TRANSFER AND UTILISATION OF AGRICULTURAL IRRIGATION INNOVATIONS IN TANZANIA: A CASE OF BASIN IRRIGATED PADDY INNOVATIONS IN MVOMERO DISTRICT

BY

NOEL MANOA SOLOMON

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL EDUCATION AND EXTENSION OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

Use of improved technologies has remained the major strategy used by governments to increase agricultural productivity and promote food and livelihood security to smallholder farmers in different countries. However, irrigation schemes using water harvesting and simple river diversion practices produce the bulk of paddy for local consumption in Tanzania. Thus, this study was conducted to assess the extent of availability, transfer and utilisation of selected irrigated paddy production innovations in Mvomero district, Morogoro region. Specific objectives of the study were to: identify basin irrigated paddy production innovations available to the extension service; determine the extent to which basin irrigated paddy production innovations are transferred and utilised and identify factors contributing to success or failure in transfer and utilisation of basin irrigated paddy production innovations. Data were collected from 134 respondents comprising of 120 farmers, 4 village extension workers and 10 key informants using questionnaires, researcher's diary and checklist. Data were processed and analysed using programme for Statistical Package for Social Science (SPSS) and "content" analysis technique. The findings showed that available irrigated paddy production innovations appear difficult and not easily understood by farmers and field extension workers. The extent of transfer of irrigated paddy production innovations take the form of advice mainly through group and individual methods. It was concluded that some of the constraints to transfer such innovations are of extension nature while others are beyond the responsibilities of extension worker. The study recommended that efforts be made to refine basin irrigated paddy production innovations; design continuous process of training for extension workers and conduct case studies on acquisition of information by extension workers from district agricultural offices.

DECLARATION

I, NOEL MANOA SOLOMON, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has neither been submitted nor concurrently being submitted in any other institution.

Noel Manoa Solomon
(MSc AEE Candidate)

22/11/2011
Date

The above declaration is confirmed

Prof. R.M. Wambura

(Supervisor)

22/11/2011
Date

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DEDICATION

To my beloved father Solomon Nkigi and my mother, the late Maria who made a lot of efforts in laying down the foundation for my education.

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LIST OF ABBREVIATIONS

AR&D	Agricultural Research and Development
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
CSA	Carrot and Stick Approach
DADPs	District Agricultural Development Plans
DALDO	District Agriculture and Livestock Development Officer
DDA	Dual Development Approach
FA	Frontal Approach
FAO	Food and Agricultural Organisation
Fig.	Figure
IA	Improvement Approach
NARS	National Agricultural Research Stations
NGOs	Non-Governmental Organisations
NSGRP	National Strategy for Growth and Reduction of Poverty
O&M	Operation and Maintenance
PIM	Participatory Irrigation Management
R&D	Research and Development
RPOs	Rural Producer Organisations
SMS	Subject Matter Specialist
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
TA	Transformation Approach
TDT	Technology Development and Transfer

TDV	Tanzania Development Vision
URT	United Republic of Tanzania
USAID	United States Agency for International Development
WUA	Water Users Association

CHAPTER ONE

1.0 INTRODUCTION

This is a study of availability, transfer and utilisation of selected basin irrigated paddy production innovations in Mvomero district of the Morogoro region, Tanzania. Use of improved technologies has remained the major strategy used by governments to increase agricultural productivity and promote food and livelihood security in different countries. Traditional irrigation schemes using water harvesting and simple river diversion practices produce the bulk of paddy for local consumption in Tanzania. Farmers can potentially increase their productivity through adoption of river basin water management innovations, practices and technologies if appropriate extension services are put in place. However, many conventional extension approaches in Tanzania have received criticisms for being limited to demonstration of technologies, limited use of farmers' knowledge and using already packaged information. The purpose of this study was therefore to assess the extent of availability, transfer and utilisation of selected basin irrigated paddy production innovations in Mvomero district.

1.1 Background Information

The importance of irrigation for increased food production and food security need no emphasis (Newak, 1987). According to North (1994), 30-40 % of the world's food comes from the irrigated 16 % (about 250 million hectares) of total cultivated land. There are wide regional variations in the proportion of irrigated agricultural land: 38 % in Asia; 15 % in Latin America and 4 % in sub-Saharan Africa. Total irrigated land on the African continent is estimated to be about 12.2 million hectares. Six countries (Egypt, Madagascar, Morocco, Nigeria, South Africa and Sudan) account for nearly 75 % of the irrigated land in Africa. Shrestha and Chennat (1993) noted that in sub-Saharan Africa water control has, in the past, played relatively minor part in agricultural development. However, this is now changing. Many sub-Saharan African countries have realised the critical role of irrigation in food production. In these countries it is believed that a major part of new irrigation developments should be "small scale" if they are to meet the household, local and national food security objectives, ensure equity and usher sustainable rural development.

Place *et al.* (2002) noted that as African agriculture remains largely rain-fed and as water scarcity issues are receiving much more prominence, more work on technology development and adoption studies in this area are anticipated. Science and technology policies have been evolving throughout time and are understood in the context of innovation systems, which means that there are many related actors and the development and utilisation of science and technology takes place through complex process. Technological change has been the basis for increasing agricultural productivity and promoting agricultural development in many countries. A feature of successive government agricultural extension service organisations in several countries in many decades has been the free flow of knowledge between researchers in different disciplines, extension agents and farmers (Seville, 1965; Maunder, 1972; Garforth *et al.,* 2003). The system of agricultural extension work in Tanzania (mainland) that has been practiced and developed over the years is basically run by the government. It involves the attempts to change or influence local people's farming practices (DeVries, 1978).

Ponjee (1979) noted that the pre-independence experience with agricultural extension and settlement led in part to adoption of a "Dual Development Approach (DDA)", the "Transformation Approach (TA)" and "Improvement Approach (IA)" in Tanzania. The

TA aimed at modernising agriculture through planned village settlement schemes with expensive capital investment, trained management personnel and modern technology. The IA sought to gradually improve traditional agriculture through extension and credit programmes among small scale farmers and by encouraging cooperatives production in villages. By mid-sixties the failure of the dual approach was apparent. Most settlement schemes were overcapitalised and poorly planned. They led to the creation of spoon-fed dependent and privileged class of farmers who became source of envy and irritation to the rest of the rural population. The hope for demonstration effect also failed to materialise as very few farmers had resources to support the application of what they learned. The improvement approach seems to have been more successful although it also encountered major problems. Since early adopters controlled considerably more resources than average farmers, the latter could not follow this example. The improvement approach contributed to increased rural class differentiation which was contradiction of the country's policy which espoused socialism and equity.

In 1967 Tanzania revisited its development policy, resulting in restatement of development goals and strategies in the Arusha Declaration (Nyerere, 1967). As a result of Arusha Declaration, Tanzania's Five Year Plan (1969-1974) adopted the "Frontal Approach (FA)"to socialist development. According to this approach a whole range of government and political institutions were to be mobilised behind socialist principles. Efforts to educate and politicise the peasants largely gave way to use of government controlled rewards and pressures, a combination which was also sometimes known as Carrot and Stick Approach (CSA) to village development. Adoption of Arusha Declaration in 1967 set the scene for a more interventionist state committed to stepping up the pace of development in the country. In the interventionist regime the aim was to modernise the agricultural sector through facilitation of diffusion of new technologies into the sector by providing free agricultural extension services, subsidised farm implements and subsidised inputs on credit basis (Nyerere, 1967).

Mounting economic difficulties led to a policy shift towards a free market economy in mid 1980's, where all types of public support to the agricultural sector were eliminated resulting in unsatisfactory performance of the agricultural sector and mounting poverty (URT, 2003). According to URT (2004), the current research and extension system in Tanzania is mainly public funded, although decentralising and rightsising the research establishment have relieved the government's budget strain through complete privatisation of major cash crops. Decentralisation has put extension services under the local government authorities to enhance greater client participation in technology development and transfer (TDT) and making these processes participatory as opposed to the previous centralised top-down set-up. It has in addition, brought research and extension closer to better save the farmers. Agricultural research has major role to play in increasing productivity and profitability of the agricultural sector through development of scientific knowledge to generate improved technologies for production systems. Agricultural extension complements this effort by transferring technologies developed by national research stations to the farmers.

Tanzania's agriculture is facing a great general opportunity to transform itself from a traditional, rather backward system, to a modern, strongly commercial sector (URT, 2006). Under the Tanzanian Strategy for Growth and Reduction of Poverty (NSGRP/MKUKUTA) and in line with the Agricultural Sector Development Strategy (ASDS), irrigation has been declared a particularly high priority. The Agricultural Sector

Development Programme (ASDP) now includes two components. One is concerned with demand-driven smallholder schemes implemented at district level. The other which operates at national level, is concerned with operation of irrigation services, the development of bulk service infrastructure and the facilitation of increased private sector irrigation and service delivery. At the same time the ASDP, including its irrigation components, is predicated on broader assumption that agriculture is being comprehensively decentralised and that local demand for services to the sector, including irrigation services, will be included in the District Development Plans (DADPs).

Morogoro region (where data for this study were collected) is one of the 29 administrative regions in Tanzania (Fig. 1). The region has an area of 70 799 km^2. Administratively it is divided into 6 districts of Morogoro Urban, Morogoro, Mvomero, Kilosa, Kilombero and Ulanga. It comprises of 543 villages which are grouped into 141 wards with a population of 1 759 809 at annual growth rate of 2.6 % (URT, 2008). Due to fertile soils, favourable rainfall and wide range of altitudes, a considerable number of crops are grown in the region. Sisal is the major export crop grown in large scale plantations, while coffee and cotton are grown on limited scale by smallholder farmers. Major food crops produced are maize, paddy, sorghum, sugarcane (mainly grown on large scale plantations), cassava, oil seeds and pulses.

