IMPACT OF INDIGENOUS BASED INTERVENTIONS ON LAND CONSERVATION: A CASE STUDY OF SOIL CONSERVATION AND AGROFORESTRY PROJECT, ARUMERU DISTRICT, ARUSHA, TANZANIA.

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE) OF SOKOINE UNIVERSITY OF AGRICULTURE.

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ABSTRACT

Land degradation has been identified as a serious problem in Tanzania since the 1920s. A number of factors do contribute to land degradation, some being important in one area than in another. Among the factors normally cited include deforestation, overgrazing and inappropriate farming practices. Several attempts by the government of Tanzania to arrest the problem have been mostly directed towards land conservation through externally sponsored interventions based on top- down approaches. Indigenous based interventions are among the alternatives practices adopted by the Soil Conservation and Agroforestry Project in Arusha for land conservation to restore soil fertility and increase agricultural productivity in Arumeru Districts. The main purpose of the study was to assess the impact of indigenous based interventions on land conservation. More specifically the study intended, first to assess farmers' perception on land degradation; secondly, assessing the adoption of indigenous based interventions; thirdly assessing the impact of those interventions; and lastly assessing the sustainability of those interventions. Data for the study were collected under two phases. Phase one of the study involved reconnaissance survey together with a Participatory Rural Appraisal (PRA) techniques in Manyire village. Other tools used were checklist and participant observation. The second phase was mainly based on questionnaire survey. Questionnaire survey was done in Oldonyosapuk, Olchorovus, Manyire and Ekenywa Villages. PRA data were analyzed with the help of the local communities and the results were communicated back to them for verification. The Statistical Package for Social Sciences was used to analyze quantitative data whereas Content and Structural-Functional analysis was used for analyzing qualitative data. Findings of the study suggest that the rate of land degradation was perceived by respondents to be rather severe. Results of the study also showed that interventions, which require minimal labour or minimal capital, have been highly adopted by many farmers while labour/capital intensive ones have been taken up by few farmers. In the overall, the interventions are said to have eased-up farm operation and contributed towards increased crop yield, improved soil conservation and increased income. Success in some of the interventions warrants wider promotion of the practices (sustainability) beyond the project area. Farmers are aware of the issues related to land degradation and problems of declining soil fertility. Land conservation measures are in- built into many of the cultural practices in the survey area. Logistic model showed that extension service was the most important factor, which influenced the probability of adoption of indigenous based interventions on land conservation. Other factors included: farmers' age, education level and land ownership.. The results also suggest that the most important factors influencing the yield of maize and beans were: land size, farmers' age, frequency of extension contacts, climatic factors, land management practices (intercropping) and accessibility to markets. The results imply that increased application of farmyard manure, restricting animal movements on conserved land and more training on improved pastures would increase the impact of indigenous based interventions. The results of this study provide a strong case for the promotion of indigenous based interventions as an appropriate solution for land conservation and as a means of increasing agricultural production on a sustainable basis.

DECLARATION

I, Julius Fanuel, do here declare to the Senate of the Sokoine University of Agriculture that this dissertation is my original work and has not been submitted for a degree award in any other University.

Signature...

Date........22.05.2002..

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This work is dedicated to my beloved parents, Fanuel Mollel and Ruth Noah who laid down the foundation for my education and my dear wife, Christina Sumaye for her tireless support.

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ABBREVIATIONS

SCAPA	Soil Conservation and Agroforestry Project in Arusha Region
Tshs	Tanzania shillings
PRA	Participatory Rural Appraisal
LITI	Livestock Training Institute
SPSS	Statistical Package for Social Science
SIDA	Swedish International Development Authority
WWF	World Wildlife Fund
URT	United Republic of Tanzania
MTNRE	Ministry of Tourism and Natural Resources
UNESCO	United Nations Educational, Scientific and Cultural Organization
FAO	Food and Agriculture Organization
VSCC	Village Soil Conservation Committee
MOA	Ministry of Agriculture

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

1.1.1 Overview

A number of definitions have been used interchangeably for the concept of land conservation. In the following section an attempt was made to provide some working definitions for the concept of land conservation, soil conservation, sustainable land conservation and sustainable land management.

1.1.2. Definitions and explanations.

1.1.2.1 Land conservation

Land conservation is the specific use and protection of land including wise choice of land use and pursuit of necessary measures of soil management and erosion control, especially against erosion by water (Sheng, 1989)

1.1.2.2.Soil conservation

Soil conservation is the promotion of optimum use of land in accordance with its capability so as to assure its maintenance and improvement (Dudal, 1981). Soil conservation practices must protect the soil from the raindrop impact and its positive influence on soil properties (Kirkby, 1980; Morgan, 1986; Singh *et al;* 1990 Per and Erikson, 1994)

1.1.2.3 Sustainable land conservation

Sustainable land conservation is that which does not degrade the soil or significantly contaminate the environment, while providing necessary support to human life (Young, 1989).

1.1.2.4. Sustainable land management

Dumanski *et al.*, (1991a) considers sustainable land management as a package of technologies applied at all levels of land use, which individually or in aggregate contribute to sustainable agriculture. It aims at maximizing the efficient use of inputs in relation to the amount and quality of the output, while long- term environmental and social concerns are associated with the outputs. It evaluates management not only in terms of production efficiency, but also in terms of its impact on the environment and its ability to ensure equity down the generations.

Sustainable land management is an extension of maximum economic yield in that it does not only try to maximize the efficient use of inputs, but also considers the long term environmental and social costs (Dumanski *et al.*, 1991b). Sustainable land management maintaining the productive potential of land resources, and checking for land quality degradation.

1.1.3 Land degradation and some conservation efforts in Tanzania

In Tanzania, soil erosion and overall land degradation has been identified as a serious problem since the 1920s (Kauzeni *et al.*, 1987). The degraded area is estimated to range between 33 percent to 45 percent of the total land area United Republic of Tanzania (URT, 1991). Figure 1 shows the state of land degradation. The processes of land degradation vary and not easily detected and measured. However, both central and local governments recognize land degradation as a major issue for the country. A number of factors contribute to land degradation, some being more important in one area than in another. Among the factors cited for land degradation include:

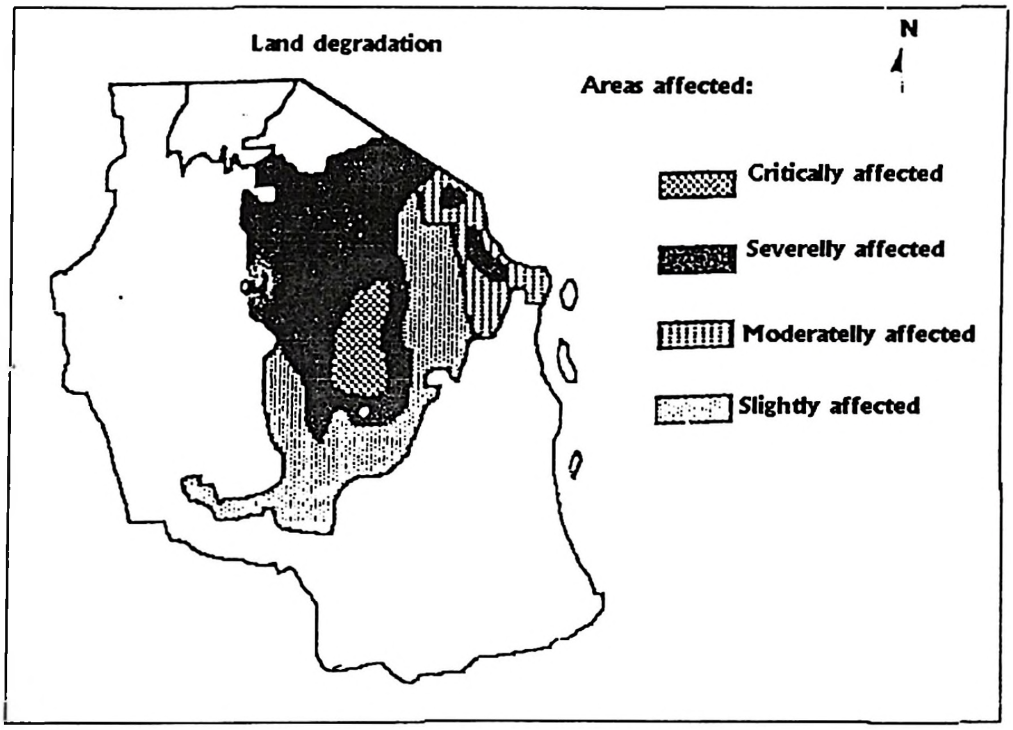


Figure 1: The state of land degradation in Tanzania.
Source: URT, 1991.

inappropriate cultivation techniques; the growing population with unmatched provision of technology; inappropriate land tenure and overstocking Ministry of Tourism and Natural Resources (MTNRE, 1994). External forces have also played part as international terms of trade have worked against the Tanzanian farmer, lowering prices of the farm products and increasing prices of farm inputs.

Even before independence in 1961, the problems of land degradation were known. As a result, various soil conservation programmes were established on a trial basis to combat the problem. Demonstration plots, conservation orders and directives (e.g. destocking of livestock, planned fires, etc.) were thus first introduced by the colonial government. Most of these measures were concentrated in mountainous areas where land degradation was most apparent. These areas include Kilimanjaro, Uluguru, Usambara, Pare and Meru Mountains. The local authorities of these areas were charged with administering the orders. Meanwhile experiments were carried out at agricultural research stations to quantify soil and water losses. These experiments were expected to provide insights for conservation activities (FAO, 1986).

Partly as an outcome of these early initiatives, but also due to the escalating problem of land degradation, several integrated conservation schemes were established in different parts of the country e.g. Sukumaland, Kondoa-Irangi and Masailand. Later, after independence, they were followed by such programmes as Hifadhi Ardhi Dodoma (HADO) in Dodoma Region, Soil Erosion Control and Agroforestry Programme (SECAP) in Lushoto district Tanga Region, Hifadhi Ardhi Shinyanga (HASHI) in Shinyanga Region, Hifadhi Mazingira (HIMA) in Iringa Region and the Kigoma- Ujiji Soil Erosion Control Programme in Kigoma Region.

The nature of the land degradation problems, successes and failures of the above mentioned schemes and programmes have been the focus of many studies (Kikula *et al.*, 1990) Information has also been accumulating from many other parts of Tanzania, where land use planners, foresters, agriculturists, and social scientists have endeavoured to analyze the processes of land degradation in terms of cause-effects relationships and possible solutions (Per, 1999). Some of these analyses have rightly taken the interdisciplinary approach, given that land degradation processes: their causes, effects and possible solutions cut across different sectors and disciplines. Other analyses, however, have taken narrower approaches and inevitably their perspectives have been limited in scope. All in all, in the course of time, there has been large volumes of literature accumulating on land degradation and related subjects (Kikula *et al.*, 1990)

In spite of many programs on land conservation, land degradation is still a big problem in Tanzania. Plausible reasons include the top-down approach and concentrating more on mechanical measures in preventing erosion and run-off, and also ignoring the contribution of indigenous knowledge in addressing the problems

1.1.4.Consequences of land degradation

Land degradation is of much concern as it strikes at one of the basic elements of survival of mankind i.e. the productivity of land (Kikula *et al.*, 1990). Soil erosion as a major form of environmental degradation in the tropics is a major constraint to agricultural production (Beets, 1990). Due to the vastness and the physical diversity of Tanzania, there is no single solution to environmental degradation and the dwindling of the land resource base. This entails combinations of different practices in conserving the land.

Among the areas, that are threatened by land degradation in Tanzania is Arusha Region, specifically Arumeru District. The problem of land degradation in Arumeru district can be traced back to the 1930s (Per, 1999). About 2 percent (57.92 km square of the district is severely eroded. According to SCAPA (1997) the major causes of soil erosion and land degradation are high population density in high potential areas, forcing farmers to open up fragile lands for farming; poor farm management, overstocking and overgrazing in the low potential areas. Other factors include deforestation and poor forest management resulting into lack of woodfuel and timber, low level of awareness regarding land and environmental degradation within the farming community, and among government and political leaders. Lastly there are inadequate appropriate facilities and skills within the extension system to solve problem of the soil erosion as well as encroachment and cultivation in the water sources and riverbanks. These processes in the final analysis lower the potential capacity of the land to produce food due to over exploitation of land and other resources (Liwenga, 1995).

In efforts to combat land degradation which is a serious problem in Arumeru District a land conservation project known as " Soil Conservation and Agroforestry Project in Arusha" (SCAPA) was established in 1989 with assistance from the Swedish International Development Agency (SIDA). The programme was designed to rehabilitate eroded areas, specifically Mukulati and King'ori Divisions (Mawenya, 1994.)

1.2 Problem statement and study justification

Over the years there has been several attempts by the government and other agencies to arrest the problem of land degradation mainly through externally sponsored interventions through tree planting. However, experience gained with externally sponsored interventions, for example "Forests Trees and People Program" in Babati District, show that planting of trees alone is not effective in controlling land degradation (Lohay, 1998) Also many donor assisted development programs have proved to be unsustainable when the donors pull out and leave the program operations to the local community (Luhasi, 1998).

Land conservation measures, when implemented on the basis of externally sponsored interventions alone, rarely produce adequate solutions to soil erosion problems. In order to be successful, land conservation programme must establish a sustainable agriculture at a higher productivity level through a combination of different interventions (Doolette *et al.*, 1988). Based on the above fact, SCAPA adopted the approach of indigenous based interventions.[1]

Indigenous based land husbandry techniques include:

- The use of farmyard manure to improve the fertility of the soil;
- Contours across the slope: Traditionally farmers used to construct contours across the slope whether in the middle or at the top of the farm to stop overland flow from the catchment above the farm or neighboring farms;

[1] In this study, 'indigenous based interventions' means the combination of indigenous interventions and external practices

- Intercropping: This is a traditional farming method for many years and contributes substantially to soil and water conservation;
- Ploughing-in crop residues: in areas where moisture regime is not a limiting factor, farmers usually plough-in crop residues after harvest in order to control weeds, pests and diseases; and
- Tree planting.

Externally sponsored interventions are based on top-down approaches and aim at bringing the dynamics indigenous knowledge into the line with the interest and perspectives of external authorities and to produce the image of the state as being key to rural development (Lane 1992, in Kajembe, 1997).

Experience has shown that programs based on bottom up approaches are far more likely to succeed and last than those based on top down approaches. Although the introduced interventions in Arumeru District were based on bottom up approach, their impact on land conservation is not known. As of now, no empirical studies have been conducted to assess the impact of these indigenous based interventions.

The adoption of a new agricultural technology is important for assessing the impact of agricultural research investment (Norton and Davis, 1981; Jahnke *et al.*, 1986; CIMMYT, 1993; Collinson and Tollens, 1994) and for guiding technology development to satisfy the needs of the clients. Technology adoption brings potential impact at the farm household level (Sanginga, 1998).

This study intended to assess the impact of indigenous based interventions on land conservation. The results from this study will contribute knowledge, which may be useful in prescribing indigenous based interventions that may promote effective land conservation in Arumeru District and in other parts of Tanzania.

1.3 OBJECTIVES

1.3.1 Overall objective

To assess the impact of indigenous based interventions on land conservation in Arumeru District.

1.3.2 Specific objectives

(i) To assess the perception of farmers on land degradation.

(ii) To assess the adoption of indigenous based interventions.

(iii) To assess the impact of indigenous based interventions.

(iv) To assess the sustainability of the indigenous based interventions.

