IMPACT OF VALLEY BOTTOM CULTIVATION (*VINYUNGU*) ON POVERTY ALLEVIATION IN MTITU RIVER BASIN, KILOLO DISTRICT, IRINGA, TANZANIA

BY

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ABSTRACT

The study on contribution of valley bottom cultivation (*vinyungu)* to poverty alleviation in Mtitu River Basin in Kilolo District was conducted in order to examine the role of this type of agriculture to rural livelihood. This type of agriculture has been practiced over many decades. In Mtitu River Basin almost all valley bottoms are used by small farmers who practice farming in lowlands, usually called *vinyungu*, a type of farming practiced in dry season. Tanzania Government has been restricting agricultural activities that are carried along rivers, in catchments and in all valley bottoms, but still many areas of this type are used for agricultural activities. The specific objectives of this study were: (i) To investigate agricultural activities in Mtitu river Basin, (ii) to examine the importance of valley bottom cultivation (*vinyungu*) to people's income, (iii) to examine why people prefer *vinyungu* and (iv) to assess the sustainability of valley bottom cultivation in the context of environmental conservation. Data were collected through structured, semi-structured questionnaires, Focused Group Discussion (FGD) and non-participatory observation. Purposive, stratified and simple random sampling were employed to obtain the respondents for *vinyung*u. These were eight villages with 15 respondents each village comprising a total of 120 respondents. Data processing and analysis were done at SUA using Statistical Package for Social Sciences computer software in conformity with the objective of the study. Research findings have revealed that contribution of valley bottom cultivation to income poverty in Mtitu River Basin in Kilolo District is beneficial to farmers when compared to upland farming. This is so because what the individual farmer earned per year was large as compared to cash income obtained from upland farming. In order to make *vinyungu* sustainable as a form of agriculture the farmers should follow all regulations set by the Kilolo District Council and the Rufiji Basin Water Office in Iringa.

DECLARATION

I, KYANDO FABIAN ELIAS, do hereby declare to the Senate of Sokoine University of Agriculture that the work presented here is my own, and has not been submitted for a higher degree in any other University.

_____ _____

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The above declaration confirmed by

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Prof. Z. S. K. Mvena Date

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DEDICATION

To my father Elias Nyosole Kyando and my late beloved mother Augusta Timu Luvanda who died in 1997 and laid the foundation of my education.

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DADP	District Agricultural Development Plan
DANIDA	Danish International Development Agency
DSI	Development Studies Institute
FGD	Focused Group Discussion
GDP	Gross Domestic Product
GRRCA	Great Ruaha River Catchment Area
ILFEMP	Institutional and Legal Framework for Environmental Management Project
MAFS	Ministry of Agriculture and Food Security
NEP	National Environmental Policy
PO-RALG	President's Office-Regional Administrative and Local Government
PRSP	Poverty Reduction Strategy Paper
RBWO	Rufiji Basin Water Office
SACCOS	Servings and Credit Co-Operatives Society
SAI	Support Africa International
SMUWC	Sustainable Management of the Usangu Wetlands and its Catchments
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
SSSA	Soil Science Society of America
SUA	Sokoine University of Agriculture
TAS	Tanzania Shillings
UNESCO	United Nations Educational, Scientific and Cultural Organization
URT	United Republic of Tanzania

VEO	Village Executive Officer/Village Extension Officer
VG	Village Government
WUA	Water Users Association
WUF	Water User Fees
WWF	World Wildlife Fund for Nature Conservation

CHAPTER ONE

INTRODUCTION

1.1 Background information

Mkavidanda and Kaswamila (2000) pointed out that traditional irrigation that utilizes natural moisture or water from either natural springs or river diversions has been increasingly practiced as a means of ensuring food security and income generation to smallholder farmers. In Iringa Region where the land is characterized by varied landforms and relatively high water table, valley bottom farming systems of *vinyungu* has been reported to supplement food and income generated from rain-fed farming. *Vinyungu* farming is a traditional farming system in Iringa Region practiced by smallholder farmers usually in valley bottoms or flood plains. Ideally, these areas are characteristically more moist areas for a long period of the year, allowing the cultivation of multiple annual crops.

The Mtitu River contributes large volume of water to Little Ruaha River, which then contributes 16 percent (84 percent contributed by Great Ruaha River and other rivers) of its water to Mtera Dam **(**RBWO, 2001). It is used in irrigation farms of paddy rice at Pawaga in Iringa, domestic water Supply in Iringa Municipality, fishing industry in Mtera dam that generates hydroelectric power and it facilitates many agricultural activities to livelihood of rural and urban dwellers in Iringa districts and beyond.

In the 1980s there had been a number of efforts in Tanzania to promote irrigation farming in order to increase food security. These efforts concentrated on small and large-scale irrigation schemes, which were often too mechanized and expensive for most Tanzanian farmers (Maganga, 1998). There is ample evidence that most of these schemes or projects

failed partly due to their poor management and environmental degradation such as sedimentation and Salinization.

Since 1993 there has been a decrease of water flow in the Little Ruaha River, a problem that is observed to be very critical during each year (usually from July to November). The consequence of decrease to river flow is associated with human activities taking place along the river, catchments and valley bottoms. Many farmers depend on their livelihood from these wetlands for income generation. Also it has been observed that during dry season agricultural activities shift from upland to lowlands. Different crops are grown along the river and valley bottoms in these valley bottoms.

There are a number of agricultural activities taking place in valley bottoms and along the river; these include farming of different crops and other commercial activities. Cultivation of paddy rice, maize, construction of bricks, irrigation activities, gardening, cutting of trees for firewood, charcoal burning, burning bricks to mention just a few (SMUWC, 2001). Valley bottoms are important landscapes and critical natural ecosystems that provide significant environmental and socio-economic benefits to humans (Roggeri, 1998; Silvius *et. al.*, 2000; Stuip *et. al.*, 2002). Because of their characteristics (example, heavy soils, thick vegetation – sometimes an extensive flat lands), wetlands function as sponges that store water (and nutrients) during the wet season and maintain base flow during the dry season (Dugan, 1990; Roggeri, 1995). Rich soils and high moisture holding capacity make valley bottoms particularly attractive for agriculture.

For many years farmers have used indigenous methods to cultivate the *vinyungu* to meet food security and livelihood needs without necessarily causing wetland degradation

(Adams, 1993; Banzi *et al.*, 1992; Erickson 1985; Roggeri, 1995; Scoones, 1991) defined here as human-induced wetland loss that causes the impairment of wetland functions (Ramsar Convention Bureau, 1990). The loss is usually associated with reasons ranging from growing human activities in and around the wetlands to ignorance on their livelihood value and/or the value for their long-term management.

In recent years, valley bottoms have come under extreme pressure as many have been converted to agriculture thus raising a concern over the sustainability of wetland cultivation (Dixon & Wood, 2003; Ringrose *et al.,* 1988). There is accumulating evidence that shows wetlands are being destroyed at an alarming rate in developing countries (Williams, 1991; Jensen *et. al.,* 1993; Jensen *et. al.,* 1995; Roggeri, 1995; Gravis and Kalburtji, 1998;, Munyati, 2000; Dixon & Wood, 2003; Liu *et al*., 2004; Wang *et al.,* 2006) and that failure to design sustainable programs to preserve them threatens their very existence.

This is true especially in tropical developing countries where wetlands are among the least protected ecosystems. This study focused on a traditional farming system called *vinyungu* in catchments and along river streams, common in valley bottom areas of Iringa region to determine how this farming system has evolved over time, what were the driving forces behind this evolution, and the impact on livelihoods of the population depending on these *vinyungu*.

1.2 Statement of the problem

Vinyungu have existed for long time in Iringa Region. Few studies have established in Kilolo District on socio-economic contribution of these valley bottoms to the livelihood of

the population that resides around them. Despite the growing awareness of valley bottom values and functions and consequences of human intervention to these values and functions, the issue of valley bottoms loss and degradation has received much less attention compared to other major environmental issues such as desertification and deforestation (Acreman and Hollis,1996). The study established the extent to which these *vinyungu* contribute towards the social and economic well being of the residents of Mtitu River Basin in Kilolo District

1.3 Objective of the study

1.3.1General objective

The general objective of this study was to investigate the contribution of *vinyungu* in alleviating income poverty to people's livelihood in Mtitu River Basin in Kilolo District.

1.3.2 Specific objectives

(i) To identify agricultural activities in Mtitu river Basin.

(ii) To examine the importance of valley bottom cultivation (*vinyungu*) to people's income.

(iii) To examine why people prefer valley bottom cultivation (*vinyungu* farming).

(iv) To assess the sustainability of valley bottom cultivation (*vinyungu* farming) in environmental conservation.

1.4 Research questions

(i) What kind of agricultural activities are carried out in Mtitu river Basin?

(ii) To what extend do people's income depend from valley bottom cultivation (*vinyungu* farming)?

(iii) Why farmers prefer valley bottom cultivation (*vinyungu* farming)?

(iv) Do farmers have knowledge on conservation of valley bottom cultivation?

1.5 Significance of the study

A large population in Mtitu River Basin depends on Little Ruaha River for livelihood. People rely on agricultural activities as their main economic importance for income generation as the means of poverty alleviation in terms of food and income.

Understanding the drainage and cultivated wetlands may encourage farmers to more sustainable practices so as to sustain their livelihoods. Previous studies in Tanzania have tended to focus on major wetlands that are mostly associated with activities of greater economic importance such as large-scale agriculture, transportation and fisheries (Pallela, 2000). Lema (1996) who studied *vinyungu* farming system and associated technologies reported that this system continues to receive little attention as it is largely considered a sidelined agricultural activity. Mkavidanda and Kwasamila (2001) looked at the role of *vinyungu* in poverty reduction and concluded that *vinyungu* are key factors in sustaining livelihoods and reducing poverty.

In contrast, this study focused on *vinyungu* farming system on a small setting and it looked at the effect of this practice from the landscape point of view and the extent of valley bottom cover change as a result of transformations in *vinyung*u farming. Quantitative knowledge on changes of land use, the extent of valley bottom conversion, and their economic and environment consequences may encourage best management practices that would sustain valley bottom benefits. This knowledge would also be useful for a better understanding of the relationships between human activities and observed environmental changes.

1.6 Hypotheses

Null hypothesis: There is no close relationship between people's income and cultivation of valley bottom in Mtitu River Basin.

Alternative hypothesis: There is close relationship between people's income and cultivation of valley bottom in Mtitu River Basin.

1.7 Definition of terms as used in the study

Vinyungu:	Is a Kiswahili version of the Hehe/Bena word *kinyungu* (singular) or *fyungu* (plural) which is the valley bottom dry period farming practices in farmers harness water from rivers and or springs to produce both food and cash crops at substance level using traditional irrigation techniques or are simply ridges or raised beds that are about 0.6 m high and 4-20 m wide with a cambered surface sloping down to the open drain on either side, (Majule & Mwalyosi, 2003) or v*inyungu* is a local term, which refers to farmlands or fields in valley bottoms or floodplains cultivated during the dry season utilizing natural moisture or water diverted from rivers/streams or harvested from rain to produce food and cash crops
Wetlands:	Collective term for ecosystem whose formation had been dominated by water and whose processes and characteristics are largely controlled by water
Agricultural bio-diversity:	Includes mixed agro-ecosystem, crop species, livestock and fish species, plants soil organisms in cultivated areas, biocontrol agents for crop and livestock, wild species, cultural and local knowledge of diversity.
Land:	Implies land cover, land use, farming systems, biodiversity and

	fisheries.
Livestock:	Implies livestock numbers, range carrying capacity, range conditions.
Irrigation:	Implies irrigation water systems, irrigation efficiency and community irrigation management. Or any process other than natural precipitation which supplies water crops, orchards, grass or any other cultivated plants (Stern, 1989).
Community:	Implies rural areas (sub-villages, villages and rural districts) understanding of local resources management and rural livelihood.
Biodiversity:	The total variability within and among species of all living organisms and their habitat.
Ecosystem:	An ecological system formed by the interaction of a community of organisms with their physical environment.

1.8 Conceptual framework

It is generally accepted that a farmer is constrained by a number of social, political and environmental factors. There must be favourable condition in order to ensure that agricultural production is undertaken at a profitable scale and in a sustainable manner. In this study, a *vinyungu* farmer is trying to maximize vegetable and crop production in order to raise income.

A challenge in analyzing land-use/cover change lies in linking the driving forces of change to the observed land-use/cover changes. There is a considerable variety of theoretical and modeling frameworks and tools that are used to conceptualize land-use issues in wetlands. This includes theories on social and economic determinants of land-use/cover change and use of tools that are either descriptive or explanatory (Briassoulis, 2000). According to Briassoulis (2000) “description of land-use changes from one type of land use or cover to

another over a given time period and within a given spatial entity" while "explanatory attempts to address the question of 'why' these changes have occurred (or, are occurring) and to uncover the factors or forces that bring about these changes directly or indirectly, in short or in a long run."

