FARMERS' WILLINGNESS TO PAY FOR IRRIGATION WATER: THE CASE OF DOHO RICE IRRIGATION SCHEME IN EASTERN UGANDA

BY

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DECLARATION

I Namyenya Angella do solemnly declare that the work presented in this thesis is original and my own and no part has ever been produced or submitted to any university for a degree award.

Signed…………………………………..... Date …………………………

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This thesis has been submitted with our approval as University Supervisors

Signed.. Date……………………………

DR. FREDRICK BAGAMBA

Signed... Date...

DR. DICK SSERUNKUUMA

DEDICATION

This book is dedicated to all my family members but especially to my parents; Mr. Sewanyana Samuel and Mrs. Sewanyana Octavia Komugisha in appreciation for their support and love but most of all for the person they have made me today.

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LIST OF ACRONYMS

FIEFOC	Farm Income Enhancement and Forestry Conservation project
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
MWE	Ministry of Water and Environment
UBOS	Uganda Bureau of Statistics
Ush.	Uganda shillings
WTP	Willingness to pay

ABSTRACT

The government of Uganda is currently rehabilitating three major irrigation schemes whose infrastructure had broken down due to poor maintenance. Among these schemes is Doho rice irrigation scheme. It is expected that after the rehabilitation, the farmers at this scheme will assume responsibility for its operation and maintenance. Each farming household will be expected to pay a user fee per acre per season in order to cover the maintenance costs. This study was thus aimed at determining farmers' willingness to pay to maintain irrigation water supply, using Doho rice scheme as a case study. The specific objectives included: to determine farmers' willingness to pay to maintain irrigation water supply at Doho rice irrigation scheme; to characterise the farmers at Doho rice irrigation scheme based on their willingness to pay; to identify factors influencing farmers' willingness to pay for irrigation water at Doho rice irrigation scheme. A stratified random sampling procedure was employed to select a sample of 200 respondents at Doho rice irrigation scheme; and using a questionnaire, cross sectional data were collected. The contingent valuation method using the bidding game was applied to elicit the farmers' willingness to pay. Descriptive statistics and a double log-linear model were used to analyse the data in light of the study objectives.

The findings show that the average willingness to pay for irrigation water by farmers at Doho irrigation scheme is Ush. 20,000 per acre per season. This value is higher than the Ush. 15,000 per acre per season needed to cover the cost of maintaining irrigation water supply at Doho. The results further show that formal education, farm size, experience in practical irrigation farming, participation in training related to soil and water conservation, rice growing or irrigation water management and access to credit and markets influence farmers' willingness to pay.

The study therefore recommends charging Ush. 15,000 per acre per season. This is because not only does it generate sufficient revenue to cover the maintenance costs, but is also below the average willingness to pay implying that a large proportion of farmers would willingly pay this amount without coercion. In addition, government should intensify training in soil conservation, water management and rice growing, promote farmers' access to affordable credit, bring markets closer to the farmers and also put in place active land rental markets.

CHAPTER ONE

INTRODUCTION

1.1 Background

In the recent years, Uganda has witnessed erratic onset and cessation of rainfall seasons (MWE, 2007). This, coupled with increasing frequency of droughts has frustrated rain-fed agriculture and as such, investment in irrigation is considered critical for agricultural production (MAAIF, 2012). The development of irrigation holds significant potential to improve productivity and reduce vulnerability to variability in rainfall (Bekele, 2010). Irrigation provides benefits to the farming community and to the wider sectors of the economy. To the farming community, the benefits come in form of improved crop productivity and increased farm income. The wider sectors of the economy accrue benefits of irrigation in form of income and employment effects in the agro-industry sector and the non-farm sector of the economy (Bhattarai *et al.,* 2006). Hence investments in irrigation, once properly targeted and accompanied by improvement in access to complementary agricultural inputs can be an important vehicle for enhancing agricultural productivity (You, 2008).

Consequently, the government of Uganda has prioritised rehabilitation of the existing irrigation schemes whose infrastructure had broken down over a long period of mis-use and poor maintenance (MWE, 2012; MWE, 2009). Currently, the schemes under rehabilitation include Doho, Mubuku and Agoro irrigation schemes in Butaleja, Kasese and Lamwo districts, respectively (MAAIF, 2012). In order to ensure sustainability, it is expected that after the rehabilitation, the farmers at the respective schemes will assume responsibility for their operation and maintenance. Each farming household will be expected to pay user fees to cover operational costs to maintain water supply to the schemes (MAAIF & FIEFOC, 2010).

Construction of the major irrigation schemes in Uganda started in the 1960's. Doho rice irrigation scheme in particular was constructed between 1976 and 1985 by the government of Uganda to promote rice production in eastern Uganda through provision of irrigation water, improved rice seeds, farm tools, marketing and milling services. Following its completion, the government of Uganda partitioned Doho irrigation scheme into ten blocks of 1A, 1B, 2A, 2B, 3, 4A, 4B, 5A, 5B and 6 covering a total area of 2500acres; and each block was partitioned into smaller plots that were leased to individual farmers at first come, first served basis. The government of Uganda retained the role of maintaining the irrigation structures through the Ministry of Agriculture, Animal Industry and Fisheries up until the early 1990s (MWE, 2012). During this period, the irrigation and drainage channels were regularly de-silted by the government of Uganda which enabled sustainable flow of irrigation water to the rice fields.

However, driven by budgetary constraints around 1994 and examples of successful collective action in irrigation water management in other parts of the world (Meinzen-Dick *et al.*, 2000), the government of Uganda withdrew its support and devolved management of the irrigation scheme to Doho Rice Scheme Farmers' Association. The Association adopted an earlier resolution made by farmers, district officials and local leaders at a meeting held in 1994, which required all farmers to pay an irrigation user fee of Ush 5,000 per acre per season towards the cost of de-silting of the irrigation and drainage channels. A committee composed of an elected chairperson and 10 block-level executive members and counsellors was set up to collect user fees and monitor collective action on each block. A by-law was enacted stating that those who did not comply with user-fee payment or participate in collective channel maintenance in any cropping season would have their plots of land withdrawn from them the following two seasons and rented out to willing farmers (Ochom, 2004; Sserunkuuma *et al.*, 2003).

1.2 Problem Statement

Following the devolution of management of Doho rice irrigation scheme from government of Uganda to farmers, a collective action problem arose, characterised by failure to achieve the desired outcome of adequate supply of irrigation water to rice plots through collective effort. This was attributed to shortage of funds to de-silt irrigation channels, attributed to the failure of farmers to comply with the by-law requiring each farmer to pay the irrigation user-fee of Ush. 5000 per acre per season. Literature shows that 34% of the farmers did not fully comply with the by-law on user fee payment in 2001 (Sserunkuuma *et al.,* 2003). The main factors emasculating compliance were found to be poor awareness of the by-law and the associated benefits; poor enforcement of the by-law; and the negative perception by farmers of the private benefits they derived from compliance. One fifth to one quarter of the farmers surveyed in 2001 perceived the private benefits derived from the scheme not to be worth the cost incurred; and the study found a significant negative relationship between compliance with the by-law and the perception that benefits of compliance are lower than the costs.

The negative perception was caused by the extensive silting of the channels, which significantly reduced water conveyance to some rice fields. The lack of sufficient incentives in form of water supply for payment of user fees partly explains why one-third of the farmers did not comply with the user fee by-law (Sserunkuuma *et al.*, 2003). Failure to adequately de-silt the channels had set up a cycle of failure in which an insufficient number of farmers paid user fees in a given season, which in turn lowered the amount of irrigation water supplied to the rice plots, limiting rice yields and farmers' ability and willingness to pay the user fees in the following season.