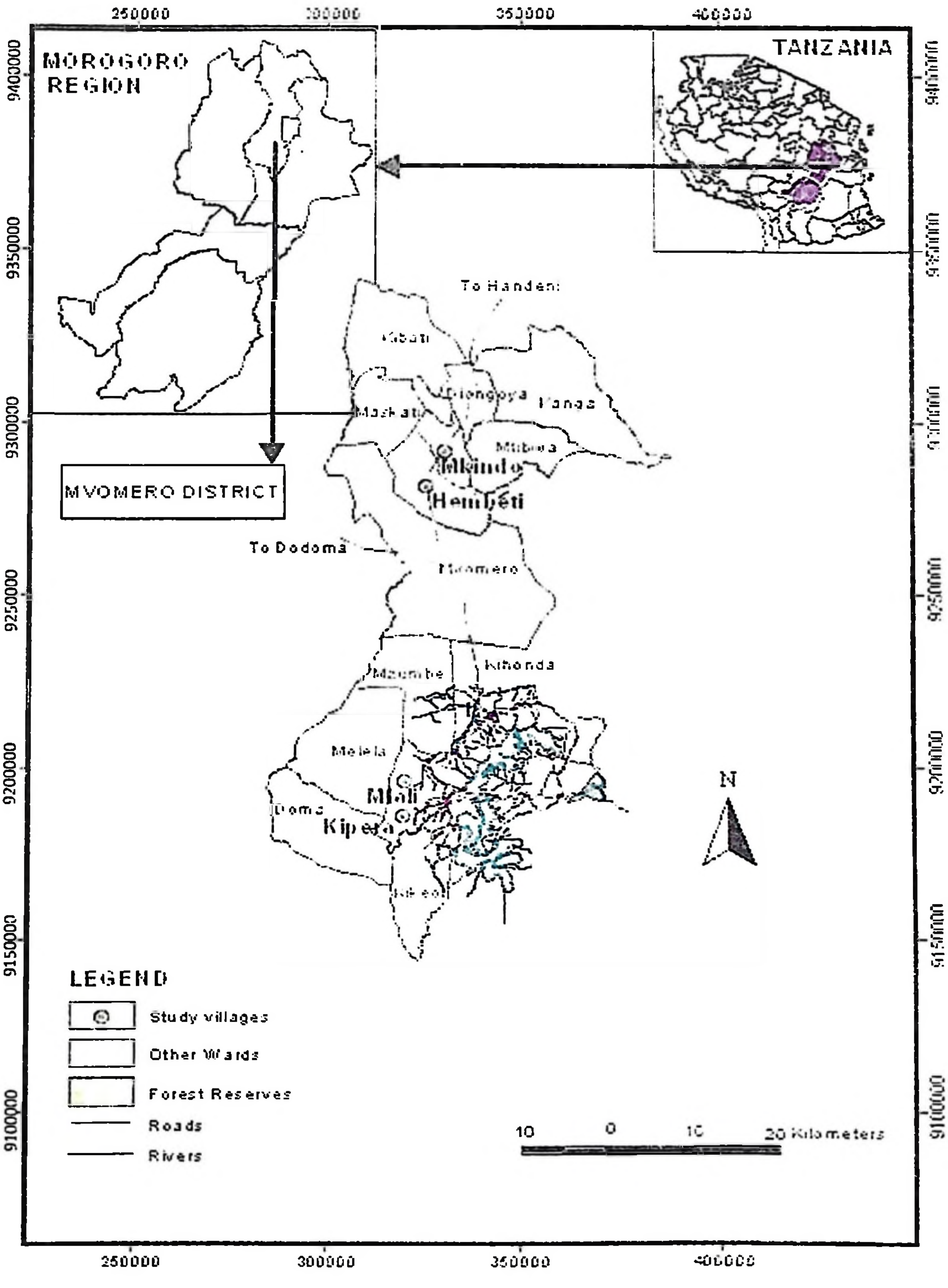

Figure 1: Morogoro region map showing Mvomero district and the study villages

According to Nkonya *et al.* (1997), the smallholder farmers in the region traditionally use water as a common property. Water is used according to customary laws of each area and proximity guides the rights to use water. Two major sources of basin irrigation system are common in smallholder irrigation: direct river diversion and water harvesting. Other sources used on limited scale include shallow wells and small earth dams. Mvomero district farmers are among the farmers who use basin irrigation system and need utilisation of appropriate basin irrigation innovations. The district (Fig. 1) covers about 7 332 500 ha comprising a population of 260 525 at a growth rate of 2.6 % (URT, 2008). The extent of availability, transfer and utilisation of basin irrigated paddy innovations and their policy implications remain to be clarified by this study. With this in mind, the problem outline for the study is set in perspective.

1.2 Problem Statement and Justification of the Study

The Tanzania Development Vision (TDV) has set a target of achieving a level of general standards of living typical of medium income countries by year 2025 (URT, 2005). Use of improved technologies has remained the major strategy for government increase agricultural productivity and promote livelihood security (Place *et al.*, 2002). Traditional irrigation schemes using simple river diversion and water harvesting produce the bulk of paddy for local consumption in Tanzania. Agricultural research has a major role to play in increasing productivity and profitability of the sector through development of scientific knowledge to generate improved technologies for production systems. Agricultural extension complements this effort by transferring technologies developed by the national research stations (NARS) to farmers.

Farmers can potentially increase their productivity through adoption of innovations, practices and technologies if appropriate extension services are put in place. However, many conventional extension approaches in Tanzania have received criticism for being limited to demonstration of technologies, limited use of farmers' knowledge and using already packaged information (USAID, 1995). This criticism has focused partly to performance of extension workers in rural areas who form the backbone and offer a good basis on which to establish a more effective system for dissemination of extension innovations from research institutions. Extension workers are perceived as being unable to influence farmers' agricultural practices and thus being ineffective in their job. This study, therefore, intended to concentrate on innovation dimension. It sought to determine the availability of suitable selected basin irrigated paddy production innovations to the smallholder farmers and assess the extent of transfer and utilisation of such innovations, in order to ascertain the extent to which they could be integrated within the farming systems and made the engine of economic growth and poverty alleviation in Tanzania.

1.3 Objectives

1.3.1 General objective

To assess the availability, transfer and utilisation of selected basin irrigated paddy production innovations in Mvomero district.

1.3.2 Specific objectives

(i) To identify basin irrigated paddy production innovations available to the extension service.

(ii) To determine the extent to which basin irrigated paddy production innovations are transferred and utilised.

(iii) To identify factors contributing to success or failure in transfer and utilisation of basin irrigated paddy production innovations.

1.4 Research Questions

(i) What basin irrigated paddy production innovations are available to the extension service in Mvomero district?

(ii) Do farmers receive any advice on selected basin irrigated paddy production innovations from field extension agents or other sources? If so, in what way(s) does that advice reach them?

(iii) What is the state of farmers with regard to knowledge, trial and adoption of selected basin irrigated paddy production innovations?

(iv) What are the characteristics of innovations and how do these characteristics affect the transfer and adoption or rejection of selected basin irrigated paddy innovations?

1.5 Operational Definition of Key Terms

The terms that will be used frequently in the text are defined here to provide a common basis for conveying meaning. These include: irrigation, basin irrigation system, poverty alleviation/reduction; rural/agricultural development; agricultural extension; extension agents; technology; innovation; availability of innovations; transfer of innovations, adoption/rejection of innovations and key variables used in the study.

1.5.1 Irrigation

Irrigation has been defined as an art of supplying crops with water by means of rivers and pipes (Carter, 1986). In this study, it refers to practices of supplying water from rivers as water sources to basin irrigated paddy production by smallholder farmers.

1.5.2 Basin irrigation system

Basin irrigation system has been defined as surface irrigated area which has no longitudinal slope and complete perimeter dikes/bunds to pond water and prevent run-off (Walker and Skogerboe, 1987). Level basin systems are used for growing paddy. In this study, it refers to all surface irrigated areas with level basins surrounded by dikes/bunds (embankments) to pond water used by smallholder farmers for the purpose of growing basin irrigated paddy in the study area.

1.5.3 Poverty alleviation/reduction

Poverty alleviation is a strategy that seeks to reduce the level of poverty in a community, or people or countries. It involves improving the living conditions of people who are already poor. Bagachwa (1994) and Makombe (1999) define poverty reduction as lifting the poor out of poverty. According to Limbu (1995), poverty reduction entails increasing the ability of people to acquire necessities, namely: adequate food; adequate and decent clothing and better shelter/housing that include better places to sleep. In this study, the term poverty alleviation/reduction will be used interchangeably to mean increased income and decreasing inability to attain the basic needs of the smallholder farmers through basin irrigated paddy farming in the study area.

1.5.4 Rural/agricultural development

Rural development is a process integrated in economic and social objectives, which must seek to transform rural society and provide better and more secure livelihood for rural people (Jones, 1986). In this study, the term rural and agricultural development will be used interchangeably to mean the perception of smallholder farmers in rural areas of possible and often new ways and means of developing their economies through basin irrigated paddy farming.

1.5.5 Agricultural extension

Agricultural extension is a system of informal education, which assists farmers to improve farming methods and techniques through the application of scientific knowledge (Maunder, 1972). In this study, it refers to the transfer of information to smallholder farmers involved in basin irrigated paddy farming in Mvomero district to enhance the transfer of the selected irrigation innovations.

1.5.6 Extension agents

Extension agent is an individual who is fully employed and engaged in extension work in rural communities (Swanson and Claar, 1984). In this study, it applies to the staff employed in Mvomero district council responsible for extension work in villages where the study was done.

1.5.7 Technology

Technology is broadly defined as a mix of knowledge, organisations, procedures, machinery, equipment and human skills to produce desirable appropriate products (Rosenberg, 1976). Also sometimes it refers to the application of science to practical tasks in agriculture and industry. In this study, it refers to application of science to practical tasks in basin irrigated paddy farming in the study area.

1.5.8 Innovation

Rogers (2003) defined an innovation as "an idea, practice, or object that is perceived as new by an individual or group of individuals". In this study, an innovation means ideas or practices but more often new combinations of existing elements as perceived by the smallholder farmers practicing basin irrigated paddy farming in the study area.

1.5.9 Availability of innovations

Availability of innovations refers to a situation whereby innovations can be easily used or obtained by an individual (Rogers, 1995). In this study, it refers to simplified ideas or innovations to the extent of being easily utilised by the smallholder farmers practicing basin irrigated paddy farming in the study area.

1.5.10 Transfer of innovations

Transfer of innovations generally refers to the process by which innovations produced or generated in one place become transferred to another (Anderson, 1994). In this study, it refers to the process by which basin irrigated paddy farming innovations are transferred to smallholder farmers in the study area.

1.5.11 Adoption/rejection of innovations

The terms refer to a decision to apply or fail to apply an innovation and continue or not continue to use it (van den Ban and Hawkins, 1996). It is a decision to make full use of a new idea as the best course of action or fail to make use of such an idea. Sometimes also is referred to as innovation-decision process and it involves: awareness; interest; evaluation; trial and adoption. In this study, it refers to the decisions made by the smallholder farmers to utilise or not utilise the basin irrigated paddy farming innovations in the study area.

1.5.12 Key variables used

The definitions of key variables (background, independent and dependent variables) used in the study are given in Appendix 1. Literature review is presented in the following Chapter.

CHAPTER TWO

2.0 LITERATURE REVIEW

This Chapter reviewed literature of other study findings so as to provide a theoretical framework which guided the development of the conceptual framework on which the analysis of data for this study was based. It focuses on: irrigation; rural/agricultural development; agricultural/irrigation innovations; availability of innovations; transfer of innovations; adoption/rejection of innovations and conceptual framework for analysis of the study data.

2.1 Irrigation

In the past, increases in agricultural production have come about through expansion of land under cultivation, crop intensification and yield improvements. There are signs, however, that water will become a limiting factor in all three methods of expansion (URT, 1996). In the face of rapid population growth, irrigation will play an important role in the effort to increase and sustain food and cash crop production. Effective crop production under irrigation requires adequate management and efficient use of irrigation water, particularly in poor countries, where greatest potential for increasing crop production is often to be found in irrigated agriculture (FAO, 1998).

Many studies on smallholder farmer managed irrigation systems have been carried out in Tanzania. However, most of these studies dealt with evaluation of performance of irrigation systems and water management aspects particularly in operation, maintenance, formulation and organisation of water users (WUA) and their related problems (Angeir, 1992). FAO (1998) studies in Mombo and Majengo irrigation schemes reported that the main reasons for poor operation and maintenance of smallholder irrigation schemes in

Tanzania are inadequate resources which have been spread too thinly; financial resources which meant that construction has been done badly and not completed; and very little effective support has been given to farmers to either complete or operate the schemes.

In Africa, a number of innovations in irrigation and water harvesting have been documented (Reij and Waters-Bayer, 2001). These include; harvesting of rain water to irrigate coffee plants in the central highlands of Ethiopia; economising of water through pits in Burkina Faso; the infiltration ditches and trenches in northern Zimbabwe; the use of upturned plastic bottles to irrigate melons and traditional techniques of harvesting rain water in the arid areas of Tunisia. Irrigation innovations in response to the market are some of the innovations to be mentioned. Obliviously, farmers are keen to seek solutions to old and new problems through experimentation. Propensity to experiment and try out new ideas may be more pronounced in areas of diversified agriculture and poor extension services like in Africa than in developed countries with less diversification and excellent research and extension facilities (Sawadogo *et al.*, 2001). Therefore, Africa still has a major resource waiting to be tapped, and that is the creativity of its farmers.

Ethiopian farmers have been practicing traditional irrigation to cope up with climate variability and rainfall uncertainty since long time. Such practices are supported by farmers' innovations. In their innovations, farmers are often ahead of the scientists. According to Heemskerk (2005), a study on participatory irrigation management (PIM) reforms implemented in India to facilitate farmers' participation in irrigation management, through water user groups, revealed that there was an inefficient water use, social power capture by rural elites in the name of participation, inadequate support from government institutions and government's inability to alleviate poverty.