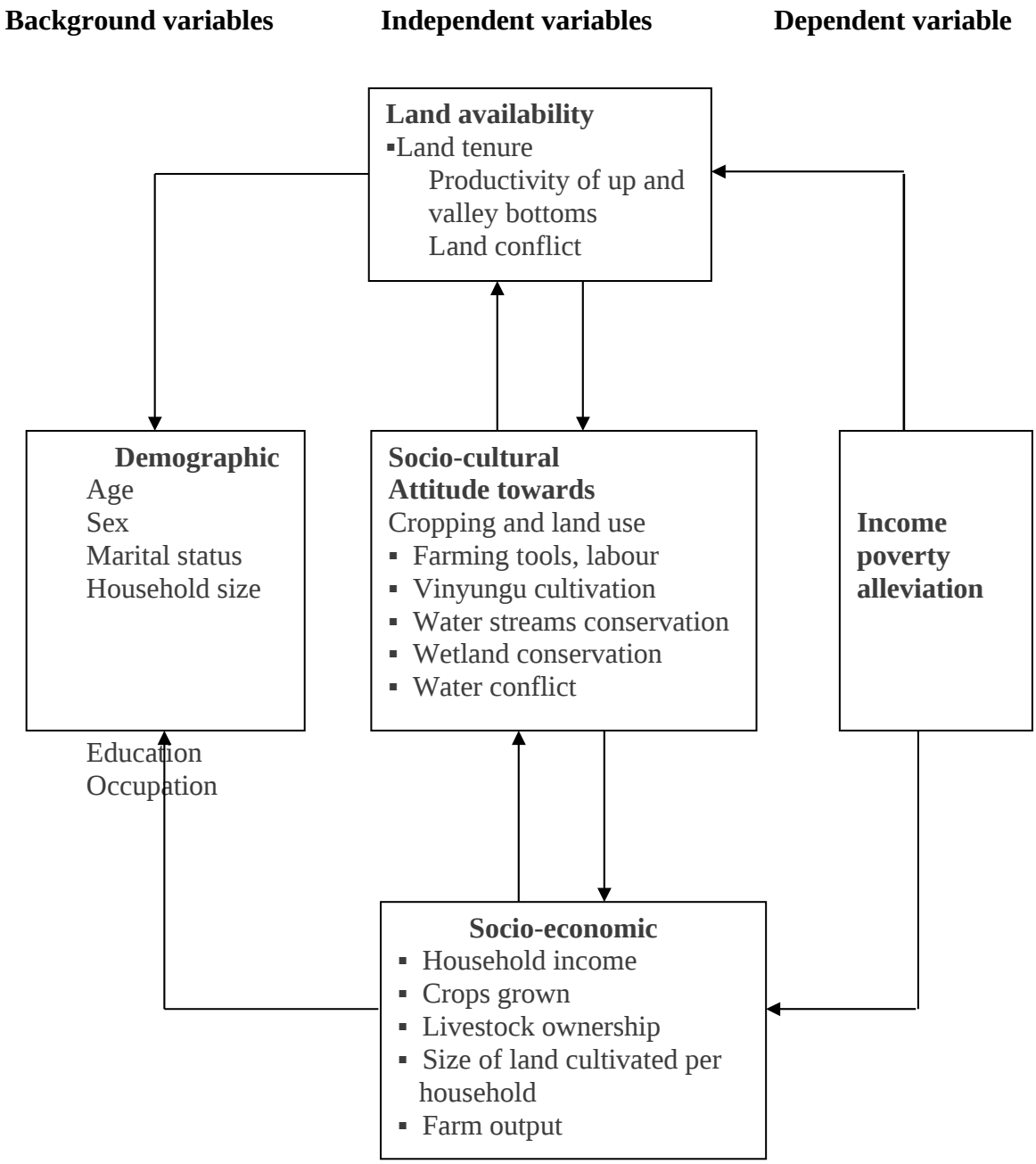

Figure 1: The interrelationship among different factors that affects wetland farming, (*vinyungu*)

Vinyungu farming is practiced in valley bottoms and due to intensive cultivation, *vinyungu* face a number of problems including over cultivation of land resource, intensive application of both chemical fertilizers and pesticides, intensive and unplanned use of water resource and conflicts particularly in land and water use/distribution. Land and

water degradation is also a serious problem in valley bottoms due to poor management of these resources. A sustainable production and profits from *vinyungu* farming, therefore, depends on how different factors are integrated together in the figure above.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

In this chapter the literature on the contribution of valley bottom cultivation (*vinyungu*) in income poverty alleviation at the household level is reviewed. First, the history of *vinyungu* in Iringa Region and its definition are outlined followed by contribution of *vinyungu* to rural livelihood, irrigation systems in Tanzania, conserving and secondly sustaining agricultural biodiversity due to valley bottom cultivation and water policy for *vinyungu* farming is discussed.

2.2 Agriculture farming in Tanzania

Agriculture is the backbone of Tanzania's economy and over 80% of the rural population is involved in agriculture. Agriculture is undertaken largely by smallholder farmers, sometimes in semi-arid areas, with less than 800 mm of rainfall. The majority of farmers depend upon rainfall in the production of food and cash crops. This kind of agriculture is severely constrained by drought that drastically reduces crop yields. The Tanzanian government has identified irrigation farming as one of the strategies for agricultural development (URT, 1997; URT, 2002). In the 1980s there had been a number of efforts in Tanzania to promote irrigation farming in order to increase food security. These efforts concentrated on small and large-scale irrigation schemes which were often too mechanized and expensive for most Tanzanian farmers.

Topographically, Iringa Region is characterised by dissected, hilly-to-rolling plateaus and valleys of tectonic origin. This landform is the result of several erosion cycles. According to URT (1986), Iringa Region is one of the major food crops producing area in the country. However, food shortage has been reported to occur widely due to drought

(URT, 1997). Agricultural production in the region is strongly influenced by the pattern of rainfall which decreases from highlands in the Southeast to the lowlands in the Northwest. The rainfall pattern in Iringa Region is mono-modal with a single rainy season from November to May and dry conditions during the rest of the year (RADP, 1986). The mean annual rainfall is about 1000 mm whereby 900 mm fall during the rainy season (December-May) and about 100 mm fall during June-November. The region has a number of perennial streams which are potentially important for both wet and dry season farming, making agriculture possible for two seasons (DANIDA, 1982).

The total land area suitable for agriculture in the region is 4,194,800 ha but only 414,517 ha are currently utilized. Soil fertility in the region is not high although the production of maize, wheat, sunflower, sorghum, pyrethrum, tobacco and tea can be increased by improving soil fertility. Other crops produced include a variety of vegetables such as tomatoes, cabbages and peas (URT, 2002).

According to URT (1995) maize yield in Iringa Region ranges from 0.6 to 1.5 tones per ha in the dry lands and wetlands, respectively. Wheat production ranges from 200 to 1800 kg/ha. The production of sunflower is estimated to be between 500 and 1000 kg/ha while the average production of sorghum is only 400 kg/ha. Tomato production ranges from 8 to 20 tones/ha depending on soil fertility and the variety used. *Vinyungu* is a local term that refers to farmlands or fields in valley bottoms or floodplains cultivated during the dry season utilizing natural moisture or water diverted from rivers/streams or harvested from rain to produce food and cash crops. In doing so, farmers to a large extent cope with the problem of moisture stress common during the dry season.

Vinyungu are simply ridges or raised beds that are about 0.6m high and 4-20m wide with a cambered surface sloping down to the open drain on either side. They are created by first clearing the land, then burning the cleared vegetation, followed by hand hoe plowing (when ditches and ridges are also constructed), and lastly, harrowing, to smoothen the ridges. This type of farming is possible in Iringa because the ground water table in most places is relatively high (Ravnborg, 1990; Lema, 1996).

A historical account indicates that this farming practice has been around for decades. However the scale of farming has been progressively increasing. For example, *vinyungu* farming practice in Kalenga Division goes back to more than 63 years ago when people were forced to cultivate wetlands due to drought, in 1939/49, a period also devastated by World War II. Prior to that period, people were already cultivating *vinyungu* although at a relatively small scale. At that time *vinyungu* were characterized by the following:

i) Natural soil wetness throughout the year;
ii) Presence of wetland plants;
iii) Minimum or no use of agricultural inputs such as chemical fertilizers and pesticides;
iv) High food crop productivity for home consumption and;
v) Small plots per acre (Culwick, 1935)

Figure 2: *Vinyungu* cropped with vegetables.

The major contribution to the economy of Kilolo District comes from agriculture. In Kilolo District for example, agriculture contributes 81.7% to the district's Gross Domestic Product (GDP) while other activities (livestock keeping, forestry, and trading) collectively contribute the remaining 18.3%. Otherwise, the majority of the community consists of subsistence farmers who have a very low income and are generally categorized as poor hence with less contribution to the GDP (National Bureau of Statistics, 2004). Valley bottoms are the most ideal resource for agricultural production. As such, farmers in wetland areas have devised a traditional farming system called *vinyungu* that allows all year-round cultivation of crops (Majule and Mwalyosi, 2003).

Figure 3: Harvested crops (Irish potatoes) from valley bottoms in Kilolo District.

Thus, according to Mkavidanda and Kaswamila (2000) farmers can earn between TAS 7000 and 14 000 per 100 kg bag of maize and between TAS 30 000 and 34 000 per 100 kg bag of beans produced in *vinyungu.* On the other hand, one *tenga* (a tenga is locally made by using small bamboos for carrying tomato or other products) can on average carry 20 kg of tomatoes and it gives TAS 2000 or 3000 to a farmer when sold locally. Often times, maize produced from *vinyungu* during the dry season tends to supplement upland maize production as well as increasing household income through the sale of green maize (locally known as *gobo*) (Boesen and Ravnborg, 1993). This suggests that *vinyungu* irrigation system has a potential for improving food security and income levels of farmers and thus contributes to poverty alleviation.

2.3 *Vinyungu* with Poverty Reduction Strategy and water policy

The objective of the National Water Policy (URT, 2002) for Water Resource Management is to develop a comprehensive framework for promoting the optimal, sustainable and equitable development and the use of water resources for the benefit of all Tanzanians, based on a clear set of guiding principles. Therefore good irrigation management is needed such that each water user gets the amount of water available throughout the year, or at least when needed. Through this kind of management, irrigated agriculture can improve household income and hence poverty alleviation (socio-economic improvement).

The National Environment Policy encourages good irrigation management to reduce undesirable environmental impacts such as soil salinity, water pollution and the spread of waterborne diseases. This kind of management could lead to sustainable irrigation (water management) for poverty alleviation. Social and development policies have important

indirect effects on water use and management. Water use conflicts in the community could be avoided if proper irrigation management was put in place

Tanzania's Poverty Reduction Strategy Paper (PRSP, 2004) has set out the medium term strategy for poverty reduction and indicators for measuring progress. It defines the objective for poverty reduction by 2010, with the following key areas for achieving its goal:

(a) Reducing poverty through equitable economic growth

(b) Improving human capabilities, survival and social well-being; and

(c) Containing extreme vulnerability among the poor.

The PRSP recognizes the heavy dependence of the poor on the general environment that is soil, water and forests, in particular the reliance of household on environmental resources for income generation. Water is considered a key factor for socio-economic development and the fight against poverty. Deliberate efforts are needed in the management of resources in order to sustain the required pattern of growth and consumption and to ensure that all the socio-economic activities maximize their capacities as articulated in the Tanzania Development Vision 2025. This entails integrated planning, development and river basin management in support for food security and poverty reduction as well as safeguarding the environment

According to ASDP (2005) currently, Tanzania has inadequate institutional and legal framework for environment management. The issue is being gradually addressed by the Vice President's Office and progress is expected to be made shortly through the Integrated and Legal Framework for Environment Management Project (ILFEMP) initiatives.

A key issue is how the cross-cutting issues that make up the management of the country's environment; an environment which agricultural dependent can best be tackled, and what institutions and laws are required to achieve effective results. President Office–Regional Administration and Local Government (PO-RALG) has developed joint "Introductory Guidelines and Training Modules" to build capacity of council staff, councilors and other stakeholders on both environmental and gender issues. We live in an age of increasing environmental awareness. There is a concern about population pressure and the concomitant loss of resources, habitat and biodiversity (ASDP, 2005).

According to Poverty Reduction Strategy Paper (PRSP, 2005) farmers are infinitely knowledgeable about the diversity growing in their fields and adapt to make use of it to manage their production system. They know which varieties are best suited to certain types of land and how best to use diversity to manage their soils, water and other elements. According to United Nations Educational, Scientific and Cultural Organization (2002) eradicating poverty through literacy is the only way successful in forging a clear link with local development, in particular:

(i) The contents of rural literacy education should be relevant to farmer's lives and should be taught in a way that learners find interesting;

(ii) Rural literacy and post-literacy education should introduce new planting, cultivation and industrial technology to local communities;

(iii) Rural literacy and post-literacy education should cover such topics as health and environment protection so as to contribute to enhancement of quality life.

According to WWF (2006) on its workshop concerning environment conservation and the state of Little Ruaha River, it pointed out that Tanzania is faced with great destruction of environment in land degradation, and water catchments. This

> destruction is caused by agricultural activities that are not sustainable that are carried in catchments and on hills and other gentle sloping areas. “Pastoralists shift with their herds from one place to another looking for feeds and water thus contributing to great environment destruction”.

Millions of rural people, especially in Sub-Sahara Africa and large part of Asia, continue to live in abject poverty. Their chances of achieving a better life depend on more efficient use of land and water reserves (Ford Foundation, 1985).

2.4 Upland farming as compared to *vinyungu* preference

It has been claimed by farmers that upland farming is decreasing in productivity due to its soil that has lost its fertility. In many rural farms, farmers had been abandoning with upland farms year after year in this decade due to various reasons. These include long periods of drought hence land is becoming dry, loss of soil fertility, decrease in yields, poor farming methods and the seeds applied and other unknown reasons.

According to National Bureau of Statistics (1997) low percentages in crop production is attributed by to many factors including poor agricultural infrastructure and soil infertility. Soil infertility, coupled with droughts, has reduced the regions production levels in terms of yield per unit area. According to DANIDA (1982) twice after ten years occurs crop failure due to rainfall unreliability causing food production to drop more than half the normal production. Examples of very low production of maize occurred in 1996 where an average of two tones of maize per hectare was harvested against the normal capacity of 6.5 tones per hectare, despite government subsidies (National Bureau of Statistics, 1999).

Availability of water and fertile soils in valley bottoms make them attractive for agriculture. The numerous perennial streams in the region provide reliable water for both wet and dry season farming and as such, the government of Tanzania is already promoting irrigation schemes in such ecosystems (DANIDA, 1982). While high soil water content of the valley bottom swamps may make cultivation difficult, farmers in Iringa region have devised an indigenous technology called *vinyungu* to overcome this problem and improve crop production in the region.

Over the years the technology has been transformed to cope with the prevailing situations such as unreliable rainfall and increasing soil fertility. The transformation, which includes further expansion of cultivated area, has not been examined to determine its extent and implications on wetland resources and the overall sustainability of the practice.