To break this cycle, rehabilitation of the entire irrigation system was recommended to increase water supply to farmers and improve rice yields on their fields as well as their willingness and ability to pay the user fees. In accord with this recommendation, the government of Uganda has since October 2011 embarked on the rehabilitation and revitalization of Doho rice irrigation scheme as well as those at Mubuku and Agoro. After completion of the rehabilitation process, the responsibility of maintaining the scheme at Doho will again revert to the farmers (MWE, 2012); and it is envisaged that a user fee will be charged per acre per season to raise funds for operating and maintaining the irrigation scheme. Poor awareness and enforcement of the user- fee by-laws at Doho and the associated poor compliance cited above can be attributed to the manner in which the by-law was enacted with limited involvement, sensitization and consultation of farmers, which led to low farmer buy-in.

Nkonya *et al.*, (2001) observe that it is difficult to effectively enforce and enduce compliance with by-laws that are not clearly understood or ratified by farmers. With the impending transfer of management responsibility to farmers after rehabilitation of Doho rice irrigation scheme, and the accompanying need for farmers to contribute towards the maintenance costs, it is imperative to determine how much farmers are willing to contribute through collective action. This study aims to estimate farmers' willingness to pay to maintain the supply of irrigation water. It compares the willingness to pay with the cost of maintenance in an effort to estimate an appropriate maintenance charge, as opposed to just setting user fees without a correct assessment of farmers' willingness to pay like was the case before.

1.3 Objectives

The main objective of this study was to determine farmers' willingness to pay to maintain irrigation water supply, using Doho rice irrigation scheme as a case study.

The specific objectives were:

1. To determine farmers' willingness to pay to maintain the supply of irrigation water at Doho rice irrigation scheme.
2. To characterize the farmers at Doho rice irrigation scheme based on their willingness to pay.
3. To identify factors influencing farmers' willingness to pay to maintain the supply of irrigation water at Doho rice irrigation scheme.

1.4 Hypotheses

1. On average, farmers' willingness to pay is higher than the maintenance cost per acre per season.
2. Socio-economic factors such as education, experience in irrigated agriculture, farm size, access to credit, and access to training influence farmers' willingness to pay to maintain the supply of irrigation water.

1.5 Significance of the study

This study determined farmers' willingness to pay user fees; and how this varies across the rice farmers at Doho Rice irrigation scheme. It was conducted at a time when the rehabilitation of Doho rice irrigation scheme was on going. This makes the study timely to determine farmers' willingness to pay to maintain the supply of irrigation water ahead of completion of the rehabilitation process. The estimates of the farmers' willingness to pay computed from the gathered data have the potential to serve as a guide for policy makers and farmers in determining the appropriate maintenance charge, before farmers are asked to start paying. Secondly, this study can contribute to the body of knowledge and deepening empirical literature on willingness to pay for irrigation water.

1.6 Scope of the study and organisation of the thesis report

The study focused on farmers at Doho rice irrigation scheme in Butaleja district, to assess their willingness to pay to maintain the supply of irrigation water and the determinants of their willingness to pay. Chapter one of the study discusses the background, problem statement, objectives, hypotheses and significance of the study. Chapter two discusses literature on farmers' willingness to pay for the resource as well as the factors that influence the willingness to pay. Chapter three presents the theoretical framework, conceptual framework, empirical model specification, data collected and the methods used to collect and analyse the data. The results and discussions are presented in chapter four. The last chapter presents the conclusions and recommendations from the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Concept of willingness to pay

Willingness to pay refers to the economic value of a good to an individual under given conditions (Yang *et al.,* 2007). It is the maximum sum of money the individual would be willing to give up for an increase in the quantity of a good or quality of the good such as an environmental amenity (Agudelo, 2001). The consumers' Willingness to pay is becoming increasingly popular and is one other standard approach that is used by market researchers and economists to place a value on goods or services for which no market –based pricing mechanism exists (Chandrasekaran *et al.,* 2009). An individual Willingness to pay for something is used as a measure of utility that he or she derives from the entity in question hence a measure of benefit of the entity to the individual. Willingness to pay surveys are very important in that they can be used to answer the question of "How much can be charged?" They help to estimate the number of clients who will pay a given price, the amount of revenue that will be generated by that price in relation to what is required to accomplish a given task, and the characteristics of individuals who will or will not pay that price. It can also be used to estimate the revenue maximizing price for a product or service (Foreit & Foreit, 2004).

2.2 Determining willingness to pay

There are two basic theoretical approaches available for making reliable estimates of willingness to pay. These include: the indirect or revealed preference and the direct or stated preference approach (Yang *et a1.*, 2007; Whittington *et al.,* 1992). The indirect techniques rely on observable behaviour to deduce how much something is worth to an individual even though it is not traded in markets (Lipton *et al.*, 1995). They involve observing and modelling of consumers' behaviour based on the approximate expenditure in terms of time and money to obtain the goods or services. These methods then infer about willingness to pay through measurement of revealed preference and produce value estimates that are conceptually identical to market values (Chandrasekaran *et al.*, 2009). In valuing water for example, the indirect methods use data on observed water users' behaviour such as quantities used, travel times to collection points and perceptions of water quality to assess the response of consumers to different characteristics of an improved water system (Whittington *et al.*, 1990). The two mainly known revealed preference methods are the travel cost method and hedonic price method. The direct approach methods assess the value of non-market goods by using individuals' stated behaviour in a hypothetical setting (Alpizar *et al.*, 2001). These stated preference techniques are classified into choice modelling and contingent valuation method (Pearce & Ecezdemiroglu, 2002).

The contingent valuation method uses survey questions to ask respondents to directly value the good or service in a hypothetical market. It simply asks an individual how much they would be willing to pay for the improvement in the resource (Whittington *et al.*, 1990). By means of an appropriately designed questionnaire, a hypothetical market is described where the good or service in question can be traded. This contingent market defines the good or service itself, the institutional context in which it would be provided, and the way it would be financed. Respondents are then asked to express their maximum willingness to pay for a change in the provision of the good or service. Theoretically, contingent valuation is well rooted in welfare economics, namely in the neo-classical concept of economic value based on individual utility maximisation. This assumes that stated willingness to pay amounts are related to respondents' underlying preferences in a consistent manner (Hanley *et al.*, 2001).

The contingent valuation survey usually has three main parts: The first is a detailed description of the good being valued and the hypothetical market in which the good is provided to the respondents. The second part is the core part in a contingent valuation survey: the willingness to pay question. The third part usually asks demographic questions and debriefing questions to respondents (Guo *et al.*, 2006). This method is the most obvious way to measure nonmarket values since it involves directly questioning individuals on their willingness to pay for a good or service (Rahim, 2008). The goods that have been valued by the contingent valuation method include; environmental amenities, natural resources, new private commodities and health risks (Guo *et al.*, 2006). In natural resources, contingent valuation studies generally derive values through elicitation of respondents' willingness to pay to prevent injuries to natural resources or to restore injured natural resources (Rahim, 2008).

