FACTORS INFLUENCING FARMERS' PARTICIPATION IN OPERATION AND MAINTENANCE OF SMALLHOLDER IRRIGATION PROJECTS IN GICHUGU DIVISION, KIRINYAGA EAST DISTRICT, KENYA

BY

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DECLARATION

This research project is my own original work and has not been presented for the award of a degree in any other university.

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DEDICATION

This research project is dedicated to my loving wife Pauline and my three daughters Cecilia, Phyllis and Juliana. They have been very understanding and have stood with me despite the many week-ends I have been away from home in an effort to make this project a reality.

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ABBREVIATIONS AND ACRONYMS

ALDEV	African Lands Development
DAO	District Agricultural Officer
DIO	District Irrigation Officer
FAO	Food and Agricultural Organization
FASID	Foundation for Advanced Studies in Development
GOK	Government of Kenya
IIMI	International Irrigation Management Institute
IWUA	Irrigation Water Users Association
IWUAs	Irrigation Water Users Associations
JICA	Japan international Corporation Agency
M&E	Monitoring and Evaluation
MOALD	Ministry of Agriculture and Livestock Development
MWI	Ministry of Water and Irrigation
NIB	National Irrigation Board
O&M	Operation and Maintenance
SIPMK	Smallholder Irrigation Programme Mount Kenya Region
SSIU	Small-scale Irrigation Unit
WUA	Water Users Association
WUAs	Water Users Associations

ABSTRACT

Smallholder irrigation development in Kenya has gained momentum over the last decade due to support from both the government and development partners. There has also been growing interest in this sector on the part of farmers due to sensitization by stakeholders on the need for intensification of agricultural production. However the major challenge has always been poor performance due to inadequate farmer participation, low level of government support services, weak Irrigation Water Users Associations (IWUAs) and inability of the beneficiaries to raise required funds. Farmers' participation in irrigation development and management has been studied by many researchers within the context of project development cycle because of the contribution of irrigation to food security and rural livelihoods.

A target population comprising of 1052 irrigation farmers practicing irrigation within the set up of smallholder irrigation projects with functional WUAs was studied. The research design adopted was descriptive survey research. A sample size of 105 farmers from randomly sampled projects was drawn using cluster sampling technique. Data was collected using researcher administered questionnaires. The data was analysed using descriptive and inferential statistics according to the research questions and objectives of the study.

The findings of this study will provide useful feedback to stakeholders in the irrigation sector so that appropriate polices and strategies can be formulated to ensure full participation of farmers in O&M. Irrigation extension workers will also be guided by the findings to plan field activities geared toward effective O&M. The people in the study area will also benefit from enhanced irrigation management and agricultural productivity resulting from implementation of the study's recommendations. Majority of the respondents indicated that they often refer to the Irrigation Water Users Association by laws in their day to day irrigation activities. The study concluded that although farmers get water for irrigation on their farms, the water received is not adequate for the irrigation areas allowed and that majority do not get water for irrigation as scheduled especially the tail section members. It also concluded that extension services were inadequate. The study recommended that the farmers should be aware of important issues that arise in their daily irrigation farming activities and their responsibilities within the IWUA set up geared towards managing and improving the irrigation system. It also recommended further investigations in a number of areas for improvement of O&M.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

The last few decades have witnessed a paradigm shift in a large number of countries around the world where programmes have been adopted to transfer management of irrigation systems from government agencies to Water Users Associations(WUAs) or other private entities (Vuren, Papin & Haouari, 2004). According to Vuren et al (2004), this involvement of irrigation water users in all aspects and all levels of irrigation management has a number of infrastructural and societal benefits that include quick response to system breakdown (hence reducing maintenance costs), avoiding destruction of infrastructure by farmers, reducing water theft, promoting better maintenance, creating sense of ownership, stimulating self development, democracy and efficient management. There is therefore a general consensus that for sustainability of irrigated agriculture, Operation and Maintenance (O&M) of irrigation and drainage systems is critical and needs to be improved (Jurriens & Jain, 1993).

Since the mid 1980's, WUAs world over have taken more management and O&M roles in irrigation systems while the role of governments has been gradually declining or totally withdrawn (Shah, Koppen, Merry, Lange & Samad, 2002). Experiences from countries with substantial irrigation undertakings such as Mexico, Chile, India, Philippines, Columbia and others show that Governments have engaged irrigation farmers to embrace participatory irrigation management and irrigation management transfer programmes in order to achieve financial and physical sustainability of irrigation systems, improve water management and agricultural productivity and counter budgetary constraints(Vuren et al, 2004) . At the same time farmers have realized the need to gain control over the irrigation systems and create a feeling of ownership.

Irrigation potential in Sub-Saharan Africa is estimated to be about 34 million hectares out of which only 15% has been exploited (Food and Agricultural Organization (FAO), 1986). Most of these are smallholder irrigation projects which strive (with government support) to achieve food self-sufficiency and generate income from local and foreign sales of agricultural produce. Chibisa, Mautsa& Mukoto (2008) note that in trying to achieve these targets, the projects are often faced with problems such lack of effective project operation and maintenance and

production support services due weak management and inadequate operating budgets. Faced with these challenges, it is not uncommon for farmers to revert to other diverse activities resulting in dormant irrigation areas and low production (Chibisa, et al, 2008).

According to Scheltema (2003), smallholder irrigation occupies an important part of the total irrigation activities in Kenya with smallholders managing about a third of the total irrigated area in 1990 with the share now rising to about half. This can also be seen in the substantial resources that have been invested in irrigation development in recent years. According to the Government of Kenya (GOK), out of the total national irrigation potential of 540,000 hectares, 114,600 hectares have been developed under the three main categories namely; smallholder projects 49,000(43%), national schemes 20,600(18%) and private schemes 45,000(39%) (GOK, 2010). It is estimated that about Kenya shillings 7.5, 3 and 5 billion has been invested so far by the private sector, smallholder farmers and donors respectively (Gichuki, Gichuki, Matsuoka & Onchoke, 2010). A substantial amount of these resources have been used to support smallholder irrigation development in a bid to expand irrigation through development of sustainable production systems (GOK, 2010).

In line with global trends, Kenya has adopted new paradigm of development of irrigation projects in recent years with a major shift from the colonial era top down approach involving centrally managed large scale projects to a bottom up approach. The latter approach according to the Ministry of Water and Irrigation(MWI), views the farmers as the drivers of development where they express the need for irrigation and take full responsibility for project operation, maintenance and management for long term sustainability (MWI, 2003). This is further underpinned in the draft national irrigation policy which advocates for full participation of farmers and other stakeholders in the identification, planning, design, implementation, operation and maintenance of irrigation schemes (MWI, 2011).

Smallholder irrigation development in various parts of the country has gained momentum in the last 10 years following substantial support from the government and development partners. However the major challenge has always been poor performance due to inadequate farmer participation, low level of government support services for example extension, weak Irrigation Water Users Associations(IWUAs) and inability of the beneficiaries to raise required funds

(GOK, 2010). These issues point to the fact that sustainability of newly developed or rehabilitated projects is largely pegged on farmers' ability to take responsibility for O&M in the spirit of the new development paradigm.

1.2 Statement of the Problem

Farmers' participation in Operation and Maintenance of smallholder irrigation projects remains poor despite the various efforts made by the Ministry of Water and Irrigation and other stakeholders in strengthening and training of Irrigation Water Users Associations and provision of irrigation extension. For example between December 2005 and November 2010, the Ministry in collaboration with Japan International Corporation Agency(JICA) spent over 300 million shilling in a project aimed at capacity building IWUAs in irrigation scheme operation, maintenance and management among other components (MWI/JICA, 2010). It has been noted that every financial year the field extension officers undertake a number of farmers' capacity building activities. These activities are geared towards strong and functional IWUAs, improvement of knowledge and skills in water management, irrigation agronomy and general infrastructure management as well as carrying out irrigation as serious economic and business activity. However, a general decline in performance and sometimes total collapse of newly constructed or rehabilitated projects has been noted (Gichuki, Gichuki, Matsuoka & Onchoke, 2010).

While many small scheme development programmes have been supported by international funding agencies, governments and NGOs, Chancellor & Hide (1997) observe that there is little published information on small scheme design and performance to identify the determinants of success or failure to help evaluate design options. It is still not clear which factors influence farmers' participation in O&M though it remains limited despite its crucial role in smallholder irrigation sustainability. As noted in the introduction section, in the past irrigation development in Kenya used to be top-down where communities did not have a say in the development initiatives. However as noted by Thwala (2010), communities in rural areas should be given an opportunity to identify and define their needs since they are better informed about their local situations. A review of most of the published material reveals that there is need for more exploration of pertinent issues related to O&M of smallholder irrigation projects from the farmers' perspective.

In particular, Gichugu Division has a high concentration of smallholder irrigation projects. The farmers rely on water from rivers emanating from Mt. Kenya which is one of the largest water towers in Kenya. Farmers organize themselves into IWUAs and abstract water by gravity which is in turn channelled to the farms through a system of canals and pipe networks. Despite the long experience in operating the irrigation systems, O&M challenges often arise in the division leading to water conflicts, poor water management and neglected or underperforming systems. In most such circumstances while seeking solutions to these problems, farmers often turn to individual behaviour rather than the recommended participatory approach through IWUAs. The District Irrigation Officer (DIO) Kirinyaga East District alludes to this in the annual report when he mentions weak IWUAs, inadequate funds and inadequate farmers' capacity as some of the challenges facing irrigation development in the division (DIO, 2011). This study therefore sought to understand some of the factors that influence farmers' participation in O&M of smallholder irrigation projects in Gichugu Division of Kirinyaga East District.

1.3 Purpose of the Study

To investigate the factors that influence farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division of Kirinyaga East District.

1.4 Objectives

1. To determine the influence of farmers' commitment to the Irrigation Water Users Association on farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division
2. To establish the influence of farmers' knowledge and skills on farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division
3. To assess the influence of reliability of water supply on farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division
4. To explore the influence of quality of extension services on farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division
5. To investigate the influence of competing economic activities on farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division

1.5 Research Questions

The study answered the following questions:

1. To what extent does farmers' commitment to the Irrigation Water Users Association influence farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division?
2. How do farmers' knowledge and skills influence farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division?
3. To what extent does reliability of water supply influence farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division?
4. How does quality of extension services influence farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division?
5. To what extent do competing economic activities influence farmers' participation in operation and maintenance of smallholder irrigation projects in Gichugu Division?

1.6 Significance of the Study

In many forums addressing food security issues in Kenya, irrigation has been mentioned as the ultimate solution to the hunger cycle that afflicts the country year after year. With smallholder irrigation accounting for 42% of irrigated land in the country and still expanding coupled with adverse effects of climate change there is need to focus on this sector and manage it sustainably (GOK, 2010). One of the policy objectives outlined in the draft irrigation policy is to expand the area under irrigation by an average of 40,000 hectares per year in line with vision 2030 while enhancing sustainability through participation of farmers and support groups in all irrigation development processes (MWI, 2011). Sustainability of smallholder irrigation is pegged on the fact that the irrigation system is owned, operated and maintained by the farmers themselves. However this remains a major challenge despite the increased funding in recent years.

Statistics show that there is a general decline in the economic rate of return of irrigation projects from a high of 20% during planning and design stage to around 6% during the first 5years of operation, dropping to less than 3% after 10 years. It is suspected that among the major constraints leading to this situation are inadequate knowledge, experience, skills as well as negative attitudes therefore reducing the Irrigation Water Users capacity to operate and maintain irrigation infrastructure and guarantee reliable and equitable water supply to farmers (Gichuki et al, 2010). The information gathered through this study therefore will provide useful feedback to

stakeholders in the irrigation sector so that appropriate polices and strategies can be formulated to ensure full participation of farmers in O&M. Irrigation extension workers will also be guided by the findings to plan field activities geared toward effective O&M. Finally the people in the study area will benefit from enhanced irrigation management and agricultural productivity resulting from implementation of the study's recommendations.

1.7 Delimitation of the Study

The study was conducted in Gichugu division of Kirinyaga East District and focused on some of the variables that influence farmers' participation in O&M. The District is endowed with a high concentration of smallholder irrigation projects. The farmers in this area have long experience in irrigation and the area is also accessible making data collect easy. It covered irrigation farmers in smallholder irrigation projects with formally organized Irrigation Water Users Associations.

1.8 Limitations of the Study

Gichugu division is a relatively small geographical area and as the study was confined to irrigation farmers within smallholder irrigation projects in the area, it is advisable that the results be generalized with caution to other parts of the country. The study also involved first hand information collection from the field and this required time and resources which were limited. Experience of enumerators and cooperation of respondents was also limiting. This was addressed by soliciting for funds from the researcher's employer in good time. Similarly the study was scheduled to coincide with days that were convenient to both the enumerators and farmers. As such the researcher strove to avoid field visits during market or other busy days. Experienced enumerators were also recruited to assist in the study.

1.9 Assumptions of the Study

The following assumptions were made during the study:

- The respondents were honest and gave correct answers during the data collection stage
- Irrigation farming carried equal importance in different ecological zones of the division
- Trainings and extension services interventions were evenly spread across the division
- The sample chosen represented the population and the data collection instrument measured the desired concepts.

1.10 Definitions of Significant terms

Economic activities Those undertakings in which irrigation farmers in Gichugu division spend their time and resources in return for income to meet diverse needs.

Extension services Refers to the techniques and skills offered to irrigation farmers on need and demand basis by qualified Government employees and other stakeholders in irrigation and related matters.

Maintenance This is a set of activities carried out to ensure that the irrigation system functions optimally according to how it was designed and implemented. They are more of periodic rather than routine procedures to address foreseen or actual problems in the system.

Operation Involves all activities encompassing water abstraction from source, conveyance, distribution, application and irrigated crop production in every farm in the project area. They are routine day to day procedures.

Paradigm shift New way of looking at irrigation development from top down (government leading the process) to bottom up (farmers expressing the need and actively participating in the process)

Participation This is the process of irrigation farmers taking an active and direct role in decisions regarding management of smallholder irrigation projects. This includes taking certain responsibilities, providing resources and ideas.

Smallholder irrigation projects These are community based projects that use a bottom up approach to development upon the beneficiaries expressing the need. The beneficiaries are actively involved in the development process and take full responsibility for scheme operation, maintenance and management.

Smallholder irrigation It is a system of irrigation where beneficiaries take a lead role in the whole project cycle from initiation to evaluation and finally determine how to sustain the benefits.

Sustainability This is the continued and increased enjoyment of irrigation project benefits over a long time by project members in an environmentally friendly way so that the same benefits can be enjoyed by future generations.

Irrigation Water Users Association This is a group of farmers within a given geographical area who come together for the purpose of utilizing a common water source for irrigation. It has a formal organizational structure through which members join efforts to install, operate, maintain and manage the irrigation facility for the benefit of all members.

Farmers' Commitment Refers to the devotion and dedication of Gichugu division farmers to IWUA planned activities seen in terms of time, energy and obligation to adhere to set rules

Knowledge and skills Refer to a cluster of competences required by irrigation farmers in Gichugu Division to carry out irrigated agriculture demonstrated by translation of extension messages into practical undertakings to take care of the irrigation infrastructure as well as carrying out sound water management and agronomic practices

Reliability of water supply It is the situation where all IWUA members in a project receive water from the irrigation system when and where they require it and in adequate amounts to sustain crops during the entire growing period

1.11 Summary

This chapter has outlined the emerging trends in irrigation management with emphasis on operation and maintenance. It has been noted that globally, many countries have taken steps in order to allow farmers to have more say in the operation and maintenance of the irrigation systems through irrigation management transfer and participatory management. This new development has been replicated in Africa as well as Kenya where smallholder irrigation farmers are expected to sustain project benefits through proper O&M. It has however been realized that this remains a big challenge despite various efforts to strengthen farmers' capacity. This has led to the justification of this study as an attempt to understand factors influencing O&M and therefore influence policies and strategies at national and field level as various actors utilize the results of the study. Finally this chapter has highlighted the scope of the study where only five variables were looked at, the challenges faced and how they were addressed, the basic assumptions underlying the study as well as definition of the significant terms used in the study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents reviewed literature relating to the study. Research articles and studies related to irrigation development and management are analysed and discussed in terms of the findings, challenges and recommendations from a global, continental and local perspective. Particular emphasis has been laid on smallholder irrigation in relation to the changes that have taken place in the sector in the last two and half decades. The literature brings out the paradigm shift where irrigation farmers have become drivers of their own development through participation in the whole process instead of relying on the initiative of governments and other stakeholders. This shift has led to ownership and sustainability. Irrigation water Users associations (IWUAs) become important formal entities for farmers' involvement in managing and sustaining the projects by ensuring reliable supply of water and hence sustainable production. A key aspect of sustainability that comes out in this review is the Operation and Maintenance (O&M) of the projects after implementation. Farmers through the IWUAs are expected to carry out these activities to ensure not only optimum performance of the projects but also reap maximum benefits from their efforts. The issues highlighted in the chapter therefore include but not limited to the following; irrigation development, concepts of participation, operation and maintenance of smallholder irrigation projects, some factors that influence farmers' participation in operation and maintenance i.e. farmers commitment to the Irrigation Water Users Association (IWUA), farmers' knowledge and skills, reliability of water supply, quality of extension services and competing income activities.

