towards the biological and physical or technical aspects of agroforestry (Mureithi *et al.*, 1995; Senkondo, 1996) more than its acceptability to rural people. In the same line of thought, it can be pleaded that the emphasis of agroforestry research to date has been on the performance and management of the inter-cropped species neglecting its adoption which greatly depends on the socio-economic contribution (O'Kting'ati and Shayo, 1998). Thus, there is paucity of information on the likely impact of agroforestry on the socio-economic situations of Tanzanian rural farmers (Senkondo, 1996). This justifies conduction of research on adoption in Turiani and other areas of the country so as to avoid undesirable impact and hence result in sustainable farming systems.

Findings of the present study will be useful not only to the rural people of the study area but also to change agencies since addressing the constraints limiting agroforestry adoption will likely necessitate formulation and modification of strategies for increased

adoption and hence sustainability of the farming systems. This is possible because the present study considered the linkages within the overall farming system of the study area, which in several occasions have been ignored by researchers in Turiani and other areas of Morogoro (Lekule *et al.*, 1996).

1.4 Objectives of the study

The broader objective of the present study was to identify factors affecting the adoption of agroforestry practices in Turiani Division in order to recommend strategies for improvement and sustainability of the farming systems. The specific objectives were:

(a) To identify agroforestry practices carried out in the study area;

(b) To identify factors motivating the adoption of agroforestry practices;

(c) To identify factors limiting the adoption of agroforestry practices;

(d) To determine the role of the interaction between livestock, crops and trees (and shrubs) in agroforestry systems in the study area;

(e) To examine gender roles in the farming systems of the study area.

1.5 Hypotheses

Null Hypothesis (Ho): Adoption of agroforestry practices is independent of socio-economic, cultural, service related and political factors.

Alternative Hypothesis (H_A): Adoption of agroforestry practices is dependent on socio-economic, cultural, service related and political factors.

CHAPTER TWO

LITERATURE REVIEW

2.1 Adoption of innovations

2.1.1 Introduction

Rogers (1995) defined adoption of an innovation as a decision to make full use of an innovation as the best course of action available. The author introduced the so called *"model of innovation decision process"* which explains the whole sequence of events occurring to an individual from the time he or she becomes aware of an innovation until the adoption stage. The whole process is referred to as the innovation-decision process. Rogers' model consists of five stages, namely knowledge, persuasion, decision, implementation and confirmation In the same line, Lionberger and Gwin (1991) agreed that thought-out adoption decisions are the product of a sequence of influences operating through time rather than something happening instantaneously. The authors provided an agricultural research based model for describing what happens in the individual adoption process.

Similar with Rogers (1995), the model provides five stages that the adopter goes through, awareness being the first and adoption, the last stage. The model entails that at awareness stage, people get general information about a new idea, product or practice for the first time but not its details. Since farmers are not satisfied with mere knowledge or general information, they need and actively seek additional and detailed information

about the innovation (interest stage). Having the detailed information the farmer decides whether the idea is good to him or not (evaluation stage) after which the potential adopter tries the new idea or practice a little first and more later (trial stage). After successful trial, usually on their farms and often after observing or consulting with others farmers may take up the innovation for full use (adoption stage). Depending on innovation type, some stages may be skipped and the most frequently skipped is the trial stage due to difficulties in trying a little first and more later (Lionberger and Gwin, 1991).

In a social system, it is not possible for all individuals to adopt an innovation at the same time. Basing on the degree to which an individual or other unit of adoption is relatively earlier in adopting an innovation (innovativeness), Rogers (1995) classified members of the social system into adopter categories. In normal frequency distribution the author presented the adopter categories and their approximate percentages of individuals as innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%), which are briefly explained in the following sections.

In practice, the conventional methodology of studying adoption of innovations given by Rogers does not take into account the variability of the different communities and farmers' preferences, which are based on their livelihood strategies. Instead, it assumes that farmers of a certain social system will adopt an innovation from a change agent in the same way, as others would do in other social communities after doing the necessary

innovation decisions. Consideration of this aspect could likely alter Rogers' adopter categorisation. Therefore, Rogers' adopter categorisation can not be generalised.

It should be noted that, since farmers are rational in decision making they balance between a wish to innovate and the expected worth of the innovation (Blum, 1989). This implies that the most desired innovations will likely be adopted by greater proportion of members in the first instance than the Rogers' proportion (2.5 %) and vice versa.

2.1.2 Innovators

Innovators are venturesome individuals in a social system, who are very eager to try new ideas, have substantial financial resources and the ability to understand and apply complex technical knowledge. They are also capable of coping with a high degree of uncertainty and playing an important role in importing new ideas. In terms of social relations, these are cosmopolitan whereas in a social system they are regarded as the gate keepers in flow of new ideas. The innovators are generally referred to as the first to adopt a new idea and represent the first 2-3 % of individuals in a social system (Lionberger and Gwin, 1991).

2.1.3 Early adopters

These are a more integrated part of the social system than the innovators. Whereas innovators are cosmopolites, early adopters are regarded to be localites (Msuya, 1998). Members of this category are said to speed the diffusion process and are the ones to which potential adopters seek advice and information about the innovation since they

find it necessary to make judicious innovation decisions (Lionberger and Gwin, 1991). According to Rogers (1995), this category decreases the uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near peers by means of interpersonal networks. Early adopters representing 10 -15 % of members of the social system, are informed and persuaded to adopt a new innovation by research sources (Lionberger and Gwin, 1991).

2.1.4 Early majority

The category of early majority comprises members who adopt new ideas just before the average member of the social system but after the early adopters. The members interact frequently with the peers but they seldom hold leadership positions unlike early adopters. This category links the very early to adopt and the relatively late to adopt in the diffusion process. The innovation-decision period of early majority is relatively longer than that of the innovators and early adopters (van den Ban and Hawkins, 1996 cited by Msuya, 1998).

2.1.5 Late majority

These are members of the social system, who adopt innovations relatively late. The members of this category adopt the innovation after the majority of people in the society have adopted. The adoption by this category has been described to rely on economic necessity and peer pressure (Rogers, 1995).

2.1.6 Laggards

Laggards are the last group in a social system to adopt innovations. According to Rogers (1995), these people posses no opinion leadership and are the most localite in their outlook. The individuals often make decisions in terms of what has been done in previous generations and interact primarily with others who also have certain traditional values. It can therefore be argued that laggards tend to be suspicious of innovations and change agents (van den Ban and Hawkins, 1996 cited by Msuya, 1998). When they finally adopt an innovation it may have been superseded by another more recent idea, already being used by the innovators.

2.2 Factors affecting adoption of innovations

2.2.1 General overview

Adoption of innovation has been found to depend on a variety of factors. This is because some innovations relate to the individual, some to the situation the individual is in, and some to the nature of the practice. Some innovations are also subject to the control and manipulation of change agents and of the farmer while some are not (Lionberger and Gwin, 1991). It is an unhidden truth that several studies have identified various factors to be associated with adoption of innovations but there exist differences with geographical location. For example, in Israel and the Gaza strip, Blum (1989) did a study to investigate the use of various sources of information at different stages in the decision making process by Arab traditional farmers. The author found that, availability of extension services and the length of time during which farmers were exposed to the innovation were the influencing factors in adoption of agricultural innovations. Where

socio-economic family bonds were strong, the author found family to influence adoption decision.

In another study, Guerin and Guerin (1994) identified constraints in adoption of agricultural technologies by farmers in Australia. According to the authors, the major constraints identified were the complexity of the technology to comprehend, observability of the outcomes, financial cost, farmers beliefs and opinions towards the technology, farmers perception of the relevance of the new technology, farmers attitudes towards risk and change and farmers level of motivation. In Nigeria, land tenure was found to be a major obstacle in adoption of diversified and sustainable forms of food production (Osemeobo, 1993).

2.2.2 Factors affecting adoption of agroforestry practices

The available literature is deficient in the factors affecting the adoption of agroforestry farming systems in Tanzania. Researchers have been concentrating their efforts more on livestock, agricultural crops and forest trees separately than in integrative nature. In Turiani for example, Mwalukasa (1997) explored the role of the interaction between crops and livestock in the household income but trees which could be an important component of the farming system were ignored in the study. However, in some other places of the world various factors have been found to influence adoption of agroforestry practices. Similar with other agricultural innovations, factors that are of influence in one geographical location may not necessarily be of relevance in other

areas. The major commonly influencing factor reported in literature has been found to be awareness of the expected benefits from the innovation and the access to resources.

For example, in central plateau of Burkina Faso, Ayuk (1997) identified profitability of the technology and water availability as the main factors enhancing the adoption of agroforestry practices. Similarly, Matthews *et al.* (1993), Scherr (1995) and Zinkhan (1996) observed profitability of the innovation as a factor motivating adoption of agroforestry in Southern Ontario in Canada, Western Kenya and the Southern states of the United States of America respectively. Knowledge as a resource was also a key factor in adoption of agroforestry. Caveness and Kurtz (1991) identified lack of information (knowledge) and material support as constraints to agroforestry adoption in Senegal. In Southern Somali, the successful adoption of live fences as an agroforestry practice was found to be geared by increasing population, decreasing available farm land, community stress, low labour input required and their secondary benefit of fuel wood production (Madany, 1991). Isac (1994) cited by Sanchez (1995) identified some principal components that determine adoptability of an agroforestry practice. These include degree of market integration, perceived benefits, farmers' natural resource base and their resource endowment.

Perceptions and claims are not an exception in influencing adoption of agroforestry systems. Most of the perceptions, attitudes or claims are a result of some cultural beliefs, which in most cases do not allow for importation of new ideas and hence socio-economic reforms. In Turiani Division, Makauki *et al.* (1999) have reported cultural

beliefs or taboos as a factor limiting farmers from participating in multipurpose tree planting. According to the authors, farmers had attitude that planting certain species of trees such as *Terminalia catappa* (mkungu tree) would cause death through persistent sickness. According to the author, planting trees especially coconut palms (*Cocos nucifera*) around the homestead was also believed to attract thunderstorm that could destroy the whole family.

Similar results were reported by Zinkhan (1996) who confirmed that rejection of agroforestry innovations is associated with the farmers' perception that the technology involves a high level of uncertainty. Despite such beliefs, the author believes that efforts of extension services could encourage the adoption of the technology. Isac (1994) cited by Sanchez (1995) observed similar findings. The author reported cultural preferences as one of the factors that determine the adoptability of an agroforestry practice. In some areas, agroforestry is believed to be so laborious that, the adopting farmer fears to suffer from shortage of time for other obligations. Such beliefs have been found to hinder adoption of agroforestry systems (Glauner, 1995).

2.3 Gender roles in farming systems in Tanzania

2.3.1 Access to resources

In Tanzania, there is a great disparity between men and women in ownership and access to different agricultural resources, services and benefits. The disparity is in most cases in favour of men. For example, FAO (1994) observed the disadvantage of women in access to land. The documentation reported women's small size of land holdings as well

as an overall trend of increasing landlessness. Such a disparity still exists despite the country's agricultural and livestock policy which insists on equal and equitable access to land by all citizens. The policy states openly that "in order to enhance and guarantee women's access to land and security of tenure, women will be entitled to acquire land in their own right not only through purchase but also through allocation" (MAC, 1997).

The differential impact of land tenure and land policy on men and women has great influence on the adoption of agroforestry innovations (Tiruneh and Rahmato, 1994). Bonnard and Scherr (1994) asserted that access to resources, user rights and control over the benefits of the resources are important factors to consider in planning agroforestry interventions. This signifies the adoption of gender perspective in decision and implementation of policies concerned with resource use and control in the rural environment.