1.4 Conceptual Framework

Conceptual Framework prevents fragmentation of knowledge into diverse segments of unconnected statements. Katani (1999) argues that conceptual framework binds facts together and provides guidance towards collection of realistic data and information. Research performed without the guidance of the conceptual framework is usually sterile for the reason that the researcher does not know quite well what data to collect and when he/she has collected them, he/she cannot put them to use (Kajembe, 1994)

The problem of land degradation in the study area causes temporary or permanent lowering of productive capacity of the land. In order to cope with land degradation, indigenous based interventions have been developed. These interventions have impact on the key crops (i.e. maize and beans) grown in the study area. The impact, adoption, and sustainability of the indigenous based interventions are very much affected by socio economic factors that prevail in the society. Figure 2 depicts a conceptual framework that puts into context indigenous based interventions on land degradation aimed at sustainable land conservation.

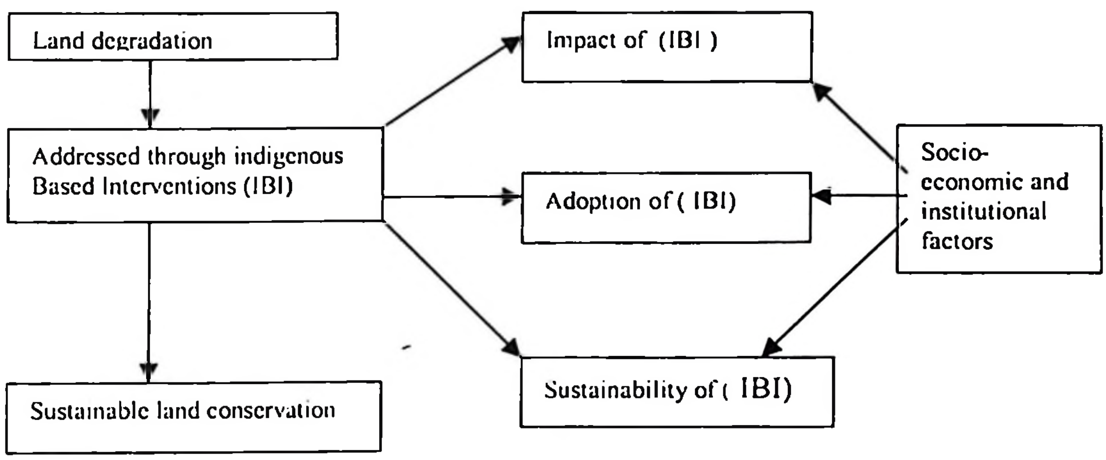


Figure 2: Conceptual Framework

1.5 Research questions

(i) How did the local farmers perceive the rate of land degradation in the study area?

(ii) What is the adoption rate of different indigenous based interventions advocated by SCAPA?

(iii) What is the productivity of crops per hectare, grown under indigenous based interventions?

iv) What are the socio –economic factors enabling or constraining productivity?

(v) What are the socio-economic factors influencing sustainability of indigenous based interventions?

1.6 Hypothesis

The following hypothesis was used to guide the study.

- The indigenous based interventions adopted by farmers to cope with land degradation depends to a large extent on socio-economic factors such as age, education, income level, awareness of the problem of land degradation, household size, farmsize and land tenure.

1.7 Limitations of the study

1.7.1 Problems of recall data

Failure of farmers' memory was a big limitation. For example there was a notable difficulty on the part of the respondents to give correct account of household's production data such as area of land they own, number of livestock units they own and income per season.

1.7.2 Informants being busy

Questionnaires were administered during the farming period. Farmers were occupied with farming activities and hence were reluctant to spend their time being interviewed.

1.7.3 Convention of units

Convention of units was also a problem since some farmers use local units (e.g. *debe*, *bags* etc), which are not standardized. Farmers tended to mix units, for example, acres and hectares. In most cases it was difficult to know the exact acreage for different crops. Actual observation was done by the researcher to minimize the problem.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The concept of Indigenous Knowledge

In June 1992, the United Nations Conference on Environment and Development (UNCED) met in Rio de Janeiro and discussed the urgent need to develop mechanisms that would lead to protecting the earth's biodiversity. Many of the documents signed by the UNCED reflect the need to conserve the knowledge on the environment that is being lost in many communities (Warren *et al.*, 1993). The use of indigenous knowledge in nature conservation can be traced back to the early works of anthropologists and geographers (Barlett, 1980), ecologists (Atteh, 1993) and economists (Norgaard, 1984). They were concerned with environmental deterioration and sustainable production.

Kajembe (1994) defines indigenous knowledge as "sum of experiences and knowledge of a given ethnic group that forms the basis for decision making in the face of familiar problems". Lugeye (1994) defines it as "a mixture of knowledge created endogenously within a society and knowledge acquired from outside and integrated within the society". Other terms which are used synonymously with indigenous knowledge are: local knowledge, rural peoples knowledge, ethno science and farmers knowledge (Van der Kemp and Schuthof, 1989).

In general, people with the richest indigenous knowledge have least formal education (Cunnigham, 1991). Thus, there is a tendency among the elite to treat such people with contempt. However, indigenous knowledge makes the baseline for much of the modern science and technology. Indigenous knowledge is very important but apparently it is neither recognized nor rewarded equitably. When indigenous knowledge is lost it cannot be recovered (Kamara, 1994), thus efforts must be done to preserve it.

Many indigenous communities all over the world have been qualified for their keen indigenous knowledge and management practices they have been applying in biological resource conservation (Lusigi, 1982; Wastern, 1982; Bell, 1984; Martin, 1984; Baaldus, 1987; Atteh, 1989; Niamir, 1990; Warner, 1991). Indigenous knowledge is also well known for its important role in agricultural production (Sands, 1986; Warner, 1991) and animal husbandry (Lane, 1990; Niamir, 1990). Thus indigenous knowledge and associated practices should be at the core in the process of land conservation.

2.2 The role of indigenous interventions on land conservation.

Indigenous soil conservation has been one of the major preoccupations of Tanzania folks even before the introduction of soil and water conservation programmes by colonial administration (Kauzeni *et al.*, 1987). Some of the documented conservation practices in Tanzania in pre colonial era include the mixed farming system in Ukara Island in Lake Victoria (Thornton and Rouce, 1936); the traditional terracing among the Iraqw in Mbulu District which ensures that organic matter content and water are retained in the farms for good agricultural production (Hartley, 1938); the Ufipa mounds systems, which is used by the Fipa people in Rukwa to promote /restore soil fertility and to conserve water (Lunan, 1950); the Matengo pits/Ngoro system which is a traditional farming and land management technique applied by the Matengo people in Mbinga district; and rotational furrowing in Mufindi district which minimize soil erosion and thus capturing the nutrient that would otherwise be eroded and transported to valley bottom farms and rivers (Stenhouse, 1944).

Studies on agricultural practices under the Sokoine Extension Project revealed that most farmers in Morogoro and Kilosa districts were still using indigenous agricultural practices (Flatley, 1980; Ngeti, 1989; Lugeye, 1991). The main practice used by farmers in these areas is intercropping. Barrow *et al.* (1992) reported that there is abundant indigenous knowledge about trees, soil, livestock and pasture in Shinyanga region. A good example is the use and management of 'Ngitiri's'. These are areas set aside and are closed during rainy seasons but opened for grazing during dry seasons. Another example is *insitu* conservation and sustainable management of indigenous trees on farm and grazing lands in Sungamile village in Kahama District.

The study on training needs assessment carried out in Iringa District by Lugeye and Muturi (1993) found that farmers were involved in a number of indigenous land conservation activities such as the use of ridges, ploughing across the hills, making contours, use of farm yard manure and incorporation of crop residues. Implementing soil conservation practices on the basis of indigenous knowledge greatly increases the rate at which farmers adopt them. Indigenous soil conservation practices are ecologically sound and need to be taken into account when efforts are made to introduce modern agricultural techniques (Indigenous knowledge and Development Monitor, 1994). Mossi farmers in Burkina Faso provide an example of how indigenous as well as newly introduced soil conservation practices are implemented. Mossi farmers use indigenous soil conservation techniques such as application of manure, mulching, stone lining and fallow (Indigenous Knowledge and Development Monitor, 1994). These indigenous soil conservation techniques are integrated with newly introduced conservation techniques such as micro –catchment conservation, living hedges, strips of vegetation and reforestation. The integration brings about sustainable management of the resource (Richards, 1985).

Local knowledge within the Barabaig society in Tanzania has historically helped them to maintain the productivity of their land. The Barabaig apply rotational grazing methods to manage their pastureland (Lane, 1990). The socio cultural infrastructure of the Maasai has helped them to conserve land. Traditionally the Maasai are grouped into geographically known ecological units with well-defined boundaries known as "Oloho". These boundaries limit livestock movement and control pasture and water use. The society provides various customary rights and obligations with respect to grazing and water usage (Kuney, 1992). Pastoralists have elaborate ways of using pasture e.g. transhumance and lending of livestock if one has too many (Kajembe, 1994). This reduces grazing pressure on the land and in a way, helps the people who are stockless.

Indigenous practices are ecologically sound and should be supplemented and improved rather than replaced by modern technology. If resources are to be used sustainably, indigenous soil conservation systems must be recognized by extension services and used as springboards for promoting soil conservation practices among local farmers. Indigenous soil conservation systems should be improved and not carelessly supplemented by international scientific knowledge systems (Indigenous Knowledge and Development Monitor, 1994).

Many studies have shown that rural people in developing countries have intimate knowledge of their natural environment, (including plant and animal life as well as climate and soils) and of environmental processes. They make rational resource management decisions based on that knowledge. Communities have well-established systems and carefully developed techniques which, over many years, allowed them to survive in harsh conditions (van Vlaenderen and Nkwinti, 1993). Taking indigenous knowledge as the basis for development empowers local people by increasing their self-reliance, their confidence and their capacity to utilize and manage their local resources. This, however, does not mean that indigenous knowledge is superior to scientific knowledge. That indigenous knowledge has its shortcomings is clear from the existence of debilitating diseases, natural resources degradation etc. in many developing settings (Brouwer, 1998). The plea that is made here is for a combination of local knowledge in development in which indigenous knowledge (including methods, concepts, classifications) is used as a starting point for a process in which indigenous and scientific knowledge can merge into an effective development strategy which is controlled by the local people rather than the development agents.

2.3 Impact of land conservation practices

It is important to understand the meaning of impact. The term impact means different things to different people. In discussing the impact of any research programme for example, one can identify two broad categories of interpretation (Anderson and Herdt, 1990). In the first category, some people look at the direct output of activity and call this an impact, e.g., a variety, a breed, or a set of recommendations resulting from a research activity. Most of the biological scientists belong to this category. The other category goes beyond the direct product and tries to study the effects of this product on the ultimate users, i.e., the so-called people level impact. The people level impact looks at the fit of the programme within the overall research and development of the country. Most social scientists, donors, planners and policy makers belong to this category. Horton, (1990) argues that the ultimate goal of research and development is to discover or revise facts that have practical beneficial application in development. Impacts begin to occur only when there is a behavioral change among the potential users. This second type of impact deals with the actual adoption of research output and subsequent effects on production, income, environment and/ or whatever the development objective may be.

The peoples' level impact of any research activity cannot be assessed without information about the number (extent) of users and the degree (intensity) of adoption of improved techniques, and the effects of these techniques on the output. The adoption of any technology is determined by several factors, which are not part of the original research activity. This introduces numerous non-researchable factors into the analysis. Impact studies compare "the with" and "the without" or before and after situation of a given technology transfer or project (David, 1996).

In order to come up with proper land conservation methods, there is a need to have a good understanding of all the factors involved in the process of land degradation. A development approach considering farmers perceptions of the problems and simple landscape management methods is appropriate and effective in sustaining productivity Portch *et al.*, 1980*)*. (Blustain, 1982; Rogers, 1983 and The introduction of new technologies can radically change land use, and the increased yields obtained allow farmers to adopt more appropriate farming techniques that protect the soil better and motivate them into more productive land activities (FAO, 1986).

Production and conservation can be compatible on most lands if appropriate agricultural technologies are developed and used. The approach adopted by SCAPA is the application of indigenous based interventions. The agronomic practices used include contour farming, tree planting, and intercropping. Others are ploughing- in crop residues and applying farmyard manure. The structural practice is the use of cut off drains. All these methods were found to improve land productivity (Nimlos *et al.*, 1987). This study considered some of these interventions.

2.4 Indigenous-based interventions

2.4.1. Intercropping

Intercropping, the growing of more than one crop in the same field simultaneously has a significant role in tropical agriculture (Gunasema, 1980; Nyambo *et al.*, 1980; Chatterjee *et al.*, 1989). In intercropping, crops are planted with a regular spacing between and within rows (Ndakidemi *et al.*, 1996). Intercropping plays a role in pest and disease control, provision of economic benefits to the farmer against falling prices of one commodity and minimizing the risk of crop failure, giving a continuous plant cover over the land for most or all of the year; provides good protection against raindrop impact and accelerated soil erosion (Schwab, *et al.*, 1993). Furthermore, intercropping results in more intensive use of the land than can be achieved with continous cropping or crop rotation (Per and Eriksson, 1994).

Intercropping is a way through which farmers may reduce total dependence on industrial fertilizers. If correct combinations of intercrops are sought, then efficient utilization of below ground resources in terms of time and space could be achieved (Kapande, 1982). For instance, intercropping involving legumes and non legumes, early maturity, late maturity and crops with different rooting depths have shown yield advantages (Kapande, 1982). This could be due to a possible advantage as a non leguminous crop gets nitrogen from a legume crop in association or over time. Whereas in the case of maturity differences or differences rooting depth, the yield advantage could be possible due to efficient utilization of below ground resources in time and space. A well-managed intercropping system could result in profitability and greater soil and water conservation potential than most monocropping practices (Gilley *et al.*, 1999).

In Nigeria, Aina *et al.* (1979) found that vegetal cover provided by close canopy and low growing soybean was quite effective in controlling erosion on Alfisol soils. They also reported that a crop with rapid development of ground cover such as soyabean and cowpeas would be suitable for those areas where frequency of erosive storms is high, especially early in the growing season. In Nicaragua, Honduras and Bolivia, a participatory research on intercropping and water conservation practices for hillside farmers was conducted and the results indicated that the practices were effective, accepted by farmers and led to improved productivity on hillside farms (Sims and Sinclair, 1997)

2.4.2. Ploughing in crop residues

Leaving crop residues in the field has been suggested as a way of increasing yields and replenishing soil nutrient levels (Muchlig-Versen *et al.*, 1997). Various studies have shown that crop residues can help in improving the permeability of soil and make it less vulnerable to eroding agents (Nyaki, 1993). Maize stover, bean and pigeon peas straws are used as mulch in farms, and the effect of mulching in retarding water losses due to evaporation is one of the conservation practices. This practice is very beneficial in young crops generally because the potential evapotranspiration is very high and rainfall is very unreliable during this crucial phase.

Crop residues application to fields in West Africa has resulted in increased pearly millet grain yields (Muchlig-Versen *et al.*, 1997; Marschner *et al.*, 1995; Bationo and Mokwunye, 1991;Verma *et al.*, 1992). Crop residues reduced wind erosion losses and improved crop stands (Michels *et al.*, 1995a; 1995b) and enhanced root growth (Bababc, 1997). Crop residues trapped wind -blown dust with high nutrients levels (Bationo *et al.*, 1993) and high soil pH and lower Al and Mn levels, (Bationo *et al.*, 1993;Hafner *et al;* 1993. In addition, crop residues application increased N fixation and dry matter of groundnut (*Arachis hypogaea L*) (Rebafka *et al.*, 1993), but legumes have generally been less affected than cereal crops (Buekert *et al.*, 1997). Although retaining crop residues on the field reduces the export of nutrients, a net loss of nutrients commonly occurs (Buekert, 1995). Crop response to residues application is greater in the lower rainfall zones than in the higher rainfall zones (Buekert *et al.*, 1997) and greater on unfertile degraded soils than on more fertile soils (Buekert, 1995).

Crop residues application is commonly used by producers to regenerate soils with wind and water-eroded surfaces (Taylor-Powell *et al.*, 1991). Crop residues are used for many other purposes in West Africa by reducing the amount of residues available for soil replenishment. Lamers and Bruentrup (1996) studied the use of crop residues and found that the highest gross margin returns for land was from mulching with crop residues.

