IRRIGATION MANAGEMENT TRANSFER: FARMERS' WILLINGNESS TO PAY FOR OPERATION AND MAINTENANCE OF SELECTED IMPROVED SMALLHOLDER IRRIGATION SCHEMES IN MBEYA, TANZANIA

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A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF THE SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2019

ABSTRACT

The Irrigation Management Transfer reforms across the world have been focusing on gradual shift from government toward farmers. The motive behind these reforms is to increase efficiency, financial sustainability, and reduce public financial burden while making farmers responsible for financing Operations and Maintenance (O&M) costs. The Willingness to Pay (WTP) for O&M costs is important for sustainability of improved smallholder irrigation schemes. Unfortunately, since the beginning of the implementation of IMT reforms in Tanzania, none has conducted a study to assess farmers' WTP for O&M costs. This study was therefore conducted in Mbeya urban and Mbarali districts to assess farmers' WTP for O&M costs and to assess profitability and challenges facing farmers in improved smallholder irrigation schemes. Primary data were collected from 301 randomly selected farmers from four improved irrigation schemes. Results show that farmers were willing to pay on average 45 000 TAS per acre per year. Further, the logistic regression results show that, the determinants of WTP were education level, sex of household head, awareness and perception on IMT reforms. In addition, access to credit, extension services and crop income influenced WTP positively and significantly. Thus, intervention made with a focus on the determinants of WTP will enhance the sustainability of irrigation schemes through farmers' payments. Moreover, gross margin results indicated that farmers were practicing profitable farming with a gross margin averaged at 812 126 TAS per acre while the highest and the lowest margin was 1 827 095 TAS and 273 143 TAS for onions and maize respectively. Accessibility of agricultural extension services, marketing, post-harvest handling and management of the schemes were challenges facing farmers. The study recommended that, continued sensitization on the rationale of IMT reforms, encouraging farmers to produce “more profitable crops” such as onions and tomatoes, provision of agricultural extension and credit services, and enforcement of a by-law mandating farmers to become members of irrigator associations are important matters to be addressed. Lastly, marketing related challenges, including poorly organized agricultural marketing, use of unstandardized weighing scales, poor post-harvest handling especially for onions, need to be addressed through collaborative efforts of both government and farmers.

DECLARATION

I, **Hamad Mahamud Ngaiza**, do hereby declare to the Senate of Sokoine University of Agriculture, that this thesis is my original work and has not been submitted for a higher degree award in any other University.

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This declaration is confirmed.

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ACKNOWLEDGEMENTS

I first thank the “Almighty God” for his blessings and strength, which enabled me to work throughout since the planning stage until completion of this work. I believe without God’s blessing, it would not have been possible to reach this stage given challenges I have passed through.

I wish to convey my heartfelt gratitude to all people whose support in one way or another gave me an encouragement in undertaking this study. Though it is not possible to mention all of them here, some of them will be presented here by their names.

I am highly indebted for the privilege of working with my insightful and knowledgeable supervisors, Professor Reuben M. J. Kadigi and Dr. Damas Philip for the rest of time I spent doing this research work. It was through their continuous discussion, advice and encouragement that enabled me fulfil one of my dreams in academic carrier. There are no words I can use to explain my sincerely grateful, only God who knows how I appreciate their support.

My sincere thanks also go to my colleagues in the School of Agricultural Economics and Business Studies (SAEBS) in no order of importance; Charles Mgeni with whom I had discussions on how to improve this study from the time I enrolled at Sokoine University of Agriculture as a PhD candidate until I completed. In addition, I thank Dr. Felix Nandonde, Dr. Roselyne Alphonce, Dr. Daniel Ndyetabula, Dr. Jeremia Makindara, and Dr. Waized Betty for their support. In addition, I thank Prof. Nganga

I. Kihupi and Prof. Gilead I. MLay for their constructive criticism in the course of improving this thesis, I appreciate their support.

I wish to extend my sincere thanks to the Dean of School of Agricultural Economics and Agribusiness, Dr. Adam Akyoo and the Head of the Department of Agricultural Economics and Agribusiness, Dr. Daniel W. Ndyetabula for being positive and understanding in the course of completing this study. I also thank all staff in the School of Agricultural Economics and Business Studies of Sokoine University of Agriculture for their support provided to me directly or indirectly for all the time I was doing this study.

I would like to express my appreciation to all leaders of irrigators' association in Mbarali and Mbeya urban with whom I worked very closely from the time I went to be introduced as a researcher in 2014. These include Mr. John Soda (Iganjo scheme), Mr. Hamis Jairos (Ipatagwa scheme), Mr. Filosi (Luanda Majenje scheme), and Mr. Nelson Vicent (Igomelo scheme). Local authority leaders in the wards where respondents came from are highly appreciated for their support throughout implementation of this study.

My profound appreciation go also to research assistants who were involved in data collection during the pilot and main survey execution; Ms Ajile Mwang'anda, Mr. Gwakisa Albon, Mr. Amenye Anyisile, Mr. Mohamed Ibadi and Mr. Henry Yohana, indeed they played a great role in this study.

I am also extending my words of thanks to Prof. E. R. Mbiha, Prof. E. M. M. Senkondo and Prof. B. Chove whom assisted me in bursaries through the scholarship awarded from the World Bank: Science, Technology and Higher Education Project. Also, the postgraduate team at Sokoine University of Agriculture specifically Prof. Muhikambele and Mr. Kajimbwa, Mr. Siwiti, Ms Asha and others who are not mentioned here, their assistance is highly appreciated. Special thanks are also due to the top management of Sokoine University of Agriculture, for giving me permission for undertaking this study. I would like to thank in a very special way my family members specifically my parents, Hajjat Saada S. Byarugaba and my father the late, Mahamud H. Ngaiza for their guidance and support throughout in my academic carrier. Last but not least I thank my children Naylah, Najmah, Nahaad and my wife Saida for their support and words of encouragement from when this study started until the end.

Lastly, I extend my heartfelt appreciation to all individuals that have not been mentioned by names here but they assisted me somehow in the course of completing this study. Their contribution is highly valuable and recognized.

DEDICATION

I proudly dedicate this work to my mother Hajjat Saada S. Byarugaba and my father, the late Mahamud H. Ngaiza for their love, care and support that enabled to take many bold steps in my academic carrier up to this achievement "*Aksanteni sana."*

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LIST OF ABBREVIATIONS AND ACRONYMNS

ADB	Asian Development Bank
AGWATER	Agriculture Water
ANOVA	Analysis of Variance
CDF	Cumulative Distribution Function
CVM	Contingent Valuation Method
DADPs	District Agriculture Development Plans
DBDC	Double Bound Dichotomous Choices
DC	Dichotomous Choice
FAO	Food and Agriculture Organization
FMIS	Farmers Managed Irrigation Schemes
GM	Gross Margin
GRRC	Great Ruaha River Catchment
IB	Iterative Bidding
IMF	International Monetary Fund
IMT	Irrigation Management Transfer
IWMI	International Water Management Institute
MLE	Maximum Likelihood Estimation
NAFCO	National Agriculture and Food Corporation
NGO	Non-Government Organization
NIP	National Irrigation Policy
O&M	Operation and Maintenance
OE	Open Ended

OLS	Ordinary Least Square
PASS	Private Agricultural Sector Support
PC	Payment card
RP	Revealed Preference
RUT	Random Utility Theory
RWH	Rain Water Harvesting
SACCOS	Savings and Credit Cooperative Society
SAP	Structural Adjustment Programmes
SP	Stated Preference
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
TAFSIP	Tanzania Agriculture and Food Security Investment Plan
TAS	Tanzanian Shillings
TR	Total Revenue
TVC	Total Variable Costs
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
USAID	United States Agency for International Development
VICOBA	Village Community Bank
WTP	Willingness to Pay
WUA	Water User Associations
WUG	Water User Groups

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agricultural production in most parts of developing nations (including Tanzania) is largely practised under rain-fed systems (You *et al.*, 2011; Calzadilla *et al.*, 2009), and to some extent under small-scale and large-scale irrigation systems. The small-scale irrigation systems in Sub-Saharan Africa comprise of improved and traditional systems, which are practised highly on a large proportion of land under irrigation as opposed to large-scale irrigation systems, which account for only 17 percent (Lankford *et al.*, 2016).

Just before 1990s, large-scale irrigation systems in Tanzania were owned by the government where there was a formal government sponsored irrigation organization responsible for Operation and Maintenance (O&M). For example, the National Agricultural and Food Corporation (NAFCO), which collapsed in 1996, was the government organization, which was responsible for the management of parastatal large-scale irrigated farms such as Dakawa Rice farm and Mbarali Rice farm (Chachage and Mbunda, 2009).

Following bad performance which resulted from mismanagement, the government privatised the schemes during the 1990s (URT, 2009). In addition, the government support for irrigation was directed towards the improvement of traditional irrigation schemes mainly for irrigation infrastructure and organizing smallholder irrigators into formally registered entities, which are responsible for operation and maintenance (Lankford *et al.*, 2016; URT, 2009).

Though both smallholder and large-scale irrigation systems have been playing an important role in terms of employment and food security, large-scale irrigation systems experienced serious deficiencies in management (poor operation and maintenance) that led to underperformance of substantial investments (Lankford *et al.*, 2016; Inocencio *et al.*, 2007). At the same time, smallholder irrigation schemes in Sub-Saharan Africa and Tanzania in particular have faced many challenges, which include low levels of efficiency, poor marketing of produce, low availability of extension services, and lack of finance for operation and maintenance (Kadigi *et al.*, 2012: Oates *et al.*, 2017).

Despite the availability of land suitable for irrigation (42.5 million hectares) in Africa, irrigation is however practised on a very small proportion of the area. It is estimated to be around 13.4 million hectares, which is equivalent to only about 6 and 31.53 percent of the total cultivated land and the potential area for irrigated agriculture respectively (You *et al.*, 2010; FAO, 2005).

In Sub-Saharan Africa, it is estimated that, 10 percent of agricultural production comes from irrigated land, which accounts for 4 percent (7.8 million ha) of the region's total cultivated area (Kadigi *et al.*, 2012). The average rate of expansion of irrigated area over the past 30 years has been 2.3 percent per annum. The expansion slowed down to 1.1 percent per year during 2000–2003, which varies widely from country to country but has since then picked up as a result of renewed investments by multilateral and bilateral donors, foundations, and governments (You *et al.*, 2010).

Up to 1990s, the level of government involvement in O&M of irrigation facilities was very high in developing countries (FAO, 2007). African countries such as Madagascar, Mauritania, Niger, Senegal, Somalia, Sudan, Zimbabwe, and Tanzania are good examples in this regard. However, these countries and others across the world, which in the past promoted more government involvement in managing irrigation facilities, started to adopt new policies that focus on private ownership and control of irrigation facilities. The policies create incentives for farmers to take over the management (i.e. operations and maintenance) of irrigation schemes, while government agencies remain with the role of improving management of water at the intake and main canal (ADB, 2012; Svendsen and Nott, 2000).

Such an arrangement of high government involvement in the management of irrigation systems, has failed to respond to the needs of users, particularly of smallholder farmers; and many of the established irrigation schemes continue to suffer from deterioration due to inadequate financial resources allocated for O&M of irrigation infrastructures (Malik, 2008; FAO, 2007; Catmak *et al.*, 2004).

In an attempt to address the above shortcomings, some institutional reforms, which embraced decentralization (Bocher, 2012) were introduced during the 1980s and picked up during the 1990s in most of developing nations, especially by development organizations such as the Food and Agriculture Organization (FAO), United States

Agency for International Development (USAID), and the World Bank. These reforms have included among others the adoption of “Irrigation Management Transfer” (IMT) model. This model was expected to deliver many positive outcomes and impacts, including the empowerment of farmers, better system maintenance and services, reduction of irrigation costs by the government, high water productivity, and profitable agriculture (Meinzen-Dick, 2014; Jana, 2013; Merrey and Cook, 2012; Suhardiman, 2008; FAO, 2007).

The philosophy of IMT hinged on the development of cooperation and involvement of farmers in running, managing, and maintaining irrigation systems at secondary and tertiary levels through “Water User Groups” (WUGs) or “Water User Associations” (WUAs) (Suhardiman, 2013; Rap, 2006). This philosophy is generally considered to be a reflection of new recognition of participatory initiatives and local control over water resources management by user communities, their determined power to shape their future livelihoods from irrigated agriculture and a reduction of the role of the state (Mdee *et al.*, 2014; Kadigi *et al.*, 2012). Important in this recognition is the acknowledgement that decentralized management systems involving WUAs or any other farmer-based organizations are regarded as not only the most appropriate way of achieving sustainable and equitable development for agricultural based economies in developing countries, but also of achieving community livelihood improvement (Huang *et al.*, 2010; Rap, 2006; Kay, 2001).

In Tanzania, as is the case with many other Sub-Saharan countries in Africa, the IMT model was overwhelmingly welcomed and adopted as a rider for lifting poor farmers out of poverty (Rap and Wester, 2013; Lein and Tagseth, 2009). It is estimated that 450 392 hectares of land are under irrigation in the country (URT, 2013). By 2008, the country had about 289 245 hectares under improved irrigated agriculture with more than 1 000 irrigation schemes most of them managed by smallholder farmers (AGWATER, 2010).

Currently the government of Tanzania has been improving the traditional irrigation schemes and emphasizing on the new decentralized approach in management those facilities (URT, 2009). These efforts have been demand driven and implemented through a participatory approach between the government and beneficiaries. The improvement of traditional irrigation schemes in the country has been going together with organization of beneficiaries into formally registered entities known as Water User Groups" (WUGs) or "Water User Associations" (WUAs). These entities have been responsible for the management of the schemes.

According to the Water Resources Management Act of 2009, farmers as beneficiaries of water use through irrigation practices are responsible to pay for water use permit through their irrigators associations following government withdrawal in management, operation and maintenance of irrigation schemes. Farmers operating irrigated farming in the improved irrigation schemes have been required to contribute the needed funds in order to pay the water bill as well as the collection of water charges required to cover O&M. So the current status of of management, operation and maintenance of improved irrigation system in the country.

Generally, the management of irrigation schemes in the country suffers from different management problems that include poor operation and maintenance of the irrigation infrastructure, poor leadership and low level of skills for farmers to handle management aspects of the scheme and on-farm water management as identified in the National Irrigation Policy (2009). Because of the importance of irrigation systems in the country, the government has been implementing decentralized irrigation policy that was aimed at effective and sustainable management system for operation and maintenance of both improved and non-improved irrigation schemes (URT, 2009).

However, it should be noted that for the model to work well and meet the expected outcome, the implementation of the model should be informed by systematic specific study, which identify the willingness of farmers to pay for O&M toward sustainable implementation of the model. This study therefore addresses this matter. The study used evidence from the implementation of the IMT model in selected irrigation schemes in Mbeya Region, and identified the willingness of farmers toward undertaking the key role under new reforms.

1.2 Problem Statement and Justification

Contemporary developments in the irrigation sub-sector across the world are dominated largely by participatory reforms, which increased the involvement of water users in irrigation management (URT, 2013; Munoz*et al.*, 2007), with a substantial withdrawal of external assistance from the government to finance O&M (Mutambara *et al.*, 2014). These reforms are centred on providing sustainable and adequate financing for operation and maintenance of irrigation and drainage services and for facilitation of investment in the required rehabilitation or upgrading of irrigation systems (Suhardiman, 2013; Kloezen *et al.,* 1997).

Water pricing and payment for irrigation water to finance O&M activities has often been a pivotal feature of these reforms. Water pricing for financing O&M especially in the irrigation sub sector has often been a pivotal feature of these policy reforms to enhance and achieve efficiency, fiscal or financial sustainability of the irrigation systems and reduce burdens on public finances (Meinzen-Dick, 2014; Koopman *et al.,* 2001; Kloezen *et al.,* 1997). The reforms require irrigators to be responsible for financing O&M in irrigation schemes through payment of water user fees.

Despite the substantial shift toward decentralization of management of smallholder irrigation schemes in Sub-Saharan Africa, many irrigation schemes in the region continue to witness low levels of farmers' participation on O&M of irrigation schemes, low cost recovery and blurred or skewed management responsibilities. Others include weak irrigators' organizations leading to the failure of undertaking effective irrigation water management and infrastructure maintenance, and hence low irrigation efficiencies (URT, 2013; URT, 2009; Kissawike, 2008; FAO, 2007; van Koppen *et al*., 2004; Sokile *et al*., 2003).

Likewise, extensive reviews by scholars (e.g. Kadigi *et al.,* 2012; Matekere and Lema, 2011) reveal that, low performance in smallholder irrigation schemes is attributed to many factors. These include among others high investment costs, inadequate or lack of maintenance due to insufficient O&M, poor planning (top-down), ineffective participation of beneficiaries and clarity in the roles of IMT institutions, and the lack of autonomy and accountability. In addition, the small size of holdings, which make investment in irrigation facilities uneconomic, the lack of secure land tenure; and limited access to credits also contribute to the failure of IMT in developing countries (IWMI, 2003; Merrey *et al*., 2002; Kabutha and Mutero, 2001).

Smallholder farmers in most of the improved or government constructed irrigation schemes still perceive these schemes as government owned (Ferguson and Mulwafu, 2004). This perception has made farmers to believe that the governments are responsible for financing operation and maintenance activities. This perception has resulted in farmers abdicating their role of paying costs required to cover O&M. Consequently, irrigation schemes have performed below expectation due to inadequate maintenance (Matekere and Lema, 2011).

In general, payment for O&M of irrigation infrastructure has been a big challenge for most in farmers' managed irrigation schemes (FMIS) (Mosha *et al.*, 2016; URT, 2006). Yet little is known about the precise role of each factor and the extent to which it influences farmers' willingness to pay for O&M under the IMT model.

Several studies have been conducted in the country on the field of irrigated agriculture and participation of community in irrigation water resource management.

Such studies include Van Koppen *et al.,* (2004), Sokile *et al., (*2003), Kagubila (1994), and recently Mosha *et al.,* (2016).

However, none of these studies have evaluated the willingness of farmers to pay for O&M of improved smallholder irrigation schemes and the factors which influence this willingness. It is therefore imperative to investigate factors to inform policies and strategies for sustainable implementation of IMT in the country.

This study was therefore conducted in order to fill this gap of knowledge regarding IMT in improved smallholder irrigation schemes managed by farmers themselves using the case of selected improved smallholder irrigation schemes in Mbeya Region in Tanzania. Specifically, the study investigated the willingness of smallholder farmers to participate in the management of irrigation schemes by financing the operation and maintenance activities and identified factors that influence farmers' willingness to pay for such expenses.

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective of this study was to examine the willingness of smallholder farmers to pay for Operation and Maintenance (O&M) costs and to assess profitability from irrigated farming and challenges facing smallholder farmers in improved smallholder irrigation schemes.

1.3.2 Specific objectives

(i) To assess profitability and its determinants in improved smallholder irrigation schemes in the study area;

(ii) To determine smallholder farmers' willingness to pay for O&M costs of improved smallholder irrigation schemes in the study area;

(iii) To assess factors that influence farmers' willingness and the amount of payment for O&M costs in improved smallholder irrigation scheme in the study area; and

(iv) To identify challenges facing smallholder farmers under improved smallholder irrigation schemes in the study area.

1.3.3 Research questions

(i) Are the smallholder farmers in irrigation schemes willing to pay for operation and maintenance costs of smallholder improved irrigation schemes? If yes how much?

(ii) What are the challenges facing improved smallholder farmer's irrigation schemes in the study area.

1.3.4 Hypotheses tested

(i) Socio economic factors do not determine profitability in improved smallholder irrigation schemes in the study area;

(ii) Personal attributes such as education level of an individual farmer do not influence willingness to pay for O&M in improved smallholder irrigation schemes; and

(iii) Willingness to pay decision for O&M and amount to pay are not influenced by socio economic factors like income generated from irrigated farming

1.3.5 Significance of the study

The information generated from this study would help government institutions or organizations and other stakeholders in the irrigation sub sector in making various decisions, which are necessary for enhancing sustainable performance of smallholder improved irrigation schemes in the study and other areas of the country. Moreover, the estimation of the amount which farmers are willing to pay and associated factors which can influence farmers' willingness to pay for O&M can also help policy makers in designing appropriate mechanisms for successful implementation of IMT.

The study findings will inform policy makers and other interested parties such as development agencies on sustainable development and management of smallholder improved irrigation schemes and sustainable utilization of land and water resources as identified in the 'National Irrigation Policy' (NIP). The recommendations from this study will contribute to the successful implementation of NIP and achievement of global sustainable development goals on food security and poverty reduction realized from increased productivity and income as a result of improved water use efficiency accruing from well operated and maintained irrigation infrastructures.

In addition, the study findings and other parts of the document could be used as a source of information for other related studies that will be conducted in the future on irrigated agriculture.

1.3.6 Organization of the thesis

This thesis is organized in five chapters. Chapter one presents detailed presentation of the background information, problem statement and justification, objectives of the study. Chapter two presents literature review particularly literature on IMT and Willingness to Pay (WTP), theoretical framework, Contingent Valuation Methods (CVM) and lastly the conceptualization of the study. Chapter three presents the research methodology used in the thesis. Chapter four follows where results and discussion of findings are presented. Lastly, the conclusion and recommendations of what have emanating from the study are summarized and presented in chapter five.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Irrigation Management Transfer

Irrigation Management Transfer (IMT) refers to the process of shifting management responsibilities and authority from centralized government irrigation agencies to a financially autonomous local-level non-profit organization. This is controlled by water users of the system in which these users have a significant voice in the control process and responsibility (FAO, 2007; Johnson III *et al.,* 2004; Shah, 2002).

IMT may entail transfer of decision-making authority (or governance); transfer of ownership of scheme infrastructure (which is normally considered privatization), and transfer of water rights from the government to water users associations (as in Mexico). IMT may also include passing over to water users partial management responsibilities, such as water delivery, canal maintenance, and payment for irrigation services (as in Sri Lanka and Philippines), while final approval of O&M plans and budgets are subject to government approval (as it was with the first wave of IMT in Colombia) (Sishuta, 2005: Vermillion and Sagardoy, 1999).

The Management Transfer as a process for irrigation sub-sector reform dates back to early 1970s, when different countries experienced a general disappointment with the performance of irrigation systems despite huge investment made by governments and international agencies including the World Bank through loans and grants in the 1950s and 1960s (You *et al.,* 2011; FAO, 2007; Munoz *et al.,* 2007).

In 1980s, there was a major concern on the performance of most of developing economies in Asia, Latin America, and Africa, which caused severe financial crisis. The financial crisis was characterized by some or combination of escalating domestic government debts, escalating government foreign debts (inability to service its international debt) and out-of-control inflation (Munoz *et al.,* 2007; Mollinga and Bolding, 2004). Due to this, international donor agencies and creditors, including the World Bank, International Monetary Fund (IMF), Asian Development Bank (ADB), and the United States Agency for International Development (USAID) required developing economies to pursue the general Structural Adjustment Programmes (SAP) (Suhardiman and Giordano, 2014; Sen, 2000). Among the alternative strategies under SAP was decreasing public spending in most sectors in order to stimulate the stagnated economy (Molle and Berkoff, 2007). This disengagement did not spare the agricultural sector and the irrigation sub-sector in particular where budget allocated to defray irrigation costs was insufficient (Jana, 2013) to cover O&M costs.

Prior to SAP, governments had to set up irrigation agencies that not only identified, designed and built irrigation schemes but were also engaged in their management afterwards (Sishuta, 2005; Merrey *et al.,* 2002). It was therefore common in many countries for the irrigation agencies to receive one of the largest budgets dedicated to the agricultural sector (Munoz *et al.,* 2007). Despite such allocation of financial resources, the performance of many irrigation systems was inconsistent with the level of investment.

Government Irrigation Agencies, which were responsible for running irrigation schemes failed to carry out maintenance because of decreased budget allocations from the central governments and poor institutional arrangements for infrastructure management (Rap and Wester, 2013; FAO, 2007; Munoz *et al.*, 2007). This created a deterioration cycle that led to the conception of the idea of transferring the management of the schemes directly to water users, since the state management was considered as bureaucratic and financially inefficient in conducting overall system management (Moore, 2004).