According to Victor and Laurel (2005) the impact of change in climate in East Africa is accompanied by:

(a) Decreased rainfall, increased temperature and evaporation in dry areas;

(b) Frequent spells leading to serve water shortage;

(c) Decrease in forest areas that can be cultivated and decline in yield and

(d) Increased food shortage and famine.

The major cause of soil degradation is a complex phenomenon including interaction among biophysical and socio-economic or political factors (Lal and Stewart, 1990). Generally, the cause of soil degradation can broadly be categorized as either natural or human induced factors. Payton *et al*. (1992) observed that, natural causes include climatic and landscape factors or process that have been in operation over long periods in the geological time scale. Whereas human-induced factor in the tropics has been reported as over-exploitation of land resources through agricultural practices, deforestation and fire.

2.5 Irrigation Systems in Tanzania

Of the total 43 million hectares suitable for agricultural production in Tanzania, only about 6.3 million hectares are under cultivation (URT, 1997). It is estimated that out of the cultivated land, one million hectares are suitable for irrigation. However, less than 200,000 hectares are currently under irrigation. Crops grown on irrigated land by smallholder farmers include; paddy, maize, beans, sugarcane and vegetables. Crops and livestock are adversely affected by droughts and thus, irrigation seems to hold the key in stabilizing agricultural and animal production (RADP, 1986; Stern, 1989; URT, 1997; Maganga and Juma, 2000).

The main sources of water for irrigation in Tanzania include rivers, lakes, and ground water. These water sources can be exploited for irrigation and represent a great potential for irrigated agricultural development. Furthermore, water-harvesting technologies are now available and can be used to prevent surface run-off from steep slopes. Sustainable irrigation farming can lead to the following:

(a) Improved crop productivity and food security;

(b) Increased crop productivity and income, contributing to poverty alleviation and;

(c) High value crop products such as vegetables and flowers.

Appraisal of irrigation in Tanzania up to 1970 revealed about four major types of irrigations (Mascarenhas *et al.,* 1985). These irrigation types have never changed significantly to-date. Instead, there has been an improvement in the management strategies aimed at improving productivity. Based on the technology used and the scale or size of the farm, the four irrigation types are:

i) Traditional or smallholder irrigation

ii) Village irrigation schemes

iii) Medium to large scale state farms

iv) Privately owned irrigated estates.

2.5.1 Traditional irrigation

This type of irrigation is the most important in Tanzania in terms of extent. Here the farmers' resources are limited and the individual schemes cover relatively small areas. It has been estimated that about 150 000 hectares could be categorized under this type of irrigation (Mascarenhas *et al.*, 1985).

Traditional irrigation is a practice which has evolved over the cause of time, without any known outside institutional intervention. The practice emerged from knowledge obtained through observation, experimentation and handing it down through generations' people's experience and wisdom. Hans *et al*. (1996) have pointed out that traditional irrigation has

emerged and shaped from detailed understanding of local conditions in response to changing socio-economic, political and ecological conditions. As pointed out by Adams *et al*. (1994) and quoted by Maganga (1998) traditional irrigation is not just a static and timeless activity. Instead, it is a dynamic process that varies geographically and where irrigating communities are capable of assimilating and adapting outside knowledge and experiences to improve their own situation.

An example of traditional irrigation includes *Vinyungu* (Mkavidanda and Kaswamila, 2000) and *Mapata* (Kafiriti, 1999). *Vinyungu* (in Iringa) and *Matapa* (in Tanga) are the same forms of irrigation but what differs are place of location. Other traditional irrigation practices have been reported in Kilimanjaro by Banzi *et al*. (1992). Under traditional irrigation system, water is normally obtained from low-cost, temporary or semi-permanent river diversion structures. Traditional irrigation is characterized by having temporary intake structures which are frequently replaced, poor soil and water loss leading to water loss through seepage and soil loss through erosion.

2.5.2 Village irrigation schemes

In this type of irrigation, the government draws plans and constructs the scheme but farmers are responsible for the distribution of water. There are cases where farmers have managed to organize themselves to dig irrigation canals, such as in Nyeregete village in Usangu Plain (Maganga and Juma, 2000). In this type of irrigation, experience is very mixed. Some of the irrigation schemes succeed while others do not due to various reasons. These include poor maintenance of schemes, conflict amongst villagers on water share, decrease of water streams leading to drying of schemes.

2.5.3 Medium to large-scale state farms

This type of irrigation in Tanzania is owned by Government wholly or in part. In this case, the schemes are designed and constructed by engineers. Land irrigated is rather flat and is farmed by smallholders. The distribution of water and general management of these schemes is usually under a government agency, although District or Village Councils administer some of them. Water is obtained from reservoirs, properly built river diversions or by pumping. Examples include Igurusi, Chimala, Kapunga, Kimani and Madibira in Usangu Plains (Maganga and Juma, 2000).

2.5.4 Privately owned irrigated estates

In this type of irrigation, hired employees work on the farm. Water is obtained from river diversions or bore holes. The sugar estate at Arusha-Chini, coffee estates in Kilimanjaro, and Mbarali Rice Farm in Mbeya Region are few examples. The major problems associated with the failure of this irrigation type in most cases include soil pollution, poor management and lack of institutional support (Boesen and Ravnborg, 1993).

2.6 Traditional irrigation systems in Iringa

The common irrigation system practiced in Iringa Region is *Vinyungu* irrigation system. This is a traditional irrigation system practiced by smallholder farmers growing mainly maize, beans and vegetables in valley bottoms or flood plains. These areas are characteristically moist for a long period of the year. Thus, *vinyungu* is a local term referring to valley bottom dry season farming practice in which farmers utilize natural moisture, or divert water from rivers and streams, or harvest rain water to produce both food and cash crops. In doing so, farmers to a large extent cope with the problem of moisture stress common during the dry season. This type of irrigation is possible in Iringa because the ground water table in many places is relatively high (Ravnborg, 1990; Lema, 1996).

Often times, maize produced from *vinyungu* during the dry season tends to supplement upland maize production as well as increasing household income through the sale of green maize (locally known as *gobo*) (Boesen and Ravnborg, 1993). This suggests that *vinyungu* irrigation system has potential for improving food security and income levels of farmers and thus contributes to poverty alleviation.

Although not yet quantified scientifically, large amount of products from *vinyungu* particularly vegetables (tomatoes) and green maize are exported to urban centres including Dar es Salaam. This demand puts tremendous pressure on *vinyungu* because people seem to earn relatively more through sales of *vinyungu* crop produce. Mtatifikolo and Comoro (1999) pointed out that the expansion of tomato cultivation in Iringa is seen to bring in a new socio-economic system and culture hence, the new farming system, which is financially beneficial to farmers. This therefore, suggests that *vinyungu* farming is likely to continue being practised, though care needs to be taken to ensure its viability and sustainability.

Due to technological changes, it is likely that traditional *vinyungu* farming is being transformed in order to increase productivity. The original *vinyungu* were characterised by reliance on natural soil moisture and minimum or no use of artificial inputs like fertilizers and agrochemicals. The current trend is to use considerable amount of agricultural inputs:

Vinyungu irrigation practises vary from one community to the other within the region for the following reasons:

- Some *vinyungu* may be located in narrow river gorges where relatively narrow strips of land on either side of the river/stream are cultivated, hence limiting crop production.
- In other cases the farmland (flood plain) on either side of the river/stream is relatively wider allowing extensive cultivation.
- The steepness of the slopes, the slope length and quality (erodibility of the soil) is dependent on the topography of the country, and these may affect productivity.
- The size of the river and the rate and amount of flooding and the associated meandering is also important for crop productivity.
- Agricultural activities in catchments where the river originates can impact on *vinyungu* farming differently.

2.7 Summary

This chapter presented a review of the literature on contribution of valley bottom cultivation (*vinyungu*) in income poverty alleviation. The literature showed that this form of agriculture has economic importance in income poverty alleviation to people residing near these areas. The valley bottom cultivation has been in practice since the 19th century, indicating that *vinyungu* had been beneficial to rural societies in terms of food supply for household consumption and cash income.

The literature revealed that farmers had been shifting from upland farms to valley bottoms cultivation due to soil productivity and moisture content of these valley bottoms. Also the practice of v*inyungu* farming is seen to be associated with the traditional irrigation mostly during dry season of the year.

Moreover, there are conflicting findings on the contribution of valley bottom cultivation to people's income in regard to the nature of farming and its implication to environmental conservation. There is practically available data for *vinyungu* in Iringa Region although not all areas have been researched on the subject matter; hence gaps in information justify the present study.

CHAPTER THREE

METHODOLOGY

3.1 Description of the study area

Iringa Region consists of seven districts namely; Mufindi, Iringa Rural, Kilolo, Iringa Urban, Njombe, Ludewa and Makete. Kilolo is one of the six districts in Iringa Region in southern Tanzania. It is about 45 kilometers South-east of Iringa Municipality. Administratively the district is composed of divisions, wards and villages.

The study was based at Mtitu River Basin, the area where many streams and catchments are found; these include the following villages Lusinga, Lukani, Kilolo, Ilamba, Kihesa Mgagao, Boma la ng'ombe, Kihesa Mgagao, Mwatasi, Mtitu, Kidabaga, Ng'uruhe Utengule. Ng'ang'ange and Kidabaga. Ukumbi and other villages that drain water in Mtitu River.

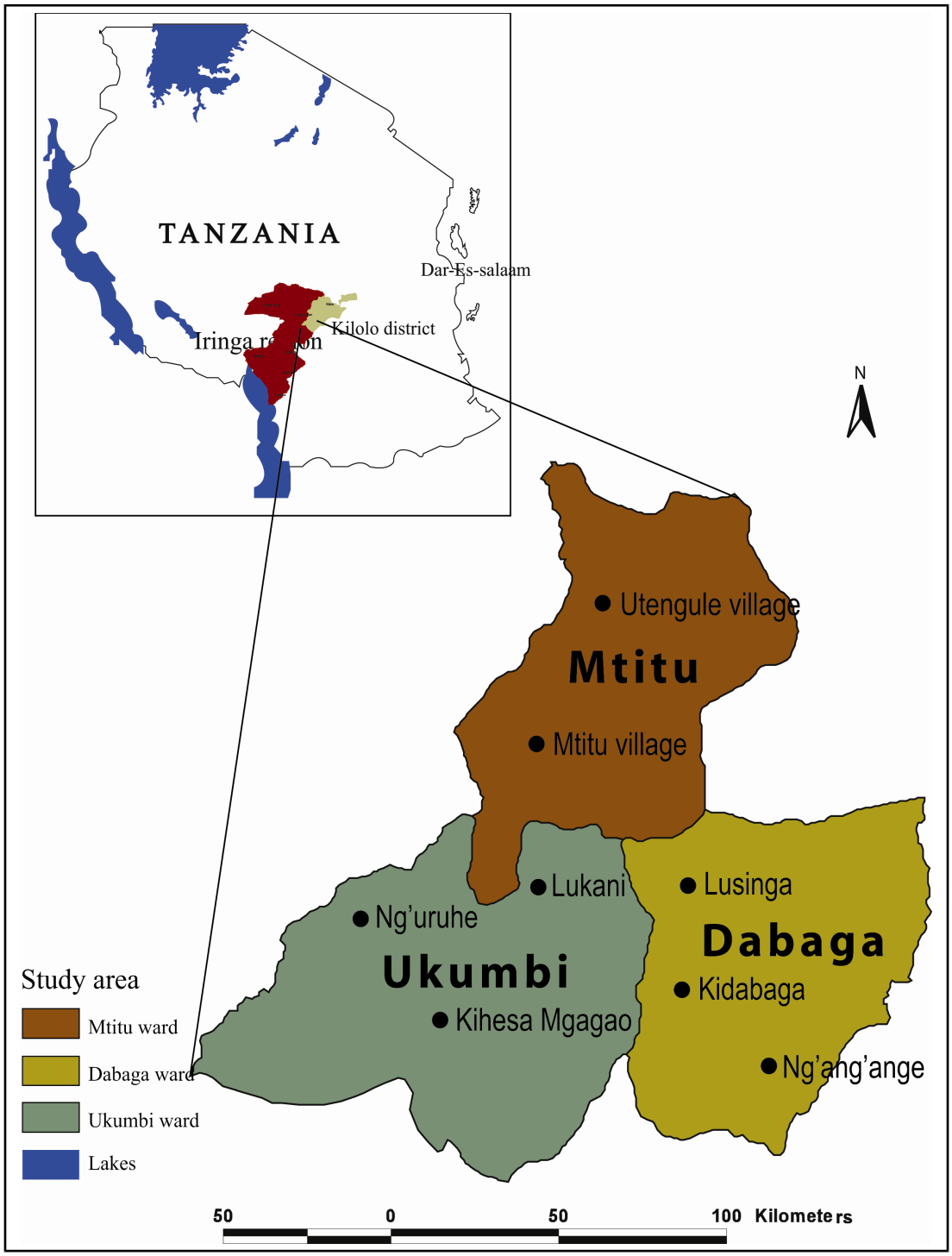

Figure 4: Study area Kilolo District

In 2006 projected census, the human population of Kilolo District was 215 864 whereby 106 709 were males and 109 155 females with an average household size of 4.5 (National Bureau of Statistics, 2006). The population grew by 25 % for Kilolo District over a period of 16 years i.e. between 1988 and 2006. About 80 percent of the population lives in rural

areas and engage in agriculture as their main livelihood activity. The study covered 8 villages out 16 villages located in the Mtitu River Basin. The 8 selected villages were those with significant valley bottom cultivation and upland farming. The eight selected villages had a population of 19 464 within the three wards (URT, 2006).

3.2 Research design

A cross sectional research was used in this study. The cross sectional research design allows data to be collected at a single point in time and used in a descriptive study and for determination of relationships of variables (Bailey, 1998; Babbie, 1990). It is considered to be favorable because of resource limitation and time for data collection. Both qualitative and quantitative were used to collect data. Quantitative data were obtained through interviews while qualitative technique was utilized for collection of qualitative data through FGD from key informants.