2.4.3. Application of farm yard manure

Tanzania is endowed with a large number of livestock such as cattle, goats, sheep, pigs, donkeys and poultry. Efficient use of manure from these animals could substantially alleviate the problem of declining land productivity in most parts of the country. Kyomo and Chagula (1983) reported animal manure output in Tanzania of about 11 million tonnes per year, which could supply total nitrogen of about 77,000 tonnes assuming average manure nitrogen content of about 0.7%. They further observed that this is more than three times the amount of nitrogenous fertilizers used in Tanzania in 1980. Irrespective of such enormous potential, very little amount of animal manure is being utilized for crop production in most parts of the country. Kimbi *et al*, (1992) observed that in extensive livestock grazing systems only about 1% of farmers apply animal manure on the land, indicating serious underutilization of such a resource. A study conducted by Gabriel (1998) revealed that one of the major reasons for underutilization of animal manure for crop production is lack of technical know-how by most farmers. This is also to a large extent due to lack of scientific basis for advising farmers on aspects such as application rates, storage techniques and appropriate manure application methods.

Animal manure has many important benefits for crop production. Animal manure supplies a wide range of essential plant nutrients along with organic matter which improves soil characteristics such as water holding capacity, soil infiltration and drainage (Brady, 1984). With the increasing urban agriculture in Tanzania, livestock keeping under zero grazing system gives a greater challenge to the management of animal manure and increased opportunity for its use in crop production.

In Tanzania, substantial research has been carried out on the use of animal manure for crop production. Initial research efforts date back as early as 1928 (Martin, 1928; Martin *et al*., 1937; Scaife, 1968; 1971). Generally results form these studies indicate that in most cases application of animal manure increased yields of most field crops such as maize, sorghum, cotton and millet. A combination of animal manure with inorganic fertilizers resulted in highest yield responses compared to either of the sources applied alone.

Peat and Brown (1962) reported average cotton yields of about 550 kg/ha per year from application of animal munure. Scaife (1968) observed a significant increase in seed cotton yield from application of 7.5 tonnes per hectare of cattle manure at Ukiriguru-Mwanza. Scaife (1971) reported other positive crop responses to application of animal manure on groundnuts and Evans and Mitchell (1962) on pigeon pea in Kagera Region. In these studies, cattle manure increased yields of the crops and sustained the fertility of the soil. Application of animal manure and other organic materials such as compost and mulch have been known to sustain good yields of banana and coffee in Kilimanjaro region (Kasembe *et al.*, 1983). Using cattle and poultry manure, Massomo and Rweyemanu (1989) observed that both sources significantly increased common bean yield/plant and seed yield per unit area. Semoka and Ndunguru (1983) observed that despite of the low nutrient contents of animal manure from open kraals, a similar trend in relation to their effects on crops yield were obtained suggesting long term beneficial effects of these sources on land productivity.

2.4.4. Contour farming

Contour farming is ploughing, planting and cultivating across the slope following the contour, generally on gently sloping land. Each contour row can be viewed as a small dam that checks the speed of run-off water and reduces erosion on well-drained soils. Contour farming is one among the cultural practices which include early planting, tillage practices, ridging, mulching and applying organic fertilizers, compost manure and green manuring (Uriyo *et al., 1979*).

According to Thadei *et al.* (1996) this practice alone is not effective in controlling soil erosion, hence the need for contour farming to be combined with other practices including biological measures and physical measures. Biological soil conservation measures are practices related to crop and soil management including crop rotation, mixed cropping, intercropping, grass strips, strip cropping and trash lines. Physical soil conservation measures, on the other hand, include terraces, cut-off drains and artificial waterways.

SCAPA adopted contour strip cropping which is a practice of growing alternative strips of different crops (mainly pastures and fallow) in the same field with annual crops. Strip ploughing can also be done by ploughing every strip on the contour and leaving the alternate strip in sod. When the ploughed strip is reseeded the sod strip is, in turn, ploughed. The strips conserve soil and water. Strip cropping is used where contour farming is not enough to check the erosion. Strip cropping is a more intensive soil conservation practice than contour cropping.It is however, not as intensive as terracing hence it is often combined with terracing (Cook *et al.*, 1987). Strips are laid across the direction of the prevailing wind so that any soil blown from bare strips is caught and held by grass strips. Trees and grasses can act as windbreak and can also control water erosion. In controlling erosion caused by wind, trees or grasses may be planted in strips so that soil particles carried by wind may be deposited on or near the grasses strip (Uriyo *et al.*, 1979).

The effectiveness of the system depends mainly on use of high plant populations. Additionally early planting and mulching can help to control erosion. Crops such as maize can be alternated with pasture. In the case of waterways, the planting of suitable grasses and shrubs can reduce erosion (Cook *et al.*, 1987).

2.4.5. Tree planting

In dry land farming areas, growing trees is much more difficult. Growth rates are slow, survival rates are poor and protection of seedlings is more of a problem. Farmers are therefore more cautious about investing time and effort in tree growing. While projects have found that farmers are willing to plant some trees, the uptake of seedlings from nurseries has often been disappointing. Some projects are finding that encouraging natural regeneration is more acceptable to farmers than tree planting because it is cheaper and less risky. Some have also broadened their focus and are now promoting contour bunds and other physical techniques aimed at improving agricultural production (Kerkhof, 1990).

In pastoral areas, tree-planting efforts have had poor results almost everywhere. The costs involved are high, and growth rates are usually very low. Protecting areas from grazing animals has been found to be a much more effective way of restoring the natural vegetation and tree cover (Arnold, 1990). A number of projects have used food or cash payments to encourage people to plant trees or carry out soil conservation and other work. Although it is questionable whether farmers will be more motivated enough to continue this work once the incentives are withdrawn, the physical achievements of these projects have often been considerable (Kerkhof, 1990).

Where farmers have voluntarily chosen to grow trees on their land they have generally been very selective in what species they have planted. Their views on species choice have often varied widely from those of project staff; nitrogen fixing species, for example, have often been less popular than projects initially assumed (Tefera, 1999). Projects which have responded to such preferences have generally had a much better response than those which have retained fixed ideas about what trees should be grown (Kerkhof, 1990). A number of factors have been shaping peoples' attitudes towards tree growing (Kerkhof, 1990).

- In areas where agro-ecological conditions favour tree, crop and livestock systems as the most productive use of the site, farmers may respond to declining land availability through more intensive intercropping of trees, and other perennial and annual crops. Such an evolution has been quite widely observed in the humid tropical belt in Asia and Africa within which home gardens feature as an important part of farming systems (Arnold, 1990);

- Where labour resources are limited, farm households are forced to turn into increasingly off-farm employment, low-input tree crops may be employed as a way of keeping land in productive use;

- Farmers may also grow trees where lack of access to capital prevents farmers from adopting more capital-intensive crops. In highland areas of Kenya, for example, lack of capital appears to be one of the principal determinants of farmers' choice between tea and woodlots (Dewees, 1990);

- In areas where livestock are not used as a way of maintaining a reserve of capital, farmers may grow trees for this purpose;

- Farmers also use trees to help manage risk where repeated drought threatens other crops; and

- Trees are also grown to help diversify farm production, to provide products and income in the period between the main harvests, and to help bridge the peaks and troughs in seasonal demands for labour (Chambers and Leach, 1987).

The use of agroforestry techniques to boost crop production has been the explicit aim of several projects. Promising results have been obtained from intercropping trials in the project known as Agropastoral *de* Nyabisindu, Rwanda, (PAP) but these have not yet been confirmed in farmers' fields. Similarly, there is some evidence that the windbreaks in the Majjia Valley project in Niger have led to a net increase in crop production. But the results are very variable and, up to now, it has not been possible to draw any firm conclusions (Kerkhof, 1990). The agroforestry systems have some constraints, which, if poorly planned and managed, can hamper productivity.

- The fact is that trees take up land, which might be used for crop growing.
- They also compete with adjacent crops for light and soil nutrients. Any increase in crop yields in the overall system must be sufficient to outweigh these negative effects if the farmer is to obtain a net benefit. While positive effects on crop yields may be occurring in some cases, they certainly cannot be guaranteed. Unless there is specific evidence to rely on, it is dangerous to make any assumptions about improved crop yields (Budelman, 1994).

It is better to view projects in a broader context which takes into account their potential for providing tree products, environmental improvements and other benefits (Kerkhof, 1990). The SCAPA project has generally been able to bring about significant increase in tree planting. A total of 1,113,900 million multipurpose tree seedlings have been distributed and planted on the farmland and farm boundaries, and the survival rate of the planted trees is estimated to be 75 percent (SCAPA, 1997).

2.5. Adoption of conservation technologies

2.5.1. Resource endowment as a basis for farmers' decision

Farmers' decision to adopt a conservation practice is determined by the resource endowments that are at their disposal. These include: land, capital and labour. Differences in resource endowment, such as power to command traditional land rights, differences in availability of cash, family labour, and farm sizes may implies according to Rogers (1983) differences among farmers in their capacity to adopt technologies that require exploitation of these bases.

Farmers will not adopt technologies without economic incentives (Pawlick, 1989). This means that new technologies must have some advantages over the existing ones. Medium and long-term conservation technologies can only be adopted if individual farmers will get immediate returns from working towards such a goal.

Wenner (1989) outlined five preconditions, which are important in determining farmer's motivation to participate in soil conservation activities. They are:

(i) Soil erosion should be visible and considerable. This means a farmer will respond to soil conservation if erosion is obviously damaging land or crops seriously.

(ii) There must be short-term economic gains. Conservation for future means nothing if farmers are faced with severe economic pressure.

(iii) Loss of land is unacceptable. Actions, that mean less of land or putting land away from production, are not acceptable.

(iv) Investment, including labour input, must be profitable. The assumption that peasant farmers (or their families) have unlimited labour reserve and that their labour doesn't cost anything has been disapproved. Farmers are reluctant to adopt conservation measures that have higher cost of making them in order to realize minimum benefits.

(v) The last precondition is that traditions must be understood and respected. Traditional methods are preferred over new methods because they are simple and are based on long experience of special conditions related to culture and environment. A new method according to Wenner (1989) involves an element of risk, which is difficult for small farmers. It is therefore easier and more efficient to use a traditional method with some improvement than to try and introduce completely new methods.

Many attempts to control land degradation in the past have been directed mainly at preventing soil loss by employing physical measures. These did not take into consideration the social, cultural and economic processes, which are important to understand the people's behaviour towards change. According to Kelly (1982), what really get in the way of effective soil conservation are the social institutions.

The following section reviews literature about different socio- economic factors that are important in influencing adoption of soil conservation interventions.

2.5.2 Institutional and socio economic factors influencing adoption of indigenous based interventions

There is a large number of institutional and socio economic factors that influence adoption of soil conservation measures including the degree to which the technology is appropriate for farmers' conditions and how it is supported by other institutions such as research and extension (Van den ban and Hawkins, 1988; Russel and Dowswell, 1992; CIMMYT, 1993). Other factors include those associated with farmers such as their education, age and land tenure (Rogers, 1983; Nowak, 1987; Anosike and Coughenour, 1990).

2.5.2.1 Institutional factors

2.5.2.1.1 Research and Extension

These are publicly operated systems for providing services to the farmers. These include institutions such as research and extension and those dealing with credit and marketing (Machumu, 1995). Rejection or acceptance of a new idea largely depends on how the information is relayed from the source, which is mainly the extension service. However, the process of transmitting technology has tended to be bureaucratic, hierarchal and communication is always downwards thus hampering upward feedback from the farmers (Mlozi and Mvena, 1990).

Institutional research had little success in generating agricultural technologies which are widely adopted by small scale, resource poor farmers. It is argued that many improved technologies although technically sound, are not even appropriate to the agro- climatic conditions. According to Byerlee, *et al.*, (1992), Farmers reject technologies not because they are conservative or ignorant, but because they rationally weigh, the changes in incomes and risk associated with the given technologies under their natural and economic circumstance and decide that for them the technology does not pay.

Smallholder farmers who are in most cases resource poor tend to avoid risk associated with credits, which could otherwise improve their investments to produce more (Holden *et al.*, 1996). Minde (1990) writing on credit, commented that the perpetual low margin and the inability to qualify for credit by the lending institutions lead to a cyclic problem of lack of capital for farm investment by the smallholder farmers. With regard to markets, many of the markets in the third world countries tend to be missing and imperfect. This causes price distortion, which makes farmers misuse or degrade land resources through improper farming practices (Holden and Sankhayan, 1997).

2.5.2.1.2 Land tenure

Security of land tenure is often cited as a necessity for stimulating farm investments and resources conservation. Security of land tenure affects farmers planning horizons and confidence which they can make them capture the long-term benefits of investment in soil conservation (Cramb and Nelson, 1998;Shivley1999). Research has also shown that security of tenure tends to increase adoption of land improvement technologies (Anim, 1999). Studies done in India by Kerr *et al*, (1992) and in Tanzania by Stahl (1991) and Loiske (1991) cited by Lundgren *et al.*, (1993) show that farmers cultivating on privately owned land are characterized by high investment in various aspects of soil conservation. Although investment in soil conservation has been found to be lower on rented land than on privately owned land, ambiguity can sometimes arise regarding the role of land tenure in influencing adoption. Shivley (1999) contends that while land security may be a precondition for investment in maintaining land productivity, in some settings, investment on land may actually help farmers to obtain *defacto* right over land. That is, agricultural investment such as soil conservation may be used as a way to legitimize claim to land since local authorities tend to recognize traditional forms of land tenure when good land use practices are observed.

However, Holden *et al.* (1996) argues that security of tenure is only a necessary but not sufficient condition for poor peasants to undertake conservation investments. Poverty and high rates of time preference may induce the farmers to degrade the environment even under conditions of secure rights to land. In Tanzania, all land belongs to the state under three main forms: general land, village land and reserved land (Land act, 1999). The common practice however, has been for a farmer to have the right to land that he has actively been cultivating. By tradition, grazing land and water holes have also been free for all to use (Christiansson *et al.*, 1993). In this sense, if the community of users does not work out arrangements to respond to appropriate changes, destructive competition caused by free rider tendencies or conflict may result into resource degradation what Hardin (1968) calls the "tragedy of the commons".

2.5.2.2 Socio economic factors

2.5.2.2.1 Education

Education is a tool that can make people manage resources properly including land. Through education farmers may know the rationale for taking care of their environment from the point of view of their farming practices and other socio-economic factors (Rutatora, 1993). The technical proficiency of the clients and their perceived ability to undertake a change can define the extent to which various kinds of innovations can be considered for introduction (Croxton and Appletion, 1984 cited by Steel, 1995). The relationship between education level and attitude towards land degradation is an empirical question as it provides farmers with the necessarily skills to establish and maintain investments in soil conservation. Some skills adoption however, is not necessary perfectly correlated with years of schooling (Machumu, 1995). For example, Senkondo *et al* (1998) found that adoption of rainwater harvesting technologies in Western Pare was not significantly explained by education level but rather by other factors such as experience in farming and perceived technological characteristics.

2.5.2.2.2 Farmers' Age

Age and experience of a farmer is likely to have a range of influences on the household decisions on adoption rate. Old age may, for example, influence the farmer in the direction of not adopting (Amir and Pannel, 1999). With regard to experience, Adesina and Baidu –Forson (1995) argue that older farmers may have experience in cultivation and more able to assess the characteristics of a modern technology than young farmers, therefore they will be in a better position to adopt. In their study, Senkondo *et al.* (1998) found that farmers with more experience in farming were able to adopt rainwater-harvesting technologies compared to those with less experience. Robberstad (1997) argues that old farmers are less likely to invest in soil conservation activities that are beyond their reasonable life expectancy. However, this can also be due to the fact that old people are generally conservative in character and cannot be expected to match with young people in the process of agricultural transformation. Due to inconsistency of findings about the relationship between age and innovativeness, Adesina and Baidu –Forson (1995) concluded that there is no agreement in the adoption literature concerning the effect of age on adoption rate as the effect of age on adoption rate tends to be location and technology specific.