2.2 Global perspectives of irrigation development and management

According to Vermillion (1997), irrigated agriculture now and in the foreseeable future is faced with a major challenge of how to produce more food with less water for the ever increasing world population. Vermillion notes that by 2027, over 80% of this food will come from irrigated land. This is further supported by various FAO studies whose results project that the world population will hit the 9 billion mark in 2050 and with irrigated agriculture at present accounting for 47% and almost 60% of all crop and cereal production respectively in developing countries, irrigation will continue rising in importance (Bruinsma, 2009). The world is thus faced with an

even more urgent challenge of utilizing water more efficiently and productively in the light of increasing competition for this vital resource.

Water has always been a scarce resource all over the world. This has been made worse by the emerging trends of global warming, environmental degradation and climate change. Irrigation therefore cannot continue enjoying its former status in terms of water usage (Mudau, 2010), more so because agriculture is the most notorious user of accessible fresh water accounting for about 70% of water withdrawals globally (FAO, 1993). Many governments have progressively reacted to this dilemma by devolving natural resources management to local authorities. This phenomena has become prevalent in several sectors due to the recognition by governments that local organizations are the best placed to effectively monitor the use of such resources. This decentralization is particularly strong in irrigation where participatory management through irrigator organizations has become the norm in irrigation reform worldwide (Bandyopadhyay, Shyamsundar & Xie, 2007). Bandyopadhyay et al (2007) indicate that major strides in reforms were made starting in USA, South America, Europe and some parts of Asia from 1950s to 1970s and eventually in other developing countries in the 1980s and 1990s.

Studies and experiences from countries with successful and self governing irrigator associations such as Mexico and Philippines point to certain characteristic features including being strong in planning and execution of O&M policies and plans, having high membership rates within their service areas, holding regular meetings, operating and resolving conflicts within the framework of their by-laws, obtaining a major part of their livelihood from irrigated farming and emphasis on financial accountability and transparency (Araral, 2003). Chandrasekaran, Umashankar., Duraiswaminathan, & Jayakumar (2002) also allude to this in reference experiences from India that suggest that ability of farmers to rehabilitate the system, financial autonomy, intervention and resolution of disputes and interest in learning about better farming technology are some of the factors that make WUAs sustainable in the long run.

International experience with transferred management responsibility is summed up by Shah (2002) as suggesting that four conditions are critical and must be met for an irrigating community to succeed in such responsibility: (i) it must demonstrate the promise of major improvement in livelihoods for a majority of beneficiaries (ii) the irrigation system must be key

to creating such an improvement (iii) the cost of self management must be acceptably small compared to the improved income and (iv) the proposed organization design be seen to have low transaction costs.

2.3 Theoretical basis for community participation

The term participation has become the key word in project development. It is used to mean different things by different people in different contexts. Therefore the first step in understanding the theoretical framework of community participation is to define the term. There are several dimensions adopted by writers in the definition of community participation. The World Bank (2004) defines participation as "a process through which stakeholders influence and share control over development initiatives, and the decisions and resources which affect them". Okazaki (2008) citing Connell (1997) and Arnstein (1969) brings out two dimensions of participation. First, participation is not just about achieving the more efficient and more equitable distribution of material resources; it is also about the sharing of knowledge and the transformation of the process of learning itself in the service of people's self-development. Second, the purpose of participation is power distribution, thereby enabling society to fairly redistribute benefits and costs. The concept of community participation is viewed as basis for project success because its main objectives are empowerment, building beneficiary capacity, increasing project effectiveness, improving project efficiency and project cost sharing (Thwala, 2010). It is a dynamic process in which all members of a group contribute to the attainment of group objectives, share benefits from group activities, exchange information and experience and follow the rules, regulations and other decisions made by the group (Singh,1992).

A set of theories exist stating the conditions under which people do or do not participate in collective action such as Olson's(1971) theory, McClusky's 1970 theory of margin, Buchanan and Tullock's(1965) theory of collective action and Arnstein's (1969) ladder of citizen participation. Some of these theories are discussed below and form the basis of community based irrigation participatory development and management model.

2.3.1 Arnstein's ladder of citizen participation

The theory of 'ladder of citizen participation' introduced by Arnstein in 1969 emphasized that citizen participation has to be accompanied by power distribution. The eight rungs or steps are categorized into three levels of gradual evolution starting with non-participation followed by

degrees of tokenism and degrees of citizen power. Arnstein thus presents participation as a continuum where at one extreme the public effectively has no say or power at all. Power is progressively transferred and at the extreme of maximum participation there is citizen or public control. Taylor (1998) terms the ladder as a lovely piece of conceptual analysis of public participation showing that participation can be interpreted in several different ways and that there can be more or less participation.

It can be observed that Arnstein's ladder can help identify not only the current level of community participation but also the steps required to encourage greater involvement. Thus the ladder can be useful in understanding the situation of irrigation farmers and their associations and their current state of involvement in development. Arnstein's ladder has its own limitations. For example, the use of a ladder implies that more control is always better than less control. However, increased control may not always be desired by the community and increased control without the necessary support may result in failure (CAG consultants, 2009). This emphasizes the need for collaboration with stakeholders and other actors for communities such as irrigators to access the necessary support for sustainable growth.

2.3.2 Empowerment theory

Empowerment is a process by which people gain control and mastery over their lives and influence others who affect their lives. It emphasizes democratic participation, improvement and self determination of individuals, organizations or communities (Sue & Patricia, 2011). Empowerment theory (Perkins and Zimmerman, 1995) has roots in community psychology, citizen participation and action research. Empowerment model assumes that problems are best addressed by people experiencing them; people possess valuable knowledge about their own needs, values and goals; people have strengths that should be recognized and build on and, processes can be implemented that develop independent problem solvers and decision makers (Sue & Patricia, 2011).

Building on Arnstein's ladder, Rocha (1997) expands the 'ladder of empowerment' to include a variety of empowerment theories that emerged in the 1980s. Empowerment is seen as a means and a goal to acquire basic human needs, education, skills and hence achieve a certain quality of life. Thwala (2010) citing Wignaraja (1991) and Tascconi and Tisdell (1993) observes that the

principle of empowerment states that people participate because it is their democratic right to do so and participation means having power. According to this concept, participation is the natural result of empowerment. Empowerment is not a means to an end but is the objective of development. Empowerment entails more than having the power to make decisions. It demands the knowledge and understanding to make correct decisions.

Communities and organizations such as IWUAs cannot make wise decisions if they do not have the required information. The support organizations such as extension agents are required to be sources of information and should be a channel of information to the communities so that they will be able to make right and informed decisions (Thwala, 2010). This concept therefore applies to farmers' participation in irrigation management whereby the farmers rather than stakeholders hold authority and resources to make decisions. They also take action and dictate the pace of their irrigation development. The stakeholders should form linkages to ensure information is sourced and delivered to the farmers in timely and utilizable manner and also empower them to realize their potential.

2.3.3 Theory of participative behaviour

This theory was propounded by McClusky in 1970. It is also called the theory of margin and defines margin as a function of the relationship of 'load' to the 'power'. Load refers to the self and social demands by a person to maintain a minimum level of autonomy while power refers to resources such as abilities, possessions, position, allies among others which a person can command to cope with the load. Raghuvanshi (1995) cites Lupanga's (1988) hypothesis on load and power to explain the lack of peoples' participation in development activities in the third World. The hypothesis is that most of the rural people have heavy load and little power hence they are preoccupied with mere survival to participate meaningfully in development activities. Efforts to mobilize people to participate must therefore include reduction of the load or raising power or both (Raghuvanshi, 1995). The obvious limitation of the hypothesis is that it cannot explain why poor people participate in some development activities and not others. Singh (1992) and Raghuvanshi (1995) conclude that some technology and programme specific factors affect peoples' participation. These include expected returns and costs of participation, attitudes, values and skills of people, design and other characteristics of project, legal, political and institutional environment prevailing at the time (Korten, 1983).

This model is particularly applicable to smallholder irrigation farming because farmers approach this undertaking from a commercial angle. They readily participate in collective action when organized in manageable groups so long as the expected private benefits from collective action exceed the expected private costs of participation. Of particular importance is the farmers' own institutional set up and the rules and regulations governing them because they are an assurance that among other things, the expected benefits would in fact accrue to the participants. In other words, based on this model it can be argued that farmers are sensitive to the opportunity cost of participation given that there are other economic activities they can engage in.

2.4 Irrigation development and management in Africa

Lessons from irrigation development in Sub-Saharan Africa indicate many failed irrigation initiatives characterised by projects that have experienced problems in technical, institutional and organizational aspects (Sishuta, 2005). Research and lessons further indicate that poor maintenance and lack of effective control over irrigation practices have resulted in the collapse of many irrigation systems (Gyasi, Engel & Frohberg, 2006).This is because farmers were expected to comply with directives from project managers and consultants who dealt with technical aspects and largely ignored the human factor in irrigation development. Irrigation agencies using the top-down, centrally planned model have largely failed to raise sufficient revenues from the collection of water charges to meet operational expenses.

The irrigation agencies, mostly large corporations like Agriculture and Rural development Corporation (South Africa), the Nile Agricultural Services Administration (Sudan) and National Irrigation Board (Kenya), have seen their functions of management and provision of other services in schemes curtailed often leaving a legacy of dependent and impoverished farmers (Shah, et al, 2002). Consequently, there has been growing promotion of community-based irrigation management in many developing countries to improve efficiency and reduce cost (Gyasi, et al, 2006). This has been anchored in new water policy dispensations that confer water rights to users, while promoting sustainability and efficiency through new management entities such as Water Users Associations (Perret, 2002).

According to Sishuta (2005) research studies return a positive picture of farmer managed projects. The main concern however has been whether such positive gains which include reduced

costs to governments and farmers, financial self reliance, efficient use of water and increased crop production can be sustained in the long run. Often the push by farmers to take over and manage their affairs has posed new challenges and opportunities of technical, financial and human capacity nature with consequences in the operations of the schemes (Kabutha & Mutero, 2011).

2.5 Irrigation development and management in Kenya

Irrigation development in Kenya is still at its infancy with only 21% of the national potential exploited so far. The development history portrays mixed achievements and challenges due to the often confusing categorization of projects and approaches. However faster development has been achieved from the 1980s when policy orientation shifted to empowerment and strengthening of farmers' organizations to take over smallholder irrigation management roles previously carried out by the government and donor agencies.

2.5.1 Historical background

Like many other African countries, Kenya has a long and interesting irrigation development history. Development of estate or large scale irrigation in Kenya started in the colonial era when the African Lands Development (ALDEV) program was set with the aim of promoting rural development in African reserves (MWI, 2011). At independence in 1963 with the main development goals of fighting poverty, ignorance and disease, irrigation was seen as a major contributor in this undertaking(Gichuki et al, 2010). The enactment of the irrigation act of 1966, paved way for the development and management of public schemes like Mwea, Perkera and Hola. Prior to this and even up to the 1990s, farmers were forced to work in these large irrigation schemes, first as slaves in the 19th century and then as unpaid labourers during World War II. Well into the 1990s then, they worked as "free" but still dependent workers with no say on management of the schemes or benefit from the produce (Neubert, 2007). Starting with the agitation for take over of management by farmers in Mwea scheme due to perceived high handedness of NIB(Kabutha & Mutero,2002), the end of the 1990s saw the collapse of all but one of the NIB irrigation schemes, some of which were even taken over and operated by the farmers. Due to emerging challenges of running large projects like schemes operating under capacity, NIB, with the consent of the farmers, took over some management functions of the schemes based on an understanding with the farmers.

Smallholder irrigation schemes have existed for centuries as indigenous systems and for many years the main impulse for change to smallholder irrigation development was from outside using a top-down approach. Farmer driven smallholder irrigation development started only recently after a transition period during which outside assistance was sort to promote farmer participation Scheltima (2003). The Small Scale Irrigation Unit (SSIU) was established in 1977 with the assistance of the Dutch Government. Then operating under the Ministry of Agriculture and now under the Ministry of Water and Irrigation since 2003 as Irrigation and Drainage Branch, it is mandated to promote smallholder irrigation projects that are fully and independently managed by water user associations (Neubert, 2007).The country also has large privately managed commercial farms that specialize in flowers and horticulture that started emerging in the 1980s and are scattered around Naivasha, Eldoret, Nairobi and Nanyuki.

Ngigi (2002) observes that irrigation projects that had previously been show cases have largely deteriorated and in some cases neglected. Therefore there is need to evaluate past and current irrigation development in order to come up with sustainable strategies for future. In pursuit of these strategies, there is need to encourage less government intervention in favour of beneficiary participation to build self sustaining systems. In a paper titled preliminary evaluation of irrigation development in Kenya, Ngigi (2002) also argues that institutional measures should be taken to strengthen WUAs. This should be done through participative gender balanced training in diverse issues such as decision making, scheme management, leadership skills, financial management record keeping and enforcement of by-laws.

2.5.2 Categorization of irrigation projects and associated challenges

Three broad categories or organizational types can be identified although there is no obvious distinction between them. Smallholder schemes or projects that are of variable size and operated by Water Users Associations within the project set up. Weak WUAs, inadequate skills and scarcity of water have been identified as some of the major challenges affecting their organizational capacity (MWI, 2003). NIB schemes that cover several hundred hectares and are managed and developed by the National Irrigation board (NIB).They have faced threats of near collapse situations in recent years due farmers' protests over management. Commercial flower and horticultural farms embracing modern technologies and targeting export markets. They have often been challenged to weigh their activities against declining water resources and

environmental degradation. Becht (2006), reports that several commercial growers have started using innovative techniques and better irrigation management to reduce water wastage and to treat waste water.

2.5.3 Growth of smallholder irrigation in recent years

Irrigation development is expensive and even though it continues to expand, the pace is now slowing worldwide (Nhundu & Mushunje, 2010). The high development costs are partly to blame for waning donor interest in this sector. However, since the end of the1980's there has been a tendency to promote small irrigation projects and user participation in Africa because of the better results obtained (FAO, 2005). Smallholder development approaches bring about ownership of the process with farmers make their contributions through skilled and unskilled labour, locally available materials and cash. This significantly lowers the per-hectare development cost and reduces investments required for rehabilitation making it a viable option.

Chancellor & Hide (1997) state that "programmes for small irrigation scheme development have become popular with governments and funding agencies. By comparison with large projects, small schemes potentially involve lower total capital cost; less time for project development and implementation; less complex design. They provide the opportunity for participatory development and for orderly devolution to farmers of costs and responsibilities for operation and maintenance". However, Gyasi et al (2006) differs with this position when he looked at the determinants of the success of community-based institutions for irrigation management and states that the assumption that communities and user groups will manage the systems sustainably may not hold in all cases.

From the mid 1970s, Kenya government policy took a major turn from the traditional approach where plans for irrigation development originated from the regional authorities based on the availability of physical resources like water and good topography (Scheltima, 2004). At that time farmers' participation was reduced to saying 'yes' in public meetings with the hope of benefiting from employment in form of casual labour. New developments have however focused and stressed on design for farmer' management (MOALD, 1992) with recent emphasis shifting to strengthening farmers' organizations led irrigation schemes(JICA, 2000).

2.6 Basis for Farmers' participation in O&M of smallholder irrigation projects

Farmers' participation is an all encompassing process requiring active involvement of project beneficiaries and stakeholders in the whole project cycle from inception to monitoring and evaluation (M&E) (MWI, 2003). Therefore, farmers' participation is firmly anchored in the project cycle. From the point of view of smallholder irrigation development, several distinct stages can be identified i.e. project identification, pre- feasibility, feasibility, detailed design, implementation and M&E.