The idea behind transfers is based on the assumption that farmers would be able to operate and maintain the irrigation scheme properly and would be able to collect the water service fees from a group of peer users (Rap and Wester, 2013; FAO, 2007). This belief came in part from the framing of neo-liberal development discourse about problems of the state and the promise of private action (Carney and Farrington, 1998) and in part from initial successful experiences in farmer managed irrigation systems.

The IMT reforms in the irrigation sub-sector has been due to the underlying argument that (a) operational costs of government irrigation systems would decrease if farmers through their Water User Associations would collectively manage the systems (Sishuta, 2005); (b) rapid deterioration of irrigation infrastructure would cease if farmers had a sense of ownership of the infrastructure; (c) systems maintenance would be improved if WUAs were in charge of operation and maintenance funds; and (d) water would be used more efficiently and distributed more equitably if farmers were involved in the overall system of O&M (Suhardiman and Giordano, 2014).

2.2 A Global Overview of Irrigation Management Transfer

Irrigation management transfer is a major reform in the irrigation sector, which has been taking place in countries all over the world. Different countries continue to adopt the model from time to time depending on the readiness and the environment. It is well documented that early efforts of transferring irrigation management from the government to farmer organizations occurred as far back as the 1960s in the United States of America, Bangladesh, and Taiwan Province of China (FAO, 2007; Munoz *et al.,* 2007). Others include Colombia, Mali and New Zealand in the 1970s and Philippines, Mexico, Tunisia and the Dominican Republic in the 1980s.

The IMT reforms became a national strategy in most developing countries in the 1980s and 1990s where countries such as Morocco (1990), Australia (1994), Turkey (1994), Peru (1995), Albania (1996) and Zimbabwe (1997) initiated the process (Rap, 2004). The new century already shows examples of interventions taking place in Sudan and Pakistan (2000), India (2001), and China (2002), each of which has experienced a unique result. Moreover, there are other countries in Africa apart from the aforementioned ones, which have embarked on some form of IMT. These countries include Madagascar, Mauritania, Senegal, Niger, Tanzania, Sudan, and Somalia (FAO, 2007; Vermilion, 1997).

In the countries where IMT is adopted, many mixed results have been experienced (Suhardiman and Mollinga, 2012; Garces-Restrepo *et al.*, 2007). For example, at the beginning of IMT policy implementation, countries such as Mexico and Indonesia had both very little positive impact and improvement on water distribution (Kloezen *et al.*, 1997). However, as time passed by, more improvements and positive outcomes on water distribution and partly on maintenance were registered (Rap and Wester, 2013; Palacios, 1999).

The programme of handing over irrigation systems to farmers has been widely implemented in Mexico than in anywhere else in the world. As a result, Mexico's IMT programme is considered a 'success' in water-policy management, and it is regarded as an international showcase policy model for promoting neo-liberal water reforms (Rap, 2006; Johnson III *et al.*, 2004; Johnson, 1997). Successful performance of Mexico's irrigation sector has been regarded as evidence for the rationality of neo-liberal development orthodoxy (Suhardiman and Giordano, 2014), which is taking place in different parts of the world.

2.3 Selected IMT Success Stories

The level and extent of achievement for the propagated transfer policy differs from one country to another. As noted in section 2.2, some countries have realized the outcomes in a more successful way than others have (Suhardiman, 2013; World Bank, 2001). On the one hand, the governments have benefited from reduced costs of financing O&M; and on the other hand, farmers have benefited from increased irrigation efficiency.

Therefore, the implementation of IMT has in general resulted in many benefits including among others the following:

a) Users' associations managed to perform their basic functions of water delivery, effective canal maintenance, collection and mobilization of funds, and labour which rose to more than 50 percent of the amount needed (Garces-Restrepo *et al.*, 2007)

b) Although there is a cost increase on the farmers' side, the transfer has reduced the financial burden to the governments (Garces-Restrepo *et al.*, 2007; Svendsen and Nott, 2000).

c) More importantly, the quality of maintenance has been reported to increase in most of the countries, especially where governments decreased their contribution to O&M slightly (Garces-Restrepo *et al.*, 2007; Svendsen and Nott, 2000). For example, in Sudan, after the adoption of IMT, both in-kind and monetary contributions of farmers have resulted in an improved maintenance of the scheme. Furthermore, farmers in Mali have gone even further to the extent of outsourcing maintenance activities to contractors after the irrigation systems were fully transferred from the government to WUAs.

d) IMT has improved the timeliness and equity of water delivery (Kadigi *et al.*, 2012; Miyazato *et al.*, 2010) due to smooth delivery scheduling.

e) Improvement in the delivery of water has brought multiplier effects: farmers have managed to expand irrigated land, where there was an opportunity to do so, and have increased cropping intensity which has resulted in higher volumes of harvests (Miyazato *et al.,* 2010; Garces-Restrepo *et al.,* 2007), and increased household income as a result.

f) Where the participatory IMT approach has been implemented, a sense of ownership of irrigation facility among farmers has been created (Kadigi *et al.,* 2012).

Therefore, IMT has been viewed as a long-term solution for the sustainability of government-managed irrigation schemes because of the several positive results achieved in many countries that adopted the model (Suhardiman, 2008). However, the literature suggests that where there is a significant reduction on the government subsidies, which were provided before transfer, the cost of irrigation required in financing O&M to farmers increased substantially (Merrey, 2002; Vermillion, 1997).

The devolution of authority and responsibilities of O&M of irrigation scheme require farmers to mobilize funds through payment of “water user fees.” Hence, the voluntary payment of water user fees is viewed as one of the necessary factors for sustainability of the smallholder irrigation schemes, which are operated under the IMT framework.

2.4 Irrigation Management Transfer in Tanzania

Tanzania has 44 million hectares of land, which is classified as suitable for agriculture. Nevertheless, it is only 10.8 million hectares, which are actually cultivated (URT, 2005; URT, 2009; Kayandabila, 2013). Out of 44 million hectares suitable for agriculture, about 29.4 million hectares (66.8%) are suitable for irrigation, whereby 2.3 million hectares (7.8%) are classified as high potential, 4.8 million hectares (16.3%) as medium potential, and 22.3 million hectares (75.8%) as low potential (Rwehumbiza, 2014; PASS, 2013; URT, 2011; Chiza, 2005). As of June 2008, only 289 245 hectares were already under improved irrigated agriculture (URT, 2009). However, the most recent available information indicates that the area with improved irrigation infrastructure expanded to 345 690 hectares (URT, 2011), most of which are managed by smallholder farmers (IWMI, 2010).

Despite the abundant potential area for irrigation in the country, the level of irrigation development is still low resulting in marginal use of irrigation potential (URT, 2013; URT, 2011). Vagaries of weather, resulting from climate change, have been affecting agriculture in the country due to over dependence on rainfall (Rwehumbiza, 2014; Droogers, 2011; Tarimo, 2011). The government has been giving high priority to irrigation development as stipulated in the National Irrigation Policy of the United Republic of Tanzania.

There have been interventions from government and donors of improving irrigation efficiency in the country. These interventions include construction of concrete weirs and intake structures with control gates, division boxes, lining main canals and rehabilitation of some traditional smallholder irrigation schemes, and transferring scheme management responsibilities to smallholder farmers (Rwehumbiza, 2014; Chiza, 2005; Koopman *et al.,* 2001).

Most of the irrigated activities in the country are undertaken by smallholder farmers through either traditional (unimproved) irrigation schemes or modern (improved) irrigation schemes. Traditional irrigation schemes are operated on 80 percent of the total area under irrigation (URT, 2002), and they are normally initiated and operated by farmers. They include schemes based on traditional furrows (in the highland areas) and simple water diversion (in the lowlands) (IWMI, 2010; Koopman *et al.,* 2001).

Traditional irrigation systems largely depend on gravity flow of water conveyance systems, originally constructed by villagers who partially dammed a river with local materials in order to divert water into a system of canals. At the junction between the main and secondary canals, traditional mud division structures are used to control the direction of the water flow.

The main weir of traditional irrigation schemes (the intake structure on the river) often deteriorates rapidly, and it can be washed away during heavy rains. Generally, these schemes tend to have poor infrastructure, poor water management, low yields (low irrigation efficiency), high salinity, and water logging problems. All of these resulted into time wastage, as farmers spend a lot of time maintaining and rebuilding their scheme (Mwilongo, 2013; IWMI, 2010). Most of the existing improved irrigation schemes were originally established and operated by smallholder farmers and after some time, the government and donors funded the improvement or construction of new diversion structures, gated canal intake and water division boxes with more permanent materials and canals that are partly lined with concrete materials.

The layout of the irrigation canals in the improved schemes is well defined as opposed to similar structures under traditional schemes. The improved schemes however have high initial investment cost of construction. The maintenance also needs to be done regularly due to wear and tear of infrastructure (Rwehumbiza, 2014; Mwilongo, 2013; URT, 2009; Mwakalila and Noe, 2004).

The government has not only been directing its support to the improvement of traditional irrigation schemes but it has also organized beneficiaries of the constructed irrigation schemes into formally registered entities (User Associations or Co-operatives), which are responsible for operation and maintenance of the scheme. The performance of improved irrigation schemes has gradually improved in terms of water management, water use efficiency, and crop yields. For example, yields of up to 10 t/ha of paddy, which is by far the predominant irrigated crop in the country, was achieved by some smallholder farmers, however the average yield of 4.0 to 5.0 t/ha are common (URT, 2009).

Both traditional and modern forms of irrigation schemes are concentrated in the mountainous eastern regions of Tanga, Kilimanjaro, and Arusha; and in the southwestern regions of Morogoro, Iringa, and Mbeya. Moreover, there are also irrigation schemes, which depend on rainwater harvesting (RWH) techniques and flood recession schemes in the arid and semiarid areas of central and western parts of Tanzania. Subsistence farmers in these areas have introduced simple techniques, which allow them to control artificially the availability of water for crops due to unreliable and shortage of rainfall in these parts (IWMI, 2010; URT, 2009). The RWH techniques involve a mechanism of diverting runoff or ponding rainwater into bunds.

Irrigation schemes that depend on rainwater harvesting techniques suffer from poor infrastructure of diverting harvested water and lacks control of water in the bunds. Generally, irrigation schemes that depend on rainwater harvesting are largely characterized by poor water management, low yields, or total crop failure.

Despite various efforts including investing in the irrigation sub-sector, which are made by the government and other development partners, a number of challenges are continuing to hamper the subsector as elucidated in the Tanzania Agriculture and Food Security Investment Plan (TAFSIP-2011). One of these challenges is low financial capacity of smallholder farmers to invest in the infrastructures for their traditional irrigation systems, thus most of these schemes operate below expectation.

In addressing the challenges, significant transformation has been implemented in the sub-sector with a view of achieving economic growth, food security, and responding to variability of climate change (Rwehumbiza, 2014; URT, 2014; Giordano *et al.*, 2012.). Among the transformation implemented is the adoption of IMT policy reform, which was sought to provide sustainable and efficient utilization of available water resources for irrigated farming.

The policy also lays a foundation for sustainable development and management of water resources on the changing roles of the government from service provision to coordination, policy and guidelines formulation, and regulation by establishing an effective legal and institutional framework that focuses more on beneficiary participation (Lein and Tagseth, 2009). By considering water as an economic good, farmers are also responsible as other beneficiaries of the resource, of undertaking efficient management while bearing the cost of operation and maintenance to enhance efficient utilization of the resource.

2.5 Theoretical Framework

2.5.1 Concept of willingness to pay (WTP) in irrigation water management

The concept of "Willingness to Pay" has gained significant attention in the field of irrigation management following the adoption of IMT reforms in the irrigation sub-sector. The fact that the reform frameworks require farmers to contribute own financial resources, understanding farmers willingness of paying for water user fees has been regarded as important. The fund raised from fees plays a pivotal role in financing operation and maintenance of irrigation scheme (Angella *et al.*, 2014). However, how much a person is willing to pay for goods or services depends on the perceived economic value and on the utility of the good in question. These two values are said to determine the maximum price an individual is willing to pay

(Breidert, 2007). In this case, the payment for O&M expenses enables farmers to access irrigation water needed in crop production. The supplied water will lead farmers to realize higher crop productivity, which is associated to generate higher utility, *ceteris paribus.*

In the literature, WTP is considered as an economic concept, which aims at determining the amount of money a consumer is willing to pay or sacrifice in order to obtain a good or service. In this study, WTP is the act of supplying irrigation water. The consumers' WTP is popular in different academic field and it is one of the standard approaches that is used by market researchers and economists to place a value on goods or services such as surface irrigation water under smallholder scheme for which no market-based pricing mechanism exists (Chandrasekaran *et al.,* 2009; Freeman, 2003: Wertenbroch and Skiera, 2002).

The Fourth Principle of the 1992 Dublin statements requires water to be regarded as any economic good, which needs to be used efficiently and equitably. The principle therefore encourages conservation and protection of water resources due to its economic use (World Meteorology Organization, 1992). Thus understanding farmers' WTP for irrigation water under improved smallholder irrigation scheme in the country is vital in the devolution of scheme management. Such understanding provides an insight on the magnitude of economic value, which is attached by farmers in using such agricultural investments.

2.5.2 Random utility theory and willingness to pay

The Random Utility Theory (RUT), which was developed by McFadden (1975), is a useful tool that has been used to study the process of individual willingness to pay for goods or services from a group of available alternatives (Adalja *et al.,* 2015; Meenakshi, 2012; Olynk *et al.,* 2010; Greene, 2003; Marcelo, 2003; McFadden, 1999). The theory has been used widely in economics due to its ability to describe, explain, and predict choices between two or more discrete alternatives (Green, 2012). such as being willing or not willing to pay for irrigation water user fees, which are required to finance O&M of the scheme (Megzebo *et al.,* 2013; Biswas and Venkantachalam, 2015; Alemayehu, 2014).

The McFadden random utility theory is based on the assumption that when an individual faces a set of feasible discrete choices, he/she will select among alternatives, which maximize his/her utility. In this regard, individual farmers have two alternatives, which are mutually exclusive, either willingness or unwillingness to pay for operation and maintenance.

The theory requires that, when an individual farmer is facing a set of discrete choice alternatives and he is rational (economic consumer theory), then he/she will choose the alternative with greatest utility. Farmers under improved irrigation schemes are assumed to generate utility from use of irrigation water in the course of crop production. The payment for O&M will enable farmers to access irrigation water, eventually this will enable farmers to get higher output from crop production which is likely to lead higher farm income (profitability) *ceteris paribus*. On the other hand, without paying for O&M expenses, farmers will not access irrigation water and hence will end up with lower yields that will lead to lower income and hence lower utility. Therefore, from the random utility framework, the decision maker will choose the choice for specific alternative if:

$U_{in} > U_{in}\ \forall\ j \neq i$, where j are the different choices from the choice set (*Cn*) and n is the labelled decision maker (farmer). The probability that the decision maker will choose certain alternative is given by:

$P(i\,|C_n) = \Pr(U_{in} > U_{jn}, \forall\ j \# C_n)$ ………………………………………………………. (1)

But for a binary choice, the choice set C_n will have two alternatives, *i*, and *j*, and therefore the probability that a decision maker n (farmer) will choose alternative *i* (willing to pay, WTP=1) or *j* (unwilling to pay, WTP=0) is:

$P_n(i) = \Pr(U_{in} > U_{jn}$, and $P_n(j) = 1 - P_n(i)$ ……………………………………………. (2)

Each of the alternative to be selected by an individual has an associated utility, and it is proposed that:

$U_{ij} = X'_{ij}\beta + \varepsilon_{ij}$ …………………………………………………………………………….

(3)

Where:

$X'_{ij}\beta$ = the deterministic part of the utility that depends upon observable

characteristics of individual farmers

ε_{ij} = the error term (random component) which represents factors that affect utility

but are not included

β = parameter estimates

X' = the observed explanatory variables of the decision maker

The random utility theory proposes that such utility has two components:

(a) Random component and

(b) Deterministic component which is represented in the utility function by explanatory variables

The parametric estimation of binary responses can be estimated through binary choice models where the common one includes the linear probability model, logistic and probit models. The linear probability model may generate predicted values less than 0 or greater than one, which is a violation of the basic principles of probability (Gujarati, 2004; Gujarati, 2003).

From the aforementioned models used when dealing with binary or qualitative responses, both probit and logistic regression models are still the most widely used in econometric applications (Greene, 2012; Senkondo *et al.,* 2011; Wooldridge, 2009). The logistic distribution has been widely used in estimating models (Green, 2012), which are discrete choices in nature where the response variable is dichotomous as presented above on the assumption that the function follows a logistic distribution. Based on this assumption, it follows that;

$$\text{Prob } (\text{Y}_\text{i} = 1 \mid \text{x}) = \frac{\exp\ (\text{x}'\beta)}{1 + \exp\ (\text{x}'\beta)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where Prob ($Y_i = 1$) is the probability that a farmer is willing to pay operational and maintenance, and β is a vector of variable parameters to be estimated while x is the corresponding vector of explanatory variables. The model has been used widely in different studies of a similar nature on binary responses such as in irrigation, extension services, marketing, the environment, and resource economics. Some studies that adopted the model include Uddin *et al*. (2016); Temesgen and Tola (2015); and Biswas and Venkatachalam (2015).

The estimation of the parameters is performed using the Maximum Likelihood Method (Garcia, 2005; Gujarati, 2004). Although both logistic and probit models have similar characteristics, the logistic distribution (logistic model) has also been used in many research applications, perhaps partly because of its mathematical convenience which makes it easier than probit model (Green, 2008; 2002).

Nonetheless, scholars (e.g. Cameron, 1988; De Oca *et al.,* 2003; Davidson and Mackinnon, 2004; Senkondo *et al.,* 2011) argue that both logistic and probit regression models are identical, use cumulative distribution function, and they provide similar results when they are used to estimate binary non-linear models.

The choice between the two models is usually arbitrary (Schmidheiny, 2013) and can often be ruled by convenience after considering factors such as availability of appropriate software and significance of the independent variable. Based on these observations, the logistic regression model was adopted for analysing willingness to pay for O&M of smallholder improved irrigation schemes using four selected irrigation schemes from Mbeya urban and Mbarali districts in Mbeya region. It was envisaged that the utility farmers get from using the irrigation facilities would influence the decisions of paying for O&M cost.

When individual farmers consider paying for O&M costs, their choices and valuation are constrained by income. Accordingly, income has to correlate with the amount of money farmers are willing to spend in order to continue receiving services from the scheme. Thus, income is regularly included in the preference and is always expected to have a positive effect on WTP for a product or services provided (Carson *et al.,* 2001). This means the higher the farmer’s income, the more willing they will become to pay for O&M.

2.6 Empirical Review

The random utility theory has been used in different studies that involve binary discrete choices to provide the underpinning theoretical framework. In irrigation management, such studies are mainly focusing on willingness of individual farmers toward payment for irrigation water to finance O&M expenses. Some studies that have developed following random utility theoretical framework are described below.

Megzebo *et al.* (2013) used the random utility theory when determining the economic value of irrigation water in Wondo Genet District, Ethiopia and the study revealed household income, age of respondent, education level, size of cultivated land and awareness of availability of irrigation water and environmental problems were influencing farmers’ willingness to pay for irrigation water.

Biswas and Venkatachalam (2015) also adopted the random utility to estimate the willingness to pay for improved irrigation water in Karnataka, India Malaprabha. The study found that willingness to pay was influenced by crop income and the zone of the village in the irrigation scheme.

Besides that, Alemayehu (2014) used the random utility theoretical framework when conducted a study on smallholder farmer's willingness to pay for improved irrigation water in Koga irrigation project, Ethiopia. The study revealed that education level, family size, gender and household income of respondents were influencing the willingness to pay for improved irrigation services.

Harun *et al*. (2015) when analysing factors influencing willingness to pay for irrigation water in the Kurdistan Regional Government, Iraq, also used the random utility theoretical framework. The findings revealed that, zone expected with high water deficit were corresponds with higher willingness to pay.

Using the random utility framework, Akter (2007) conducted a study to determine farmers' willingness to pay for irrigation water under government managed small-scale irrigation projects in Bangladesh. The study concluded that, age and education level of respondent, household income, ownership of farm land were factors influencing willingness to pay for irrigation water.

In general, random utility theoretical framework has been widely used to provide sound footings in the willingness to pay studies for irrigations services and therefore this study justified using the same as other studies conducted in irrigation water management.

2.7 Approaches Used to Measure Willingness to Pay

Economists, psychologists, marketing experts, and policy makers are interested in determining the value people place on market and non-market goods, for many reasons including forecasting the success of new products, understanding consumer behaviour, determining welfare effects and or success of public policy or technological innovation (Lusk and Shorgen, 2008).

Although there is no ideal method for the determination of the willingness to pay in the literature, all of the proposed methods are based on different assumptions with diverse strengths and weaknesses (Haasel *et al.,* 2016). Moreover, WTP methods can be categorized based on how the data collection method is administered (Breidert *et al.,* 2006). Methods for estimating WTP is clarified into revealed and stated preference. The two groups of method are also known as preference-based methods (Carlsson, 2011; Breidert *et al.,* 2006). There are two preference-based methods used to estimate WTP of individuals on goods or services, which are distinguished, based on:

(a) Actual or simulated price response data (Revealed Preference Method)

(b) Survey techniques (Stated Preference Method)

The price response data from the first method (Revealed Preference Methods) are measured using consumers' or individuals' actual action (Carlsson, 2011). Data from individuals can be captured through either market observations (through sales volume at different prices which infer purchase decision) or by performing experiments. To capture data though experiments, individuals are subjected to products with different prices in real or simulated purchase situations and the reactions for the products are then recorded (Haasel *et al.*, 2016).

There are two different techniques of eliciting WTP for individuals through stated preference based methods. Regardless of the kind of the technique used in stated preference method, both methods assess the value of a product in a hypothetical setting (Carlsson, 2011). The two techniques are categorized as direct and indirect surveys[1] and they have been used in many studies for collecting data, which are required to estimate WTP.

The direct survey is further subdivided into expert judgment and customer survey whereas the indirect one is divided into conjoint analysis and discrete choice analysis. Under expert judgment, individuals who are expert in the field of interest and who are believed to have high knowledge regarding customer needs on the product or services are involved in measuring the amount individuals are willing to pay for a given good or service. However, in customer survey technique, respondents are asked to indicate the acceptable amount, they are willing to pay for the supply of goods or services (Mangham *et al.*, 2009; Kjaer, 2005; Hamilton *et al.*, 2003).

[1] For details on indirect survey technique see Daniele *et al.* (2014); Olynk *et al.* (2010) and Meenakshi *et al.* (2012)

The two standard preference-based approaches of valuation in economics have been developed from the rationality assumption according to economic theory. Both approaches are based on the premise that people have well-defined pre-existing preferences and values for all goods and services (Fujiwara and Campbell, 2011). The valuation exercise is undertaken such that it accurately recovers the values attached by individuals on goods or services under study.

Generally, the stated preference techniques use surveys in which people make statements in relation to their WTP for goods or services while the revealed preference techniques infer people‘s WTP for a good by examining their actual real-life behaviour in relation to the market or in the consumption of the good itself.

Each of the aforementioned methods or techniques shows that different data origins and collection techniques have advantages and drawbacks, and none of them is perfect. Which one should be used by the researcher, depends upon the ability to provide valid and reliable results, time availability, financial constraints, the context of the experiment, and the nature of products in question. This is especially when it is difficult to develop choice scenarios of the service or policy under consideration (Hellali *et al.*, 2015; Meenakshi *et al.*, 2012; Breidert *et al.*, 2006). Since mid-1990s, there has been a dramatic increase in the use of stated preference methods in various fields including agricultural and food economics, agribusiness, environmental and resource economics, health economics, transport, real estate appraisal, and marketing (Carson, 2011; Lipscomb, 2011; Louviere *et al.*, 2010; Cho *et al.*, 2008).