According to Namara *et al.* (2003), studies on irrigation water management under the right conditions do lead to substantial improvements in households' food security and incomes, and they do so in a cost-effective manner. This is especially true for treadle pumps, low cost drip and sprinkler systems, the system of paddy intensification, clay pot irrigation, conservation farming practices that integrate nutrient and water management, a variety of in-situ and ex-situ water harvesting and storage technologies. Namara *et al.* (2003), further observed that despite the significant economic advantages and the concerted support of the government and NGOs, the extent of adoption of irrigation water management technologies remains unsatisfactory.

Feder *et al.* (1985), in a study on farmers in China operating a small-scale surface irrigation technology, namely, basin check irrigation revealed that they consumed much less water than other surface irrigation technologies although that scheme required investment in terms of labour. The study further revealed that traditional surface irrigation still played an important role to those farmers. On the other side, the study revealed that broadly adopted modern irrigation technologies by farmers left more water in the canal, so that more farmers could benefit from public water conveyance systems and consequently improving the overall water efficiency. In addition, Gillies *et al.* (2008), on a study of improving the performance of basin irrigation layouts in Australia, observed that the design and performance of basin irrigation systems in the rice growing areas improved water productivity, reduced risk of water logging, increased range of crop that could be grown profitably, reduced operating costs (machinery and labour) and environmental costs.

2.2 Rural/Agricultural Development

Development incorporates economic growth, but adds to the conditions that the majority of the population benefits from this increase (growth and equity) and that basic needs such as food, shelter and water are met (Todaro, 1989). Oakley (1991) notes that rural development is a process integrated in economic and social objectives, which must seek to transform rural people and provide better and more secure livelihoods for rural people. Rural development therefore is a process of analysis, problem identification and proposal for relevant solutions. This process is usually encompassed within a programme or project which seeks to tackle problems identified. Jones (1986) observed that rural development involves the perceptions of rural people of possible often new ways and means of developing their economies. He noted that usually this implies the development of agriculture as a means to an end; rural development also involves the active concern of improvement of wealth and well being of all rural inhabitants. Ascroft and Rolling (1985) noted that agricultural development in the broader sense requires a number of conditions which have been called the mix, following the market tradition. He further observes that "the essence of the mix is more than the sum". He names the elements of the mix as: good farm prices; accessible markets and credit; technology development; processing facilities and extension.

In the 1960s and 1970s rural development approaches tended to be rather top-down and based on delivering technical solutions to the farmers without considering their needs, aspirations and priorities (FAO, 1995). The solutions were usually technically sound, developed by agricultural research. However, they did not fit the farmers' requirements and abilities. Often research efforts on sophisticated systems that required high level of external inputs like hybrid varieties, irrigation, agrochemicals and machinery, not taking into account that most farmers have restricted or no access to these inputs and usually cannot afford buying them (Haverkort, 1991). Consequently the developed technologies were incompatible with the socio-economic context of the farmers and hence not adopted.

2.3 Agricultural/Irrigation Innovations

Innovation refers to the process of creating and putting into use combinations of knowledge from many different sources (Mytelka, 2000). Thus, innovation may be brand new, but usually it involves new combinations of existing knowledge, i.e., small, gradual changes in technology, processing, organisational management, and/or creative imitation. This implies that it is not just an invention of a new idea, but that this idea is actually "brought to market", used, put into practice, exploited in some way and may be leading to new products, processes, systems attitudes or services that improve something or add value (Lado, 1989). Rogers (1983) noted that there are different kinds of innovations: The main ones are: (a) incremental innovation (where something is adopted or modified) which may mean that an idea is transferred to a new setting or that existing ideas are embedding in a new setting; and (b) radical innovation (which involves completely new ideas). Gupter (2000) observed that agricultural development requires and depends on innovation, which has been considered to be a successful application of knowledge with social and economic difference. Innovation as a process and outcome is therefore crucial in irrigation development. A good innovation should have five attributes, namely: relative advantage; compatibility; complexity; triability and observability (Rogers, 1995).

Studies on irrigation water management in the Nile Delta in Egypt had an effort to make water delivery more efficient and responsive to farmers' needs (Sumberg, 2004). Findings from this study revealed that by replacing open or lined canals with piped canals improved water levels, distribution, reduced water loss, lowered operating costs of irrigation schemes and increased farm efficiency. Also studies in Asia on irrigation methods (drip irrigation and micro-irrigation versus standard sprinkler systems), management models (information services for farmers), new technologies (automated delivery systems) and the water intake and distribution grids (replacement of open-air irrigation channels with conduits and repairing the existing ones) revealed that furrow irrigation leads to substantial water loss through evaporation and infiltration. On a more local level, replacement of sprinklers by drip systems and micro-spray systems could achieve savings (Sumberg, 2005).

Scoones (1995) confirmed the prevalence of innovation and adaptability among African pastoral groups. New agricultural technologies are considered to have been determinant in sub-Saharan African agriculture. Agricultural Research and Development (AR&D) therefore features prominently in agricultural development policies. Over the last two decades the context for agricultural development and innovation has changed thus affecting AR&D institutions and Rural Producer Organisations (RPOs) (Feder *et al.*, 1995). Hussain *et al.* (2003) noted that a study on irrigation innovations such as operation, maintenance and system performance in South East Asia in gravity-fed irrigation schemes in the paddy fields determined whether and how quality of operation and maintenance (O&M) services influenced the sustainability of irrigation schemes. Findings from this study revealed that paddy irrigation schemes faced an uncertainty due to the fact that they offered poor economics and low incomes in future; hence improved (O&M) performance could not rescue farmers. Hussain *et al.*, (2003) further observed that lack of competitiveness of paddy farming drived younger family members off the farms and the older members who stayed behind concentrated on basic subsistence crops, social capital would erode and O&M standards were likely to suffer.

2.4 Availability of Innovations

2.4.1 Traditional/indigenous innovations

Most recent African indigenous knowledge literature, especially in agriculture, emphasises that Africans are innovators. Good examples of local innovations and discoveries include (Feder, 1993): crop breeding, grafting against pests: water harvesting; soil management; conservation and processing. Indigenous agricultural innovations have continued to be important as most of the locally grown food is for local consumption. One of the salient features of traditional farming systems throughout the developing world is their high degree of biodiversity. These traditional farming systems have emerged over centuries of cultural and biological evolution and represent accumulated experiences of indigenous farmers interacting with the environment without access to external inputs, capital, or modern scientific knowledge (Chang, 1977; Grigg, 1974).

Using inventive self-reliance, experiential knowledge, and locally available resources, traditional farmers have often developed farming systems with sustained yields. For example in Latin America alone, more than two and a half million hectares under traditional agriculture in the form of raised fields, poly-cultures and agro-forestry systems document a successful adaptation to difficult environments by indigenous farmers (Altieri *et al.*, 1991). Many of these traditional agro-ecosystems, still found throughout the Andes, Meso America and the lowland tropics, constitute major in-situ repositories of both crop and wild plant germ plasm. From an agro-ecological perspective, these agro-ecosystems can be seen as a continuum of integrated farming units and natural or semi-natural ecosystems where plant gathering and crop production are actively pursued.

Nabhan (1983) noted that plant resources are directly dependent upon management by human groups; thus, they have evolved in part under the influence of farming practices shaped by particular cultures and the forms of sophisticated knowledge they represent. Perhaps the greatest challenge to understanding how traditional farmers maintain, preserve and manage biodiversity is to recognise the complexity of their production systems. Today, it is widely accepted (Liebowitz, 1999) that indigenous knowledge is a powerful resource in its own right and complementary to knowledge available from western scientific sources. Therefore, in studying such systems, it is not possible to separate the study of agricultural biodiversity from the study of the culture that nurtures it. Liebowitz (1999) explained the features of biodiversity inherent to traditional agro-ecosystems, and the ways in which peasants apply local knowledge to manage such biodiversity to satisfy subsistence needs and to obtain ecological services. Traditional agriculture is rapidly disappearing in the face of major social, political, and economic changes; therefore, a case is made herein for the preservation of these traditional agro-ecosystems in conjunction with the maintenance of the culture of the local people. The conservation and management of agro-biodiversity is not possible without the preservation of cultural diversity.

2.4.2 Generation of modern/scientific innovations

Backer (1994) noted that there are several stages in generation of innovations. The first stage is the discovery, characterised by the emergency or a concept or results that establish the innovation. A second stage is development where the discovery moves from the laboratory to the field and scaled-up, commercialised and integrated with other elements of production process. According to Kagashiemi (2002), in case of patentable innovations, between time of discovery and development, there might also be a stage where there is registration for patent. If the innovation is embodied once it is developed and it is to be produced and marketed. For embodied innovation the marketing stage consists of education, demonstration and sale.

Different empirical studies have shown that knowledge, in fact, cannot be easily generated in research organisations, and passed down to the extension services and development projects which diffuse it among farmers (Warren, 1989). In response, new ways of managing knowledge have emerged across developing countries, focusing on new dynamics such as participation, collaboration and joint learning between farmers and other agents contributing to the development and diffusion of knowledge beyond the traditional farmer-extension link. The foundations contract knowledge suppliers, such as research organisations and private knowledge consultants, to transfer knowledge to the farmers. Implicitly, this scheme promotes a form of knowledge management that reaches beyond the farmer-extension link, involving a third institution – the regional foundations – as promoters, analysts, financers and coordinators of knowledge exchange. The scheme has proved successful in terms of financial management and identification of demands for technology although there has been some criticism of the ability of the system to reach all farmers and whether it has sufficient impact on improved livelihoods.

Knowledge management is concerned with ways of exchanging knowledge among those who can develop it and those who can use it. The lack of exchange of knowledge among and between farmers, and those who produce of farm-relevant knowledge, has often been regarded as the key issue in pro-poor agricultural development (Leeuwis, 2004). For that reason, many agricultural extension and development programmes, run by both governments and international donor agencies, have focused on diffusing knowledge to farmers who, in turn, were expected to gain from applying this knowledge in their production practices. Knowledge can be understood as both information and skills that are acquired through individual experience, trial and error, within an organisation or a learning community, or from outsiders adapting it to local contexts. Knowledge that rural and farming communities are typically interested in includes cultural management practices; new agricultural technologies; diagnostic information about plants, animal diseases and soil related problems; market information on inputs and sales (prices, seller, buyers, retailers); market demand and quality of products required for these markets; and land records and government policies. The concerted efforts and practices used by organisations and individuals to identify, create, accumulate, re-use, apply and distribute knowledge are commonly labeled knowledge management.

Knowledge management in developing countries, however, has a distinct connotation. For example, small farmers do not need to look for cutting edge technology. Rather, they need to get access to the often abundantly available knowledge that can improve their livelihoods (Liebowitz, 1999). Extension and development agencies try to assist farmers to access this type of knowledge but they are often biased to a certain trajectory of development, e.g. new plant varieties or processing technologies, where they have comparative advantages and can leverage funding. Poor farmers, however, would not feel comfortable to absorb one type of knowledge promoted by a certain technology provider if they have not cross-checked its usefulness with other farmers, community members and authorities, other development agents and even with product buyers. The issue here is that farmers try to reduce risk by contacting multiple sources of information in order to trust in a certain type of technology.

First-generation knowledge management, both in the corporate sector as in agricultural development, has emphasised a top-down and technological perspective where the main goal was getting the right technological information to the right people at the right time. Rolling and van de Fliert (1994) found that most investments in agricultural research and extension were based on the assumption that agricultural science generates technology which extension experts transfer to users, ignoring local knowledge creation and sharing, as well as the relevance of articulating demands by farmers and promoting their self-confidence and empowerment.