According to Chancellor and Hide (1996), O&M capability and needs of farmers should be reviewed at detailed design stage and farmers trained on the same during implementation in preparation for handing over of the project. O&M therefore becomes the most important post-implementation activity. It is critical to entrench and operationalize O&M in M&E as the purpose of M&E is to improve the operation and management of a project and draw useful lessons for other projects (FASID, 2000). It is now acknowledged that full participation in monitoring of the system and taking timely corrective measures goes a long way in maintaining the systems in proper working conditions and guaranteeing sustainability after project implementation. However in studies of several projects in West, Central and East Africa, it has been reported that farmers experience difficulties in getting adequate extension support and sustainably managing the projects after implementation (Morardet, Merrey, Seshoka, & Salley, 2005).

2.7 Responsibility for Operation and Maintenance

O&M revolves around the ability to carry out activities that will ensure optimum utilization of irrigation infrastructure and management of various irrigation undertakings. The complexity of carrying out O&M largely depends on the model used and the institutional arrangements put in place. These will in turn determine the role of farmers and other stakeholders whose participation will be influenced by several factors including their mutual cooperation, knowledge and skills and the adequacy of the system to meet their needs and expectations.

2.7.1 IWUAs and O&M

According to MWI (2003), three models of O&M have been tried in Kenya based on the institutions responsible for O&M. The first one involves an authority doing all O&M activities in

large schemes e.g. Mwea where farmers are treated as tenants. O&M costs are then recovered by the authority from the farmers' produce. The second management model involves O&M by IWUAs through a water undertaker in large smallholder schemes e.g. South-West Kano. Farmers in such schemes pay a fee for the O&M of major infrastructure by the Undertaker who in turn handles the technical requirements that farmers are unable to handle. As the case study on Mwea by Kabutha (2002) documents, these two models have faced major challenges due to their failure to fully integrate the beneficiaries and have largely been abandoned.

The third Model involves IWUAs taking the full responsibility for O&M with some technical advice from a government agency and other stakeholders. This management system is seen as the best option for smallholder farmers under IWUAs as involvement of WUAs in decision-making processes is essential to prevent conflicts and social barriers. The role of WUAs is also very important because they can create real value of water and therefore no agency can effectively take up their role (Sarvestani, Baghaei, Kardani, & Bagheri, 2011). Bagadion (2002) however cautions that despite the various roles that WUAs may have in irrigation system management, the question becomes which of these roles would enable sustainable irrigation management and suggests that it may be more useful to address this in the context of specific circumstances of different countries.

Based on the above argument, the approach to O&M in smallholder irrigation is to organize farmer in a particular project to form an Irrigation Water Users Association (IWUA). These Associations are water management entities that operate at local level for the sole purpose of carrying out irrigation management functions. The role of the WUA is to enable a community to pool financial and human resources in order to carry out more effectively water related activities. They usually obtain water rights by applying for and acquiring a water permit and also attain some form of legal recognition by being anchored in relevant water acts as in south Africa (Perret & Touchain, 2002) or just by being registered as self help groups by relevant government departments as is common in Kenya (Scheltima, 2002).

Lack of legal recognition and clarity of by-laws has led to weak IWUAs that are unable enforce by-laws even within their membership. In a research carried out in two smallholder schemes in Malawi, Ferguson & Mulwafu (2004) indicate that farmers are less likely to understand the need to join the association, own it or to follow its rules if issues are not well articulated. This is

especially so where they are being weaned from government support to self reliance. Capacity building in O&M was therefore identified as an integral part of the scheme development process that had not been effectively synchronized with the process.

2.7.2 Implication of Operation and Maintenance on sustainability

There has been increasing concern over the years that many irrigation schemes are performing below expectations for a number of factors with the overriding one being lack of proper O&M. This leads to malfunctioning of infrastructure that has taken considerable attention to plan, design and construct because of paying little attention to O&M issues (Sargardoy, Bottrall, & Uittenbogaard, 1986). According to Sargardoy et al (1986), the three fundamental causes of poor operation that need to be addressed to ensure sustainability are; lack of technical skills in planning, implementing and monitoring the system, poor management skills e.g. corruption, conflicts between farmers, lack of incentives for those doing the job and technical deficiencies in the infrastructure.

To sustain project benefits and ensure that irrigation and drainage facilities remain functional, adequate O&M is a necessary condition. This is supported by case studies of successful projects. The cases show that they are characterized by the involvement of direct stakeholders and beneficiaries in all project phases, particularly O&M procedures (Morales & Mongcopa, 2008).

2.7.3 Operation and maintenance activities and challenges

The main objective of operation and maintenance of projects is to ensure that timely and adequate water is received by the farmers and the system is kept working in satisfactory manner. Sargardoy et al (1986) observe that farmers often lack interest in maintenance activities because of failure to realize their importance, lack of knowhow or feeling that the work benefits others rather than themselves.

O&M activities occur at individual farm level or at IWUA (project) level. Depending on the type of system and irrigation method farmers undertake a number of O&M activities including paying water charges, attending IWUA meetings and trainings, electing IWUA leaders, providing labour for communal activities e.g. de-silting intakes and clearing canals, operation and care of water control gates and valves replacing burst pipes etc. At farm level the activities include water application, crop production, using and taking care of irrigation field structures and

equipment among others. All this is done in the context of IWUA by-laws as what an individual does at whichever level can affect the performance of the project hence the need to do proper planning, implement and monitor the O&M plans. Other prerequisites for effective O&M are training in the performance of technical tasks and development of local problem solving skills (SIPMK, 2011).

Experiences gained from the implementation of the Smallholder Irrigation Projects in Mount Kenya Region indicate that O&M faces several challenges. Farmers are limited by their technical knowhow hence may not understand how the system works and this may lead to conflicts. Another problem relates to poor leadership where the committee creates problems due to lack commitment, accountability or communication. Lack of participation is another challenge which occurs if all members do not participate in communal activities. Related to this is lack of rules or rules that are applied selectively making some members feel discriminated while others are favoured. Finally, farmers who do not meet their financial obligations for water charges threaten execution O&M activities (SIPMK, 2011).

2.7.4 Commitment to Irrigation water Users Association and participation

Devolvement of management of irrigation systems to Water User Associations has been driven by need to relieve governments the burden of raising finances from collection of water charges (IIMI, 1994) and also the notion that productivity and sustainability of the irrigation systems will be improved (Kolavalli & Brewer, 1999). While this has meant a reduced role for government agencies in operation and maintenance (O&M), fee collection, water management, and conflict resolution (Bandyopadhyay et al, 2007), there is surprisingly little evidence about its impacts (Shyamsundar, P., Araral, E., Weeraratne, S., 2005).

The IWUA is an important grassroots institution whose role is to represent the farmers' interests in order to achieve their objectives. It gives the farmers a strong voice concerning the management of the irrigation system and hence become masters and determiners of their own fate (Yap-Salanis, 1994). The farmers in turn are expected to honour their obligation to the institution by creating an enabling environment for the IWUA to carry out its mandate. Because of funds constraints and lukewarm support from the governments as observed in studies by Chandrasekaran et al (2002), farmers' commitment should be seen in their prompt payment of water and other charges. According to Morales & Mongcopa (2008) review of partly successful

and unsuccessful irrigation and drainage project revealed that often less successful projects were not effectively operated and maintained due to lack of funds for O&M and poor revenue collection from beneficiaries. The poor O&M often reduces the sustainability of benefits.

According to Uphoff (1986) participation of any kind stems from people's decisions to allocate a portion of their time, thought and energy to dealing with problems through some form of collective action. This implies that IWUA members must dedicate time to meetings, attend communal work and participate in electing their leaders. This is because leadership influences participation and makes it more coordinated and effective by providing direction, encouragement and discipline. The effectiveness of an organization and the sustainability of participation depend crucially on the quality of leadership elected by Water Users (Uphoff, 1986). The leadership must be seen to be accountable and transparent for the general members to trust and have a positive perception about them.

Effective participation and collaboration must be governed by rules and regulations. Commitment is not always voluntary and effective by-laws are needed to assist the leadership in instilling discipline. However, adherence to by-laws and their enforcement has been challenging to most IWUAs as legal recognition has not been fully addressed. Vermillion (1997) observes that legally recognized water users associations enhance farmer confidence in the service and willingness to invest in the long term viability of the system. The extent to which sanctions can be applied to members is also governed by the legal backing of IWUA rules. Without proper legislation status, most smallholder schemes are run by IWUAs whose rules are applied on the basis of local agreements among members with the backing of the local administration.

In a set of studies conducted across nine Eastern and Southern Africa countries by Improved Management of Agricultural Water in Eastern and Southern Africa Project (IMWESA), Mati, Hatibu, Phiri & Nyanoti (2007) assert that local level policies and laws on agricultural water management exist in form of articles of association, by-laws and customary laws. The policies though mostly embedded in indigenous knowledge and social values, have enhanced access to irrigation water by smallholder farmers through creation of WUAs for O&M. This arrangement has ensured equity of water distribution and prompt conflict resolution. Mati et al (2007) recommend that the overall responsibility of agricultural water management should be mandated

to specific institutions and governments should support such institutions with proper legislation, financing and technical capacity.

The extent to which IWUAs are able to carry out the management functions of enforcing water distribution rules, organizing maintenance, collecting water supply charges and financial management depends on a number of factors including: (i) farmers' involvement as this increases the sense of ownership and responsibility among the participants as shown by studies in Nepal, Indonesia, Pakistan and Philippines(Morales & Mongcopa, 2008),(ii) transparent and accountable leadership as leaders perceived to be corrupt lose their moral authority to enforce rules and regulations (iii) existence of by-laws that are designed by the IWUA rather than seen to have been imposed from outside (iv) appropriate legislation so that they are recognized as the legitimate users and managers of the irrigation systems thus promoting legitimacy and effectiveness (Gyasi et al, 2006).

Commitment to Operation and maintenance can be influenced by gender especially in regard to decisions on what field operations to carry out, who to carry them out and what amount of labour is involved. In a study of gender responsibilities for the operation and maintenance of 4 smallholder sprinkler irrigation schemes, Motsi & Madyiwa (undated) found that men made 49.3% of decisions and women 27.6% while the 23.7% were made by children, men and women combined. Women provided 78% of labour and together with children they were more involved in operation activities such as planting, weeding and harvesting compared to men. As Meinzen-Dick & Zwerteveen (2001) have observed, irrigation organizations often exclude women through formal and informal membership rules and practices despite the fact that greater involvement of women leads to effectiveness of the organizations by improving their compliance with rules and maintenance contributions.

2.7.5 Knowledge and Skills and participation in O&M

According to Svubure, Ahlers & van der Zaag (2007), people are reluctant to participate in community activity when they do not have enough information to act responsibly. Knowledge and skills are important aspects of human capital that need to be enhanced as the technological environment changes to allow farmers intensity and diversify production. Extension service

providers are relied upon to impart knowledge in irrigation water management methods which may involve new operation procedures and techniques, equipment and production methods.

Improved knowledge, skills and perceptions will enable water users mobilize more of their resources to implement specified O&M activities and become more involved through user organizations (Coward & Uphoff, 1986). A general assumption has been that involvement of local water user associations in pre-implementation and implementation activities is a means of developing their skills and ensuring willingness of beneficiaries to contribute towards maintenance of the projects (Bagadion & Korten, 1991). As farmer' participation improves, so will sustainability of the project be assured as the farmers learn to operate within their resource endowment and plan their O&M activities accordingly instead of relying on the government or other stakeholders.

Irrigation farmers need a number of skills in order to carry irrigation operations effectively. Regarding O&M, they need to know how to operate the water supply, the right agronomic practices, give the right amount of water according to various crops requirements, maintain the equipment and structures at various levels of the irrigation system and also take care of the environment. O&M viewed in this context entails a holistic approach to irrigation water management. According to Kortenhorst (1980) this calls for intensive farmer training which is even more highly focussed than in rain-fed farming. Farmers can gain Knowledge and skills from various sources the most important being trainings attended, exposure tours, demonstration of technology, their experience in irrigation and learning from peers. Recent research has identified lack of technical skills as one of the major factors causing underperformance of most smallholder irrigation schemes (Fanadzo, 2012).

In studies of WUAs carried out in Turkey, Kiymaz, Ozekici & Hamdy(2007) demonstrated that lack of sufficient knowledge in irrigation issues like water saving, when and how much to irrigate and environment led to problems of efficient use of water in the fields by farmers. This could lead to low productivity of water and hence affect crop yields. Studies by Machethe, Mollel, Ayisi, Mashatola, Amin & Vanasche (2004) also indicated that farmers apply excess water when it is their turn to irrigate their plots resulting in low water productivity. Farmer training has been demonstrated to improve productivity and income levels in many countries

(Fanadzo, 2012). Machethe et al (2004) recommend practical training in water management and irrigation scheduling for both farmers and extension agents.

Proper planning of O&M activities is a prerequisite to their execution. Farmers should be involved in preparation of O&M plans and schedules at the project design stage with details of O&M requirements of all the structures within the irrigation system. Project sponsors should avoid O&M problems at this stage by proper physical and institutional design choices compatible with locally available skills and capacity (Morardet et al, 2005). The WUA, as the institution in charge of O&M should be targeted for capacity building so that quality services can be offered. However it is known that training may be wrongly targeted where there is inadequate knowledge on who carries out operation and maintenance activities (Motsi & Madyiwa, undated).

Leadership skills are also needed if O&M has to run smoothly. Weak leadership can lead to disintegration of WUAs as conflicts occasionally arise over allocation and use of resources like water and funds. Leadership can be strengthened through basic training of farmers and their leaders in group dynamics, record keeping, and management. Fanadzo (2007) recommends that revitalization programmes for smallholder schemes should focus on hardware as well as software constraining factors like capacitating farmers in basic crop husbandry and irrigation management skills. According to Grimm & Richter (2008), irrigation systems need strong and viable WUAs that are able to manage, operate and maintain the system and therefore the technical know-how and management skills of small scale irrigation farmers need continuous improvement. This corroborates the findings by the Ministry of Water and Irrigation that inadequate management and technical skills are important factors contributing to weak farmers' organizations (MWI, 2003).

2.7.6 Reliability of water supply and participation in O&M

Ideally an irrigation system should deliver water when and where it is needed and in adequate amounts to sustain crops during the entire growing period. There is usually high water demand during the dry period when irrigation is at the peak and crops are fetching maximum returns. Water supply during this period is therefore critical. Inefficiency in water use has been identified as a major cause of under performance of irrigation systems by many researchers (Aheeyar &

Smith, 1999). As Pazvakawambwa & van der Zaag (2001) observe after a study of Nyanyadzi smallholder scheme, the low performance of such schemes is largely attributable to unreliable and inadequate water delivery.

The extent to which deficiencies in O&M procedures can affect performance has been demonstrated in Philippines where studies found that modest changes in water distribution procedures was associated with 97% increase in the production of the system overall and a 1497% increase in the tail section of the system. The conflict between the upstream and downstream users was therefore addressed without introducing any physical improvements (Sargardoy et al, 1986). According to Uphoff (1986), the adequacy and reliability of water supply is often the main factor influencing farmer decisions to participate. In situations of abundance all that is required from farmers is maintenance but where the supply is unreliable and farmers' efforts lead to no improvement, participation is not seen as a solution.

Reliability of water supply can be viewed from three critical levels depending on location of the farmers. Farmers at the head of the project experience minimal problems with water followed by those in the middle. The worst problems occur at the tail end. In a research carried out in Majengo area in Tanzania it was found that irrigation increased productivity per acre but only 12% of the farmers benefited since water did not adequately reach all the plots (1996). Other studies in Sri Lanka showed unpredictable deliveries at the three levels with farmers at head in some schemes inefficiently using and draining water while tail enders lacked adequate supply(Aheeyar & Smith,1999). This is a factor that often affects who participates in irrigation management.

Low water availability also induces negative coping behaviour in individual farmers and can weaken the institutions that manage the system (Pazvakawambwa & van der Zaag, 2001). Shyamsundar et al (2005) note that evidence on impacts of management by local associations is mixed as most studies report positive impacts on operations i.e. increased water-use efficiency, reliability, adequacy and timeliness of water delivery, increase in service area, responsiveness to their members' needs, and more equitable water distribution etc. A less positive picture however emerges on maintenance with beneficiaries tending to under-invest in this area.