3.3 Sampling procedures

During formal survey, a procedure for random sampling of respondents was employed using the existing village household lists from the Village Executive Officers; in which the respondents from all selected villages were obtained by purposive, stratified and simple random sampling since each individual farmer had an equal chance of being selected. Purposive sampling was employed in the study because, the research dealt with villages found with typical *vinyungu*. Hence all the eight (8) selected villages were those found with significant vinyungu and upland farming. Also purposive sampling gave the selection of sample units that conformed to some pre-determined criteria of this study.

Stratified Random sampling was employed in this study because the informants who involved in *vinyungu* farming were heterogeneous. This means that men and women involve in *vinyungu* farming; hence there was a need to obtain each stratum of respondents in order to enhance the representativeness of the sample by giving proper representation to sub-groups in the population. Then the list of respondents was prepared basing on their homogeneity (men and women separately).

The study used simple random sampling to get individual respondents from each sub-population of the village farmers of *vinyungu.* Small pieces of paper with words labeled YES and NO were filled and mixed well depending on the number of respondents desired by the researcher (15 respondents engaging in *vinyungu* were sampled from each village). Then the pieces were thrown on a table and each farmer (from list obtained to the Village Executive Officer) was allowed to pick one piece of paper. Then the farmer who picked a piece labeled YES was the selected as a respondent.

The formal survey questionnaire was carried out in all selected villages. It enabled quantification of information gathered during informal survey. The questionnaire was administered on individual household basis. Farmer interviews took place at their homesteads to facilitate observation by the researcher and build rapport with farmers. The head of household whether husbands or wife participated in responding to questions asked.

3.4 Instrumentation

The instruments employed for data collection in the study were structured, semi-structured questionnaires, Focused Group Discussion and observation.

Table 1: Distribution of household from Focused Group Discussion by sex

Ward	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
Mtitu	8	13.1	5	8.2	13	21.3
Ukumbi	12	19.7	14	23.0	26	42.6
Dabaga	12	19.7	10	16.4	22	36.1
Total	32	52.4	29	47.6	61	100.0

The sample of Focused Group Discussion was obtained from key informants who significantly involved in *vinyungu* farming. Information obtained from FGD helped to supplement descriptive statistics of the study.

3.4.1 Primary data collection

Primary data in the study were collected from farmers practicing *vinyungu* and those dealing with agricultural activities (upland farming). During the individual household's interviews, interviewees were provided an opportunity to decide whether or not they would be willing to participate, to ensure participatory process. All the respondents gave a strong participatory response during filling the questionnaire in the entire household visited.

3.4.2 Secondary data collection

Secondary data on the contribution of *vinyungu* farming (valley bottom cultivation) to income poverty alleviation were obtained from various sources of information including Sokoine National Agricultural Library (SNAL), Rufiji Basin Water Office (RBWO) in Iringa Region and Ruaha Water Program Office (WWF) in Iringa, internet and from other documented sources of information.

3.5 Data processing and analysis

Data processing and analysis were done at Sokoine University of Agriculture, Morogoro, Tanzania. The data collected were edited, coded and summarized prior to the analysis using Statistical Package for Social Sciences (SPSS) computer software in conformity with the objectives of the study. Descriptive Statistics particularly frequencies and percentages were used in the analysis. Cross tabulation was used for bivariate analysis to test associations between some individual variables and dependent variables.

3.6 Limitation of the study

There are many villages in Kilolo District that contribute water to Mtitu River. Due to time and financial constraint the study covered 8 villages only out of 16 of the Mtitu River Basin.

3.7 Summary

This chapter described the study area and presented the methodology used for collecting and analyzing the Data. The geo-physical characteristics of the study location were highlighted. Then, the survey design and the technique used in sampling the households were presented. The chapter ended up with data processing and analysis and the limitation of the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

In this chapter the results of the study are presented and discussed. It is divided into the following four sub-sections: demographic factors (age, household size, education, occupation and asset ownership), land tenure (land availability and ownership, *vinyungu* productivity and cropping preference), socio-cultural (attitude towards land use and cropping, farming tools, water use/conflict and catchments conservation) and economic (farm size, crops sold and household income).

4.2 Demographic characteristics of respondents

4.2.1 Sex of respondent

Gender and age of respondents are an important parameter in social analysis. Different age groups perform certain sets of activities in many communities. Age also can be seen as a function of knowledge and experience as well as a measure of maturity of an individual within the community.

Data obtained in Table 2 shows that many farmers who were involved in *vinyungu* activities were men (75 percent) followed by females (25 percent). This is because crops harvested from *vinyung*u are marketable nowadays. But in former years (1980s) farmers who were involved more in *vinyungu* farming were women. It is claimed that men have been involving in *vinyungu* farming by the current decades due to fact that crops harvested from *vinyungu* fields earn a lot of money when sold.

Table 2: Distribution of respondents according to sex (N = 120)

Ward	Male		Female		Total	
	n	%	n	%	n	%
Mtitu	23	19.2	8	6.7	31	25.8
Ukumbi	32	26.7	14	11.7	46	38.4
Dabaga	35	29.2	8	6.7	43	35.8
Total	90	75.1	30	25.1	120	100.0

Other respondents claimed that, the involvement of men in *vinyungu* was due to the decline of soil fertility of upland fields. That is in the 1980s men possessed upland fields in which they were selling maize to earn money while women were engaged in *vinyungu* for vegetable production that was for household supplements. But as the time went by soil fertility in uplands declined and the number of fields declined too. Hence men had to shift into valley bottom cultivation in search for plots that earns money.

According to Agricultural Policy of Tanzania (1997) women in the country produced about 70 percent of the food crops and also bear substantial responsibilities for many aspects in the family, export crops and livestock production. The involvement of both men and women in agricultural activities is accompanied by different factors. Attention to gender means recognizing that households in farming systems are not solitary units with undifferentiated labour, resources and incentives, but are in fact made up of women, men, and children/elders who may share, complement, differ or be in conflict in their needs for or interest in improved technologies (Feldstein and Jiggins, 1994).

4.2.2 Age of respondents

Many respondents of the household were adults, their ages ranged from 28 to 51years within the three wards of the study. In Table 3 data indicate that each household had a family (married) and possesses responsibilities. Data show that, there were a great

difference between farmers engaging in *vinyungu* farming i.e. young people (25-30 years) and adults aged (41 year and above) find potentiality of valley bottom cultivation.

Table 3: Distribution of respondents according age (N = 120)

Ward	Age of respondents		
	Mean age	Standard deviation	Total
Mtitu	37.1	8.5	31
Ukumbi	42.4	10.6	46
Dabaga	40.6	9.5	43
Total			120

4.2.3 Marital status of respondents

Data in Table 4 indicates that many respondents (96.7 percent) interviewed were married. It explains that these respondents had their own settlement and are independent in obtaining daily family requirements. Since the interview conducted was based on particular household the respondents who reported that they are unmarried (3.3 percent) were young men who started new settlement (left their parents) and were to get married later. These were observed at Dabaga ward (Lusinga, Kidabaga and Ng'ang'ange villages) and Mtitu ward (Utengule and Mtitu villages).

Table 4: Distribution of respondents according to marital status (N = 120)

Ward	Marital status					
	Single		Married		Total	
	Number	Percent	Number	Percent	n	%
Mtitu	2	1.7	29	24.2	31	25.9
Ukumbi			46	38.2	46	38.2
Dabaga	2	1.7	41	34.2	43	35.9
Total	4	3.4	116	96.6	120	100.0

4.2.4 Education of respondents

Respondents interviewed from the study showed different classes of education. About 88.3 percent of them had primary education and 7.5 percent had secondary education.

Education is a very important factor for making various decisions in life. From this information it indicates that many respondents possessed low level of education.

Table 5: Distribution of respondents according to education of respondents

Ward	Level of education				Total
	Primary education	Secondary education	Diploma/degree	Adult education	
Mtitu	29	1	1		31
Ukumbi	43	3			46
Dabaga	34	5			43
Total					
n	106	9	1	4	120
%	88.3	7.5	0.8	3.3	100

Data in Table 5 reveal that many residents who live in rural areas are those majorities with primary education and few possessed secondary education. Hence the success in an agricultural activity or any development activity is associated with education especially formal education. Having enough knowledge in agricultural farming may improve agricultural productivity and enable to conserve the environment. Education is argued to be one of the strongest determinants of household income and welfare and also education of the household head is important because is the one who takes major decisions concerning household income; especially production decisions (World Bank, 1996).

4.2.5 Size of household of respondents

The distribution of the respondents from the study indicates that many households have unevenly distributed household sizes. From Table 6 it is observed that, the surveyed area of Mtitu River Basin 43.3 percent of the household had a family size of 4 to 6 followed by families with size of 7 to 9 (26.7 percent) and 1 to 3 (20 percent). Few households (10 percent) had a family size of 10 and above. Observation done by the study showed that in families with large population there were many dependants (orphans and adults) while

those ranging with 1 to 3 were young married couples. Also information from the table indicates that many households fall at 6 per household. Meaning that many household had average of 5 to 6 members. It has been hypothesized that households in rural areas are large as

Table 6: Distribution of respondents according to household size of (N = 120)

	Household size of respondent				
Ward	1-3	4-6	7-9	10 and above	Total
Mtitu	9	12	8	2	31
Ukumbi	8	17	11	10	46
Dabaga	7	23	13		43
Total					
n	24	52	32	12	120
%	20	43.3	26.7	10	100

Where N = total population of respondents, n = sub population of respondents

4.2.6 Assets owned by respondents per household

Information found from the study indicated that many households were observed to possess various assets. Data in Table 7 on assets shown were those aiming to reduce income poverty if they were sold. The assets were land (fields), forest (trees for timber), cattle, poultry (chicken), swine (pigs), and goats. Among these the leading asset interviewed and observed to be possessed by many farmers was land (95 percent) and it showed that many farmers depended on land for agricultural activities and non agricultural activities.

Land was the only natural resource that enables them to engage in agricultural productive activities. Chicken (69.2 percent), (Trees (39.2 percent) and cattle (33.3) were observed to be owned by respondents. This is supported by Agricultural Sector Development

Programme (2003) that states “roughly one third of rural income come from available natural resources, and these resources are particularly important for poorest members”.

The uses of trees for many respondents were; timber production for sale, house construction for their settlement and other uses like firewood. Information obtained from farmers of *vinyungu* concerning uses of cattle domestication were for farming (ox-plough), sales and other socio-cultural purposes like bride price in marriage for many societies in Tanzania. Other assets were pigs and goats. Swine production in rural areas was growing at a high rate (many household started domesticating); this is because its pork is consumed by many and its demand is high in Iringa and Dar es Salaam and perhaps in other regions of Tanzania.

Table 7: Asset ownership of respondents (N = 120)

Ward	Assert owned						Source of Asset	
	Land	Tree	Goat	Cattle	Pig	Chicken	Bought	Inherited
Mtitu	28	6	5	12	4	25	50	31
Ukumbi	44	21	5	16	7	34	82	47
Dabaga	42	20	10	12	20	34	93	39
Total								
n	114	47	20	40	31	83	225	117
%	95	39.2	16.7	33.3	25.8	69.2	65.8	34.2

Where N = total population of respondents, n = sub population of respondents

Ownership of assets by respondents showed that 65.8 percent of the assets were purchased and 34.2 percent were owned by way of inheritance. The purchased assets were land, cattle, pigs, chicken and goat. Investigation showed that those who purchased the land were government employees-teachers and businessmen who migrated from other villages and regions in search for better life. This is because Mtitu river Basin is a good

area for agriculture especially for crops like maize, tomatoes, beans, cabbages, pigeon peas sweet and round potatoes, fruits, and other vegetables.

Land ownership was indicated by family inheritance and documented local letter from the village government. Either it was noticed that no individual respondent had a title deed (a legal document constituting evidence of a right, especially to ownership of property). This is due to the fact that the provision of a title deed in Tanzania for many rural areas is not yet introduced. Therefore ownership of a title deed for land to rural citizens of Tanzania currently is a problem. It is so because land is the only property for them to facilitate the reduction in poverty income.

4.2.7 Main activities in income generation

The main activity leading to income generation for many farmers was crop farming (82.5 percent). In Table 8 it shows that rural communities rely on land for food and income generation. Studies done on this issue indicated that cropping takes place more in low than upland. Large land was available for cropping throughout the year. Information also shows tat other farmers (14.2 percent) engaged in both activities (crop and livestock farming), few farmers (8 percent) were seen to engage with livestock keeping and other respondents were employed (primary school teachers). The data indicate that in rural settings many people are engaged in cropping as the only source of income generation.

Table 8: Main activities in income generation (N = 120)

	Main generating income activity				
Ward	Crop farming	Livestock keeping	Both 1 and 2	Employed (teaching)	Total
Mtitu	28		3		31
Ukumbi	39	1	5	1	46
Dabaga	32		9	2	43
Total					
n	99	1	17	3	120
%	82.5	0.8	14.2	2.5	100

1 = crop farming, 2 = livestock keeping

4.3 Agricultural activities in Mtitu River Basin

The aim of this study was to investigate important agricultural activities taking place in Mtitu River Basin. Among the activities observed were agricultural farming of crops and animal domestication (grazing) and tree plantation (timber production). Agricultural activities for crops were found in both in the upland and the lowland. But for the period the survey was conducted (September to November) many activities were done in lowlands (valley bottoms). Various types of crops were observed in valley bottoms within the surveyed area of Mtitu River Basin (Mtitu, Ukumbi and Dabaga wards). These were maize, beans, sweet and round potatoes, pigeon peas, tomatoes, green vegetables, cabbages and sun flower.

4.3.1 Crops grown during dry (July-November) and wet seasons (Dec-April)

Information obtained from interviewed respondents showed that various crops are grown in valley bottoms during dry and wet seasons. Indicating that in Mtitu River Basin most land is cultivated throughout the year. Investigations done through non-participatory observation showed that few farmers raised crops in upland/main fields during the dry season (July to November).