The limitation of Tanzanian women is not only in access to land. They also have limited access to credit. According to FAO (1994), in the year 1992 women comprised only 15 % of the total membership of formal rural savings and credit associations. It is contended that women's access to loans has tended to be confined to donor supported special grants. The small size of their agricultural enterprises, high rate of illiteracy, predominance in the subsistence sector and lack of land as collateral have been limiting the access of this gender category to formal credit (FAO, 1994).

2.3.2 Division of labour

Women in Tanzania and most developing countries have been carrying a greater proportion of the whole farm and domestic work relative to men. It is due to this reason, that the role of women in different farming systems has been recognised throughout the world. Approximately 98 % of economically active rural women are engaged in agriculture (FAO, 1994). These women farmers contribute substantially to both commercial and subsistence agriculture as casual labourers and unpaid family workers. In many African countries nearly all the tasks connected with food production such as sowing or planting, weeding, harvesting and transporting the crop home are left to women while activities like tree felling are always done by men (Boserup, 1989 cited by Mbago, 1997). However, gender division of labour is not uniform in all social communities. In some areas women get assistance from men beyond tree felling. For example, men may participate in the task of hoeing and general land preparation prior to sowing (Mbago, 1997). Even with such help, time use studies in Tanzania show that women spend more hours per day than men in both productive and reproductive activities. Traditionally, women are responsible for almost all activities of dairy husbandry such as feeding, milking, milk processing and marketing (FAO, 1994).

In Morogoro a study by Anandajayasekeram and Due (1984) cited by Mbago (1997) on farming systems, confirms women's greater contribution than men in production of different agricultural crops. The authors have reported the contribution of women as 67 %, 59 % and 48 % of the labour requirement for rice, beans and maize respectively. In Dodoma, the previous studies have shown that women produce and control grain while

their male counterparts are highly involved in livestock production and in Coast region women produce all the rice (Mbago, 1997). In Zanzibar, unlike other areas, both men and women participate fairly equally in such activities as site clearance, land preparation, sowing and planting while women carry out most of the weeding, harvesting, transportation, threshing, processing and storage activities (FAO, 1994).

Given the variations in gender roles in different geographical locations, it is not proper to assume that Turiani Division could resemble any other area in terms of gender division of labour. Additionally, the available literature does not separate the roles played by different age-based gender classes in such complex farming systems as agroforestry. The role of children in most cases has thus been disregarded. It should then be noted that in designing agroforestry interventions and assessing programme impacts, there is a need to go beyond simple gender distinctions and look at additional stratifiers (Bonnard and Scherr, 1994).

2.3.3 Decision making

Decision making is an important component prior to adoption of any idea. It can be pleaded that self-decision on one's obligation is more worthwhile than when decision is made by a party that is not responsible for its implementation. In many areas of Tanzania decision making is male-dominated in almost all farming activities, even in those where women contribute the majority of the labour (FAO, 1994). However, joint decision is commonplace. The denial of decision making opportunity to women is therefore a threat to the adoption of some agricultural and environmental conservation

innovations such as agroforestry. The implication may probably be lack of sustainable farming systems and continued deterioration of the environment.

In decision making positions in ministries and government bodies women are accordingly under-represented. FAO (1994) has shown that out of 20 decision making positions in the then Ministry of Agriculture and Livestock Development, there were no women while out of 20 principal secretaries there was only one woman (5 %). The data further showed that there were only three female ministers out of 17 ministerial positions (15 %) while in planning commission and ministry of finance there were only one (3 %) and five (25 %) women out of 32 and 20 positions respectively. The situation was somewhat relieving in the ministry of Community Development, Women Affairs and Children since two out of 5 decision makers were women (40 %)

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1 Description of the study area

The study was carried out in Turiani Division in Morogoro Rural District, Morogoro Region. Turiani is about 100 km North of Morogoro Municipality along the Kilosa-Handeni road. The district lies between longitudes 37°10' and 38°31' East and between latitudes 5°5' and 7°4' South. Turiani Division is comprised of five wards, namely Mtibwa, Diongoya, Kanga, Mhonda and Sungaji, which is the division's headquarters. The main crops grown in the area are maize, rice and sugarcane (Mwalukasa, 1997). Dairy cattle keeping, multipurpose trees, biogas technology and sunflower production have been promoted by The Foundation for Sustainable Rural Development (SURUDE), a farmer based non-governmental organisation established in 1993 with its headquarters at Lungo village, Turiani. SURUDE in collaboration with the DANIDA funded SUA-MU ENRECA project is developing a systematic monitoring system for the various interventions and changes occurring in the farming systems in Turiani. This has been the reason for selecting the study area in order to assess farmers' perceptions and hence adoption of the interventions related with tree planting activities.

3.2 Research design

Cross sectional research design (Casley and Kumar, 1988) was adopted in the present study. The objective of the study that allows collection of information at one point in time and the limited time justify the use of the selected design.

3.3 Sampling procedures

The target population for the present study was all farmers in Turiani Division. The study employed a multistage sampling technique starting at the division and ending at the household level. The technique is convenient for studying large and diverse populations as well as populations whose list of the actual individuals to be studied is hardly available (Fowler, 1993). Additionally, the technique reduces the amount of travelling for interview and hence the corresponding cost (Casley and Kumar, 1988). The sampling stages or phases were the wards, villages and finally the households, the actual survey subjects.

The sampling procedure started by employing simple random sampling to select two out of the five wards of Turiani Division. The selected wards were Mtibwa and Sungaji. Using the same technique, three villages from each ward were selected making a total of six villages. From Mtibwa ward, Kidudwe, Kunkhe and Lungo villages were selected while Kilimanjaro, Komtonga and Mbogo villages were selected from Sungaji ward. From each village, 30 households were selected by purposive sampling ensuring that 50 % had adopted agroforestry innovations and 50 % had not. The whole procedure made a sample of 180 households available for the study.

3.4 Data collection

3.4.1 Instrumentation

Structured questionnaires were the main instruments used for data collection. Two types of questionnaires were developed one for the actual survey subjects, the farmers and another one for key informants such as extension officers, political leaders and progressive farmers. The questionnaire for key informants aimed at verifying and supplementing the survey information given by the farmers. Farmers' questionnaire was comprised of both open ended and close ended questions focusing on socio-economic, political, cultural and service related aspects and their connection with agroforestry adoption. Such aspects as background characteristics, land ownership, income, types of crops cultivated, livestock kept and trees grown, extension services, farmers' perceptions and beliefs and gender roles were thus covered.

3.4.2 Primary data

Before collection of primary data, individual in-depth approach was adopted whereby formal and informal interviews with key informants were conducted so as to get an insight of the research problem. To achieve validity, the first draft of the questionnaire was pre-tested at Lungo village so as to allow for necessary additions, omissions and modification of some questions. In this procedure, 20 farmers participated. In order to avoid the problem of non-response, collection of the primary data was done by the researcher, assisted by an enumerator who was trained by the former. The exercise was done by visiting and interviewing household heads in their homes through

administration of questionnaires. Physical observation was also employed in individual farms so as to verify and supplement some of the information given by the respondents

3.4.3 Secondary data

Secondary data were obtained from SURUDE office in Turiani and Sokoine National Agricultural Library (SNAL) at Morogoro.

3.5 Data analysis

In order to draw conclusions the collected survey data were coded and analysed by using Statistical Package for Social Sciences (SPSS) computer software. Descriptive statistics such as frequencies, percentages and means were determined. Where desired, cross tabulation sub-programme involving Chi-square test was used to test association between adoption of agroforestry and other qualitative variables. Cross tabulation is both a powerful way of communicating information and the commonest form of data presentation (Casley and Kumar, 1988). To compare means of some individual pairs of quantitative variables between adopters and non-adopters of the innovation, T-test was employed In both Chi-square and T-test, the level of statistical significance used was 5 % and where significant, the comparison was done at lower levels (1 % and 0.1 %) as well. Gender roles were evaluated through simple gender analysis framework (GAF) which involved resource analysis, activity analysis and benefit analysis.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Farmer's background characteristics

4.1.1 General

The background characteristics of the respondents interviewed in the present study are shown in Table 1. The parameters included sex, age, marital status, education level and family size for both the adopters and non-adopters of agroforestry (AF) innovations.

4.1.2 Sex

More than 50 % of the selected sample for the present study constituted male respondents. Of the 90 adopters of agroforestry innovations interviewed, 70 % and 30 % were male and female respondents respectively. The situation was different in the case of non-adopters whereby 53.3 % and 46.7 % were male and female respondents respectively. The distribution was statistically ($P<0.05$) associated with adoption of AF innovations. The portrayed imbalance in sex distribution resulted from the approach of the present study that involved interviewing the household head.

Table 1 Distribution of respondents by their background characteristics

Characteristic	Adopters (n=90)		Non-adopters (n=90)		Probability
	Number	Percent	Number	Percent	
Sex					
Male	63	70	48	53.3	
Female	27	30	42	46.7	0.021
Age					
21-30	15	16.7	32	35.5	
31-40	24	26.7	29	32.2	
41-50	19	21.1	13	14.4	
51-60	14	15.6	8	8.9	
61-70	13	14.4	7	7.8	
More than 70	5	5.6	1	1.1	0.027
Marital status					
Single	8	8.9	12	13.3	
Married	72	80.0	63	70.0	
Divorced	4	4.4	8	8.9	
Widowed	6	6.7	7	7.8	0.061
Education level					
No formal education	15	16.7	15	16.7	
Adult education	12	13.3	2	2.2	
Primary education	55	61.1	69	76.7	
Secondary education	3	3.3	1	1.1	
Post Secondary education	5	5.6	3	3.3	0.037
Family size (persons)					
1-4	23	25.6	45	50.0	
5-7	23	25.6	24	26.7	
8-10	20	22.2	11	12.2	
11-13	18	20.0	7	7.8	
More than 13	6	6.7	3	3.3	0.004

Source: Survey data (1999).

4.1.3 Age

In the present study, greater proportion of the adopter respondents (80.1 %) were found between the age of 21 and 60 years while 82.2 % of non adopters aged between 21 and 50 years. The mean age of the respondents was 46 and 39 years for adopters and non-adopters respectively. By using Chi-square test, age distribution of the respondents was found to be significantly ($P<0.05$) associated with adoption of AF technologies, the majority being of the middle age (21-60 years). This implies that the selected sample was within the Tanzania's economically productive class which ranges from the age of 15 to 64 years (Mandara, 1998).

4.1.4 Marital status

Results from the present study indicate that the majority of the respondents (70 % and 80 %) were married while 8.9 % and 13.3 % of the adopters and non-adopters of AF respectively had not got married (i.e. were single). Of the adopters and non-adopters respectively, 4.4 % and 8.9 % were divorcees while 6.7 % and 7.8 % were widowed (see Table 1). Findings of the present study portray a clear situation of most rural areas of Tanzania where the majority of people of the adult age are married. This is probably necessitated by livelihood responsibilities that would otherwise be difficult for the individual to accomplish in a single marital status. The distribution of the phenomenon was not statistically ($P>0.05$) different among the adopter and non-adopter categories.

In Morogoro Region, similar results were reported in Mvomero and Mang'ula Divisions by Swai (1998) and Laizer (1999) respectively.