The water distribution system and the fairness in distribution are a potential source of conflict and reluctance to participate. Water distribution system varies across projects and can either be by continuous flow or rotation depending on a prior agreement. Thus water distribution must be governed by rules that serve to simplify decision making and reduce potential conflicts especially where there are many potential users. However farmers often act against the rules due to the failure of the system to deliver water as it should (Brewer, Sakthivadivel & Raju, 1997). The success of the system of distribution depends on the perception of fairness in the resource allocation. Perception of unfairness could lead to derailment of cooperative efforts and it is important for the WUAs to promote equity in order to improve cooperation for sustainable management of projects (Gyasi et al, 2006).

2.7.7 Quality of extension services and participation O&M

Human Resources are central to the attainment of an organization's mission and their capacity to carry out their activities effectively will determine the extent to which the envisaged targets will be met (MWI, 2008). In this regard, extension services are an important source of information to farmers regarding irrigation and agronomic technologies and innovations. Farmers need to keep abreast with what researchers and manufacturers of equipment are doing. They need skills on how to acquire, fix, operate and maintain such equipment and innovations. This link is provided mostly by technicians in the Ministry of Water and Irrigation as well as ministry of Agriculture and other stakeholders who have the required skills. Extension officers reach farmers through various ways; trainings and workshops, seminars, barazas, organized tours, print and other media among others. To sustain the gains, follow-up visits and supervisions by the extension staff are supposed to be carried out on a regular basis. According to Salami, Kamara, &Brixiova (2010), the effectiveness of extension services in Kenya declined throughout the 1990s. This was due to inappropriateness of the training and visit extension model pursued, delayed adoption of alternative models and sharp reduction in the operational budgets of the sector ministries.

One of the most constraining factors in extension is competence and availability of extension staff. Developing countries suffer a shortage of qualified staff particularly those specialized in irrigation due to lack of formal education facilities (Kortenhorst, 1980). The ministry of Agriculture for example has only approximately 5000 extension staff distributed across Kenya(MOA, 2008), resulting in very high farmer/staff ratio hence inadequate coverage. Similarly the Ministry of Water and Irrigation suffers the same fate with only about 168

irrigation technical staff distributed thinly in the country's 209 districts against a requirement of 1276(MWI, 2008). The scarcity of staff has led to the policy of 'demand driven' extension where farmers are supposed to look for the officers and not the other way round. This arrangement has its own challenges as farmers are often unwilling to leave their farming activities to seek help unless it is an emergency situation. According to Machethe et al (2004), for smallholder agriculture to advance, support services that are accessible to majority of the farmers are required as international experience indicates that with adequate access to farmer support services, smallholder farmers can increase productivity significantly. Such services include extension, marketing and credit services.

The competence and confidence of the staff in handling technical issues also varies considerably as they have been trained at different levels. As Kortenhorst (1980) observes, very little is being done to improve the manpower situation in those countries where, from senior staff down to farmer level, skills and knowledge are apparently the major constraint for irrigation ever to become an integral part of a balanced smallholders' farming system. Studies by Machethe et al (2004) indicate that extension personnel can be inadequately trained in their technical area hence affecting their confidence, credibility and performance.

From 1997 to date the government has not employed any irrigation technical personnel. This problem is compounded by the situation where the experienced officers are approaching retirement age without any succession management plans. The ministry has identified this as a major challenge in its strategic plan. It observes that " Given the transitional nature of the Ministry's role in the water sector and the high expectations by the stakeholders for more and better services it is critical that the Ministry develops a sustainable human resource capacity that is adequate (in numbers, skills and competencies), committed and deployed appropriately"(MWI, 2008). Smallholder irrigation farmers expect technicians who are available when needed to deliver timely messages on irrigation management in relation to crop production at all levels of the system but the current situation is not promising.

2.7.8 Competing economic activities and participation O&M

People's participation in community activity is dictated by the positive benefits to be gained. Since benefits seldom come without costs, one usually participates when the benefits outweigh

the costs (Svubure, et al, 2007). Smallholder farmers participate in irrigation for two basic reasons; to improve their food security and generate income to meet their financial needs. In making the decision to concentrate their efforts in irrigation then they have to make comparisons with other available alternatives because irrigation is a labour intensive form of agriculture (van Rijn, 2004).

Apart from engaging in irrigation, smallholder farmers are faced with the following choices; engaging in rain-fed agriculture, livestock rearing, hiring out their labour, formal and informal employment, waiting for remittances from working relatives among others. Smallholder farmers are known to engage in almost all of these activities in varying intensities. It is not uncommon to find irrigation being carried out by some farmers on part time basis as they also divide their time between other income earning activities. The enthusiasm with which irrigation projects start and the seemingly successful take off period often turns to declining yields, diminishing returns, and growing indebtedness of farmers (Gichuki et al, 2010, Kortenhorst, 1980). This partly explains the loss of interest by farmers, the diversification to other enterprises and the eventual failure of projects.

According to Neubert (2007), labour demand for irrigation is considerably higher and the activity comes with more work for smallholder households. It is also closely related to gender as most of the extra work is taken by women. Findings indicate that this can however be balanced by readily available water for domestic use which in turn increases their participation. Men's labour in rural settings is scarce as they tend seek employment off the farm in industries and small businesses. Mudima (2002) asserts that from a socio- economic point of view a smallholder farmer has better income than a labourer in urban industries because of the many demands on the latter's income.

Information on contribution of irrigation farming to household income of project beneficiaries is limited presumably because of poor record keeping but findings of studies by various researchers show that households do not derive income from farming only but had other strategies for sourcing income (van Averbeke, Denison Mnkeni, 2011). Even where irrigation projects are commercially viable, farmers view the projects first and foremost as avenues for food security while also relying on off-farm sources of income like wages, small businesses and pensions (Machethe, 2004).

Introduction of irrigated agriculture in an area finds an already existing farming system with activities that are either productive or consumptive, all drawing from or contributing to the same family resources. Thus the importance of the existing and the new farming system is determined by the farmers setting of resources, constraints and values with the farmer as the ultimate decision maker (Kortenhorst, 1980). Rain-fed agriculture and livestock keeping often compete with irrigation for resources. Rain-fed agriculture is less intensive and requires fewer inputs than irrigation. Farmers need to assess the returns in both cases in order to make informed choices. Studies by Oni, Maliwichi & Obadire (2011) in Vhembe District, South Africa showed that food security was significantly improved by irrigation, with food secure households comprising 86% of the study population compared to dry-land farmers at 53%.

According to Peden, Freeman, Astatke & Notenbaert (2005) case studies show that irrigation farmers benefit from livestock keeping. For example, 90 per cent of Gezira irrigation farmers in Sudan keep livestock and about 36 per cent of tenants' income comes from selling animal products. Similarly in Ethiopia's small community based irrigation systems, livestock was kept for providing farm power therefore reducing demand for human labour. Livestock competes favourably with crop production especially the drier districts where irrigation is also practiced. In their study of the socio-economics and commercialization of irrigation in Makueni and Meru Central Districts, Freeman& Silim (2002) found out that livestock was a major economic activity in the areas though smallholder farms were predominant. Crop production contributed 9 and 76 per cent of the total agricultural income in Makueni and Meru Central respectively. The rest of the income can be attributed to livestock and other activities with livestock being predominant in the drier Makueni District. Peden et al (2005) observe that in both Kenya and Ethiopia, smallholder dairy producers have a significant advantage when they use agricultural water and crop residues to feed their livestock. Peden et al (2005) further suggest that effort should be made to assess and value the role of livestock in household enterprises and to understand how returns on investments in agricultural water development will enhance or reduce returns from various livestock enterprise options in planning irrigation.

Freeman & Silim (2002) contend that irrigation reduces the risk of crop failure therefore providing greater incentives to increase crop production and diversify into higher value crop production. This increases farmers' income, yet irrigation expansion issues of access to water,

enterprise profitability and access to markets start to emerge as they are directly related to distribution of benefits accruing to stakeholders. In particular, availability of market for certain commodities can determine where farmers will concentrate their efforts. It can be an incentive or disincentive for continued operation of the project. Neubert (2007) say that among the major concerns of smallholder schemes are the improvement of marketing conditions and a better access to credits, which calls for special lines of credit and the creation of marketing cooperatives. The current arrangement where smallholder farmers continue to use market intermediaries is prone to problems as farmers rarely get the right information about overall market conditions because of deliberate misinformation by the intermediaries (Freeman & Silim, 2002).

While profitability of well managed projects is not in doubt, data from some studies tend to differ. Studies on some long established schemes in East and Southern Africa indicate that farmers' incomes did not fully cover the true economic costs but presumably because agriculture was their traditional livelihood and alternative occupations were unavailable, they continued to farm (Chancellor & Hide, 1997). (Shah et al, 2002) also affirm that because of their tiny farms, smallholder groups get little income which could be negative if the value of family labour was fully costed. On the other hand data on smallholder horticultural crops production indicate that it is highly profitable when compared to alternative crops with gross margins for the most profitable horticultural crop being about 400 percent higher than competing maize crop (Freeman & Silim, 2002).

In his research report, Mudima (2001) reported that socio-economic findings from case studies of successful smallholder irrigation projects have shown that they can be financially and economically viable if planned, implemented in the right way while taking into consideration other success factors such as technology, institutional support and farmers' commitment. Mudima (2001) therefore recommends that farmers should be involved in all project phases and be trained in water management, irrigated crop production, and marketing as well as general management and operation and maintenance. Other factors that may influence farmers' participation and management capability include farmers' net income, size and complexity of the irrigation system, local politics, laws and policies, local social customs and practices among

others which are largely dependent on the prevailing economic, social and political conditions (Bagadion, 2002).

Mupawose (1984) questioned the economic viability of smallholder irrigation schemes in Zimbabwe and pointed out that certain smallholder schemes have failed and are under-utilized due to poor management, lack of inputs and irrigation experience by farmers. Chancellor & Hide (1997) posted different results in a study of 13 schemes in Kenya, Egypt and Zimbabwe. Out of the 8 schemes managed by farmers in the study, 5 were found to be technically, financially and economically viable as planned. The remaining 3, though strongly affected by problems including water shortage, the farmers were still willing to continue to irrigate a reduced area.

2.7.9 Conceptual framework

The conceptual framework depicted below shows the relationship between the independent, dependent and intervening variables. Farmers' participation in O&M has been identified as the dependent variable. Five independent variables will be investigated in the study namely; farmers commitment to the IWUA, farmers' knowledge and skills, reliability of water supply, quality of extension services and competing economic activities. Some intervening variables that affect the dependent variable though not very significantly have been included in the framework for completeness sake but will not be investigated.

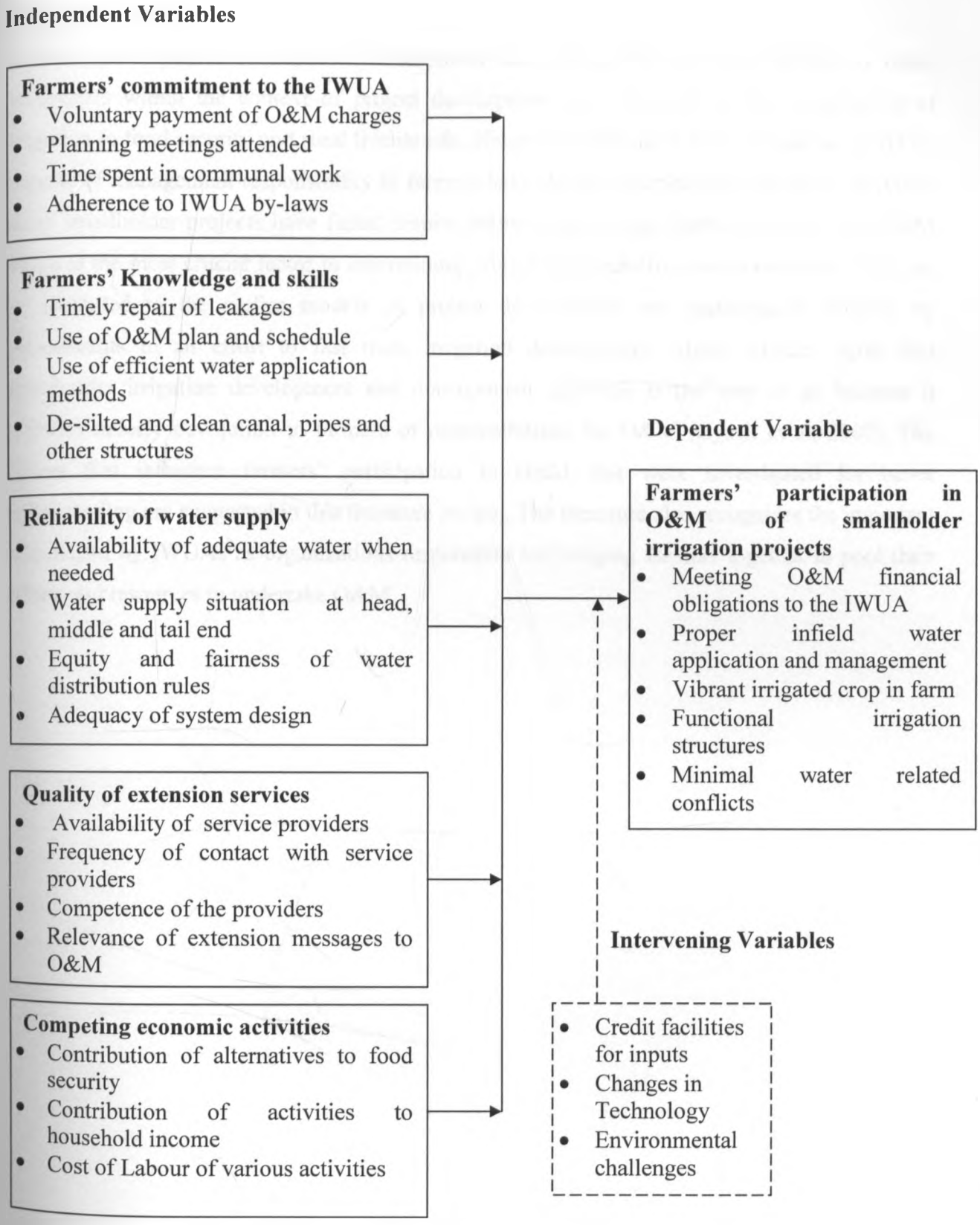

Figure 1: Conceptual Framework

2.7.10 Summary

Farmers' participation in irrigation development and management has been studied by many researchers within the context of project development cycle because of the contribution of irrigation to food security and rural livelihoods. However experiences from around the world on transfer of management responsibility to farmers have shown contradicting outcomes. In Africa many smallholder projects have failed despite efforts to encourage farmers to take over O&M which is the most crucial factor in determining project sustainability after completion. This can be attributed to the earlier models of project development and participation adopted by governments in an effort to fast track irrigation development. Many scholars agree that smallholder irrigation development and management approach is the way to go because it provides orderly devolution to farmers of responsibilities for O&M (Gyasi, et al, 2000). The factors that influence farmers' participation in O&M that were investigated for better understanding are suggested in this literature review. The literature also recognizes the important role played by IWUAs as organizations responsible for bringing farmers together to pool their efforts and resources to undertake O&M.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design, target population, sampling procedure and methods of data collection that were used in this study. A detailed description of the way the study variables were measured is also presented. Finally, a tabulation of data analysis methods that were utilized is presented.

3.2 Research Design

This study utilized descriptive survey research design. According to Kothari (2004), descriptive research studies are concerned with describing the characteristics, specific predictions and narration of facts of a particular individual or a group. This design assisted in description of phenomena by obtaining information on perceptions, attitudes, behaviour or values from the individuals surveyed (Mugenda and Mugenda, 1999).

3.3 Target population

According to the Division irrigation projects inventory, there are 40 operational smallholder irrigation projects in Gichugu division with a total of 5,300 farmers. The number of farmers per project ranges from 20 to 150 (District Irrigation Officer (DIO), 2011). Only smallholder projects with at least 100 hundred farmers were included in this study as they were considered to have adequate membership to articulate the study objectives. Therefore, the target population was limited to 9 projects comprising of 1052 irrigation farmers practicing irrigation within the set up of smallholder irrigation projects with functional WUAs (characterised by existence of an elected project committee). Table 1 below presents the targeted projects based on the number of farmers. The Division was chosen because it has a high concentration of operational smallholder irrigation projects. The agricultural and hence irrigation potential is high as it lies on the wind ward side of Mount Kenya with many permanent rivers. The topography also allows easy abstraction of water by gravity. A variety of horticultural crops that include French beans, cabbages, tomatoes, kales, bananas and rice are grown in irrigation farms ranging in size from 0.1 to 1 hectare. Some of the projects have been operating since the colonial days hence the farmers have a lot of experience in irrigation. The need to intensify agricultural production through irrigation means that the farmers in the division attach a lot of importance to operation

and maintenance of irrigation projects. It was therefore a Division worth studying to give some insights into O&M issues in irrigation.