There are various elicitation formats used in a contingent valuation method. The most widely used elicitation formats are; open-ended; bidding game, payment card and single bounded or double bounded dichotomous choice. Open-ended elicitation asks "what is your maximum willingness to pay?" According to Cameron and Huppert (1989), while one would prefer to elicit a respondent's exact willingness pay for an increase in the quality of a public good using an open-ended question, respondents find it very difficult to name a specific sum. To avoid non-response, researchers have found it more fruitful to pose the valuation questions through bidding where the respondent is asked if he or she is willing to pay a starting bid price. If the respondent's answer is "yes", the interviewer then increases the bid until the respondent answers no. The highest yes response value is then recorded as the maximum willingness to pay. For "no" responses, the interviewer instead decreases the bid until the respondent answers yes. The maximum willingness to pay is then elicited. However, if the respondent says no throughout, zero willingness to pay is recorded. Payment cards present respondents with a visual aid containing a large number of monetary amounts, the respondents tick sums they are definitely willing to pay and put crosses against those they definitely are not willing to pay. In single-bounded dichotomous choice, respondents say yes or no to a single willingness to pay amount or bid. With double-bounded dichotomous choice, the respondent says yes or no to a stated sum and is then asked to say yes or no to higher/lower bids (Pearce& Ecezdemiroglu, 2002).

The contingent valuation technique is superior to other valuation methods because it is able to capture use and non-use values. Other valuation methods like hedonic pricing and travel cost method tend to under estimate satisfaction derived from services rendered since they measure only the use values (Niringiye and Omortor, 2010). The contingent valuation technique can take into account non-use values, such as the utility individuals derive from the existence of environmental goods, even if they do not use it (Hutton, 2001). It is a very flexible method as researchers can construct a hypothetical market with a desired provision structure and payment vehicle for a very wide range of public or private goods (Guo *et al.,* 2006). Since it is based on hypothetical scenarios, it can provide estimates of willingness to pay for systems which do not currently exist (Onodipe, 2003) hence it can be used to measure willingness to pay for proposed policies. Since Doho irrigation scheme was yet to be handed over to farmers, the contingent valuation method was appropriate to create a hypothetical scenario to find out how much the farmers would be willing to pay after management is devolved to them.

However, several potential biases may arise that could undermine the validity of the preference information gathered by using the contingent valuation method. Among others, these include the following: (i) Strategic bias which may arise from the fact that the respondents may refuse to respond to survey questions or would not reveal their "true" willingness to pay for strategic reasons. They may do this if they think there is a “free rider” situation. (ii) Information bias whereby people are willing to pay depending on the quantity and quality of the information provided to them, including the way questions are constructed (iii) and Hypothetical bias due to the fact that respondents are not making real transactions (Hussen, 2000). The hypothetical nature of the questions in contingent valuation surveys may pose problems as people’s stated preferences may deviate from their true preferences (Niringiye & Omortor, 2010; Guo *et al.*, 2006). These potential biases make reliability of this method questionable. However, it is possible to control such biases (Calkins *et al.,* 2002). According to Whittington (2002), well designed and properly executed contingent valuation methodology studies provide high quality willingness to pay information.

2.3 Empirical Studies on willingness to pay using the contingent valuation method

The existing literature on willingness to pay provides a number of previous studies where the contingent valuation method has been used to determine willingness to pay for irrigation water. Alemayehu (2014) used the contingent valuation method to estimate the mean willingness to pay of small holder farmers for improved irrigation water in the case of the Koga irrigation project in Ethiopia. The study findings showed that households convey their willingness to pay with a mean value of 128.88 Birr/hectare/ year (US$6.78hectare/year) and the total willingness to pay in the Koga irrigation command area was estimated to be 1,753,799.04 Birr/year (US$ 92,951.34). The study identified education level, household size, gender, total family income and cultivated land size as the main factors affecting household’s willingness to pay of improved irrigation water.

Alhassan *et al.* (2013) estimated farmers’ willingness to pay for improved irrigation services in Bontanga Irrigation Scheme in Northern Ghana using the contingent valuation method. The mean willingness to pay was found to be GHC 16.32 (US$ 8.50) per ha per year. The study identified location of farm, land ownership, and land lease prices as the significant and influencing factors that affect farmers' willingness to pay for the irrigation water.

Mezgebo *et al.* (2013) carried out a study to determine the economic value of irrigation water in Wondo Genet area by eliciting household's willingness to pay using contingent valuation method in the form of double bounded closed ended questions with open ended follow up questions. Results showed that the total willingness to pay from double bound elicitation method was computed at 156,786.1 birr (1US$=17birr) per annum for five years, while the willingness to pay from open ended elicitation method was computed at 128,264.55 birr year. The study further found that households' income, age, cultivated land, awareness and educational level are the key determinants of demand for irrigation water.

Tang *et al.* (2013) conducted a contingent valuation study on farmers' willingness to pay for irrigation water in Shiyang River basin, Northwest China. The results showed that the average willingness for irrigation water is higher than current irrigation water price. Family size, household income, area of irrigation land, the major source of irrigation water, respondents satisfaction with the management and farmers' attitude towards whether current water price could recover the water supply cost influenced the willingness to pay.

Using the contingent valuation method, Chandrasekaran *et al. (*2009) carried out a study to determine the economic value of tank irrigation water by analysing the farmers' willingness to pay for irrigation water under improved water supply conditions during wet and dry seasons of paddy cultivation: a case of tank irrigation systems in South India. The results revealed that farmers were willing to pay considerably more than the average operation and maintenance costs incurred by the state on tanks. Family labour force, area under rice cultivation, and the water requirement were found to be the significant factors influencing farmers' willingness to pay in the wet season, while in the dry season, the area under cultivation and water requirement were found to be significantly influencing the farmers' willingness to pay for irrigation water. Irrespective of seasons, the significant and most influencing factors that determine the farmers' willingness to pay for irrigation water from tank were found to be area under rice and water requirement.

Kassahun (2009) used the contingent valuation method to explore how beneficiary households in the Upper Blue Nile Basin of Africa value irrigation water to enhance agricultural productivity. Under this broad objective, there were two specific goals. The first was to estimate the households' willingness to pay to establish payment for ecosystem services (PES) for upland soil and water conservation measures that ultimately reduce sedimentation loading in the newly constructed reservoir. The model revealed that the expected aggregate willingness to pay for the total of 7,000 hectares of irrigable land was 964,320 birr per year (9.65 birr equal US$1.) with a household utility maximising price of 192birr per hectare of irrigable land per year. The second objective was to examine the magnitude and determinants of labour supply behaviour of farm households for the routine management and maintenance of irrigation infrastructure in the Upper Blue Nile basin of Ethiopia. It was found that households' willingness to contribute labour was influenced by education, age of the household head, expectations about yields in irrigated agriculture, wealth of the household, involvement in off-farm activities, time taken to walk to the nearest market, the households' dependency ratio and randomly assigned bid working days.

Akter (2007) estimated the value of irrigation water in a small scale irrigation project in Homna sub-district in Bangladesh. The study used the contingent valuation method to elicit farmers' willingness to pay for the irrigation water, using irrigation charges per decimal land area per cropping season as the payment vehicle. It was found that mean willingness to pay was 1670 Taka(US$ 27.83) per kani (30 decimals of land) per cropping season; and there was a significant impact of age, education, family size, number of income sources and ownership of farmland on willingness to pay.

Latinopoulos, (2001) employed the contingent valuation method to measure farmers' willingness to pay for irrigation water: a case study in Chalkidiki, Greece. The results indicated that farmers' willingness to pay for an overall improvement in agricultural water services depended not only on their demographic socio characteristics but also upon their personal experience in perceptions of the impacts of the water system under conditions of declining water resources availability.