4.1.5 Level of education

The majority of the respondents in the present study had attained primary education while about 17 % of all the respondents did not have access to formal education. Of the adopters and non-adopters respectively, 13.3 % and 2.2 % attended what is commonly known as literacy classes or adult education (Table 1).

For both the adopter groups, about 83 % of the respondents were literate taking for granted that those who had attended formal schooling of any kind knew how to read and write. Such a reasonably high literacy rate is necessary in facilitating the task of communicating agricultural innovations to rural people by change agents.

Similar observations were reported by Shenduli (1998) and Mandara (1998) who were of the opinion that knowing how to read and write was enough in adoption of innovations whose dissemination involved posters, extension leaflets, newsletters or other written materials. Since AF is a simple practice, its adoption is not likely to differ much between different categories of education level. Rather, it can be influenced by participation in various projects and attendance to training sessions such as short courses, meetings, workshops, seminars etc. Such opportunities can trigger their motivation thereby facilitating adoption process. Therefore, the adoption

imbalance observed in the present study was not necessarily caused by the respondents' education.

The statistically significant ($P<0.05$) association between level of education and adoption could be relevant when considering innovations that involve complicated dissemination instructions. In view of this, Machumu (1995) and Msuya (1998) argued that although primary education could enable farmers to read and write, it might not be very helpful in the adoption of technologies that require comprehension of written materials which demand skilful training. In the same line, Bwana (1996) observed farmers' level of education to be associated with the adoption of improved storage technology.

4.1.6 Family size

Family size in the present study was determined by considering all the members present in each household. Thus, the number of children, dependants and parents altogether made the respondent's family size. It was revealed that the majority of the households had from 1 to 10 persons for the adopters of AF and from 1 to 7 persons for those who did not adopt (Table 1).

It was observed that, 38 % of the interviewed households had between 1 and 4 persons while less proportion was recorded for family size greater than 13 persons (6.7 % of adopters and 3.3 % of non-adopters). The overall average family size was 8 and 5 persons for adopters and non-adopters respectively. Such distribution suggests

the availability of manpower for various household activities more for adopters than for non-adopters of AF innovations. The association observed between family size and adoption of AF innovations in the present study was statistically significant ($P<0.01$).

Similar with the present study, Nouve (1999) documented an average household size of 8 persons in Turiani Division

4.2 Socio-economic status of the respondents

4.2.1 Income

The respondents were asked to mention the major source of their income, whether farm or non-farm activities. The average yearly income of each individual was also recorded and was divided by 12 in order to obtain an average monthly income. Table 2 thus presents the distribution of respondents by source and level of their income. The table shows that, majority of the respondents in both adopter groups were found to depend on farming as their major source of income. However, greater proportion was observed for adopters than for non-adopters (72.2 % vs. 60 %) suggesting that those involved in farming activities were likely to adopt AF innovations more that those who did not, although the association was not statistically significant ($P>0.05$). It was also observed in the present study that only 2.2 % and 1.1 % of adopter and non-adopter respondents respectively depended on non-farm activities as their major source of income. Of the adopters, 25.6 % were found to depend on both farming and non-farm activities as their major income

source but the proportion for non-adopters was greater (38.9 %). The main non-farm activities were identified as small-scale trading (e.g. retail shops, kiosks, selling food items) and employment.

The aim of farmers to diversify their income generating channels is to spread risks that are a common experience in their normal lives. Mandara (1998) who observed involvement of farmers in more than one enterprise in order to spread risks reported similar results.

Table 2 Distribution of respondents by source and level of income

Parameter	Adopters		Non-adopters		Probability
	Number	Percent	Number	Percent	
Source of income					
Farming activities	65	72.2	54	60.0	
Non-farm	2	2.2	1	1.1	
Both	23	25 6	35	38.9	0.147
Income level (TAS*)					
Up to 30 000	38	42.2	45	50.0	
30 001-60 000	25	27.8	29	32.2	
More than 60 000	27	30	16	17.8	0.157

* TAS = Tanzanian Shilling (USD 1 = TAS 797).

Source: Survey data (1999).

It was further observed that about 42 % and 50 % of the adopters and non-adopters respectively earned an average monthly income of TAS 30 000 or less. The respondents who earned up to TAS 30 000 showed a skewed distribution such that higher income was earned by the adopters of AF than otherwise. Thus, only 2.2 % of the adopters earned TAS 10 000 or less while 3.3 of non-adopters earned the same,

and 10 % of the adopters earned between TAS 10 001 and 20 000 relative to 27.8 % of non-adopters. For the higher level (20 001-30 000), greater proportion was recorded for adopters than for non-adopters (i.e. 30 % vs. 18.9). Of the adopters, 70 % earned at most TAS 60 000 per month while the proportion of non-adopters earning the same amount was 82.2 %. This indicates that, the proportion of adopters earning more than the above amount exceeded that of non-adopters (30 % vs. 17.8 %).

Despite the above variations, income level and adoption of AF innovations were not statistically associated ($P>0.05$) proving that the practice can be adopted by members of any socio-economic status. Nevertheless, adopters exceeded their counterparts in average monthly income by about TAS 10 000 (i.e. 54 955 vs. 44 441).

Generally, the average income earned by farmers in Turiani exceeded that of many other rural communities. For example, Msuya (1998) reported lower income levels for farmers of Mwanga District in Kilimanjaro Region. According to the author, only 17.8 % of the respondents were earning more than TAS 110 000 per year (about TAS 10 000 per month). Such a great difference has probably been attributed by differences in the prevailing farming systems. Whereas the farmers of Turiani were engaged in sugarcane and paddy production systems as their main income source, those of Mwanga and most other areas of Tanzania were not involved in the cultivation of such crops, which are economically potential relative to other agricultural crops like maize and beans. Nouve (1999) has shown that sugar cane and paddy alone could give an average annual income of TAS 863 421 (about 72 000 per

month) per individual in Turiani Division, thereby confirming the superiority of the two crops observed in the present study.

4.2.2 Social status

Social status of the respondents was determined by assessing the ownership of properties and individual's position in the society such as being a political leader, religious leader, employee or an ordinary small-scale farmer. Each position was given a score of one point. In property ownership, assets worth at least TAS 50 000 such as music system, bicycle, motorbike, sofa set and sewing machine were considered and each was given a score of one point similar to each leadership position. The summation of points scored by each respondent was recorded and ranked as low, medium or high status. Low, medium and high status levels corresponded to 1-3, 4-5 and more than 5 score points respectively.

It was then revealed in the present study that, majority of the respondents (51.1 % of the AF adopters and 47.8 % of non-adopters) were in the medium social status (Table 3). Only 30 % of the adopters were in the low social status but a higher proportion (44.4 %) was observed for the case of non-adopters of AF innovations. Moreover, the adopters were found to exceed non-adopters in the proportion of high status (18.9 % vs. 7.8 %) implying that individuals of high status were more innovative than were those of low status. The skewed distribution ($P<0.05$) of social status between the two groups complements the adopters' superiority observed in income level thereby

identifying socio-economic status as a factor that influenced adoption of AF innovations in Turiani Division.

Table 3 Distribution of the respondents by their social status

Social status	Adopters		Non-adopters		Probability
	Number	Percent	Number	Percent	
Low	27	30	40	44.4	
Medium	46	51.1	43	47.8	
High	17	18.9	7	7.8	0.034

Source: Survey data (1999).

4.3 Land acquisition

The present study has revealed that farmers in Turiani have acquired their land through different modes The distribution of respondents according to the modes of land acquisition was highly associated ($P<0.001$) with adoption of AF innovations. Table 4 shows that 32.2 % of the adopter respondents, purchased their land while the proportion for non-adopters who obtained their land through the same mode was about half that much (15.6 %). Whereas 20 % of the adopters inherited their land from elders, 31.1 % of non-adopters acquired their land through the same route. Generally, it was noticed in the present study that a good proportion of the respondents acquired their land through government allocation (41.1 % for adopters and 32.2 for non-adopters). This is a common practice in many areas of Tanzania. The table further indicates that none and 20 % of the adopters and non-adopters

respectively acquired their land through renting (or hiring). Another mode, which was identified by the respondents, was free holding though by a small proportion.

Table 4 Distribution of respondents by land acquisition modes

Mode of acquisition	Adopters		Non-adopters		Probability
	Number	Percent	Number	Percent	
Given by Village government	37	41.1	29	32.2	
Inherited	18	20.0	28	31.1	
Purchased	29	32.2	14	15.6	
Hired (rented)	-	-	18	20.0	
Free holding	6	6.7	1	1.1	< 0.001

Source: Survey data (1999).

Results of the present study imply that greater proportion of farmers who obtained their land through purchasing and government allocation adopted AF innovations probably because they were confident of land ownership right. Lack of land ownership right may be considered as one of the factors that hindered the adoption of AF technologies in the study area since all the respondents who rented land did not adopt the innovation. The tenants did not bother to plant trees on hired plots since they might not be sure of benefiting from the products after maturity, which would apparently take long.

The present finding is in agreement with Tiruneh and Rahmato (1994) who reported that the mode of land acquisition affects the adoption, success and realisation of agroforestry innovations. Similar with findings of the present study, Nouve (1999) observed renting and purchase as modes of land acquisition in Turiani Division.

4.4 Farm size

In the present study, the respondents were requested to tell the size of their farms. Where necessary, the researcher had to estimate the size on physical observation in order to validate the data given by the respondent. Majority of the respondents were found to have small pieces of land around their homes. However, T-test has shown that the acreage of land for those who adopted AF innovations exceeded that of non-adopters significantly ($P<0.05$). The average land size for the adopters of AF was 1.5 acres while non-adopters had an average of 1 acre only around their homes. Such an observation implies that size of land is an important factor that influences adoption of AF innovations. It can therefore be argued that small size of land per household could have been one among other factors, which hindered the adoption of agroforestry practices in Turiani.

Similar with the present study, Nouve (1999) observed insufficiently small farm size per household in Turiani. The results of the present study are in agreement with those of Minjas (1994) who argued that traditional farming systems in Africa are characterised by small farm size.

4.5 Agroforestry farming systems practised in Turiani

4.5.1 General observations

Through observation, the present study has shown that there existed various farming systems in Turiani Division. Based on the type of farming practised, the most widely adopted farming systems involved the cultivation of such crops as sugar cane and

paddy as pure stands and that of maize, sunflower, vegetables, sweet potatoes, taro, groundnuts, banana and so forth either in pure stands or in inter-cropping system. Multipurpose trees were also observed some in pure stands but mostly integrated with agricultural crops and/or livestock resulting in agroforestry systems.

The main agroforestry system practised was identified as the homegarden. The system involves planting of trees or shrubs in combination with agricultural crops around the homestead. In some cases, livestock were a component of the system mostly in zero grazing thereby allowing for interaction of the three components for the benefit of the farm household. Various trees and shrubs shown in Table 5 were being well managed in the homegardens as opposed to farms located away from the homestead where trees had not been planted. Training on planting and management of the trees was provided by a farmer based non-governmental organisation known as Foundation for Sustainable Rural Development (SURUDE) whose main aim was to improve the living standard of rural people. The organisation has taken the issue of environmental protection seriously through planting of multipurpose trees (Sarwatt, 1998). Another agency identified to offer advice to farmers on tree planting activities was Heifer Project International (HPI), another non-governmental organisation.