Gichugu division covers an area of 362 km^2 out of which 257 km^2 is agricultural land (District Agricultural Officer (DAO), 2011). According to the 2009 population census, the population is estimated at 124,672. The Division comprises of 9 locations namely; Baragwi, Kirima, Ngariama, Karumandi, Njukiini, Gachigi, Thumaita, Ruathai and Njukiini south. However out of these, five locations are the busiest in terms of irrigation; namely Kabare, Baragwi, Kirima, Njukiini and Ngariama.

Table 1: Targeted projects with at least 100 farmers

Project	Number of farmers
Thimu Gatu	120
Kii Murinduko	150
Rukenya	115
Mukindu	125
Miruri	130
Kamweti/Karumandi	100
Karumandi	102
Rupingazi	100
Kiandunyi	110
TOTAL	**1052**

The table above shows the targeted projects from where the study sample was taken. The 9 projects have a target population of 1052 farmers.

3.4 Sampling procedure

Cluster sampling procedure was used in this study. This method is adopted when the total area of interest is big and involves dividing the area into small non-overlapping areas. A number of the small areas (clusters) are then randomly selected with the final sample consisting of all units or samples of units in these clusters (Kothari, 2004). Cluster sampling was considered convenient and economical in this study because as observed by Mugenda &Mugenda (1999), it would not

be possible to obtain an authentic sampling frame due to the large population (farmers and projects) distributed over a large area. The clusters forming the target population were the 9 projects listed above.

According to Mugenda & Mugenda (1999), a sample size of 10% of the accessible population is enough for descriptive studies. This therefore means that the target population above gave a sample size of 105. The next step was to randomly list the 9 projects (clusters). Using a table of random numbers, three clusters namely Kii-Murinduko, Rukenya and Miruri projects were selected to make the required sample size of 105 and equal samples of members in the selected clusters were interviewed.

3.5 Methods of data collection

The study utilized researcher administered questionnaires to interview the farmers. A total of 6 local enumerators were thoroughly briefed and used to administer the questionnaires with close supervision by the researcher. This implies that the subjects were guided through the items and the responses recorded. This approach was utilized to take care of the possibility that some subjects were not in a position to interpret or respond to the questions due their level of literacy. The questions were both open-ended and closed ended to gather the required information. This facilitated in-depth responses and eased the process of analysis. Field observations were also made and recorded as respondents were interviewed in order to make informed judgements on responses to particular variables.

The researcher followed laid down procedures for data collection. An introduction letter was obtained from the University of Nairobi in order to carry out the research in Gichugu Division. The researcher then visited the District Headquarters for permission to courtesy call and blessings to conduct the research by the District Irrigation Officer. The latter linked the researcher with the selected projects' IWUA officials who served as guides and links to the sampled respondents. The officials also assisted in recruiting local knowledgeable enumerators. The questionnaire was administered by interviewing the irrigation farmers in the sampled clusters as outlined in the sampling procedure above.

3.6 Validity and reliability

Sound measurement should meet the tests of validity and reliability. For reliability and validity to exist in data, data collection techniques must yield relevant and correct information and therefore reliability and validity are measures of this relevance and correctness (Mugenda & Mugenda 1999).

3.6.1 Validity

According to Kothari (2004), validity refers to the extent to which an instrument measures what it is supposed to measure. Validity of the measuring instrument was tested by requesting research experts from the University of Nairobi and professional colleagues to validate the questionnaire before it was used for actual data collection. These experts looked at the questionnaire in terms of the three types of validity in data. One was content validity addressing the extent to which the instrument provides adequate coverage of the topic under study. The experts checked the extent to which the research questions and objectives were addressed by the instrument. The other one was construct validity, the measure of the degree to which data obtained from an instrument meaningfully and accurately represents the theoretical concept. Finally they checked criterion-related validity, which refers to the use of a measure in assessing subjects' behaviour and specific situations (Mugenda & Mugenda 1999).

3.6.2 Reliability

Reliability refers to the fact that a measuring instrument provides consistent results after repeated trials. Pretesting of the questionnaire was done using a selected sample similar to the sample to be used in the study. This was done in Kiarukungu project in the neighbouring Mwea Division where smallholder irrigation is also practiced. Comments and suggestions made by the pre-test respondents were incorporated in order to address some deficiencies or vagueness in the questionnaire and hence help in improving it. The pre-test sample was taken as 5% of the intended sample. This was in conformity with Mugenda & Mugenda(1999) recommendation of a sample of between 1% and 10% depending on the size of the study sample.

3.7 Operationalization of variables

The table below shows the variables in the study, how they were measured and data analysis techniques.

Table 2: Operationalization of variables

Variable	Type of variable	Indicators	Measurement	Measurement Scale	Data analysis Method
Farmers' participation in O&M	Dependent	- Meeting O&M financial obligations to the IWUA - Proper infield water application and management - Vibrant irrigated crop in farm - Functional irrigation structures - Minimal water related conflicts	- Level of participation shown by records, observations and responses	Nominal	- Descriptive statistics Central tendency Frequency distribution
Farmers' commitment to the IWUA	Independent	- Voluntary payment of O&M charges - Planning meetings attended -Time spent in communal work - Adherence to IWUA by-laws	- Attitude towards IWUA - How often	Ordinal	- Descriptive statistics Central tendency Frequency distribution Correlation analysis
Farmers' Knowledge and skills	Independent	- Timely repair of leakages - Use of O&M plan and schedule - Use of efficient water application method - De-silted and clean canals, pipes and other structures	- Efficiency and smooth operation of the system	Ordinal	- Descriptive statistics Central tendency Frequency distribution Correlation analysis
Reliability of water supply	Independent	- Availability of adequate water when needed - Water supply situation at head, middle and tail end - Equity and fairness of water distribution rules - Adequacy of system design	- Level of water related complaints	Nominal	- Descriptive statistics Central tendency Frequency distribution Correlation analysis
Quality of extension services	Independent	- Existing providers - Frequency of contact with service providers - Competence of the providers - Relevance of extension messages to O&M	- Effectiveness and efficiency of the service	Ordinal	- Descriptive statistics Central tendency Frequency distribution Correlation analysis
Competing economic activities	Independent	- Contribution to food security - Contribution to household income - Cost of Labour of various activities - Market price of various products	- Perception of value to household welfare	Ordinal	- Descriptive statistics Central tendency Frequency distribution Correlation analysis

3.8 Methods of data analysis

The data that was collected from the respondents was both quantitative and qualitative. In order to address adequately the objectives of this study, the data was first coded according to the items in the questionnaire. Computer programmes i.e. excel spreadsheet and Statistical Package for Social Science (SPSS) were used to analyse the data. Descriptive and inferential statistics i.e. measures of central tendency, frequency distribution and correlation were used for quantitative data. The qualitative data assisted in detailed description of the study and making conclusions regarding the study.

3.7 Summary

This chapter presents a detailed account of the research methodology. Quantitative research design was used in order to generate data that could be analysed to meet the objectives of this cross-sectional study. The target population comprised of farmers sampled from the population of smallholder irrigation farmers in the target division using cluster sampling procedure. Researcher administered questionnaires were used to collect data through a questionnaire survey done in the target community. Finally the chapter has clearly shown how the variables were measured with a tabular presentation of operationalization of variables.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND PRESENTATION

4.1 Introduction

This chapter is a presentation of results and findings obtained from field responses and data, broken into two parts. The first section deals with the background information of the respondents, while the other five sections present findings of the analysis, based on the objectives of the study where both descriptive and inferential statistics have been employed to bring out the issues in the best way possible.

4.2 Response rate

Data was collected form the head, middle and tail end sections of the three sample clusters and out of the 105 questionnaires administered, 96 were filled and returned. This represented a 91.42% response rate as shown in table 3 below, which is considered satisfactory to make conclusions for the study. This high response rate can be attributed to the data collection procedures, where the researcher personally administered questionnaires and waited for the respondents to fill and picked the filled questionnaires.

Table 3: Response rate

Respondents	Questionnaires administered	Questionnaires filled & returned	Percentage
Head sections	35	32	91.42
Middle sections	35	33	94.29
Tail end sections	35	31	88.57
Total	**105**	**96**	**91.42**

4.3 Validity and Reliability Analysis

The questionnaires used had items that were to be responded to. For reliability analysis Cronbach's alpha was calculated by application of SPSS. The value of the alpha coefficient ranges from 0 to 1 and may be used to describe the reliability of factors extracted from dichotomous (that is, questions with two possible answers) and/or multi-point formatted questionnaires or scales (i.e., rating scale: 1 = poor, 5 = excellent). A higher value shows more

reliable generated scale. Cooper & Schindler (2008) indicated 0.7 to be an acceptable reliability coefficient. The study involved questionnaires from 96 respondents. As the alpha coefficients were all greater than 0.7, a conclusion was drawn that the instruments had an acceptable reliability coefficient and were appropriate for the study.

Table 4: Cronbach's Alpha

Cronbach's Alpha	No of items
.866	96

4.4 Demographic information

The study sought to investigate the demographic information of the respondents which included sex, position in the household, age and land size.

4.4.1 Distribution of respondents by Sex

The respondents who were interviewed comprised of male (54%) and female (46%) as depicted in figure 2 below. This conforms to the observation that most decisions in O&M have been shown to be made by men as observed in studies by Motsi& Madyiwa (undated) and the assertion by Dick & Zwerteveen (2001) for greater involvement of women for effectiveness of irrigation organizations.

Table 5: Distribution of respondents by sex

Respondents	Frequency	Percentage
Male	52	54
Female	44	46

4.4.2 Distribution of respondents by age

The study sought to determine the respondents' age distribution in order to determine the age group that was actively involved irrigation. The findings were as indicated in Table 5 below showing the distribution of respondents by age. The majority fall between 30-49 years. This indicates a small percentage of youthful farmers, as only 6(6.1%) are below 30 years. However, those falling between 30-39 years constitute majority at 44.9%, and are reasonably young.

National Youth Policy sets the upper limit of youth at 35 years (GOK, 2008). The cumulative 51% shows that the farmers are reasonably young and by extension, energetic to drive their irrigated agricultural activities towards sustainable O&M.

Table 6: Distribution of respondents by age

	Frequency	Percent
21-29	6	6.1
30-39	43	44.9
40-49	41	42.9
50-59	6	6.1
Total	**96**	**100.0**

4.5 Farmers' commitment to the IWUA

The IWUA is an important grassroots institution whose role is to represent the farmers' interests in order to achieve their objectives. It gives the farmers a strong voice concerning the management of the irrigation system and hence become masters and determiners of their own fate. The study therefore found it paramount to determine farmers' commitment to the Irrigation Water Users Association (IWUA) based on certain questions in order to provide an insight of how they value the importance of their association in taking care of their farming needs. The findings were as indicated in Table 6 below:

Table 7: Farmers' commitment to the IWUA

Statement	Very Often	Often	Sometimes	Not Often	Not at all	Mean	Std deviation
How often do you refer to the IWUA by-laws in your day to day irrigation activities?	16(16.67%)	32(33.33%)	25(26.04%)	14(14.58%)	9(9.38%)	3.33	1.23

How often are you penalized for non-compliance with the by-laws?	8(8.33%)	10(10.41%)	25(26.04%)	31(32.29%)	22(22.92%)	2.49	1.67
The by-laws are applied fairly to all	6(6.59%)	26(28.57%)	14(15.38%)	23(25.27%)	22(24.18%)	2.43	1.71
I attend planning meetings organized by IWUA committee	25(26.04%)	36(37.5%)	18(18.75%)	12(12.5%)	5(5.2%)	3.67	1.11
I contribute to the discussions and resolutions made in such meetings	28(29.16%)	41(42.71%)	14(14.58%)	9(9.37%)	4(4.16%)	3.83	0.96
I participate in the election of IWUA committee	28(28.45%)	37(37.32%)	12(12.21%)	10(10.56%)	8(8.16%)	3.67	1.21
I trust the committee's decisions regarding the project management	15(15.17%)	44(44.21%)	24(24.18%)	8(8.16%)	5(5.14%)	3.58	1.31
I pay O & M charges	24(24.56%)	47(47.78%)	13(13.26%)	8(8.16%)	4(4.34%)	3.82	0.99
I participate in communal works for repairs and maintenance of project infrastructure	32(32.43%	52(52.87%)	6(6.41%)	4(4.12%)	2(2.09%)	4.13	0.72

I spare time at short notice for project's adhoc and emergency works	8(8.33%)	36(37.5%)	41(42.7%)	8(8.33%)	3(3.13%)	3.39	1.23

From the findings in Table 6 majority 32(33.33%) of the respondents indicated that they often refer to the Irrigation Water Users Association by-laws in their day to day irrigation activities with few, 9(9.38%) indicating that they do not at all refer to the by-laws in their daily activities. Further the findings indicated that majority 31(32.29%) indicated that they are not often punished for non compliance with the by-laws governing the irrigation system with few 8(8.33%) indicating that they are very often punished for non-compliance with the by-laws governing Irrigation Water Users Association. The findings further indicate that on average the rules are not often applied fairly to all. This implies that the laws governing irrigation water users are not strictly adhered to though they are understood. The mean score of 3.33 confirms this partial compliance. Therefore the study infers that the parties concerned (IWUA committees) and members are not very committed in their obligation to follow the rules.

Furthermore majority 36(37.5%) indicated that they attend meetings organized by their committee with only few 5(5.2%) indicating that they do not attend meetings organized by their association. This implies that meetings are taken seriously which may be due to the important issues and resolutions affecting farming and the irrigation system being discussed in such meetings. Majority 52(52.87%) also indicated that they often participate in communal work for repairs and maintenance of their projects infrastructure and cumulatively 44(45.8%) spare time for such works even at short notice. A majority of farmers 71(85.3%) also pay O&M charges.

The findings concur with Chandrasekaran et al (2002), that farmers are expected to honour their obligation to their institution by creating an enabling environment for the IWUA to carry out its mandate and farmers' commitment should be seen in their prompt payment of water and other charges. The impressive attendance of meetings and elections points to Uphoff's (1986 observation that participation of any kind stems from peoples decision to allocate portion of their time, thought and energy in collective action. Effective participation and collaboration must be governed by rules and regulations but the above findings show that rules are not very effective

which conforms with Vermillon(1997) who observes that most smallholder schemes are run by IWUA rules applied on the basis of local agreements without proper legislation. However commitment is not always voluntary and effective by-laws are needed to assist the leadership in instilling discipline. This also conforms to a set of studies conducted across nine Eastern and Southern Africa countries by Improved Management of Agricultural Water in Eastern and Southern Africa Project (IMWESA), Mati, Hatibu, Phiri & Nyanoti (2007) which assert that local level policies and laws on agricultural water management exist in form of articles of association, by-laws and customary laws. The policies though mostly embedded in indigenous knowledge and social values, have enhanced access to irrigation water by smallholder farmers through creation of WUAs for O&M. This arrangement has ensured equity of water distribution and prompt conflict resolution. Mati et al (2007) recommend that the overall responsibility of agricultural water management should be mandated to specific institutions and governments should support such institutions with proper legislation, financing and technical capacity.