2.6 Environmental, biological and institutional factors affecting crop production

Major factors affecting crop production in the tropics include climate (Mduruma, 1996), diseases and insect pests both in the field and during storage and poor soil fertility (Misangu, 1997). Other reasons include land management practices, farm size as a basis for yield increase and inefficient marketing system (Marandu *et al.*, 1988)

2.6.1 Climatic factors

Environmental characteristics are derived from the influence of nature (Machumu, 1995). CIMMYT (1993) observed that climatic factors play an obvious role in the management of farming systems. Rainfall patterns limit/enhance the crops that can be grown and regulate planting and harvesting schedule.

2.6.2 Soil management practices.

Research results obtained from a range of soils and climatic conditions indicate that the best method of soil erosion control is good soil and crop management (Lal, 1979). Preference is given to soil and crop management techniques that minimize run off through improvement in soil structure and water infiltration (Panabokke, 1977).

2.6.3 Farm size as a basis for yield increase

Yield has always been the most important issue to a farmer. Increasing the yield of crops can be achieved by either increasing frequency of cropping or by expanding farm size (Due *et al.*, 1985). Therefore, high yield is an incentive to crop promotion.

2.6.4 Marketing system

In general, raising farm productivity depends mainly upon the use of increased quantities of purchased inputs. The ability to purchase inputs, however, depends very much upon farmer's receipts from sales of farm products. This in turn is determined by an efficient marketing system linking rural supply and demand areas. If market channels are efficient, they will normally induce farmers to become more commercialized. As argued by Raju and Von Open (1980), access to efficient markets serves as an incentive for farmers to specialize in the production of certain crops which are comperatively advantageous for the area. In the absence of readily available markets for produced crops, farmers may experience problems with disposing of their produce (Mtenga, 1999).

2.7 Sustainable Land Conservation

Sustainable means continued production, at levels or above those of today, coupled with conservation of the natural resources on which that production depends. In brief: Sustainability =Production + Conservation (Young, 1990). In the past, the soil erosion problem was often looked at, from engineers' point of view and therefore land conservation was not closely linked with farming practices or agricultural production in general (Chinene *et al.*, 1994). Physical structures such as terraces and cut-off drains were considered to be the main land conservation measures. The idea was to solve erosion problem by safely draining water away from the affected land. However a new concept of sustainable land husbandry has recently been introduced. It is called sustainable land husbandry. Sustainable land husbandry aims at maintaining the land's productivity through good management of soil, water, vegetation and animals. Well-developed crops and other vegetation protect the soil from erosion. As most small-scale farmers produce crops, keep livestock and plant trees on their farms, advice on land conservation must include all these aspects. A good balance between crop and livestock production is a key to sustainable land conservation (Chinene *et al.*, 1994). The main goal should be improved agricultural production on sustainable basis like fodder crops growing on soil conservation structures (e.g. contours) and on parts of the farms that are not suitable for crops. The farmer then can harvest the fodder to feed animals and sell the excess to others. Further more, manure from productive stall- fed animals (zero grazed animals) can be applied to the farms to maintain fertility of the land. A wide choice of soil conservation measures suitable to different physical conditions and cultural practices is inevitable for a sound sustainable land conservation (Per, 1999).

The failure of many projects have been commonly attributed to political, economic, and social constraints that impinge upon the project from outside, for example bureaucratic inertia and confusion, lack of official commitment, political instability, constantly changing policies, chronic shortage of funds and poor infrastructure. Within the project framework, the technical, organizational, operational and institutional factors have been influencing the sustainability of land conservation projects (FAO, 1986):

(i) **Technical factors**: many land conservation projects develop techniques and approaches in advance, which are not robust and not well proven, and cannot be applied under the local circumstances in which the project is operating (Kerkhof, 1990).

(ii) **Operational factors:** Inadequate financial and logistical support, lack of incentives to project staff and beneficiaries, delays in the delivery of essential equipment and supplies, the bad ways of phasing out project inputs which do not help the beneficiaries to carry on the project initiative after donor assistance ceases. Lack of motivation of project staff and of beneficiaries have also contributed to failure of project benefits to be sustainable (Chitere and Mutiso, 1991). Lack of assessment of the recurrent costs can lead to failure of projects (Vespoor, 1993).

(iii) **Organizational factors**: Within the project framework, poor planning and design, poorly designed initial surveys, over ambitious objectives and time schedules, and high staff turnover are frequently cited as causes of project failure (Nkya, 1993). Lack of collaboration between beneficiaries and project staff has been obvious in some projects.

(iv) Institutional factors: The institutions involved in the project have to recruit and deploy sufficient manpower and financial resources to cover the recurrent costs of the project initiative (FAO, 1986). Some projects rely heavily on the local institutions (formal and informal) involved in the project to carry on the project's activities without a check on whether these institutions implement the project's plans or not. The sustainability of the project is influenced because, these institutions can organize, mobilize, support, exchange information or collect money from the community members contrary to the project's plans (Cleaver and Elson, 1995). Under this factor; failure of projects to be sustainable, has been greatly caused by the nature of the project itself, which particularly in weak institutional settings, generates a set of project dynamics which makes the project goal of capacity-building difficulty to achieve (Unesco Institute For Education, 1995). The dynamics of the project, which are determined in large part by the working relationships that develop between the different parties involved, are crucial determinants of a project's success, since normally the project has an organizational culture different from the host institutions.

CHAPTER THREE

3.0 STUDY AREA AND METHODOLOGY

3.1 Study area

3.1.1 Location

Arumeru District is located between latitudes $35^0\ 37^1$ to $35^0\ 47^1$ East and latitude $3^0 17^1$ to $3^0\ 27^1$ South. It borders Simanjiro District to the east, Hai District to the northwest, Kiteto District to the south, and Monduli District to the north (Fig 3). The District has 6 divisions, 32 wards and 133 villages.

3.1.2. Agroecological zones

Arumeru District has three agro-ecological zones namely:

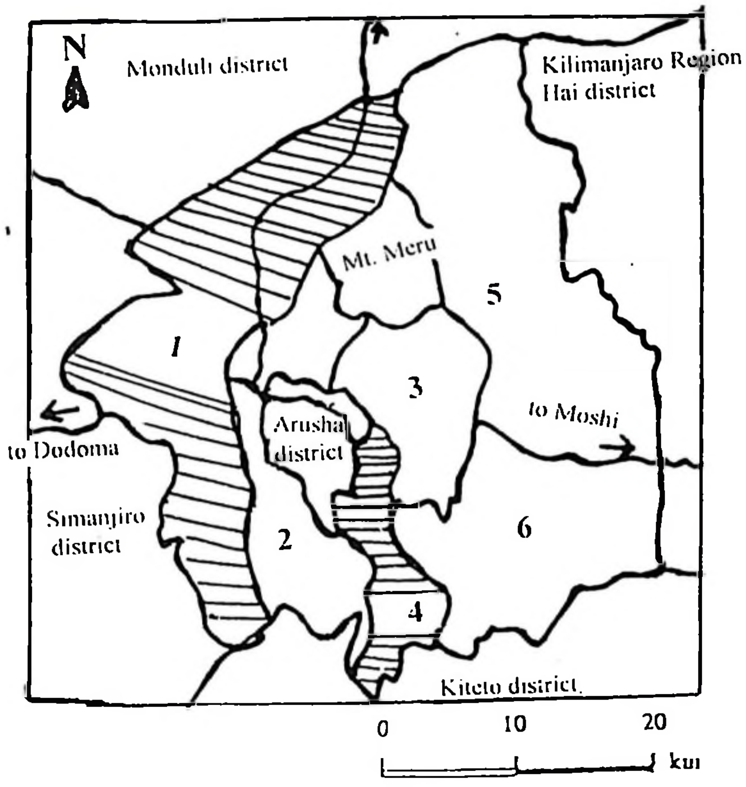
-The high potential areas;

-The medium potential areas and;

-The low potential areas.

3.1.2.1 High potential areas

The term 'high potential' is used to distinguish areas that, depending on characteristics of rainfall pattern, temperature and soil fertility, can be used for intensive agricultural production. The term 'highland' (normally a physically identified area recognized by altitude) is also commonly used to describe these fertile high potential mountainous areas. High potential areas are densely populated with volcanic ash nitosol soils moderately developed and bimodal rainfall ranging between 1000 and 1500mm per annum. The area has high



Divisions of Arumeru district:

1.Mukulat- Study division
2.Enaboishu
3.Poli
4.Moshono- Study division
5.Mbuguni
6.King'ori

Figure 3: A map of Arumeru district showing the study divisions.
Source: Adapted from Soil Conservation Notes, (1994).

altitude at 1500 or more metres above sea level (masl) on the eastern slopes of Mount Meru and is densely populated due to relatively fertile soils and higher levels of precipitation. Crops grown are mainly coffee, banana, fruits (avocado, citrus, pawpaw etc.). Animals kept are mainly exotic and mixed breeds of dairy cattle, which are stallfed because people living in these areas tend to concentrate on small family farms of about 0.8 ha (on average) and produce just enough food for consumption and very limited surplus for sale.

3.1.2.2 Medium potential areas

The term 'Medium potential areas refer to land resources with physical limitations for intensive small-scale farming as compared to the high potential areas. Crops grown are maize intercropped with beans, coffee, and banana with a semi extensive livestock system. Maize is an important crop in these areas, normally intercropped with beans. Coffee and surplus maize are grown for commercial purposes. Precipitation in this zone is slightly lower than that found in high potential areas and ranges between 800 and 1000 mm per annum. Soils in these areas are more brown, less leached and slightly more fertile than those in the low potential areas. Altitude ranges between 900 and 1500 masl, animals are mainly free- grazed and few are stall-fed.

3.1.2.3 Low potential areas

The term 'low potential' also commonly refer to 'lowlands' mainly plains surrounding the mountains. These lowland areas are relatively dry compared to the high and medium potential areas. The amount of rainfall is less than 800mm/annum.

It is normally erratic and bimodal (Nkonya *et al.*, 1991). Soils are similar throughout this area whereas the cropping and livestock patterns are also similar due to the relatively low precipitation. The soil is volcanic ash more developed than in high and medium potential areas (Cunard *et al.*, 1985) Maize is intercropped with beans, wheat and barley are grown in western areas. Livestock rearing is quite extensive and concentrates mainly in raising local breeds (zebu), with very few improved dairy cattle. Goats, sheep, donkeys and chicken are also kept. Soil erosion is quite pronounced due to vulnerability of the volcanic soils and rolling topography (Cunard *et al.*, 1985 and Nyaki, 1993)

3.1.3 Vegetation

Both indigenous and planted forests surround the steep slopes of Mount Meru. The southern sides of the steep slopes of Mount Meru have a well-developed montane forest belt, while the northern sides are mainly agricultural land or planted forests. In general, more than half of the district is cultivated and the rest is bush and open grasslands.

3.1.4 Population

According to the 1988 census, the population of Arumeru District is as follows:

Total: 321,604

Male: 159,194

Female: 162,410

Ratio of Male: Female is 1:1

Population growth rate is 3.06%

The dominant tribes are Wameru and Waarusha (Laizer, 2000).

3.1.5 Farming systems

The majority of small-scale farmers are practising mixed farming. Family labour is the main production manpower, although some farmers having relatively large farms are forced to hire labour. Coffee is the major cash crop in the district. Other crops in the highland include pyrethrum, sugar cane, bananas, potatoes, maize, fruits and vegetables, while the lowland zone to a large extent is grazing land. Crops produced in the lowland areas include mainly maize, beans, cassava, sorghum, pigeon peas, sweet potatoes, sunflower and wheat.

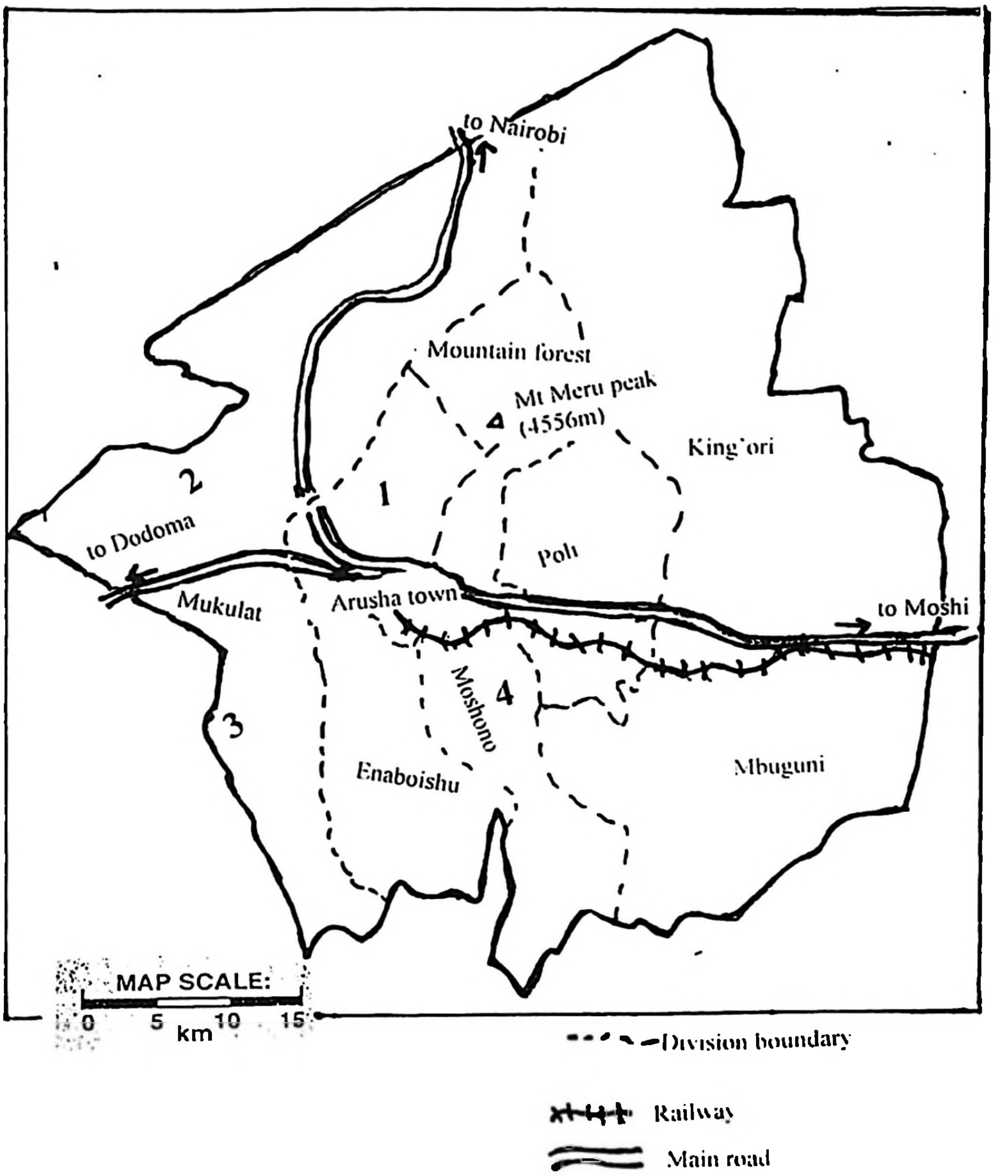
3.1.6 Study villages

The study was carried out in four villages namely Olchorovus, Oldonyosapuk, Ekenywa and Manyire (Fig 4).