The trees were meant for such uses and functions as wind breaking, boundary marking, construction purposes, soil conservation, termite control and provision of shade, fuel wood, livestock fodder, cooking oil, medicines, fruits and nuts. It should

Table 5 Common multipurpose tree species adopted by farmers in Turiani Division

Tree species	Common name (Swahili, Vernacular or English)	Use
Gliricidia sepium	Quick stick, tree of iron, mother of Cocoa (English)	Fodder, soil fertility improvement, fuel wood, windbreak, boundary.
Leucaena Leucocephala	Mlukina, mlusina (Swahili), leucaena (English)	Fodder, soil fertility improvement, fuel wood, windbreak, boundary.
Sesbania sesban	Mlindaziwa (Swahili).	Fodder, soil fertility improvement
Morus alba	White mulberry (English), Mkooye (Chagga)	Fodder, fruits, fuel
Tecoma stans	Msolo (Swahili)	Ornamental, hedgerow, boundary
Pithecelobium dulce	Mchongoma (Swahili)	Ornamental, hedgerow/live fence.
Senna siamea	Mjohoro (Swahili)	Shade, boundary, windbreak, fuel, construction poles and withies
Delonix regia; also *Poinciana regia* (Mbuya *et al.*, 1994)	Flamboyant (English), mkrismas, mkakaya (Swahili)	Shade, fuel
Terminalia catappa	Bastard/tropical almond (English), mkungu (Swahili).	Shade, edible nuts, fuel
Cedrella ordorata	Msegerea (Swahili)	Timber
Tectona grandis	Teak (English), mtiki, msaji (Swahili)	Timber, poles, fuel
Grevillea robusta	Silky oak, Grevillea (English), mgrivea (Swahili)	Timber, poles and withies, fuel
Cocos nucifera	Coconut (English), mnazi (Swahili).	Edible nuts, rooting material, palm wine
Anacardium occidentale	Cashew nut (English), Mkorosho, mkanju, mbibo (Swahili)	Shade, edible nuts, fuel
Annona muricata	Mstafeli (Swahili)	Fruits, shade, fuel
Psidium guajava	Guava (English), mpera (Swahili)	Fruits, fuel
Synadenium volkensii	Mluwa (Nguu), jani la mchwa (Swahili), Mwaasa, maasa (Chagga)	Termite control
Azadirachta indica	Neem (English), mwarobaini (Swahili).	Medicinal (e.g. fever, mosquito repellent)
Mangifera indica	Mango (English), mwembe (Swahili).	Fruits, fuel, shade
Sclerocarya birrea	Mng'ongo or mwembe ng'ongo (Swahili).	Fruits, fuel, shade
Carica papaya	Papaw (English)	Fruits
Citrus sinensis	Orange (English), mchungwa (Swahili).	Fruits, Fuel
Artocarpus heterophyllus	Jack fruit (English), mfenesi (Swahili)	Fruits, fuel, shade

Source: Survey data (1999).

be noted that the majority of tree species were found to perform a number of functions, thus the name multipurpose trees (see Table 5).

Homegarden AF systems are widely distributed in many areas of the world and have been extensively documented (Fernandes *et al.* 1984). Characteristically, homegardens are largely for subsistence representing a risk bearing farming system (Oduol and Aluma, 1990). The present study has identified similar uses of trees and shrubs as those reported previously by O'Kting'ati and Mongi (1986) and Rugalema (1994) in homegardens of Kilimanjaro and Kagera Regions respectively. Makauki *et al.* (1999) who worked in Turiani observed similar results. Similarly, Sarwatt (1998) reported fodder, building poles, hedgerows and improvement of soil fertility as the main uses of multipurpose trees planted in Turiani, findings which are supported by the present study.

4.5.2 Major types of crops grown

Being an important agroforestry component, a number of agricultural crops were identified in Turiani for both the adopters of AF innovations and non-adopters. The cropping systems adopted by non-adopters was either monoculture whereby the crops were grown in pure stands or inter cropping whereby two or more crops were grown on the same piece of land. On the other hand, the adopters inter-cropped one or more agricultural crops with multipurpose trees on the same piece of land. The major types of crops grown were identified and the distribution of their adoption by the respondents is presented in Table 6.

Table 6 Distribution of the respondents by the major types of crops grown

Type of crop	Adopters		Non-adopters	
	Number	Percent	Number	Percent
Maize	83	92.2	77	85.5
Paddy (Rice)	71	78.9	71	78.9
Sugarcane	38	42.2	29	32.2
Sunflower	13	14.4	3	3.3
Groundnuts	2	2.2	1	1.1
Soybeans	2	2.2	-	-
Sweet potatoes and taro*	13	14.4	19	21.1
Banana	20	22.2	3	3.3
Cassava	24	26.7	22	24.4
Common Beans	-	-	2	2.2

* Also known as cocoyams, dasheen and eddoes (Perseglove, 1968).

Source: Survey data (1999).

The table shows that maize (*Zea mays*) and paddy (*Oryza sativa*) were the main food and cash crops cultivated in the study area followed by sugarcane (*Saccharum officinarum*), which was purely meant for cash. It was observed in the present study that 92.2 % and 85.5 % of the adopters and non-adopter respectively cultivated maize crop while 78.9 % of the respondents in each category were found to engage in the cultivation of paddy. Sugarcane was cultivated by 42.2 % and 32.2 % of the adopters and non-adopters respectively. Other crops cultivated by the respondents in Turiani were identified as sunflower (*Helianthus annuus*), groundnuts (*Arachis hypogaea*), sweet potato (*Ipomoea batatas*), taro (*Colocasia esculenta*), soybeans (*Glycine max*), banana (*Musa paradisiaca*), cassava (*Manihot esculenta*) and common beans (*Phaseolus vulgaris*). In the cultivation of these crops, the proportion of adopters involved exceeded that of non-adopters except for common beans, sweet potatoes and taro (see Table 6). Sugarcane and paddy in either adopter category were

cultivated in pure stands while for the adopters of AF innovations, the rest of the crops were cultivated in inter-cropping systems involving multipurpose trees.

It was surprising to note that the adoption of common beans in Turiani was not as high as it is in other areas of Tanzania. Other crops, which showed to get minimum attention of farmers, were groundnuts and soybeans. Nouve (1999) reported similar results. Out of 90 sampled farmers, the author found no one was engaged in the cultivation of common beans and groundnuts. The author observed the cultivation of such other crops as maize, paddy and sugarcane as the main crops similar with findings of the present study.

The choice of crop type by the farmers was not dependent on the adoption of agroforestry innovations. However, sunflower cultivation was being promoted by SURUDE, as a newly introduced crop (Sarwatt, 1998; Nouve, 1999) hence facilitating its technology transfer more to the beneficiaries who were all adopters of AF innovations than to non-beneficiaries of the project. The biased extension service has therefore created awareness to adopters thereby portraying the limited adoption of the crop by non-adopters of AF innovations. Nevertheless, the adoption of sunflower cultivation was still not encouraging. The reason given by farmers, which was confirmed by the key informants, was the interference of weather hazards including the El-Nino catastrophe. Unexpectedly prolonged rains killed and washed away much of the sown seeds thereby necessitating repeated sowing for several times.

4.5.3 Types of livestock kept in Turiani

Table 7 shows the types of livestock kept in Turiani. The level of livestock husbandry in the whole farming system of the study area was generally low agreeing well with the previous studies (Lazaro and Mbiha, 1994). Findings of the present study identified local chickens as the most prominent type of livestock kept in the study area. It was observed that 81.1 % and 74.4 % of the adopters of AF and non-adopters respectively kept local chickens while the proportion of local cattle keepers did not exceed 8.9 %. Other types of livestock kept by both adopter and non-adopter groups were local goats, sheep and ducks. Apart from local chicken, adopters of AF were found to keep layers though by a small proportion (2.2 %) and dairy cattle (34.4 %) while non-adopters did not. Such a biased distribution of respondents has shown a highly significant association ($P<0.001$) between adoption of AF innovations and dairy cattle keeping.

The probable reason for the observed relationship is the way technology transfer has been effected by the promoting agencies. SURUDE has been supplying seedlings of multipurpose trees used as fodder in its strategies to promote dairy cattle husbandry and environmental protection in the area. The organisation was extending extension services to the beneficiaries of its Heifer In Trust (HIT) scheme free of charge through field visits, seminars and workshops. Through the scheme, a farmer was loaned an in-calf (pregnant) crossbred heifer which would be recovered by paying the first heifer of one year old and a down payment of TAS 80 000. On the other hand, the policy of HPI was to give a heifer to a farmer who would pay back two

calves from the cow. Likewise, the project was used to extend its extension services to its beneficiaries only. Like SURUDE, the great emphasis of the project was to advocate planting of fodder trees by livestock keepers around homesteads, mixed with farm crops.

Table 7 Distribution of respondents by the type of livestock kept

Livestock type	Adopters(n=90)		Non-adopters(n=90)		Remarks
	Number	Percent	Number	Percent	
Dairy cattle	31	34.4	0	0	***
Local cattle	8	8.9	2	2.2	NS
Local goats	25	27.8	16	17.8	NS
Local sheep	3	3.3	3	3.3	NS
Local chickens	73	81.1	67	74.4	NS
Ducks	19	21.1	12	13.3	NS
Layers chicken	2	2.2	0	0	***

NS = Not significant (P>0.05); *** Highly significant (P<0.001)

Source: Survey data (1999).

The implication is that dairy cattle keepers had to plant available tree seedlings so as to avoid shortage of fodder. The consequence has therefore been the promotion of adoption of AF innovations more among farmers who were involved with dairy cattle husbandry than otherwise hence making dairy farming a potential motivating factor in AF adoption. It was therefore difficult for those with no livestock to adopt AF due to lack of opportunity to get training as well as lack of felt motive such as need for fodder. Makauki *et al.* (1999) observed similar findings. The scholars reported an association between livestock type and planting of multipurpose trees in Kidudwe, Kunkhe and Kidudwe villages of Turiani Division.

The system of planting fodder trees or shrubs in ordinary crop fields around homesteads as was observed in the present study, has been reported to be a better economic alternative than having a pure fodder woodlot separated from the main field (O'Kting'ati and Shayo, 1998).

4.5.4 Interaction between trees, crops and livestock

Being major components of the existing homegarden agroforestry systems, trees, farm crops and livestock were found to play an important role in the livelihood of farmers through their interacting relationship. In the present study, the advantage of the interaction was known only to some proportion of the adopter-respondents despite their decision to adopt the innovation. The distribution of respondents according to their perception towards the benefit of the interaction between the three components is presented in Table 8. Discouragingly, the table reveals that a big proportion of the respondents (45.5 %) were not aware of the benefit accrued from the interaction of trees, livestock and crops although they were aware of the components' independent benefits. The majority of such respondents were not used to keeping livestock other than local chickens and ducks. It should also be noted that, some farmers who kept local cattle, sheep and goats were in this category since their animals were let to graze and browse on the available natural pasture land. The animals were brought back in the evening so as to spend night hours in a prepared shed. Despite the adoption of outdoor livestock production system, the dung that accumulated overnight could provide a good manure bank for fertilising crop plants (e.g. maize, sunflower etc) as well as trees in the homegardens. In the same way, the

contribution of droppings from local chickens and ducks to soil fertility of the homegardens should not be underestimated. In return, the animals were getting feed from the trees and occasionally, from crops. From physical observation, the respondents were found to benefit from this kind of interaction but lacked awareness.

Table 8 Distribution of adopters' perception on the benefit of the interaction between trees, livestock and crops (n=90)

Beneficial interaction	Number	Percent
None	41	45.5
Cyclic without biodigesters	43	47.8
Cyclic with biodigesters	6	6.7

Source: Survey data (1999).