4.6 Farmers Knowledge and Skills according to the members

The study further sought to determine farmers' knowledge and skills. This was done by prompting questions to the respondents and noting down if the respondent knows, is uncertain or does not know the answer to the question. The findings were as indicated in Table 7 below:

Table 8: Farmers knowledge and skills according to members

Statement	K	UN	NK	Total frequency
Who is supposed to repair leakages of pipes and canals at field level	56(58.33%)	24(25%)	16(16.67%)	96(100%)
What are some of the problems associated with application of excess water in your farm	44(45.83%)	31(32.29%)	21(21.87%)	96(100%)
Who is supposed to unclog the irrigation system of silt and debris	24(25%)	46(47.25%)	26(26.99%)	96(100%)
What is the importance of an O & M plan	21(21.67%)	58(59.56%)	17(17.23%)	96(100%)
Which is more efficient in water application between furrow and drip irrigation methods	52(54.21%)	24(25%)	20(20.83%)	96(100%)
Where can you get information on appropriate irrigated crop production	49(50.79%)	32(33.46%)	15(15.35%)	96(100%)
What is the importance of an active IWUA committee to your project	36(37.5%)	53(55.34%)	7(7.03%)	96(100%)
What are the funds you contribute for O & M supposed to be used for	42(43.56%)	36(37.23%)	18(18.78%)	96(100%)
What is the importance of working together as an IWUA group	53(55.34%)	41(42.98%)	2(2.08%)	96(100%)
What is the importance of taking care of the water catchment	64(66.67%)	20(20.83%)	12(12.5%)	96(100%)

From the findings in table 7, majority 56(58.33%) of the respondents demonstrated a clear understanding of who is supposed to repair leakages of pipes and canals at field level, 24(25%) indicated uncertain and 16(16.67%) did not know the answer to the question. Further majority 44(45.83%) of the respondents also indicated a clear understanding of the problem associated with application of excess water in the farm, followed by 31(32.29%) who were uncertain about the problems associated with application of excess water in their farms with few 21(21.87%) demonstrating that they do not know the dangers that are involved when excess water is applied in the farm. Further majority 58(59.56%) of the respondents indicated that they were uncertain about the importance of an O&M plan, 21(21.67%) were correct with few 17(17.23%) indicating

that they do not know about the importance of O & M plan. Furthermore majority 42(43.56%) had reasonable information about the use of the funds they contribute, 36(37.23%) were uncertain and few 18(18.78%) indicated that they did not know how the funds they contributed for O&M are supposed to be used. Further majority 64(66.67%) indicated clear understanding of the importance of taking care of the water catchment areas, 20(20.83%) were uncertain with few 12(12.5%) indicating that they did not know the importance of taking care of the water catchment area.

The findings demonstrated mixed understanding of issues in critical knowledge areas related to O&M with majority biased towards possessing necessary knowledge and skills. However knowledge is lacking in critical areas like maintenance of the system and preparation of O&M plans. These findings conform to SIPMK (2011) indication that O&M faces several challenges among them limited technical knowhow of farmers leading to lack of understanding of how the system works and hence conflicts. On the other hand demonstration of Knowledge and skills in key areas concurs with (Coward & Uphoff, 1986) that improved knowledge, skills and perceptions will enable water users mobilize more of their resources to implement specified O&M activities and become more involved through user organizations. From the commitment to meetings observed above, the findings seem to agree with Bagadion & Korten(1991) that the farmers through the local water user association have been involved in pre-implementation and implementation activities and have acquired some skills and willingness to contribute towards maintenance of the projects. As observed by Kortenhorst (1980) the findings point to the need for intensive and even more highly focussed farmer training in order to address lack of technical skills as one the major factors causing underperformance of most smallholder irrigation schemes (Fanadzo, 2012).

The knowledge gap observed in the findings on system O&M and water application concurs with studies in Turkey (Kiymaz, Ozekici & Hamdy, 2007) which demonstrated that lack of sufficient knowledge in issues like water saving, when and how much to irrigate and environment led to problems of efficient use of water in the fields by farmers. This is further reinforced by studies by Machethe, Mollel, Ayisi, Mashatola, Amin & Vanasche (2004) indicating that farmers apply excess water when it is their turn to irrigate their plots resulting in low water productivity.

4.7 Reliability of water supply

Irrigated agricultural production and hence participation in O&M largely depends on availability of water for irrigation and therefore the study found it paramount to determine from the respondents how reliable was the water supply for irrigation purposes.

4.7.1 Reliability of water supply according to the members

The study sought first to determine the reliability of water supply according to the total members respondents based on some questions regarding the reliability of water supply. The findings were as indicated in Table 8 below.

Table 9: Reliability of water supply according to members

Statement	Yes (Frequency)	No (Frequency)	Total Frequency
Do you get irrigation water on your farm	72(75%)	24(25%)	96(100%)
Is the water received adequate for the irrigation area allowed	43(44.79%)	53(55.20%)	96(100%)
Do you get the water when scheduled	54(56.25%)	42(43.75%)	96(100%)
Do you get adequate water during the peak irrigation season	62(64.58%)	34(35.42%)	96(100%)
Are there water distribution rules in place	57(59.38%)	39(40.63%)	96(100%)
Are the rules applied fairly to all	43(44.79%)	53(55.21%)	96(100%)
Do the rules assist in equitable distribution of water	59(61.46%)	37(38.54%)	96(100%)
Does the irrigation system have adequate capacity to deliver required amount of water	56(58.33%)	40(41.67%)	96(100%)
Do you have water related conflicts in your [illegible]ject	60(62.5%)	36(37.5%)	96(100%)

From the findings 72(75%) of the respondents indicated that they get water for irrigation on their farms with only a small proportion of 24(25%) indicating that they do not get water for irrigation on their farms. Further majority 53(55.20%) indicated that the water received is not adequate for

the irrigation area allowed with 43(44.79%) indicating that the water received is adequate for the irrigation area allowed. Further majority 54(56.25%) of the respondents indicated that they do not get water for irrigation as scheduled with only 42(43.75%) indicating that they get water for irrigation as scheduled. Majority 57(59.38%) also indicated that there are water distribution rules in place with majority 59(61.46%) confirming that the rules assist in equitable distribution of water. Majority 53(55.20%) indicated that the rules are not applied fairly to all. Further majority 56(58.33%) also indicated that the irrigation system in place has adequate capacity to deliver the required amount of water with 40(41.67%) indicating that the irrigation system in place does not have the required capacity to deliver the required amount of water. Finally majority 60(62.5%) of the respondents indicated that there are always water related conflicts in their project with few 36(37.5%) indicating that there are no water related conflicts in their projects.

This means that water management system is inefficient in its operation leading to failure of equal distribution of water to all members in all parts of the irrigation areas. This concurs with Pazvakawambwa & van der Zaag (2001) who observed after a study of Nyanyadzi smallholder scheme that ideally an irrigation system should deliver water when and where it is needed and in adequate amounts to sustain crops during the entire growing period. There is usually high water demand during the dry period when irrigation is at the peak and crops are fetching maximum returns hence the need for an efficient system. The findings also confirm that inefficiency in water use is a major cause of under performance of irrigation systems as observed by many researchers (Aheeyar & Smith, 1999). The low performance of such schemes is largely attributable to unreliable and inadequate water delivery.

4.7.2 Reliability of water supply according to location within project

The study sought to determine the reliability of water supply according members' location within the project i.e. head, middle or tail end of the project. This was based on the same questions regarding the general reliability of water supply. The findings were as indicated in Table 9 below showing on average the respondents from the three sections who said yes to the questions posed.

Table 10: Reliability of water supply according to location

Statement	Head section (%mean)	Middle section (%mean)	Tail section (%Mean)
Do you get irrigation water on your farm	42	30	24
Is the water received adequate for the irrigation area allowed	52	32	12
Do you get the water when scheduled	49	31	16
Do you get adequate water during the peak irrigation season	50	32	14
Are there water distribution rules in place	36	39	21
Are the rules applied fairly to all	43	34	19
Do the rules assist in equitable distribution of water	59	23	14
Does the irrigation system have adequate capacity to deliver required amount of water	56	35	5
Do you have water related conflicts in your project	20	34	42

From the findings majority 42% of the head section respondents indicated that they get irrigation water on their farm compared to 30% of respondents in the middle section with few 24% of the respondents at tail section who indicated that they get irrigation water on their farms. Further the study indicated that majority 52% of the head section receive adequate water for the irrigation area allowed compared with 32% in the middle section with only few 12% of the tail section indicating that they receive adequate water on their farms. The findings further indicate that the tail farmers experience major water shortage problems e.g. they do not get water when scheduled, their irrigation system does not have adequate capacity to deliver require amount of water as indicated by their low means of 16%, and 5% respectively. The study also found that water related conflicts increase from the head section (20%) to the middle section (34%) and are worst at the tail end at 42%.

The findings conforms to studies in Philippines where it found that modest changes in water distribution procedures was associated with 97% increase in the production of the system overall and a 1497% increase in the tail section of the system. The conflict between the upstream and downstream users was therefore addressed without introducing any physical improvements (Sargardoy et al, 1986). The findings also concur with Uphoff (1986) that the adequacy and reliability of water supply is often the main factor influencing farmer decisions to participate. In situations of abundance all that is required from farmers is maintenance but where the supply is unreliable and farmers' efforts lead to no improvement, participation is not seen as a solution. Water related conflicts therefore inevitably arise as seen from the responses from tail enders.
This study conforms to studies on reliability of water supply viewed from three critical levels depending on location of the farmers. Farmers at the head of the project experience minimal problems with water followed by those in the middle. The worst problems occur at the tail end. This is concurs with studies carried out in Majengo area in Tanzania which found that irrigation increased productivity per acre but only 12% of the farmers benefited since water did not adequately reach all the plots (Shitundu & Luvanga,1996). Other studies in Sri Lanka showed unpredictable deliveries at the three levels with farmers at head in some schemes inefficiently using and draining water while tail enders lacked adequate supply(Aheeyar & Smith,1999). This is a factor that often affects who participates in irrigation management and also leads to conflicts.

The findings also concur with Pazvakawambwa & van der Zaag (2001) as well as Shyamsundar et al (2005) who indicated that low water availability also induces negative coping behaviour in individual farmers and can weaken the institutions that manage the system. The study also conforms with Shyamsundar et al (2005) who note that evidence on impacts of management by local associations is mixed as most studies report positive impacts on operations i.e. increased water-use efficiency, reliability, adequacy and timeliness of water delivery, increase in service area, responsiveness to their members' needs, and more equitable water distribution. However beneficiaries tend to under-invest in maintenance aspects leading to inadequate system capacity as it proceeds from the head to the tail end. The water distribution system and the fairness in distribution are a potential source of conflict and reluctance to participate. The study shows that water distribution is governed by rules that serve to simplify decision making and reduce potential conflicts especially where there are many potential users as acknowledged by majority of the respondents. However some farmers often act against the rules due to the failure of the

system to deliver water as it should as noted by Brewer, Sakthivadivel & Raju (1997). The success of the system of distribution depends on the perception of fairness in the resource allocation. The findings confirm that perception of unfairness could lead to derailment of cooperative efforts and it is important for the WUAs to promote equity in order to improve cooperation for sustainable management of projects as observed by Gyasi et al (2006).

4.8 Quality of Extension services

Extension services are an important source of information to farmers regarding irrigation and agronomic technologies and innovations. The study sought to find out from the respondents how reliable and available extension services in the area were.

4.8.1 Quality of Extension services according to the members

The findings on the quality of extension services among the farmers aimed at providing an insight into the level of services offered by the extension officer and their availability were as indicated in Table 10 below.

Table 11: Quality of extension services according to members

Statement	Strongly agree	Agree	Not sure	Disagree	Strongly disagree	Mean	Std deviation
There are enough extension service providers in the area	15(16.67%)	31(33.33%)	24(26.04%)	13(14.58%)	8(9.38%)	3.23	1.13
Extension service providers often visit my farm	7(8.33%)	9(10.41%)	24(26.04%)	30(32.29%)	21(22.92%)	2.39	1.57
I can communicate with extension service providers if I need them	5(6.59%)	25(28.57%)	13(15.38%)	22(25.27%)	21(24.18%)	2.33	1.61

I receive regular training in irrigation from extension staff	24(26.04%)	35(37.5%)	17(18.75%)	11(12.5%)	4(5.2%)	3.57	1.01
The extension messages delivered assist me to do irrigation better	27(29.16%)	40(42.71%)	13(14.58%)	8(9.37%)	3(4.16%)	3.73	0.86
I have learned modern approaches to irrigation from extension service providers	27(28.45%)	36(37.32%)	11(12.21%)	9(10.56%)	7(8.16%)	3.57	1.11
The extension service providers look confident when delivering messages	14(15.17%)	43(44.21%)	23(24.18%)	7(8.16%)	4(5.14%)	3.48	1.31
I am satisfied with the services of extension service providers	23(24.56%)	46(47.78%)	12(13.26%)	7(8.16%)	3(4.34%)	3.72	0.89
I prefer other sources of information to extension service providers	32(32.43%	51(52.87%)	5(6.41%)	3(4.12%)	2(2.09%)	4.03	0.62

From the findings in Table 10 majority 31(33.33%) agreed that there are enough extension service providers in the area, followed by 24(26.04%) who were not sure about the adequacy of extension service providers in the area with few 8(9.38%) strongly disagreeing that there are enough extension service providers in the area. However majority 30(32.29%) disagree that extension service providers often visit their farms with only 7(8.33%) and 9(10.41%) strongly agreeing and agreeing respectively. Further the findings indicated that majority 35(37.5%) receive regular training in irrigation from extension staff with only 4(5.2%) indicating that they do not receive regular training in irrigation from extension staff. Further majority 46(47.78%) indicated that they are satisfied with the services of extension service providers with only 3(4.34%) indicating that they are very dissatisfied with the services of extension service providers. Further majority 51(52.87%) of the respondents agreed that they prefer other sources to extension service providers. This implies that other than extension service providers, other sources e.g. agricultural shows, seminars and other agricultural journals are very vital to farmers in learning new farming techniques. The findings also indicated that Majority 25(28.57%) agree they can communicate with the extension service providers if they need them but on average the most of the respondents disagree with this notion. Further findings indicated that most of the farmers 67(71.87%) had gained from the extension messages delivered and also most 63(65.77%) had learned modern approaches to irrigation from the extension service providers. Majority 43(44.21%) agreed that extension agents looked confident while only a few 4(5.14%) strongly disagreed.

The findings largely agree with the observations of Salami, et al (2010) that the effectiveness of extension services in Kenya declined throughout the 1990s. Though the extension providers were indicated as just adequate in the area, they do not often visit the farms. This was due to inappropriateness of the training and visit extension model pursued, delayed adoption of alternative models and sharp reduction in the operational budgets of the sector ministries. In particular the 'demand driven' model seems not to be working as the findings indicated that on average majority of the farmers cannot communicate with the extension agents when they need them.

The findings also agree with observations that one of the most constraining factors in extension is availability of extension staff where the ministry of Agriculture has only approximately 5000

extension staff distributed across Kenya (MOA, 2008), resulting in very high farmer/staff ratio hence inadequate coverage and the Ministry of Water and Irrigation has only about 168 irrigation technical staff distributed thinly in the country's 209 districts against a requirement of 1276(MWI, 2008). This may account for the lack of regular visits to individual farmers surveyed in the area and the high preference for other sources of information as the demand is high. This concurs with Machethe et al (2004), who note that for smallholder agriculture to advance, support services that are accessible to majority of the farmers are required as international experience indicates that with adequate access to farmer support services, smallholder farmers can increase productivity significantly. However the findings contradict the observations on competence where developing countries are said to suffer a shortage of qualified staff particularly those specialized in irrigation due to lack of formal education facilities (Kortenhorst, 1980). Majority of the surveyed farmers indicated that they received regular trainings and that the trainings were relevant and imparted useful knowledge in modern irrigation technologies that assist doing irrigation in a better way. The extension agents were also largely confident in what they were delivering. This means that the extension officers in the area are adequately trained and qualified.

4.9 Competing economic activities

As peoples' participation in community activity is dictated by the positive benefits to be gained weighed against the labour invested, the study made an effort to find out if the community had decided to concentrate their effort on irrigation or other activities common in the area based on economic considerations.

4.9.1 Level of contribution according to members

The study further sought to establish the level of contribution of irrigation, livestock and rain-fed crops to the food security and household income in comparison to labour requirements. The average findings for the three surveyed projects were as indicated in table 11.

Table 12: Activity contribution to household food security and income

Economic activity	Irrigation (mean)	Livestock (mean)	Rain-fed crops (mean)	Other activities (mean)
Level of contribution to household food security	4.21	4.05	3.26	0
Level of contribution to household income	4.37	3.29	3.65	0
Labour requirement	4.55	3.18	3.71	0

NB: Very low= 1, Low=2, Average= 3, High= 4, Very high= 5.