Other related empirical studies apart from those for valuing irrigation water where the contingent valuation method was used are; Wendimu and Bekele, (2011) to assess the determinants of household's willingness to pay for quality water supply: the case of Wonji Shoa sugar Estate in Ethiopia. The result of the study revealed that the income of the household, education level of the respondent, reliability on existing water supply, respondent perception about quality of the existing water supply, household family size and age of the respondent were significant variables in explaining the willingness to pay. The mean willingness to pay for quality water supply was found to be $ 0.025 per 20L container charged by Oromiya regional government in Ethiopia. The demand for safe drinking water was also estimated for the study.

Ogunniyi *et al.* (2011) used the contingent valuation method to study the determinants of rural households' willingness to pay for safe water in Kwara state on a sample of 120 households. The results confirmed that household age had a negative and statistically significant impact on willingness to pay for both quantity and quality. Income, water consumption and water source had negative and statistically significant impact on willingness to pay for better quantity. Willingness to pay for improved water quality is positively related to waiting time and education. Rural households showed a much higher willingness to pay for better quantity than for improved quality.

The above empirical literature review shows that the contingent valuation method is viable to elicit willingness to pay for irrigation water. However, no studies to estimate the farmers' willingness to pay for irrigation water using the contingent valuation method have been undertaken in Uganda more so at Doho irrigation scheme especially with the rehabilitation of the irrigation scheme. This study was thus undertaken to address this knowledge gap.

2. 4 Factors influencing willingness to pay for a good or resource

Willingness to pay is likely to be influenced by various factors ranging from socio-demographic, farm-specific, market related, policy-institutional related factors as well as attitudes and perceptions. Among the socio-demographic factors are education, age, household size and farming experience. Education is hypothesized to have a positive effect on willingness to pay. A higher level of education is expected to increase farmers' ability to obtain, analyze, and use information. This positive effect was found in several studies (Alemayehu, 2014; Adepoju & Omonona, 2009; Akter, 2007; Akankwasa, 2007; Khorshiddoust, 2004; Mezgebo *et al.*, 2013; Mwaura *et al.*, 2010; Ogunniyi *et al.*, 2011; Va´squez *et al.*, 2009; Wendimu & Bekele, 2011).Other studies, however, show a negative impact of education on willingness to pay (Moffat *et al.*, 2012; Tessendorf, 2007).

Age is also believed to be positively associated with willingness to pay. Usually older age is associated with more knowledge and skill in farming. This enables the older people to better understand the benefits of new or improved technologies and services than the young ones, hence the higher likelihood to have a higher willingness to pay contingent on the private benefit derived from the resource. Studies by Moffat *et al.* (2012); Akter (2007) reported this positive relationship. On the contrary, some studies show a negative relationship between age and willingness to pay (Addis, 2010; Gossaye, 2007; Kaliba *et al.*, 2003; Ogunniyi *et al.*, 2011; Omonona & Adeniran, 2012).

Household size is another important factor affecting willingness to pay. Several studies report a negative relationship between household size and willingness to pay (Tang *et al.,* 2013; Addis, 2010; Moffat *et al.*, 2012; Tessendorf, 2007; Wendimu & Bekele, 2011). The reason for this type of behavior is that a bigger household size encounters more difficulties in terms of budgetary constraints, hence the decreased willingness to pay (Moffat *et al.*, 2012;

Tessendorf, 2007). In contrast, a positive influence of household size on willingness to pay was obtained in various studies (Alemayehu, 2014; Calkins *et al.,* 2002; Akter, 2007; Gossaye, 2007; Kaliba *et al.*, 2003; Rodriguez & Southgate, 2003).

With regard to farming experience, willingness to pay is believed to increase as farming experience increases. Experience with the use of an input or service enables the farmer to appreciate the benefits that can be accrued from it assuming that the experience is positive, hence a higher willingness to pay. Some studies corroborate this positive relationship (Addis, 2010; Kassahun, 2009; Latinopoulos, 2001).

The farm-specific factors believed to influence willingness to pay include farm size and proximity to the resource. With regard to farm size, various studies have shown that it positively influences willingness to pay (Addis, 2010; Mezgebo *et al.*, 2013; Rohith & Chandrakanth, 2011; Ulimwengu & Sanyal, 2011). The possible reason for this kind of behavior is that larger farm plots demand more water (Mezgebo *et al.*, 2013) and also due to the fact that larger farms would generate more income from their land (Addis, 2010).

Proximity to the resource is another important farm variable that influences willingness to pay. Several studies report that willingness to pay increases with distance from main water source (Farolfi *et al.*, 2007; Rohith & Chandrakanth, 2011). However, Alhassan (2012) Olajuyigbe & Fasakin (2010) report a negative impact of distance from main water source on willingness to pay. Others, for example Sserunkuuma *et al.* (2003) hypothesize an inverted U-shaped relationship as farmers receiving plenty of water because of their proximity to the source may be expected to be less willing to pay, which is also true for those expecting too little water because of excessive distance from the source.

Market accessibility is an important market-related factor that influences willingness to pay. It is expected that households located closer to the markets have a higher willingness to pay. This is because market accessibility facilitates the flow of inputs in to production areas and outputs in the markets as the transaction costs are reduced (Sentayi, 1997). This enables households closer to the markets to receive a higher price and therefore higher returns from their output. Proximity to markets also increases farmers' access to credit facilities and income generating activities like off-farm employment (Bagamba, 2007) that increase their income and thus ability and willingness to pay. A study by Ulimwengu & Sanyal (2011) reports that market accessibility increased farmers' willingness to pay for agricultural services. This was shown by the inverse relationship between the distance to the market and willingness to pay for the agricultural services. However, in some cases due to access to nonfarm labour markets, the probability of diversifying into nonfarm activities may increase, whereby farmers reallocate labor from farm to nonfarm activities and become less likely to commit to farming; thus having lower willingness to pay.

The policy-institutional factors which form part of the broader environment that affects the willingness to pay include accessibility to extension services, accessibility to credit and participation in training. Access to extension services is expected to increase willingness to pay. Extension provides farmers with information related to better agricultural technologies. This improves their knowledge and thus awareness of the need to pay so as to protect a resource. A study by Addis (2010) reports a positive relationship between access to extension and willingness to pay. Access to credit is also positively associated with willingness to pay. Households with access to credit are more likely to have a higher ability to invest in the necessary complementary inputs that would enhance the ability for effective utilization of the irrigable land. A few studies show results that are consistent with the positive relationship between access to credit and willingness to pay (Addis, 2010; Illukpitiya

& Gopalakrishnan, 2004). With regard to training; a study by Calatrava & Sayadi (2005) shows that it is positively associated with willingness to pay. Training tends to increase households' awareness of the need for the resource and hence appreciation of the need to pay for it.

With regard to attitudes and perceptions, a classical attitude-behaviour paradigm assumes that behaviour can be predicted by attitudes. This would mean that general attitudes and perceptions have a direct effect on willingness to pay (Liebe *et al.,* 2011); and a few studies show a direct relationship between willingness to pay and peoples' attitudes and perceptions (Addis, 2010; Wendimu & Bekele, 2011).

CHAPTER THREE

METHODOLOGY

3.1Theoretical framework

Willingness to pay is based on the concept of “Environmental valuation” which is a series of techniques that economists use to assess the economic value of market and non-market goods, including natural resources and resource services (Lipton *et al.,* 1995). Economic value has its foundation in neoclassical welfare economics (James & Lee 1971)which is a branch of economics that endeavours to formulate propositions that enable us to state whether social welfare in one economic situation is greater or less than in another (Yew, 2004). Its basic premises are that the purpose of economic activity is to increase the well-being of the individuals who make up a society.