Table 9: Crops grown during dry season (July to November) (N = 120)

Crops	Maize	Beans	Potatoes	Cabbage	Pigeon Peas	Tomatoes	Tree seeds
Mtitu	17	11	10	2	11	1	
Ukumbi	20	31	17	11	34	5	1
Dabaga	35	20	22	2	12	1	
Total							
n	72	62	49	15	57	7	1
%	64.3	55.4	43.8	13.4	50.9	6.3	0.9

Table 9 above shows that crops most preferred during wet season by the farmers were maize, beans, pigeon peas and potatoes. Studies show that there were crops which were cultivated in both seasons. This is shown in the data from Tables 9 and 10 that maize (98.2 percent) and beans (62.4 percent) took a great chance of being cropped throughout the year in Mtitu River Basin in Kilolo District. The two crops were leading because; they are used for food consumption and business purposes.

Table 10: Crops grown during wet season (December to April) (N = 120)

Crops	Maize	Beans	Potatoes	Cabbage	Pigeon Peas	Tomatoes	Tree seeds
Mtitu	30	14		5	1	1	
Ukumbi	3	18	3	8	3	1	3
Dabaga	44	36	3	2			1
Total							
n	117	68	6	15	4	2	4
%	98.2	62.4	5.5	13.8	3.7	1.8	3.7

Also there ware other crops that were grown throughout the year. Pigeon peas (50.9 %), potatoes (43.8%) and cabbage (13.4%) followed by other crops which were grown in small percent.

4.3.2 Availability of Land for farming

Table 11: Availability of land for farming (N = 120)

Ward	Enough land for farming		If no how do you meet family needs			
	YES	NO	Land lending	Wage labour	Salary	Buy and sell livestock
Mtitu	16	15	9	5		
Ukumbi	35	10	4	2	2	1
Dabaga	41	2	13	1		1
Total						
n		27	26	8	2	2
%		22.7	52	32	8	8

n/N-does not sum up to 120 because some respondents didn't respond.

Data obtained in Table 11 revealed that 77.3 percent of *vinyungu* farmers had enough land for cultivation meaning that they practiced both upland and lowland farming. This information revealed that farmers of *vinyungu* practiced agricultural activities in upland during the wet season only (November to May) and from June to October were engaged in valley bottoms. Also, this information revealed that farmers practiced cultivation in uplands and valley bottom farming throughout the year. Other respondents (22.7 percents) were observed to possess only the uplands.

Moreover, farmers who reported to have no enough land had other means to acquire family needs. These included land lending (52%), engaging in wage labour (32%), using salary (8%), buying and selling livestock (4%) and selling of furniture (4%). This indicates that many farmers owned land and it was enough for agricultural activities.

4.3.3 Sources of capital for farming

Respondents were asked to identify the sources of capital for their agricultural activities. The aim was to understand the means by which the farmers obtain capital to fund

farming activities. The information in Table 12 revealed that 68.9 percent of respondents obtained capital from selling the surplus crops produced and 12.6 percent from selling surplus crops produced and livestock. This further shows that farmers were able to utilize their natural resources efficiently because all they depend was derived from land (natural environment).

Table 12: Source of capital for farming (N = 120)

Ward	Source of capital for farming							
	Selling surplus Crops	Livestock selling	Local breweries selling	Providing wage labour	Selling surplus crops and livestock	Loan from SACCOS	Selling timber	
Mtitu	22	3	2		4			
Ukumbi	32	3		4	3	3		
Dabaga	28	1	1	2	8		3	
Total								
n	82	7	3	6	15	3	3	119
%	68.9	5.9	2.5	5	12.6	2.5	2.5	100

Figure 5: Irish potatoes harvested from *vinyungu* in Kidabaga village

The harvested Irish potatoes were ready for transport to Dar es Salaam. This was observed at Kidabaga village in Kilolo District. Other respondents reported to obtain capital for farming through various sources like providing wage labour (5 percent), selling local

breweries (3 percent), loan from SACCOS (3 percent), and selling timber (3 percent). All these sources of capital were reported to assist them in their daily farming activities.

4.4 Importance of valley bottom cultivation to people's livelihood

The objective of this study was to investigate the importance of valley bottom cultivation (*vinyungu*) to rural communities in their daily requirements for family and other expenditure. It was also possible to get a history of how long had this community been engaged in such an activity. The information obtained from respondents revealed that, valley bottom cultivation was beneficial for daily food requirements and small cash money which they earn after selling vinyungu products (all that is harvested from fields**).** Based on the study by Tenge and Kaswamila (2000) and Majule and Mwalyosi (2005) *vinyungu* farming plays a significant role in generating income as well as providing a buffer to the local communities during drought periods which are currently occurring frequently.

4.4.1 Years farmers have been in vinyungu farming

The information in Table 13 indicate that rural communities in Mtitu River Basin had been engaging in *vinyungu* for an average of 20 years. From this data it is argued that *vinyungu* farming emerged around 1986. Views obtained from FGD showed that the importance of *vinyungu* captured great attention around 1990 in which many activities of maize production accumulated in valley bottoms.

Table 13: Years and amount of acres in *vinyungu* cultivation (N = 120)

Ward	Average years	Std. Dev	n	%	Acres cultivated			
					Average	Std Dev	n	%
Mtitu	16.4	7.1	31	25.8	0.91	0.7	30	25.2
Ukumbi	24.1	14.7	46	38.4	0.96	0.6	46	38.7
Dabaga	19.1	7.4	43	35.8	1.4	0.5	43	36.1
Total			120	100			119	100

The data in Table 13 revealed that an average of 1.1 acres is cultivated per year in the surveyed wards. Discussion from FGD showed that almost every farmer of *kinyungu* had a minimum of one quarter (for those in which *vinyungu* areas were narrow and small) and acres where *vinyungu* were accumulated a farmer had a maximum of two acres. Higher average yield was observed at Dabaga because the valley bottoms found at Dabaga ward were moister as compared to other two wards surveyed. It is claimed that Dabaga Natural Forest Reserve had a great influence in drainage system and vegetation cover and hence *vinyungu* in that area were not irrigated. The average number of acres cultivated in Mtitu and Ukumbi wards was low due to moisture scarcity in *vinyungu.*

Vinyungu farming system is believed to have started as far back as the 1890s (Culwick 1935) and were practiced mainly by women and on small fields with little or no economic contribution to the livelihoods of the people that practiced it. Recently, however, a combination of socio-economic factors are causing the intensification of the farming system, in size of *vinyungu* fields and the number of people involved in this farming practice. Among them is the increased market demand for food and other wetland products (Majule & Mwalyosi, 2003; Mkavidanda & Kaswamila, 2001) like vegetables for urban centers in Iringa region as well as the distant city of Dar es Salaam and other regions.

4.4.2 *Vinyungu* size now as compared to 25 years ago

It is noted that at present most valley bottoms are in danger of becoming dry areas due to agricultural activities practiced by farmers. The study asked the respondents to reflect back and provide information concerning *vinyungu* size by comparing now to the past. What was observed is that *vinyungu* have taken the highest priority among activities taking place in Mtitu River Basin. *Vinyungu* are said to be the dominating business

activity in many areas of Iringa Region. Data in Table 14 show that 85 percent of farmers said *vinyungu* plots have increased in size as compared to the past.

Majule and Mwalyosi, (2005) pointed out that, there was evidence that there has been an expansion and intensification of *vinyungu* farming to an extent that cultivation which was originally restricted to vegetables, onions and potatoes has been extended to maize cultivation for commercial purpose as well as for household consumption. This has resulted into reduced water availability in valley bottoms as well as declining soil fertility due to continuous cultivation and over use of excessive chemical fertilizers. The photo below shows commercial *vinyungu* fields at Mtitu that were very small in the past decades currently extended for cash crops, like beans, maize and Irish potatoes

Arrow indicates where Mtitu River crosses. All natural vegetation is almost cleared
Fields for cash crops (cultivated).

Figure 6: Commercial *vinyungu* fields at Mtitu Village

Part of the field (greenish) is cropped and the other part of the field (reddish brown) is uncropped. In the figure above there is a large extension of *vinyungu* fields (not actual *vinyungu* but commercial fields –large *vinyungu* plots cropped for cash crops).

Table 14: Response on *Vinyungu* size as compared to 25 years ago (1981-2006)

Ward	Have increased	Have decreased	Total
Mtitu	19	12	31
Ukumbi	40	6	46
Dabada	43		43
Total			
n	102	18	120
%	85	15	100

Few respondents (15 percent) reported to have no changes in size of *vinyungu* as compared to 25 years ago. Observation done by the study indicate that many valley bottoms in Mtitu River Basin were cultivated by *vinyungu* plots/fields and in these valley bottoms, land had been cleared out leaving planted fields or grass. All these show that valley bottoms are attractive for agricultural activities.

Figure 7: Extended *vinyungu* plots in Ng'uruhe Village in the same valley bottom

Mtatifikolo and Comoro (1999) pointed out that due to technological changes it is likely that traditional *vinyungu* farming is being transformed in order to increase productivity. The original *vinyungu* were characterized by reliance on natural soil moisture and minimum or no use of artificial inputs like fertilizers and agrochemicals. The current trend is to use considerable amount of agricultural inputs. The environmental implication of these practices would definitely vary. Therefore, there is need to understand these

impacts so as to develop appropriate management strategies to cope with the changing situation.

4.5 Preference of valley bottom cultivation (*vinyungu* farming)

The Government of Tanzania has been restricting people from using valley bottoms /catchments or in all areas where there is a source of water all over the country by the current decade. All these have been proclaimed by the nation due to the adverse effects on the environment that we depend for our whole life. Emerging consequences include land degradation, climate change, decline and drying of water streams, loss or migration of wild animals, emerging dry lands (farms) and other many environmental changes that are happening currently in our country. This study interviewed farmers regarding to their reasons for preferring *vinyungu* farming. The major reason is that farming has become increasingly important in terms of food security and income generation in Iringa Region due to the following reasons:

i) Intensive cultivation of these areas has enabled farmers to increase the production of cash and food crops (tomatoes, vegetables and green maize)
ii) Upland areas have been increasingly depleted of soil fertility thus making them less productive and less dependable.
iii) Shortage of rainfall due to climate variability has forced farmers to concentrate more in valley bottoms where farming is possible due to high soil moisture availability.

4.5.1 Owning *vinyungu* and its motivation for cultivation

This study also sought to find out the motivation that makes farmers prefer *vinyungu*. In Table 15 reveals that 92.5 percent of respondents owned *vinyungu* plots. This showed

that many farmers possessed these plots but 7.5 percent of respondents said they didn't possess them.

Table 15: Motivation for *vinyungu* cultivation through the year

Ward	Owning vinyungu		Motivation for vinyungu cultivation				
	Yes	No	Easily obtained	More productive	Cult. through	Dry	
Mtitu	24	7	1	14	3	7	
Ukumbi	44	2		31	7	7	
abaga	43		2	36	5		
Total							
n	111	9	3	81	15	14	120
%	92.5	7.5	2.7	71.7	13.3	12.4	100

Observations made showed that these farmers were used to rent plots from those with more plots of valley bottoms by paying certain amount of money. Discussion with farmers in FGD showed that one *kinyungu* was rent for TAS 6,000/= up to 10,000/= depending how large the plot was and its productivity per year.

The leading motivating factor for *vinyungu* cultivation was seen to be the productivity as compared to upland areas (71.7 percent). This was the most important fact because most of the uplands in villages surveyed were dry during the summer period. Hence farmers had little or no interest with upland farms because of exhausted soils due to prolonged use of farming. Other motivating factors for owning *vinyungu* were cultivation throughout the year (13.3 percent) and as a copping strategy for the dry season (12.4 percent). This means that there were no any other strategies to farmers; the only way was to engage in valley bottoms cultivation during dry the period (July to November). Also, farmers preferred *vinyungu* because some crops sustained both seasons of the year and these included maize and beans.

4.5.2 Practice of crop rotation in *vinyungu*

The productivity of *vinyungu* fields enabled farmers to practice crop rotation throughout the year. Through FGD respondents said they were interested more in that practice because they harvested different crops in a short time and these crops helped to sustain their daily food and cash requirements. Table 16 indicates that farmers had interest in certain types of crops that they prefer in rotation. About 46.8 percent of the crops practiced in rotation maize and beans were leading because all the two crops were used as food crops. For example maize was sold as green maize (*gobo*) all the seasons and other farmers sold maize when they are dry. The same applies to beans that farmers could sell this crop at different stages of its growth either green beans or sold when they are dry.

Table 16: Crop rotation practice in *vinyungu*

Ward	Practice of crop rotation in *vinyungu*					
	Peas-cabbage maize	Beans-potato-maize	Beans-maize	Vegetable-tomato	Tomato-maize	
Mtitu	10	7	7			
Ukumbi	13	13	19	1	4	
Dabaga	8	9	26			
Total						
n	31	23	52	1	4	111
%	27.9	20.7	46.8	4	3.6	100

Other crops found to have an interest to farmers in rotation were: pigeon-peas → cabbage → maize (27.9 percent), beans → Irish potatoes → maize (20.7 percent) and few farmers said they practice pigeon peas → tomatoes → maize (3.6 percent) and the last and least was tomatoes → green vegetables (Chinese vegetables, salad and amaranths). Data obtained through FGD revealed that crops in *vinyungu* depend on the family food requirements and local market demand. Currently Irish potatoes and pigeon peas are in high demand, this makes farmers try to find other alternative of rotations. Respondents

were also asked to give information on how many harvests were made per year from one plot of *kinyungu*, it was noticed that two to three harvests were done.

4.5.3 Use of manure and fertilizer

This study also examined the use of manure or fertilizer in *vinyungu*. The results showed that 90.8 percent of the interviewed farmers apply both manure and fertilizer.