From the findings majority indicated that the major contributor to household food security is irrigation followed by livestock and rain-fed crops as indicated by means of 4.21, 4.05 and 3.26 respectively. Further the findings indicated that irrigation is the major contributor to the household income as indicated by a mean of 4.37, followed by rain-fed produce with a mean of 3.65 and few indicating livestock with a mean of 3.29. Finally as far as labour requirement is concerned majority indicated that irrigation farming requires intensive labour as indicated by a mean of 4.55, followed by rain-fed crops with a mean of 3.71 and a few indicating livestock as indicated by a small mean of 3.18. The findings also indicated that there were no other significant economic activities competing with irrigation.

The findings show that the farmers in this area mostly concentrate their efforts in irrigation farming as compared to other competing activities common in the area. These findings concur with Svubure, et al, (2007) who found that people's participation in community activity is dictated by the positive benefits to be gained. It appears that even though the benefits of irrigated farming come with costs, the benefits outweigh the costs hence the continued concentration on irrigation compared to other enterprises. The farmers seem to indicate that they participate in irrigation because assurance of food security and generate income generation. This is in concurrence with studies by Oni, Maliwichi & Obadire (2011) showing that food security is significantly improved by irrigation. The findings contradict the contention that in making the decision to concentrate their efforts in irrigation farmers compare labour requirements with other available alternatives because irrigation is a labour intensive form of agriculture (van Rijn, 2004). However the findings agree with Neubert (2007) who observes that labour demand for

irrigation is considerably higher and the activity comes with more work for smallholder households.

Although farmers are known to divide their time between other income earning activities and the enthusiasm with which irrigation projects start and the seemingly successful take off period often turns to declining yields and indebtedness of farmers as noted by Gichuki et al (2010) and Kortenhorst (1980), the results suggest otherwise as the surveyed farmers indicated they are highly enthusiastic about irrigation. The findings agree with studies by Peden et al (2005) where irrigation farmers were shown to also benefit from livestock keeping. The findings further concur with Freeman & Silim (2002) who found that livestock competes favourably with crop production especially in drier Districts where irrigation is practiced. Their study on commercialization of irrigation in Makueni and Meru Central Districts found out that livestock was a major economic activity in the area though smallholder farms were predominant. The findings therefore indicate that irrigation is highly prioritized in the study area while livestock and rain-fed crop production compliment it.

4.10 Farmers' participation in O&M

The respondents' ability to carry out O&M to ensure optimum functioning and utilization of infrastructure as well as management of various irrigation activities were considered the main determinant of participation in O&M. Hence the study sought to understand the real situation in the area.

4.10.1 Farmers' participation in O&M according to the members

The study further sought to determine the farmer's participation in operation and maintenance in order to evaluate the role of farmers in the operation and maintenance of the irrigation system and the general farming system. The findings were as indicated in table 12.

Table 13: Farmers' participation in O&M

Statement	Yes (Frequency)	No Frequency	Total (Frequency)
Active members of IWUA	64(66.67%)	32(33.33%)	96(100%)
Meet O & M financial obligations	76(79.17%)	20(20.83%)	96(100%)
Proper infield water management	49(51.04%)	47(48.96%)	96(100%)
Vibrant crop in the farm	35(36.45%)	61(63.94%)	96(100%)
Few water related conflicts	38(39.58%)	58(60.42%)	96(100%)
Functional common irrigation infrastructure e.g. canals, piping intake, gates	59(61.46%)	37(38.54%)	96(100%)
Functional farm level structures	54(56.25%)	42(43.75%)	96(100%)
Installation of water saving technologies	58(60.42%)	38(39.58%)	96(100%)
Records of farm operations	59(61.46%)	37(38.54%)	96(100%)
Possession of a copy of by-laws/understanding of by laws	45(46.88%)	51(53.13%)	96(100%)

From the findings as indicated in Table 12 majority 64(66.67%) indicated that they were active members of Irrigation Water Users Association with few 32(33.33%) indicating that they were not active members of Irrigation Water Users Association. Further majority 76(79.17%) also indicated that they meet O & M financial obligations. Majority 49(51.04%) of the farms observed indicated that there was proper infield water management with 47(48.96%) indicating poor infield water management. Further majority 59(61.46%) indicated that the common irrigation infrastructure was functional. Installation of water saving technologies was also of major concern and majority 58(60.42%) of the respondents indicated that they had installed some form of the technology. However majority 51(53.13%) indicated that they do not possess a copy of by-law with 45(46.88%) indicating that they possess a copy of by laws. Finally majority 59(61.46%) indicated they keep record of farm operations while the rest 37(38.54%) do not.

The findings indicate average to above average performance in most of the activities used to gauge farmers' participation in O&M as most activities achieved 50% and above. An exception to this was only in three areas namely crop production, management of conflicts and possession

of copies of by-laws where the achievement below 50% implying poor to below average participation. Since majority of the farmers indicated that they were active members of the IWUA, the findings concur with Yap-Salanis (2004) that the farmers in the area had a strong voice in the management of the irrigation system and had become masters of their own fate. This also confirms Uphoff's (1986) contention that IWUA members usually dedicate time to meetings, communal work and other activities.

The findings indicate that most of the farmers meet O&M financial obligations and hence the projects surveyed have overcome one of the challenges threatening execution of O&M which is failure to meet financial obligations as observed by SIPMK (2011). Though the IWUAs have shown high participation in most of the O&M responsibilities, the findings on existence of conflicts and failure to possess a copy of the by-laws by most members indicate that the laws and hence the IWUA are not legally recognized and point to Mati et al (2007) assertion that governments should support IWUA with proper legislation and technical capacity. This concurs with Vermillion (1997) that farmers' confidence in the service will be enhanced and they will be willing to invest in the long term sustainability of the system.

4.11 Correlation and Regression analysis

The study sought to analyse the finding to out if any correlation existed among various study variables in order make further interpretations of the data. The results of this analysis are presented in the table 13 and 14 below.

Table 14: Correlation analysis matrix

	Farmers commitment	Farmers knowledge and skills	Reliability of water supply	Quality of extension services	Competing economic activities	Farmers participation in O & M
Farmers commitment	1					
Farmers knowledge and skills	0.953	1				
Reliability of water supply	0.554	0.452	1			
Quality of extension services	0.853	0.85	0.418	1		
Competing economic activities	0.917	0.445	0.965	0.871	1	
Farmers participation in O & M	0.865	0.785	0.688	0.734	0.567	1

The correlation matrix indicates that farmers' commitment to the IWUA was highly and positively correlated with Farmers participation in O&M as indicated by a strong Pearson correlation coefficient of 0.865. Further the correlation matrix indicated that farmers' knowledge and skills is also strongly and positively correlated with farmers' participation in O&M as indicated by a strong Pearson correlation coefficient of 0.785. Further the correlation matrix indicates that reliability of water supply is strongly and positively correlated with farmers' participation in O&M as indicated by a strong and positive Pearson correlation coefficient of 0.688. Also from the correlation matrix, quality of extension services is strongly and positively correlated with farmers' participation as indicated by a Pearson correlation coefficient of 0.734. Finally competing economic activities is moderately correlated with farmers' participation in O&M as indicated by a correlation coefficient of 0.567. From the results the study can deduce that all these factors are very crucial in influencing farmers' participation in O&M as they all

indicated a strong positive relationship. However competing economic activities have only a moderate influence.

Table 15: Regression model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.887401	0.787481	0.754786	0.8143

a. Predictors: (Constant), Farmers commitment, Farmers knowledge and skills, Reliability of water supply, Quality of extension services, Competing economic activities

From the results shown above, the model shows a goodness of fit as indicated by the coefficient of determination (R^2) with a value of 0.7875. This implies that the independent variables i.e. farmers' commitment to the IWUA, farmers' knowledge and skills, reliability of water supply, quality of extension services and competing economic activities explain 79 percent of the variations of farmers participation in O&M. Therefore the independent variables strongly and positively influence the dependent variable.

CHAPTER FIVE

SUMMARY, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter is a synthesis of the entire study, and contains summary of research findings, exposition of the findings in line with the research questions and objectives. It also includes conclusions, recommendations and suggestions for further research based on the findings.

5.2 Summary of findings and discussions

Majority of the respondents indicated that they often refer to the Irrigation Water Users Association by laws in their day to day irrigation activities with few indicating that they do not at all refer to the Irrigation Water Users association in their daily activities. Further the findings indicated they are not punished for non compliance with the by-laws governing the irrigation system with few indicating that they are very often punished for non-compliance with the by-laws governing Irrigation Water Users Association. This implies that the laws governing irrigation water users are not strictly adhered to and therefore the study infers that the IWUA Management has not laid down proper enforcement procedures. It is also evident that the rules are enforced using local mechanisms making them ineffective. Furthermore majority indicated that they attend meetings organized by their committee and actively participate in the deliberations with only few indicating that they do not attend meetings organized by their association. This implies that meetings are taken seriously which may be due to the important issues affecting farming and the irrigation system being discussed in such meetings. Majority also indicated that they participate in communal work for repairs and maintenance of their projects infrastructure. Majority of the farmers also indicated that pay O&M charges indicating that they are aware of the importance of such contributions. The correlation analysis findings further indicated that farmers' commitment to the IWUA was highly and positively correlated with farmers' participation in O&M with a Pearson correlation coefficient of 0.865.

The findings therefore indicated that the farmers' performance was above average on most of the activities used to gauge commitment the IWUA and participation in O&M except in management of conflicts and ownership of by-laws which were rated below average. This concurs with Yap-Salanis (2004) contention that in being active member of the IWUA the farmers had a strong voice in management of their affairs and could determine their destiny. The

ability to meet O&M financial obligations indicates that the farmers have overcome one of the major challenges threatening execution of O&M (SIPMK, 2011). This will help improve productivity and sustainability of the irrigation system as noted by Kolavalli & Brewer (1999). The findings on the existence of conflicts and poor ownership of by-law concur with Mati et al (2007) on the need for governments to support IWUAs with proper legislation, financing and technical capacity to enhance local level by-law enforcement mechanisms. This also concurs with Chandrasekaran et al (2002) observations that farmers are expected to honour their obligation to their institution by creating an enabling environment for the IWUA to carry out its mandate. Further more because of funds constraints and lukewarm support from the governments as observed in various studies, farmers' commitment should be seen in their prompt payment of water and other charges. The findings also conform to Vermillion (1997) assertion that most smallholder participation and collaboration efforts are governed by rules and regulations applied on the basis of local agreements without proper legislation. Commitment is not always voluntary and effective by-laws are needed to assist the leadership in instilling discipline. This also conforms to a set of studies conducted by Mati et al (2007) that assert that local level policies and laws on agricultural water management exist in form of articles of association, by-laws and customary laws mostly embedded in indigenous knowledge and social values. These have enhanced access to irrigation water by smallholder farmers through creation of WUAs for O&M.

From the findings majority of the respondents demonstrated a clear understanding of who is supposed to repair leakages of pipes and canals at field level while some indicated uncertainty and others did not know the answer to the question. Further majority of the respondents also indicated a clear understanding of the problem associated with application of excess water in the farm, followed by those who were uncertain about the problems associated with application of excess water in their farms with few demonstrating that they do not know the dangers that are involved when excess water is applied in the farm.

Further majority of the respondents indicated that they were uncertain about the importance of an O & M plan, some were correct with few indicating that they did not know about the importance of O & M plan. Furthermore majority had reasonable information about the use of the funds they contribute, quiet a number were uncertain and few indicated that they did not know what the funds they contributed for O & M were supposed to be used for. Further majority indicated clear

understanding of the importance of taking care of the water catchment areas, quiet a number were uncertain with few indicating that they did not know the importance of taking care of the water catchment area. From the correlation analysis findings, farmers' knowledge and skills were found to be highly and positively correlated with farmers' participation in O&M as indicated by a Pearson correlation coefficient of 0.785.

The findings indicate that farmers have mixed understanding of issues related to O&M. They therefore concur with SIPMK (2011) that O&M faces challenges like technical knowhow of farmers which may lead to misunderstanding of how the system works and hence conflicts. The findings also concur with (Coward & Uphoff, 1986) that improved knowledge, skills and perceptions will enable water users mobilize more of their resources to implement specified O&M activities and become more involved through user organizations. The commitment to meetings findings indicate proper involvement of local water user associations in pre-implementation and implementation activities and have developed their skills hence their willingness to contribute towards maintenance of the projects as observed by Bagadion & Korten (1991). As observed by Kortenhorst (1980) the findings call for intensive farmer training which is even more highly focussed than in rain-fed farming. This is reinforced by recent research that has identified lack of technical skills as one the major factors causing underperformance of most smallholder irrigation schemes (Fanadzo, 2012).

Finally the findings also concur with a set of studies of WUAs carried out in Turkey, Kiymaz, Ozekici & Hamdy (2007) demonstrated that lack of sufficient knowledge in irrigation issues could lead to low productivity of water and hence affect crop yields. Farmer training has been demonstrated to improve productivity and income levels in many countries (Fanadzo, 2012). Machethe et al (2004) recommend practical training in water management and irrigation scheduling for both farmers and extension agents.

From the findings the respondents indicated that they get water for irrigation on their farms with only a small proportion indicating that they do not get water for irrigation on their farms. Further majority indicated that the water received is not adequate for the irrigation area allowed with some indicating that the water received is adequate for the irrigation area allowed. Further majority of the respondents indicated that they do not get water for irrigation as scheduled with

quiet a number indicating that they get water for irrigation as scheduled. Majority also indicated that there are water distribution rules in place with majority confirming that the rules assist in equitable distribution of water. Further majority also indicated that the irrigation system in place have adequate capacity to deliver the required amount of water with few indicating that the irrigation system in place does not have the required capacity to deliver the required amount of water. Finally majority of the respondents indicated that there is always water related conflicts in their project with few indicating that there are no water related conflicts in their projects. This means that water management system is inefficient in its operation leading to failure of equal distribution of water to all members in all parts of the irrigation allowed areas.

From the findings majority of the head section respondents indicated that they get irrigation water on their farms, followed by middle section with few respondents from the tail section indicating that they get irrigation water on their farm. Further the study findings indicated that majority of the head section agreed that the water received is adequate for the irrigation area allowed, with middle section and tail section disagreeing that the water received is adequate for the irrigation area allowed. Further the findings indicated that majority of the head section get the water when scheduled, followed by middle section with few of the tail section members indicating that they get water when scheduled. Further the findings indicated that there are water distribution rules in place as indicated by head section members, middle section members and tail section members respectively and that the rules in place help in fair distribution of water as indicated by majority of the head section members. However majority of the tail section members indicated that they have water related conflicts in their projects, followed by respondents from middle section who indicated that they usually have water related conflicts in their projects with few of the respondents from the head section indicating that they usually have water related conflicts in their area. This implies that farmers at the tail location experience water shortage leading to inconsistency in irrigation cycle hence water related conflicts among the farmers using the irrigation water system. The correlation analysis findings indicated that reliability of water supply was highly and positively correlated with farmers' participation in O&M with a Pearson correlation coefficient of 0.688.

The findings concur with Pazvakawambwa & van der Zaag (2001) who observed that ideally an irrigation system should deliver water when and where it is needed and in adequate amounts to

sustain crops during the entire growing period; otherwise low water availability can induce negative coping behaviour in individual farmers. This also confirms that inefficiency in water use can be a major cause of under performance of irrigation systems as noted by many researchers (Aheeyar & Smith, 1999). The low performance of smallholder schemes is largely attributable to unreliable and inadequate water delivery.

Similarly the findings conform to studies in Philippines where they found that modest changes in water distribution procedures was associated with 97% increase in the production of the system overall and a 1497% increase in the tail section of the system and that conflict between the upstream and downstream users was addressed without introducing any physical improvements (Sargardoy et al, 1986). They also concur with Uphoff (1986) that the adequacy and reliability of water supply is often the main factor influencing farmer decisions to participate.

The findings also confirm that farmers at the head of the project experience minimal problems with water followed by those in the middle. The worst problems occur at the tail end. This concurs with research carried out in Majengo area in Tanzania which found that irrigation increased productivity per acre but only 12% of the farmers benefited since water did not adequately reach all the plots (1996). It is also in line with studies in Sri Lanka that showed unpredictable deliveries at the three levels with farmers at head in some schemes inefficiently using and draining water while tail enders lacked adequate supply(Aheeyar & Smith,1999).

The findings assert that water distribution must be governed by rules that serve to simplify decision making and reduce potential conflicts especially where there are many potential users. However farmers often act against the rules due to the failure of the system to deliver water as it should as observed by Brewer, Sakthivadivel & Raju (1997). The findings also prove that as noted by Gyasi et al (2006), the success of the system of distribution depends on the perception of fairness in the resource allocation. Perception of unfairness could lead to derailment of cooperative efforts and it is important for the WUAs to promote equity in order to improve cooperation for sustainable management of projects.