During the last decades this approach has been repeatedly put in question (Chambers *et al.,* 1989; Russel and Ison, 2000; Leeuwis, 2004) and more balanced approaches have become common where the focus is not only on the supply side but also on satisfying the demand for the production of new knowledge. It has been shown (Inkpen, 1996; Sveiby and Simons, 2002) that for the corporate business sector, relevant knowledge is created collectively, in groups, through mechanisms of networking and communication. For the agricultural sector Sumberg *et al.*, (2003) have argued that for knowledge to be absorbed by the community of users, it needs to get applied, reworked, adjusted and improved. Today's second-generation knowledge management emphasises collaboration in the management of knowledge.

However, second-generation knowledge management is not to be achieved by simple means. Scoones (1995) argued that knowledge management cannot be improved by simple measures, such as by transferring power from the outside to the inside, from researchers to farmers, but only through complex social processes that do not necessarily follow systemic patterns. According to Sorenson *et al*., (2006), knowledge creation requires knowledge management practices capable of involving multiple agents, consistent with recent approaches to innovation based on the ideas of auto organisation of entrepreneurs (Miles *et al*., 1997), social R&D networks and complex adaptive systems (Kauffman,1995).

In a complex adaptive system, individuals and organisations act and survive by adapting and learning to organise themselves into communities, providing the necessary ground for the creation and improvement of knowledge. Agents in such a system are free to act and learn independently or collectively. In other words, their collective behavior is complex, not managed from above but emergent from the structure of the network of interactions in which they are embedded. Creativity and innovation increase with the diversity of the members in the system, and the levels of learning and adaptation increase with the density of communication within the system. According to Sorenson *et al*. (2006), research is an important component but not always the central component of innovation. Knowledge created by research is a fundamental building block of an innovation system. The path to using that knowledge successfully in an economy depends, however, on the time and place at which it enters the innovation system. The knowledge created through research can be spatially and/or temporally separated from the innovation system where it is used. Research is an important source of knowledge for innovation, but it serves principally as a complement to other knowledge and other activities.

2.5 Transfer of Innovations

Feder *et al.* (1985) observed that agricultural extension system in developing countries has always been challenged with the task of transferring agricultural innovations from the researcher to the farmers. The major role of extension system is therefore to facilitate such a link. This is viewed as a three step process passing scientific information in agriculture from research scientist to the extension worker then the participating farmer. For effective performance of extension worker it is imperative that he be conversant with the communities at both ends, which are the research and farming communities. He must therefore himself be a liaison between research and farmers for transfer of innovations from research centres to farmers and farmers to research centres, especially indigenous/traditional innovations. The extension service plays a major role in innovation transfer.

World Bank (1992) argued that researchers can take care of generating appropriate technologies to Tanzanian condition in a well controlled micro-climate but agricultural extension services is most necessary to disseminate what has been generated to the farming community. The extension service in general covers institutional and/or approach adopted to transfer technologies. The professional and technical competence of extension workers are probably the most important input to any country's extension system. According to Rolling and de Jong (1999) many extension scientists are now convinced that, it is no longer desirable to use transfer of technology approach in which the extension administrators decide on the targets to be realised by the field level extension agents. A more participatory approach is instead preferred, in which farmers decide which changes are desirable and what kind of support are needed for extension to realise these changes.

Nelson (1993) suggested that innovations transferred to farmers have to be appropriate, i.e. tied to other economically beneficial activities that address the expressed need for food security, income generation, risk management and social objectives of the rural poor and build from knowledge, capital and expectations of local communities. The extension service in general covers institutional set up including staffing and strategy and/or approach adopted to transfer technologies. Feder (2003) found that the diffusion of information in a social system depends on interpersonal communications among individuals. These horizontal communications occur between farmers with similar social and economic characteristics and who are able to persuade each other to adopt innovations and knowledge. Individuals from other communities, who are identified as outsiders of the social structure, are not considered as key players, especially in isolated rural areas.

Studies on transfer of agricultural innovations on how paddy farmers in Philippine utilise communication to engage in dialogue, i.e., exchange, negotiate and form meanings on farming including innovations (Genilo, 2009). The studies further observed that innovation transfer should be viewed with communication as meaning negotiation rethink on how information becomes knowledge, recognise local knowledge, manage local communication and contextualise audiences within their communities.

2.6 Adoption/Rejection of Innovations

The adoption of appropriate innovations is an important issue in agricultural development. However, many development project officers fail to use strategies to identify and select opinion leaders who can leverage the diffusion and adoption process. Heemskerk (2005) observed that agricultural innovations are changing to be more demand driven to respond to farmers' needs. Farmers need to be active participants of the development and diffusion of innovations to make adoption happen. The role of the change agent in the diffusion process is to promote a participatory environment where opinion leaders will lead the diffusion and adoption of innovations.

According to Namara *et al.* (2003), adoption, adaptation or rejection of innovations are a function of many factors including lack of information or access, lack of fit between the innovations on offer and the capacities and needs of households, inefficient promotion strategies, flawed assumptions about households' needs and capacities and the real costs and benefits from their perspectives, ineffective targeting, lack of capacity to manage projects offering a large array of small-scale technologies to thousands of poor households and lack of credit. Namara *et al.* (2003) further observed that one of the controversies surrounding the agricultural water management technologies is whether they are suitable for adoption by poor households. Several studies have shown that the better off farmers dominate the current adopters.

In a study on adoption and diffusion of agricultural innovations in less developed countries, Pardey (1979) found out that where adoption is a decision at the individual farmer level, it is subject to various constraints such as credit and information. Various elements change over time (cash resources are augmented, information accumulates and experience is gained) making adoption and diffusion a dynamic process. The study further observed that diffusion patterns depend critically on complicated (and sometimes unobservable) relationships between different elements such as the risks associated with various innovations, the nature of farmers attitudes to risks, the existence of fixed adoption costs (either actual or imputed) and the availability of cash resources. Pardey (1979) noted that similar innovations may experience different adoption patterns in different areas and by different groups of farmers. Specifically, the relationship between farm size and adoption can take different shapes due to a host of factors. This study showed that innovations involving higher fixed costs are adopted at a higher rate by larger farmers. Innovations which are neutral to scale are eventually adopted by all classes of farmers, but larger farmers are typically among the early adopters.

Yoav and Nira (1973) on adoption and diffusion studies in less developed countries confirmed that the "intensity" of adoption (e.g., proportion of area allocated to new variety, quantity of fertiliser per acre) may be higher on smaller farms, under certain conditions, while in other cases the opposite is observed. The conflicting evidence stems from the fact that farm size is a surrogate for a number of factors, some of which have contradicting effects. Dean (1974) noted that studies which tried to empirically establish the role of perceived risk and risk aversion in explaining adoption of innovations have usually been afflicted by measurement problems. In some cases, proxies which measure the access to information (such as contact with extension) or ability to decipher information (education, literacy) are used in order to infer on the role of uncertainty, with obvious difficulties in interpretation.

Labour supply problems may sometimes inhibit adoption of innovations, if these are labour-intensive. Efraim and David (1982) further observed that labour-replacing innovations can be adopted quite rapidly in other areas, where labour availability depended on seasonal and uncertain supply. Credit supply is not necessarily an obstacle to adoption, as evidence on this matter is mixed. Richard and Edmond (1966) observed that a common weakness is the tendency to consider innovation adoption in dichotomous terms (adoption/non-adoption) even though the actual decision made by farmers is defined over a continuous range (such as quantity of fertilisers used). Another aspect where progress can be made is the simultaneous nature of many of the decisions on adoption when a package of new practices is promoted.

Rogers (2003) emphasised that "the opinion leaders approach magnifies the change agent's effort". Therefore it is important for change agents to recognise the social network and empower opinion leaders to share the responsibility of diffusing innovations to other farmers. The involvement of opinion leaders increases the credibility of innovations because these opinion leaders convince their peers to adopt appropriate innovations. In addition, innovations that are validated by an opinion leader acquire local sponsorship and sanction. Therefore, to achieve long-term adoption, opinion leaders should lead the diffusion process. Change agents, as sole entities of the diffusion of innovations, have scarce resources and limited access to peers. Rogers (2003) suggests that communication strategies should target opinion leaders, who then are going to target their peers.

Heemskerk (2005) found a natural characteristic of farmers that they innovate to sustain, expand and improve their production systems. Feder (1993) found farmers were willing to adopt conservation farm technologies but many farmers discontinued the use of the technology because of socio-economic factors. Therefore, it is important to promote the diffusion of agricultural innovations among all farmers through social networks. The process of diffusion of an innovation occurs when it is communicated through certain channels over time among members of the social system. Rogers (2003) observed that a common source of information in all stages of the adoption process of an innovation was interpersonal communication between farmers, friends and neighbours. Starting with the awareness stage, farmers (potential adopters) learn about an innovation from peers. This occurs in a social learning process which lowers uncertainties related to adoption. Later, during the interest stage, farmers gather details about the innovation from other farmers. Then, in the evaluation stage, farmers discuss the positive and negative aspects of adopting the innovation with other farmers.

There is often a significant interval between when an innovation is developed and available in the market and the time it is widely used by producers. Rogers (1983) noted that adoption and diffusion are the processes governing the utilisation of the innovations. Measures of adoption may both be the timing and extent of new technology utilisation by individuals. Diffusion can be interpreted as aggregate adoption. van den Ban (1999) observed that an adoption process is a mental process through which an individual passes from first knowledge of an innovation to decision to adopt or reject and to later confirmation of decision. Rogers (1995) has given five stages of adoption: awareness; interest; evaluation; trial and adoption. According to Rogers (1995) the level of adoption depend on the following factors: source of information; intrinsic characteristics of the innovation itself and its appeal to clients (complexity, probability, riskness and compatibility with other activities); characteristics of units concerned (resources, size, type of activities and degree of specialisation). Rogers further adds that there are five perceived attributes of innovations in universal terms: relative advantage; compatibility; complexity; triability; and observability.

According to Mwaseba *et al.* (2006) studies on adoption/rejection of agricultural innovations from smallholder paddy farmers in Tanzania reveal that apart from the age and level of education of the head of households which had an influence on the adoption of herbicide in study areas, the influence of other variables on the adoption of fertiliser and transplanting varied between the study areas. Moreover, the study showed that adoption of the selected innovations is context-dependent in Tanzania and paddy farming is characterised by the predominance of traditional paddy varieties. The study further revealed that farmers grow these varieties for household consumption or income, or both, under crop management practices that are well attuned to the available resources. Mwaseba *et al.* (2006) further noted that rejection and adaptation of innovations make sense, given the production circumstances in which the farmers operate.

2.7 Conceptual Framework

The literature from the present Chapter has been reviewed from a wide perspective of agricultural production and irrigation innovations. The reflections drawn in this review provides the basis for assessing the availability, transfer and adoption of irrigated paddy innovations in Tanzania. In the context of the present study the purpose of which was to assess the availability, transfer and utilisation of selected basin irrigated paddy innovations in Mvomero district; the conceptual framework shown in Fig.2 was developed. This conceptual framework was for analysing a large volume of data and was oriented towards establishing findings which fulfil objectives of the study. It allows drawing implications on the extent to which irrigated paddy innovations could be integrated within the farming systems of smallholder farmers and made the engine of economic growth and poverty alleviation in Tanzania. The research methodology is presented in the following Chapter.