3.1.6.1 Olchorovus

Olchorovus Village is located at 32 km from Arusha town. The village is accessible throughout the year. The total population of the village is 2073 among which 1023 are actively working adults, the rest being young, old or disabled. The main economic activities are agriculture and livestock keeping. Food crops grown are maize, beans and tobacco. The major soil type in the village is black soils. The land terrain is mostly hilly and with many gullies.

The inhabitants of the village are mainly Waarusha. The vegetation is planted and natural forests on the eastern side and agricultural land on the remaining sides.



Key:

1.Oldonyosapuk
2.Olchorovus
3.Ekenywa
4.Manyire

Figure 4: A map of Arumeru District showing the study villages.
Source: Compiled by Assmo and Korhonen with information from Land Use Planning and Soil Conservation Unit, Arusha (1992).

3.1.6.2 Oldonyosapuk

Oldonyosapuk Village is located at about 15km from Arusha town. The total population of the village is 2247 among which 1101 are actively working adults, the rest being young, odd or disabled. The main economic activities are agriculture, and indoor livestock keeping. Food crops grown are maize, beans, banana and round potatoes. The major soil type is volcanic. The inhabitants of the village are mainly Waarusha and few Wameru. The vegetation is planted forest on the northern sides and agricultural land on the remaining sides.

3.1.6.3 Ekenywa

Ekenywa Village is located at about 20 km from Arusha town along Arusha- Nairobi highway. The village is accessible throughout the year. According to 1998 population census the number of people were about 2910 people among whom 1200 were males, 740 females and 970 children. The main economic activities are agriculture and livestock keeping. Food crops grown are maize, beans while cash crop is wheat. The land terrain is undulating and the soil is mostly volcanic. The inhabitants of the village are Waarusha, Wameru and Wachagga. The vegetation is mainly agricultural land.

3.1.6.4 Manyire

Manyire Village is located on the southern side of the Livestock Training Institute (LITI) Tengeru about 32 km from Arusha town. The village is accessible throughout the year. The village has about 2284 people among whom 602 were females, 544 males and 1138 children. The vegetation is open grassland. The main economic activities are agriculture, livestock keeping and petty business. Food crops grown include maize, beans and round potatoes. The inhabitants of the village are mainly Waarusha, Wachagga, Wameru, and few Warangi.

3.2 Methodology

3.2.1 Study design

The study was carried out in two phases. Phase one involved carrying out reconnaissance survey and Participatory Rural Appraisal (PRA); while the second phase involved mainly questionnaire surveys. Reconnaissance survey was conducted in all the three agro- ecological zones of Arumeru District. The purpose was to get acquainted with the study area, select the study villages, pre- test the questionnaire, discuss the research proposal with SCAPA project officials and village leaders and build teams for the fieldwork.

3.2.2 Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) approach is essentially a process of learning about rural conditions in an intensive, interactive and expeditious manner (Mc Cracker *et al* 1988; Devavaram, 1992). Participatory Rural Appraisal techniques were used in Ekenywa, Oldonyosapuk, Olchorovus and Manyire in Mukulat and Moshono Divisions. Through PRA I met various stakeholders in the study villages including farmers, village leaders, village extension agents, women groups and religious leaders to name just a few. Methods used include resource mapping, wealth ranking, venn diagramming and time lines. These methods were applied to help participants evaluate their own situation. (Mearns *et al.*, 1992; 1994).

3.2.3 Questionnaire survey

Questionnaire survey was done during the second phase of the study to pursue major issues identified during reconnaissance survey and PRA. Other tools used included checklists and participant observations. Data were collected using structured questionnaires (Appendix 1) with both open-ended and close-ended questions. The researcher and two-field assistants administered the questionnaire. The questionnaire was designed to provide answers on issues such as land holdings, indigenous based interventions, farm size, and tree planting.

Pretesting of the questionnaire was done during PRA exercises to check reliability and validity of the questions Most of the questions were responded and therefore very little modifications were made to the original questions. In closed or forced questions, a number of alternative answers were provided while in open- ended questions respondents were required to give their own answers (Appendix 1).

3.2.4 Sampling intensity

The sample unit of the study was the household. In this study a household is defined as a group of people who eat from a common pot. They usually share a dwelling houses and may cultivate the same land. They recognize the authority of one person, the household head who is the ultimate decision- maker for the household (Poate and Daplyn, 1988 as cited by Kajembe, 1994). Simple random technique was used to select the sampling units. According to this method every individual has an equal chance of being selected. Each member of the universe sampled is listed once in the sampling frame (Liwenga, 1995). Out of 41 villages where land conservation measures are being instituted, 10% of the villages (equivalent to 4 villages) were randomly selected by use of random numbers.

3.2.5 Allocation of sampling units

SCAPA is addressing land conservation in all three agro-ecological zones. There are 41 villages practising land conservation. In the high potential areas, there are 7 villages. In the medium potential areas there are 9 villages, and in the low potential areas there are 25 villages.

For a given number of sampling units, allocation to each agro-ecological zone (stratum) was done by proportional allocation.

$ni = p_i n$, but $p_i = Ni/N$

Where p_i = proportion of stratum area to total area.

ni = number of sampling units for the ith stratum

Total number of villages = 41 given as 7:9:25

- For high potential area $ni = \frac{7}{41} \times 4$ (The number of sampling unit needed)
  $= 0.682 \approx 1$ village
- For medium potential area $ni = \frac{9}{41} \times 4 = 0.878 \approx 1$ village
- For low potential area, $ni = \frac{25}{41} \times 4 = 2.43 = 2$ villages

Total = 4 villages

3.2.6 Selection of sample households

A Random sampling procedure was employed in picking out the households. According to Boyd *et al.* (1981) for a random sample to be representative it should at least constitute 5% of the total population. By use of random number, 5% of households (an average of 21 households in a village) were randomly selected from village registers. In total, 84 households out of 1,680 households in the sampled villages were interviewed.

3.2.7 Checklist

A checklist was used to collect information from key informants. A key informant is an individual who is accessible, willing to talk and has great depth of knowledge about issues in question. Key informants are not only members of the clientele, but are most often informed outsiders (Mettrick, 1993). For this study an open-ended discussion was made with the District Agricultural and Livestock Development Officer, District Forest Officer, Ward Extension Officers, Village Extension Officers, and Village Executive Officers (Appendix 2).

3.2.8 Participant observation

Participant observation as the name implies, is distinguished by the fact that the observer himself/herself forms part of the situation he/she is studying. Much information can be obtained simply by observing what goes on. What farmers say and what they do may not necessarily coincide; they may sometimes report the standard practice in the neighbourhood rather than what they themselves do. Observing operations in the field gives an opportunity to discuss with the farmer what, why and how things are done. It is always essential to keep one's eye open when visiting the farm and to check what you are told against what you see

(Mettrick, 1993). Curiosity, willingness to learn from other people and ability to adapt to their rhythm and life style (Martin, 1995) were the main tools used.

In this study, the method of participant observation was primarily used to tie together the more discrete elements of data gathered by other methods. Thus, an iterative process between participant observation and other research methods evolved. The other methods allowed aspects of life in the study area to be isolated and studied out of context of the community life. Participant observation permitted these elements to be examined within the context of the social system. At times, this resulted into a more complete understanding of both the individual elements and the whole. In other situations, new questions about life in the study area emerged.

3.3 Data analysis

3.3.1 Descriptive and inferential statistics

Data collected by using PRA techniques in phase one were analyzed with the help of the communities and the results were communicated back to them. Data collected in phase two were analyzed by using both quantitative and qualitative methods. The Statistical Package for Social Sciences (SPSS) was the main tool used to analyze the quantitative data.

In using SPSS, the variables were summarized and coded. Most of the analysis with the quantitative data falled under the domain of "descriptive statistics". The function of the second domain "inferential statistics" was to provide an idea about whether the patterns described in samples were likely to apply in the population from which the samples were drawn (de Vaus, 1986). In this regard, cross tabulation, and logistic regression analyses were employed.

Cross tabulation is both a powerful way of communicating information and the commonest form of data presentation (Casey and Kumar, 1988). Logistic regression is useful for situations in which one wants to predict the presence or absence of a characteristic or outcome based on values of a set of predictor variables. It is similar to a linear regression model but is suited to models where the dependent variable is dichotomous. Independent variable can be interval or categorical. Logistic regression coefficients can be used to estimate odds ratios for each of the independent variable in the model. Logistic regression is applicable to a broader range of research situations than discriminant analysis.

Logistic regression models were estimated using the household survey data. The models estimate the probability that a farmer do practise intercropping, contour making, ploughing in crop residues, application of farmyard manure and tree planting as conservation interventions for land degradation and grow maize and beans.

The general model used in logistic regression was:

$$\text{Prob}\ (event) = \frac{1}{1+e^{z}}$$

The probability not occurring was estimated as:

Prob.(no *event*) = 1-Prob(*event*)

$$Z_i = B_0+B_1X_1+B_2X_2+\ldots\ldots\ldots\ldots\ldots\ldots B_pX_p$$

Where,

Z_i = the ith observed value of the key conservation interventions (ploughing in crop residues, intercropping and tree planting) or crop yields (maize and bean yields)

X_i = Independent variables such as ....for i=1 to p

B_o =Intercept

B_i =Coefficient estimates for i =1 to p

e = the base logarithms, approximately 2.718.

i =1,2,3,................................p

The specific hypotheses tested were:

H_0: b=0; (Meaning that there is no correlation between key conservation interventions or crop yields (dependent variables) and socio-economic factors (independent variables)

against

H_1: b≠0; (Meaning that there is positive or negative correlation between key conservation interventions or crop yields (dependent variables) and socio- economic factors (independent variables)

A two -tailed t-test at 0.05, 0.01 and 0.1 levels of significance were used to test the hypotheses implying that Ho: was rejected only where P< 0.05. In this study the Wald statistics was used to explain the influence of different socio- economic factors on key conservation interventions or crop yields.

3.3.2 Content and Structural –Functional Analysis

Content and Structural – Functional analysis techniques were used to analyze qualitative data and information. The components of the verbal discussion held with key informants were analyzed in detail with the help of content analysis method. In this way the recorded dialogue with respondents was broken down into the smallest meaningful units of information or themes and tendencies. These helped the researcher in ascertaining values and attitudes of the respondents. Structural – Functional analysis sort to explain social facts by the way in which they relate to each other within the social system and to the physical surrounding. This type of analysis helped the researcher to distinguish between manifest and latent functions. Manifest functions are 'those consequences which are intended and recognized by the actors in a system'. Latent functions are 'those consequences which are neither intended nor recognized' (Thomlison, 1965 as cited by Kajembe and Luoga, 1996).

CHAPTER FOUR

4.0. RESULTS AND DISCUSSION

4.1. Historical background of land degradation in Arumeru District.

The problem of land degradation in Arumeru District started in the highlands of Mount Meru and then extended to the lowland areas of the District. The study revealed that about 70.0 percent of the respondents in all the study villages perceived the rate of land degradation being rather severe. This realization has come after the local communities in the study area have faced shortage of arable land, pasture and water for quite sometime (Per, 1999). Their responses are summarized in Table 1.

Table 1: Distribution of respondents by their perception on the rate of land degradation in historical perspectives

Perception	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Severe	20	23.8	11	13.1	18	21.4	10	11.9	59	70.2
Slightly severe	1	1.2	10	11.9	3	3.6	11	13.1	25	29.8
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

The historical time with regard to land degradation in the district can be divided into three periods, namely: the colonial era; the independence era; and the present era.

The colonial era represents the time before Tanganyika (Tanzania mainland) got her independence. As early as in the 1930s the British Colonial Authorities recognized soil erosion to be a problem and therefore imposed restrictions on cultivation above 500 masl on Mount Meru to protect the forest areas, and introduced the construction of terraces on sloping farm lands (Spear, 1997). The colonial authority's main efforts to reduce problems of soil erosion and increase farm production were, however, concentrated to large- scale farming on lower altitudes around the mountain. The small- scale farmers perceived such conservation practices as unsuitable for the diversified small- scale farming systems practised on the mountain. Terracing as advocated by the colonial authorities was therefore rarely implemented among the small- scale farmers living further up on the mountain slopes (Per, 1999).

Issues of utilization and conservation of land resources at the time of independence were delicate issues in the Arumeru District and often seen with skepticism by the local population. The suspicion that the local population had towards the authorities meant that the Tanzanian administration held a low priority on issues of land use in these fertile coffee producing areas around Mount Meru (Japhet *et al.*, 1967). Instead, issues of land use and soil conservation largely focused on the surrounding lowland areas. Generally speaking efforts to preserve land resources in Arumeru District, as well as in other parts of Tanzania, were often not as successful as predicted (Spear, 1997). One reason for this situation was related to the farmers skepticism of soil conservation activities imposed by the colonial government, coupled with a technical top down oriented approach that had limited or non existent involvement of the local population.

One such example can be seen in the lowlands around the Kisongo area located on the undulating lowlands South of Mount Meru in the Arumeru District. In the 1970s in order to reduce the problems of soil erosion in this area, extension staff implemented schemes of constructing terraces and planting trees using machinery. The involvement of the local population in the process was almost non existent. The interest or concern for terracing the land by the local community was therefore quite limited. Consequently, constructed terraces were not maintained, and animals grazed the planted trees. Within a short period, most of the constructed terraces were destroyed and the planted trees killed. Today, only traces of these terraces can be found in the area (Per, 1999).

In the present era, starting from the mid 1980s, the Arusha Regional administration stressed that problems of land degradation were not only a problem in the lowland areas of the region, but also in the highlands of Mount Meru. Signs of erosion and degradation of land resources were becoming a problem also in the fertile highland areas due to population pressure, which forced small- scale farmers to clear environmentally fragile areas for cultivation. In turn, these farming practices tended to activate degradation process and eroding the land resources. According to Massao (1993), it is estimated that over 500 hectares of forest on the slopes of Mount Meru were cut or burnt in 1990 indicating the severity of forest depletion. As noted by Ahlback (1988) this is regarded as a major problem since the natural and planted forests on Mount Meru serve an extremely important function regarding soil protection and regulating water flows from the mountanous areas.

Furthermore, apart from the intensive crop production on the upper slopes of the mountain, the Arumeru District contains large herds of livestock mostly concentrated in the low potential areas surrounding Mount Meru. Based on the available livestock statistics and the study by Semu *et al.* (1992) Arumeru District has an overstocking rate exceeding 70%. Overgrazing, arising from overstocking and poor management of grazing lands, thereby causing severe erosion in the lowland areas of the district.

4.2. Adoption rate of indigenous based interventions

The extent of adoption was estimated by requesting the respondents to indicate whether they were using the interventions introduced by the SCAPA project. The interventions examined included contour making, intercropping, tree planting, ploughing in crop residues and application of farmyard manure.

Most of the farmers in the study area had experienced land degradation; this raised the question as to what interventions they normally applied in order to conserve the land against degradation. Their responses are summarized in table 2. The key indigenous based interventions mentioned included intercropping, ploughing in crop residue and tree planting.

4.2.1. Intercropping

Table 2 shows that about 86.0 percent of the respondents had adopted intercropping and, about 14.0 percent grew crops in pure stands. These findings suggest that intercropping was the most used farming practice in the study
villages than monocropping. These findings agree with those of Adesina and

Table 2: Adoption rate of indigenous based interventions

Interventions	Adopters	Non adopters	Total	Ranking with reference to adoption
Contour making	45.2	54.8	100.0	4
Intercropping	85.7	14.3	100.0	2
Tree planting	90.5	9.5	100.0	1
Ploughing in crop residues	69.0	31.0	100.0	3
Application of farm yard manure	36.9	63.1	100.0	5

Source: Survey results, 2001

Zinnah, (1993); and Adesina and Baidu - Forson, (1995), that adoption or rejection of technologies by farmers may reflect rational decision making based upon farmers' perceptions of the appropriateness (inappropriateness) of the technologies under investigation. Chartterjee *et al.* (1989) also reported that intercropping provides economic benefits to the farmer against falling prices of one commodity and minimizing the risk of crop failure.