Since irrigation water is a non-marketed good, using the stated preference method is more appropriate for eliciting WTP as opposed to other methods. Though there is variety of stated preference methods, the Contingent Valuation Methods (CVM) is the most frequently applied for the valuation of non-market goods. This method was developed during the 1960s (Zapata *et al.,* 2012; Chandrasekaran *et al.*, 2009; Bruce, 2006; Carson and Hanemann, 2005).

The CVM requires careful administration in order to minimize errors and bias, which may otherwise provide invalid results (Alemayehu, 2014; Carson, 2012; Cho *et al.,* 2008; Biller *et al.*, 2006; Hamilton *et al.*, 2003). The researcher has to ask an individual, questions with reference to goods under valuation and the amount that an individual is willing to pay for that good or its attributes. The questions can be either open-ended or closed-ended (Biswas and Venkatachalam, 2015; Carson and Louviere, 2011; Carson and Hanemann, 2005).

There is a debate on whether or not CVM can measure accurately individuals' willingness to pay (Carlsson and Martinsson, 2001), there is nevertheless evidence based on the validity tests on the ability of CVM to do exactly this. Hence the CVM continues to be a useful tool of measuring WTP in water resource management and other fields as well (Carson, 2011; Venkatachalam, 2006; Salman and Al-Karablieh, 2004).

Nonetheless literature on CVM elucidates shortcomings of the technique (Venkatachalam, 2004; Whittington, 2002; Whittington *et al.,* 1990). If the shortcomings are not carefully handled, the results may be misleading and provide invalid inferences. The CVM has been vulnerable to problems such as format bias (elicitation effects), embedding effect (part-whole bias), ordering problem (sequencing), starting point effects or bias, strategic bias, information effects or bias, non-response bias, payment vehicle, free rider problem, and warm glow effect (Venkatachalam, 2006; Salman and Al-Karablieh, 2004; Venkatachalam, 2004). However, problems, which have been of particular concern in most of the literature on CVM, include three types of bias: strategic bias, starting point bias, and hypothetical bias.

Strategic bias arises when an individual thinks they may influence an investment or policy decision by not answering the interviewer’s questions truthfully (Le Gall-Ely, 2009; Whittington *et al.,* 1990). Such a strategic behaviour may influence individual's answers in either overstating or understating the actual WTP amount. Individuals may overstate their actual WTP when they assume that their stated WTP value would influence the provision of goods or services under valuation, provided that the stated WTP would not have any basis for the future pricing policy. Understating occurs when individuals state a lower WTP amount in the expectation that others would pay enough for that good and therefore they need not have to pay (Fujita *et al.,* 2005; Whittington *et al.,* 1992 as cited by Venkatachalam, 2004).

Starting point bias (anchoring) is encountered in the dichotomous choice contingent valuation surveys (Alberini *et al.,* 2005), if the initial price affects the individual's final willingness to pay (Fujiwara and Campbell, 2011; Flachaire and Hollard, 2007; Chien *et al.,* 2005; Fujita *et al.,* 2005). During eliciting WTP through a bids question format, the respondent who is unsure of an appropriate answer to the valuation of good in question and wants to please the interviewer may interpret the initial price as a clue as to the "correct" bid.

Hypothetical bias is another widely acknowledged problem, which has been affecting WTP studies (Carson, 2012; Lusk and Hudson, 2004). The bias occurs when there is divergence in WTP values between the real and hypothetical amount proposed (de-Magistris and Pascucci, 2014; Moser *et al.,* 2014; Jacquemet *et al.,* 2013; Bosworth and Taylor, 2012; Stachtiaris *et al.,* 2011; Carlsson, 2010). It is often alleged, that individuals may not take contingent valuation questions seriously and will simply respond by giving whatever answer first comes to their mind (Jacquemet *et al.,* 2013). Where this type of hypothetical bias is prevalent, bids will presumably be randomly distributed and not systematically inclined.

When using CVM, a researcher can choose to use one of the five alternative approaches proposed by Bateman *et al.* (2005) and Kjaer, (2005) as follows.

(a) Open-ended (OE): "How much are you willing to pay?"

(b) Single bounded Dichotomous choice (DC): "Would you pay for X (TAS) to…?"

(c) Double-bounded dichotomous choice (DBDC): The dichotomous choice question is followed up by another dichotomous choice question depending on the previous answer.

(d) Iterative bidding (IB): Involves a series of dichotomous (yes/no)-choice questions followed by a final open-ended WTP question. The bidding increases until the respondent says no.

(e) Payment card (PC): Respondents select their maximum WTP amount from a list of possible sums presented on a card.

But of these options for estimating WTP through CVM, the Double Bounded Dichotomous Choice (DBDC) approach has been extensively used whereas an individual is subjected to a "follow up" bid subject to the "yes-no" options of the initial bid. The "follow up" bid is "higher" if the initial response is "yes" for the initial price offered and "lower" if the initial response is "no" (Hanemann *et al.*, 1991).

The DBDC has been more efficient than the single bounded and other elicitation formats because more information is collected from each respondent (Scarpa *et al.*, 2011; Vermeulen *et al.*, 2010; Bateman *et al.*, 2005; Kjaer, 2005; Haab and McConnell, 2002). The DBDC is mostly used in valuation studies for non-marketed goods since it provides more statistical information as opposed to single dichotomous choices and other elicitation formats (Donfouet *et al.*, 2011).

By considering the random utility model, the most common general econometric model formulation of WTP for a DBDC-contingent valuation studies can further be clarified as proposed by Haab and McConnell (2002), Hanemann *et al.* (1991) in Equation 5.

$$\boldsymbol{WTP_{ij}} = \beta' x_{ij} + \varepsilon_{ij} \quad (5)$$

Where WTP_{ij} is the j^{th} respondent's willingness to pay (*bid amount*) for O&M that is unobservable, and $i=1, 2$ represents the response to the initial dichotomous choice question (DC1), and the follow up bids from dichotomous choice question (DC2) respectively. Whereas x_{ij} ($i = 1, 2$) is a vector of explanatory variables including the bids (B), individuals' demographic and socioeconomic characteristics (such as income, age, gender, education and other selected factors.

Let $\boldsymbol{B_1}$ be the initial bid subjected to an individual and the 'follow up bid' by $\boldsymbol{B_u}$. The follow up bid is contingent upon the response to the initial bid: if the response to the initial bid is "no" a second but lower ($\boldsymbol{B_d}$) bid is offered ($\boldsymbol{B_d}<\boldsymbol{B_1}$) and if the response to the initial bid is "yes," a second but higher ($\boldsymbol{B_u}$) bid follows ($\boldsymbol{B_u}>\boldsymbol{B_1}$). Hence, the DBDC survey generates four sets of responses, yielding both upper and lower bounds on the respondent's WTP.

Following Watson and Ryan (2007); Haab and McConnell (2002), let t_1 be the base bid at the initial dichotomous choice question (DC1) and t_2 be the follow up bid at the second dichotomous choice question (DC2). The four possible responses are:

(a) When respondent's answer is "YES-YES", $WTP \geq t_2$;

(b) When respondent's answer is "NO-NO", *WTP* $< t_2$;

(c) When respondent's answer is "YES-NO", $t_1 \leq WTP < t_2$;

(d) When respondent's answer is "NO-YES", $t_1 > WTP \geq t_2$

Generally, the literature suggests that well-designed contingent valuation studies can help to overcome biases or shortcomings when a double bounded dichotomous choice is used. Thus, careful considerations were taken in this study to minimize problems that are likely to affect contingent valuation studies.

2.8 Alternative Ways of Reducing Hypothetical Bias

Studies have discussed a range of alternative techniques to deal with hypothetical bias. The proposed methods include the cheap talk script (Cummings and Taylor, 1999), solemn oath (de-Magistris and Pascucci, 2014; Carlsson *et al.,* 2013; Jacquemet *et al.,* 2013), honesty priming (de-Magistris *et al.,* 2013), cognitive dissonance (Alfnes *et al.,* 2010), and calibration (Whitehead and Cherry, 2007; Lusk and Schroeder, 2004). Of all the aforementioned techniques, the cheap talk script[2] is often preferred and was adopted in this study.

2.8.1 The cheap talk script technique

The cheap talk script was introduced to reduce and mitigate against hypothetical bias in contingent valuation studies and it has proven to work effectively (Cummings and Taylor, 1999).

[2]Cheap talk' alerts the respondents to the issue of hypothetical bias just before asking the hypothetical questions to try to minimize this form of bias

The basic idea of the ‘cheap talk’ approach is to present a script that describes hypothetical bias, why it occurs, and its consequences on the quality of data generated and preference estimated. Once the respondent is informed about the matter; then he/she becomes aware of the problem of hypothetical bias prior to the actual hypothetical questions whereas the expectation is that the respondent will behave as rationally as possible throughout the hypothetical valuation situation (Accent, 2010).

2.8.2 Types of cheap talk script in literature

There are two types of cheap talk forms that can be found in the literature namely, ‘hard’ and ‘soft’ cheap talk. The two are distinguished by features, which are discussed by Carson and Groves (2011). Whereas the ‘hard cheap talk’ presents a respondent’s statement indicating that some respondents do not tell the truth in a survey, the ‘soft cheap talk’ form instead informs the respondent about the existence of deviation between survey responses and the actual individual actions, which are mainly due to lack of careful budget consideration.

Hence, the soft cheap talk requires each respondent to consider actual income constraint and payment obligations and to recognize this commitment during the survey. Thus, this study adopted the two cheap talk scripts technique during WTP elicitation.

The use of cheap talk script can improve preference elicitation under certain circumstances provided there is a well-designed contingent valuation survey. In addition, scholars (e.g. Loomis, 2014; Jacquemet *et al.*, 2011; Aadland and Caplan, 2006; Cummings and Taylor, 1999) advised to switch from using long and detailed forms of the script to shorter ones in CV studies so as to minimize bias which might arise from the respondents.

2.9 Standard Guidelines in Conducting WTP Studies through CVM

Arrow *et al.* (1993) in the NOAA[3]panel report laid down a complete set of guidelines that would assist in generating an ideal CV survey. The emphasis is on the appropriate sample size; the use of personal interview, and pretesting the CV questionnaire

Likewise, Bateman and Turner (1993) provided a list of comprehensive guidelines in conducting CV studies which are still adopted in designing and implementing WTP studies[4]. Some of these guideline provided in the document are as follows;

(a) Only goods that are familiar to the respondent should be used in CV studies; (b) Scenarios should be realistic, plausible, clearly understood and not having a high degree of uncertainty; and (c) The payment vehicle should be realistic and appropriate such as taxes or user fees. Others include, (d) the estimate of use values are likely to be more accurate than the non-use values; (e) Use open-ended and dichotomous choice formats to provide lower and upper valuation boundary estimates; and (f) The sample size must be large enough so as to statistically significant.

[3]NOAA stand for: National Oceanic and Atmospheric Administration
[4]More details on the guidelines see: Bateman, I.J and Turner, R.K. (1993). Valuation of Environment, Methods and Techniques: The contingent valuation method. In: Kerry Turner R (Eds). Sustainable Environmental Economics and Management: Principles and Practice. London: Belhaven Press. (120-191)

In addition, other scholars (e.g. Makindara, 2006; Olesegun and Boyd, 2005; Rahmatian 2005) suggested other considerations for a good CV study. as these are as follows (a) knowing the community and their familiarity with good or service; (b) specifying the nature of good and the changes to be valued; and (c) reminding respondents about their budget constraints. Others include, (d) inform the respondent about frequency of required payment; and (e) inclusion of validation questions in the survey, to verify comprehension and acceptance of the scenario.

For example, CVM has been employed to estimate the economic value of irrigation water and to assess factors influencing farmers' WTP for irrigation water in many previous studies. Some of these studies include, Astatike, (2016) in Ethiopia; Biswas and Venkatachalam (2015) in India, Harun *et al.* (2015) in Iraq, Alemayehu (2014) in Ethiopia, Omondi *et al.* (2014) in Kenya, Mezgebo *et al.* (2013) in Ethiopia, Alhassan *et al.* (2013) in Northern Ghana, and Tang *et al.* (2013) in Northwest China. Others include, Assefa (2012) in Ethiopia, Jaghdani *et al.* (2012) in Iran, Mesa-Jurado *et al.* (2012) in Spain, Karthikeyan (2010) in India, Storm *et al.* (2010) in Morocco, Chandrasekaran *et al.* (2009) in India, Weldesilassie *et al.* (2009) in Ethiopia, and Akter (2007) in Bangladesh. So CVM was used in this study to estimate farmers' WTP for O&M costs following empirical evidence of its applicability in different studies conducted in the field of irrigated farming.

2.10 Conceptual Framework for the Study

The conceptual framework for this study (Fig. 1), shows the inter-relationship between different variables that are necessary in conceptualizing the concept of WTP for O&M of irrigation schemes.

The conceptual framework assumes that, WTP for O&M of irrigation scheme is a function of many factors, including the household socio-economic characteristics, frequency of supplied irrigation water, access to markets, farm income, and access to support services. Others include household farm characteristics, awareness of farmers of irrigation management transfer (IMT) policy, and perception on the devolution efforts.

Farmers' willingness to pay for O&M is motivated from the benefits farmers are deriving from irrigated farming. The benefits which are realized (farm income) are assumed to influence willingness of farmers in paying for O&M expenses (Tabieh *et al.*, 2015; Liebe *et al.*, 2011). Therefore, an increase in farm income will result in farmers' willingness to pay for O&M under current reforms.

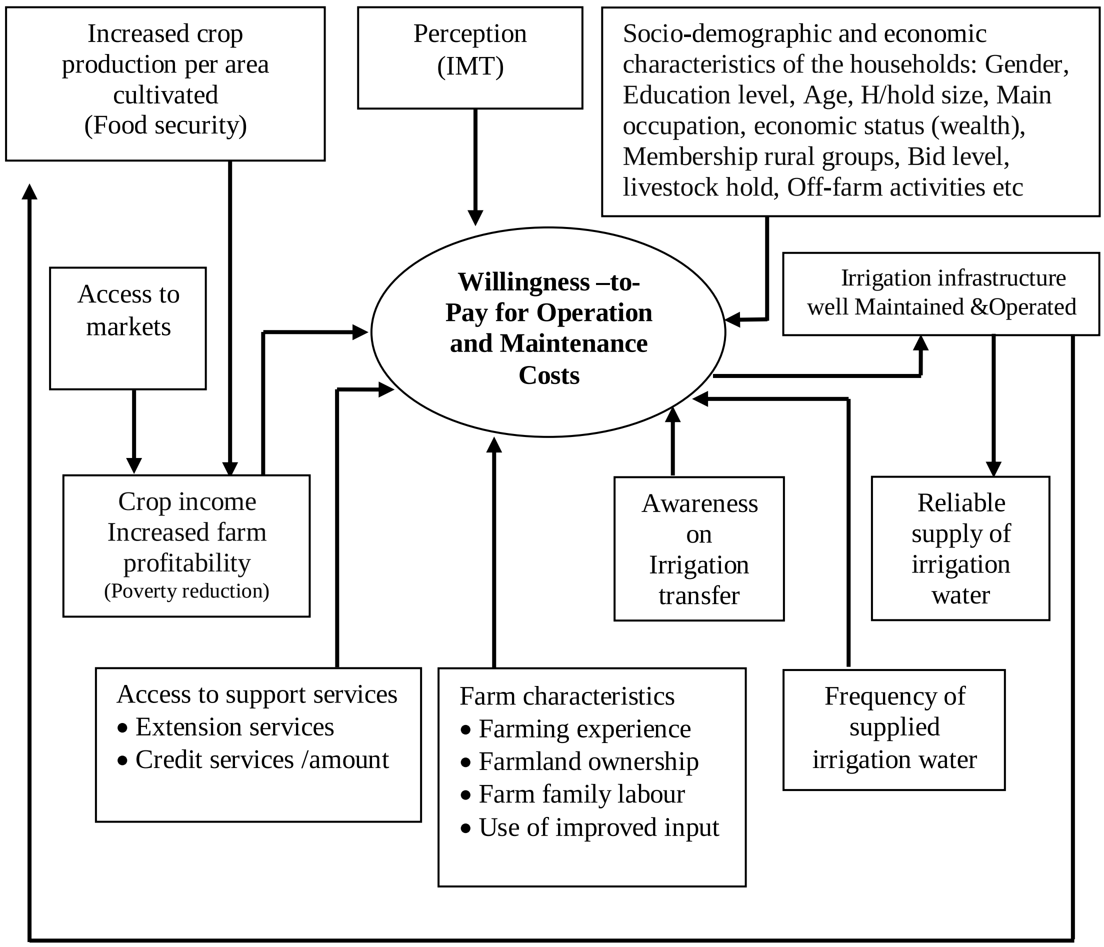

Figure 1: Conceptual framework for the study on farmer's WTP for O&M

Source: Own conceptualization after reviewing different literature

As shown in the conceptual framework in Figure 1, socioeconomic characteristics of the household heads were assumed to influence positively the willingness to pay for

O&M expenses. These characteristics include gender, age, education level of the head of household, household size, main occupation of household head, household income level, membership in rural groups, engagement in off-farm income generating activities, livestock holding.

Access to support services was also among variables that were assumed to influence willingness of farmers to pay for O&M. If farmers were accessing extension services as required, they would be able to adhere to the required agronomic practises that would result in more harvests and hence farm income. Therefore, an increase in economic welfare would influence their payment behaviour toward O&M cost.

Farmers under irrigation schemes were also assumed to access credit from public and private financial service providers. The credit would be accessed from formal financial institutions such as banks as well as micro-finance institutions (SACCOS, VICOBA, and NGOs). Such credit is used for agricultural related activities to purchase different resources such as improved seeds, which are needed to realize more produce from farming activities.

Farmers' awareness about the reforms on irrigation transfer policy, which are currently promoted by the government, donors, and NGOs are also assumed to influence farmers' willingness to pay for O&M expenses in their irrigation schemes. Such payments are important since they facilitate timely maintenance of irrigation infrastructure throughout the year while farmers receive supply of water as required.

Smooth supply of water for irrigation increases crop productivity, which reduces poverty through increased household income.

In addition, access to profitable market for crops would enable farmers to get good prices which results into more crop income. The obtained income is important to finance farm operations such as payment for O&M expenses, purchasing fertilizers, improved seeds, and labour. Thus, increased crop income from irrigation will provide an incentive for smallholder farmers to have a positive attitude toward payment for O&M expenses.

The perception of farmers regarding the ongoing policy reforms in the sub-sector can create a sense of ownership due to the usefulness of the irrigation scheme. This will influence them to see the rationale behind their involvement in the management of improved irrigation scheme. A negative perception can make farmers see their participation as less important and this is likely to jeopardize the sustainability of the scheme since the funds required to finance O&M will not be available.

Farm related characteristics, which include variables such as farming experience of household; ownership of farmland within the scheme; availability of farm family labour and the use of improved agricultural inputs were also among factors, which could affect farmers' decision of paying for O&M expenses of the scheme.

The frequency of supplied irrigation water (adequate) was assumed to have an influence on the willingness to pay decision. This is because if a farmer was supplied adequate water he/she would produce more crops leading to become more willing to pay. Likewise Household with more farm characteristics such as farming experience and farm labour would be expected to be more willing to pay than is the case with those with lower characteristics. The relationship of other variables is as shown in the conceptual framework.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1 Geographical location

Mbeya Region is located in the South Western Corner of the Southern Highlands of Tanzania lying between latitude 7^{o} and 9^{o} south of the Equator and longitudes 32^{o} and 35^{o} east of the Greenwich Meridian. The region lies at an altitude varying between 475 metres and with high peaks of 2 981 metres above sea level at Rungwe district.

The region shares borders with Zambia and Malawi to the South, Songwe Region to the West; Tabora and Singida Regions to the North; and Iringa and Njombe Regions to the East. The region has an area of 35 954 square kilometres and about forty-seven percent of the land area is arable. The region has abundant water sources and a rich base of natural resource, which account for the region’s productivity (URT, 2007).

3.1.2 Climate

The climate is generally tropical with temperatures ranging from 16 ^{0}C in the highlands and 25^{0}C in the lowland areas. The region receives abundant and reliable rainfall with a mono-modal rainfall pattern. The dry season normally begins in June and ends in December while the wet season begins from January to May. Annual rainfall varies from 650 mm to more than 2 600 mm.

3.1.3 Administration

Administratively the region comprises of six districts namely Chunya, Kyela, Rungwe, Busokelo, Mbarali, and Mbeya Urban[5]. The region headquarters is located in Mbeya city and about 80 percent of the region's populations are engaged in agriculture.

3.2 Selection of the Study Area

The study was conducted in Mbeya region. The region is found in Rufiji basin which is the largest in the country with high potential for agriculture, where irrigated agriculture is the largest consumptive use of water in the basin (URT, 2007).

Mbeya Region has many irrigation schemes including large Irrigation farms (schemes) such as Mbarali and Kapunga and large smallholder irrigation schemes such as Madibira and Kimani. In addition, the region has many improved irrigation schemes of smallholder farmers with management transfer aspects. The region is also important in food production in the country. Thus, the presence of many smallholder

[5] http://www.mbeya.go.tz/mbeya

improved irrigation schemes with IMT aspects was the criterion for selecting Mbeya Region for this study. Besides that, selected irrigation schemes are found in Mkoji sub-catchment (upper and middle zones), which is the most exploited catchment of the Great Ruaha River Catchment (GRRC).

Two districts, which are Mbeya Urban and Mbarali were purposively selected. From the two districts, representative sample of smallholder farmers was drawn from selected improved irrigation schemes. The type of crops grown which are mainly paddy and horticultural crops was another reason for selecting representative schemes from the study area. The selected irrigation schemes where the study was conducted are as shown in Figure 2. All of the selected schemes had improved irrigation infrastructures and IMT aspects.

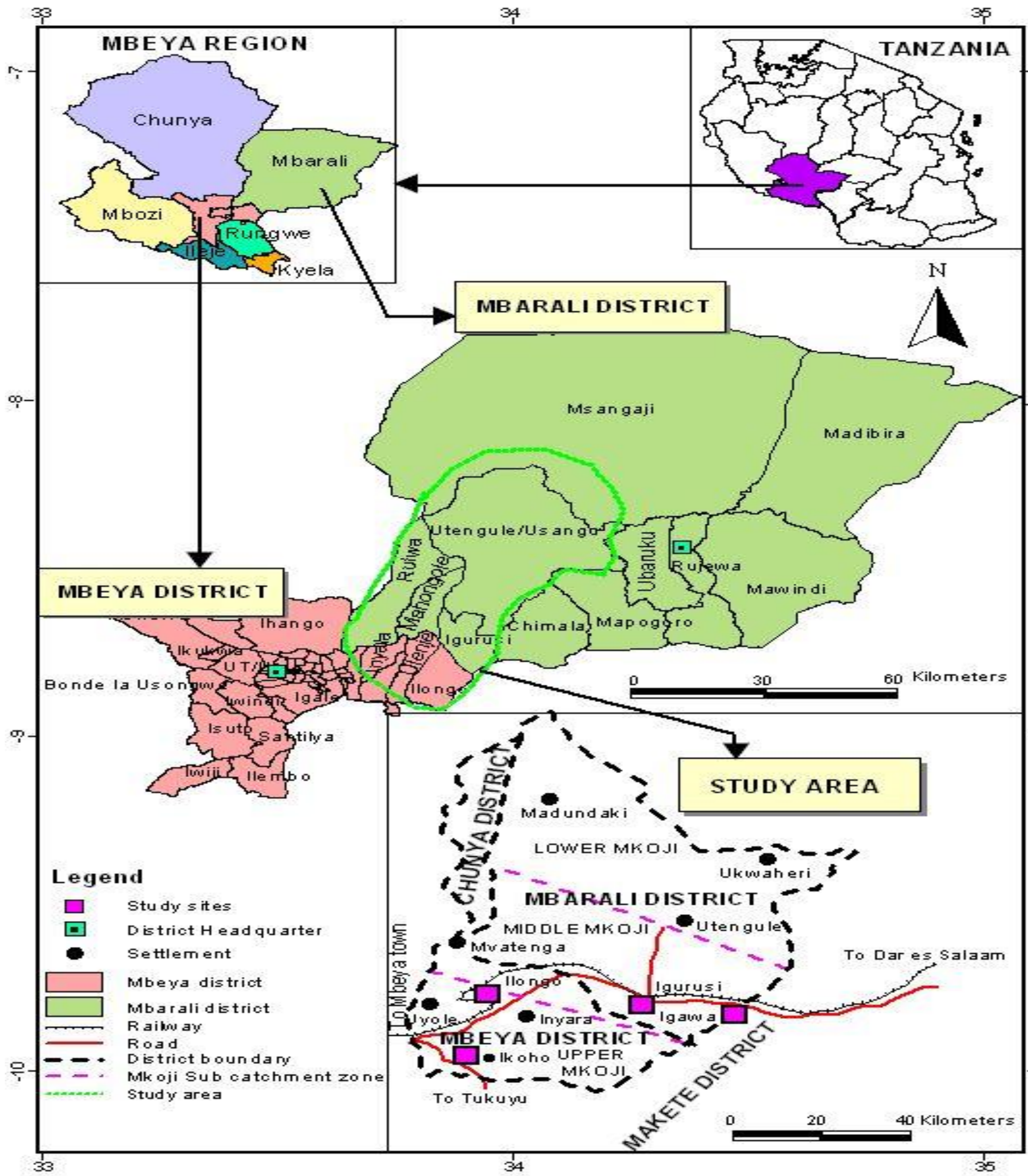

Figure 2: Map showing location of improved smallholder irrigation schemes surveyed

3.3 Agricultural Production in the Study Area

3.3.1 Crop farming

Mbeya Region has high potential for rain-fed and irrigated agriculture. In the region, different types of food and cash crops are grown at large and small scale. Major food crops, which are produced in the region include, maize, paddy, sorghum, beans, potatoes (Irish, round, and sweet), cassava, bananas, groundnuts, sesame, tomatoes, onions, fruits such as pineapples and vegetables. Main cash crops are coffee, tea, tobacco, pyrethrum, wheat, millet, sunflower, cocoa, and palm oil.