On the other hand, 49 respondents (54.4 %) claimed to benefit from a cyclic interaction between the three components of agroforestry system. These were of two groups, namely those who had biodigesters and those who did not have. The two groups of farmers were practising zero grazing whereby animals were kept in a pen and feeds brought to them by the farmer (cut and carry method). The whole proportion of dairy cattle keepers observed in the present study was in this category, which included a few members keeping local cattle, goats and sheep.

The multipurpose trees planted in their homegardens provided fodder for feeding the livestock and shade for farm crops. Humus from decomposed tree materials such as

leaves was also in favour of the growth of farm crops. It was encouraging to note in the present study that farmers were aware of exceptional role played by leguminous trees and browses such as *Gliricidia sepium, Leucaena leucocephala* and *Sesbania sesban* in soil fertility improvement through fixation of nitrogen gas from the atmosphere. The process results in the addition of soil nitrates and nitrites, which are important fertilisers for the growth of other plant species in the homegardens, such as cereal crops. On their side farm crops in the agroforestry system could produce crop by-products such as maize stover, hominy feed and sunflower seed cake to be used as livestock feeds thereby narrowing the problem of forage scarcity. The contribution of livestock in the farming system was to provide dung and urine, altogether known as farmyard manure (FYM) for fertilising both crops and trees in the field resulting in a complete cyclic relationship of the three components. Of all the adopters, 47.8 % admitted to benefit through this cycle. Figure 1 shows the whole cycle of interaction between trees, livestock and crops.

Of special interest in the present study is the adoption of low cost tubular plastic biodigester (TPB) by adopters of AF (6.7 %) who had dairy cattle. The beneficiaries of the biodigester obtained gas (biogas) for cooking purposes thus reducing the impact of cutting trees. A complete unit of the digester was found to cost about TAS 60 000 (about US $ 75) and may last for 4 to 5 years (Mwenda, G.M., personal communication, 1999). The technology has been disseminated by SURUDE to the beneficiaries of HIT scheme as one of its environmental protection strategies (Sarwatt, 1998).

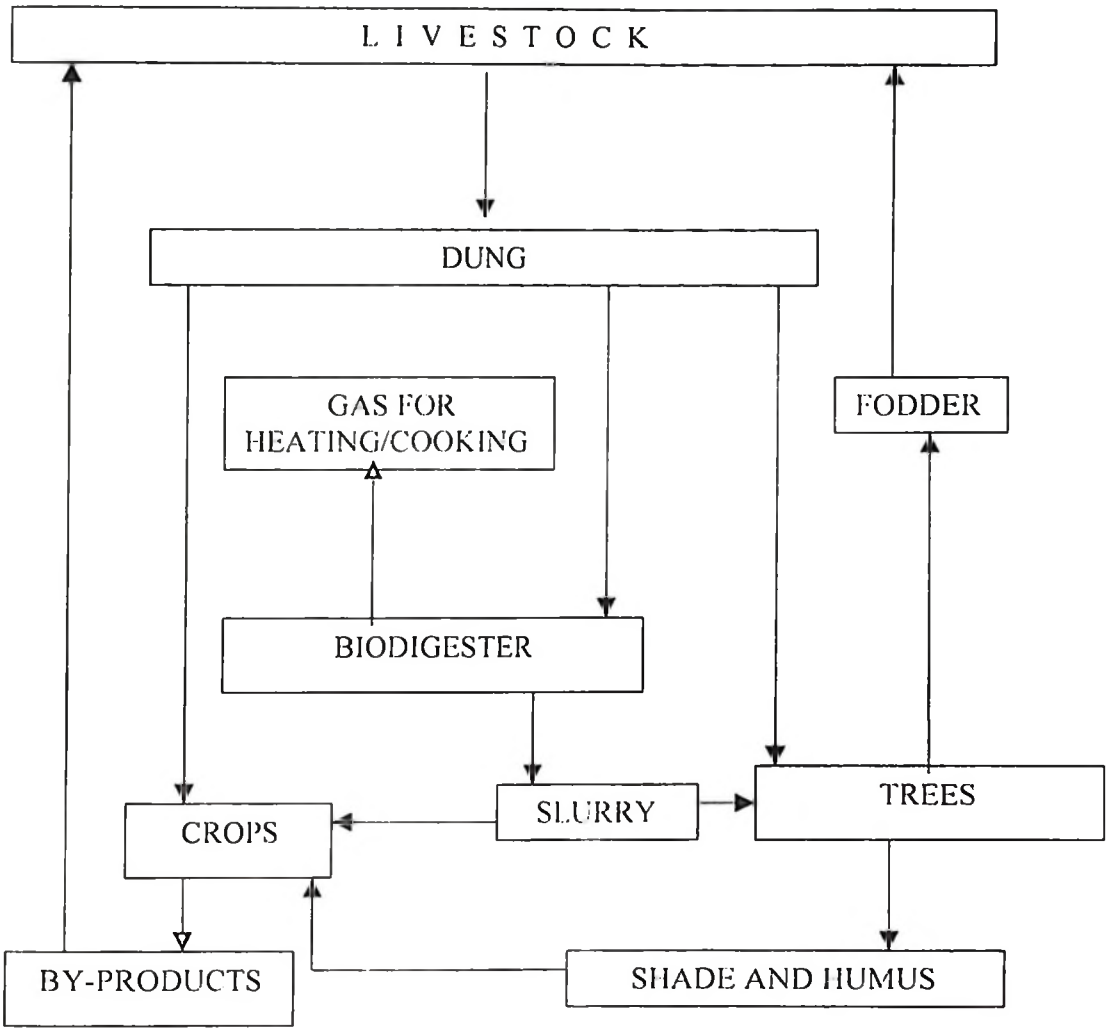

Figure 1 Interaction between trees, livestock and crops in Turiani Division

In a nutshell animal excreta from the shed is fed into the biogas plant which digests it after adding a lot of water. After the decomposition process, gas is collected in a reservoir and through delivery tubes, it goes to the utilisation sites. The decomposed manure (slurry) is ejected as a product of improved quality and is directed to the field for fertilising crops and trees. The technology has several implications to the livelihood strategies of the farmer such as saving time, which would otherwise be used for fetching firewood. The value of cow dung as fuel has been acknowledged by FAO (1996). The document also commended mixed farming systems that include livestock over those of crops only.

The cyclic integrative nature of trees, livestock and crops observed in the present study predicts enhancement of sustainability of the existing farming systems and reduces the rate of deforestation and hence environmental degradation. Findings of the present study agree with Sanchez (1995) who asserted that agroforestry farming systems enhance sustainability in agricultural systems. Makauki *et al.* (1999) reported similar interaction for the livestock based farming systems in Turiani.

4.6 Factors motivating the adoption of AF practices in Turiani.

In the present study farmers were asked to mention factors which motivated them to plant multipurpose trees in their fields. All the adopter-respondents (100 %) claimed to have planted trees because they were aware of the innovation's benefit although specific reasons differed among the individuals. The study has therefore indicated that farmers would adopt new technologies in order to attain economic benefits. The

respondents maintained that the innovation was cheap and simple, with no complexities in the whole process from planting, handling and harvesting. Specific reasons, which motivated farmers to engage in tree planting activities, are presented in Table 9.

Table 9 Distribution of respondents by reasons for planting trees (n=90)

Reason for adoption	Number	Percent
Need for Fruits and nuts	58	64.4
Need for shade	37	41.1
Need for fuel wood	30	33.3
Need for boundary	29	32.2
Need for livestock fodder	28	31.1
Termites control and need for medicine	27	30.0
Need for wind break	25	27.8
Need for environmental beauty and protection	21	23.3
Need for timber	20	22.2
Need for construction poles and withies	16	17.8
Income generation	4	4.4

Source: Survey data (1999)

The table indicates that 64 4 % of the respondents sought need for fruits and nuts as the major reason that motivated them to plant trees around their homesteads. The most common fruit trees identified were guava (*Psidium guajava*), mango (*Mangifera indica*), "mng'ongo" (*Sclerocarya birrea*), papaw (*Carica papaya*), and jack fruit (*Artocarpus heterophyllus*) while cashew nut (*Anacardium occidentale*), coconut palms (*Cocos nucifera*) and bastard or tropical almond (*Terminalia catappa*) were the main nut producing trees identified. It was asserted by the respondents that growing *Anacardium* and *Terminalia* spp. brought a secondary benefit of keeping children around the homestead, fetching the nuts and breaking them under the shade

while the secondary benefit provided by coconut was provision of roofing material as well as palm wine. Its primary reason for adoption was the provision of edible nuts for cooking and trading purposes.

Other primary reasons for adoption were identified to be the need for shade, fuel wood, farm boundary mark, livestock fodder, termite control, wind break, construction poles and withies, timber and income generation through sale of tree products (Table 9). White mulberry (*Morus alba*), whose primary reason for adoption was provision of livestock fodder was reported to have a secondary benefit of providing fruits for children. The fruits were said to be highly preferred by children and thus assisted in keeping them around the homestead similar with cashew nut and bastard almond. Environmental beauty and protection was another reason pointed out in the present study. It was alleged that when in the homegardens, trees provide a specific and beautiful environment (microclimate), which allows family members to inhale fresh air. Additionally, trees were stated to reduce the severity of soil erosion thereby playing an important role in soil and environmental conservation.

Biological termites control and need for medicine were other benefits that favoured adoption of tree planting. Termite control was done by inter-cropping a shrub of the family Euphorbiaceae known as *Synadenium volkensii* with the desired tree seedlings. A cutting of the insecticidal shrub and the desired tree seedling were to be planted in the same hole. This allows for killing and expulsion of the insects around

the seedlings. The present study found the insecticidal shrub to have been extensively applied in controlling termites more in coconut palms than in other tree species. Similarly, the use of *Synadenium spp.* to control termites in trees was previously reported by Makauki. *et al.* (1999). The use of indigenous shrubs in control of termites was also reported in Kenya by Adoyo *et al.* (1997) who observed significant role of *Tithonia diversifolia* in the problem. Neem tree (*Azadirachta indica*) was found to be a famous medicinal tree in the present study. The plant was believed to repel mosquitoes as well as treating several human illnesses including malaria.

The effect of *Azadirachta spp.* on mosquitoes was also acknowledged by NRC (1992). According to the data, products of the tree are toxic to mosquito larvae and disrupt molting. The tree is known to affect more than 200 insect species (NRC, 1992). Furthermore, the respondents admitted that provision of fuel wood was a secondary benefit in all the agroforestry systems let alone its primary objective, hence reducing the wide spread problem of fuel wood scarcity. This secondary benefit was thus responsible for triggering continued adoption of the innovations.

Other previous studies have reported similar results. For example, the economic incentives for land use change were also reported by Scherr (1995), Matthews *et al.* (1993) and Zinkhan (1996) as a factor influencing adoption of AF innovations. Ayuk (1997) and Isac (1994) cited by Sanchez (1995) pointed out perceived benefits as one of the principal determinants of adoptability of an agroforestry practice. Findings of the present study were also in line with those observed by Madany (1991) who

identified fuel wood production as a secondary benefit that geared adoption of live fences as an agroforestry innovation in Somali. Similar with the present study, Bwana (1996) observed profitability, simplicity and compatibility of an agricultural innovation to be important factors in adoption.