4.2.2. Ploughing in crop residues

Table 2 shows that 69 percent of the respondents had adopted this practice whereas 31 percent of the respondents are non-adopters. The plausible explanation for this relatively low adoption could be that data for this study were collected during the dry season, the critical time for livestock feeds, hence it was possible that crop residues were fed to livestock. The study by Mollel *et al.* (1993) showed that crop residues are an important source of feed during dry season.

4.2.3. Application of farmyard manure

Table 2 shows that about 37.0 percent of the respondents had adopted application of farmyard manure and about 63.0 percent of the respondents were non-adopters. This finding shows that application of farmyard manure had a low rate of adoption by farmers in the study area. Table 3 shows that application of farmyard manure was not closely associated with respondent's source of income. People who depend on livestock as a source of income are many in the study area and therefore are expected to use higher amount of farmyard manure in their farms.

This result is contrary to that of Davies *et al.* (1982) who reported that the use of farmyard manure increases with the ownership of livestock. The unexpected relationship between use of manure and livestock ownership was explained by Gabriel (1998) that one of the major reasons for under utilization of animal manure for crop production is lack of technical know how by most farmers. This is also to a large extent due to lack of scientific basis for advising farmers on aspects such as application rates, storage techniques and appropriate manure application methods.

Table 3: Distribution of respondents by source of Income

Activity	Olchorovus		Oldonyosapu		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Business	-	-	-	-	1	1.2	7	3.6	4	4.7
Crop/ livestock	6	7.1	-	-	2	2.4	7	8.3	15	17.9
Crop/livestock/trees	9	13.1	21	25	9	13	7	8.3	50	59.5
Crop/livestock/business	4	4.8	-	-	7	8.4	5	4.8	15	17.9
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

4.2.4. Contour making

Table 2 shows that about 45.0 percent of the respondents had adopted contour making and about 55 percent of the respondents are non-adopters. The results suggest that contour making had low rate of adoption by farmers. Similar results were reported by Holden *et al.*, (1996) that smallholder farmers who are in most cases resource poor tend to avoid risk associated with adoption of new technologies. According to Hudson (1987), the slow rate of adoption of what appear to be a satisfactory new method or the poor adoption of new conservation techniques is the inability of the subsistence farmers to take risks. Farmers will not adopt technologies without economic incentives (Pawlick, 1989). This means that new technologies must have some advantages over the existing ones.

4.2.5 Tree planting

Table 2 shows that 90.5 percent of the respondents had adopted tree planting. Trees are planted around farm boundaries, homesteads, and in woodlots. The common sources of seedlings in the study area were SCAPA and individual nurseries (Table 4). The free of charge availability of seedlings from SCAPA could explain why many people have engaged themselves on tree planting. Trees are the major long-term crops grown by the villagers, and they are grown for many reasons including woodfuel, timber, fruits, poles, fodder and soil erosion control. Tree species mostly prefered in the study villages includes: *Leucaena leucocephala*, *Leucaena diversifolia*, *Sesbania sesban* and *Calliandra calothyrus*. Other tree species include *Markhamia lutea*, *Eucalyptus species* . *Grevillea robusta* and *Senna siamea*. Fruit trees include *Carica papaya*, *Mangifera indica*, *Psidium guajava*, *Citrus limon and*

Citrus sinensis. Other tree species that are used in the study area are *Acacia species and Casuarina species.*

Table 4: Source of seedlings

Source	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Individual nurseries	2	2.4	5	5.9	2	2.4	-	-	10	10.7
Purchase	1	1.2	1	1.2	2	2.4	-	-	6.	4.8
Organization	2	2.4	-	-	5	5.9	-	-	5	83
SCAPA	16	19.0	15	17.9	12	14.3	21	25	64	76.2
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

4.3. Socio- economic factors affecting adoption of indigenous based interventions

Logistic regression analysis equations were developed to depict influences of socio economic factors on the key indigenous based interventions. The key indigenous based interventions were chosen on the basis of those adopted by more than 50 percent of the sampled population (Table 2). These are intercropping (85.7%), ploughing in crop residues (69%) and tree planting (90.5%). The minor indigenous based interventions are those adopted by less than 50 percent of the sampled population. These are contour making (45.2%), and application of farmyard manure (36.9%).

The results of the three logistic regression models on the factors influencing adoption of the key indigenous based interventions are presented in Table 5.

Table 5: Logistic models for factors influencing farmers' decision to adopt indigenous based interventions

Independent variable	Intercropping	Ploughing in crop residues	Tree planting
Gender	0.396 (0.565)ns	-1.628 (2.11)ns	0.760 (2.052)ns
Household size	-0.210 (0.073)ns	-1.778 (2.919)ns	0.384 (0.259)ns
Farmers' age	1.868 (3.549)*	1.605 (2.200)ns	-0.884 (1.379)ns
Education level	-0.681 (1.592)ns	-1.165 (3.694)*	-0.163 (0.096)ns
Land size	0.419 (0.862)ns	0.833 (2.806)ns	0.183 (0.138)ns
Land ownership	0.910 (3.760)***	0.121 (0.790)ns	0.697 (3.463)*
Marital status	0.610 (0.508)ns	0.327 (0.281)ns	0.206 (0.365)ns
Extension contacts	1.501 (5.170)**	1.150 (3.670)***	1.241 (4.230)**
Income	0.231 (0.881)ns	0.050 (1.151)ns	0.070 (0.682)ns
Constant	-1.512 (2.776)ns	-7.290 (5.622)**	-0.844 (1.381)

-2 log likelihood 81.83	-2 log likelihood 145.11	-2 log likelihood 91.49
Goodness of fit 72.38	Goodness of fit 52.9	Goodness of fit 98.45
Overall classification 75.45	Overall classifications 82.40	Overall classification 71.21
Number of cases 84	Number of cases 84	Number of cases 84

Note: values in the parentheses are wald statistics

*= Significant at 0.1 level

**= Significant at 0.05 level

*** = Significant at 0.01 level

ns = Not significant

The high likelihood of the observed results indicated that the models were reliable and the results shows that in overall the cases were correctly classified in intercropping, ploughing in crop residues, and tree planting adoption models respectively, suggesting that the models fitted the data well. Variables found to have a significant effect on the probability of adoption of indigenous based interventions are farmers' age, education level, land ownership and frequencies of contact with extension services. Variables that had no significant effect on probability of adoption are gender, household size, land size, marital status and income of the farmer.

4.3.1 Farmers' age

The coefficient associated with the age of the farmer is significant at 0.1 level for intercropping (Table 5). However, many researchers including Mbata (1997) found it difficult to classify this variable as to whether it influences probability of adoption negatively or positively. This study assumed the variable to have a positive influence on probability of intercropping. This result implies that older farmers are opportunistic in trying new technologies than young farmers because they have more experience, resources and authority. Table 6 shows that the majority of the farmers about 58.0 percent on aggregate, are aged above 41 years and hence are considered old.

4.3.2 Education level

The coefficient associated with education level is negative but significant at 0.1 level for ploughing in crop residues (Table 5). The results suggest that farmers

Table 6: Distribution of respondents by age

Age (years)	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
< 25	4	5.9	2	2.4	3	3.6	2	2.4	12	14.3
25 - 40	5	7.2	7	8.3	8	9.5	2	2.4	23	27.4
> 41	10	11.9	12	14.3	10	11.9	17	20.2	49	58.3
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

who had higher education have lower probability of ploughing in crop residues as an intervention on land conservation than those with low or no formal education.

Figure 5 show that there was quite a high rate of literacy (i.e. people who can read and write) in the study area. On aggregate about 63.0 % of respondents had attained primary and secondary education.

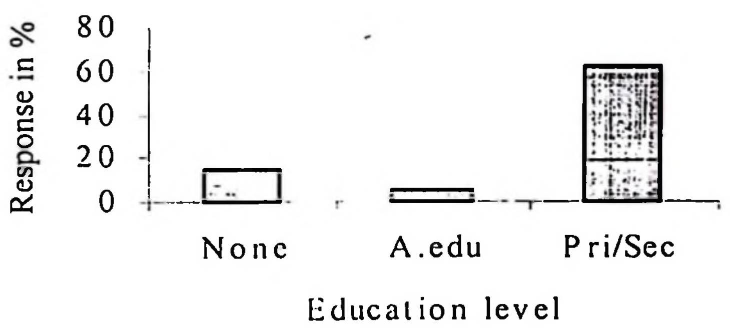


Figure 5: Distribution of respondents by education level

Source: Survey results, 2001

Key: A.edu =Adult education;

Pri/Sec=Primary and Secondary education

4.3.3. Land ownership

The coefficient of ownership of land had expected priori sign and was found to be significant at 0.1 and 0.01 levels for tree planting and for doing intercropping respectively, but had no significant influence on the probability of adoption of ploughing in crop residues (Table5).

The implication of this is that land tenure or ownership of land was very important for farmers in the study area in their decision to adopt different interventions for land conservation. This finding is in line with other findings by Anim, (1999) and Stahl (1991) and Loiske,(1991) cited by Lundgren *et al.*, (1993) that farmers cultivating on their own land were characterized by a high probability of investment in various, practices of soil conservation. Figure 6 shows that the majority of farmers, about 82.0% on aggregate had private ownership of land obtained through purchasing, inheritance and allocation by the village governments.

4.3.4. Frequency of extension contacts

Frequencies of extension contacts were found statistically significant at 0.05 and 0.01 levels for intercropping, tree planting and ploughing in crop residues respectively (Table 5). From these results one can say that extension service in the study area was the most important factor, which influenced the probability of adoption of indigenous based interventions on land conservation. For farmers to adopt a technology they

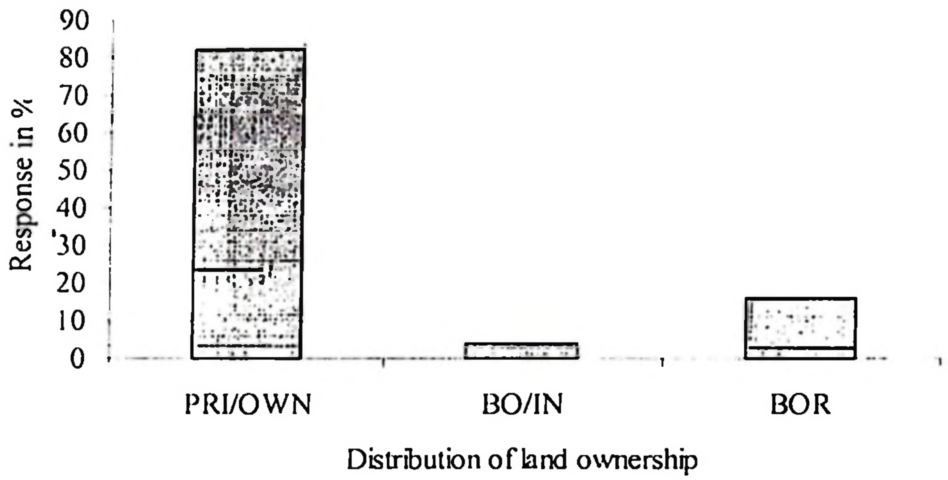


Figure 6:Distribution of land ownership

Source: Survey results, 2001

Key: PRI/OWN=Private ownership

BO/IN=Bought/Inherited; BOR=Borrowed

must first know about it. For that matter, extension is the most important source of information. Extension contacts are expected to increase farmers' knowledge and hence improve production. Farmers also obtain information from other sources including other farmers. Given that the extension service is charged with the responsibility of extending information on new technologies, the high rate of contacts with farmers may be acting as a motive for the use of technologies.

This finding is in line with that by Nowak (1983); and Pampel (1977) which showed that exposure to extension programmes is important for the farmer to develop interest, and in some cases, to have access to the technologies required to adopt the practices. Table 7 shows that the majority of farmers; about 86.0 percent on aggregate, had extension contacts.

Table: 7 Distribution of respondents by extension contact

Extension contact	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Have extension	16	20.2	21	25	14	16.7	20	23.8	72	85.7
No extension	4	4.8	-	-	7	8.3	1	1.2	12	14.3
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

4.4. Impact of indigenous based interventions

The impact of indigenous based interventions was looked under three headings. These include:

Impacts of indigenous based interventions as perceived by the respondents;

Impacts of the key indigenous based interventions on key crops (maize and beans); and Impacts of the minor indigenous based interventions on key crops.

4.4.1. Impacts of the indigenous based interventions as perceived by local people

The impact of the indigenous based interventions was estimated by requesting the respondents to single out the main positive impacts, which have originated from the SCAPA project. Their responses are summarized in Table 8.

In overall, the interventions are said to have eased - up farm operations and contributed towards increased crop yields, improved soil conservation and increased income. The results in Table 8 shows that 55.9 percent of the respondents indicated improved crop yield; 60.7 percent of the respondents reported improved soil conservation; and 58.3 percent of the respondents

Table 8: Impact of indigenous based interventions as perceived by the local people

Impact	Number	Percentage
Improved crop yield	47	55.9
Improved soil conservation	51	60.7
Increased income	49	58.3

Source: Survey results, 2001

indicated increased income. Kashuliza *et al*., (1995) reported improved crop yield and improved soil conservation through practices introduced by Farming System Research (FSR) Project. Project interventions produce environmental and social impacts, which can be positive or negative. It is an accepted fact in the literature that these impacts are difficult to identify and quantify despite the numerous attempts to address the problem (Hufschmidt *et al*.. 1983; Dixon *et al*.. 1986; and Sodebaum, 1990). As a guide to decision-makers a verbal description of the environmental and social impact associated with the project intervention is advocated.

4.4.2 Impact of the key indigenous based interventions on key crops

4.4.2.1 Intercropping

Table 9 shows that 50.0 percent of the respondents had intercropped maize and beans whereas 35.7 percent of respondents reported to intercrop maize, beans and trees and 14.3 percent of the respondents reported to grow crops in pure stands.

The coefficient associated with intercropping is positive (Table 10) and significant at 0.05 level for yield performance of maize.

Table 9: Cropping systems in the study villages.

Cropping system	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Maize	1	1.2	2	2.4	1	1.2	-	-	4	4.8
Beans	-	-	-	-	-	-	-	-	-	-
Maize +beans	10	11.9	9	10.7	11	13.1	12	14.3	42	50.0
Maize, beans + trees	8	9.5	7	8.3	5	7.1	9	10.7	30	35.7
Irish potato	-	-	3	3.6	-	-	-	-	3	3.6
Wheat	2	2.4	-	-	3	3.6	-	-	5	5.9
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

The common practice in the study villages is the combination of beans and maize (Table 9). Intercropping with tree species was also common in the study area. Beans are normally grown under intercropping system, and the practice of associated cropping is very common in areas with land shortage due to dense human population (Mkenda, 1997). This indicates that the probability of yield performance of maize was higher in farms with much intercropping.

Table 10: Key interventions affecting yield performance of maize and beans in the study area.

Independent variable	Yield performance of maize	Yield performance of beans
Intercropping	1.250 (4.280)**	1.176 (0.329) ns
Ploughing in crop residues	-1.369 (0.319) ns	1.216 (1.554) ns
Tree planting	0.230 (0.870) ns	0.120 (2.200) ns

Source: Source: Survey results, 2001

This result is contrary to Ndakidemi' *et al.*, argument's that planting maize in association with beans had no significant effect on maize yield (Ndakidemi *et al.*, 1996).

The significance of intercropping in the study villages is in line with the study by Gilley *et al.*, (1999) which indicated that intercropped crops can influence the microclimate and yield potential of adjacent crops. He also pointed out that, a well-managed intercropping system could result in profitability and greater soil and water conservation potential than most monocropping operations.