Environmental valuation applies the welfare economics concept to issues involving natural resources and the state of the environment (Lipton *et al.,* 1995). The welfare economics concept is based on the theory of utilitarianism (Boadway and Bruce, 1984) and this is often measured in terms of peoples’ willingness to pay. According to the utilitarian approach, a commodity has economic value when users are willing to pay for it. Within the utilitarian paradigm, it is assumed that consumers make choices according to their preferences in such a way that they seek to maximize their own satisfaction or utility. The user is assumed to be capable of assigning to every commodity or combination of commodities a number representing the amount or degree of utility associated with it (Henderson & Quandt, 1980).

In this study which focuses on the utility derived from improvement in the quality of a resource (irrigation water), the willingness to pay for the improvement in the quality of the resource equals the change in monetary income that would leave the respondent as well-off with the enhancement (and lower income) as without the enhancement (at the original income level) (Cameron & Huppert 1989). The welfare implications are often expressed in terms of a change in an index, usually the monetary amount which would need to be taken from or given to the agent to keep the agent's overall level of utility constant. At the level of an individual economic agent, these monetary measures take a particularly simple form: for a desired improvement in the resource, the maximum amount the agent would be willing to pay to obtain the improvement (Carson *et al.*, 2001).

In the case of Doho rice irrigation scheme, willingness to pay can be explained using the equation below:

$$V(y-WTP, p, q_1, Z) = V(y, p, q_0, Z) \ldots\ldots\ldots\ldots\ldots\ldots\ldots(i)$$

Where V denotes the indirect utility function, y is the income of the individual farmer, WTP is the willingness to pay of the individual farmer, p is a vector of prices faced by the individual, q_O and q_1 are the alternative levels of provision of the irrigation water under baseline and improved conditions, respectively (with $q_1 > q_0$ indicating an improvement from q_O to q_1), and Z is a vector of individual characteristics affecting the trade-off that the individual is prepared to make between income and the supply of irrigation water. This equation implies that willingness to pay depends on (i) the initial and final level of the good in question (q_O and q_1); (ii) respondent income; (iii) prices faced by the respondent; and (iv)other respondent socio-economic characteristics.

3.2 Conceptual framework

The conceptual framework of this study is based on the assumption that willingness to pay is influenced by a number of factors including; socio-demographic factors, farm-specific factors, market related factors, policy-institutional factors as well as farmer attitudes and perceptions. From literature, it has been observed that different factors show different effect of magnitude and direction on willingness to pay. One factor, which is found to have a negative influence on willingness to pay in one place at one time, is found to have positive impact in another area at a different point in time. This variation in areas and determining factors makes it hard for one to develop a universal model of willingness to pay with defined determinants and their hypotheses that are perfectly applicable to every place and situation. Hence, the conceptual framework presented below in figure1 describes the variables expected to influence willingness to pay at Doho rice irrigation scheme.

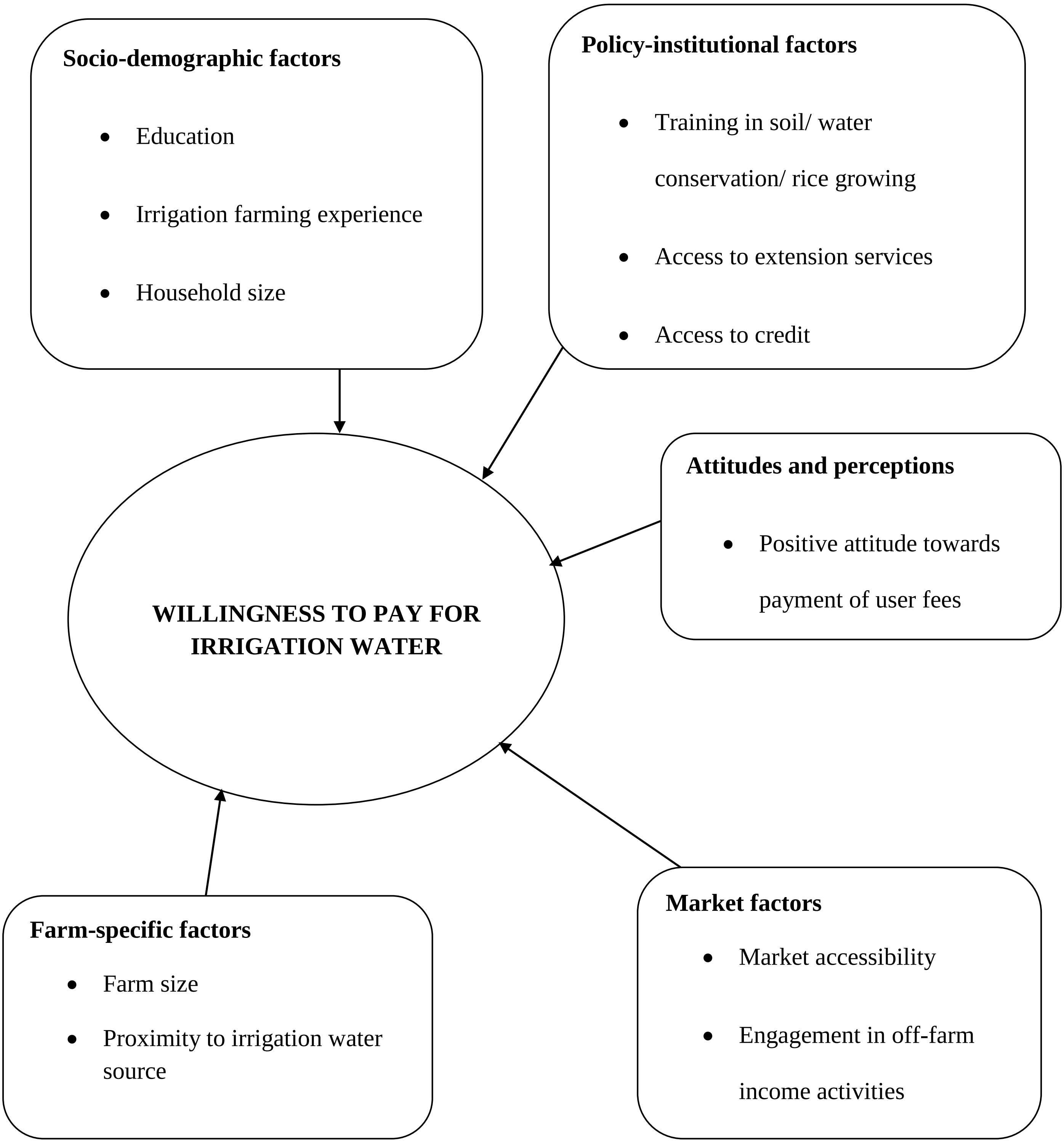

Figure 1 Conceptual framework of the factors that influence farmers' willingness to pay for irrigation water at Doho rice irrigation scheme

Source: Author’s conceptualisation

Education of the farmer captured as number of years of schooling is hypothesized to have a positive relationship with willingness to pay. This is because more educated respondents are expected to have a better understanding of the benefit of the improved irrigation water provision in agricultural production, and are thus expected to attach a higher value to irrigation water, hence a higher willingness to pay.

Experience in practical irrigation agriculture by the farmer measured in number of years of practicing irrigation farming is expected to be positive likely because farmers with longer experience are more familiar with the benefits of irrigation enjoyed when Doho rice irrigation scheme was still properly maintained and have also observed the decline in rice output through the years as the scheme deteriorated. This enables them to better appreciate the importance of their contribution towards improved water supply.