Table 17: Use of manure and fertilizer (N = 120)

	Use of manure		Use of fertilizer		
Ward	Yes	No	Yes	No	
Mtitu	27	4	31		
Ukumbi	39	7	42	4	
Dabaga	43		42	1	
Total					
n	109	11	115	5	120
%	90.8	9.2	95.8	4.2	100

Data reveal that many farmers (95.8 percent) were interested in fertilizer application in *vinyungu* plots and 90.8 percent had interest with manure application. From Table 17 it can be concluded that farmers applied both fertilizer and manure. Information from FGD revealed that fertilizer was most preferred by farmers because of its immediate positive effects to the crops being grown (improve yields) as compared to the same crop in same plot of *kinyungu*. They said if *vinyungu* plots are cultivated over a long period of time its soil gets exhausted leading to low productivity.

The survey made in Mtitu River Basin showed that many crops harvested in valley bottoms were fertilized indicating that fertilizer is effective and increased productivity. The areas found to use more manure were those found in Dabaga ward (Kidabaga and Ng'ang'ange villages) in which the climate was good; and the rainfall was frequent hence *vinyungu* farms were more wet as compared to other surveyed places. Other respondents

(4.2 percent) said they didn't use fertilizer because of high cost of the fertilizer per 50 kilograms of a bag (66.7 percent) and the use of fertilizer reduces productivity (33.3 percent). Hence the use of fertilizer was hindered by its cost and side effects to soil for prolonged use.

The above data are supported by other researchers. Majule and Malyosi (2003) who examined soil and water characteristics and found that soils under *vinyungu* cultivation were acidic with a pH of 5.1-5.5 and the water samples downstream had traces of agrochemicals and pesticides, implying that in the long-run *vinyunngu* may reduce soil and water qualities as well as agricultural production. This showed that fertilizers are currently applied by farmers in *vinyungu* plots.

4.5.4 Availability of manure

Observation and FGD held indicated that manure was obtained from their livestock. About 88.3 percent of respondents obtained manure from their domesticated livestock and 11.7 percent obtained by purchasing. Therefore the majority relied on their own resources.

Table 18: Availability of manure (N = 120)

Ward	Manure availability		Manure easily obtained and increase productivity				
	Own livestock	Buying	Farm manure	Pit manure	Dung manure	Poultry manure	Pig manure
Mtitu	27	4	2	4	25		
Ukumbi	38	8		1	36	6	3
Dabaga	41	2	1	6	34	2	
Total							
n	106	14	3	11	95	8	3
%	88.3	11.7	2.5	9.2	79.2	6.7	2.5

From this information, it shows that farmers benefit from livestock kept because they supply with them the manure for cropping. Also Table 18 shows the various types of animals kept. The manure which seemed to be used by many farmers was obtained from cattle in the form of manure. That is the stool collected when still fresh (wet) and then was accumulated to make a hip of it until becomes dry. Then farmers softened it to small particles to incorporate into soil. They said it was the only manure that was easily obtained by many households surveyed. From this information it indicates that farmers had various category of manure that is from poultry, pigs, and from other domesticated animals.

4.5.5 Crops sold from *vinyungu*

A comparison was made to study if crops from *vinyungu* were sold or not also what crops were sold and still yet were demanded currently. In Table 19 the response indicated that 97.5 percent of the crops grown in *vinyung*u were sold. But these crops that were sold differed in demand. It showed that maize (73.5 percent), pigeon peas (55.6 percent)), beans (50.4 percent) were most preferred by farmers for selling; the other crops were Irish potatoes (35.9 percent), vegetables especially cabbage (25.6 percent), and tomatoes (10.3 percent).

Table 19: Crops sold from *vinyungu*.(N = 120)

Ward	Any crops sold		Crops sold from *vinyungu*						
	Yes	No	maize	beans	p.peas	vegetable	potatoes	tomatoes	fruits
Mtitu	30	1	19	23	9	8	7	3	
Ukumbi	45	1	25	16	35	15	15	8	1
Dabaga	41	1	42	20	21	7	20	1	2
Total									
n	116	3	86	59	65	30	42	12	3
%	97.5	2.5	73.5	50.4	55.6	25.6	5.9	10.3	2.6

All these crops have high demand in Iringa, Morogoro and Dar es Salaam. The Chi-square test shows that there were no significant differences between the crops sold from *vinyungu* and that from upland farms. Meaning that these crops were grown in upland too. Although not yet quantified scientifically, large amount of products from *vinyungu* particularly vegetables (tomatoes) and green maize are sold to urban centres including Dar es Salaam.

This demand puts tremendous pressure on *vinyungu* because people seem to earn relatively more through sales of *vinyungu* crop produce. Mtatifikolo and Comoro (1999) pointed out that the expansion of tomato cultivation in Iringa is seen to bring in a new socio-economic system and culture hence a new farming system which is financially beneficial to farmers. This therefore, suggests that *vinyungu* farming is likely to continue being practised, though care needs to be taken to ensure its continuity and environmental protection.

4.5.6 Income obtained from *vinyungu*

The information on household income was obtained by asking the respondents to estimate the total net income of crops grown in *vinyungu* per year. The information obtained from respondents show that farmers earned capital from *vinyungu* crops. But sales made per year were low. It showed that sales from *vinyungu* vary from farmer to farmer depending on the investment made during the cropping period. Many respondents earned low capital and few earned more as the data show in Table 20.

Table 20: Income obtained from *vinyungu* per year (N = 120)

Ward	income obtained from *vinyungu* per year in Tshs					
	5000-20 000	21 000-40 000	41 000-80 000	81 000-100 000	100 000 and above	
Mtitu	13	7	2	3	5	
Ukumbi	8	14	11	7	5	
Dabaga	9	7	13	8	6	
Total						
n	30	28	26	18	16	118
%	25.4	23.7	22	15.3	13.6	100

n/N does not sum to 120 because few respondents did not sell crops from *vinyungu* plots

Data reveal that the majority of farmers (86.3 percent) got their cash money ranging from TAS 20 000 to TAS 100 000 and few farmers (13.7 percent) earned more than TAS 100 000. The discussion made with farmers from FGD showed that those who earned less than 50 000 TAS were the ones who cultivated small plots of *vinyungu* and they were for food and little for sale which was the surplus. On the other hand, farmers who earn their cash above 50 000 TAS were the ones who cultivate large plots of *vinyungu* aiming for sale only.

This is supported by other researchers who reported that farmers changed from small plots of *vinyungu* into large fields for commercial purposes. This transformation aimed at planting crops in *vinyungu* for cash income. Also, the expansion of *vinyungu* fields aimed at increasing quantity of crops harvested. According to Mkavidanda and Kaswamila (2000), farmers can earn between TAS 7000 and 14 000 per 100 kg bag of maize and between TAS 30 000 and 34 000 per 100 kg bag of beans produced in *vinyungu.*

4.5.7 Expansion of *vinyungu* in Mtitu River Basin

Farmers were asked to examine the trend of *vinyungu* from past to the present and their response indicated that the size of *vinyungu* has been increasing since the past. The

observations made revealed that there was an expansion of *vinyungu* especially to wide valley bottom that lie along the river. Farmers find these areas favourable for agricultural activities due to easiness of water availability; that is why many *vinyungu* plots are lined along rivers or in water streams. Also, the expansion of *vinyungu* fields enabled individual farmer to plant different crops in the same valley aiming for sale and food for family consumption. Farmers find vinyungu sales are beneficial because different crops are sold from the same field and the harvests are done every three to four months.

Table 21: Expansion of *vinyungu* in Mtitu River Basin

Ward	Current trend *in vinyungu* at Kilolo District				
	Sudden expansion	Slow expansion	Remained unchanged	Have decreased	
Mtitu	18	1	2	10	
Ukumbi	42	2		2	
Dabaga	24	18	1		
Total					
n	84	21	3	12	120
%	70	17.5	2.5	10	100

The data in Table 21 show that many respondents (70 percent) said that there was a sudden growth and expansion of *vinyungu* that was observed to be quite true due to agricultural effects on environment (deforestation, drying of water streams and catchments and land degradation). Ten percent of respondents said that there was a decrease in *vinyungu* size as compared to the past. These areas with little plots of *vinyungu* were found in villages like Utengule, Lukani, Lusinga, Ng'ang'ange, and Ng'uruhe. What happened in these villages was the decrease or drying of water in valley bottoms as a result the soil has dried and it was hard for cultivation. In other villages those *vinyungu* plots that were dried due to poor cultivation and unplanned livestock domestication were observed at Lukani, Utengule, Ng'uruhe and Lusinga.

4.6 Assessment of sustainability of valley bottom cultivation

The objective of this study was to examine the practice of *vinyungu* and its sustainability and relate it to environment conservation. The way in which *vinyungu* plots were prepared, cultivated, cropped was discussed. Also, irrigation schemes were investigated and the flow of streams was investigated together with programmes in progress and bylaws that operate in conserving natural environment. According to National Environmental Policy (NEP), among six countrywide environmental problems identified are loss of wildlife habitats and biodiversity, deterioration of aquatic systems and deforestation. NEP admits that the act of promoting agriculture as the engine of growth would jeopardize environment and the natural resource conservation. NEP wants natural resource conservation efforts to be oriented toward poverty alleviation, but stresses the need for environmental awareness.

4.6.1 *Vinyungu* preparation

Observations were made to study how *vinyungu* plots are prepared from their early stages of farming. It was observed that there are various stages that farmers operate before planting. For new plots of *vinyungu*, farmers started with clearing away trees or grass and letting them dry, fire burning, collecting plant remains (unburnt ones), land tillage, harrowing and then cropping is the last step. For old *vinyungu* plots few steps were carried out; that is clearing out grass and letting them dry, fire burning, land tillage and lastly planting takes place. The data in Table 22 show a number of respondents (83.3 percent) said that they didn’t cut down trees during *vinyungu* preparation.

Table 22: *Vinyungu* preparation (N = 120)

Ward	Cutting down trees		Tree cutting advantages		Tillage ways	
	Yes	No	Vinyungu expansion	Enough sunlight	Hand hoe	Ox-plough
Mtitu	3	28	2	1	28	3
Ukumbi	4	42	4		37	9
Dabaga	13	30	13		42	1
Total						
n	20	100	19	1	107	13
%	6.7	83.3	95	5	89.2	10.8

This indicates that many farmers still continue farming in old valley bottoms in which big trees are left and shrubs/grasses had been cleared since the past. And those who said *vinyungu* have increased means that new valley bottoms have been invaded by agricultural activities.

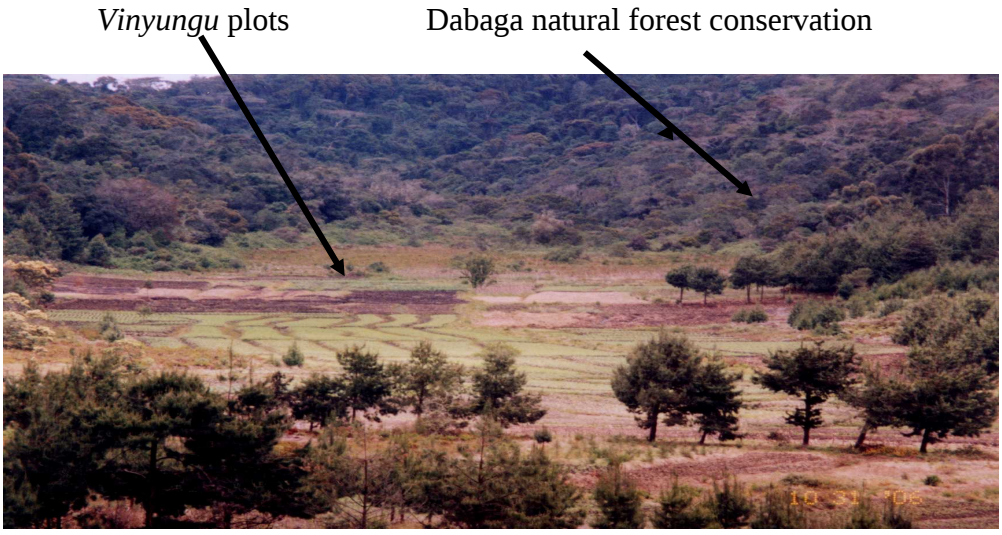

Figure 8: Catchment near Dabaga forest invaded by *vinyungu* plots.

Theses new *vinyungu* plots involved all the steps listed above. The matter here is that the natural vegetation was cleared out; the most lost species were the small tree plants, shrubs and grasses and the wild species of animals and land is exposed.

4.6.2 Improving soil fertility

Data in Table 23 show that farmers had their own traditional ways of improving soil fertility. If the soil is subjected into tillage for a long time it is exhausted. They survey was done to examine if farmers had their own means of making soil productive in daily agricultural farming.

Table 23: Traditional methods of soil improvement

Ward	Traditional soil improvement		Traditional ways			
	Yes	No	Burying plant remains	Crop rotation practice	Manure application	Farm resting
Mtitu	31		3	23	5	
Ukumbi	44	1	13	25	4	
Dabaga	43		7	22	14	3
n	118	1	23	70	23	3
%	99.2	0.8	19	59	19.5	2.5

Many respondents (99.2 percent) said that they used traditional methods that enabled them to improve soil fertility and these methods have been into practice for long periods since some decades ago. These methods are good because they are natural and traditional ones. The leading method was crop rotation (58.8 percent) showing that it was much practiced by many.

This method was good because different crops have different soil requirements and also different root zones into the soil. A good example of rotation was that of maize →beans →cabbage → pigeon peas. In *vinyungu*, maize and cabbage have long roots that penetrate into the soil so absorb lower soil nutrients and on the other hand leaves decompose into humus for few months and in so doing soil is bound and adds some nutrients easily. The same implies to decomposition of beans remains and pigeon peas

because they have short roots hence absorb more top soil nutrients. Other ways found beneficial to farmers were manure application and fallowing which are better ways and are recommended into practice for soil fertility improvement.