4.4.2.2. Ploughing in crop residues.

Table 2 shows that 69 percent of the respondents had adopted ploughing in crop residues in their farms. However, under a logistic regression model (Table 10) the results were not significant. These results is contrary to those of Muchlig- Versen *et al.*, (1997) which showed that, leaving crop residues in the field is a way of increasing yield and replenish soil nutrients levels. Lamers and Bruentrup (1996), studied the use of crop residues in West Africa, found that the highest gross margin returns to land was mulching with crop residues. A plausible explanation for this interesting observation was that by FAO, (1990) and Van Schoubreak, (1991), that adoption of new technologies does not always produce the desired effects.

4.4. 2.3. Tree planting

Table 2 shows that about 90.0 percent of the respondents had adopted tree planting. However, tree planting had no significant effect in the yield performance of crops (Table 10). The plausible explanation could be that there is reduction of output of food crops where trees compete for use for arable land and or depress crop yields through shade and root competition (Nair, 1989). Another plausible explanation could be that, the incompatibility of trees and agricultural crops due to allelopathic effects either of trees on crops or vice versa (Lulandala, 1994). Furthermore, it can be argued that the presence of tree vegetation on the land management unit may attract pests and diseases that can in turn cause problems to the associated crops (Lulandala, 1994). The study by Kerkhof (1990) showed that trees compete with adjacent crops for light and soils nutrients.

4.4.3. Impact of the minor interventions on key crops

4.4.3.1 Contour making

Table 2 shows that 45.2 and 54.8 percent of the respondents were adopters and non-adopters of contour making respectively. The above findings suggest that contour making had a low rate of adoption less than 50 percent and had no impact on the yield of maize and beans. Bernstein *et al.*, (1992), pointed out that in order to have impact; projects must have developed and released technologies that have been adopted by a large proportion of producers/ consumers, and the adopted technologies must have resulted in an improvement that can be measured/ quantified.

4.4.3.2. Application of farmyard manure

Results in table 2 show that 36.9 percent of the respondents applied farmyard manure. 63.1 percent of the respondents were non-adopters of this intervention. The results suggest that application of farmyard manure had low rate of adoption. This could be explained by the fact that farmers in the study area applied very little amount of manure due to lack of means of transport. Similar results were also reported by Kimbi *et al.*, (1992) that very little amount of animal manure is being utilized for crop production in most parts of the country. Kyomo *et al.*, (1983) argue that most of the studies on utilization of animal manure for crop production in Tanzania have largely focused on crop yield responses of various field crops with very little effort in relating such responses to availability of nutrients. Efficient utilization of animal manure requires thorough understanding of the relationship between crop responses and availability of nutrients in the soil following animal manure application.

4.5 Socio-economic factors affecting yield performance of maize and beans in the study area

Table 11 shows the summary statistics for the logistic model analysis. Six of the eleven parameters included in the alternative performance model were significant.

Use of maximum likelihood approach yielded parameter estimates that are asymptotically efficient and consistent. Parameter estimates were evaluated at the 0.01, 0.05 and 0.10 significant levels. Crops were chosen on the basis of those grown by more than 50 percent of the sampled population (Figure 7). These are maize (92%) and beans (78 %).

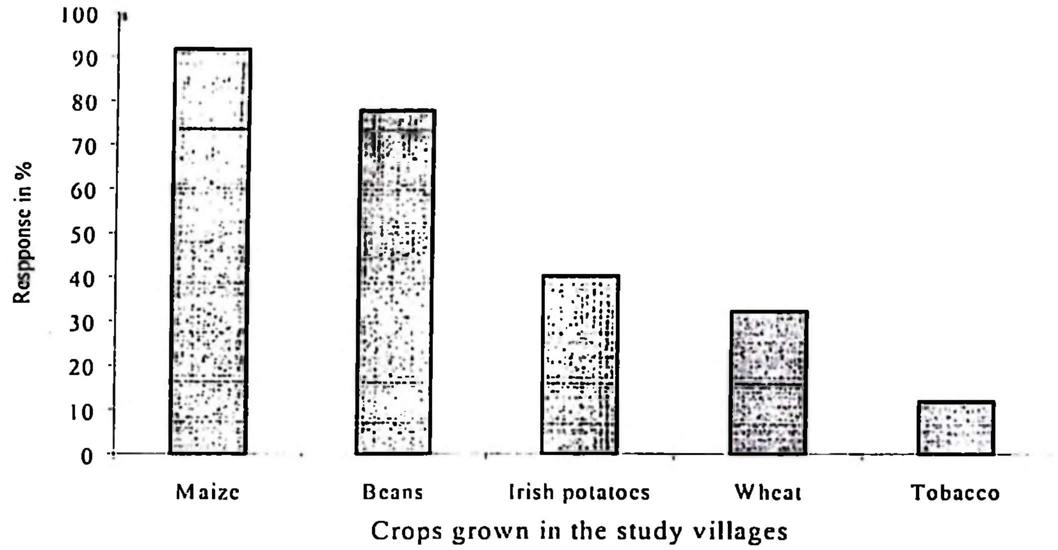


Figure 7:Key crops grown in the study villages

Source: Survey results, 2001

4.5.1. Land size

The coefficient of land size as a variable had expected priori sign and was found to be significant at 0.05 level of confidence with a positive relationship with yield performance of maize (table 11). These findings are in line with other findings by Akinola, (1987) and Hossain (1988) that land size is an indication of level of economic resources available to farmers and the probability that a farmer would get better yield increases as land size increases. Figure 8 shows that the majority of farmers, 62.0 percent on aggregate had land size above 4.0 ha.

Table 11: A logistic models for socio- economic factors affecting yield performance of maize and beans in the study area

Independent variable	Yield performance of maize	Yield performance of beans
Farmers' age	1.601 (6.160)**	0.670 (4.907)**
Income	4.4 (1.624)ns	0.569 (1.020)ns
Land size	0.760 (6.623)**	1.821 (2.620)ns
Input use	2.571 (2.469)ns	0.572 (0.346)ns
Market	1.241 (4.230)**	1.272 (3.268)**
Climatic factors	0.810 (3.871)***	0.2134 (3.061)**
Extension	-0.056 (4.132)**	-1.436 (4.932)**
Constant	-5.290 (3.621)**	-1.030 (0.460)ns

Source: Survey results, 2001

-2log likelihood 92.68	-2log likelihood 105. 244
Goodness of fit 95.45	Goodness of fit 86.93
Overall classification 79.72	Overall classification 70.70
Number of cases 84	Number of cases 84

Note: values in the parentheses are Wald statistics

*= Significant at 0.1 level

** = Significant at 0.05 level

*** = Significant at 0.01 level

ns = Not significant

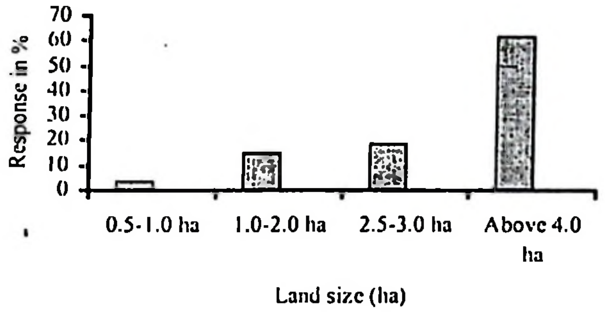


Figure 8: Distribution of land size in the study villages

Source: Survey results, 2001

4.5.2. Farmers' age

Table 11 shows that the coefficient associated with age of the farmers is positive and significant at 0.05 level for yield performance of maize and beans. This indicates that yield performance of maize and beans were higher to farmers who are old than young farmers. This is expected because the majority of farmers who are old were growing maize and beans. Adesina and Baidu - Forson (1995) argue that old farmers may have experience in cultivation and more able to assess the characteristics of a modern technology than young farmers, therefore they are in a better position of adopting the technology and getting high yield. Figure 9 shows that the majority of farmers who are old, above forty-one years have satisfactory yield of maize that is from 5 bags to above 25 bags per hectare (SCAPA, 1997)

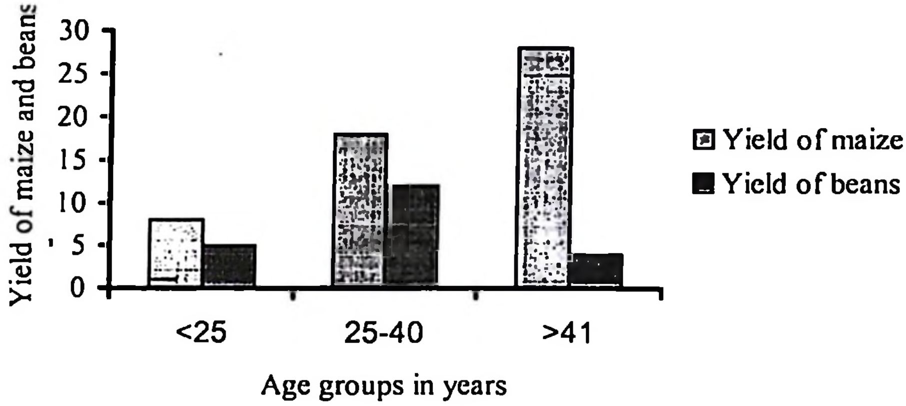


Figure 9: Distribution of respondents by yield performance and age group

Source: Survey results, 2001

4.5.3. Frequency of extension contacts

The unexpected negative relationship between extension contacts and dependent variables (Table 11) is a challenge in this study because as discussed earlier in section 2.5.2.1.1, extension contacts are expected to increase farmers' knowledge and hence improve production. However, observations show that not all farmers adopt whatever extension officers recommend. Some do not adopt because of lack of resources, ignorance and some are just rigid. It is also possible that some extension messages are not properly delivered or are delivered at the wrong time, and place. On the other hand the negative sign may be related to the prevalent inefficiencies in the extension channels in Tanzania, as it has not succeeded in educating farmers on the use of improved varieties and adoption of new practices for land conservation (Mattee, 1994).

4.5 4. Climatic factors

The coefficient associated with climatic factors was positive and significant at 0.01 and 0.05 for yield performance of maize and beans respectively (Table 11). This indicates that climate had a higher probability for increase in yield performance of maize and beans. This is in line with CIMMYT (1993) results that climatic factors play a significant role in the management of farming systems. Rainfall patterns limit/enhance the crops that can be grown and regulate planting and harvesting schedule.

4.5.5 Market

The coefficient associated with market was positive and significant at 0.05 levels of significance for yield performance of maize and beans (Table 11). The results suggest that good markets for the produce had higher probability for increasing yield of maize and beans. Raju *et al.*, (1980) argues that access to efficient markets serve as an incentive for farmers to specialize in the production of certain crops which are comparatively advantageous.

4.6 Sustainability of indigenous based interventions

The sustainability of the indigenous based interventions were determined by asking the respondents about their opinions. Respondents mentioned some factors thought to influence sustainability of the interventions. These include:

- Awareness on land husbandry and land conservation;
- Presence of by- laws; enforcing land conservation;
- The use of local resources for land conservation;

- Integration of crops, livestock and trees;
- Capacity building of staff, paraprofessionals, and farmers.

4.6.1. Awareness on land husbandry and land conservation.

The result of the survey shows that 100 percent of the respondents are aware of the land husbandry and environmental conservation. Awareness of the people about the project helped SCAPA to achieve its objectives. Many farmers adopted the interventions that SCAPA project is disseminating. The level of awareness has increased tremendously among the farming communities. According to Sharma (1992), designing strategies around specific social actors, and constructing or strengthening groups require at least two key elements:

(i). Awareness of the project activities;

(ii). Tangible economic incentives and benefits to the social actors.

The study showed that a greater proportion of the respondents, 79.8 percent indicated that there was close collaboration and trustfulness between project officials and the villagers. This is in line with what Kerkhof (1990) pointed out that the Village Afforestation Programme in Kondoa District, Dodoma Region was successful in its initial phases because of collaboration and trustfulness with farmers. Reynold *et al., (1988)* reported that the long term sustainability of a farming system depend upon awareness and acceptance by the farming community. Table 12 shows the distribution of respondents by degree of collaboration.

Table12: Distribution of respondents by degree of collaboration

Degree of collaboration	Number and % of respondents									
	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Good	18	21.4	18	21.4	10	11.9	21	25	67	79.8
Poor	3	3.6	3	3.6	11	13.1	-	-	17	20.2
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

4.6.2. Presence of by- laws enforcing land conservation practices

The study villages were found to have laid down by- laws that restricted villagers from doing activities that destroy the environment. These by- laws restrict villagers in four important issues: free grazing of livestock in the crop fields; cultivating and grazing on conserved areas; cutting trees haphazardly and starting up unauthorized fires. Table 13 shows that 83.3 percent of the respondents are aware of the existence of these by-laws and awareness of the by- laws varied between villages.

Respondents were also asked to show if the by laws were effective in controlling the environment. Table 14 shows that 52.3 percent of the respondents reported that the by- laws are effective while the rest 47.7 percent indicated that they are ineffective.

Table 13: Respondents awareness of the by- laws.

Awareness	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Yes	14	17.9	19	25	15	17.9	19	22.6	70	83.3
No	6	7.1	-	-	6	7.1	2	2.4	14	16.7
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

Table 14: Response of farmers on the effectiveness of the by- laws.

Effectiveness	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Effective	4	4.8	21	25	8	9.5	11	13.1	44	52.3
Ineffective	17	20.2	-	-	13	15.5	10	11.9	40	47.7
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

Individuals who are convicted for destroying the environment are normally sent to the village office where they are fined. The maximum fine is ten thousand shillings (Tshs. 10000.00). Out of this, two thousand shillings (Tshs. 2000.00) go to the village government fund, three thousand shillings (Tshs.3000.00) remain with the environment committee, four thousand shillings (Tshs. 4000.00) is given to the person whose farm was destroyed and the remaining one thousand shillings (Tshs.

1000.00) is given to the person who apprehends the culprit as a motivation for the job well done.

Informal discussion with some villagers revealed that there were problems of inconsistency in administering the fines paid by the convicted individuals. Inconsistency involved the culprits not paying the fines or paying less than what is specified because of fear to jeopardize the good relationship that existed amongst themselves. Kelly (1982), reported that there is inconsistency in administering the local institutions to meet the needs of individuals and the community because of economic instability, change in the structure of the family, village and tribal organizations.

4.6.3. The use of local resources for land conservation

The study revealed that the majority of the respondents 84.5 percent use the locally available resources for preparing and conserving the land. The locally available resources for conserving the lands include: maize straw, beans stover, grass mulch and locally available seed varieties. This implies that they do not depend entirely on donor - assistance to get the resources in implementing conservation activities. This implies that, the ability of the farmers' economy to sustain further development from their own resources is very substantial. This complies with what was reported by UNESCO- Institute for Education (1995) that, the productivity of assistance over short period could be measured by the increase in output resulting from the fuller use of domestic resources.

The locally available resources for managing the land include hand hoes, sickles, brachetes, and of oxens. Most of the agronomic activities such as weeding and sowing were done by hand hoe. This was also reported by Portch *et al.,.(* 1980); Blustain,(1982) and Rogers, (1983) that simple inexpensive landscape management methods may be more appropriate and effective in sustaining productivity. According to FAO (1986) the development initiative must be suitable for conditions in the localities served. Results in figure 10 show that 84.5 percent of the respondents indicated using locally available tools.