Household size measured by number of people per household is hypothesized to be negative because of the higher demands on the family's resources to cater for the needs of a large family. The bigger the family size, the more difficulties encountered in terms of budgetary constraints, hence the lower the willingness to pay.

Farm size measured in acres is hypothesized to have a positive influence on willingness to pay for irrigation water because farmers with larger land endowment also cultivate larger rice plots at Doho rice irrigation scheme and earn higher income from rice when the supply of irrigation water is adequate.

Market accessibility measured by the distance from the farm to the nearest rice market is hypothesized to have a negative relationship with willingness to pay because of the lower returns from rice farming as those further from the market incur higher transaction costs compared to those closer, hence lower returns from their outputs and thus less willingness to pay.

Participation in agricultural training on soil and water conservation, rice growing and irrigation water management is a dummy variable that takes on a value of one if the respondent had participated in training related to soil and water conservation, rice growing or irrigation water management and zero otherwise. Training is likely to increase farmers' willingness to pay. This is because; training tends to increase farmers' awareness of the dangers of unabated siltation of the irrigation channels and appreciation of their role in abating these dangers through payment of user fees, as well as appreciation of the ensuing benefits

Accessibility to extension services is a dummy variable that takes on a value of one if the respondent had accessibility to extension services in the past two years and zero otherwise. Access to extension is likely to increase the willingness to pay because extension improves the agricultural knowledge of the farmer and thus tends to increase farmers' awareness of the need to contribute towards the cost of maintaining the supply of the irrigation water.

Access to formal credit is a dummy variable that takes on a value of one if the respondent had access to formal credit sources in the past two years and zero otherwise. Credit enables cash constrained farmers to invest in complementary inputs to irrigation, thereby increasing their output and income; and thus their willingness to pay. The need to earn money to pay back the acquired credit also likely contributes to the higher willingness to pay, with the hope that this will lead to increased rice output and income to enable them to pay back the credit.

Engagement in off-farm activities is a dummy variable where 1 indicates farmer participated in an off-farm business and 0 otherwise. Participation in off-farm activities is ambigious. If the farmer believed that irrigation agriculture had a lower expected return than the off-farm business, they may not place a high value on the sustainability of irrigation agriculture. On the other hand, participation of the farmer in off-farm activities may have a positive effect on willingness to pay by making cash available.

Attitude towards payment of user fees is a dummy variable, which takes on a value of 1 for respondents with a positive attitude towards payment of user fees and zero otherwise. Farmers with a positive attitude towards payment are expected to have a higher willingness to pay as behavior can be predicted by attitudes.

Proximity to irrigation water source was also captured as a dummy variable with farmers at a distance less than or equal to 4Kilometres from the water source taking on a value of 1while those at a distance more than 4Kilometres taking on a value of 0. Proximity to water source is expected to be negative as farmers close to the source may be less willing since they receive water even when the scheme is not properly functioning compared to those far from the source who would like to ensure that the scheme is functioning properly for them to be able to access water.

3.3 Empirical Model Specification

For studies in which the dependent variable is continuous, the Ordinary Least Square (OLS) method is most commonly used because it produces the Best Linear Unbiased Estimators (BLUE) of the standard errors. Since in this study all the survey respondents expressed their willingness to pay as a continuous positive amount of money, the ordinary least square (OLS) model was found to be appropriate. A double log-linear regression model for the continuous variables was adopted to normalize these prior to running the regression.

The general form of the model is specified as:

$$\ln Y_i = \beta_0 + \beta_i \ln X_i + \mu_i \text{.................................}(ii)$$

Where: $\ln$ is natural logarithm, Y_i is the dependent variable X_i is a vector of explanatory variables, β_0 and β_i are the parameters to be estimated, and μ_i is the random error term.

Thus, the estimated OLS model explaining variation in willingness to pay across sampled farmers at Doho rice irrigation scheme is specified as:

$$\ln WTP = \beta_0 + \beta_1 \ln EDU + \beta_2 \ln EXP + \beta_3 \ln HHS + \beta_4 \ln FSIZE + \beta_5 \ln DMKT + \beta_6 TRA + \beta_7 EXT +$$

$$\beta_8 CRE + \beta_9 OFFA + \beta_{10} ATT + \beta_{11} PSOURCE + \mu_i \text{...}(iii)$$

The description of the variables used in the model and their hypothesized relationship with willingness to pay is shown in table 1

Table 1 Variables and their hypothesized relationship with willingness to pay

Variable	Description	Expected sign
WTP	Farmers' willingness to pay	
EDU	Education of farmer measured in years of schooling	+
EXP	Practical irrigation farming experience of farmer measured in years	+
HHS	Household size measured as number of household members	-
FSIZE	Farm size measured in acres	+
DMKT	Distance of the farm in Kilometres from the nearest market where rice is sold.	-
TRA	Dummy for participation in training related to soil and water conservation, rice growing or irrigation water management (1= Trained, 0= Otherwise)	+
EXT	Dummy for access to extension services (1= Accessed extension in the past two years, 0= Otherwise)	+
CRE	Dummy for access to credit (1= Accessed credit in the past two years, 0= Otherwise)	+
OFFA	Dummy for engagement in off-farm activities by the farmer (1= Farmer engaged in off-farm activities, 0= Otherwise)	±
ATT	Dummy for attitudes towards payment for the maintenance of supply of irrigation water (1= Positive attitudes towards payment, 0= Otherwise)	+
PSOURCE	Proximity to water source; (1≤ 4 Kilometres, 0 >4 Kilometres)	-
$\ln$	Natural logarithm	
β_i	regression parameters	
μ_i	random error term	

3.4 Description of the study area

The study was conducted at Doho rice irrigation Scheme located 34^{0}02’E and 0^{0}50'N on the right bank of river Manafwa in Mazimasa and Kachonga sub-counties of Butaleja district in the eastern part of Uganda. It is found 25km from Mbale town along Kampala-Mbale road (Figure 2).

Figure 2 Map of Uganda showing the study area

Source: www. mapsofworld.com

Doho rice irrigation scheme covers an area of 2500 acres occupied by 4385 households. It was divided into 10 blocks of unequal size, namely; 1A, 1B, 2A, 2B, 3, 4A, 4B, 5A, 5B, 6, for the purpose of easier management (Figure 3). The 10 blocks are connected by three layers of channels, namely; main, sub and tertiary channels. The main channel provides irrigation water from River Manafwa to the scheme branches out into the sub channels, which provide irrigation water to each of the 10 blocks. Basically, each block has one sub channel and consists of smaller zones called strips, each surrounded by a tertiary channel that provides irrigation water to farmer plots by a tertiary drainage channel. The tertiary drainage channel for one strip serves as the tertiary irrigation channel for the strip next to it. After flowing through the paddy fields, water is collected in the main drainage channel through the tertiary and sub-drainage channels and drained back into River Manafwa (Nakano & Otsuka, 2011)

The region receives bimodal rainfall with two peaks in the months of March-May and August-October. The first dry season comes in December-February and the second in June-July. The temperature ranges from a maximum of 30.7^0C to a minimum of 15.4^0C on average, with the mean annual temperature and rainfall estimated at 22.7^0C and 1186mm, respectively (MAAIF & FIEFOC, 2010).

Doho rice irrigation scheme was selected because of two major reasons. First, it is one of the schemes under rehabilitation before being handed over to farmers to manage and maintain. Secondly collective maintenance has been tried before at this scheme only that the maintenance charge was set by government without prior assessment of farmers' willingness to pay.