4.6.3 Soil erosion control in Mtitu River Basin

Investigation and observation made in *vinyungu* fields showed that areas in gentle slopes, river banks and in *vinyungu* plots where activities are dominant erosion existed. This happens most during rainy season when rivers flood and when rain water from up hills flows in cultivated plots, and then the soil and other sediments are carried away. This occurs due to poor mode of agriculture that had been practiced for decades. In Table 24 it was observed that (64.2 percent of respondents) there was little erosion experienced in *vinyungu.*

Table 24: Soil erosion control methods

Ward	Soil erosion state			Prevention methods		
	No erosion	Little erosion	Pronounced erosion	Contour farming	Tree planting	Grass planting
Mtitu	6	24	1	4	3	24
Ukumbi	12	30	4	19		27
Dabaga	19	23	1	20	3	20
Total n	37	77	6	43	6	71
%	30.8	64.2	5	35.8	5	59.2

Five percent of the respondents said that there was pronounced soil erosion. This has been noticed more in areas where *vinyungu* plots were cultivated along the banks of rivers, when it rains abrasion takes place. It can happen that banks or part of *kinyungu* is covered by mud or carried away. Sustainability and productivity of *vinyungu* farming systems is now a big concern due to associated land degradation (Mtatifikolo and Comoro, 1999; Mkavidanda and Kaswamila, 2000; NORPLAN, 2001).

Deforestation and soil degradation has been reported to threaten traditional irrigation schemes in Kilimanjaro (Banzi *et al., 1992*). Also, Kaswamila and Tenga (1997) reported that over-cultivation around water sources is a threat to traditional irrigation practices in Lushoto District due to accelerated soil erosion of riverbanks. It is feared that the new-*vinyungu* farming practices is likely to aggravate the soil degradation process due to excessive utilization of chemicals aimed at increasing crop production.

Respondents were asked to respond to the choice of methods they apply in preventing soil erosion it was noticed that various methods are practiced such as grass planting (59.2 percent), contour farming (35.8 percent) and tree planting (*Mivengi*) and other trees that store water. These methods are helpful to some extent because they reduce the effect of erosion and elephant grasses are harvested as fodder for livestock. Kerr and Sanghai (1991) reported that, since 1920s numerous reports had warned against the disastrous effects of increasing erosion, land degradation, deforestation and mismanagement of natural resources due to increasing demographic pressure in East Africa.

4.6.4 Irrigation methods in *vinyungu*

Investigation was made to examine the way in which *vinyungu* plots/fields were irrigated and how these *vinyungu* were watered because it is a dry period agriculture.

Table 25: Irrigation methods in *vinyungu*

Ward	*Vinyungu* irrigation		Irrigating method		
	Yes	No	Use dip well	Small canals	Bucket water can
Mtitu	25	6	3	12	10
Ukumbi	39	6	7	5	25
Dabaga	15	28	2	13	
Total					
n	79	40	12	30	35
%	66.4	33.6	15.6	39	45.5

Data obtained in Table 25 indicate that many *vinyungu* plots were irrigated (66.4 percent) and 33.6 percent said they didn't irrigate *vinyungu*. The observation made showed that in only two villages, *vinyungu* plot were not irrigated because soil was always moist. This was noticed at Ng'ang'ange and Kidabaga villages; these villages are near the forest and many areas have been planted trees.

Through observation it was noticed that the irrigation schemes constructed allowed a large volume of water to sink in canals before the water gets to the *kinyungu* plot. Also many canals had been constructed locally and were old ones, hence water travels a long distance till to reach the field intended to irrigate. The local constructed canals were found in Mtitu and Ng'ang'ange where *vinyungu* activities were accumulated. According to Majule and Mwalyosi, (2003) the quantity of water per *kinyungu* per crop is determined by experience.

It also showed that a large volume of water was used during the dry period (July to November) in Mtitu River Basin. These canals which were locally constructed were distributed unevenly in valley bottoms and the amount of water used is unknown. Through discussion with respondents, there were small groups in each village known as Water User Association (WUA) in which each member paid for water used in irrigation and that they had a routine that was followed by each person. Irrigated land was far more productive than rain fed land, and the expansion of irrigated acreage over the past thirty years has contributed to gain in food production (World Resources, 1995). The World Bank (1991) has pointed out that irrigation has fundamentally influenced not only agricultural productivity but also incomes, employment and subsequently development

According to SMUWC (2001) drawing high volume of water in upstream of the Mtera reservoir particularly for irrigation activities is the root cause of low flow to the Mtera Dam. The majority of irrigators on the other hand were smallholder farmers. They argued that they either do not get their share of water or they get very little and too late to be of any significant use.

4.6.5 Existence of water use conflicts

An investigation was done to examine the conflicts associated with *vinyungu* and the problems accompanied by such practice. In Table 26, many respondents (68.3 percent) said, they had experienced water conflict several times especially where *vinyungu* were many and dry. Also, these conflicts rise in places with commercial *vinyungu* fields. It is so because farmers want to harvest many crops as a result large area is cultivated and it is by struggle for water. But conflicts that emerged were to some extent solved by the WUA, and all were based on water sharing mechanisms for irrigation purposes.

Vinyungu farming is practiced in valley bottoms and due to intensive cultivation they face a number of problems including over cultivation of land resource, intensive application of both chemical fertilizers and pesticides, intensive and unplanned use of water resource and conflicts particularly in land and water use/distribution. Land and water degradation was also a serious problem in valley bottoms farming due to poor management of these resources.

Table 26: Existence of conflict in water use (N = 120)

Ward	Any conflict in water use		Problems in *vinyungu* irrigation			
	No	Yes	Water decrease	Poor irrigation	Water distribution	Far distance
Mtitu	3	28	26	12	2	8
Ukumbi	12	34	30	10	1	13
Dabaga	23	20	14	13		3
Total n	38	82	70	35	3	24

%	31.7	68.3	88.6	44.3	3.8	30.4

The problems pointed out by respondents are listed in Table 26 and these include the decrease of water in streams (88.6 percent), many small streams that contribute water to Mtitu River have dried up and their drainage was decreasing year after year due to unplanned agriculture. The other problem in water conflict was the poor irrigating equipments/technology (44.3 percent) that farmers used. For example the use of several deep wells around the field hindered the natural drainage of streams while the use of buckets for large *vinyungu* plots was a tiresome job and consumed time, use of locally constructed canals lose much water through infiltration; the lost water through infiltration would be spent by other farmers in other places nearby. Effects for such poor irrigation schemes are the decrease in Little Ruaha River in dry season and hence less volume of water being contributed to Mtera Dam during summer.

4.6.6 Environmental conservation in Mtitu River Basin

The study examined the conservation of wetlands in valley bottoms in which *vinyungu* plots were extreme. It identified that there were some programmes that were carried on the district, concerning sustainability of *vinyungu* and their conservation to environment.

Table 27: Conservation strategies in valley bottoms (N = 120)

	Attending seminar for conservation		Government plan on *vinyungu* farming	
Ward	Yes	No	Stop *vinyungu* farming	Plan sustainable agriculture
Mtitu	31		2	29
Ukumbi	46		3	43
Dabaga	43		6	37
Total				
n	120		11	109
%	100		9.2	90.8

In Table 27 the response from respondents indicated that, farmers had attended several seminars for water and environmental conservation. Each respondent (100 percent)

interviewed said had attended workshops aiming to make valley bottoms become green and well nourished for the betterment of human life and biodiversity as whole. Through Focused Group Discussion, respondents pointed out that, the World Wide Fund for nature conservation; through the Ruaha Water Programme Office-Iringa is working on conservation of valley bottoms and wetlands/catchments and environment as a whole.

It facilitated many seminars in the Southern Highlands (Iringa and Mbeya regions) to restore the flow of water in the Great Ruaha River. Farmers in Kilolo were trained on better ways to conserve the valley bottoms and environment as a whole. These activities were carried out in association with the staff from Rufiji Basin Water Office (RBWO) based in Iringa. WWF formed various groups in each district that take care of the valley bottoms and rivers contributing water to the Great Ruaha River. In general the WWF office in Iringa has the following objectives:

i) Strengthening environmental conservation
ii) Restoring biodiversity (wild animals and plants) that are on the verge of extinction
iii) Strengthening and building capacity on Community Based Organizations (CBOs) that deal with environmental conservation.
iv) Disseminating environmental knowledge
v) Participatory encouragement to whole society in environmental conservation
vi) Facilitating planning, implementing and policy evaluation (WWF, 2004).

4.7 Summary

The chapter presented results and discussion of the contribution of valley bottom cultivation (*vinyungu*) to income poverty alleviation. Results showed that there were various agricultural activities (crop and animal husbandry) taking place in Mtitu River

Basin. The study in this chapter revealed that farmers in Kilolo District depend much from *vinyungu* for their livelihoods. Results of this study and findings from other researchers indicate that, the valley bottoms provide food crops and cash income to farmers in Kilolo District.

The chapter has also revealed the preference of farmers to valley bottom cultivation. Results indicate that farmers prefer *vinyungu* due to productivity of the soil as compared to upland farming which is cultivated at single season (during rain season); while *vinyungu* are cultivated throughout the year. Other factors observed to contribute the shift from upland are: infertility of the upland farms, long dry period which does not influence various crops through the year while valley bottoms favours crop rotation of different crops at short period (two or more crops are planted at the same time within the same piece of land).

Farmers preferred *vinyungu* farming due the following observed factors:

a) Wetness of the soil found in *vinyungu*

b) Vinyungu allow cropping throughout the year

c) *Vinyungu* produces (vegetables and other grown crops), are many as compared to upland farming, data obtained indicate three harvests per *kinyungu* per year

d) Water is available for the grown crops during dry period.

e) Coping strategy during dry period (July to November).

f) Crop productivity due to soil fertility

g) Food is available in household throughout the year.

The results in this chapter have revealed that, farmers for extent have knowledge on conservation of *vinyungu* in their farming fields.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This chapter gives a brief of conclusion and recommendations derived from the findings of this study. The conclusions and recommendations are presented according to the objectives of this study, in order to provide current information on the contribution of valley bottom cultivation (*vinyungu* farming) to poverty alleviation. Also providing impact of this type of agricultural farming to sustainability and environment conservation.

5.2 Summary of major findings

Valley bottoms are important landscapes and critical natural ecosystems that provide significant environmental and socio-economic benefits to farmers. Valley Bottoms function as sponges that store water and nutrients during the wet season and maintain base flow during the dry season and thus control floods, river and dam sedimentation and improve water quality (Roggeri, 1995).

Due to their productive soil with high nutrients and reliable moisture all the year round compared to the upland cropped land, valley bottoms have been found to be the most ideal resource for agricultural production and as such they are being rapidly converted into agricultural land throughout the country in order to produce food crops to ensure food security and cash income. *Vinyungu* faming system is basically a valley bottom form of agriculture practiced mostly in Kilolo and other districts in Iringa

Region. Studies conducted in Mtitu River Basin have indicated that the current *vinyungu* agricultural farming system which is practiced mostly in river valley bottoms, along river

side and in valley bottoms/catchments are beneficial to farmers since *vinyungu* provide both food and cash income to meet their daily life requirements. Despite the benefits obtained from *vinyungu* practice there also side effects to environment and have resulted into drying of some streams and water sources due to poor agricultural practices. The other effects are expansion and intensification of *vinyungu* farming to an extent that cultivation which was originally restricted to vegetables (small ridges of green vegetables), onions and potatoes has now been extended to farming other crops to increase yields.

Cash income obtained from valley bottom cultivation of *vinyungu* for poverty alleviation ranged between TAS. 20 000/= to 50 000/=to many respondents and few respondents reported to earn more than 100 000/= to 300 000/=for *vinyungu* per year. Hence *vinyungu* crops contribute a little to income poverty alleviation since what is sold is the surplus from food security. It is so because crops harvested from *vinyungu* fields are planted for household consumption and part of the harvest (surplus) is sold.

5.3 Conclusion

The following conclusions are made with regard to the study findings:

a) *Vinyungu* started with small scale cultivation of vegetables currently have gained popularity due their potential in cultivating multiple crops mainly for income and food security.

b) Various agricultural activities have been observed taking place in Mtitu River Basin, these include crop and animal husbandry. Many *vinyungu* fields are cultivated during dry period drain a large volume of water for irrigation from streams flowing nearby.

c) Canals constructed for bringing water in *vinyungu* are damaged and others are trapped distantly, hence much water is lost on the way through infiltration before

reaching to the field.

d) Farmers apply agrochemicals *in vinyungu* in order to increase yields. Some of these *vinyungu* are cultivated up to marginal areas, hence subjected to soil erosion and pollution (due to pesticides and insecticides) into water streams.

e) There was existence of by-laws and regulations that guide practice of *vinyungu*, the by- laws were set by farmers themselves (Water User Association) with help of District Facilitating Team (DFT) under financial support from WWF-Iringa. Under WUA farmers have set bylaws that limit them cultivating near catchments and along rivers.

f) Contribution of *vinyungu* (valley bottom cultivation) to income poverty alleviation in Kilolo District is beneficial to farmers as compared to upland farming. Therefore the alternative hypothesis is accepted and the null hypothesis is rejected.

5.4 Recommendations

Basing on the findings of this study the following recommendations are made

a) All the extended *vinyungu* plots/fields that are for commercial purpose should be abandoned; especially those along rivers, water streams for the regeneration natural vegetation. For it is this type *vinyungu* that may have caused deforestation, eroding river banks, and sedimentation in Ruaha River and Mtera Dam. Hence soils in upland fields should be improved for their fertility to increase productivity (yield).

b) Farmers should use organic manures in *vinyungu* farming obtained from local livestock in both up and low land; because most of upland farms have been cultivated for long periods so as to improve soil fertility

c) The established by-laws and regulations that limit them to cultivate very close to river banks and in catchments must be enforced. And whenever possible District

Land Use Sector should insert demarcations that indicate limits of cultivation.

d) Issues concerning soil conservation should pay attention to gender division of labour, decision-makers and control over land. More success will be achieved when the interest of women and men are properly explored and incentives to each group are attached to soil conservation packages.

e) Provision of adult education on environment conservation is an important key that and should be programmed in the district development schedules. It has been observed that, people in rural communities don't possess much knowledge in making the natural environment sustainable

f) In order to raise rural income, households should be encouraged to look for non-farm employment by engaging in small-scale income generating projects that require little capital and technical requirements.