In the region, smallholder farmers and small number of commercial farmers of tea in Rungwe and rice in Mbarali District dominate agriculture. The arable land in the region, which provides high potential in the production of different types of crops, has made Mbeya among the six regions earmarked nationally as the producer of surplus food for internal consumption and export. Both rain fed and irrigated crops are produced in the region at different intensities.

Though different types of crops are grown under irrigated farming in the region, paddy is still the most predominant irrigated crop grown through irrigation. In general, water for irrigation is taped from various perennial rivers originating from highlands and flow by gravity into farms.

3.3.2 Irrigation practices

Mbeya is one of the major crop producing regions in the country with a large number of irrigation schemes producing different annual crops including rice, maize, beans and vegetables (URT, 2006). The region also has a big number of improved smallholder irrigation schemes where IMT has been implemented by the government.

The potential area suitable for irrigation is estimated to be 110 721 hectares. The area under irrigation is around 51 046 hectares (46.1%) where 25 626 hectares are under improved irrigation and 25 420 hectares are under traditional irrigation systems. In order to make sure that the available irrigation potential is utilized, the government has continued to improve structures of traditional irrigation schemes when funds are available. The area under irrigation differs proportionally across all the districts in the region, where Mbarali and Mbeya have large area with irrigated farming.

Majority of households practicing irrigated farming in the region, receive irrigation water that flows through canals while other farmers use hand and motor pumps as well as hand buckets.

3.3.2.1 Crop production during rainy season

Crop production system in the study area is practised during the rainy and dry seasons. In the rainy season, farmers produce different crops including tubers, horticultural crops, and cereals. Maize is the only crop, which is grown across all irrigation schemes because of its importance in food security at the household level.
During the rainy season, rainfall and weather conditions provide good climatic condition for this crop in terms of water availability. Next in importance is paddy, which is produced by many farmers in Igomelo, Luanda-majenje, and Ipatagwa irrigation schemes. Rice serves as both food and cash crop. Tomatoes are grown as a cash crop by many farmers in Igomelo, Luanda-majenje, and a few farmers from Iganjo scheme. Onions is another cash crop in the area, which is grown by many farmers in Igomelo irrigation scheme.

While maize is mainly grown for household consumption, tomatoes, onions, and paddy are the major cash crops grown in Igomelo scheme. Paddy and tomatoes are the major cash crops grown by farmers in Luanda-majenje and paddy is a major cash crop grown by farmers in Ipatagwa. Vegetables and Irish potatoes are the major cash crops produced in Iganjo scheme during the rainy season.

Surprisingly, during rainy season, many farmers from Iganjo scheme were not engaged in crop production within the scheme. Instead, they undertook farming outside the scheme as a way of avoiding high costs of production resulting from high use of fertilizers under irrigated farming in the scheme.

3.3.2.2 Crop production during dry season

During the dry season, irrigated farming becomes the only available option for crop production in the area. During the dry season, farmers produce crops that do not need much irrigation water mainly horticultural crops. Crop like paddy is not produced during the dry season for fear of crop failure, which may result from reduced flow of water in the scheme vis-à-vis crop demand.

Only few farmers are engaged in crop production during the dry season. Maize is the dominant crop produced mainly for food consumption in both seasons. Cash crops, which are produced during the dry season, include onions and tomatoes, which are dominant in Igomelo irrigation scheme while beans and tomatoes are common in Luanda-majenje. Farmers in Ipatagwa scheme produce beans, onions, and tomatoes through irrigated farming during the dry season. In Iganjo irrigation scheme, Irish potatoes, beans, and vegetables are the major cash crops produced during the dry season.

3.4 Description of Improved Smallholder Irrigation Schemes Surveyed

3.4.1 Igomelo irrigation scheme

Igomelo irrigation scheme is located in Mbarali District, about 100 kilometres from Mbeya city. The scheme was established by small-scale farmers in 1974 as a traditional irrigation scheme until 1997 when farmers decided to formulate the Igomelo Irrigation Cooperative Union "*Chama cha Ushirika wa Umwagiliaji Igomelo*" with 195 members. Since its inception, there has been an increase in the number of irrigators reaching 382 irrigators. The scheme was upgraded by the government, from a traditional to an improved irrigation scheme using funds from the World Bank, between 2001 and 2002. Farmers devoted labour as their contribution during the construction of irrigation infrastructure. The scheme receives water abstracted by furrow from the Mbarali River. The irrigated area under the scheme is around 312 hectares plus the potential area for irrigation of about 100 hectares. The improvement of the scheme was done mainly at the intake (Plate 1) and partially by lining the main canal (Plate 2).

Plate 1: Improved intake at Igomelo irrigation scheme

Plate 2: Part of Igomelo main canal lined with concrete and stone masonry

3.4.2 Luanda Majenje irrigation scheme

The Luanda Majenje scheme is in Mbarali District located around 50 kilometres from Mbeya Urban near the Dar es Salaam highway. The scheme was established in 1997 following the intervention from the Government of Tanzania and the United Nations Development Programme (UNDP), which facilitated the construction of improved intake for the scheme (Plate 3). Approximately, 300 hectares are irrigated under the scheme.

Plate 3: Intake of Luanda-Majenje Improved Irrigation Scheme

Water for irrigation is abstracted from the Lunwa River and conveyed through the main canal by gravity up to the farms. The canal is partly lined with concrete materials and stone masonry (Plate 4). Management of the scheme is carried out by Luanda_Majenje Cooperative Union "*Chama cha Ushirika Umwagiliaji Luanda majenje*," a cooperative, which was also established for improving farmers' welfare collectively.

(4a) Lined canal **(4b) Unlined canal**

Plate 4: Lined and unlined main canal at Luanda-Majenje Irrigation Scheme

3.4.3 Ipatagwa irrigation scheme

Ipatagwa Irrigation Scheme is a smallholder improved irrigation scheme found in Mahongole Ward, Mbarali District located around 35 kilometres from Mbeya Urban along the Dar es Salaam highway. The scheme was established in 1998 as a traditional irrigation scheme and improved in 2002 mainly at the intake. As other improved schemes surveyed in the district, not all parts of the structures in the scheme, especially the main and secondary canals were initially constructed using concrete as of 2016. The total area under cultivation in the scheme is around 540 hectares and is managed by the formalized Ipatagwa Farmers' Association "*Umoja wa wakulima Ipatagwa.*"

3.4.4 Iganjo irrigation scheme

Iganjo Smallholder Irrigation Scheme is located in Iganjo Ward, 16 kilometres from Mbeya City near Tukuyu highway. The scheme started in 1967 as a tradition irrigation system until 2007 when it was improved using funds from the District

Agricultural Development Plans (DADPs). The scheme has a total of 110 hectares, which are under crop production, and the abstracted water for irrigation flows from the Nkwanana River. The intake of the scheme is well constructed with stone masonry and lined with concrete materials like the other smallholder schemes surveyed. Likewise, the scheme is managed and operated by a formalized farmers' association known as *"Bonde la Uyole Cooperative Union."*

3.5 Research Design

This study adopted a cross-sectional design, where data from selected smallholder farmers were gathered through a single visit survey. This design was adopted because the data required to make scientific inference was possible to be collected at once from the population. The design saves time and financial resources for the researcher and it provided the researcher with opportunity of studying many respondents at a time (Salkind, 2010). The selected sample size was optimum and fulfilled the requirements of the representation of farming households under irrigation schemes (Kothari and Garg, 2014; Singh and Masuku, 2014; Israel, 2012).

3.6 Sample Size

A sample size of three hundred and twenty (320) farmers were randomly drawn from four improved smallholder irrigation schemes in Mbeya urban and Mbarali Districts. The number of interviewed farm households was estimated using the formula proposed by Yamane (1967) as presented in Equation 6.

$$n = \frac{N}{1 + N(e)^2} \qquad (6)$$

Where:

n = sample size

N= population size

e = level of precision which represent an error the researcher would be willing to accept (0.05)

Based on Equation 6, a sample size of 320 respondents was considered sufficient for a population of 1607 smallholder farmers from the selected improved irrigation schemes.

3.7 Sampling Procedure

There are several sampling techniques, which were employed to obtain the sample households for the study. These include both non-probability and probability sampling techniques. Specifically, the study employed the purposive sampling and simple random techniques.

From Mbarali and Mbeya Urban Districts, four smallholder improved irrigation schemes were selected purposively. Selected schemes were Igomelo, Luanda-Majenje and Ipatagwa from Mbarali district and Iganjo scheme was chosen from Mbeya Urban District. These schemes use surface irrigation systems to deliver water from the intake via furrows to the farms.

The selection of these irrigation schemes was motivated by the presence of IMT and the type of crops produced, which were mainly paddy and horticultural crops. These crops are important in the sub catchment as they regarded as both food and cash crops. In addition, due to limited time, it was not possible to include all irrigation schemes in the study area. Then from each scheme, a sample of eighty respondents was drawn to make a total of three hundred and twenty respondents.

Lists of farmers comprising upstream and downstream users in the selected schemes were obtained from leaders of each of the scheme. From the list, upstream and downstream farmers were identified through the assistance from scheme leaders. Random numbers were generated against the name of individual farmers through Microsoft-Excel 2010. Equal proportions of upstream and downstream users were drawn through simple random sampling from the lists of respective scheme to constitute the needed sample from each scheme.

The sample size drawn from each scheme met the rule of thumb of having at least 30 respondents (Sekaran, 2011). However during an interview, 19 respondents were not available, hence only 301 respondents were interviewed. This sample size is large enough to give point estimates for parameters and to estimate WTP when CVM is used (Calia and Strazzera, 2000). The distribution of the interviewed farmers is presented in Table 1.

Table 1: Distribution of farmers interviewed

Sex	Farm location	Name of irrigation scheme Igomelo	Luanda Majenje	Ipatagwa	Iganjo	Total (n=301)
Female	Upstream	2 (2.6)	9 (12.2)	6 (8.0)	11 (14.5)	28 (9.3)
	Downstream	4 (5.2)	5 (6.8)	6 (8.0)	16 (21.1)	31 (10.3)
	Total	**6 (7.8)**	**14 (19.0)**	**12 (16.0)**	**27 (35.6)**	**59 (19.6)**
Male	Upstream	36 (47.4)	26 (35.1)	32 (42.7)	28 (36.8)	122 (40.5)
	Downstream	34 (44.8)	34 (45.9)	31 (41.3)	21 (27.6)	120 (39.9)
	Total	**70 (92.2)**	**60 (81.0)**	**63 (84.0)**	**49 (64.4)**	**241 (80.4)**
Total		**76 (100)**	**74 (100)**	**75 (100)**	**76 (100)**	**301 (100)**

Note: Numbers in brackets are percentages.

For all schemes, the majority (80.4%) of interviewed farmers were male-headed households and a few (19.6%) were female-headed households. The Iganjo scheme has the highest, 35.6% number of female-headed households participating in irrigated farming while Igomelo scheme has the lowest (7.8%).

Interviewed farmers were from different wards. For Iganjo scheme, the respondents came from the Iganjo, Igawilo, Nsalaga and Uyole wards while for Igomelo, Luanda-Majenje, and Ipatagwa scheme, respondents came from Lugelele, Igurusi Mahongole wards respectively (Table 2).

Table 2: Distribution of respondents by irrigation schemes and wards

Ward	Name of Irrigation scheme Igomelo (n= 76)	Luanda Majenje (n= 74)	Ipatagwa (n= 75)	Iganjo (n= 76)	Total (n= 301)
Iganjo	0	0	0	11 (14.5%)	11 (3.7%)
Igawilo	0	0	0	25 (32.9%)	25 (8.3%)
Igurusi	0	74 (100.0%)	0	0	74 (24.6%)
Lugelele	76 (100.0%)	0	0	0	76 (25.2%)
Mahongole	0	0	75 (100.0%)	0	75 (24.9%)
Nsalaga	0	0	0	6 (7.9%)	6 (2.0%)
Uyole	0	0	0	34 (44.7%)	34 (11.3%)
Total	**76 (100.0%)**	**74 (100.0%)**	**75 (100.0%)**	**76 (100.0%)**	**301 (100%)**

The interviewed respondents came from several villages. Thirteen villages for Iganjo irrigation scheme, three for Luanda Majenje irrigation scheme and two villages for Ipatagwa and Igomelo irrigation schemes.

The thirteen villages for the Iganjo scheme include Chemichemi, Ibara, Kibonde nyasi, Mponji, Mtakuja, Mwanyanje, Nsalaga, Utukuyu, Uyole, Ishinga, Itanji, Itezi and Iwambala. Three villages from Luanda Majenje include Majengo, Lwanyo, and Majenje; while two villages for Ipatagwa were Ilaji and Ilongo. Likewise, two villages for Igomelo scheme were Igawa and Igomelo.

3.8 Type of Data and Sources

3.8.1 Types of data

In order to address each of the specific objectives, both quantitative and qualitative data were collected. The data, which were gathered included mainly the primary quantitative data. The collected data included the quantity of crop harvested, output price and the cost of production incurred under irrigated farming. Primary qualitative data were on the responses from farmers on their willingness to pay for O&M costs and associated qualitative variables assumed to influence WTP. Moreover, data on different bid prices offered to respondents in order to determine factors influencing WTP decision and the amount which individual farming household reported to have been paying were also gathered. Qualitative data on challenges facing farmers undertaking irrigated farming were also collected from respondents.

3.8.2 Sources of data

Different steps were employed to facilitate primary data collection. After identifying the study area, the first step was the preliminary survey, followed by development of data collection tool, recruitment and training of enumerators, and pre-testing of questionnaire, which was then followed by the main survey implementation. For the household survey, the questionnaire was administered to respondents through face-to-face interview.

3.9 Preliminary Survey

A preliminary survey was carried out in June and July 2014 in order to get background information about the study area. The information gathered during this session was used to improve the setup of the thesis such as designing bid categories, which were used during the main survey. Moreover, preliminary visit was important since it was used as a platform of explaining to leaders of Water User Associations and local government institutions (ward and villages) the purpose of the study and requesting for their active participation during implementation the study.

3.10 Development of Research Instrument

After getting information from the preliminary survey, the next stage involved developing data collection tool. The information collected during the preliminary survey played a useful contribution in designing the questionnaire, which was used to gather data from individual household heads. In addition, a checklist was designed to gather information from groups of farmers and leaders of Water User Association as key informants.

The questionnaire contained several sections. The first section included identification details on social demographic characteristics of individual households and the location of farm in the scheme. The second section covered information on general socio economic and demographic characteristics of all household members.

The third section covered information on land tenure and agricultural production. The information needed was on the type of crops grown, inputs use, quantities of crops harvested and household labour availability. Information on access to extension services and livestock keeping also is covered in this section.

Information on households' participation in rural economic institutions and accessibility of capital to sampled households was covered in section four of the questionnaire. Moreover, information related to water use practices and services provided by water user associations to farmers in undertaking irrigated farming was captured in section five of the questionnaire. Other important information to the thesis was captured from section six up to nine (Appendix 1).

3.11 Recruitment and Training of Enumerators

Prior to conducting the main survey, enumerators who were university graduates were recruited and trained for one week before pre-testing of the questionnaire.

3.12 Questionnaire Pre-testing

Prior to the main survey, the questionnaire was pre-tested, and all enumerators were participated in the exercise. A total of twenty smallholder farmers from Iganjo, Igomelo, Ipatagwa, and Luanda Majenje irrigation schemes were interviewed during the pretesting, five farmers from each scheme. Some of the questions were then revised in the questionnaire during a joint discussion with enumerators. The final version of the questionnaire was prepared after incorporating the necessary changes.

3.13 Main Survey Implementation

The main survey was executed for the duration of six months starting from the end of November 2014 to April 2015.

Information from leaders of the schemes and key informants was captured during semi-structured meetings held at each of the surveyed scheme. A checklist was used to lead the discussion on different aspects (Appendix 2), which were not limited to scheme management especially on O&M, water distribution, challenges experienced under the existing management system, agricultural production in the area, crop marketing, and opinion on the current irrigation management practices.

Appointments were made five days before the date scheduled for an interview through Ward Executives Officers (WEO), WUA leaders and Extension Officers of respective irrigation scheme. Face-to-face interview with household heads or representatives took place where the respondents were available but most of them were at their homes and sometimes at their farms within the scheme. Though the questionnaire and checklist were constructed in English, the interviews were conducted in Kiswahili. The enumerators translated the questions into Kiswahili but the response was recorded in English. After the interview, questionnaires were checked by enumerators and the researcher to ensure the information captured was correctly recorded.

3.14 Bid Design Process

The bids were designed during the pretesting of questionnaire, where farmers were asked open-ended questions to state the amount that they would be willing to pay in order to finance O&M expenses of the scheme. Following responses experienced during pretesting several bids were constructed are; 7 000TAS, 12 000 TAS, 17 000 TAS, 20 000 TAS, 30 000 TAS, 40 000 TAS, 55 000 TAS, 70 000 TAS and 100 000 TAS as water user fees per acre per year.

3.15 Elicitation of Farmers' WTP for Operation and Maintenance

In eliciting WTP for O&M, the CVM with a double bounded dichotomous format was used. To ensure respondents state the amount, which reflects their actual preferences according to their socio-economic standing, the concept of cheap talk script was adopted. Under cheap talk, the respondents are reminded the importance of being honest on stating the amount of money which they may be able to pay for O&M.

The cheap talk script was applied before presenting willingness to pay valuation question to the respondents. The cheap talk script was adopted following Cummings and Taylor (1999) who recommend it when conducting CV studies as a way of reducing and or eliminating hypothetical bias (Appendix 3).

In addition to the cheap talk script, farmers were told that the amount, which they would be willing to pay, would be used for financing O&M to ensure sustainable operations. This was done in order to eliminate farmers' apprehension on the revenue that would be collected by their WUA leaders and therefore, farmers were in a position to state a more realistic WTP value.

The payment vehicle chosen in this study was "Water Use Fee or charge" which is paid per acre per year, and is widely accepted universally by farmers, within the irrigation sub-sector (Biswas and Venkatachalam, 2015). Likewise, water charges follow Bateman and Turner (1993) guidelines, which propose the use of realistic and appropriate payment vehicle when conducting contingent valuation studies.

After the cheap talk script, respondents were told to create a hypothetical market like situation where irrigation water is sold so as the funds collected will be used to finance O&M activities in the scheme they operated. Then, each of the respondents was asked whether he (she) was willing to pay for O&M costs. If the respondent indicated a positive response, he (she) was presented with an initial bid value, which was then subjected to a follow-up bid that was contingent upon the response experience on the initial bid. Respondents who agreed to the given bid levels were then asked to specify the maximum amount they would be willing to pay for O&M expenses, and this was regarded as the maximum amount for a particular household.

3.16 Analytical Framework

Data from the household survey were cleaned, summarized, and coded using the STATA version 13 software and Microsoft Excel computer program. Then preliminary analysis was executed after data coding where correction of errors was done accordingly. The analysed data were summarized and presented using tables and bar charts, followed by detailed explanation in chapter four. Each of the analytical technique used to analyse specific objectives is presented hereunder.

3.16.1 Analysis of profitability and its determinants

The analysis of profitability was done following the Schultz's argument on profit maximization theory. The focus of argument put forward by theorists on profit maximization behaviour assume that, the household as the production firm tend to maximize profit (Mendola, 2007). However, the theory has been criticized because it only take into account the profit maximization and ignore other household goals. Following that, the utility maximization theory has been applied since it encompass the dual character of farming households as both production and consumption unit. It was therefore with this argument that in calculating profitability of farming households, the value of crops considered were those which was harvested (consumed and sold).

To assess profitability of irrigated crop production and its determinants in the study area, two stages each with different method were involved. The farm budgeting method as used by Item *et al., (*2014); Onia *et al.* (2012); Kibona and Mishili, (2011); Makindara *et al.* (2009) was adopted to compute the Gross Margin (GM) per acre of each individual farmer for the previous cropping season (2013/14). The gross margin analysis was used because of low level of fixed costs (almost negligible) associated to smallholder farming in the study area, which suggests that the gross margin is very close to the net farm income. Exclusion of Fixed cost is one of the limitations when using the gross margin analysis as a measure of profitability and therefore precautions need to be taken to use it especially when the enterprise has fixed costs.

The gross margin was calculated based on the argument that, in order for farmers to be willing to pay for O&M, they need to undertake profitable irrigated farming. Thus, the gross margin obtained from irrigated farming would motivate farmers to commit their financial resources in supporting O&M activities of irrigation schemes.

The gross margin per acre was calculated as presented in Equation 7.

$$\frac{\text{GM}}{\text{Acre}} = \sum_{n=1}^{n} \frac{TR - TVC}{Farmsize\ (acres)} \qquad \text{.. (7)}$$

Where:

n = Number of crops grown by a farming household (dry and rainy seasons)

$\frac{\text{GM}}{\text{Acre}}$= Total Gross Margin per acre in Tanzanian shillings (TAS)

TR= Total value of crops harvested (TAS)

TVC= Total variable costs incurred in crops production (TAS)

The revenues considered here covered the value of crops produced in the irrigation schemes only. Only five crops that were mainly cultivated in the schemes were considered, which includes maize, paddy, onions, irish potatoes and tomatoes. The computation was done by multiplying the quantity of each crop produced and the average prevailing market price in the area at the point of selling. The production costs were for labour, fertilizers, pesticides, insecticides, seeds, and fees (water use permit) paid to the scheme during the production period.

The analysis of variance (ANOVA) was further used to assess whether the gross margin of sampled farmers across the surveyed irrigation schemes were statistically different from one another. Further, the Kruskal-Wallis test was conducted to determine the relative ranking of each scheme's performance in terms of gross margin.