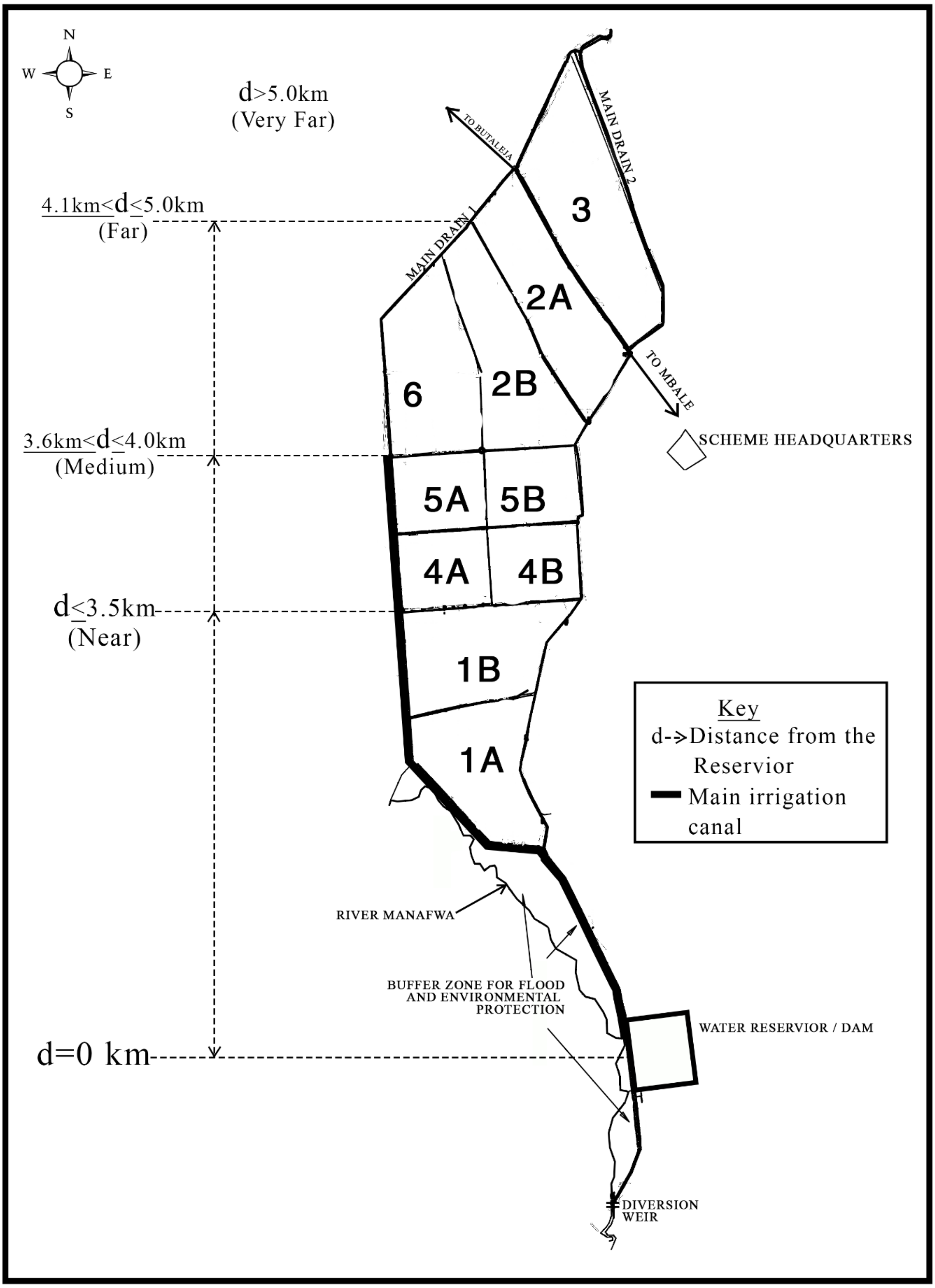

Figure 3 Map showing location of the 10 blocks with respect to water source/reservoir

3.5 Sample size and Sampling procedure

The study involved a survey of 200 farmers randomly drawn from among the rice farmers at Doho rice irrigation scheme. A stratified random sampling procedure was employed, using the 10 blocks that make up Doho rice irrigation scheme as the strata to ensure that farmers on all blocks are represented in the study sample. Using the list of farmers for each block, a proportionate number of households was randomly drawn based on the household population of that block relative to the number of households at Doho rice irrigation scheme (see Table2).

Table 2 Sample size distribution

Block name	Total number of farming households	Number of sampled households
1A	337	15
1B	612	28
2A	507	23
2B	477	22
3	476	22
4A	261	12
4B	314	14
5A	336	15
5B	344	16
6	721	33
Total	**4385**	**200**

3.6 Data collection

Data were gathered from the sampled farmers using a structured questionnaire (Appendix A) administered through in-person interviews. To elicit farmers' responses on willingness to pay for irrigation water, the study used a contingent valuation approach involving the iterative bidding game (Randall *et a l.*, 1974). The game starts by querying individuals at some initial monetary value and keeps raising or lowering the value until the respondent declines or accepts to pay. The final amount of money is interpreted as the respondents' willingness to pay. Despite criticism of the bidding game approach as being prone to starting point bias, which makes the final willingness to pay amount at the end of the bidding game systematically related to the initial bid value, Whittington *et al.* (1990) argue that the bidding game produces better quality willingness to pay data in developing countries than in industrialised countries. This is because it is well understood and accepted by respondents in developing countries, who are used and prepared to negotiating over the price of just about any item they purchase on a regular market, unlike their cohorts in the industrialised countries.

In this study, the starting bid price was set at Ush. 5000 per acre per season, which the farmers at Doho rice irrigation scheme were required to pay according to the existing by-law enacted in 1994(Ochom, 2004; Sserunkuuma *et al.,* 2003). Since the commodity to be valued(irrigation water) was familiar to the respondents, the bidding game was not framed in a probalistic sense, but rather the respondent was asked if they were willing to pay the starting bid price of Ush. 5000 per acre per season to experience adequate supply of irrigation water following the de-silting of irrigation and drainage channels. If the respondent answered "yes", the bid was increased until the respondent answered no. The highest yes response value was recorded as the maximum willingness to pay. If the respondent answered "no", the bid was reduced until the respondent answered yes, and the highest yes response value was recorded as the maximum willingness to pay. Farmers were not actually required to pay the bid amount they stated, which could have rendered this measure of willingness to pay biased and subjective. This was a key limitation of this study. However, the fact that the study involved valuation of a familiar commodity for which they were already paying helped to purge some of the bias. Additional data were collected on socio-demographic characteristics (age, gender, education, household size, years of irrigation farming), farm size, rice production and marketing, access to training and extension related to rice production and irrigation water management, access to credit and farmers' perceptions and attitudes about who should be responsible for paying the cost of maintaining the supply of irrigation water.