It is important therefore for the Tanzanian Government to design programmes that may alert farmers on the benefits of this ecosystem. There should be seasonal outreach programmes that:

(i) Inform farmers on the range of benefits that can be derived from the valley bottoms and;

(ii) Encourage farmers to adopt farming methods that conserve the valley bottoms; that might offer an agreeable solution for the farmers to recognize the value of their valley bottoms.

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APPENDICES

SOKOINE UNIVERSITY OF AGRICULTURE

Appendix 1: Household members' questionnaire

SURVEY INSTRUMENT **Date: _____**

Impact of valley bottom cultivation (*vinyungu* farming) to income poverty alleviation in Mtitu river Basin

Questionnaire for household members.

Please, you are kindly asked to provide sincerely information on the following questions. All information provided will strictly be confidential

Respondents name _____

Village_____

Ward_____

Date_____

A: Background information (demographic)

Please tick (√) or fill where appropriate

1. How old are you? _____

2. Gender of the respondent

a) Male [ ],b) Female [ ]

3. Marital status

a) Single [ ], b) Married [ ],c)Divorced [ ], d) Widowed [ ]

4. How many are you in your household?

a) 1- 3 [ ], b) 4- 6 [ ], c) 7- 9 [ ] d)10 + [ ]

5. What is your highest level of education?

a) Primary school education [ ], b) Secondary school education [ ]

c) Post secondary school education [ ],

d) Others (specify) _____

6. What is your major economic occupation?

_____

a) Farming (specify) [ ], b) Livestock keeping (specify) [ ]

c) Both (a) and (b) [ ]

d) Wage employee [ ](specify)_____

e) Non farm business [ ] (specify)_____

7. Which properties of the following do you own in your household?

_____

Property	how acquired		allocated
	Bought	inherited	
Land	[ ]	[ ]	_____
Woodlot (forest)	[ ]	[ ]	_____
House	[ ]	[ ]	
Goats	[ ]	[ ]	
Cattle	[ ]	[ ]	
Sheep	[ ]	[ ]	
Donkey	[ ]	[ ]	
Chicken	[ ]	[ ]	
Pigs	[ ]	[ ]	

B: Land availability, ownership and cropping preference

8. What indicates ownership of land by a farmer in your villages? i) village government letter/certificate of ownership [ ] ii) local government letter/ certificate of ownership [ ] iii) title deed [ ] , iv) nothing [ ]

9. Do you own as much land as you need for agricultural activities?

i) Yes [ ] ii) No [ ]

10. If "No" how do you cope with the daily needs of your family?

_____

11. What are three most important crops grown for income generation in your household: i)_____ ii) _____ iii) _____

12. Which other important crops are grown for food availability within household?

i) maize [ ], ii) wheat [ ], iii) beans [ ], iv) sweet potatoes [ ], v) cabbages [ ], Pigeon peas [ ] , others specify

_____

3. What crops are grown in/around the wetland in the dry season?

Crops: _____, _____ ,_____

14. What are main crops grown in/around the wet season?

Crops: _____, _____, _____,

15. Do you own *vinyungu* for agricultural activities? i) YES [ ], ii) NO [ ]

16. What inspired/attracted people to cultivate *vinyungu*? i) cheap/easy to get [ ] ii) more productive compared to uplands [ ] , iii) cultivated throughout the year [ ], iv) dry season alternative (water availability) vi) close to people's working places [ ] vi) other _____

17. Do you practice crop rotation in *vinyungu*?

i) Yes [ ] ii) No [ ]

18. If "YES", how is the rotation from one season to another_____?

19. Are the *vinyungu* plots in your villages irrigated? I) Yes [ ], ii) No [ ]

20. If "YES" which methods of irrigation are used?

_____

C: Tools, input and output

21. What is the most commonly used method in vinyungu preparation?

i) Hand hoeing [ ], ii) Ox plowing [ ], iii) Tractors [ ]

22. Do you apply farmyard manure in *vinyungu* cultivation?

i) YES [ ] , ii) NO [ ] ,if NO go to #24

23. How is output (productivity) per *kinyungu* when manure is applied?

i) No change in output [ ] , ii) Output increases [ ].

24. What makes you do not apply manure in *vinyungu*?

_____

25. Do you apply fertilizer in the *vinyungu* cultivation? i) Yes [ ], ii) No [ ]

26. How is the yield per *kinyungu* as compared to manure application?

i) No change in output [ ] , ii) Output increases [ ], iii) Just the same [ ]

27. If No, what might have triggered the use of fertilizer? _____

_____

28. For what crops is the manure used?

_____ , _____ , _____ .

29. What types of manures are easily available and effective for crop yield?

i) Farmyard manure [ ] , ii) compost manure [ ] , iii) dung manure [ ] iv) Chicken manure [ ], v) pig [ ].

30. How is the manure used in agricultural activities obtained?

i) own animals [ ], ii) buy [ ]

31. Are there any other traditional methods that you use to improve the soil fertility of your land? i) Yes [ ]ii) No [ ]

32. If "yes", what are these methods? _____ , _____

33. Where do you obtain the cash needed to pay for farming expenses?

i)_____

ii)_____

D: Valley bottom cultivation preference

34. Why do you prefer *vinyungu* farming?

i) _____

ii) _____

35. When did you start practicing *vinyungu* farming in your village?

_____

36. What advantages do you find in *vinyungu* farming as compared to upland farming?

i)_____

ii)_____

37. How important to you are the *vinyungu f*or crop production compared to upland fields?

i) Very important [ ] ii) Important [ ] iii) Fairly important [ ]

iv) All important [ ]

38. How important to you are the *vinyungu* for income generation compared with upland fields?

i) Very important [ ] ii) Important [ ] iii) Fairly important [ ] iv) All have equal important [ ]

39. Is there more or less renting of land now than in the past? i) More [ ]

ii) Less [ ] iii) No change [ ]

40. What is the main reason? I) land unavailability [ ] ,ii) land very expensive [ ],

iii) others_____

E: Cropping and Land Use about 25 years ago compared to today.

41. Twenty five years ago, what were three main activities undertaken in the wetland by the villages around the Mtitu? (in order of importance) i) _____ ii) _____ iii) _____

42. Twenty five years ago, what were three main crops for food in your villages (rank in order of priority)?

i) _____ ii)_____ iii) _____

43. Thirty-five years ago, what were the 3 main crops for income in your villages (in order of priority)?

i) _____ ii)_____ iii) _____

44. Are there any new crops or varieties in this village now that were not grown Twenty five years ago? i) Yes [ ] ii) No [ ]

45. If yes, please list crops in order of importance i) _____ii)_____ iii) _____

46. When did you start to grow them? (Year) _____

47. What is the main driving force for farmers to grow the most popular new crop?

i) quick return for money & effort [ ] ii) less laborious [ ] iii) fetch more money [ ] , iv) needed to try different options [ ] v) strong marketing by outside sources [ ] .

48. Are there crops/varieties that you planted in the past that you no longer plant (or have sharply reduced planting)? i) Yes [ ] ii) No [ ]

49. If yes, which ones? i)_____ ii) _____ iii)_____

50. How can upland yields be compared to the past? i) increased [ ], ii) decreased [ ] iii) same [ ]

51. How would you describe the trends in *vinyungu* utilization?

i) uses have increased tremendously [ ] ii) uses have increased slightly [iii) uses have remained the same [ ] iv) uses have declined [ ]

52. How would you compare the current wetland size to that of the 1985s?

i) Has decreased [ ] ii) Has increased [ ] iii) No changes [ ]

53. How would you compare the current vegetation cover/ natural state of the wetland to that of the 1985s? i) has increased/improved [ ]ii) has decreased/declined [ ] iii) no change [ ]

54. What would you say about the current state of the soil erosion in this area especially around the wetland? I) No erosion [ ] ii) some erosion [ ] iii) highly eroded [ ]
55. What would you say about relations over use of water for cultivation in the valley bottoms? i) no conflict [ ] ii) some/rare conflicts [ ] iii) rare but huge/deadly conflicts [ ], iv) conflicts are often but not huge [ ] v) conflicts are often and very huge [ ].
56. What would you say about the population trends? I) has increased [ ] ii) has declined [ ] iii) no change [ ] iv) Don't know [ ]
57. Why do you think people chose this area for valley-bottom cultivation? i) lack of land [ ] ii) soil fertility [ ] iii) water availability [ ] iv) Other_____
58. Do you perceive agricultural activities detrimental to the valley bottoms? i) Yes [ ] ii) No [ ]
59. If "Yes", what has been the largest impact on wetland resources? i) reduced water flow [ ] ii) reduced soil fertility [ ] iii) soil erosion [ ] iv) human conflict [ ] v) other _____
60. Are there any management plans in your village with regards the future of the wetland resources? I) Yes [ ] ii) No [ ]
61. If "No", what would you say should be the number one undertaking or consideration for the future of the wetlands? i) drained/ further opened to economic [ ] ii) be left alone to recover [ ] iii) a land use plan developed to balance human and environment needs v) maintain the current status quo [ ] iv) Others _____
62. Have you ever been directed or advised by the government /NGOs on wise uses and strategies for wetlands? i) Yes [ ] ii) No [ ]
63. If yes, what kind of directives/advise?

_____

64. Why do you think the government has reduced or banned valley bottom cultivation?

_____

65. What do you think the government should do with regards valley bottom cultivation? I) ban it [ ] ii) promote sustainable cultivation through participatory management planning [ ] iii) should not interfere [ ] iii) others specify _____

Thank you for your cooperation

Appendix 2: Group checklist

SURVEY INSTRUMENT **Date: _____**

Impact of valley bottom cultivation to poverty alleviation in Mtitu river Basin

Sokoine University of Agriculture, Morogoro.

Please, you are kindly asked to provide sincerely information on the following questions. all information provided will strictly be confidential

I. Background

1 (a) Main tribe(s) _____

1 (b) Number of farmers present: i) Male [ ] ii) Female [ ]

1 (c) Name of village _____

II. **Land availability, ownership and cropping preference**

2 What indicates ownership of land by a farmer in your village?

3 What are the three most important crops grown for food in your villages? :

i) _____ ii) _____ iii) _____

4 What are the three most important crops grown for income generation in this village?

_____ _____ _____

4 What are the main crops grown in/around the valley bottoms (*vinyungu*) in the dry season?

i) _____ ii) _____ iii) _____

6. What inspired/attracted people to cultivate "*vinyungu*?

7. Do farmers in your villages practice crop rotation in *vinyungu* cultivation?

i) Yes [ ] ii) No [ ]

8. If "No" why is that the case? _____

9. Are the *vinyungu* plots in your village irrigated? I) Yes [ ] ii) No [ ]

III.Input, tools and labour

10. What is the most commonly used method of land preparation in the *vinyungu*

_____

11. Do farmers in your villages use fertilizer in the *vinyungu*? i) Yes [ ] ii) No [ ]

12. If No, what might have triggered the use of fertilizer recently?

    i) _____

    ii) _____

13. Do farmers in your villages use manure in *vinyungu* farming? i) Yes [ ] ii) No [ ]

14. Type of manure i) _____ ii) _____iii) _____

15. Where do you get the manure used in farming?

    i)_____ ii) _____

16. Are there any other methods (local/traditional) that you use to improve the soil fertility of your land? i) Yes [ ]ii) No [ ]

17. If yes, what other methods do you use? _____

18. Do you use hired labour in *vinyungu* farming? i) Yes [ ] ii) No [ ]

19. Where do you obtain the cash you need to pay for farming expenses?

    _____

IV. Valley bottom cultivation and its conservation

20. Why do you prefer *vinyungu* farming?

    i) _____ ii) _____

21. When did v*inyungu* farming activities start in your village?

    _____

22. What advantages do you find in *vinyungu* farming as compared to upland farming?

    i) _____

    ii) _____

23. Mention the crops you sell from *vinyungu* i) _____

    ii) _____ ii) _____

24. Where are the markets for the crops you sell?

    _____

25. What the uses of income generated from *vinyungu* farming?

    i) _____--____ ii) _____ iii) _____

26. How many *vinyungu* plots are cultivated per farmer?

    _____

27. What is the average income earned from *vinyungu* activities per year?

    _____

28. What makes farmers in your village shift from upland cultivation to valley bottom cultivation? I) _____ii) _____
29. How new *vinyungu* plots are prepared?

_____

V. Cropping and Land Use as compared today in *vinyungu* farming

30. What were the main activities taking place in valley bottoms from the past in this village? i) _____ii) _____
31. What activities are taking place today in valley bottoms that were not in the past? _____
32. What are the environment changes that have taken place in valley bottoms due agricultural activities? i)_____
    ii) _____
33. What changes are taking place in water flow where *vinyungu* farming are carried out?

_____

34. How can upland yields be compared to the past?

_____

35. How can *vinyungu* size be compared from the past? i) increased [ ] ii) decreased [ ] iii) same [ ]
36. How would you compare the current vegetation cover/ natural state of the valley bottoms to that of the past?
37. Why do you think people chose this area for valley-bottom cultivation?
38. What has been the biggest impact on valley bottom resources due to *vinyungu* practice?
39. Are there any management plans in your villages with regards the future of the valley bottom resources? I) Yes [ ] ii) No [ ]
40. If yes what management activities do you practice in conserving the valley bottoms?
    i)_____ ii) _____ iii) _____
41. Have you ever been trained by the government or NGOs on wise use strategies for management of wetlands?
    i) Yes [ ] ii) No [ ]
42. If yes, what kind of advise is your village provided?

i) _____ ii) _____

iii) _____iv) _____

43. Why do you think the government has reduced or banned valley-bottom cultivation ?

i) _____ ii) _____

44. What do you think should the government do with regards to valley-bottom cultivation? _____

Thank you for your cooperation