A regression model was used to identify factors that determined profitability under irrigated farming. Gross margin per acre as a dependent variable was regressed against independent variables. The Ordinary Least Square (OLS) regression analysis was used to determine factors that cause variation of the dependent variable (Green, 2008). The multiple linear regression model is as presented in Equation 8.

$$Y = \beta_o + \beta_1 HHSex + \beta_2 Educat + \beta_3 Locfarm + \beta_4 Farmlabour + \beta_5 Extensionvisit + \beta_6 Farmexp + \beta_7 Livestockhold + \beta_8 Irrigatefreq + \beta_9 Creditaccess + \sum_{i=1}^{3} \delta_i D_i + \varepsilon \quad \ldots\ldots (8)$$

Whereas:

Y = Gross margin per acre; β_o = Constant term

β_1 up to β_9 = Coefficient of independent variables; ε = Error term

δ_i = Coefficients of dummy variables

D_i = Irrigation schemes (D_1=Luanda majenje, D_2=Ipatagwa and D_3= Iganjo)

Since farmers at Igomelo schemes were mostly producing horticultural crops like onions (high value crop), it was anticipated that their gross margin would be higher than that of farmers in other schemes. Therefore in the regression model, Igomelo scheme was used as a control variable to other schemes included in the study. This was because farming households in Igomelo scheme were associated with higher gross margin than farmers in Luanda majenje, Ipatagwa and Iganjo schemes. Three dummies for Luanda majenje, Ipatagwa and Iganjo irrigation schemes were included in the regression model

The definitions of independent variables used in the linear regression model and their expected sign are presented in Table 3.

Table 3: Definition of explanatory variables used in linear regression model with their expected sign

Variable name (Codes)	Variable description	Type	Expected (signs)
HHSex	Sex of household head (1=Male; 0= Female)	Dummy	+
Educat	Education level of household head (years)	Continuous	+
Locfarm	Location of the farm in the scheme (1= Upstream; 0= Downstream)	Dummy	+
Extensionvisit	Frequency of extension visit per year (number)	Continuous	+
Farmexp	Farming experience (years)	Continuous	+
Creditaccess	Access to farm credit last year	Dummy	+
Livestockhold	Number of livestock measured Tropical Livestock Unit (TLU)	Continuous	+
Farmlabour	Total household members available for farming activities (number)	Continuous	+
Irrigatefreq	Frequency of irrigation water supply per month	Continuous	+

Violation of the classical linear regression model assumptions such as multi-collinearity and heteroscedasticity that could affect the coefficient estimates and hence lead to a biased model was checked. The Variance Inflation Factor (VIF) was used to diagnose multi-collinearity and the White's test to check for heteroscedasticity. F-test was used to test the goodness fit of the model to explain the existing relationship between the explanatory variables and gross margin as a dependent variable.

The estimated gross margin per acre estimated in Equation (7) were then used as one among the independent variables in the logistic regression model when identifying the factors that influencing farmers' willingness and amount to pay for O&M

3.16.2 Analysis of smallholder farmers' willingness to pay for O&M

The analysis of willingness of smallholder farmers' to pay for operation and maintenance was done following the responses from interviewed households on whether they were willing or not willing to pay for operation and maintenance costs of irrigation facility. The collected data from the responses of farmers were analysed through descriptive analysis where frequency and percentage were obtained and summarized.

3.16.3 Analysis of factors that influence farmers' willingness and amount to pay for O&M

3.16.3.1 Factors influencing farmers' willingness to pay for O&M costs

In order to identify factors that influence the willingness of smallholder farmers' to pay for O&M of improved irrigation schemes in the study area, a logistic regression model was applied since it is most suitable for the analysis involving binary responses.

The binary household's responses on the willingness to pay for O&M were regressed against the bid values, which were the farmers' willingness to pay, demographic variables, socio and non-socio-economic, farm level characteristics and other selected variables as shown under the description of explanatory variables. The logistic regression model is based on a cumulative logistic probability with the ability to predict the probability of farmers' willingness to pay for O&M expenses of the scheme.

The logistic regression model is based on the supposition that the probabilities of willingness to pay (P_i) depend on a vector of known explanatory variables (X_i) and a vector (β, coefficient) of unknown variable. The specific econometric model, which was estimated is specified in Equation 9.

Thus, $$Y = \frac{1}{1 + exp^{-Z}} \qquad (9)$$

Where

Y = Responses of household to WTP which is either 1 if Yes or 0 if No

$Z = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_n X_n + \mathcal{E}$

β_o= Equation constant term

X_1= Price or bid that households were willing to pay

$\beta_1 \ldots\ldots \beta_n$ = Coefficients of explanatory variables $X_1 \ldots\ldots X_n$

X_2 = Education level; X_3 = Sex of household head; X_4 = Access to credit;

X_5 = Off-farm activity; X_6 = Credit amount taken; X_7 = Livestock hold;

X_8 = Access to extension visit; X_9 = Farming experience; X_{10} = Gross margin;

X_{11} = Awareness on IMT; X_{12} = Perception on IMT; X_{12} = Membership in rural economic group; and $\mathcal{E}$ = Error term

Thus, in the model, the dependent variable was the farmer's decision on willingness to pay for O&M expenses from the services received through improved irrigation infrastructure which assumed the value of 1, if the farmer was willing to pay for O&M and 0, if otherwise. Meanwhile, several independent variables were assumed to influence WTP decision for O&M in the study. The selection and identification of variables were carried out after a review of different existing theoretical and empirical studies used CVM in the irrigation sub-sector especially on irrigation water pricing and management of irrigation schemes. The hypothesized variables and their expected effect on WTP are as specified in Table 4.

Table 4: Definition of explanatory variables used in logistic and tobit models with their expected sign

Variable name (Codes)	Variable description	Type	Expected (signs)
Bidamount	Bids in TAS (7 000; 12 000;17 000;20 000; 30 000; 40 000;55 000;70 000 and 100 000)	Continuous	-
HHSex	Sex of household head (1=Male; 0= Female)	Dummy	+
Educat	Education level of household head (years)	Continuous	+
AgeHH	Age of household head	Continuous	+
Offarm	Availability of off-farm economic activity (1= Off-farm; 0 No off-farm)	Dummy	+
Extensionvisit	Frequency of extension visit per year (number)	Continuous	+
Farmexp	Farming experience (years)	Continuous	+
Cropincome	Total income from sales of crop (TAS)	Continuous	+
Memberrural	If the household head is a member of any rural institution (1= Member; 0 otherwise)	Dummy	+
AwareIMT	Awareness on IMT policy reforms (1= Aware; 0 otherwise)	Dummy	+
PerceptionIMT	Perception on IMT (1= Important, 0 = Not important)	Dummy	+
Creditamount	Amount of farm credit received last cropping season	Continuous	+
Credidaccess	Access to credit (1= Accessed, 0= Not accessed)	Dummy	+
Livestockhold	Number of livestock measured Tropical Livestock Unit (TLU)	Continuous	+
Farmlabour	Total household members available for farming activities (number)	Continuous	+

3.16.3.2 Mean and aggregate willingness to pay

In order to calculate the mean willingness to pay amount for the households across the four irrigation schemes in the study area, coefficient estimates obtained from logistic regression Equation 9 were used. The calculation of the mean WTP was done using the formula derived by Hanemann *et al.* (1991) as presented in Equation 10.

$$\textit{Mean WTP} = \frac{1}{|\beta_1|} * \ln(1+exp\,\beta_o) \qquad \text{...} (10)$$

Where:

β_o = Coefficient of intercept from Equation 9

$/\beta_1/$= An absolute values of bid coefficient estimates obtained from the logistic regression Equation 9

Mean WTP = is the estimated mean willingness to pay of households for O&M of smallholder irrigation schemes.

The estimated mean obtained from Equation 10 was then used to measure the aggregate value for O&M from each of the surveyed scheme. The aggregate value was estimated by multiplying the Mean WTP by the total number of irrigable acres from the valid responses of households on WTP in accordance with Astatike, 2016; Angella *et al.* 2014*;* Mezgebo *et al.* 2013).

3.16.3.3 Factors influencing the amount that farmers were willing to pay

Tobit or Censored normal regression model (Green, 2003) was used to analyse factors that were assumed to influence the amount that farmers were willing to pay (AWTP) for O&M of smallholder improved irrigation schemes in the study area. The Tobit model was adopted because the independent variables were completely observed from the sample size interviewed while the dependent variable was incompletely observed. An incomplete observation of the dependent variable data was experienced because some farmers were unwilling to pay for O&M and therefore they were assumed to have zero 0 WTP (Jana, 2013).

According to Wooldridge (2009) and Green (2003), when analysing a data set where the variable of theoretical interest is not observed or lost, the Tobit model is quite convenient since it produces the estimates which are not biased as the model can take into account that defect. The standard Tobit model is presented in Equation 11 and it was estimated using a Maximum Likelihood Estimation (MLE).

$y_i * = X_i \beta + \varepsilon_i$ ………………………………………………………………………. (11)

$y_i = y_i * \quad if \; y_i > 0$

$y_i = 0 \qquad if \; y_i \leq 0$

Where y_i* is the latent dependent variable, y_i is the observed dependent variable (maximum willingness to pay for ith household, $AWTP_i$), X_i is the vector of the observed independent or explanatory variables, β is the vector of coefficients, and ε_i is the error term assumed to be independently normally distributed: $\varepsilon_i \sim (0, \sigma^2)$.

Therefore, Equation 11 can further be specified as follows:

$AWTP_i = \beta_o + \beta_1$Educat + β_2 Offarm + β_3 Cultlandsize+ β_4GrossMargin +

β_5Irrigatefreq+ β_6Extensionvisit + β_7Farmlabour+ β_8 Inputimprov +

β_9Marketaccess+ β_{10}Cropselltime+ +β_{11}Memberrural+ β_{12}Farmexp .... (12)

The independent variables presumed to influence the amount farmers were willing to pay (AWTP) for O&M are as specified in Table 4.

3.16.3.4 Description of explanatory variables used in logistic model

While some independent variables were assumed to have a positive influence, others were expected to show a negative relationship with the dependent (WTP). All the independent variables and their line of influence toward WTP are further described in this section.

The amount of bid was expected to have a negative influence on the WTP for O&M of smallholder improved irrigation scheme. Meaning that if the bid amount is increased, the likelihood of a farmer to express willingness to pay for O&M would be lower and vice versa (Biswas and Venkatachalam, 2015; Tang *et al.,* 2013; Weldesilassie *et al.,* 2009; Akter, 2007). Thus, the majority of farmers in the study area were expected to accept lower bids than higher ones as their contribution to finance O&M activities of the scheme.

It was also hypothesized that the sex of the respondent would have a positive relationship with WTP decision for O&M expenses. Male-headed households were expected to have higher likelihood on the WTP than female-headed households would have since male-headed households are financially stronger than are female-headed households (Astatike, 2016; Alemayehu, 2014). In addition, this trend is also associated with land rights where men own much of the land under irrigation practices. Thus, households headed by males were more likely to be willing to pay for O&M than households headed by females since they often use irrigated land as tenants.

The level of education of farmers was assumed to have a positive relationship with farmers' decision on WTP for O&M. Farmers with a higher level of education (measured as the years of formal schooling), were expected to have higher likelihood of WTP for O&M. Educated farmers were expected to have high knowledge and awareness of the benefits of improved irrigation infrastructure hence a higher WTP for irrigation services. More importantly, educated farmers were expected to have a broader understanding regarding the significance of the prevailing IMT policy reforms and hence have higher likelihood of paying for O&M expenses.

Likewise, households that were earning incomes from undertaking off-farm income generating activities were also expected to have higher likelihood of expressing a WTP to pay for O&M. This was because these households would be generating more income, which could supplement farming operational activities.

Farming experience was also among the variables hypothesized to influence WTP for O&M positively. Households that operated irrigated farming enterprises for many years were expected to have a higher probability of being willing to pay for O&M due to higher perceived benefits compared to households with relatively shorter experience. The positive relationship has also been revealed in some studies such as Chandrasekaran *et al.* (2009) and WeldeGiorgis (2004) because farmers who have been engaged in irrigated farming for many years were expected to have a positive attitude towards irrigation due to its importance and therefore they would exhibit higher likelihood of paying for O&M. Moreover, older rural farmers tend to be less educated, which limits their ability to engage in alternative income generating activities, hence they accumulate more experience in farming.

A positive relationship was also expected to be experienced in relation the coefficient for extension services. Households, which accessed extension services were expected to increase the probability of paying for O&M expenses within the scheme. If a farmer has access to extension advice, their efficiency in crop production is expected to result into more gross margin, which then influences their ability to pay for irrigation services which is likely to improve their productivity further.

It was further assumed that individuals' perception on the usefulness of scheme and willingness to pay for O&M correlated positively, because an individual's behaviour on paying for a good or services can be explained by a positive perception regarding the reforms being implemented in the subsector. Thus, farmers with such positive perception are expected to be more willing to pay for O&M expenses than is the case for farmers with a negative perception.

The gross margin (crop income) obtained from irrigated crop production was hypothesized to have a positive association with the likelihood of WTP. Households, which accrued higher gross margin (crop income), were expected to have a higher likelihood toward paying for O&M costs than households earning lower gross margin.

Awareness on IMT policy was also hypothesized to have a positive effect on the WTP for O&M. Therefore, they were expected to be willing to pay for O&M, since they understand the underlying reasons for such reforms and associated concerns on availability of irrigation water.

Membership to farmer's groups or rural associations were also assumed to have a positive influence on the attitude of farmers towards paying for O&M, since such membership was an avenue for farmers to benefit from the advantages of being a member. These include learning about good agricultural practices, access to credit, markets, and other aspects required to improve the welfare of farmers (Akinola, 2008). Furthermore, several studies and development efforts to promote farmers' welfare have focused on farmer groups rather than on individuals (Koudokpon *et al.*, 1995).

Access to credit was also expected to have a positive influence on WTP, because credit can be used to finance farm operations. In addition, the amount of farm credit taken to finance farming activities was expected to have a higher likelihood on WTP. Higher farm credit would enable farmers to purchase improved seeds and fertilizers, which are important in increasing productivity and hence producing more crops and generating higher gross margin, which would enable farmers to pay for the O&M.

The number of livestock possessed by the household was also assumed to influence WTP decisions positively. Households with higher livestock ownership (measured in Tropical Livestock Unit as proposed by FAO, 2003) were expected to show higher probability of paying for O&M expenses than was the case with those owning low livestock numbers. Hence, a family that owns livestock could earn more income from the sale of livestock and related products, where such incomes can be used to finance farm operations such as paying for O&M, purchasing improved inputs that would increase productivity.

The overall goodness-of-fit of the logistic and tobit regression models was checked from the chi-square test and the McFadden Pseudo R-squared. In addition, odd ratios and elasticity were calculated to measure the effect of changes of independent variables on the dependent variable.

3.16.4 Challenges facing improved smallholder farmer's irrigation schemes

Descriptive analysis was used to analyse challenges facing smallholder farmers under improved irrigation scheme. The identified challenges were analysed and summarized in frequency tables where frequencies and percentages were determined.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 General Findings

4.1.1 Socio economic characteristic of respondents

The socio economic characteristics of respondents are presented in this section. The socio economic characteristics presented include sex (Table 5) and marital status (Table 6), age of household head, education level, household's size, and main occupation of the head of the household.

Table 5: Distribution of respondents by sex

	Name of Irrigation Scheme				
Sex	**Igomelo**	**Luanda Majenje**	**Ipatagwa**	**Iganjo**	**Total**
Female	6 (7.9%)	14(18.9%)	12 (16.0%)	27 (35.5%)	59 (19.6%)
Male	70 (92.1%)	60 (81.1%)	63 (84.0%)	49 (64.5%)	242 (80.4%)
	76 (100.0%)	**74 (100.0%)**	**75 (100.0%)**	**76 (100.0%)**	**301 (100.0%)**

Irrigated farming across improved smallholder irrigation schemes is mostly practiced by male-headed households (80.4%) as opposed to female-headed households, which accounted for only 19.6% of the total irrigated farming households in the study area. The higher percentage of male-headed households is probably attributed to ownership of land where 70.1% of men have access to land than women which account for only 19.6%. Majority (73.8%) of the households were also married while the rest 14.6%, 6.3% and 5.3% were widowed, unmarried and divorced households respectively as shown in Table 6. In addition, 85.1% and 27.1% were married male and female-headed households respectively.

Table 6: Marital status of respondents

Marital status	Female	Male	Total
Unmarried	1 (1.7%)	18 (7.4%)	19(6.3%)
Married	16 (27.1%)	206 (85.1%)	222 (73.8%)
Divorced	11 (18.6%)	5 (2.1%)	16 (5.3%)
Widowed	31 (52.5%)	13 (5.4%)	44 (14.6%)
Total	**59 (100.0%)**	**242 (100.0%)**	**301 (100.0%)**

The findings in Table 7 reveal that mainly individuals aged above 30 years, representing 89.7% of farming households in the area. Those who were aged between 21 and 30 years accounted for 10.3% of the interviewed farmers. About 23.3% of farmers were above 60 years old. The minimum and maximum ages of farmers in the area were 21 and 90 years respectively and the mean age was 49 years. This implies that majority of farmers who practised irrigated farming under improved smallholder irrigation schemes in the area, were adults and elders while individuals aged below 30 years, their participation was lower than the former. Lower involvement of youth in farming is attributed to the negative perception of young people towards farming as compared to older one (Njeru, 2017).

Table 7: Distribution of households by age, education level and household size

Age categories	Frequency	Percent
21-30	31	10.3
31-40	67	22.3
41-50	83	27.6
51-60	50	16.6
Above 60	70	23.3
Total		**100.0**
Mean		48.9
Minimum		21
Maximum		90
Education level	**Frequency**	**Percent**
Primary level (1-7)	264	87.7
Ordinary level (9-12)	16	5.3
Post-secondary level	3	1.0
Didn't attend school	18	6.0
Total		**100.0**
Household size	**Frequency**	**Percent**
1 up to 2	42	14.0
3 up to 4	111	36.9
5 up to 6	98	32.5
More than 6	50	16.6
Mean		4
Minimum		1
Maximum		7
Total		**100.0**

The results (Table 7) show that, the majority (87.7%) of farmers had attended only basic primary school level. Only 5.3 and 1 percent had attended ordinary and post-secondary education respectively, whereas 6% did not attend any formal education system available. Furthermore, as indicated in Table 7, on average the household size composition consisted of 4 members, which was similar to that of the national average while 36.9% of the households constitued large groups of members ranging from 3 to 4 individuals.

Majority of farmers (97%) practicing irrigated farming depend on crop production as their main economic activity that bring income to the households (Table 8) and only few were depend on livestock keeping, agribusiness entrepreneurs and employees in both private and government sectors as a primary source of their livelihood incomes. In addition, close to one third of the households (24.6%) were engaged in secondary income generating activities, which were largely small business retail, crop trading, artisan and the provision of farm labour to other farmers.

Table 8: Distribution of households by main occupation

Occupation	**Frequency**	**Percent**
Crop production	293	97.0
Livestock keeping	2	.7
Agribusiness	1	.3
Private sector employee	1	.3
Government employee	4	1.7
Total		**100.0**

4.1.2 Land tenure

4.1.2.1 Farm plots ownership and acquisition

Majority of farmers (87.7 %) owned the land they operated while a small proportion (11.3%) operated on hired farm plots. Rental costs of farmland varied from one irrigation scheme to another depending largely on the type of crops grown in the scheme. On average, the cost of renting an acre of farm plot costs was 105 400 TAS but the cost was higher in Igomelo irrigation scheme averaging at around 165 000 TAS, compared to the average cost of 75 000 TAS in Luanda Majenje scheme. Higher hiring costs in Igomelo scheme were attributed to not only the supply and demand for farmland but also the type of crops grown in the scheme, for example onion, which is regarded as a high value crop with higher returns.

Households have used different ways to acquire farmland they are currently operating in the scheme. About 34.2% of the households inherited the irrigated land while 32.2% purchased the land from other farmers. About 21.3% of the farmers, obtained farm plots after being allocated by the government. The remaining 11.3% rent the land they use while 1% has been granted by friends and relatives (Fig. 3).

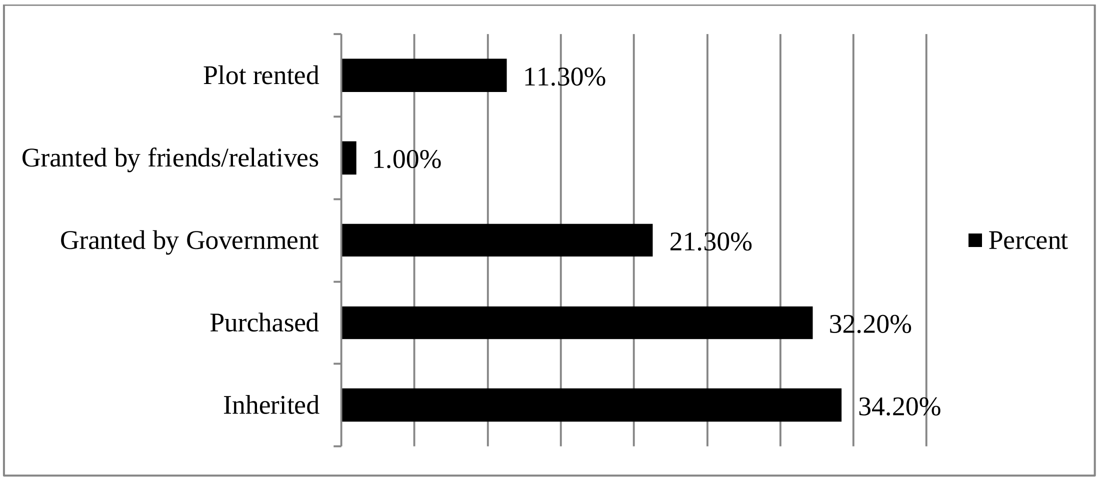

Fig. 3: Means of land acquisition by farming households in irrigation schemes

4.1.2.2 Size of plots operated by farmers in irrigation schemes

Farming activities under smallholder-improved irrigation schemes in Mbeya Urban and Mbarali districts were operated under small farm plots with a minimum acreage of 0.25 and maximum of 8 acres. Some farmers owned more than one farm plots, which were located in different farm blocks within the scheme. About 55.5% of farmers undertook crop production on farm plots with an area ranging from half an acre to one acre. Another 25.9% of farmers produced crops on plots with sizes ranging from more than 1 to 2 acres. On average, crop production in the study area was operated on plots averaging at about 1.5 acre. Renting farm plots to other individuals in the irrigation scheme was a common practice, especially to farmers who didn't own adequate land for cultivation.

4.1.3 Management of irrigation schemes in the study area

4.1.3.1 Distribution of irrigation water in the irrigation schemes

The distribution of irrigation water in the scheme was implemented by WUA leaders depending on the schedule prepared in each scheme. Leaders in the association had drawn the schedule for water allocation, commonly known as "*zamu′za maji"*. At the junction of the main and secondary canals, there are several division boxes each having a control gate (Plate 5). 'Gate operators' chosen among farmers in the schemes manage these division boxes. The control gates are fixed at the intake of secondary canals, where they are opened and closed periodically to allow conveyance of water into irrigated plots through the tertiary canals. In most cases, water distribution was done on a rotational basis mainly in the dry season where farmers undertake irrigated farming. Sometimes during the rainy season when there is a need to irrigate crops from the schemes due to shortage of rainfall, the distribution schedule is reactivated.

Plate 5: Control gate opened to allow water flow into secondary canal at Igomelo scheme

The schedule for water rotation system needed to be observed throughout the dry season since the available water in the system remained the only source for crop production. Majority (90%) of surveyed farmers from Igomelo, Ipatagwa and Luanda Majenje schemes accessed irrigation water for at least once in a week, with the exception of few farming households, that is, 7.2% and 3.6% from Iganjo scheme who receive water once and twice per month respectively depending on the requirements of crops.

Despite the stipulated arrangement for irrigation water distribution in the scheme, about one third (31.9%) of the farmers complained about receiving a limited amount of water, which was not enough for the crops grown. Farmers who complained about insufficient water had different views on the causes of the problem. About thirty one percent of the farmers felt that the shortage of water flow was caused by insufficient water in the main canal but 1% insisted that the problem was a result of negligence of irrigation scheme leaders (gate operators) to observe the distribution schedule.

Though the majority (81.7%) of farmers were satisfied with how their leaders were executing water distribution arrangement as per schedule, 18.3% of farmers claimed that there was a violation of the rotation, which was believed to happen after unscheduled farmers have bribed the gate operators to allow water flow to their fields during the night. As a result, farmers who were supposed to get water as scheduled ended up receiving limited amount of water during the day. Farmers who raised this concern said they sometimes conducted patrol at night to make sure that farmers adhered to the distribution arrangement according to the scheduled rotation in order to avoid unnecessary conflicts among the irrigation scheme members.