4.7 Factors hindering adoption of AF practices in Turiani

Factors, which hindered adoption of AF practices in the study area, were explored by asking the respondents of reasons, which caused poor participation of farmers in tree planting. In addition non-adopters were requested to give reasons for not adopting the innovation and the results are presented in Table 10.

The table shows that land scarcity and lack of awareness both to AF farming system and to the benefits thereof, were big constraints limiting the adoption of the innovation. Lack of awareness of the benefits created a kind of uncertainty in farmers towards the outcomes thus rejecting technologies related to AF. Other constraints that prevented some respondents from adopting AF technologies included shortage of tree seeds and seedlings, claim of insufficient time to care for trees and farm crops simultaneously and the attitude that trees reduce crop yield through excessive shade and occupation of space. The adoption effect brought about by the claim of insufficient time contradicts findings of the previous study that, interested land users indicate a willingness to participate in agroforestry systems despite the anticipated increase in overheads and labour intensity (Matthews *et al.*, 1993). The fear of yield reduction entails lack of

awareness since trees could be managed in a way to allow for good handling and performance of other crops.

Table 10 Distribution of respondents by reasons hindering adoption of AF practices

Reason	Adopters(n=90)		Non-adopters(n=90)	
	Number	Percent	Number	Percent
Reasons for not adopting at all:*				
Not aware of the system	Na	Na	22	24.4
Not aware of the benefit	Na	Na	23	25.6
Land scarcity	Na	Na	24	26.7
Shortage of seeds and seedlings	Na	Na	8	8.9
Insufficient time to care for trees	Na	Na	7	7.8
Effect of excessive shade	Na	Na	6	6.7
Reasons for poor participation:				
Short time of exposure	36	40	47	52.2
Lack of external motivation	32	35.6	21	23.3
Lack of self motivation	14	15.6	13	14.4
Inadequate extension services	34	37.8	24	26.7
Cultural beliefs	17	18.9	6	6.7
Not known	4	4.4	0	0

* Only for non-adopters; Na = not applicable.

Source: Survey data (1999).

SURUDE beneficiaries submitted that they were regularly being trained on how to manage the trees so that they would not become a menace to their development. Similar with the respondents' assertion, Mwenda, G.M. (personal communication, 1999) contended that farmers were trained to cut the tree branches at a knee-height of an ordinary person, when harvesting livestock fodder. This would facilitate handling and performance of farm crops. The farmers were also advised to plant the trees on farm

boundary and/or in rows across the field following contour lines in order to control soil erosion. Key informants confirmed the provision of such service to farmers.

In the present study, some respondents claimed that although people were aware of the innovation, more time was still needed in order for non-adopters to improve their awareness through observing what project beneficiaries do. Both the adopters (40 %) and non-adopters (52.2 %) of AF claimed that insufficient time of exposure caused poor participation of farmers in AF practices. In the same line, 37.8 % and 26.7 % of adopters and non-adopters respectively claimed of inadequate extension services being one of the factors, which caused poor participation in tree planting through denying awareness to farmers. Lack of both self and external motivation was another factor, which caused poor participation of farmers in agroforestry practices in the study area (Table 10). The respondents identified the tendency of farmers not to have background history of planting or managing trees as one of the factors causing lack of self-motivation. It was claimed that people who had history of planting trees around their homestead such as those from Kilimanjaro and Kagera regions did not hesitate to participate in the exercise (Msaki, H. personal communication, 1999). The key informants also acknowledged this argument. Of the adopters, 4.4 % did not give any reason for poor participation since they did not know. They wondered why some people had not adopted the farming system despite its variety of benefits.

Cultural beliefs were among the factors that caused poor participation of farmers in tree planting in the normal field as acknowledged by both adopters (18.9 %) and non-

adopters (6.7 %). There was a belief that planting *Terminalia* or *Sclerocarya* trees around the homestead would attract bats and demons, which in turn could cause conflicts and sicknesses in the household leading to death. The trees were also accused of having power to expel the landowner away from his residence completely leaving his family lonely. Additionally, such trees were believed to bring misfortunes thus making the soil unproductive. Some of the respondents had an illusion that growing coconut palms around the homestead would attract thunderstorm thus killing the family members and destroying the whole household compound. It therefore implies that the success of AF programmes is largely dependent on the attitudes and willingness of land users towards the target innovations (Matthews *et al.*, 1993).

Results of the present study agree with some of the previous findings in different areas. In selected villages of Turiani Division, Makauki *et al.* (1999) pointed out land scarcity, short time of exposure, low level of motivation, inadequate extension services, attitude of reduced crop yield and cultural beliefs (taboos) as major limiting factors in multipurpose tree planting similar with results of the present study. The uncertainty reported in the present study was similarly observed by Zinkhan (1996) in the Southern States of the United States of America (USA). Caveness and Kurtz (1991) reported similar findings. The authors identified lack of information and material support as constraints to agroforestry adoption in Senegal. Similar with the present study, Blum (1989) identified length of time and availability of extension services as factors that influenced adoption of agricultural innovations in Israel. Lack of extension services in Turiani was also reported by Nouve (1999). Guerin and Guerin (1994) enumerated

farmers' beliefs, opinions and level of motivation to be adoption constraints in dissemination of agricultural technologies in Australia, results which agree with the present findings.

4.8 Problems faced by the adopters of agroforestry systems

Despite the adoption of AF practices in Turiani, the farmers were found to face a number of problems, which retarded the progress of the innovation and thus threatened continued adoption. The most important problems identified are presented in Table 11.

Table 11 Distribution of problems faced by farmers in tree planting (n=90)

Problem	Number	Percent	Attempted solution
Termites attack	32	35.6	Replanting, indigenous methods, chemicals.
Weather uncertainty (Drought)	15	16.7	None
Shortage of seeds and seedlings	22	24.4	Looking from other sources (e.g. Morogoro, friends)
Fire hazards	15	16.7	Making fire break
Destructive livestock	5	5.6	Warning the livestock owners
Neighbours' complaints	3	3.3	Apologising and educating them
Water shortage	30	33.3	Discuss in village meetings

Source: Survey data (1999).

Of all the problems, termites attack to seedlings was reported by the greatest proportion of the respondents (35.6 %). The problem was found to be a menace throughout the study area. Some indigenous methods were attempted in order to solve the problem. One of the methods involved the application of one or more of

such by-products as farmyard manure, ash, rice husks, sand and used lubricating oil to the planting hole, covered with soil prior to planting. Another method was inter-cropping the desired seedling with *Synadenium* shrub. Application of chemicals (commercial insecticides) was another method adopted and was declared the most effective followed by the use of *Synadenium* shrub. However, the chemicals were said to be too expensive for the majority of farmers to afford repeatedly since the problem would not occur only once. As a result, only 21.1 % of the adopters were found to use commercial insecticides while 30 % opted for the shrub.

Unreliable availability of tree seeds and seedlings, weather uncertainty especially drought, shortage of tap water, invasion by livestock particularly cattle and goats, fire hazards and neighbours' complaints were other problems encountered by farmers who had engaged in tree planting activities (see Table 11). The reported complaints were said to result from dispersal of tree seeds and extension of branches to neighbours thereby causing shade and accumulation of leaves along the boundary. When such problems emerged, the tree owners were to apologise for any inconvenience caused and simultaneously advise the reference neighbours about the benefit of having trees grown in their fields.

Makauki *et al.* (1999) have pointed out problems of insect attack, drought and shortage of seedlings in selected villages of Turiani. Ayuk (1997) also described water availability as a factor affecting the adoption of agroforestry practices in Burkina Faso. The problem of seedling shortage was also reported in other

geographical areas. Jha *et al.* (1991) observed the same problem in Chotanagpur Plateau of Bihar in India.

It can be argued that solution of the existing problems needs commitment of the reference farmers, the change agencies (government inclusive), as well as the general public in an integrative manner. For example, if a change agency establishes nurseries in different areas and educates farmers on the benefits and handling of AF systems, awareness would be improved to the majority, thus seedling scarcity and some other problems would be minimised. Neighbours' complaints of spreading tree seeds, seedlings and shading branches to their plots would as well cease because such tree extensions would now be considered resourceful.

4.9 Adequacy of extension services

The present study identified extension services available to farmers and their adequacy. Of the adopters of AF innovations, 40 % admitted to get advice on multipurpose tree planting from extension staff while the rest had just been managing their trees by borrowing skill from neighbours and friends, mostly, project beneficiaries. This situation is discouraging and confirms the allegation of respondents that inadequacy of extension services hindered agroforestry adoption (Table 10). Other extension services were also provided at an inadequate level. For example, in crop husbandry 36.7 % and 28.9 % of the adopters and non-adopters of AF practices respectively, were found to have access to advice from agricultural field officer.

Chi-Square test discovered independence ($P>0.05$) of attributes between adoption of AF and access to advice in crop husbandry demonstrating deficient technology transfer in the whole rural community. Unlike crop husbandry, in livestock production the test has proved significant association ($P<0.01$) between adoption and access to extension services, unveiling the inclination of tree planting advice by SURUDE and HPI to livestock keepers. Of the adopters, 48.9 % were accessible to advice from livestock officers while the proportion for non-adopters, was only 23.3 %.

Apart from the bias of change agencies, the limited number of field officers in the study area was another reason for inadequacy of extension services. For example, in some villages such as Lungo, Kidudwe and Kunkhe, there was no agricultural field officer (in crop husbandry) but instead, there was only one government employed livestock field officer based in Kidudwe.

The inadequacy of agricultural advice in Tanzania has been a traditional problem for a long time now. In Turiani, the problem has recently been acknowledged by Nouve (1999).

4.10 Political influence on AF adoption

Respondents in the study area were asked to judge on political influence on tree planting activities by assessing the response of farmers to national campaigns and the efforts of local government in promotion of AF adoption. "*Panda miti, kata miti*"

(Plant a tree before cutting one) national campaign was found to be known to the respondents through either radio broadcast or local political meetings addresses. Table 12 shows the influence of the campaign and local government (political) leaders on the adoption of AF technologies. The table indicates that by Chi-Square test, adoption of AF practices was found to have no significant association (P>0.05) with political influence. Reasonable proportions of both the adopters (42.2 %) and non-adopters (38.9 %) agreed on a positive influence of political campaign on adoption of AF practices while comparable proportions of the two adopter-groups (36.7 % and 38.9 % respectively) maintained that the campaign had no influence on tree planting. In both cases, only 4 % of the respondents felt that the campaign created awareness to some uninformed farmers only, and hence Rogers (1995) first stage of innovation-decision process took place. It was amazing to note that the campaign (Panda miti, kata miti) was not known to about 17 % of the respondents.

Table 12 Distribution of respondents by political influence on AF adoption

Influence	Adopters (P=90)		Non-adopters (n=90)		Probability
	Number	Percent	Number	Percent	
Influence of campaign					
Some people have adopted	38	42.2	35	38.9	
Created awareness	4	4.4	4	4.4	
No influence	33	36.7	35	38.9	
Not known	15	16.7	16	17.8	0.975
Promotion by political leaders					
Advocated in meetings	51	56.7	46	51.1	
No attempt	25	27.8	25	27.8	
Not known	14	15.6	19	21.1	0.602

Source: Survey data (1999).

In the present study, more than 50 % of the respondents established that political leaders of the local government were advocating the necessity of tree planting in public meetings but not necessarily integrating it with agricultural production strategies. However, 27.8 % of all the respondents claimed on the silence of the government leaders in the promotion of tree planting while 15.6 % and 21.1 % of the adopters and non-adopters respectively were not able to comment on the issue. The distribution observed in the present study suggests some degree of inefficiency of the local government in the nation's strategy to protect the environment. If the local governments were sufficiently effective, all the farmers would have become aware of the campaigns going on in their areas.