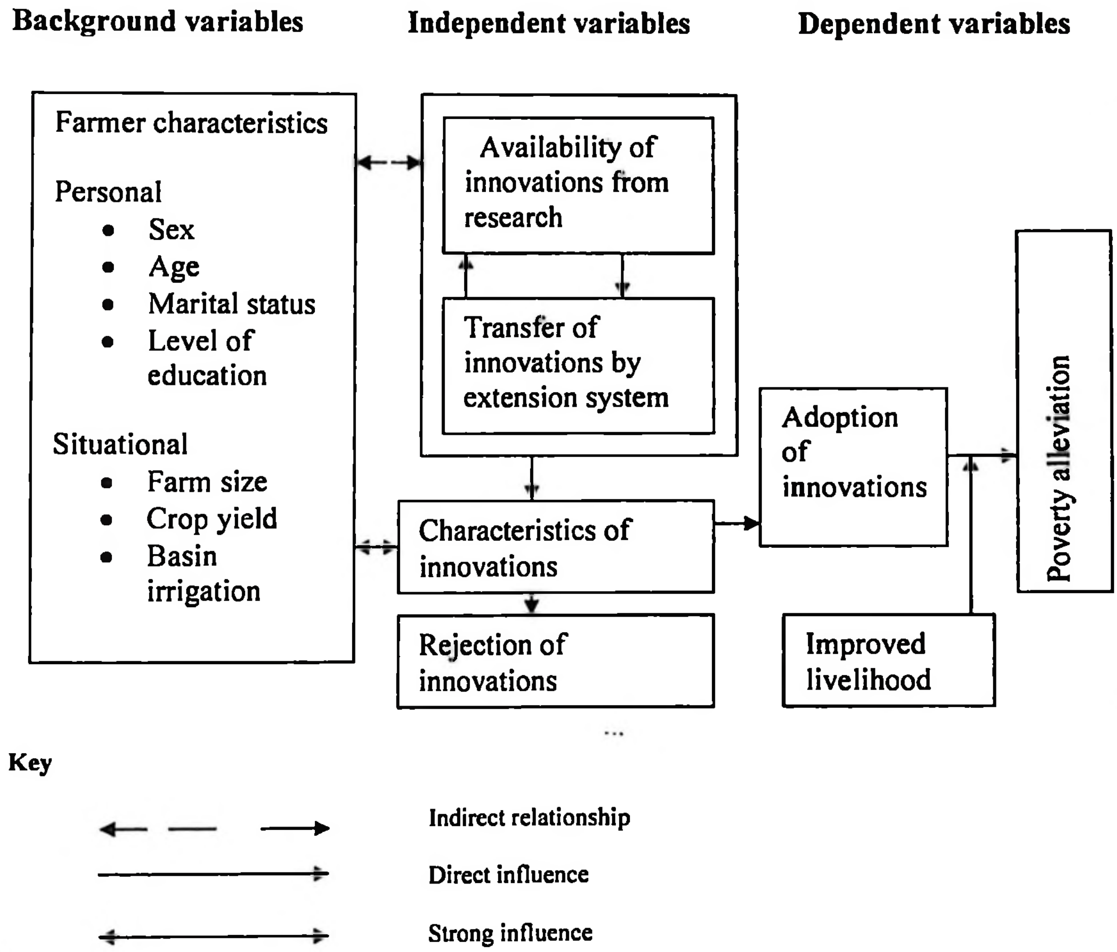

Figure 2: Conceptual framework

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Study Area

The study was conducted in Mvomero district in Morogoro region. The district was purposively selected based on evidence of existence of smallholder farmers practising basin irrigated paddy farming. The study took place in four villages, namely: Mkindo, Hembeti, Mlali and Kipera.

3.2 Study Design

A cross-sectional survey design was used in this study. The design involves collection of data at a single point in time from a random sample selected to describe the population at that particular time (Babbie, 1990). The design is suitable for purposes of description as well as for the determination of the relationships between variables. It was considered favourable because of the limited resources for data collection (Creswell, 1994).

3.3 Sampling Procedures

Sampling procedure involved multi-stage sampling technique which is convenient for a larger sampling unit (Kothari, 2004), under two main stages.

Stage 1: Purposive selection of divisions, wards and villages was done from Mvomero district based on smallholder farmers' involvement on basin irrigated paddy farming practices. There were 4 divisions, 17 wards and 101 villages during the time for data collection for this study in Mvomero district. Each division had more than 2 wards and each ward had more than 2 villages. Thus two divisions, namely: Mvomero and Mlali were purposively identified. In turn, one ward was selected from each selected division, namely: Hembeti and Mlali from Mvomero and Mlali divisions. Finally, the same sampling procedure was used to select two villages from each selected ward, namely: Mkindo and Hembeti from Hembeti ward; and Mlali and Kipera from Mlali ward.

Stage 2. The second stage involved selection of study respondents. A sample of 120 farmers (household heads) was selected (30 from each of the selected villages). To get the sample from the 4 villages, stratified and purposive sampling techniques were used to get the names of male and female household heads (HHs) from corrected register of 250 HHs (150 MHHs and 100 FHHs) from all selected villages based on involvement in basin irrigated paddy farming practices. Each of the selected villages had a minimum of 40 HHs in the corrected register and one extension agent who was involved in the study. A total number of 10 key informants was also selected using snowball technique.

3.4 Sample Size

A total number of 134 respondents comprising of farmers, village extension workers and key informants were selected and involved in the study. A summary distribution of respondents involved in the study is given in Table 1.

Table 1: Distribution of respondents (n=134) involved in the study

Type of respondent	Number		Total
	Males	Females	
Farmers	70	50	120
Extension agents	4	-	4
Key informants	7	3	10

3.5 Data Collection Instruments

Data collection instruments used were questionnaires, researcher's diary and checklist, as follows:

(a) Questionnaires (interview schedules): Two types of questionnaires were used, namely: farmers' household heads questionnaire and extension agents' questionnaire to collect primary data from household heads and extension agents (Appendix 2 and 3). All the questionnaires were completed by means of personal interviews conducted by the researcher.

(b) Researchers' diary: This was used to collect secondary data from relevant documentary sources, including: official reports from national, zonal, district and village files; websites; internet; Sokoine University National Library (SNAL) as well as researcher's observations of smallholder farmers' irrigated paddy production activities.

(c) Checklist: This was used to collect primary data from key informants to supplement information gathered through interview schedules and researcher's diary (Appendix 4).

3.6 Data Collection Procedures

Field work for data collection was conducted from October to December 2010, after getting an introductory letter from the Director, Research and Postgraduate Studies, SUA to the Mvomero District Executive Director where study was done in specific sampled villages. The author was responsible for data collection with assistance from extension agents in the study area. Before primary data collection, a preliminary survey was conducted by the researcher to familiarise with the study area as well as to acquire general information on smallholder farmers practicing irrigated paddy farming activities. Since the researcher had worked as an agriculture officer in the district, it was not difficult to establish rapport. Structured and unstructured interview schedules were used for interviewing selected smallholder farmers and extension agents. Open and close-ended questions were utilised. In open-ended questions, respondents were supposed to give their own views while in close-ended questions they were supposed to choose among the given alternatives. The HHs interview schedule was pre-tested to 10 HHs, not included in the study sample, before being subjected to the field for actual data collection in order to ensure their reliability and validity.

Of the 120 interview schedules meant for respondents, all were properly completed. Like wise, all the four interview schedules meant for extension worker respondents were also completed. As far as possible, the interviews were conducted in private and each lasted for about 30 minutes. When the interview was completed in one village, the researcher moved to the next, usually spending about 3 days in each village. In addition, data were collected from 10 key informants through directed discussions. The researcher also reviewed relevant information from Mvomero district agricultural files related to selected basin irrigated paddy production innovations. Furthermore, website from internet, Sokoine University of Agriculture National Agricultural Library (SNAL), Dakawa Research Institute, Ministry of Agriculture, Food Security and Cooperatives were rich sources of information for the study. Observations made on farmers activities related to utilisation of selected basin irrigated paddy production innovations in the study villages were also recorded.

3.7 Data Processing and Analysis

3.7.1 Data processing

Data from completed 120 HHs interview schedules were coded for computer analysis.. Each schedule had 94 variables. In addition, data from extension agents interview schedules, researcher's diary and checklist were summarised manually in single sheets of paper by ensuring that, as much as possible, the original meaning of the statements made was maintained.

3.7.2 Data analysis

Data from HHs respondents' interview schedules coded for computer analysis were analysed using programme for Statistical Package for Social Science (SPSS). The method of analysis involved univariate and bivariate analysis. It used the technique of frequency counts, means and percentages. Furthermore, data processed from extension agents' interview schedule, researcher's diary and checklist were also examined. Qualitative data were analysed using "content analysis'' technique which mainly involved transcription of recorded notebooks and then clustering information into sub-themes. Quantitative data were processed and analysed to produce frequencies to facilitate assessment of the availability, transfer and utilisation of selected basin irrigated paddy production innovations in the study villages.

3.8 Limitations of the Study

(a) Responses of interviews mostly depended on individual's memory whereby respondents rarely kept written records of their activities. Therefore there were notable difficulties for respondents to give exact answers for example on area cultivated and yield obtained per growing season. The author had to spend more time interrogating the respondents in order to allow them to think and give the correct answers which extended time intended for the field work.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

This Chapter presents the major results and discussions arising from the data analysis related to availability, transfer and utilisation of basin irrigated paddy production innovations in Mvomero district. These were discussed under three main sections. First section dealt with farmer respondents' characteristics. The second section focused on farmer respondents opinions related to availability, transfer and utilisation of selected basin irrigated paddy innovations. The final section looked at extension worker respondents' characteristics and their opinions on availability transfer and utilisation of selected basin irrigated paddy innovations.

4.1 Farmer respondents' characteristics

Farmers' characteristics included personal and situational characteristics in farming which were expected to influence their adoption of basin irrigated paddy production innovations in farming. These characteristics were examined under two main parts. The first part under personal characteristics involved: sex, age, marital status and level of education. The second part focused on situational characteristics, which included: land ownership, farm size, type of crop grown under rain-fed condition, type of crop irrigated and type of irrigation system used.

4.1.1 Farmer respondents' personal characteristics

Personal characteristics involved in this section were: sex, age, marital status and level of education (Table 2). It has been noted (Anoski and Coughenour, 1990; Rogers, 1995)

Table 2: Percentage distribution of respondents' (n=120) personal characteristics

HHs respondents' Personal Characteristics	Number	Percentage
Sex		
Male	70	58
Female	50	42
Age		
18-25	7	6
26-35	19	16
36-45	28	23
46-60	66	55
Marital status		
Single	3	3
Married	83	69
Widowed	19	16
Divorced	15	13
Level of education		
None	17	14
Adult education	13	11
Primary	84	70
Post primary	6	5

that personal characteristics, in most cases, are associated with the level of technology utilisation by smallholder farmers. Examination of farmer respondents' sex showed that of the 120 respondents, 70 were male household heads (MHHs) and 50 female household heads (FHHs). Further, examination of farmer respondents' personal characteristics is discussed under the following headings: age, marital status and level of education.

(a) Age

Data in Table 2 shows that the age distribution of farmer respondents was between 18 and 60 years. The majority (55 %) were above 45 years of age. However, the findings suggest that the study respondents were drawn from different age groups of farmers in the study villages. Therefore, this implies that irrigated paddy production activities involve farmers of different age groups in the study area.

(c) Marital status

The farmer respondents' marital status is shown in Table 2. Data in Table 2 shows that the majority (69 %) of the respondents were married. This is more likely to affect their participation in irrigated paddy production practices where an innovation can easily be carried out by a couple and readily implemented by one in absence of the other.

(d) Level of education

It was assumed that the extent to which respondents were educated would tend to influence their ability to gain knowledge. This may also affect their participation in utilisation of basin irrigated paddy innovations. The respondents were therefore asked to indicate their level of education, as given in Table 2. The data shows that 70 % of the farmer respondents had attained the level of primary education. This is a reflection of Tanzania's universal primary education policy of 1970's. Thus implying that farmers' level of education was not an important criteria in adoption/rejection of basin irrigated paddy production innovations in the study area.

4.1.2 Farmer respondents' situational characteristics

The situational characteristics studied involved factors related to: (a) land ownership; (b) type of crop grown under rain-fed condition; (c) type of crop irrigated and type of irrigation system used.