4.1.3.2 Cleaning of canals within the irrigation schemes

Cleaning the scheme mainly involved removing sand and mud deposits from the canal (desiltation), weed infestation and removing any undesirable materials in the canals (Plate 6). Proper cleaning is important in order to remove undesirable materials since prolonged silt deposition is believed to accelerate not only wear and tear of the facility but also the reduction of water flow in the canals.

(6a) Uncleaned canal

(6b) Cleaned canal

Plate 6: Parts of uncleaned (with stones and debris) compared to cleaned canal

Though cleanliness is a continuous activity, the implementation become more serious when the end of rainfall season is approaching since from there irrigation water becomes the only source for crop cultivation. In order to continue sustaining farmers' interest to participate in maintenance activities, there was a fine amounting to 5 000 TAS charged to those who did not attend the cleaning session for unjustifiable reasons.

However, in Luanda-Majenje scheme, cleaning exercise of the irrigation facility was organized differently as from other schemes. Apart from paying fees to cover water use permits, farmers were also required to contribute 10 000 TAS in order to hire people who will clean the canal. Leaders in this scheme decided to use this approach because of tendencies of farmers to ask for excuse when the cleaning exercise was executed. For example, people would even pretend to be sick in order to avoid participating in the cleaning exercise.

4.2 Profitability of Crop Production under Irrigated Farming

The findings in Table 9 show that, for the five crops, which are mostly grown in the irrigation schemes, where households produced horticultural crops (onions and tomatoes) earned higher gross margin than those produced non-horticultural crops. Results indicated that the highest gross margin were from onions averaging at 1 827 095 TAS per acre, followed by tomatoes with an average gross margin of 836 326 TAS per acre.

Table 9: Gross margin analysis summary for specific crop enterprises (maize, paddy, onions, irish potatoes and tomatoes)

Statistics	Total variable costs per crop per acre	Gross margin per acre
	Maize	
Minimum	62 000	29 167
Maximum	642 000	1 179 333
Average	172 914	273 143
	Paddy	
Minimum	60 000	151 000
Maximum	860 000	1 396 000
Average	284 119	426 293
	Onions	
Minimum	95 000	(135,000)
Maximum	1 800 000	3 908 000
Average	737 182	1 827 095
	Irish potatoes	
Minimum	96 000	(41 000)
Maximum	1 592 000	2,836 000
Average	515 902	697 773
	Tomatoes	
Minimum	65 000	(167 500)
Maximum	1 438 000	3 390 000
Average	435 453	836 326

Further, the results show that households produced irish potatoes obtained a gross margin averaged at 697 773 TAS per acre (Table 9) while paddy producers got an average gross margin of 426 293 TAS per acre and the least gross margin were earned by maize producers averaged at 273 143 TAS per acre. These gross margin findings revealed that, production of horticultural crops were more profitable than production of other crops, which were mainly cereals and tubers.

The findings in Table 10 show that, on average, the variable cost of crop production in one acre was 589 280 TAS. The minimum cost of producing crop in one acre was 75 600 TAS while the maximum was 1 286 400 TAS per acre. High production cost was found in the production of irish potatoes and onions, since both crops are labour intensive and requires the use of improved inputs as compared to other crops like maize and paddy. A higher cost was associated to the use of seed and fertilizers.

Table 10: Gross margin analysis summary for crops grown

Description	Minimum	Maximum	Average
Value of crops produced per acre			1 401 406
Production costs			
Seed	6 267	294 400	84 787
Fertilizer	14 300	504 800	141 853
Pesticides	3 967	237 000	38 743
Plot hire	55 389	180 889	100 965
Equipment hire (e.g. sprayer)	20 933	75 333	36 427
Labour	12 300	572 000	136 505
Farm Preparation	50 000	50 000	50 000
Total production cost per acre	75 600	1 286 400	589 280
Gross Margin per acre		3,908,000	812 126

Across all irrigation schemes, the cost for fertilizer application in the production costs was higher (24.07%) followed by hired labour by 23.1% of the total production costs per acre (Table 10). On average the land and under irrigation schemes was cultivated twice in a year; during the rainy season where rain fed crop cultivation is practised and in the dry season when crops are irrigated (with exception to paddy). This frequency of using the land requires fertilizer application, which resulted into higher production costs. The production of paddy and horticultural crops (onions and tomatoes) from planting until harvesting is labour intensive. As a result, family labour was insufficient for sustaining crop production and hence hired labour became a necessary supplement.

Farming households in the area were getting on average a gross margin of 812 126 TAS per acre and the maximum margin received was amounted to 3 908 000 TAS per acre while the minimum gross margin was a loss (Table 10).

Furthermore, the Kruskal-Wallis Test results (Table 11) showed that there was a statistically significant difference in gross margins per acre among improved irrigation scheme, chi-square (χ^2)= 52.47, p = 0.00, with a mean rank of 213.2 for Igomelo scheme, 128.52 for Luanda Majenje, 125.57 for Ipatagwa scheme, and 135.79 for Iganjo scheme.

Table 11: Kruskal-Wallis Test results summary

Irrigation scheme	Rank	Mean Rank
Igomelo	1	213.20
Luanda Majenje	2	128.52
Ipatagwa	3	125.57
Iganjo	4	109.89
Chi-Square		52.47
Degree of freedom (df)		3
Asymp. Sig		.000

The mean rank score values indicate that farmers in Igomelo scheme were getting the highest gross margin per acre as compared to those earned by farmers in other improved smallholder schemes in the study area. This implies that, the use of gross margin as a measure of economic efficiency in crop farming, ascertained that farming households in Igomelo scheme were more efficient than those in other irrigation schemes and farming households at Iganjo scheme were the least efficient.

4.3 Determinants of Profitability under Irrigated Farming

Generally, the fit measures of the goodness of the regression model were good where the adjusted R-square was 73% (Table 12). This implies that the covariates in the regression model were able to explain the variation of profitability by 73%. From the summary, the F-value of the overall model was significant indicating that the choice of the model was appropriate in explaining the relationship between the dependent and the independent variables. The test for multicollinearity indicated that such problem was not severe because the variance inflation factor (VIF) had a value of

3.7, which is below the minimum threshold of 5. The Dublin-Watson test for autocolleration was 1.946, which indicates the absence of problem. The White's test also revealed that there was no heteroskedasticity problem in the model.

Table 12: Factors that determine gross margin of irrigated crop production

Linear regression					
Dependent variable					**Gross margin (GM) per acre (TAS)**
Source	**SS**	**df**	**MS**		
Model	5.45E+13	12	4.54E+12		Prob > F 0.002
Residual	2.63E+13	23	1.14E+12		R-squared 0.675
Total	8.08E+13	35	3.96E+11		Adj R-squared 0.505
Variable	**Expected sign**	**Coefficient**	**Std. Err.**	**t**	**P>|z|**
Intercept	+	-5048724.096	2131978.023	-2.368	.027
HHSex	+	1725193.178**	608338.295	2.836	.009
Educat	+	555662.583**	164183.585	3.384	.003
Locfarm	+	15813.095	467268.138	.034	.973
Farmlabour	+	-115920.109	196669.949	-.589	.561
Extensionvisit	+	12434.274	65983.575	.188	.852
Farmexp	+	109685.857**	52703.523	2.081	.049
Livestochhold	+/-	-517292.703**	177266.270	-2.918	.008
Irrigatefreq	+	135463.132	114685.484	1.181	.250
Creditaccess	+	249001.205	510363.009	.488	.630
Luanda majemje	-	-1736375.115**	737017.823	-2.356	.027
Ipatagwa	-	-1458842.530**	492837.639	-2.960	.007
Iganjo	-	-1357869.604	677934.439	-2.003	.057

** significant at 5 percent level

Some of the variables, which were included in the regression model, had significant influence on the gross margin (GM) while others were not (Table 12). The variables, which had significant influence on the GM, were sex of the household head (HHSex), education level of the household head (Educat), farming experience

(Farmexp) and livestock holding (Livestockhold) measured in TLU. All these four variables had a positive influence in explaining the variation of farming profitability in improved smallholder irrigation scheme.

The results from Table 12 indicate that male-headed households were making higher gross margin (1 725 193TAS) per acre compared to female-headed households. The difference in farming profitability between male and female-headed households might be because the latter produce crops of lower value such as maize and, thus, their overall profitability tends to be lower than that of the former. For example, onions and tomatoes were largely produced by male-headed households across the four irrigation schemes while female-headed households produced maize. This was also reported by waGithinji *et al.* (2014), who found that, women in Kenya were getting low profit from farming because they chose to grow crops of low value compared to men.

The level of education attained by the head of household had also a positive influence in the gross margin of individual farming household. As the education level of household head increased by one year, the gross margin were likely to increase by 555 662 TAS per acre. This significant positive relationship between the education level and increase in farming gross margin plays an important role to enhance agricultural development. This finding is similar to Ahmadu (2011), who found that education is important in creating awareness, perception, and adoption of improved agricultural production practices that can increase productivity and farm profit.

The experience in farming had a positive and significant influence in increasing the profit margin obtained by faming households. An increase of farming experience by one was one year was likely to increase the gross margin by 109 685 TAS per acre. This relationship implied that farmers with higher farming experience are more efficient in the production of crops. An increase in in farming experience could enhance farming skills, which in turn increase the gross margin due to increased productivity. This result is similar to that of Okam *et al.* (2016) who found the positive relationship between farmers experience in farming and profitability.

Moreover, livestock holding was also among the determinants of gross margin in irrigated farming, with a negative sign and significant. Farming households with more livestock holding were likely to get low gross margin by 517 292 TAS compared with those with low holding. This relationship can be attributed to the fact that, households with more livestock holding were considering livestock as the primary economic activity and put more effort in livestock keeping and less effort in crop production. At the same time, these households were probably regarding irrigated farming as the secondary economic activity and put less effort which resulted to a decrease in the gross margin.

Besides that, the results for a control variable indicated that, the gross margin for households in Igomelo scheme was higher than that of farmers in Luanda majenje, Ipatagwa and Iganjo schemes. The difference in the gross margin between Igomelo and Luanda majenje and Ipatagwa schemes were statistically different (Table 12). The difference was as expected due to the fact that, farmers at Igomelo scheme, apart from producing other crops like maize, they were as well to a large extend producers of high value crops like onions and tomatoes compared to other schemes.

Other variables such as location of the farm plot in the scheme, available household labour for farming activities, access to extension services, farming experience of the household head, irrigation frequency and access to farm credit had no significant influence to explain the variation of the gross margin in the scheme.

Considering results in Table 12, the null hypothesis was rejected in favour of the alternative one. There was enough evidence to state that, at 0.05 level of significance, profitability (gross margin) accrued by households from irrigated farming is influenced by socio economic factors such as education level of attained by a farmer. This implies that education is one of the important aspects that enable farmers to undertake profitable farming, which could make farmers better-off economically.

4.4 Farmers' Willingness to Pay for O&M of Improved Irrigation Schemes

4.4.1 Responses on willingness to pay

Majority of interviewed farmers had a positive response on the willingness to pay for operation and maintenance expenses of improved smallholder irrigation scheme found in Mbeya Urban and Mbarali districts. The results in Table 13 show that about 92.4% of farming households were willing to pay for O&M costs whereas 7.6% of farming households were not willing to finance irrigation expenses of the scheme. The unwilling farmers mainly argued that, they were not willing to pay because they believe that the government and donors can finance O&M expenses as a way of reducing financial burden to farmers.

Table 13: Responses of farmers on willingness to pay for O&M expenses

Response	Frequency	Percent
No, I am not willing-to-pay	23	7.6
Yes, I am willing-to-pay	278	92.4
Total		**100.0**

Farmers who were willing to pay expressed different reasons for their decision (Table 14). About 37.9% of farmers were willing to pay for O&M expenses because they believe through IMT policy reforms, the payment for the service will increase efficiency in scheme management. They stated that, the funds collected from them it will be easier to undertake maintenance activities when needed instead to wait for funds from government or donors.

Table 13: Reason for willingness to pay for O&M expenses

Reason	Frequency	Percent
Increase farmers' participation in decision making on the scheme	53	17.6
Increased efficiency in managing the scheme	114	37.9
Farmers benefit by irrigating crops	87	28.9
Help to increase farmers economic welfare	14	4.7
Reduce financial burden to Government	9	3.0
(Not Applicable)	24	8.0
Total	**301**	**100.0**

About 28.9% of farmers were willing to pay for the O&M costs because they believe that no one is responsible for financing the expenses other than themselves who are benefiting from irrigated farming. About 17.6% were ready to pay for the O&M expenses since they believed that their participation in decision-making regarding the funds collected is increased as opposed to when external parties are financing O&M costs of the irrigation schemes. Through their participation, they believed that a sense of ownership to the scheme will be created and which is important for ensuring sustainable management of the schemes.

4.4.2 Factors influencing farmers' willingness to pay for O&M costs

4.4.2.1 Mean willingness to pay for O&M cost

The estimated mean willingness to pay was found to be around 45 000 TAS per acre per household per year. Further, it was found that if the amount will be charged to farmers, the added cost in crop production would be around 7.6% of the total farm production costs per acre. Still on average farmers gross margin per acre will decrease from 770 044 TAS to 725 044 TAS per acre. Hence charging the amount equal or close to the mean WTP will not be a financial burden to farmers provided farmers will continue to benefit financially from irrigated farming.

4.4.2.2 Potential aggregate willingness to pay for O&M costs

The aggregate willingness to pay which each of the scheme could generate was calculated and the results are presented in Table 15.

Table 14: Estimated aggregate WTP of the improved irrigation scheme

Irrigation Scheme	Land irrigated (acres)	Cultivated land by households with valid responses (acres)	Aggregate WTP (TAS)
Igomelo	780	749 (96.1%)	33 705 000
Ipatagwa	1350	1 233 (91.3%)	55 485 000
Luanda majenje	750	662 (88.3%)	29 790 000
Iganjo	275	252 (91.7%)	11 340 000

If farming households willing to pay for O&M in the scheme will be charged 45 000 per acre, in aggregate each of the schemes could generate funds, which could be used to finance O&M activities. For this reason, efforts are required to provide a mechanism that will enhance water user associations to collect the funds required to sustain management of the schemes.

4.4.2.3 Determinants of farmers' willingness to pay for O&M

The results of logistic regression show that the chi-square was significant indicating that, the model fitted well in explaining the relationship between the likelihood of farmers' willingness to pay and the independent variables. Some of the hypothesized variables were significant at ($p<0.05$ and $p<0.1$) while others were not as indicated in Table 15. All variables included in the model had the expected influence on WTP. The bid variable had a negative and significant relationship ($p = 0.00$), which indicates that the likelihood of accepting higher bid decreases as the bid amount increases and vice versa. The amount of farm credit (Creditamount), used to finance farming operations and total livestock holding (Livestockhold) owned by households, membership in rural economic associations (Memberrual), farming experience (Farmexp) of the household head and availability of off-farm income

(Offarm) generating activity to the household had positive insignificant influence on WTP for O&M expenses.

Table 15: Logistic regression results on determinants of farmers' WTP

Dependent variable (WTP)				1 = if the farmer willing to pay 0 = if not willing to pay		
Independent variables	**Expected sign**	**Coefficient**	**Odd ratios**	**Std. Err.**	**z**	**P>|z|**
Educat	+	0.417**	1.51	0.0324	11.4	0.00
HHsex	+	2.295**	19.14	0.284	12.42	0.00
Memberrural	+	3.472	32.00	0.339	8.78	0.686
Creditamount	+	9.52E-07	1.00	3.68e-06	0.33	0.743
Bidamount	-	-0.000027**	0.94	0.00001	-2.24	0.00
AwareIMT	+	2.871**	17.65	0.356	6.23	0.00
Creditaccess	+	3.522*	33.86	0.129	26.98	0.00
Extensionvisit	+	0.392*	1.48	0.105	4.69	0.00
Farmexp	+	0.291	1.34	0.0282	12.22	0.343
Grossmargin	+	1.46E-06**	1.00	6.86e-07	2.27	0.023
PerceptionIMT	+	3.164**	23.67	0.167	16.35	0.003
Offarm	+	2.902	18.20	0.527	4.59	0.17
Livestockhold	+	0.283	1.33	0.331	1.02	0.306
Number of observation						258
Log Iikelihood						= -119.673
LR chi2(11)						= 51.47
Prob > chi2						= 0.000
Pseudo R2						= 0.1794

** and * indicate significant at p<0.05 and p<0.1 respectively

Education level of the household head was statistically significant and conformed with a priori expectation of the influence of the decision made by farmers to pay for O&M expenses. Farmers with more years of schooling were likely to be willing to pay than those with fewer years of schooling. A change in the education from low to high level was likely to increase the probability of WTP by 51% for O&M expenses. These results conform to the results in a study by Akter (2007) who showed that show that education enhances the awareness on the value of important scarce resource such as irrigation water and therefore farmers make rational decision to pay the required funds to sustain irrigation scheme. Besides that, education enhances the awareness on different matters such as the significance of the reforms being implemented by the government.

Since education level of the household head was statistically significant at (p=0.05), it was therefore possible to reject the null hypothesis that personal attributes such as education level of an individual farmer does not influence WTP for O&M of improved smallholder irrigation schemes. This implied that, there is enough evidence regarding education as one of the important aspects that enabled farmers to make rational decisions on such matters as payment for O&M expenses

The sex of the household head was one of the hypothesized variables in the logistic model and, which was found to have a positive and significant influence with WTP. The significant positive result indicates that male-headed households were more likely to pay for irrigation water to cover for O&M expenses than was the case with female-headed households. The likelihood of male-headed households to pay for O&M were 19 times more 14% compared to female-headed households (Table 15). Biswas and Venkatachalam, 2015 also revealed the tendency for women to be willing to pay less for irrigation water services. This is associated with a tendency of women to produce crops of lower value such as maize, which results into low profitability than is the case with their male counter parts (waGithinji *et al.,* 2014). The tendency of producing lower value crop like maize by female-headed households is mainly associated with food security issues at the household level.

Farmers’ awareness of new irrigation policy had a positive significant influence on WTP. As indicated in Table 16, the probability of such farmers’ willingness to pay was 17 times more 65% compared to uninformed farmers. This implied that as farmers became familiar with IMT policy reforms, they were expected to see the rationale of contributing financial resources required to finance O&M activities of irrigation scheme where they are the primary beneficiaries. On the other hand, this result implies that people who are aware of the reforms know their responsibility as beneficiaries and the reasons for the government to withdraw from financing O&M. This result conforms to that of Mezgebo *et al*. (2013) who also found that households’ awareness of irrigation water was associated with a positive likelihood on WTP.

Access to credit positively and statistically influenced the household’s decision to pay for O&M expenses. Farming household that received credit were 33 times more 86% to be willing to pay for O&M than those with no access (Table 15). The credit accessed was used to finance farming operations such as purchasing seeds, pesticides and fertilizers that were important for increasing farming productivity. The increased harvest level enabled farmers to earn more farm income, which was used to pay for O&M and other farming operations. This finding is consistent with the finding in a study by Omondi *et al.*, 2014.

The provision of extension services to farming households was also positive and significant to determine the likelihood of farmers’ decision on WTP for O&M. Farmers who had more extension visits were likely to have the likelihood of 48%

more to pay for O&M than those with fewer visits. Access to extension services was likely to improve agricultural knowledge among farmer, and which can enhance their increase in farming outputs from irrigation practices. The increased produce could increase solvency of farmers and as a result, their willingness to pay for the service.

The gross margin (crop income) from irrigated farming was positive and significant in influencing farmers' WTP for O&M expenses. An increase in crop income was likely to increase the probability of farmers' willingness to pay for the O&M expenses. The probability of farmers to pay for the expenses was higher by 100% more as the gross margin increased. The increase in gross margin implied that farmers were benefiting from using the scheme and therefore they are more likely to see the rationale of paying for the costs needed to sustain the scheme operations. The influence of income obtained from irrigated farming was also revealed in other studies like that of Biswas and Venkatachalam (2015). Similarly

Similarly, the findings presented in Table 15 on the gross margin (crop income) variable indicate that the farmers'' decision on willingness to pay was statically determined by gross margin obtained by farming households. It is therefore ascertained that the decision of farming household on WTP was influenced by the gross margin obtained from practising irrigated farming at 0.05 level of significance; and this affirms the rejection of the null hypothesis.

The perception of farmers towards the policy reform was also among the important factors that had statistically significant influence on the decision of farmers to pay for O&M expenses. Farmers who had a positive view on the usefulness of the policy reforms had a higher probability of 23 times more 67% than those who had a negative view. Such likelihood on WTP for O&M expenses implied that farmers understood and valued positively the rationale behind the reforms. Studies which have also revealed a positive direct relationship between farmers' perception and WTP include Addis (2010) and Latinopoulos and Mallios (2001).

4.4.2.4 Factors influencing the amount of farmers' WTP for O&M costs

The Tobit results (Table 16) indicated that, livestock holding and gross margin obtained from irrigated farming influenced the amount of WTP for O&M costs. Further, the results indicated that, the model fitted well to explain the relationship between the dependent and independent variables included in the analysis. The marginal effects, p-value of the chi-square statistics seems significant and the log likelihood value is -1240.594, indicating that the model converged well.

The overall Tobit model results (Table 16) indicated that, livestock holding and income from crops (gross margin) were statistically significant at $p<0.05$ and $p<0.01$ respectively. These variables have a positive relationship with the amount which farmers were willing to pay for O&M expenses as expected. Although the remained variables were insignificant, some of them such as sex of the household head, farm labour, and perception on policy reforms had unexpected negative signs.

Table 16: Tobit results on determinants of amount farmers were willing to pay

Dependent variable					**Amount of farmers' WTP**
Independent variables	**Coefficient**	**Elasticity (ey/ex)**	**Std. Err.**	**z**	**P>|z|**
HHsex	-993.724	-.015	.1000439	-0.15	0.881
AgeHH	100.64	.118	.1676431	0.70	0.483
Memberrural	2170.624	.0308	.0517098	0.59	0.556
Farmlabour	-130.8	-.0098	.1151638	-0.08	0.937
Livestockhold	1335.84**	.0337	.0139021	2.42	0.015
Offarm	2568.255	.0158	.0314752	0.50	0.616
AwareIMT	3332.43	.04698	.0508387	0.92	0.356
Extensionvisit	556.296	.05148	.0589477	0.87	0.383
GrossMargin	0.011***	.141	.0382107	3.61	0.000
PerceptionIMT	-4912	-.1069	.1340204	-0.79	0.427
Number of observation					= 233
LR chi2(10)					= 19.07
Prob > chi2					= 0.0246
Pseudo R2					= 0.0079
Log likelihood					= -1240.594

*** and ** indicate significant at p<0.01 and p<0.05 respectively

It can be deduced from Table 16 that livestock holding influenced positively and significantly the amount which farmers were willing to pay. Farming households, which kept animals, were willing to pay higher amounts of money to finance O&M as opposed to households, which did not keep livestock. An increase in livestock holding by one unit (TLU) was likely to increase the amount farmers were willing to pay by 3.4%. Livestock ownership can be used as a source of income by the household when animals are sold, and such income obtained can be to finance various farm operations including paying for irrigation water services.

Moreover, livestock livestock owned by farming households are a good source of manure, which can be used in crop production and by doing so farmers are reducing production cost that could be bared if inorganic fertilizers were purchased. It can therefore be said that, livestock ownership plays an important role in influencing farmers to pay the needed costs to sustain O&M of irrigation schemes.

Similarly, the gross margin (crop income) from irrigated farming had a significant positive impact on the amount, which farmers were willing to pay; in that it influenced farmers to pay more money for O&M costs. The findings in Table 16 indicate that as income from crops increased by one unit, the amount (TAS) which farmers were willing to pay increased by 14.1% of the WTP amount. An increase in gross margin (crop income) means an increase in solvency, as a result farmers will be motivated to pay more to support O&M activities in the scheme. It is therefore important for farmers to increase productivity that will raise their gross margin from farming enterprises in the scheme in order to manage the payment required to cover O&M of schemes they operate. Similar results to this, were also found by Uddin *et al.* (2016) in Bangladesh and Astatike (2016) in Ethiopia.