4.11 Gender roles in the farming systems

4.11.1 Introduction

In the study area, gender roles were simply examined in three categories, namely resource analysis, activity analysis and benefit analysis. In resource analysis, the access of men and women to different resources in the community was assessed while activity analysis involved division of labour among different gender classes and decision making among the two main gender classes (husband and wife). In benefit analysis, ownership of various benefits accrued from farming activities in the household was assessed.

4.11.2 Resource analysis

Table 13 presents the distribution of respondents according to their access to different resources by gender. It was revealed in the present study that men had great opportunity to own resources relative to women. It was affirmed by more than 50 % of the respondents that, land which is a prerequisite in adoption of AF practices, was mainly owned by men while less proportion reported joint access to the resource. It was discouraging to note that in joint ownership, men still remained with the title of official registration hence more or less the same authority as in case of biased ownership to men. For women alone, the situation was worse since only 10 % and 22 % of the adopters and non-adopters respectively reported authority of women on land.

Table 13 Percentage distribution of respondents by access to resources

Resource	Adopters (n=90)			Non-adopters (n=90)		
	Man	Woman	Both	Man	Woman	Both
Land	54.4	10.0	35.6	52.2	22.2	22.2
Capital	52.2	7.8	40.0	51.1	18.9	30.0
Credit	26.7	22.2	36.7	28.9	22.2	24.4
Time	27.8	11.1	61.1	23.3	21.1	48.9
Knowledge	34.4	11.1	54.4	25.6	18.9	53.3

Source: Survey data (1999).

The gender disparity in access to land in Tanzania was also reported by FAO (1994). It should be noted that despite the potential of agroforestry, its adoption, success and realisation depend on the tenure and policy of land as well as its differential impact on men and women. Effort of the government authority in ensuring implementation

of different policy reforms in this matter is therefore an undeniable obligation. It is discouraging to note that findings of the present study contradict policy statement of MAC (1997) which entitled women to acquire land in their own right as a priority. The implication is that there have been no efforts to ensure that the policy statements were effected.

The situation was not different in access to capital since it depended to a large extent upon what was harvested from the land, which was already in men's hands. Similarly, access to credit, time and knowledge was biased in the same way indicating an obvious dominance of men in access to resources in the study area and probably other rural communities of Tanzania. However, severity of the problem was not as high as that of land and capital.

Access of women to loans was limited to SURUDE donor funded project, which has been advocating for gender equity in its HIT scheme through seminars, workshops and meetings. This has improved awareness and interest to agroforestry practices among the project beneficiaries. The couple were able to recognise that the joint loan of a dairy cow would benefit from well established fodder trees which would be providing such parallel secondary benefit as fuel wood, building materials, wind break and boundary marking. Thus, women from households dealing with dairy cattle husbandry had access to credit, time and knowledge more or less in the same way as their husbands.

FAO (1994) reported that women's access to loans in Tanzania is confined to donor supported special grants similar with findings of the present study. To a great extent, the access may be limited by women's limited access to land, high rate of illiteracy and predominance in the subsistence sector.

4.11.3 Activity analysis

4.11.3.1 Division of labour

Different activities were found to be performed by different gender classes in the study area. Table 14 presents the division of labour by gender based on type of activity in the household.

The present study discovered that some activities were gender segregated while some were gender neutral. For example, land preparation was reported by the majority as the task of male adults more than other gender groups while seed sowing, weeding, harvesting agricultural crops and transporting crops home were more or less gender neutral. There was a clear inclination towards adults in transplanting tree seedlings. However, it was more a man's task than a woman's as reported by 83.3 % and 66.6 % of the adopter respondents respectively (Table 14). The implication of the co-operation shown suggests an opportunity of success in the environmental protection strategies through adoption of AF practices. Most of the domestic activities were identified by the majority to be women's tasks such as cooking, cleaning surroundings, fetching water and fetching or gathering firewood thus agreeing with

Lazaro and Mtenga (1993) who reported the work load of women relative to men in domestic tasks.

Table 14 Percentage distribution of respondents by activity and gender class

Activity	Adopters (n=90)				Non-adopters (n=90)			
	MC	MA	FC	FA	MC	MA	FC	FA
Land preparation	28.9	87.8	18.9	48.9	21.1	77.8	10	55.6
Seed sowing	57.6	84.4	51.0	84.4	42.2	75.6	36.7	86.7
Transplanting tree seedlings	31.1	83.3	26.6	66.6	Na*	Na	Na	Na
Manure / fertiliser application	28.9	36.7	32.2	51.1	14.4	26.7	13.3	34.4
Weeding	56.7	87.8	55.6	87.8	40.0	76.7	35.6	90.0
Harvesting agricultural crops	52.2	88.9	52.2	85.6	43.3	77.8	38.9	86.7
Transporting crops home	51.1	82.2	11.1	71.1	40.0	76.7	34.4	78.9
Threshing	54.4	54.4	60.0	85.6	34.4	58.9	38.9	90.0
Fodder collection	26.7	22.2	18.9	33.3	1.1	3.3	0	3.3
Livestock feeding	33.3	30.0	23.3	40.0	8.9	5.6	0	5.6
Milking	13.3	16.7	12.2	35.6	0	0	0	2.2
Fetching water	34.4	14.4	58.9	80	21.1	17.8	41.1	91.1
Fetching/gathering firewood	22.2	22.2	67.8	83.3	14.4	21.1	45.6	85.6
Slaughtering livestock	45.6	73.3	4.4	5.6	25.6	68.9	8.9	15.6
Cooking	7.8	8.9	62.2	87.8	7.8	6.7	44.4	91.1
Cleaning surroundings	35.6	14.4	68.9	82.2	16.7	7.8	46.7	90.0
Laundry	45.6	12.2	68.9	85.6	16.7	15.6	43.3	91.1

MC=male children, MA=male adult, FC=female children, FA=female adult. * Na = not applicable

Source: Survey data (1999).

This adds hardship to rural women especially when noting that they do much of the farm work. Similar findings were also observed in Morogoro, Dar es Salaam and Zambia (Anandajayasekeram and Due, 1984; Kokuhirwa, 1984; Due and Mudenda, 1986 cited by Mbago, 1997). The situation is likely to limit the participation of

household female gender in tree planting activities, which could otherwise be of relief to them in reducing the problem of firewood shortage. The argument is in agreement with 13.3 % of the adopters and 35.6 % of non adopters who claimed that the prevailing division of labour could not allow women to participate fully in tree planting because of being too busy. Nevertheless, greater proportions (77.8 % and 56.7 % of adopters and non-adopters respectively) maintained that women could participate fully in the exercise on condition that joint household decisions (between men and women) on how to handle all farm and non-farm activities were to be made. The rest of the respondents had nothing to comment on the issue. The present study has shown that there is a need to modify the socio-cultural gender relations, which oppress female gender in rural communities.

4.11.3.2 Decision making

In the present study, the respondents were asked to identify the main decision maker in different household farm operations and the results are shown in Table 15. The findings indicate that men had greater chance to effect household decisions more than their wives did. However, little consolation existed in that more than 50 % of the respondents reported joint decisions in most of the operations. It was therefore relieving to learn that judgement on whether to plant trees and on the choice of tree species was reached jointly (54.4 %) more than by husbands alone (35.6 %). The situation suggests the possibility of successful adoption of AF innovations since it is of importance to both men and women.

Table 15 Decision making by gender as distributed among respondents (%)

Operation	Adopters (n=90)			Non-adopters (n=90)		
	Husband	Wife	Both	Husband	Wife	Both
Type of crop to grow	33.3	8.9	57.8	25.6	22.2	52.2
When to plant	25.6	15.6	58.9	23.3	21.1	55.6
When to weed	23.3	10.0	66.7	14.4	21.1	64.4
When to harvest	23.3	10.0	66.7	14.4	21.1	64.4
What to sell	27.8	10.0	62.2	21.1	21.1	57.8
When to sell	27.8	10.0	62.2	22.2	21.1	56.7
Type of livestock to buy	33.3	10.0	51.1	23.3	17.8	53.3
When to slaughter	42.2	13.3	38.9	23.3	17.8	53.3
Whether to plant trees	35.6	10.0	54.4	25.6	17.8	56.7
Tree species to plant	35.6	10.0	54.4	Na	Na	Na

Na = not applicable

Source: Survey data (1999).

It should be noted that such joint decisions should be implemented not only in agroforestry practices but also in other farm, non-farm and domestic operations in the household. This would presumably facilitate success of other environmental protection strategies, as it was the case for SURUDE

4.11.4 Benefit analysis

In benefit analysis by gender, each respondent was requested to identify members of the household, who owned different farm incentives. The percentage distribution of the respondents by ownership of farm benefits is shown in Table 16. The table indicates that male adult was the most advantageous beneficiary of the household harvests including money. Whereas male adults were found to dominate in the ownership of construction materials (timber, poles and withies) and money, female adults dominated in the ownership of fuel wood.

Although all the gender classes in the household were found to own agricultural and livestock products, the distribution still favoured male adults more than female counterparts. This portrays the real traditional male dominance prevailing in many rural households. To the contrary, milk was owned more by female adult than by the male counterpart since the former in co-operation with children was more responsible in milking and general handling of the cows (see Table 14). According to Mzava, G. (Personal communication, 1999), milk was traditionally owned only by women for solving small domestic needs such as salt, cooking oil and kerosene but after recognition of the importance of co-operation, it has now become a property of the household being under the control of both adults. Other benefits such as animal skin, fodder and fruits were owned by the whole household although male adults had an additional decision authority on them.

Table 16 Percentage distribution of respondents by ownership of farm benefits

Benefit	Adopters (n=90)				Non-adopters (n=90)			
	MC	MA	FC	FA	MC	MA	FC	FA
Agricultural crops	65.6	90.0	63.3	76.7	48.9	83.3	47.8	78.9
Livestock products								
Meat	70.0	84.4	72.2	76.7	51.1	70.0	50.0	76.7
Milk	30.0	13.3	30.0	42.2	0	1.1	0	2.2
Skin	22.2	46.7	22.2	38.9	5.6	13.3	5.6	10.0
Poles and withies	25.6	80.0	20.0	40.0	Na	Na	Na	Na
Timber	20.0	74.4	17.8	37.8	Na	Na	Na	Na
Fodder	23.3	44.4	23.3	42.2	Na	Na	Na	Na
Fuel wood	38.9	48.9	53.3	85.6	Na	Na	Na	Na
Fruits	84.4	88.9	82.2	87.8	Na	Na	Na	Na
Money	32.2	91.1	31.1	71.1	21.1	82.2	23.3	70.0

MC=male children, MA=male adult, FC=female children, FA=female adult. * Na = not applicable

Source: Survey data (1999).

The biased ownership of money and construction materials by the household male adult implies that the type of trees to be planted may favour men's vested interests neglecting the women's interest towards fuel wood availability, which would aid in saving time and energy. This may limit the adoption and success of AF innovations if fair ownership of the farm benefits among the family couple is not sought.