(a) Land ownership

In the study area land ownership was based on private farms. In order to determine land use pattern the respondents were asked to indicate the size (acreage) of the private farm

Table 3: Distribution of respondents (n=120) opinions on type of crop grown in 2009/10 under rain-fed condition, acreage and average yield by gender

Type of crop grown	Respondents			
	MHHs (n=70)		FHHs (n=50)	
	Acreage (Acres)	Average yield (kg/Acre)	Acreage (Acres)	Average yield (kg/Acre)
Cash crop				
Sunflower	97	1 500	45	1 400
Simsim	75	1 200	25	1 000
Food crop				
Paddy	180	1 800	80	1 650
Maize	140	1 850	100	1 800
Cassava	45	8 000	25	6 500
Sorghum	40	950	30	800
Average	**96.2**	**2 550.0**	**50.8**	**2 191.7**

produced an average crop yield of 2 250 kg/acre and 1 950 kg/acre, respectively, from irrigated paddy plots. These findings suggest that irrigated paddy plots yielded higher per acre from both MHHs and FHHs plots compared to what was obtained under rain-fed condition given in Table 3, which was 1 800 kg/acre for MHHs and 1 650 kg/acre for FHHs. Thus, implying that basin irrigation is more profitable under smallholder farmers paddy yields compared to what is obtained under rain-fed condition.

4.2 Farmer Respondents' Opinion on Availability, Transfer and Utilisation of Selected Basin Irrigated Paddy Production Innovations

This part will be discussed under the following sections: availability of selected basin irrigated paddy production innovations to the extension service; nature of farmers' advice that they owned in their villages. The findings revealed that farm size of respondents ranged from less than 2 to more than 5 acres with an average of 2.3 acres per farmer. The farmer respondents' farm size lies within the Mvomero district farmers' acreage farm size which ranges from 1.5 to 3.0 acres and the average farm size is slightly lower than that of Morogoro region and the country which has been reported to be 3.6 acres (URT, 2005). This suggests that the farm size situation of study respondents was not different from that smallholder farmers in the country.

(b) Type of crop grown under rain-fed condition

The respondents were asked to give major types of cash and food crops grown in 2009/2010 under rain-fed condition; acreage and average yield in kilogrammes per acre (kg/acre) as shown in Table 3. Data in Table 3 show that MHHs and FHHs produced an average crop yield of 2550.0 kg/ha and 2191.7 kg/ha, respectively, from average crop acreage of 96.2 acres and 50.8 acres, respectively. Data in Table 3 show that FHHs respondents' average crop yield per acre (compared to average acreage) was higher than average crop yield of MHHs. This implies that crop management for FHHs was better as compared to that of MHHs crop management.

(c) Type of crop irrigated and type of irrigation system used

The respondents' opinions on types of irrigated crops in 2009/10, acreage and average yield (kg/acre) by gender were examined in this part. The findings indicate that paddy was the only type of crop irrigated and the type of irrigation system used in 2009/2010 was basin irrigation by all respondents. The findings also revealed that MHHs and FHHs

Table 3: Distribution of respondents (n=120) opinions on type of crop grown in 2009/10 under rain-fed condition, acreage and average yield by gender

Type of crop grown	Respondents			
	MHHs (n=70)		FHHs (n=50)	
	Acreage (Acres)	Average yield (kg/Acre)	Acreage (Acres)	Average yield (kg/Acre)
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Sunflower	97	1 500	45	1 400
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Paddy	180	1 800	80	1 650
Maize	140	1 850	100	1 800
Cassava	45	8 000	25	6 500
Sorghum	40	950	30	800
Average	**96.2**	**2 550.0**	**50.8**	**2 191.7**

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4.2 Farmer Respondents' Opinion on Availability, Transfer and Utilisation of Selected Basin Irrigated Paddy Production Innovations

This part will be discussed under the following sections: availability of selected basin irrigated paddy production innovations to the extension service; nature of farmers' advice and adoption/rejection of innovations; and factors contributing to success or failure of innovations.

4.2.1 Availability of selected basin irrigated paddy production innovations to the extension service

The study sought to find out whether there are recommended irrigation innovations to extension services for basin irrigated paddy production in Mvomero District. The findings from district official record files revealed that there are innovations that existed since colonial times. The major sources of such innovations were Dakawa Research Institute. Table 4 gives indication of existing innovations for irrigated paddy production available to the extension service for paddy crop in Mvomero District. It was also noted that available irrigated paddy production innovations had been organised in five specific recommendations for the extension worker to transfer and for the farmer to use, as follows:

(a) Water source identification

Water source for gravity irrigation schemes or pump irrigation schemes can be a river, pond/lake or rain water harvesting whereby an intake (weir) has to be constructed so as to convey irrigation water to the field. It is recommended that sufficient amount of good quality water (pH range between 4.5- 8.5) be available for the proposed potential area for irrigation. The location of the intake (water diversion structure) point should be narrow, straight, moderate (not too gentle) and steep (to avoid sand accumulation at the intake). It is also recommended that the water flow should be stable and intake site should be geologically strong and easy access. The intake water level should be almost the same or

Table 4: Existing basin irrigated paddy production innovations in Mvomero district

Type of innovation/practice	Status of paddy production innovation
Water source identification	x[a]
Main canal construction	x
Field preparation	x
Water management	x
Operation and maintenance	x

x[a] Available innovations

at a higher elevation than the upstream end of the command area of the main canal and also be able to divert water to the main canal (it should not be very shallow). Nevertheless, irrespective of water availability, the right to using water for irrigation should be investigated. Hence, it is recommended to obtain a water right from the relevant authorities (Zonal Water Boards) that permit the use of the water for irrigation.

(b) Main canal construction

Main canal should convey water directly from water source through the intake or headwork to the field. It should be constructed according to recommended sizes, slopes and preferably be constructed with concrete to minimise water losses through seepage depending on total area to be irrigated. For the ease of water application, canal must be constructed on the highest course of the field to be irrigated, that is to say, it should follow the major ridge or the highest boundary of its command depending on topography. Also elevation of the intake point should not be very different from the elevation at the upstream-end of the command area of the main canal.

(c) Field preparation

It is recommended to prepare the basin irrigated paddy fields by ploughing and puddling before paddy transplanting so as to save irrigation water. Also it is recommended that earth bunds/dikes should be constructed and basins well levelled. Temporary levees (basin banks) should be compacted and constructed 60-120 cm wide and 15-30 cm high while permanent levees should be 150-180 cm wide and 40-50 cm high. For direct puddling, irrigation water has to be introduced to soften the paddy field one day before transplanting. When direct puddling is used it saves working hours costs, maintains field level and reduces wear to machinery parts. Two rounds of puddling are sufficient to obtain the depth of 20-25 cm required for paddy transplantation. There are many different sizes of basins ranging from 1 m^2 to 4 ha depending on: soil type, stream size, irrigation depth, field size, land slope and farming practices. It is recommended that when irrigating sandy soils whereby infiltration rate is rapid, basins should be small for water to spread quickly. When irrigating clay soils whereby infiltration rate is slow, basins should be much larger than on sandy soils.

(d) Water management

This encompasses an integrated process of diversion, conveyance and regulation, measurement and distribution and application of the right amount of water at the proper time and removal of excess water from the farm to promote increased production in conjunction with accepted cultural practices. The recommended water requirement for paddy crop is 1000 to 1500 mm per growing season. Most sensitive periods to water deficits are during flowering and during the second half of the vegetative period. For irrigation scheduling, the following recommended operations have to be taken care: during and after transplanting water depth in the basin has to be 10 cm deep; during tillering the water depth has to be 3 cm; heading or flower initiation water depth has to be maintained to 10 cm until ripening of the crop and after ripening gradually reduce the amount of water in the basin.

There are two different methods of water distribution, that is, flow sharing method and time sharing method. In the flow sharing method water is distributed continuously to each irrigation block while in the case of time sharing method, water is distributed by rotation to each irrigation block. Therefore, it is recommended to use either of the two methods of water distribution depending on the availability of water. To minimise conflicts relating to water distribution, it is recommended to take the following measures: strict implementation of the planned cropping calendar and pattern of planting; strict implementation of the schedules of water delivery and distribution; regular review of supply and use of irrigation water at different irrigation units and immediate initiation of actions on inequity in water delivery and distribution.

(e) Operation and maintenance

In principle, all operations on an irrigation scheme including the selection of cropping calendars, irrigation scheduling and other operations of the irrigation system should be the responsibility of the farmers supported by the extension services. Routine maintenance of channels, structures and other minor repairs should be organised and undertaken by farmers. It is recommended to conduct a regular/timely inspection and maintenance of irrigation infrastructure. Also operation and maintenance schedule be prepared and followed together with the establishment of operation and maintenance fund for infrastructure repair. At the intake weirs and gates it is recommended to do cleaning, removal of floating debris and foreign materials around weir bodies, trash racks and scouring sluice gates. For lined canals, it is recommended to repair damaged joints, slabs, lining cracks with concrete, weed control at joints and on surface of slabs. In case of unlined canals, it is recommended to cut and remove earth weeds and floating weeds on wetted parts of canal slopes. In drainage canals, weed control, removal of silt, repair and shaping of canal sections is recommended.

4.2.2 Farmers' perceptions on extension methods used to disseminate recommended irrigated paddy production innovations

Based on the list of irrigated paddy production innovations identified in Table 4, the study sought to determine the way farmers are advised by field extension agents, extent of advice and the degree the farmers adopt recommended practices for paddy production. The following aspects are addressed under this part: (a) extension methods used; (b) extent of use of recommended and traditional irrigated paddy production practices and (c) farmers' degree of innovativeness.

(a) Extension methods used

Identification exercise of the extension methods frequently used by extension workers in advising farmers on recommended practices for basin irrigated paddy production was done. Farmers were asked to give their responses based on three categories of extension methods, namely: individual; group and mass. Their opinions expressed in percentages of households heads respondents are as summarised in Table 5. On average, results in Table 5 show that 72.5 % of respondents identified group method as the most frequently used extension method. This was followed by individual method which scored 19.3 % of the farmer respondents and mass method which scored only 8.2 %. Therefore, group extension method was the most frequently used method followed by individual and mass methods as the least frequently used. It was also revealed that village meetings were the

Table 5: Percentage distribution of respondents' (n=120) perceptions on extension methods frequently used in relation to recommended practices

Selected recommended basin irrigated paddy practices	Extension methods used		
	Individual	Group	Mass
	Percent	Percent	Percent
Water source identification	11.2	56.7	32.1
Main canal construction	15.0	83.3	1.7
Field preparation	34.2	61.7	4.1
Water management	81.1	80.0	1.9
Operation and maintenance	18.0	80.8	1.2
Average	**19.3**	**72.5**	**8.2**

most frequently used type of group method. In relation to individual methods, it was revealed that farm visits provides solutions to farmers and extension workers on proper main canal construction practices, water management and operation and maintenance. With regard to mass method, data in Table 5 show that water source identification scored the highest (32.1 %) as compared to other selected basin irrigated paddy production practices. This implies that smallholder farmers were becoming more aware on identifying water sources for irrigation scheme establishment, so as to promote irrigated paddy production for the purpose of increasing food production in the study area.

(b) Extent of use of recommended and traditional irrigated paddy production practices

The study attempted to find the respondents' extent of use of recommended and traditional irrigated paddy production practices. The perceptions of respondents on the use of recommended and traditional irrigated paddy production practices are summarised in Table 6. In general, the findings in Table 6 show that 59.1 % and 40.9 % of respondents used traditional and recommended basin irrigated paddy production practices, respectively. This implies that more work need to be done by extension workers to increase the extent of use of recommended basin irrigated paddy production practices. In relation to the use of field preparation practices, respondents (81.5 %) felt that recommended basin irrigated paddy production practices were being used. This might be due to the fact that some farmers in the study area have been receiving training on irrigated paddy production through Farmer Field School (FFS) programme at Mkindo Farmers' Training Centre in Mvomero District.