4.5 Challenges Facing Farmers in Improved Smallholder Irrigation Schemes

Challenges facing farmers in irrigation schemes were ranging from different perspectives including access to agricultural extension services, marketing, operation and maintenance of irrigation infrastructures, post-harvest management and the management side of the schemes in general.

During interviews, it was found that majority of the households (62.5%) did not have access to agricultural extension services, while the remaining 37.5% had access to the service. About 69.1% of farmers who did not access the service complained about the insufficient number of extension officers required to offer such services as the main reason for inaccessibility to the services when needed. Moreover, it was found that despite the availability of farmers' field demonstration plots 'shamba *darasa'* in the area, farmers' attendance to these sessions was discouraging. Only 20% of farmers attended the session when offered and those who did not attend had no any justifiable reason.

Around 50% of farming households were not joined any rural economic groups despite those groups and or associations existed in the study area. On one hand, it can be argued that farmers in the area are not aware of the benefits of being members of these groups. On the other hand was possible to say that farmers were probably neglecting to cooperate in groups with other farmers in the study area, and therefore ended to loose the collective benefits of the groups. Such benefits include access to credit with minimal conditions and collective bargaining power on selling crops.

Surprisingly, it was found that majority of farmers (around 70%) were even not members of irrigators' associations simply because it was not mandatory for them to join the group. The danger of this is that some of the irrigators may lack the sense of ownership of the irrigation infrastructure, which is an important aspect for the sustainable implementation of IMT reforms.

Likewise, attendance to water user meetings is one of the identified challenges that existed in the irrigation schemes. This is because not all farmers who attended meetings of water user associations did so regularly. Only 55.14% of the interviewed farming households attended the meetings regularly, whereas 23.9% sometimes attended and 20.9 % rarely attended the meetings (Fig. 3).

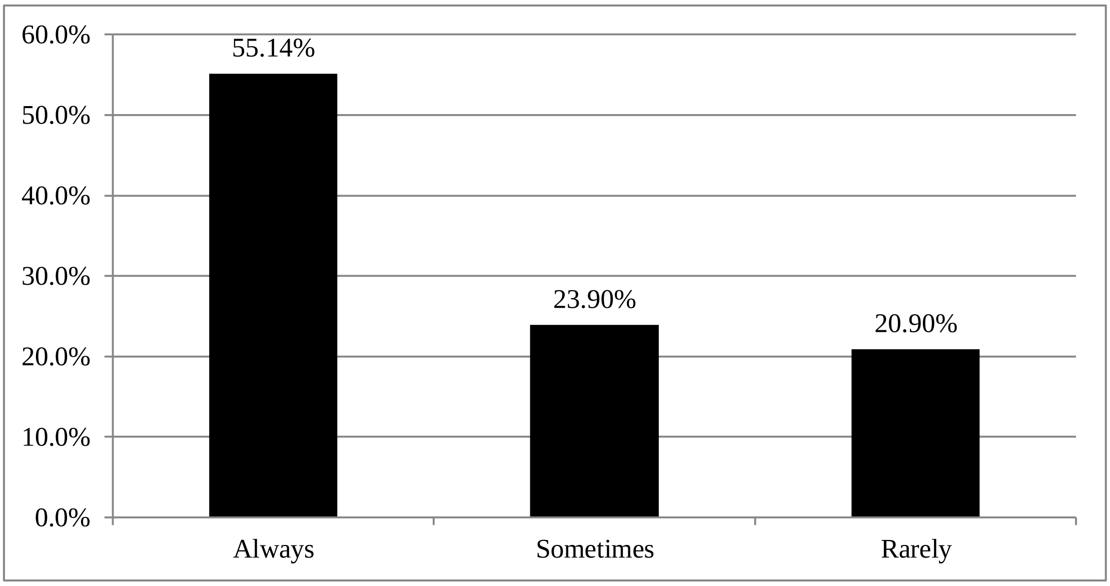

Figure 3: Farmers' attendance to irrigators' meetings

As depicted from Fig.3, almost half of the farmers did not had the tendency of attending meeting regularly, something, which is necessary for effective devolution of management in irrigation. This is because meeting attendance provided a platform for farmers to discuss issues pertaining to the management of the schemes. Hence farmers who rarely attended the meeting were likely not to be well informed regarding different matters concerning the management of the scheme.

Further, it was reported by irrigators leaders that the payment for fees directed mainly to pay for water use permit '*mchango wa maji"* was one of the challenge existed in the schemes. Although farmers had been paying the fees, association leaders in all the surveyed irrigation schemes declared two major concerns, which were experienced in the area with regard to this. The first was that some farmers did not pay the fees (up to 20% defaulting rate) and the second was the delayed payment as per the agreed time plan. Such resistance and delays in fees payment affected the timely implementation of scheduled activities within the scheme.

It was further found that under the current arrangement, farmers were paying the fees at the end of the cropping season, which was seen as a source of defaulting. One alternative way advised by scheme leaders was to change the modality of fees collection from the current one. Therefore the suggested modality would be to collect fees prior to planting period since this would motivate farmers to put more efforts in crop husbandry in order to avoid the sunk cost.

Lack of transparency on the management of the collected funds was another problem reported by farmers in the irrigation schemes. Farmers complained about the time interval taken by the leaders before disclosing the associations' income and expenditures. For example, 22% of farmers complained about the tendency of scheme leaders not to disclose expenditures from the collection made by farmers, which demotivated farmers from paying the fees. Transparency of the management of scheme operations is an important aspect, which can motivate farmers to pay for O&M costs.

Another challenge was on post-harvest management. Some farmers especially those who grew onions were using a poorly designed building (technology) for onions storage as shown in Plate 7. This was observed during data collection where farmers in Igomelo irrigation scheme had that storage facility made up of wooden materials and roofed by thatch, which caused challenges especially during rainy season. Lack of permanent and special constructed storage facility in the area is one of the major reasons for farmers in the scheme to sell the produce immediately after harvest and loose the time utility that might be gained.

Plate 7: Onion storage facility available at Igomelo irrigation scheme

The poor storage facility resulted onions to sprout during the wet season due to leakages of the thatched roofing and if farmers failed to take appropriate measures on time to curb the situation, some onions spoiled. Sometimes farmers tend to sell their onions at a lower almost throw away price as a way of reducing losses that may result from spoilage. The findings further revealed that despite farmers selling their produce through different available marketing channels, several challenges have been facing farmers as identified in Table 17.

Table 17: Marketing challenges facing farmers under irrigation schemes

Challenges	Frequency	Percent
Low price offered	179	59.5
Unstandardized measurement system exploiting farmers	18	6.0
Middlemen (*Dalali*) are too exploitative	11	3.7
Lack of official market place	11	3.7
Lack of storage facility	2	.7
Levy on crops is high	1	.3
NA	79	26.2
Total		**100.0**

NA indicates that farmers were satisfied with the prevailing marketing condition

Moreover, farmers in the area complained of lower price offered by buyers as indicated in Table 17 by more than half (59.5%) of the respondents. Farmers complained that in most cases, the price offered to their produce was low compared to the production costs incurred. The lower price resulted farmers to get lower gross margin from the crops sold The production costs was higher since the production system under irrigation schemes requires application of substantial amount of fertilizer, pesticides, and improved seed varieties for realizing high level of productivity.

Apart from low price, 6% of farmers complained about unstandardized measurement system, which exploits farmers when weighing the crops. Buyers of the crops, in most cases, were the ones who dominated the bargaining process between them and farmers. Weak bargaining power of farmers, compel farmers to comply with the proposed unstandardized weighing scales such as plastic buckets and overfilling of gunny bags *(lumbesa*[6]*)*. Farmers who sold their produce in the informal areas (especially at homes) were impossible to access the functioning weighing scales. Due to this unfair business practices, famers tend to receive lower profit margin than what would have been the case if fairness were exercised.

It is evident from Table 17 that, farmers in improve smallholder irrigation schemes faced with many agricultural marketing related challenges as discussed above. However there were other challenges raised by farmers included the exploitation by intermediaries (3.7%), lack of official market place that weakened the bargaining power of customers (3.7%) and other challenges as presented in Table 17.

[6]*Lumbesa* is a bag of crops mainly non-perishable weighted more than 90kg which does not comply with Weight and Measures Act, 1982 of the United Republic of Tanzania

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study examined the willingness of smallholder farmers' to pay for Operations and Maintenance (O&M) costs of improved smallholder irrigation schemes. Four improved smallholder irrigation schemes with Irrigation Management Transfer aspects, from Mbarali and Mbeya Urban District were studied.

Specifically, the study intended to: (i) Assess profitability of irrigated farming and its determinants in improved smallholder irrigation schemes; (ii) Determine smallholder farmers' WTP for O&M of improved smallholder irrigation schemes; (iii) Assess the factors that influence farmers' willingness and the proposed amount of payment for O&M of improved smallholder irrigation scheme, and (iv) Identify challenges facing improved smallholder farmer's in irrigation schemes in the study area.

Gross margin and Ordinary Least Square (OLS) regression analyses were employed in order to determine profitability and its determinants respectively. Descriptive analysis was used to determine the smallholder farmers' WTP for O&M expenses. A binary logistic regression model was employed to assess factors that influence farmers' WTP and a Tobit regression model was used to assess factors that influenced the amount of money that farmers were willing to pay. Finally, descriptive analysis was used to analyse the identified challenges faced smallholder farmers in improved irrigation scheme in the study area.

5.1 Summary and Conclusion

5.1.1 Profitability of irrigated farming and its determinants

On average, the total variable farm production cost in the study area was around 589 280 TAS per acre. The minimum and maximum costs of producing a crop in one acre were 75 600 TAS and 1 286 400 TAS respectively. High production cost was found in the production of irish potatoes and onions, since both crops are labour intensive and requires the use of improved inputs as compared to other crops like maize and paddy. Higher production cost was attributed to the use of inorganic fertilizers (24.07%) and hired labour amounting to 23.1% of the total farm production cost.

The gross margins averaged at 812 126 TAS per acre and the maximum margin received was amounted to 3 908 000 TAS per acre while the minimum gross margin was a loss. The Kruskal-Wallis Test showed that there was a statistically significant difference in the gross margins per acre among improved irrigation schemes, with the mean ranks indicating that farmers in Igomelo scheme were getting higher gross margins than those in other schemes.

Factors determined profitability of irrigated farming in the study area were, sex of the household head, education level of the household head, farming experience of the household head and livestock holding of the household. The first three variables were having a positive significant influence, which implied that an increase in these variables were associated with an increase in the gross margin from irrigated farming.

5.1.2 Farmers' willingness to pay for operation and maintenance expenses

Majority of farmers were willing to pay for operation and maintenance expenses while few were unwilling. Farmers were willing to pay because they believe that, the implementation of the policy was inevitable. It is therefore important for them as primary beneficiaries to pay for operations and maintenance expenses since such payment would increase efficiency in irrigated farming. The estimated mean willingness to pay per individual farming household was 45 000 TAS per acre per year, which is almost 6% of the agricultural income of the farming households.

5.1.3 Determinants of farmers' willingness to pay for operation and maintenance

The study found that socio economic and farm related variables influenced the willingness of the farmers to pay for O&M. Male-headed households were likely to be more willing to pay than the female-headed households. WTP for O&M also increased with the level of education of head of households.

Farming households that accessed credit had higher likelihood of WTP for O&M expenses than households that had no access to credit. Willingness to pay for O&M also increased with the level of awareness and perception of farmers about the implementation of policy reforms.

The importance of accessing extension services was also revealed since farmers who had access to extension services showed a higher likelihood on willingness to pay for O&M expenses. The gross margin (income) obtained from irrigated farming was also among the crucial determinants of farmers' willingness to pay for O&M expenses.

Besides, the results from Tobit model have shown that the livestock holding (in Tropical livestock Unit) and gross margin from crops were statistically significant and had positive relationship with the amount farmers were willing to pay for O&M expenses. Households with higher livestock holding and those with more income from irrigated farming were willing to pay higher amounts to finance O&M than their counterparts with low livestock holding farm and farm income.

5.1.4 Challenges facing improved smallholder irrigation schemes

Majority (62.5%) of households in the study area did not access agricultural extension services, due to insufficient number of available extension officers compared to demand. Majority of farming households were not members of any rural economic group despite the existence of such groups and or associations in the study area. Majority of farmers are not members of irrigators' associations because it was not mandatory for them to join the associations. Poor attendance to water user meetings and long duration taken by scheme leaders before reporting associations' income and expenditures were among the challenges facing improved smallholder irrigation schemes.

Other challenges include poor post-harvest handling especially among farmers who grew onions which results into sprouting and spoilage. Other challenges include, use of unstandardized measurement system, exploitation of middlemen, and inadequate number of potential buyers who could offer better prices, and lack of official market place which weaken the bargaining power of customers.

5.2 Recommendations

From the findings of this study, the following recommendations are drawn.

(a) There is a need of continued sensitization of farmers on the rationale of policy reforms toward sustainable operation of irrigation schemes, such that farmers can see the importance of their financial contribution toward supporting operation and maintenance activities. This would create an incentive to voluntary payment of O&M expenses, which is an important pillar for successful implementation of IMT. Awareness creation helps to frame beneficiaries to be ready to handle the required financial responsibilities due to IMT reforms.

(b) Farmers should be encouraged to produce both low and high value crops such as onions and tomatoes that would increase farm profitability. The increased benefit from irrigated farming would make farmers to have a positive view toward IMT and this in turn, would make farmers comprehend the rationale behind their voluntary contribution toward payment for O&M expenses. Besides, other national goals such as poverty reduction and food security would be attained sustainably.

(c) The government should set a proper irrigation water pricing an amount close to the mean WTP (45 000 TAS per acre per year) that farmers were willing to pay. The payment will be important to reflect profitability of farmers from irrigation practices. In order to reduce defaulting rate, it is also advised that the fees should be collected from farmers before planting of the crops. Further, there must be strong enforcement of penalties for those who default.

(d) It is further recommended that, provision of agricultural extension and credit services is still important to farmers in crop farming. Thus, the government and other stakeholders should continue to improve the service delivery especially by increasing extension staffs who would attend farmers. The provision of the service would increase efficiency in farming through better knowledge from extension staff. If farmers will be inefficient, it is likely that voluntary payment for O&M will be difficult and this will affect the successfulness of IMT policy reforms efforts. In addition, farmers should also be provided with soft loans since it will enable them to finance their farming activities and timely purchasing of improved inputs such as seeds and fertilizers.

(e) Similarly, the government should enforce a by-law that, that will mandate all farmers in the scheme to be members of irrigator associations contrary to the current state. Becoming a member of an association will not only benefit farmers to easily access services but it would also create a sense of ownership, which is an important aspect toward sustainable IMT implementation. While it can remain optional for farmers to join other group associations, it should be mandatory for farmers in the scheme to be members of WUA.

(f) In addition, marketing related challenges such as poorly organized agricultural marketing system, use of unstandardized weighing scales, poor post-harvest handling which limit farmers from getting storage utility especially onions producers need to be addressed. A collaborative intervention between farmers and the government can be directed to the construction of permanent building, which would be used as a warehouse. At the same time, the warehouse would serve as farmers' selling points for their produce, such that farmers can get better prices which would raise their economic welfare.

Lastly, it is recommended that, the end this study should be a springboard for further studies. Since this study was done in one region as a case, thus more surveys that are extensive can be carried out in other areas of the country to have a wide representation at the country's level. Nonetheless, the findings from this study can provide some guidance toward future research on willingness to pay for O&M expenses in other localities.

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APPENDICES

Appendix 1: Questionnaire

INDIVIDUAL QUESTIONNAIRE FOR IRRIGATION MANAGEMENT TRANSFER: FARMERS' WILLINGNESS TO PAY FOR OPERATION AND MAINTENANCE OF SMALLHOLDER IMPROVED IRRIGATION SCHEMES

Introductory statement:
"Dear Sir/Madam, I am a PhD student at Sokoine University of Agriculture, Morogoro. I am conducting this survey to study the willingness of smallholder farmers' to pay for operation and maintenance of smallholder irrigation schemes in rufiji basin with Mbeya region as a case study. Taking part to this study is voluntary and your response to questions that we will ask you will remain anonymous. Thank you for your kind co-operation

Date of interview:	**QUESTIONNAIRE No:**

SECTION 1: INDIVIDUAL HOUSEHOLD IDENTIFICATION DETAILS

Item description	**Response or Code**	
0.HOUSEHOLD FARM'S LOCATION	**1= Upstream**	**0= Downstream**
1. Region		
2. District		
3. Ward name		
3. Village name		
4. Name of household head		
5. Sex of household head 0=Female 1=Male		
6. Name of respondent		
7. Sex of respondent 0= Female 1=Male [If different from 5]		
8. Mobile Phone Contact Number		
9. Name of enumerator		
10. Name of Irrigation scheme		

SECTION 2: HOUSEHOLD'S CHARACTERISTICS

2.1 HOUSEHOLD MEMBERS' BASIC INFOMATION

All Members of HH currently resident (people who eat from the same pot), Record the information for each individual in the table below

A1	**A2**		**A3**	**A4**	**A5**	**A6**	**A7**	**A8**
Household member ID	**Name of household member**		**Relationship to HH (use code indicated below) (CODE 1)**	**0 = Female 1 = Male**	**Enter age in years (For infants record 00)**	**Marital status (if more or equal to 15 years old) 1=Unmarried 2=Married 3=Separated/divorced 4=Widowed 99=Not applicable**	**Main occupation (Use code provided) (CODE 2)**	**Years spent in school 1=(1-7) Primary level 2=(9-12) O level 3= A-Level 4= Post secondary level 99=Not applicable**
	First name	**Surname**						
1								
2								
3								
4								
5								
6								
7								
8								
Total number of household members								

Relationship to Household Head (CODE1)

1=Spouse	6=Father/mother in law
2=Child	7=Grandchild
3=Father/Mother	8=Grandfather/grandmother
4=Broyher/Sister	9=Adopted child
5=Cousin	

Main Occupation (CODE 2)

1=Crop production	6=Govnmt employee 7=Student
2=Livestok keeping	7=Student
3=Casual labourer	8=Child under school age
4=Agribusiness	9=Housewife
5=Private sector employee	10=Disabled

2.2 Apart from farming as one source of income to the household, is there any other source?

1= YES 0= NO

2.3 If YES, which one among the following?

1= Government or Private employee
2= Laborer
3= Small business retail
4= Artisan/ craftsman
5= Middleman (Dalali)
6= Other, specify……..

2.4 In the house you stay with your family is that your own property or rented? (1= Own; 0= Rented)

2.5 What is its status? Fill the table below

Wall construction	**Roof construction**	**Eletricity**	**Piped water for household daily uses**	**Presence of source of water**
A	**B**	**C**	**D**	**E**
1= Concrete 2= Bricks 3= Wood 4= Mud	1= Tiled 2= Corrugated Iron 3= Thatch	1= YES 0= NO	1= YES 0= NO, if NO go to (E)	1=Traditional well 2= Fetch from public source 3= River

SECTION 3: AGRICULTURAL PRODUCTION INFORMATION
PART 3 (A): LAND OWNESHIP AND CROP OUTPUT

3.1 How **many plots** of land **UNDER IRRIGATION SCHEME** did you operate last cropping season? _______________

3.2 What is the form of ownership for each plot cultivated (use table below)

(Fill in the information of plots operated in the irrigation scheme)

Plot number	**Size of plot [acres]**	**Form of owneship** 1= Owned by family 2= Hired 3= Owned by friends/relatives	**For plots owned by your family , in what ways you acquired them?** Means of acquiring 1= Inherited 2= Purchased 3= Granted by Govnmt/friends/relatives	**If hired, how much does it cost per one croping season (TSH)** **Note: If payment in kind, attach value**	**Total area owned [acres]**	**Total area hired [acres]**
1						
2						
3						

3.3 Does your household **rent area to** others in the irrigation scheme for cultivation purposes? (1= YES; 0= NO)

3.4 If YES, what is the size of that area _________ [Acres] **AND** Amount received ___________________ TSH

3.5 Generally how much does it cost to rent land**[1 acre]** for cultivation purpose in the irrigation scheme you are currently operating __________TSH

3.6 How many plots of land are **NOT UNDER IRRIGATION SCHEME** did you operate last cropping season? _______________

3.7 Generally how much does it cost to rent land **[1 acre]** which is outside of the scheme for cultivation purpose __________TSH per season

(Fill in the information of plots operated *outside* of irrigation scheme)

Plot number	**Size of plot (acres)**	**Form of owneship** 1= Owned by family 2= Hired 3= Owned by village	**If hired, how much does it cost per one croping season (TSH)**	**Total area owned [acres]**	**Total area hired [acres]**
1					
2					

3.8 For each of the land plot under irrigation scheme, what type of crops grown in the last cropping season? (Fill in the table below)

Plot No.	**Plot size [acres]**	**Season**	**Crop grown in each plot**	**Quantity harvested from each of the plot irrigated last time?**					**Marketing cost incurred (if any)**
			Crop code (see CODE 3)	**Quantity harvested**	**Measument scale used per quantity harvested (Kiasi kwa ujazo)** **1. Sacks (100kgs)** **2. Plastic bag (25kg)** **3. Bunch (Mikungu)** **4. Sado Pishi** **5. Bamboo basket (Tenga)** **6. Debe (20kg)**	**Equivalent to how many kilograms Sawa sawa na Kg Kwa Kiasi kimoja cha ujazo**	**Selling price per scale measurement** **Bei ya kuuzia kwa Kiasi (Tshs)**	**TOTAL value of crops produced (TSH)**	**1.Sacks for packaging** **2.Insecticides** **3.Transport**
A	B	C	D	E	F1	F2	F3	F4	F5
1		A. Rainy							
		B. Dry							
2		A. Rainy							
		B. Dry							
3		A. Rainy							
		B. Dry							
TOTAL									

CODE 3

101 Red beans	201 Egg plants	301 Carrots	***404 Garlic***
102 Yellow beans	202 Onions	302 Green pepper	***405 Banana***
103 Soy beans	203 Irish potatoes	303 Cabbages	***406 Rice***
104 Red sorghum	204 Sweet potatoes	304 Cauliflower	407 White maize
105 Peas/ *njegere*	205 Cassava	305 Spinach	408 Ground nuts
106 Cowpeas/ *kunde*	206 Yams	306 Cucumbers	**309 Sunflowers**
107 Pigeon peas/ *mbaazi*	207 Pineapples	307 Watermelon	**209 Tomatoes**
	208 Other legumes	308 Other vegetable	

3.9 For each of the land plot **NOT under irrigation scheme**, what type of crops grown in the last cropping season? (Fill in the table below)

Plot No.	**Plot size [acres]**	**Crop grown in each plot**	**Quantity harvested from each of the plot NOT irrigated last time?**					**Marketing cost incurred (if any)**
		Crop code (see CODE 3 below)	**Quantity harvested**	**Measument scale used per quantity harvested (Kiasi kwa ujazo)** **1. Sacks (100kgs)** **2. Plastic bag (25kg)** **3. Bunch (Mikungu)** **4. Sado Pishi** **5. Bamboo basket (Tenga)** **6. Debe (20kg)**	**Equivalent to how many kilograms Sawa sawa na Kg Kwa Kiasi kimoja cha ujazo**	**Selling price per scale measurement** **Bei ya kuuzia kwa Kiasi (Tshs)**	**TOTAL value of crops produced (TSH)**	**1.Sacks** **2.Insecticides** **3.Transport**
A	B	D	E	F1	F2	F3	F4	F5
1								
2								
3								
TOTAL								

CODE 4

101 Red beans	201 Egg plants	301 Carrots	***404 Garlic***
102 Yellow beans	202 Onions	302 Green pepper	***405 Banana***
103 Soy beans	203 Irish potatoes	303 Cabbages	***406 Rice***
104 Red sorghum	204 Sweet potatoes	304 Cauliflower	407 White maize
105 Peas/ *njegere*	205 Cassava	305 Spinach	408 Ground nuts
106 Cowpeas/ *kunde*	206 Yams	306 Cucumbers	
107 Pigeon peas/ *mbaazi*	207 Pineapples	307 Watermelon	
	208 Other legumes	308 Other vegetable	
	209 Tomatoes	**309 Sunflowers**	