From the findings majority agreed that there are enough extension service providers in the area, followed by quiet a number who were not sure about the adequate availability of extension service providers in the area with few strongly disagreeing that there are enough extension

service providers in the area. Further the findings indicated that majority receive regular training in irrigation from extension staff with only few indicating that they do not receive regular training in irrigation from extension staff. Further majority indicated that they are satisfied with the services of extension service providers with only few indicating that they are very dissatisfied with the services of extension service providers. Majority also agreed that they had gained form the extension messages delivered and that they had learned modern approaches to irrigation fro extension agents. Further majority of the respondents agreed that they prefer other sources to extension service providers. The correlation analysis findings gave a Pearson correlation coefficient of 0.734, indicating that quality of extension services was highly and positively correlated with farmers' participation in O&M.

The findings agree with MWI (2008) indication that human resources are central to the attainment of an organization's mission and their capacity to carry out their activities effectively will determine the extent to which the envisaged targets will be met. This is due to the fact that the respondent indicated they utilize and benefit for the services of the extension agents whenever available. The findings also confirm the observation of Salami, et al (2010), that the effectiveness of extension services in Kenya declined over the years as the respondents indicated that the local extension agents do not often visit their farms. This partly confirms the findings indicating below average performance in agronomic and water management aspects which are key indicator of farmers' participation in O&M.

The findings further confirm that one of the most constraining factors in extension is availability of extension staff MOA (2008), MWI (2008). This accounts for lack of regular visits and preference for other sources of extension messages as indicated by the respondents. It then follows that as observed by Machethe (2008), support services that are accessible are needed for smallholder agriculture to advance. The observation by Kortenhorst(1980) that developing countries suffer shortage of competent and qualified staff particularly those specialized in irrigation due to lack of formal education facilities staff is contradicted by the findings as the respondents indicated that they receive regular and relevant trainings which imparted useful skills in modern irrigation technologies. The extension agents were also confident in content they were delivering therefore the findings disagree with studies by Machethe et al (2004) indicating

that extension personnel can be inadequately trained in their technical area hence affecting their confidence, credibility and performance.

From the findings on competing economic activities, majority indicated that the major contributor to household food security is irrigation followed by livestock and rain-fed crops. Further the findings indicated that irrigation is the major contributor to the household income, followed by rain-fed produce and few indicating livestock. Finally as far as labour requirement is concerned majority indicated that irrigation farming requires extensive labour, followed by rain-fed crops and a few indicating livestock. The correlation analysis findings indicated that competing economic activities were moderately correlated with farmers' participation as indicated by a correlation coefficient of 0.567. The findings concur with Svubure, et al, (2007) who found that people's participation in community activity is dictated by the positive benefits to be gained. The findings show that food security and hence irrigation are given major priority in the area in line with studies by Oni, Maliwichi & Obadire (2011) indicating that food security is significantly improved by irrigation.

Labour requirement does not seem to deter farmers form engaging in irrigation thus the findings disagree with van Rijn (2004) that in making the decision to concentrate their efforts in irrigation farmers make comparisons with other available alternatives because irrigation is a labour intensive form of agriculture. The findings however concur with Neubert (2007) that labour demand for irrigation is considerably higher. The farmers surveyed also indicated that they benefited from livestock (Peden et al,2005) and rain-fed crop production and the findings therefore concur with Freeman &Silim (2002) who concluded that livestock competes favourably with crop production especially in drier Districts where irrigation is practiced. The findings therefore indicate that livestock and rain-fed crop production activities complement irrigation.

The regression model on the other hand had a goodness of fit as indicated by the coefficient of determination of 0.788 meaning that the independent variables explain 79% of the variations of farmers' participation in O&M. Therefore it is deduced that all the independent variables studied i.e. farmers' commitment to the IWUA, farmers' knowledge and skills, reliability of water

supply, quality of extension services and competing economic activities had a strong and positive influence on farmers' participation in O&M.

5.3 Conclusions

The study concludes from the findings on the farmer's commitment to the Irrigation water Users association that the respondents often refer to the Irrigation Water Users Association by laws in their day to day irrigation activities. Further based on the findings the study concludes that although some farmers are punished for non-compliance with the by laws governing the irrigation system, majority of the farmers are not always punished for non compliance with the by-laws governing the irrigation system. Therefore the rules are not very effective and do not serve to deter members from deviating from group norms. The IWUA management also comes out as a weak enforcer of the rules. From the findings the study also concludes that the farmers usually attend meetings organized by their committee with only few who do not attend meetings organized by their association. This implies that meetings are taken seriously which may be due to the important issues affecting farming and the irrigation system discussed in such meetings. Further the study also concludes that the farmers occasionally participate in communal work for repairs and maintenance of their projects infrastructure. The study also concludes that the farmers make prompt payment of O&M charges for sustenance of their irrigation system.

As far as farmers' knowledge and skills are concerned, the study concluded that the farmers have mixed understanding of O&M issues. For example, they have a clear understanding of who is supposed to repair leakages of pipes and canals at field level. Further the study also concludes that the farmers have an average understanding of the problem associated with application of excess water in the farm. Also from the study it can be concluded that majority of farmers were uncertain about the importance of an O & M plan and maintenance of the system. Furthermore the study concludes that farmers had reasonable information of how the funds they contribute for O & M are supposed to be used. Finally on the basis of farmers' knowledge and skills the study concludes that farmer's had a clear understanding of the importance of taking care of the water catchment areas.

On the basis of reliability of water supply the study concluded that although farmers get water for irrigation on their farms, the water received is not adequate for the irrigation areas allowed

and that majority do not get water for irrigation as scheduled. Also the study concluded that there are water distribution rules in place and that the rules assist in equitable distribution of water although the rules favour some members while discriminating others. Further the study concludes that the irrigation system in place does not have adequate capacity to deliver the required amount of water. Finally on the basis of reliability of water supply the study concludes that there are always water related conflicts in the projects due to unequal distribution of water among the members. This is partly due to the inadequacy of the design of the system to gravitate enough water to all members and the poor water management skills of the IWUA committee and members themselves. These conflicts escalate as water progresses downstream from the head of scheme to the tail end as poorly managed gravity systems always favour upstream members.

On reliability of water according to location, it is concluded that head section farmers and the middle section farmers get more irrigation water on their farms and that the tail section face scarcity of water on their farms leading poor crop yields from maturing and conflicts. Further the study concluded that the head section received adequate water for the irrigation area allowed and that middle section and tail section do not always receive adequate water for the irrigation area allowed. Further, the study concludes that there are water distribution rules in place and that the rules in place help in fair distribution of water according to the Head section members but the middle section members and the tail section members are not favoured by the rules. It can also be concluded that the farmers at the tail section have more water related conflicts due to scarcity of water for irrigating their crops.

Regarding the quality of extension services, the study concludes that there are inadequate extension service providers in the area and they do not regularly visit the farmers in their fields. However regular and relevant training in irrigation is offered by the extension staff and therefore are satisfied with the services of extension service providers. The study also concludes that farmers have gained useful knowledge in areas like modern approaches to irrigation from the extension agents and that they are qualified and confident in their areas of specialization. Further the study concludes that some farmers prefer other sources to extension service providers like print and electronic media and these are vital to farmers in learning new farming techniques.

On competing economic activities findings, the study concludes that the major contributor to household food security is irrigation followed by livestock and rain-fed crops and that irrigation is the major contributor to the household income, followed by rain-fed produce and livestock. Finally as far as labour requirement is concerned the study concludes that irrigation farming requires intensive labour, followed by rain-fed crops and livestock. Despite the labour requirement by irrigation the study find that irrigation is given high priority in the area due to its food security and income contribution though rain-fed crops and livestock compete favourably.

The study concludes that farmers' participation in O&M is above average as shown by several indicators including being active IWUA members, meeting O&M financial obligations and generally functional irrigation system. The study also concludes that some areas like crop and water management, conflicts and ownership of by-laws have not been fully addressed by the farmers. Finally the study concludes that from the correlation and regression analysis, the five independent variables have a strong and positive influence on the independent variable.

5.4 Recommendations

The study recommends that the farmers should commit themselves to the Irrigation water Users Association by abiding to the governing laws in their day to day irrigation activities. The IWUA management should penalize those who do not comply with the governing laws and should ensure that the laws are applied fairly to all members under the IWUA. The policy makers in irrigation should device mechanisms for legislation and legal recognition of the IWUAs so that they can combine local mechanisms of enforcing the rules with a more formal and effective system.

The study also recommends that the members should be more involved in meetings planned by the Irrigation water Users Association, contribute in the discussions and resolutions made in such meetings and engage the management committees so that decisions regarding the projects can be owned by all. Payment of the required operational and maintenance charges and most importantly participation in the communal work for repairs and maintenance of the project infrastructure should be emphasized.

Concerning farmers knowledge and skills, the study recommends that the farmers should be more aware of important issues that arise in their daily activities and their responsibilities like

who is supposed to repair leakages of pipes and canals at field level, the problems associated with farming activities e.g. the effect of excess water in the farm, the best practices and methods of water application e.g. furrow, drip system, sprinkler system etc.

On the basis of the reliability of water supply, the study recommends that the farmers should adopt water saving and efficient systems as a way of sharing the limited resource to ensure more equitable distribution and avoid conflicts. Further the study recommends that farmers should plan well their planting and irrigation calendar as well as the system of irrigation (rotation or 'on demand') for better water sharing and reduction of the chances of crop failure due to scarcity of water. Therefore, the study recommends better planning of water management aspects at farm level with a view to addressing scarcity through efficient use.

The study further recommends that the extension services should be extended to all farmers through a model that is practical. In this regard, the study recommends an increase in the frequency of farm visits to provide technical advice and training in new approaches to irrigation management and crop production. The study therefore recommends that first an analysis of the existing staff, the geographical areas of coverage serving, their areas of competence and actual field requirements be carried out and the identified gaps be closed by employing more staff or taking such other measures recommended from the analysis. The study also recommends that farmers be encouraged to continue seeking information from other sources other than government extension agents and in particular embrace the concept of demand driven extension where they seek services where and when they need them instead of waiting to be visited.

The study also recommends that farmers should be supported in agronomic aspects so as to have vibrant crops in their field, intensify on irrigation farm area, maximise their income, ensure food security and use farming techniques that are less labour intensive. The study also recommends that other participation aspects such as management of conflicts, ownership of by-laws and keeping of farm records be emphasized so that farmers can give them the seriousness they deserve as they have an impact on the participation and performance aspects of the projects.

5.5 Suggestions for further research

From the findings of this study, it is suggested that further research be carried out on the reasons behind farmers' non-compliance with IWUA by-laws despite the fact that they are aware of them

and refer to them in their day to day irrigation activities. The contribution of IWUA by-laws in the management of water related conflicts in smallholder irrigation projects should also be investigated. Further research is also suggested on farmers' lack of knowledge in key O&M areas like preparation of O&M plans and irrigation system maintenance. Another area recommended for further investigations is the overall performance of the irrigation systems from engineering design and management perspectives so as to understand why some project levels enjoy enough water while others have scarcity. Finally, past and current extension models as well as the slow pace of acceptance of demand driven extension model by farmers should be further investigated so as to inform policy makers on the best way forward in extension.

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APPENDIX 1: Letter of introduction

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
DEPARTMENT OF EXTRA-MURAL STUDIES
NAIROBI EXTRA-MURAL CENTRE

Your Ref:

Our Ref:

Telephone: 318262 Ext. 120

Main Campus
Gandhi Wing, Ground Floor
P.O. Box 30197
N A I R O B I

26th July, 2012

UON/CEES//NEMC/13/128

TO WHOM IT MAY CONCERN

RE: KAHURO GEORGE WACHIRA- REG.NO. L50/65177/2010

This is to confirm that the above named is a student at the University of Nairobi College of Education and External Studies, School of Continuing and Distance Education, Department of Extra- Mural Studies pursuing Master of Arts in Project Planning and Management.

He is proceeding for research entitled **"factors influencing farmers participation in operation and maintenance of irrigation projects in Gichugu Division Kirinyaga East District, Kenya."**

Any assistance given to him will be appreciated.

CAREN AWILLY
CENTRE ORGANIZER
NAIROBI EXTRA-MURAL CENTRE

APPENDIX 2: Questionnaire

Part A: General Information

1. Respondents' name (optional).....
2. Sex male { } female { }
3. Position in the Household .....
4. Age

Below 20 years	{ }	20- 29 years	{ }
30-39 years	{ }	40-49 years	{ }
50-59 years	{ }	Above 60	{ }

5. Land size under irrigated crop production .....acres

Part B: Farmers' commitment to the IWUA

Question/ statement	Very often	Often	Sometimes	Not often	Not at all
6. How often do you refer to the IWUA by-laws in day to day irrigation activities?					
7. How often are you penalized for non-compliance with the by-laws?					
8. The by- laws are applied fairly to all					
9. I attend planning meetings organized by IWUA committee					
10. I contribute to the discussions and resolutions made in such meetings					
11. I participate in the election of IWUA committee					
12. I trust the committee's decisions regarding the project management					
13. I pay O&M charges					
14. I participate in communal works for repairs and maintenance of project infrastructure					
15. I spare time at short notice for project's adhoc and emergency works					

Additional Information/comments

.....

.....

Part C: Farmers' knowledge and skills

Tick against K if the farmer is knows, UN if the farmer is uncertain and NK if the farmer does not know the answer to the question.

Question	K	UN	NK
16. Who is supposed to repair leakages of pipes and canals at field level?			
17. What are some of the problems associated with application of excess water in your farm?			
18. Who is supposed unclog the irrigation system of silt and debris?			
19. What is the importance of an O&M plan?			
20. Which is more efficient in water application between furrow and drip irrigation methods?			
21. Where can you get information on appropriate irrigated crop production?			
22. What is the importance of an active IWUA committee to your project?			
23. What are the funds you contribute for O&M supposed to be used for?			
24. What is the importance of a working together as an IWUA group?			
25. What is the importance of taking care of the water catchment?			

Additional Information/comments

.....

.....

Part D: Reliability of water supply

26. Is your farm located at the head, middle or tail end of the project.....
27. What area are you allowed to irrigate as per by-laws?..... Acres
28. Is the system of irrigation water distribution rotational or 'on demand'?

    Rotational { } on demand { }

Question	Yes	No
29. Do you get irrigation water on your farm?		
30. Is the water received adequate for the irrigation area allowed?		
31. Do you get the water when scheduled?		
32. Do you get adequate water during the peak irrigation season?		
33. Are there water distribution rules in place?		
34. Are the rules applied fairly to all?		
35. Do the rules assist in equitable distribution of the water?		
36. In your opinion, does the irrigation system have adequate capacity to deliver required amount of water?		
37. Do you have water related conflicts in your project?		

Additional Information/comments

.....

.....

Part E: Quality of extension services

Statement	Strongly agree	Agree	Not sure	Disagree	Strongly
38. There are enough extension service providers in the area					
39. Extension service providers often visit my farm					
40. I can communicate with extension service providers any time I need them					
41. I know where to get the extension service provides if I need them					
42. I receive regular training in irrigation from extension staff					
43. The extension messages delivered					

assist me to do irrigation better					
44. I have learned modern approaches to irrigation from extension service providers					
45. The extension service providers look confident when delivering messages					
46. I'm satisfied with the services of extension service providers					
47. I prefer other sources of information to extension service providers					

Additional Information/comments

.....

.....

Part F: Competing economic activities

48. Fill VH if the farmer indicates very high, H if high, A if average, L if low and VL if very low

Economic activity	Level of contribution to household food security	Level of contribution to household income	Labour requirement
Irrigation			
Livestock			
Rain-fed crops			
Other economic activity (specify)----------			
Other economic activity (specify)----------			

Additional Information/comments

.....

.....

Part G: Farmers participation in O&M

49. Participation aspect	**Yes**	**No**
1. Active member of IWUA		
2. Meet O&M financial obligations		
3. Proper infield water management		
4. Vibrant crop in the farm		
5. Few water related conflicts		
6. Functional common irrigation infrastructure e.g. canals, piping intakes, gates		
7. Functional farm level structures		
8. Installation of water saving technologies		
9. Records of farm operations		
10. Possession of a copy of by-laws/ understanding of by laws		

Additional Information/comments

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