Table 6: Percentage distribution of respondents' (n=120) opinions on the extent to which they use recommended and traditional practices

Selected irrigated paddy practices	Respondents' opinions	
	Recommended	Traditional
	Percent	Percent
Water source identification	22.5	77.5
Main canal construction	47.5	52.5
Field preparation	81.5	18.5
Water management	21.7	78.3
Operation and maintenance	31.1	68.9
Average	**40.9**	**59.1**

As regards use of water management practices, respondents (78.3 %) felt that traditional irrigated paddy farming practices were being used. This also might be due to the fact that irrigation schemes in the study area have poor irrigation infrastructure with inadequate irrigation water measuring devices to enable farmer respondents to supply correct amount of water to crops at the right time. Data in Table 6 also show that there was high rate of use of traditional basin irrigated paddy production practices with regard to use of water source identification (77.5 %) and main canal construction (68.9 %) practices. This implies that farmers in the study area are still having inadequate technology in applying such practices in irrigated paddy production practices.

(c) Farmers' degree of innovativeness

It was assumed that the degree of farmers' adoption of innovations could provide some information on the extent to which farmers utilised recommended basin irrigated paddy production practices. Three elements of adoption process were selected. These included: awareness, trial and adoption. The findings are as shown in Fig.3. Based on Fig. 3,

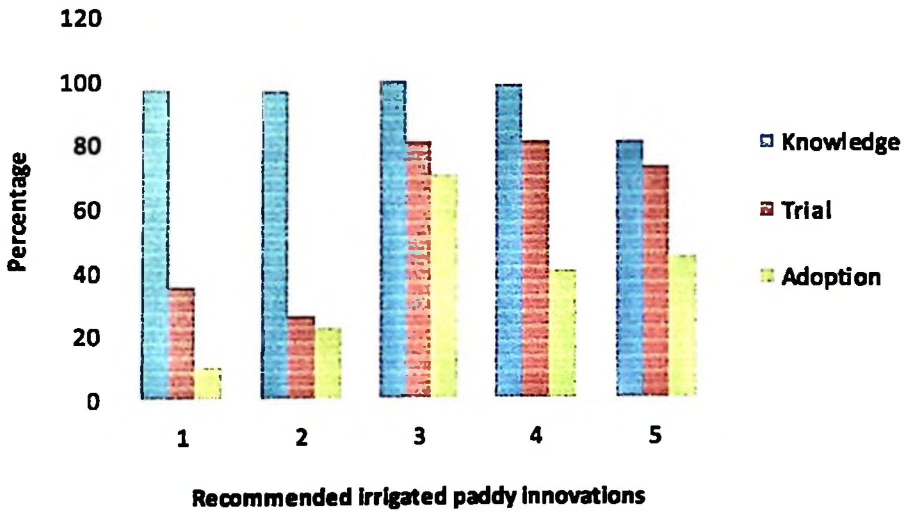

Figure 3: Farmers' degree of innovativeness

[1]Recommended irrigated paddy practices

1. Water source identification
2. Main canal construction
3. Field preparation
4. Water management
5. Operation and maintenance

several observations can be made. Generally, the extent of farmers' awareness on basin irrigated paddy innovations was higher than the extent to which they tried and adopted the innovations. In this stage the individual is first exposed to an innovation but lacks information about the innovation. During this stage of the process the individual has not been inspired to find more information about the innovation. Therefore one should expect more farmers in the awareness stage than in the trial and adoption stages. The observation further reveals that more farmers were aware on the field preparation innovation and more farmers tried the field preparation, water management and operation and maintenance practices. It also appears that more farmers adopted the field preparation practices. This implies that extension field workers put much effort in creating awareness to farmers as well as demonstrating field preparation practices. However, farmers lagged behind when it came to trial and adoption of water source identification and main canal construction innovations. This might reflect that farmers' failure' to try and adopt the innovations is probably due to difficult in technology of putting irrigation innovations into practical use.

4.2.3 Reasons for farmers' rejection of recommended basin irrigated paddy production practices

Farmers' respondents were asked to give their views on the major reasons for rejecting recommended irrigated paddy production practices as presented in Table 7. In relation to this, it was assumed that by identifying farmers' reasons for rejecting recommended irrigated paddy production practices would help to identify the extent of acceptance or rejection of recommended irrigated paddy production innovations. Overall, data in Table 7 reveal that, in general, the majority (75.4 %) of the respondents felt that rejection or failure to use recommended basin irrigated paddy production innovations was due to difficulty in technology. Specifically, 87.5 % and 85 % respondents rejected water source identification and water management practices, respectively. This could be due to inadequate and poor existing irrigation structures constructed in the irrigation schemes in the study area. With regard to water source identification and main canal construction, the findings reveal that 31.7 % and 10.8 % of the respondents considered that practices previously used were better This could be due to the existence of irrigation structures at the water sources (intakes) and main canals to convey irrigation water to the fields to the extent that only a small number of respondents had yet to adopt the practices.

Table 7: Percentage distribution of respondents' (n=120) reasons for rejecting recommended irrigated paddy production practices

Selected recommended basin irrigated paddy production practices	Practices previously used are better	Inconsistence with past experience	Difficulty in Technology	Not easily triable	Not easily observable
	Percent	Percent	Percent	Percent	Percent
Water source identification	31.7	3.6	87.5	2.6	2.4
Main canal construction	10.8	2.1	84.5	6.1	3.2
Field preparation	2.4	3.4	59.1	5.6	4.1
Water management	3.8	1.2	85.0	32.6	1.8
Operation and Maintenance	4.1	2.9	60.7	10.2	7.4
Average	10.6	2.6	75.4	11.4	3.8

4.3 Extension Workers Characteristics and Their Opinions on Availability, Transfer and Utilisation of Basin Irrigated Paddy Production Practices

Aspects with regard to village extension workers in the study area were identified so as to find the influence on the extension services provided to farmers on utilisation of basin irrigated paddy production practices. Aspects addressed under this part include: extension worker personal characteristics; extension methods used in advising selected basin irrigated paddy production innovations; use of information sources and their importance and factors contributing to success or failure of transfer and adoption of available selected basin irrigated paddy production practices.

4.3.1 Extension workers' personal characteristics

Important personal characteristics discussed in this part include: age, sex, marital status, level of education and working experience. Their age distribution ranged between 40 and 52 years while their field working experience ranged from 13 to 27 years. All the extension worker respondents were male and married. Findings further revealed that all four village extension worker respondents were government employees in the Ministry of Agriculture, Food Security and Cooperatives. The extension worker respondents had attained a secondary education and diploma in agriculture. With regard to in-service training, the findings revealed that it was not regularly conducted (at least once in the last 15 years) to extension worker respondents. This is not enough to build capacity to farmers in irrigation innovations. Therefore there is need for regular in-service training to all extension workers so as to build their capacity for advising farmers on irrigation practices.

4.3.2 Extension methods used in advising basin irrigated paddy production innovations

The study identified the extent to which the extension methods were used by the extension worker respondents in advising farmers with regard to the selected recommended basin irrigated paddy production practices, as follows: (i) water source identification; (ii) main canal construction; (iii) field preparation; (iv) water management and (v) operation and maintenance. The extension methods used by the extension worker respondents were found to be individual and group methods. The percentage distribution of village extension worker respondents on extension methods frequently used in advising farmers on selected recommended basin irrigated paddy production practices are as summarised in Table 8. Data in Table 8 show that group method was the most frequently used compared to individual method. Also the most frequently used type of group methods was group meetings.

With regard to individual method, the most frequently used type was farm/home visits compared to office visits which were used by only one respondent in the case of water management. Overall, the data in Table 8 show that in general village extension worker respondents used combination of extension methods in promoting irrigated paddy production practices. The focus of extension workers was farmer groups and individual farmer. This implies that they supplemented group extension methods, which helped them to respond to farmers concerned and problems.

Table 8: Percentage distribution of village extension worker respondents' (n=4) extent of using extension methods for advising farmers

Selected recommended basin irrigation practices	Type of extension method			
	Individual		Group	
	Farm/home visit	Office visit	Demonstration	Group meeting
Water source identification	x^a			xxx
Main canal construction	x			xxx
Field preparation	x		x	xx
Water management	x	x	x	xx
Operation and Maintenance	x		x	xxx

X^a Frequency of extension worker respondents' responses

4.3.3 Use of information sources and their importance

It was assumed that understanding village extension workers' efforts in contacting farmers and other individuals or groups for information, within and outside the villages in which they worked, would provide some indication of how they updated their knowledge related to the job of extension workers. Therefore, the village extension workers respondents were asked to give their opinions on the types of selected personal information sources they considered important for their work. The extent of use of these information sources was measured by the level of village extension workers contact with different groups/individuals that were in a position to give information related to extension. The findings on the level of importance of the information sources are shown in Table 9. In general, data in Table 9 show that extension worker respondents perceived farmers who are rich in indigenous knowledge, as being important information sources. Further more, findings in Table 9 reveal that all extension worker respondents perceived farmers, DALDO, SMS and Zonal irrigation staff as being important information sources. On average, 50 % and above of the extension worker respondents perceived all other information sources as being important. This implies that extension workers were willing to co-operate and exchange information with other stakeholders regarding transfer and utilisation of irrigated agricultural innovations to smallholder farmers.

Table 9: Percentage distribution of village extension workers respondents' (n=4) ratings of the importance of particular types of information sources

Type of information source	Extension worker respondents rating	
	Important	No opinion
Farmers	xxxx[a]	
DALDO, SMS	xxxx	
Zonal irrigation staff	xxxx	
Extension workers from other sectors	xxx	x
SUA staff	xxx	x
Research workers	xxx	x
Fellow extension workers	xx	xx

X[a] Frequency of extension worker respondents' responses

4.3.4 Factors contributing to success or failure of transfer and adoption of selected basin irrigated paddy production innovations

4.3.4.1 Constraints to extension workers to transfer of selected basin irrigated paddy production innovations

Problems facing extension worker respondents on transfer of basin irrigated paddy production innovations were identified and findings are as summarised in Table 10. Data in Table 10 show that the major problem facing field extension workers in transferring basin irrigated paddy production innovations revealed by all extension workers respondents was lack of incentives. Poor transport facilities and involvement in many other duties assigned were both revealed by two out of four extension worker respondents as constraints in transferring basin irrigated paddy production practices. These findings are in agreement with general situation in Tanzania where in most cases field extension workers lack incentives to provide good services to farmers such as appropriate working tools, transport facilities, supportive technical services and training facilities (World Bank, 2006). Involvement in many other duties assigned to them in addition to normal

Table 10: Percentage distribution of extension worker respondents' (n=4) perceptions on constraints to transfer of innovations

Type of constraint	Extension worker respondents' rating	
	Important	Not important
Lack of incentives	xxxx[a]	
Poor transport facilities	xxx	x
Involvement in many other duties	xxx	x

X[a] Frequency of extension worker respondents' responses

extension activities of field extension workers also affect the work performance of field extension workers leading to poor implementation of extension programmes. This situation could reduce the effectiveness of field extension workers, and thus affect farmers' adoption of irrigated paddy production innovations negatively.

4.3.4.2 Constraints facing farmers' adoption of selected basin irrigated paddy production innovations

Field extension workers respondents' views on problems facing farmers in adopting recommended basin irrigated paddy production practices were examined and findings are as shown in Table 11. Data in Table 11 reveal that lack of irrigation inputs was a major constraint facing farmers in adopting selected basin irrigated paddy production practices.

Inputs such as adequate irrigation water, power tillers, mechanised equipments for land levelling, improved paddy seeds, water flow measuring devices, fertilisers, pesticides and construction materials for irrigation facilities are extremely important for smallholder farmers in adopting basin irrigated paddy production practices.