PART 3 (B): CROP INPUTS

1. Document input use on crops grown **UNDER IRRIGATION SCHEME** for the past 12 months for the entire household

Plot No.	**Season**	**Crop grown last cropping season?**	**For the crop grown in this plot, how much did this household spend on ..during this season?**										**How many persons-days of family labour were used to grow and harvest the crop in this plot during season?**	**How many persons-days of hired labour were used to grow and harvest the crop in this plot during season?**	**What was the average daily wage paid to these hired laboures?(if payment in kind, note form and value equivalent)**	**Where do most of hired lobourers for this crop come from?**
			..seed and planting materials?		**...fertilizer and manure?**		**...pesticides (including spraying service)**		**..Equipment repair? If any**		**Labour and other operating expenses (if any)**					
A	**B**	**C**	**D**		**E**		**F**		**G**		**H**		**I**	**J**	**K**	**L**
		Crop code (Use CODE 3)	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Number of days	Number of days	Tsh per day	1 Same village 2 Same ward 3 Other (specify)
1	A. Rainy															
	B. Dry															
2	A. Rainy															
	B. Dry															
3	A. Rainy															
	B. Dry															
														Total input cost		

1.1 For crops grown last season under irrigation scheme, did you use improved inputs? (Tick the appropriate one)

1= YES; **0=** NO

1.2 If YES, are they always available in your village whenever needed? **1=** YES; **0=** NO

1.3 Where do you obtain most of your inputs (seeds / fertilizers etc) used in irrigated farming? **[Tick all that apply]**

1= Purchased from local input suppliers in the village
2= Purchased from town (Mbeya city) input suppliers
3= Contract-growing arrangements
4= Use own on-farm input
5= Gifts
6= Otherwise; (specify)……………………

1.4 If inputs are purchased, how are these purchases financed? (Tick all that apply)

1= Own Savings
2= Loans from family / friends
3= Credit from input seller
4= Commercial loan
5= Other (specify)……………………

1.5 How many years have you been farming in this irrigation scheme? (Tick the appropriate one)

1= Less than 1 year
2= 1-2 years
3= 3-5 years
4= 6-10 years
5= More than 10 years

1.6 Which crops grown in this irrigation scheme are regarded as being important to your households? Mention a maximum of THREE crops from CODE 5

CROP CODE	RANK OF IMPORTANCE 1ST , 2ND and 3RD	CODE OF CROP

CODE 5

101 Red beans	201 Egg plants	301 Carrots	404 Garlic
102 Yellow beans	202 Onions	302 Green pepper	405 Banana
103 Soy beans	203 Irish potatoes	303 Cabbages	406 Rice
104 Red sorghum	204 Sweet potatoes	304 Cauliflower	407 White maize
105 Peas/ njegere	205 Cassava	305 Spinach	408 Ground nuts
106 Cowpeas/ kunde	206 Yams	306 Cucumbers	
107 Pigeon peas/ mbaazi	207 Pineapples	307 Watermelon	
	208 Other legumes	308 Other vegetable	
	209 Tomatoes	309 Sunflowers	

2. Document input use on crops grown on plots **NOT UNDER IRRIGATION SCHEME (during rainy season)** for the last cropping season

Plot No.	**Crop grown last cropping season?**	**For the crop grown in this plot, how much did this household spend on ..during this season?**										**How many persons-days of family labour were used to grow and harvest the crop in this plot during season?**	**How many persons-days of hired labour were used to grow and harvest the crop in this plot during season?**	**What was the average daily wage paid to these hired laboures?*(if payment in kind, note form and value equivalent)***	**Where do most of hired lobourers for this crop come from?**
		..seed and planting materials?		**...fertilizer and manure?**		**...pesticides (including spraying service)?**		**..Equipment repair? If any**		**Labour and other operating expenses (if any)**					
A	**B**	**C**		**D**		**E**		**F**		**G**		**H**	**I**	**J**	**K**
	Crop code (Use CODE 3)	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Quanity (Kg or specify unit)	Price per unit TAS	Number of days	Number of days	Tsh per day	1 Same village 2 Same ward 3 Other (specify)
1															
2															
3													**TOTAL input cost**		

2.1 For crops grown last season out of irrigation scheme, did you use improved inputs? (Tick the appropriate one)

1= YES; **0=** NO

2.2 If YES, are they always available in your village whenever needed?

1= YES; **1=** NO

2.3 Where do you obtain most of your inputs (seeds / fertilizers etc) used in farming [out of scheme]? [Tick all that apply]

1= Purchased from local input suppliers in the village
2= Purchased from town (Mbeya city) input suppliers
3= Contract-growing arrangements
4= Use own on-farm input
5= Gifts
6= Otherwise; (specify)……………………

2.4 If inputs are purchased, how are these purchases financed? (Tick all that apply)

1= Own Savings
2= Loans from family/ friends
3= Credit from input seller
4= Commercial loan
5= Other (specify)……………………

2.5 How many years have you been undertaking farming out of irrigation scheme in your village? (Tick the appropriate one)

1= Less than 1 year
2= 1-2 years
3= 3-5 years
4= 6-10 years
5= More than 10 years

3. Document the cost for improved inputs used in production of THREE important crops in this irrigation scheme?

Crop code (use **CODE 4**)	**Plot size [acres]**	**Type of improved input used (use a list below)** **1** Pesticides **2** Chemical fertilizer **3** Organic fertilizer **4** Seed/seedling	**Quantity of input used** (specify unit)	**Cost per Unit of input** (TSH)	**Total Cost** (TSH)
1.					
2					
3					

4. Does gender has relationship with type of crops to be produced in your farm by your household?
1= YES **0**= NO

5. If YES, fill in the NEXT table

Relationship of crop to gender	**Crop code 5 (use codes provided below)**		
11. Which of the THREE crops mentioned below are those that MEN are deciding on growing?	Crop 1	Crop 2	Crop 3
12. Which of the THREE crops mentioned below are those that WOMEN are deciding on growing?	Crop 1	Crop 2	Crop 3

CODE 5

101 Red beans	201 Egg plants	301 Carrots	***404 Garlic***
102 Yellow beans	202 Onions	302 Green pepper	***405 Banana***
103 Soy beans	203 Irish potatoes	303 Cabbages	***406 Rice***
104 Red sorghum	204 Sweet potatoes	304 Cauliflower	407 White maize
105 Peas/ *njegere*	205 Cassava	305 Spinach	408 Ground nuts
106 Cowpeas/ *kunde*	206 Yams	306 Cucumbers	
107 Pigeon peas/ *mbaazi*	207 Pineapples	307 Watermelon	
	208 Other legumes	308 Other vegetable	
	209 Tomatoes	**309 Sunflowers**	

PART 3 (C): HOUSEHOLD LABOUR AVALAIBILITY AND USE IN FARMING ACTIVITIES IN THE IRRIGATION SCHEME DURING LAST CROPPING SEASON

Note: Identify all household members who are involved in provision of labour in farming activities and fill in the table below

H hold member ID (Recall Table 2)	**Name of household member**		**Sex of member** **0 = Female** **1 = Male**	**Age category in years** **0 = Below 18 years** **1 = 18-50 years old** **2 = Above 50 years**	**Is a member participate in full or part-time?** **0 = Full time** **1 = Part time**	**Which activity is a member involved mainly?** **0 = Farm prepration** **1 = Planting** **2 = Weeding** **3 = Fertilizer/pesticide application** **4 = Harvesting** **5 = All farm activities**
A	B		C	D	E	F
	First name	**Surname**				
1						
2						
3						
4						
5						

PART 3 (D): HOUSEHOLD ACCESS TO EXTENSION SERVICES

1. Did your household receive any extension services in the past 12 months?
   1= YES
   0= NO (If "NO" go to 7)

2. If YES how many times? [ ]

3. Describe the source and cost for the extension service received during the past 12 months(fill in the table below)

What types of services were received from provider? See code 6	**What was the source of the assistance (use code 7)**	**Who was responsible for the technical assistance (use code 8)**	Did you pay for that technical assistance? 1= YES 0= NO	If paid, how much did you spend on technical assistance? (TSH)
A	B	C	D	E
CODE 6 <u>Services received</u> 1 New crop introduction 2 Soil analysis 3 Seeds 4 Pest and disease control 5 Harvesting technique 6 Business managent 7 Marketing technique 8 Parking selection 9 Other (specify)	**CODE 7** <u>Source of services</u> 1 Extension agents 2 Livestock centre 3 Veterinary clinic 4 Nearby farmers 5 Other (specify)	**CODE 8** <u>Responsible party</u> 1 Ministry of agriculre 2 District governmets 3 NGO 4 Producers committee/farmers organization 5 University 6 Independent 7 Private sector 8 Other (specify)		

4. Did you follow the advice given extension officer?

1= YES 0= NO

5. Do you satisfied with technical advice given

1= YES 0= NO

6. If NO, what might be the possible reason for that ___________________________________

7. If you didn't receive any farm technical assistance, what do you think is the main reason for that?

0= Not offered
1= Not suitable
2= Too expensive
3= Don't trust providers
4= Not needed

8. Apart from using extension officers as main source of information, do you use any other source?

1= YES 0= NO

9. If YES, how often in the last cropping season as compared to extension officers visit?

0 Once 1 Twice 2 Many times

10. Which among the following was the main source of information received?
(Please elaborate your response "how")

0= TV/Radio
1= Research Centre
2= News papers
3= Mobile phone
4= Farmer Field School

PART 3 (E): LIVESTOCK KEEEPING ACTIVITIES

Document type and quantities of animals kept at your home for the past 12 months

S/No	Type of animals	Quantity	**Value if sold**
1	Cattle		
2	Goat		
3	Sheep		
4	Pigs		
5	Poultry		
6	Fish		
7	Donkey		
8	Others (specify/name)		

SECTION 4: RURAL INSTITUTIONS PARTICIPATION AND ACCESS TO CAPITAL

PART 4 (A): PARTICIPATION IN RURAL INSTITUTIONS

S/No	Type of Institution	Are you a member of any of the following group? 1= YES; 0= NO	How many years you have serving in the group **0=** Less than 1 year **1=** 1-2 years **2=** 3-5 years **3=** More than 5years
1	Savings and credit associations		
2	Farm input supply group		
3	Cooperative unoin		
4	Crop production group		
5	Water User's Association		
6	Crop marketig group		
7	Women's Association / Group		
8	Youth Association		
9	Vicoba		

PART 4 (B): HOUSEHOLD ACCESS TO CAPITAL FOR THE LAST CROPPING SEASON PART S

Household credit need and sources for the past 12 months

Reason for loan		**Did you need credit** **1= YES** **1= NO**	**Why you didn't need credit (rank THREE reasons)** **CODE 9**			**Did you receive credit needed** **1= YES** **0= NO**	**Why did you not receive credit applied** **CODE 10**	If YES in C					
								What was the source of credit? **CODE 11**	What was the amount of credit?	Did you received the amount requested? **1= YES** **0= NO**	What was the monthly interest rate charged in %?	What is the debt outstanding including interest?	Who made the decision about what to do with the money borrowed? **CODE 12**
		A	B1	B2	B3	C	D	E	F	G	H	I	J
1	Buying pesticides												
2	Buying fertilizer												
3	Buying seeds												
4	Buying farm equipment												
5	Buying transport facilities												
6	Buying oxen for traction												
7	Buying livestock												
8	Invest in irrigation system												
9	Small business capital or trade												
10	Pay farm/land rent												
11	To pay wate user fees association												
12	Other family needs (education, travel/ceremony,school fees,health etc)												

CODE 9	CODE 10	CODE 11	CODE 12
1= Not cash constrained 2=Farming is not profitable 3=Borrowing is too risky 4= No money lendes in the area 5= Interest rate is too high 6= Too onerous conditions/process 7= Lenders dont provide the amout needed 8= No credit assoiation 9= Not available on time 10= Have no idea of taking loan 11= Other (specify)......................	1= Too much procedures/process 2= No asset for collateral 3= Bad debt record 4= Nepotism 5= Other (specify)..................	1= Money lender (salesman/shop) 2= Farmer group 3= Microfinance 4= Bank 5= Vicoba 6= Relative/Friend 7= Other (specify).................	1= Self 2= Spouse 3= Self and Spouse jointly 4=All household members

SECTION 5: IRRIGATED WATER SERVICE PROVISION

1. How many times irrigated water is supplied in your farm plot per week?
   0= Once per day **1**= Twice a day **2**=Frequently **3**=Otherwise (specify)…………

2. Does this supply of water suffice the requirement of crops planted?
   1= YES **0**= NO

3. Is this supply pattern being the normal (stipulated) arrangement of the scheme?
   1= YES **0**= NO

4. If NO (above), what do you think might be the possible reason?
   0= Shortage of irrigated water in the canal
   1=Negligence of leaders on distribution schedule
   2=Theft of irrigated water from farmers

5. In this irrigation schemes, payment which you are paying is based on which between the following in a cropping season?
   0=Per land size (acreage) cultivated
   1=Payment per schedule (supply of water) regardless of acreage

6. How much per month your household paid last year for supply of irrigated water in the scheme? ____________ TSH

7. Did you manage to pay water user fees in time last year?
   1= YES **0**= NO

8. If NO above, why? (give reason (s) for that)
   0= Reason 1: ....
   1=Reason 2: ……………………………………………………………………….

9. Who is responsible to decide what to do with the fees collected in the scheme you undertake farming activities?
   0= Financial management commitee of the scheme
   1= Farmers under the scheme collectively
   2= Both financial management commitee of the scheme and farmers

10. Does the management of the scheme disclose income and expenditure information of the scheme?
    1= YES **0**= NO (give reason……………………………………………………………….)

11. Do you always attend meeting to discuss matters of concerning to operation of the scheme?
    1= YES **0**= NO

12. How often you attend those meeting?
    1= Always **0**= Sometime **2**= Rarely

13. Generally, are you satisfied with how the scheme is managed?
    1= YES **0**= NO

14. If NOT SATISFIED give reasons for that?
    0= ....
    1= ....

SECTION 6: SELECTED ASSET FOR HOUSEHOLDS' WEALTH DETERMINANTS UNDER IRRIGATION SCHEMES

PART 1

Asset category	**Asset type**	**Does the household own this asset 1= YES 0= NO**	**Number owned**	**Value if sold (TAS)**
	A	B	C	D
Farm Implements	Hoe/Jembe			
	Spade/shovel			
	Sickle/Mundu			
	Axe			
	Slasher			
	Sprayer			
	Panga			
	Wheelbarrow			
	Ox-plough			
	Power tiller			
	Tractor			
	Watering can			
Transport	Push Cart			
	Oxen/ Donkey cart			
	Bicycle			
	Motorcycle			
	Tri-cycle			
	Bajaj			
	Vehicle			
Household furniture	Improved charcoal/stove			
	Kerosene stove			
	Gas cooker			
	Water carrier			
	Fridge			
	Beds			
	Chairs			
	Sofa set			
	Table			

Continue in the next page

PART 2

Asset category	**Asset type**	**Does the household own this asset 1= YES 0= NO**	**Number owned**	**Value if sold (TAS)**
	A	B	C	D
Electronic/ Communication	Television			
	Radio			
	CD player Machine			
	Subwoofer/machine			
	Mobile phone			
	Solar power (including its accessories)			
	Generator			
Jewellery	Gold			
	Silver			
	Wrist watch			
Trees	Fruit trees			
	Other trees			
Land (acres)	Land owned			
Sheltering	House			
Livestock	Dairy cow			
	Goat			
	Sheep			
	Chicken			
	Pigs			
	Ducks			
	Fish			
Savings (remittance)	Cash served/received			

SECTION 7: HOUSEHOLD AWARENESS ON IRRIGATION MANAGEMENT TRANSFER POLICY REFORMS

1. In what ways are involved in operation and maintenance of irrigation scheme?
   0= Paying water user fees
   1= Devoting labour on maintenance activities
   2= Both of the above

2. Are you aware of the government policy to shift management (Operation and Maintenance) of irrigation facilities to farmers?
   1= YES 0= NO

3. Even if you are AWARE or NOT; Do you think this is a good approach of managing irrigation scheme?
   1= YES, it is a right approach
   0= NO, it is a not the right approach
   99=I dont know

4. If YES above, why?
   Give reason for that: …………………………………………………………..

5. If NO above, why?
   Give reason for that: …………………………………………………………..

6. Do you think it is **rational** for the farmers who are benefiting from irrigation scheme be responsible for operation and maintenance of irrigation facilities or infrastructures?
   1= Yes it is rational **0=** No it is not
   IF YES, Go to next question (7)

7. If YES above, what is your opinion on whether the following reasons are (Important or Not Important)?
   (a) It is because farmers get benefit from irrigation
       0= Not Important
       1= Important

   (b) Financial burden to the government is reduced
       0= Not Important
       1= Important

   (c) It increase efficiency in managing the resource (scheme)
       0= Not Important
       1= Important

8. If NO, why?
   0= It is because farmers don’t get benefit from irrigation
   1= It is a financial burden to farmers
   2= Both of 1 and 2 above

SECTION 8: ACCESS TO MARKET FOR CROP PRODUCED UNDER IRRIGATION

1. To whom always you depend to sell your produce? Tick all that apply
   0= Street vendors
   1= Hotels and restaurant service providers
   2= Rural assemblers
   3= Directly to consumers at local market

2. Does the selling point being in the area where production is undertaken?
   1= Yes **0=** No

3. Is it allocated and recognized formally by local authority of your village?
   1= Yes **0=** No

4. Why do you prefer to sell your produce in that place?
   0= Better price is offered there
   1= You can bargain with more buyers
   2= You have no option
   3= Other (specify) ………

5. How long does it take to reach selling point? [time in minutes]
   0= On foot [……….minutes] **1=** By transport facility [……….minutes]

6. Are you usually responsible for transporting your crop to your trading partner(s)/buyer(s)?
   1= Yes **0=** No

7. How crops are normally transported to the place of sale? [Tick all that applies]
   0= Walking **1=** Bicycle **2=** Motor cycle/Tri-cycle **3=** Vehicle **4=** Other(specify)……….

8. What is the average cost of transport per unit? TSH………..per unit……………..

9. When do you sell your produce
   0= Immediately after harvest
   1= Stored and then sold after price increase
   2= I have a deal before harvest
   3= Other (specify)…………..

10. Was there a middleman (broker) in undertaking marketing transactions?
    1= Yes **0=** No

11. Generally what can you say about accessibility of market for your produce?
    1= It is good (satisfactory) **0=** It is not good (not satisfied)

12. If it is not good (not satisfied) above; what are major problems encountered in agricultural marketing in this village?

0= ....
1= ....
2= ....
3= ....

SECTION 9: ELICITATION OF WILLINGNESS-TO PAY FOR OPERATION AND MAINTENANCE

Cheap talk:
There is great concern across the World and Africa in particular (and Tanzania also), where governments are devaluating Operation and Maintenance activities of Irrigation schemes to farmers who are the primary beneficiaries of irrigated water. The logic behind this policy change lays in the fact that the government can't finance all irrigation schemes found in the country; therefore farmers who are benefiting primarily from the facilities are supposing to do that as part and parcel of their responsibilities to commit financial resources in order to make the scheme to continue operating sustainably.

Your household is among many other farmers who are being interviewed and other households have provided answers to our valuation questions basing on their socio and economic conditions and preferences. Please provide your answers honestly on the questions which we are going to ask you on WTP for O&M"

1. Generally in order for this scheme to continue operating, do you agree that your involvement in operation & maintenance (directly/indirectly) is:

1= Important **0=** Not important

2. If important (above), do you think it is rational decision for the farmers to be left with the role of financing operation and maintenance of this scheme?

1= Yes, it is a rational decision **0=** No, it is not a rational decision

3. Do you think this transfer approach in the irrigation sub-sector is the right one on sustaining the smooth management of the scheme?

1= Yes, it is **0=** No, it is not **2=** I don't know

4. If No (above), should the government continue undertaking operation and maintenance of the scheme as it used to be in the past years?

1= Yes, should the government continue

0= No, it shouldn't be involved

2= Other alternatives should be put in place, (specify)………………………………..

5. How much is your household currently is paying as water user fees: **__________ TSH.**

6. Would you be willing to pay your financial resources (water user fees) to finance Operation and Maintenance activities as one among beneficiaries of this scheme?

1= Yes, I am willing **0=** No, I am not willing

7.Would you be willing to pay**…………TSH per plot/acre as charges for Operation and Maintenance (O&M)** of this scheme in order to continue receiving water that comes into your farm for irrigation **purposes [See choices below and Circle the bid chosen]**

S/No	BIDS DESIGNED	RESPONSE	
		YES	NO
1	7 000 TAS	YES	NO
2	10 000 TAS	YES	NO
3	12 000 TAS	YES	NO
4	17 000 TAS	YES	NO
5	20 000 TAS	YES	NO
6	30 000 TAS	YES	NO
7	40 000 TAS	YES	NO
8	55 000 TAS	YES	NO
9	70 000 TAS	YES	NO
10	100 000 TAS	YES	NO
11	Maximum		

8. If willing but none of the bids were accepted, how much you would be willing to pay for Operation and Maintenance of irrigation schemes

9. If NO above (Question 6) , how would this deficit be covered in order to make sure you continue receiving water in your farm?

   1= Through provision of payment in-kind (labour)

   2= Other sources; mention………………

   3= Don't know

11. As one among beneficiaries of this scheme, what measures do you propose to be taken in order to achieve sustainable management of this irrigation facility?

   0= Opinion I: …………………………………………………………………………………….

   1= Opinion II: ……………………………………………………………………………………

   2= Opinion III: …………………………………………………………………………………..

10. What do you propose to be done in order to cover Operation and Maintenance costs of this scheme?

   0= Option I: …………………………………………………………………………………….

   1= Option II: ……………………………………………………………………………

   2= Option III: …………………………………………………………………………..

Thank you for your time and patience!

Appendix 2: Checklist for key informants

1. Which crops are mainly grown here in this irrigation scheme?
2. Crops grown outside of the scheme?
3. Which ones are regarded as food and cash crops?
4. Which crops are produced during the rainy and dry season within the scheme
5. Which crops are produced during the rainy season outside of scheme
6. In which year do this irrigation scheme started to operate?
7. Was this irrigation scheme started from the need o the community (demand driven) or top down initiated (from government)?
8. How the daily activities of operating this scheme are operated?
9. How maintenance activities are organized whenever needed?
10. In how user's association is involved in the management of the scheme?
11. How management of the scheme is collaborated with the government in the managing the scheme?
12. Does the scheme receive some funds from the government to finance operation and or maintenance? How much and at what circumstances?
13. The management of this scheme comprises of how many committees? Mention them and their major role responsible for
14. Do the water users of this scheme pay their financial contribution in the right time as per requirement?
15. Are there any punishment/ fine for those who delay in paying fees? What are the penalties subjected to late payers?
16. Do you think the amount farmers are paying is sufficient to cover operation and maintenance costs of this scheme? 1= Yes 0 = No If YES or No, Explanations________________
17. What any other opinion(s) do you have over (management) operation and maintenance of the scheme

Thank you for your time and patience!

Appendix 3: Cheap talk script

"There is great concern across the World and Africa in particular including Tanzania, where governments are devolving Operation and Maintenance activities of Irrigation schemes to farmers who are the primary beneficiaries of irrigation water. The logic behind this policy change lies in the fact that the government cannot finance all irrigation schemes in the country; therefore, farmers who are benefiting from the facilities are supposing to finance O&M activities as part of their responsibilities for the scheme to continue to operating sustainably. Your household is among many others in the scheme who are being interviewed in order to understand your willingness toward payment for O&M expenses. Farmers who are already interviewed have provided answers to our valuation questions considering their socio and economic conditions and preferences. Please provide your answers honestly to the questions which we are going to ask you regarding on WTP for O&M in your scheme"