An AF motivating gender relation among the adopters is the comparable ownership right in livestock fodder between male adults (44.4 %) and female adults (42.2 %). It therefore implies mutual understanding of the need for livestock development and hence promotion of multipurpose fodder trees. The observation is probably an outcome of SURUDE's efforts in striving to bring about gender equity and improvement of dairy cattle husbandry in Turiani Division. Another interesting feature is the ownership of fruits by all the household members pointed out by more than 80 % of the respondents. Children benefiting from the trees satisfactorily, could expectedly participate eagerly in AF related activities.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From findings of the present study, the following conclusions are drawn:

(a) Homegardens are a common and feasible agroforestry system that can be adopted by rural farmers in Tanzania. However, success of the system depends much on the dominant farming systems in the reference area. Where livestock based farming systems predominate, the adoption of agroforestry innovations by the farmers is likely to be more successful than otherwise. The present study has confirmed that livestock are an important component of the farming system since their interaction with trees and crops enhances sustainability of the homegardens.

(b) Various primary uses of multipurpose trees are an important factor gearing adoption of agroforestry innovations. Secondary benefits of different agroforestry systems have a motivating influence as well. Nevertheless, awareness of the innovations' benefits is an integral factor that can stimulate an individual in innovation-decision process.

(c) Lack of adequate and regular extension services contribute greatly in limiting the adoption of agroforestry practices through limiting the scope of farmers' knowledge about the innovation. In Turiani Division technology transfer was

highly deficient and was skewed towards project supported farmers. Moreover, shortage of tree seeds and seedlings is another limiting factor in adoption of an agroforestry innovation.

(d) Lack of motivation has an adverse effect on adoption of agroforestry innovations. Non project supported farmers in Turiani faced lack of both self-driven and external motivation. The time of exposure to the innovation was inadequate for them to build self-motivation.

(e) Agroforestry practices are adoptable by any class of farmers irrespective of their socio-economic category. However the present study supplements that, those relatively high in socio-economic status were motivated to adopt, more than those of low status.

(f) Cultural beliefs, influence of political leadership, gender relations, people's perceptions about the innovation and the mode of land acquisition are important factors that may make dissemination of agroforestry abortive if not taken care of.

5.2 Recommendations

The following recommendations are made:

(a) Agricultural extension services should be improved in adequacy and orientation. The field officers should therefore be capable of advocating the integration of forest trees into both crop and livestock husbandry. For this to work, farmers

should be trained on the management of homegarden agroforestry systems and their benefits so as to get rid of the prevailing illusions about the innovation.

(b) Extended adoption of sunflower by farmers is recommended as it has a direct influence on community health through supply of cooking oil and on livestock nutrition through supply of seed cake thus relieving the farmer financially. This together with multipurpose trees will thus contribute to the improvement of livestock production whose tremendous influence on enhancing sustainability of agroforestry systems has been confirmed.

(c) It is recommended that, SURUDE extend its services to a wider spectrum in the Division having shown a significant success in the selected villages. This will facilitate attainment of the ultimate objective of promoting the wellbeing of farmers through enhancing sustainability of the farming systems.

(d) Rural development projects are advised to include gender dimension in the dissemination of their innovations. Detailed training of farmers should carefully focus on gender equity in their livelihood strategies rather than trying to eradicate the existing gender relations through use of the present authorities.

(e) More research is recommended especially on the use of indigenous trees and other components of the homegardens in the attempts to build sustainable farming systems. This may result in reduced production costs to an ordinary farmer.

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APPENDICES

APPENDIX 1 FARMER'S STRUCTURED QUESTIONNAIRE

FACTORS AFFECTING THE ADOPTION OF AGROFORESTRY FARMING SYSTEM IN TURIANI DIVISION, MOROGORO (R) DISTRICT

By
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Number of respondent: .....

Village: ..... **Ward:** .....

Name of enumerator: .....

Note to enumerator:

Where applicable, circle the number bearing the correct answer. For open-ended questions, you may use the reverse side if the space provided is not sufficient.

SECTION A: FARMER'S BACKGROUND

1. **(a) Sex**
   1. Male
   2. Female

   (b) Age (years):.....

   (c) Marital status:
   1. Single
   2. Married
   3. Divorced
   4. Widowed
   5. Other (specify) .....

(d) Household composition:

Category	Number
Spouse(s)	
Children:	
Male	
Female	
Dependants:	
Male	
Female	
Total	

SECTION B: FARMER'S SOCIO-ECONOMIC STATUS

2. (a) What is your highest level of education?
   1. No formal education
   2. Adult education
   3. Primary education
   4. Secondary education
   5. Other (specify) .....

(b) What is your social position?
   1. Ordinary Small scale farmer
   2. Political leader (specify) .....
   3. Traditional leader (specify).....
   4. Religious leader (specify).....
   5. Employee (specify).....

(c) What is the major source of your income?
   1. Farming activities
   2. Non-farm activities
   3. Both 1 & 2
   4. Other (specify) .....

(d) What is your average monthly income? .....

(e) What assets (properties) do you own?
   1 Radio
   2 Bicycle

3 Sofa
4 Motor bike
5 Sewing machine
6 Water source (e.g. tap, well, bore hole)
7 Milling machine
8 Other (specify) .....

SECTION C: LAND ACQUISITION AND USE

3. Since when have you been residing at this village? .....

4. How did you acquire your farmland?
   1. Purchased
   2. Inherited
   3. Given by village government
   4. Hired
   5. Other (specify) .....

5. What is the size of your farm? ..... acres

6. What is the location of your farm?
   1. Around the homestead (homegarden) ..... acres
   2. Away from the homestead ..... acres

7. What crops do you grow on your farm?

Crop	Main use

8. What types of livestock do you keep?

Livestock type	Number
Cattle:	
Dairy	
Beef	
Local	
Goats:	
Dairy	
Local	
Sheep	
Chickens:	
Layers	
Broilers	
Local	
Other (specify):	
.....	
.....	
.....	

9. (a) Do you have trees or shrubs on your farm?
   1. **Yes**
   2. **No**

   (b) If **yes**, what are they for?
   1. Wind break
   2. Boundary
   3. Shade
   4. Erosion control
   5. Other (specify).....

   How do you benefit from the interaction of trees, crops and livestock?
   .....
   .....
   .....

   (c) If **no**, why?
   1. Not aware of the system
   2. Not aware of the benefit
   3. No time (to plant and care for them)
   4. Lack of seedlings
   5. Extension workers are not readily available for consultation
   6. Other (specify).....

Do you think of tree planting (on your farm) in future?
Yes/No
Why?.....
.....

10. (a) May you give a list of tree species grown on your farm and their uses?
.....
.....
.....
.....

(b) What are the factors, which motivated you to adopt, tree planting on your farm?
.....
.....
.....
.....

(c) What do you think are the reasons for poor participation of some farmers in tree planting activities in your area?

1. More time is needed to foresee the usefulness
2. Poor external motivation
3. Poor self-motivation of farmers
4. Other (specify) .....

11. (a) What problems do you face in your tree planting activities?
.....
.....

(b) What attempts have you made to solve the above problems?
.....
.....

SECTION D: SERVICE RELATED, POLITICAL AND CULTURAL INFORMATION

12. Do you have access to the following services?
(a). Crop seeds **Yes/No**
(b). Tree seedlings **Yes/No**
(c). Veterinary services **Yes/No**

13. (a) Do you get advice on the following activities? (Use *'V'* to mark Yes or No in the appropriate columns)

Activity	Yes	No	Source
Crop husbandry	.....	.....	.....
Livestock husbandry	.....	.....	.....
Tree planting on the farm	.....	.....	.....
Other (specify)			
.....	.....	.....	.....
.....	.....	.....	.....

(b) How frequent do you get advice from extension officers?

..... per week / month / Not at all/Other(specify)* .....

Do you think the visits are adequate?

1. **Yes**
2. **No**

14. (a) What political programmes or policies do you think have influenced tree-planting activities?

Political programme/policy: **How?**

Panda mti, kata mti .....

Other (specify) .....

(b) How do village or ward government leaders promote tree-planting activities in this area?

.....

.....

.....

15. Is there any taboo, which either encourages or discourages tree planting on the farm?

1. **Yes**
2. **No**

If **yes**, explain briefly

.....

.....

* Delete what is not applicable

SECTION E: GENDER ROLES

I. Resource Analysis

16. Between man and woman, who has access to the following resources?

(Use *'V'* mark in the appropriate columns).

Resource	Man	Woman
Land		
Capital		
Credit		
Time		
Knowledge		

II. Activity Analysis

(a) Division of Labour

17. (i) Among members of the family who does the following activities?
Use the following key to fill in the table below (use *V* mark):
M = Male, F = Female, MA = Male adult, FA = Female adult, MC = Male child, FC = Female child.

	M		*F*	
Activity	***MC***	***MA***	***FC***	***FA***
Land preparation				
Hoeing				
Seed sowing				
Transplanting tree seedlings				
Manuring/fertilizer application				
Weeding				
Harvesting of agricultural crops				
Transporting crops home				
Threshing				
Fodder collection				
Livestock feeding				
Milking				
Fetching water				
Fetching fire wood				
Slaughtering livestock				
Cooking				
Cleaning the surroundings				
Laundry				

(ii) With the above division of labour, do you think there is a chance for women to participate fully in tree planting activities? **Yes/No***
Explain briefly with reasons
.....
.....
.....

(b) Decision making

18. Between the husband *(H)* and the wife *(W)* who decides to carry out the following activities?

Note: 'B'= both husband and wife

	Decision maker		
Activity	*H*	*W*	*B*
Type of crop to grow			
When to plant			
When to weed			
When to harvest			
What to sell			
When to sell			
Type of livestock to buy			
When to slaughter			
Whether to plant trees			
Tree species to plant			

* Circle the correct choice

III. Benefit Analysis

19. Who owns the following benefits?

	M		*F*	
Benefit	***MC***	***MA***	***FC***	***FA***
Farm crops				
Livestock products				
Meat				
Milk				
Skin				
Construction poles and withies				
Timber				
Fodder				
Fuelwood				
Fruits				
Money (from sales)				

20. What are your general opinions on tree planting activities?

.....
.....
.....
.....
.....
.....

THANK YOU FOR YOUR COOPERATION

APPENDIX 2 QUESTIONNAIRE FOR KEY INFORMANTS

FACTORS AFFECTING THE ADOPTION OF AGROFORESTRY FARMING SYSTEM IN TURIANI DIVISION, MOROGORO (R) DISTRICT

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Village: ..... **Ward:** .....

Occupation of the respondent: .....

---

1. How frequent do extension workers visit villagers?
   .....

2. Do you think the visits are satisfactory?
   1. Yes
   2. No

   If **no**, why?
   .....
   .....

3. Do extension workers advise farmers to plant multipurpose trees on their farms?:
   1. Yes
   2. No

   Is there any other agency, which promotes adoption of such practices? :
   1. Yes
   2. No

   If **yes**, explain briefly
   .....
   .....

4. What do you think are the factors, which motivate farmers to plant trees or shrubs on their farms?

.....

.....

5. What are the problems that limit farmers from adopting agroforestry practices?

.....

.....

.....

6. Are tree seedlings readily available to farmers?

1. Yes

2. No

If yes, what is the source?

.....

If **no** what are the associated problems?

.....

.....

7 (a) Are farmers accessible to credit?

1. **Yes**
2. **No**

(b) If **yes** what is the source? .....

Explain briefly the prevailing policies and how they affect adoption of agroforestry practices

.....

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8 a) What is the prevailing land tenure system in your area?

1. Freehold
2. Tenancy
3. Communal
4. State ownership

b) How does the land tenure system affect the adoption of agroforestry practices?

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