Low level of farmer training on irrigation practices and lack of credit were also identified as constraints to farmers in adopting basin irrigated paddy production practices by three out of four extension worker respondents. As observed by Khan (2011), the majority of the farmers especially smallholder farmers have not been able to move from subsistence to market oriented farming because they lack credit to invest on efficient practices for improving their cultural operations. Also bearing in mind that irrigation investment costs are high for farmers to afford, it becomes difficult for them to adopt recommended irrigated paddy production practices. With regard to training of farmers on irrigation

Table 11: Percentage distribution of extension worker respondents' (n=4) perceptions on constraints facing farmers in adopting practices

Type of constraint	Extension worker respondents' rating	
	Important	Not important
Low level of farmers training	xxx	x
Lack of irrigation inputs	xxxx	
Lack of credit	xxx	x

X^a Frequency of extension worker respondents' responses

practices, results in Table 11 indicate that there is low level of farmer training on recommended basin irrigated paddy production innovations. However, due to the complexity of the irrigation innovations, there is need for the extension services to provide adequate and regular training to farmers with regard to irrigation practices.

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4.4 Summary of the Discussion

The overall objective of this study was to assess the availability, transfer and utilisation of basin irrigated paddy production innovations in Mvomero district, Morogoro region. The findings show that district agricultural offices have access to information about recommended irrigated paddy production innovations based on research from our research stations. Available irrigated paddy production innovations appear to be difficult and not easily understood by farmers and field extension workers. The transfer of irrigated paddy production innovations from district agricultural extension offices to farmers generally take form of advice. Field extension workers tend to advice farmers mainly through group and individual methods. In addition, farmers prefer to use innovations which are perceived to be consistent with past experience, better than those previously used, simple to apply, triable and observable. The following Chapter presents the conclusions and recommendations regarding the major findings of the study.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

(i) The extension service seems to have an inventory of extension innovations to disseminate for basin irrigated paddy farming. In general, it would appear that for all other irrigated crops, innovations are available in forms that are difficult and vary in degree to which they can be helpful to field extension worker and the farmer.

(ii) The transfer of irrigated paddy production innovations from district agricultural offices generally take the form of advice. Field extension workers tend to advise farmers mainly through group and individual extension methods. Some of the constraints for transfer of such innovations are of extension nature while others are beyond the responsibilities of extension service.

(iii) The study has revealed that farmers prefer to use innovations which are perceived to be consistent with past experience, simple to apply, triable and observable. Continued utilisation of irrigated paddy production innovations appear to be constraint by lack of inputs and low level of farmers' training.

5.2 Recommendations

(i) Since innovations for basin irrigated paddy production are available in forms that are difficult to the farmers' use, much effort should be made to refine irrigated paddy production innovations to simple technologies that can easily be understood and disseminated to farmers. This calls for closer links among research, training and extension organisations for such technological development.

(ii) Considering that irrigated paddy production innovations have been changing with changing technology, there is a need for a continuous process of in-service training for extension workers in order to up-date their technical knowledge, expose them to extension methods and techniques, and generally provide professional re-orientation to their work.

(iii) In view of the fact that continuous utilisation of irrigated paddy production innovations is constraint by lack of inputs and low level of farmers' training, there is a need for the government to design a mechanism for providing credit to farmers and improving primary and secondary school educational quality, since this is where there are a number of youths who are expected to be future farmers in the country side.

5.3 Suggestions for Further Research

(i) To conduct case studies on the process of acquisition of information by extension workers from the district agricultural offices. The purpose of his study would be to find out if extension workers are offered opportunity to retrieve information on irrigated paddy production innovations from research stations and process it adequately for use by farmers.

(ii) To undertake case studies on interaction between field extension workers and farmers during the process of innovation transfer. The Participant -As- Observer technique could be suitable in seeking data for such study.

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APPENDICES

Appendix 1: Definition of the key variables used

Variables	Operational Definition
Sex	Biological differences between male and female
Age	Number of years lived by an individual since birth
Educational Level	Highest level of education obtained
Marital status	Current state of marriage of an individual
Farm size	Area of land owned for agricultural production purposes
Crop yield	Food and cash crop average yields
Basin irrigation	Surface irrigated areas without longitudinal slope and complete perimeter bunds to pond water and prevent runoff
Innovation	Practice, an idea or object perceived as new by an individual or group of individuals
Availability of innovations	A situation whereby practices, ideas or objects are readily used or obtained by an individual or group of individuals
Transfer of innovations	A process by which a new practice or idea produced or generated in one place is passed to another place
Characteristic of innovations	Features which influence the acceptance and utilisation of irrigation practices or ideas
Adoption of innovations	A choice to accept and fully utilise new practices or ideas. Used interchangeably with the term ''utilisation of innovation''
Rejection of innovations	A choice to refuse to accept and utilize new irrigation practices or ideas
Improved livelihood	A situation of having adequate stocks of food and cash to meet basic needs with reserves to offset risks
Poverty alleviation	Any process of increasing levels of income of poor people through irrigated agricultural production

Appendix 2: Farmers' questionnaire

- Confidential
- Respondents: Farmers
- Study topic: Transfer and utilisation of agricultural irrigation innovations in Tanzania: A case of selected basin irrigated paddy production innovations in Mvomero district.
- Region ________ district _________ ward_________ village__________
- Respondents Number_____________ Date___________

A. Farmers' Characteristics

Personal characteristics

1. Age ______ (yrs)
2. Sex _________(male/female)
3. Marital Status (Single/Married/Widowed/Divorced)
4. What is your final of education? __________ (None/Adult literacy/Primary/Post-primary/Others (Specify ______________).

Situational Characteristics

5. Do you have private farm for crop production? (Yes/No)
6. If Yes in question 5 above, what is the area of your farm? ___ (acres)
7. In relation to the following table, record number of acres, average yield and type of crop grown in 2009/10 and if it was food or cash crop

Type of crop	Area (acres)	Average yield (kg)	Major purpose

8. Have you ever irrigated your crops? (Yes/No)

If yes, use the following tables to record type of crop, number of acres irrigated in 2009/10, average yield and type of irrigation system used.

Type of crop irrigated	Area (acres)	Average yield	Type of irrigation System used

B. Availability of basin irrigation innovations

9. I would like to have your views on recommended irrigation practices involving paddy farming.

Type of practice	Opinion		
	Aware	Ever used	Used in 2009/10
Water source identification			
Main canal construction			
Field preparation			
Water management			
Operation and Maintenance			

10. What do the following practices imply as currently used in basin irrigated agriculture?

Type of practice	Implication
Water source identification	
Main canal construction	
Field preparation	
Water management	
Operation and Maintenance	

C: Transfer of basin irrigation innovations

11. Have you ever received advice from extension or any other source on the following basin irrigation practices? (Yes/No)

Type of practice	Opinion	
	Extension	Others (specify)
Water source identification		
Main canal construction		
Field preparation		
Water management		
Operation and Maintenance		

12, If Yes, in question 11 above, through what extension methods were you advised in basin irrigation practices?

Type of practice	Extension Methods		
	Individual	Group	Mass
Water source identification			
Main canal construction			
Field preparation			
Water management			
Operation and Maintenance			

D: Adoption/Rejection of basin irrigation innovations

13. What is your opinion on the use of traditional and recommended practices with regard to basin irrigation practices?

Type of practice	Traditional		Recommended	
	Mostly used	Not mostly used	Mostly used	Not mostly used
Water source identification				
Main canal construction				
Field preparation				
Water management				
Operation and Maintenance				

14. Which of the following statements accurately describe the major reason for your continued rejection or failure to use the following basin irrigation practices?

Type of practice	Practices used are better	Inconsistence with past experience	Difficulty in Technology	Not easily triable	Not easily observable
Water source identification					
Main canal construction					
Field preparation					
Water management					
Operation and Maintenance					

Thank you for your cooperation

Type of practice	Traditional		Recommended	
	Mostly used	Not mostly used	Mostly used	Not mostly used
Water source identification				
Main canal construction				
Field preparation				
Water management				
Operation and Maintenance				

14. Which of the following statements accurately describe the major reason for your continued rejection or failure to use the following basin irrigation practices?

Type of practice	Practices used are better	Inconsistence with past experience	Difficulty in Technology	Not easily triable	Not easily observable
Water source identification					
Main canal construction					
Field preparation					
Water management					
Operation and Maintenance					

Thank you for your cooperation

Appendix 3: Extension workers' questionnaire

- Confidential
- Questionnaire: Personal interviews
- Respondents: Extension Workers
- Study topic: Transfer and utilisation of agricultural irrigation innovations in Tanzania: A case of selected basin irrigated paddy production innovations in Mvomero district.
- Region ______ District ______ Division ______Ward ___Village____
- Respondents' Number___________ Date______________

A: Personal Characteristics

1. Age ________________ (yrs)
2. Sex ________________ (Male/Female)
3. Marital Status __________ (Single/Married)
4. What is your highest level of education?

   Primary/Form IV/Form VI/Others (specify)
5. Professional training? Complete as follows.

Level of training	**Final qualification**	**Specialisation**	**Year of graduation**
Certificate			
Diploma			
Degree			
Others (specify)			

6. In-service training? Complete as follows

Organised by	None	1-2	3-5	>5	Last time attended(Month& year)
DALDO					
Others (specify)					

7. Length of service in extension work ____________ (years)

8. Length of service in the present ward ____________ (years)

9. Indicate major field activities in which you have been engaged.

____

B. Availability of basin irrigation innovations

10. Are there recommended basin irrigation innovations for extension service from research stations? (Yes/No).

If yes, what are the specific recommendations by type of basin irrigation practice?

Type of practice	Specific recommendation
Water source identification	
Main canal construction	
Field preparation	
Water management	
Operation and Maintenance	

C. Transfer of basin irrigation innovations

11. Bellow is a list of selected basin irrigation practices for paddy farming.

Tick against an extension method you frequently use in advising farmers for each practice.

Type of practices	Extension Method				
	Individual		Group		
	Farm visit	Office visit	Field tour	Meetings	Demonstrations
Water source identification					
Main canal construction					
Field preparation					
Water management					
Operation and Maintenance					

12. Below is a list of statements on constraints to extension workers on transfer of basin irrigation innovations. On your opinion, rank constraints as being very important, important, not important, no opinion.

Type of constraint	Very important	Important	Not important	No opinion
Lack of incentives				
Poor transport facilities				
Involvement in many other duties				
Others (specify)				

D: Adoption/Rejection of innovations

13. What are your opinions on the use of traditional and recommended practices with regard to irrigated crops?

Type of practice	Opinions			
	Traditional		Recommended	
	Mostly used	Not mostly used	Mostly used	Not mostly used
Water source identification				
Main canal construction				
Field preparation				
Water management				
Operation and Maintenance				

14. Below is a list of constraints for farmer's adoption of basin irrigation innovations. On your opinion, rank the constraints as being very important, important, not important and no opinion based on adoption of basin irrigation practices.

Type of constraint	Opinion			
	Very important	Important	Not important	No opinion
Low level of farmers training				
Lack of irrigation inputs				
Lack of credit				
Others(specify)				

Thank you for your cooperation

Appendix 4: Key informants' checklist

- Confidential
- Checklist: Directed discussion
- Respondents: Researchers and other key informants
- Study topic: Transfer and utilisation of agricultural irrigation innovations in Tanzania: A case of selected basin irrigated paddy production innovations in Mvomero district.
- HQs…………………Region………………..District …………Division………..
  Ward………………… Village……………………
- Respondent's number…………..Date…………………..

1. Are you aware of smallholder farmers' basin irrigation system recommended innovations? YES/NO.

If YES, what are the specific recommendations by type of irrigation practice?

Type of irrigation practice	Specific recommendation
Water source identification	
Main canal construction	
Field preparation	
Water management	
Operation and Maintenance	

2. List the problems that make it difficult for farmers to adopt the recommended techniques put forward to them. Start with the most serious one.

3. List problems that make it difficult for extension workers to adequately transfer techniques /innovations to farmers. Start with the most serious one.

Thank you for your cooperation