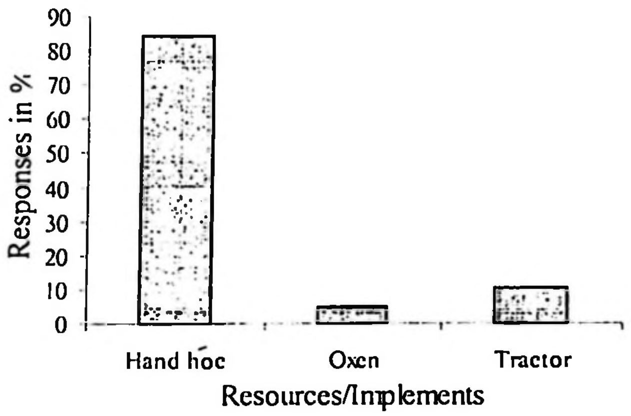


Figure 10: Distribution of respondents by the use of local resources

Source: Survey results, 2001

4.6.4. Integration of crops, livestock and trees

Table 3 shows that about 60.0 percent of the respondents had integrated crops, livestock and trees on the same field as an important aspect of sustainability. The same was also reported by Mphuru (1991) that, in developing research priorities, integration of crop, livestock and agric- silvi- pastoral systems should be considered. This system ensures a high soil protection against agents of erosion and gives high degree of nutrients recycling, thus enabling the production system to remain sustainable for a long time. Reynold *et al.*, (1988) also reported that the integration has the potential of raising sustainable yields of crops and livestock.

4.6.5 Capacity building of staff, paraprofessionals. and farmers

Table 15 show that 71.4 percent of the respondents have been provided with basic training on soil and water management. Hence the majority of the farmers have skills and knowledge of conserving the environment with minimal support from extension staff. Furthermore, the presence of village soil conservation committees (VSCC) was observed in the survey villages. The major reasons of having these committees are to ensure active participation of farmers in planning, implementation and sustaining of programme achievements (SCAPA, 1997).

The study also revealed that about 73 percent of the respondents (table 16) use the handbook "Guidelines for Soil Conservation and Agroforestry" (Mwongozo wa Hifadhi ya Ardhi na Kilimo Mseto). This is very important as far as farmers' learning ability is concerned. The same was also reported by Lugeye (1994) that, the use of Extension Training Manuals is very important in building the capacity of the farmer. The use of paraprofessionals was also noted to be one of the most outstanding and peculiar approaches used by SCAPA project. Paraprofessionals are important in training large numbers of farmers in Arumeru District, which could not be done by the regular extension services.

Table 15: Distribution of respondents by basic training attendance

Training	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Yes	12	14.3	18	21.4	15	17.9	15	17.9	60	71.4
No	9	10.7	3	3.6	6	7.1	6	17.9	24	28.6
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

Table 16: Distribution of respondents on whether they are using the Guidelines.

Guidelines	Olchorovus		Oldonyosapuk		Ekenywa		Manyire		Total	
	N	%	N	%	N	%	N	%	N	%
Yes	12	15.5	19	22.7	12	14.3	17	20.2	61	72.6
No	8	9.5	2	2.3	9	10.7	4	4.8	23	27.4
Total	21	25.0	21	25.0	21	25.0	21	25.0	84	100.0

Source: Survey results, 2001

Use of the farmers (paraprofessionals) to teach other farmers was noted to be one of the best approaches to ensure sustainability because they are most familiar with their environment therefore their advices and comments are easily accepted by the local people. Similar results were reported by Turuka (2000) that paraprofessionals are instrumental in training farmers, and is one of the mechanisms for ensuring sustainability.

SCAPA, (1997) indicated that a total of 683 extension staff, 300 ward and village leaders and 10, 878 farmers were already provided with basic training on soil and water management since 1989 to 1997.

4.7 Major constraints in implementing indigenous based interventions

The major constraints faced by farmers are summarized in figure 11.The constraints include:

4.7.1 Cost of inputs

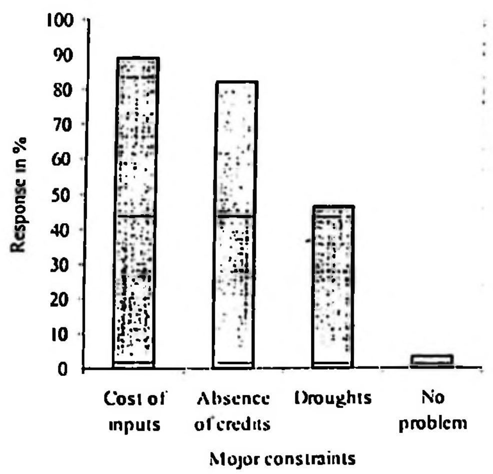


Figure11: Distribution of respondents by their reported major constraints in Implementing indigenous based interventions on land conservation

Source: Survey results, 2001

Figure 11 shows that 89.3 percent of the respondents faced the problem of expensive and unavailability of inputs. Most of the respondents have no purchasing power for buying inputs such as improved seed, inorganic fertilizer and pesticides. This is the reason why most farmers are engaged in indigenous based interventions.

Byerlee and Heisey (1992) argue that farmers may be aware of the benefits associated with the adoption of technologies (e.g. improved seeds) however, if the technologies are not easily available at a price they can afford the farmers will not adopt the technology (Figure 12). The farmers may need to be convinced that the benefits would far outweigh the costs involved. One of the methods used to create a more favourable farmers' response to modernizing agriculture is to subsidize the cost of inputs, thereby giving the farmer a better net return for his produce (Bot, 1979). However, the Tanzania government has removed subsidies that could help farmers to reduce the cost of production. Figure12 shows that 59. 5 percent of the respondents had annual estimated income range of Tshs 100,000.00 – 200,000.00.

4.7.2 Absence of credits

Figure 11 shows that 82.1 percent of the respondents mentioned unaccessibility to credit. The result suggests that the use of inputs in the survey areas was very limited due to unaccessibility to credit, low level of income (Figure 12) and low level of investment. Similar results were reported by MOA (1993) that small farmers in the vast majority of developing countries are caught in a vicious circle of low level of income, low investment in improved technology, and low level of agricultural productivity. Unaccessibility to credit is perhaps one of the most critical factors which impede peasant agricultural production.

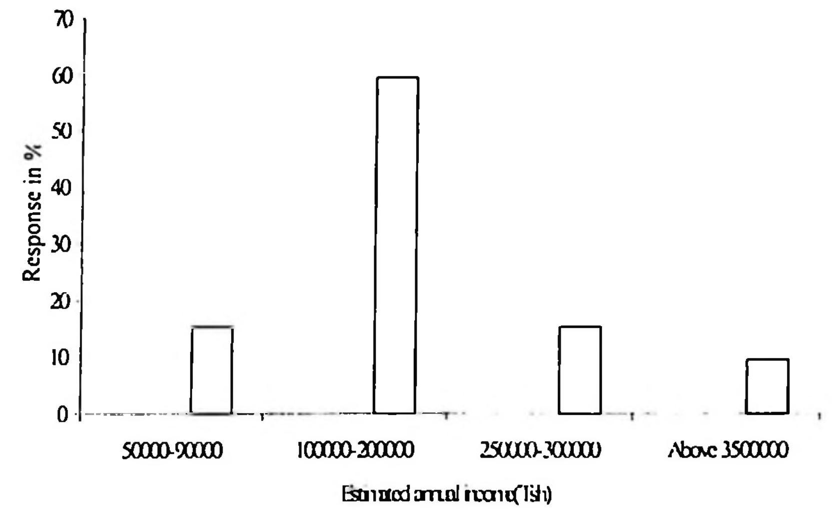


Figure 12:Disrtribution of respondents by their estimated annual income

Source: Survey results, 2001

4.7.3 Drought

Figure 11 shows that 46.4 percent of respondents face the problems of drought. Farmers in Olchorovus and Ekenywa villages mostly mentioned this problem. These areas are relatively dry compared to the other two villages (Oldonyosapuk and Manyire). Nkonya *et al.*, (1991) reported that drought remains the most important technical problem in these areas. 3.6 percent of respondents mentioned no problem in implementing indigenous based interventions.

4.8 Suggestions by respondents on how to conserve the land sustainably and improve production

Table 17 shows that 76.2 percent of respondents said that the use of farmyard manure is insignificant.

Table 17: Suggestions on how to conserve the land sustainably and improve production

Activities	N	%
Use of farm yard manure	64	76.2
Restrict animal movements	40	47.7
Training on Improved pasture	54	64.3
No suggestion	11	13.1

Source: Survey, results, 2001

Reasons mentioned for the low use of farmyard manure are lack of equipment like wheelbarrows to transport the manure to the fields and the other reason is negligence. People argued that the use of farmyard manure could improve production, at the same time conserving the environment. Mollel (1993) argued that farmyard manure has been used as fertilizer for centuries and is useful and environmentally sound.

About 48 percent of the respondents suggested that animal movements should be restricted. The project was advised to intervene and enforce by laws to conserve the land, so that they could be implemented effectively. About 64 percent of the respondents suggested the need for more training on improved pastures and reserved hay for feeding animals especially during periods of droughts.

Similar results were also reported by Douglass (1993) that improved pasture is a practical and profitable way for farmers to improve the surface conditions of their soil, maintain organic matter levels and improve animals' feeds.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

This study examined the impact of indigenous based interventions on land conservation in Arumeru District where it was introduced to restore soil fertility and prevent land degradation due to deforestation, overgrazing and inappropriate farming practices.

The results showed that the rate of land degradation was perceived by respondents to be rather severe. Results of the study also showed that interventions, which require minimal labour or minimal capital intensive, have been highly adopted by farmers while high labour/capital intensive ones have only been taken up by few farmers. In the overall, the interventions are said to have ease up farm operations and contributed towards increased crop yield and improved land conservation.

Success in some of the interventions warrants wider promotion of the practices beyond the project area. The logistic model showed that extension contact was the most important factor that influenced probability of adoption of indigenous based interventions on land conservation. Other factors include: farmers' age, education level and land ownership. The results also suggest that the important factors influencing the yield of maize and beans which are the main crops in the study area include: farm size, farmers' age, frequency of extension contacts, climatic factors, soil management practice (intercropping) and accessibility to markets.

The major constraints facing the farmers in the study area include high costs of inputs, absence of credits and drought.

5.2 Recommendations

Farmers have multiple objectives that are interlinked; therefore there should be a study by interdisciplinary team on their needs and priorities. The results of the study should be used to produce development plans that incorporate land conservation as an important aspect in development.

The study revealed that SCAPA has contributed positively towards land conservation in the area through indigenous based interventions. Indigenous based intervention ease up farm operations, contributed towards increased crop yield, and improved land conservation. Farmers in neighbouring districts can be encouraged to adopt indigenous based interventions through visiting neighbouring villages, which practices the interventions.

Furthermore, in order to find lasting solutions to the problem of land degradation in the country, an examination of the causes of misuse of land is very essential. The causes of land misuse range from inappropriate land tenure systems to lack of farm inputs. Solutions may mean changing agricultural policies: The agricultural policy should be reviewed especially the aspect of cost of inputs and absence of credits. The cost of inputs should be subsidized so as to give the farmer a better net return for his produce. The policy should also allows the farmer to have access to credit to make them have high level of income and hence high investment in agricultural productivity.

Introducing new technologies or even reallocating farmers to new lands in Tanzania where there is no population pressure.

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APPENDICES

APPENDIX 1

HOUSE HOLD QUESTIONNAIRE

Village ....

Date ....

Enumerator ....

Household No. ....

1. HOUSEHOLD DATA.

1.1 Name of the household head ....

1.2 Gender

1.Male

2. Female

1.3 Marital status.

1. Single

2. Married

3. Divorced

4. Window

1.4 Age of the household head .... Years

1.5 Household composition.

AGE	MALE	FEMALE
< 25 years		
25-40 years		
> 41 years		

1.6 Level of Education of respondent

1. None
2. Adult education
3. Standard IV
4. Standard V-Sec Education

1.7 Major source of income ....

1.8 Estimated annual income ....

2. LAND USE SYTEMS

2.1 How is land ownership?

1.Communal

2. Private

3 Other (specify)

2.1.2 Total agricultural land owned ....

Number of plots.....................

2.1.3 How did you acquire the land you own?

(1) Bought

(2) Borrowed

(3) Inherited

(4) Allocated by the government

(5) Other (specify)

2.2 Do you plant trees in your own land?

(1) Yes.......

(2) (No)......

2.2.1 Where do you plant trees?...........

2.2.2 Since when did you start planting trees...........year

2.2.3 Where do you get seedlings from (specify)?

1. SCAPA ....

2. Individual nurseries ....

3. Purchase ....

4. Organization ....

5. Other............................

2.2.4 Reasons for planting trees ....

2.2.5 Do you own livestock ?

1. Yes ....

2. No ....

2.2.6 If yes what type of livestock do you keep and their number?

1. Cattle, shoats, pigs, donkey ....no......................

2. Cattle only .... no...................

3. Sheep only ……………. no…………………

4. Goat only ……………….. no…………………

5. Donkey only ……………. no…………………

6. Others (specify) ………….. no…………………

2.2.7 How do you graze your livestock?

1. Zero grazing

2. Free range grazing

2.2.8 If free range grazing, where do you graze your livestock?

1. In the public grazing land ……………..

2. Own farm land …………………..

3. Others (specify) ………………………

2.2.9 Which crops do you grow?

1. ………………………………..

2. ………………………………..

3. ………………………………

4. ………………………………

2.3 How do you plant your crops?…………………………

…………………………………………………………

2.3 .1 What is the productivity/hectare?

1……………………………………

2……………………………………

3……………………………………

4……………………………………

2.3.2 What are the factors affecting crop production?....:.......................................

....

3.0 INDIGENOUS BASED INTERVENTIONS AND THEIR ROLE ON LAND CONSERVATION

3.1 Are you aware of indigenous based interventions, which are used in conserving the land?

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

3.1.1 If yes, which interventions among the following?

1.Intercropping........

2.Contour ploughing...........................

3.Application of farmyard manure........................

4.Ploughing in crop residues..................................

5.Tree planting...

.3.1.2 What are the impact of thefollowing.

1. Improved crop yield.........................
2. Improved soil conservation.................
3. Increased income...............................
4. Simplified farm operations................................
5. Improved plant vigour and crop quality......................

6. Others.......................................

3.1.3 Do you think that the indigenous based interventions are sustainable?

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

....

3.1.4 What are the reasons for the answer above?

....

....

3.2 Apart from these interventions mentioned above, do you have any extra interventions, which are used on land conservation?

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

3.2.1 What are they?...

3.3 What are the most limiting factors in implementing the indigenous based interventions on land conservation?..

....

4.0 COMMUNITY PARTICIPATION IN CONSERVATION

4.1 When did the project start?

Month.................. Year...............................

4.2 What is the aim of the project?

1. Improve and increase agricultural production basis through land conservation
2. Formulate a suitable integrated soil conservation extension package of rural development
3. To control soil erosion
4. Provide sites for training and demonstration of soil conservation practices
5. Others (specify)..

4.3 What is your perception on the rate of land degradation?...........................

....

4.4 Have you installed contour edges on your farm?

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

4.4.1 How many contours do you have...

4.4.2 Do you have further suggestion on how to conserve the land sustainably and improve production.?...

....

4.4.3 Are there any institutions for safeguarding the land?

1.Yes..........................

2. No..........................

4.4.4 If yes, what are they?

1...

2...

3...

4.4.5 What is your opinion about the progress of this project?

1. Successful.

2. Unsuccessful.

4.4.6 Do you have extension services in your village?

1. Yes..............................

2. No..............................

4.4.7 What type of extension package(s) are delivered ?

....

....

APPENDIX 2

Checklist for key informants

1. Village leaders

1.1 Brief history of the village

1.2 The composition of the village

1.3 Formal and informal institutions in the village

1.4 The role of these institutions towards land conservation

1.5 Awareness of the villagers towards land conservation

1.6 Impact of SCAPA on the village

1.7 Methods used in conservation of land resources

1.8 The role of the community in land conservation

1.9 Benefits of land conservation to villagers

1.10 Relationship with SCAPA

1.11 Suggestions to improve management of land resources.

2.0 The SCAPA staff

2.1 Management objectives

2.3 Management problems and their underlying causes

2.4 Strategies to improve management

2.5 Achievements/problems of the project

2.6 Land legislation and rules

2.7 Suggestions for improving SCAPA

3.0 Agricultural, livestock, Natural resources officers

3.1 Their role in land conservation

3.2 Relationship with SCAPA

3.3 Any other comments/remarks