3.7 Data processing and analysis

Data analysis used both descriptive and econometric analytical tools. Farmers' willingness to pay to maintain the supply of irrigation water at Doho rice irrigation scheme was determined by descriptive statistics. The information on farmers' willingness to pay was summarized using means and percentages. Characterization of the farmers at Doho rice irrigation scheme based on their willingness to pay was also addressed using descriptive statistics. The surveyed respondents were grouped into two categories based on their stated willingness to pay. The first category consisted of those whose stated willingness to pay was greater than or equal to Ush. 15000; the amount of money needed to cover the cost of maintenance as per the 2013/2014 annual work plan of Doho rice irrigation scheme (Appendix E). This category constituted of 116 households. The second category consisted of 84 households whose stated willingness to pay was below Ush. 15000. The t-test and chi-square tests were conducted on socio-economic characteristics of farmers in the two categories to determine if there are significant differences in means and proportions, respectively. Determination of the factors influencing farmers' willingness to pay to maintain the supply of irrigation water at Doho rice irrigation scheme was achieved through estimation of a robust double log-linear regression model using the Ordinary Least Square (OLS) Method. The Ordinary Least Square (OLS) Model was chosen because the dependent variable is continuous; hence it produces the Best Linear Unbiased Estimators (BLUE) of the standard errors. A number of reasons were considered in choosing the double log version of the regression model over linear and semi-log models. First, the double log regression model enables the presentation of the regression coefficients directly as elasticity estimates (Arimah & Ekeng, 1993; Fasakin, 2000; Olajuyigbe & Fasakin 2010). Second, it translates the skewed data into a normal distribution thereby enabling much better estimates of the explanatory variable. Third, it reduces the occurrence of heteroskedasticity (Fasakin, 2000; Olajuyigbe & Fasakin, 2010).

The regression analysis was preceded by diagnostics, which included checking for multicollinearity, using the Variance Inflation Factor (VIF). It was found that multi-collinearity was not a problem as the mean VIF was 1.46, a value below 10. The Breusch-Pagan test was conducted to check for heteroskedasicity, and was found to be significant at 5%, suggesting a problem of heteroskedasticity, which was corrected using robust standard error estimation.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Descriptive statistics of the sampled farmers

The summary of descriptive statistics of the sampled respondents is presented in Table 3.

Table 3 Summary of descriptive statistics

Continuous variables	**Mean**	**Standard Deviation**
Age of farmer(Years)	42.1	14.115
Number of years of formal education of farmer(Years)	7.3	3.519
Average household size	7.3	3.483
Practical experience in farming under irrigation(Years)	13	9.190
Farm size(Acres)	2.7	2.297
Number of plots of land owned at the scheme	1.7	1.025
Distance from farm to the nearest rice market(Km)	1.5	0.411
Categorical variables	**Percentages**	
Male headed households	94	
Married respondents	84.5	
Farmers who received training on soil and water conservation and rice growing	58	
Farmers who had access to extension services	53.5	
Farmers who engaged in an off-farm activities	29.5	
Farmers who had access to credit in the past two years	29.5	

Source: Survey 2012

The results in Table 3 revealed that the average age of the respondents was 42years. The average number of years of formal education was 7.3years while the average household size was found to be 7 individuals. The mean practical irrigation experience of the sample was 13years. The mean farmland size of the respondents at the scheme was 2.7acres and the average number of plots of land owned at the scheme is 1.7. On average, the distance from the household to the nearest market is 1.5km. Results further show that from the total sample of respondents (200), 94% of the households were male headed. Majority (84.5%) of the respondents were married. More than half (58.%) of the respondents participated in training related training related to soil and water conservation, rice growing or irrigation water management and 53.5% had access to extension services in the past two years. More than one quarter (29.5%) of the sampled farmers had at least engaged in off-farm activities. A similar proportion of households (29.5%) at the scheme had access to credit in the past two years

4.2 Farmers' willingness to pay to maintain the supply of irrigation water at Doho rice irrigation scheme

This section reports the findings on how much farmers at Doho rice irrigation scheme are willing to pay in order to maintain the supply of irrigation water. The results indicate that the average willingness to pay per acre per season is Ush. 20,000; the lowest is Ush. 1000 and the highest is Ush. 60,000. The cost required for the maintenance of Doho rice irrigation scheme is Ush. 15000 per acre per season as per the 2013/2014 workplan. The average willingness to pay by the farmers at Doho rice irrigation scheme being higher than the cost of maintenance implies that several farmers would willingly pay the required cost of 15,000 per acre per season without coercion.

Further analysis shows that more than half of the farmers (58%) were willing to pay the required maintenance cost of Ush. 15000 per acre per season. This implies that a sizeable portion of farmers attach high economic value to the irrigation water. However there are also farmers who still attach low value to the irrigation water as their willingness to pay is as low as Ush. 1000 per acre per season. According to Lange *et al.* (2006), the economic value of a commodity to an individual is the price that individual would pay for the commodity. The stated willingness to pay amount is related to the respondent's underlying preferences in a consistent manner (Hanley *et al.*, 2001). Each user is assumed to be capable of assigning to every commodity a number representing the amount or degree of utility and therefore value associated with it (Henderson & Quandt, 1980). Hence individuals are willing to pay more for a commodity if they attach more value to it. A breakdown of willingness to pay figures and the percentage of farmers willing to pay these is provided in Table 4 below.

Table 4 Farmers' willingness to pay to maintain supply of irrigation water at Doho rice irrigation scheme

WTP classes in Ush. per acre per season	Percentage of sampled farming households
0-5000	17.5
5,001-10,000	22.5
10,001-15,000	11.5
15,001-20,000	13
20,001-25,000	7
25,001-30,000	11
30,001-35,000	4
35,001-40,000	6
40,001-45,000	3
45,001-50,000	3.5
50,001-55,000	0
55,001-60,000	1
Total	**100**

Source: Survey 2012

4.3 Characterization of farmers at Doho rice irrigation scheme based on their willingness to pay

This section presents characterisation of the farmers at Doho rice irrigation scheme based on their stated willingness to pay. The sampled farmers are grouped into two categories based on whether or not the money they are willing to pay as user fees is adequate to cover the maintenance and operation costs of Doho rice irrigation scheme (Ush. 15,000 per acre per season). Analysis of farmers' willingness to pay shows that 58% of the sampled farmers (n=200) are willing to pay atleast ush. 15,000 per acre per season as user fees; the amount needed to cover maintenance costs per acre per season. These constitute the first category of farmers. The second category is composed of the rest of the farmers (42% of the sample) whose willingness to pay is inadequate to cover the costs. The characteristics of the respondents are presented in Table 5.

Table 5 Socio-economic characteristics of farmers at Doho rice irrigation scheme based on willingness to pay

Variables	All households (n=200)	WTP ≥15000 (n=116)	WTP <15000 (n=84)	Chi-Square/ t-value
Average age(years) of farmer	42.1	43.3[a](1.211)	40.4[a](1.680)	1.420
Average number of years of formal education of farmer	7.3	8.5[a](0.283)	5.6[b](0.377)	6.270
Average household size	7.3	8.1[a](0.309)	6.3[b](0.377)	3.587
Average practical experience (years) in farming under irrigation	13	15.8[a](0.855)	9.3[b](0.853)	5.163
Average total area of land owned	2.7	3.3[a](0.242)	2.0[b](0.162)	4.195
Average distance from the farm to the nearest market	1.5	1.5[a](0.425)	1.6[a](0.389)	-1.446
Average number of plots of land owned at the scheme	1.7	1.8[a](0.112)	1.6[a](0.075)	1.619
Percentage of male headed households	94	98.3 [a]	88.1[b]	8.953
Percentage of married household heads	84.5	88.8 [a]	78.6 [a]	7.232
Percentage of households received training on soil and water conservation and rice growing	58	76.7 [a]	32.1 [b]	39.75
Percentage of households who had access to extension services in the past two years	53.5	61.2[a]	42.9[b]	6.594
Percentage of households with at least one member who engaged in an off-farm activity	29.5	27.6 [a]	32.1 [a]	0.486
Percentage of households who had access to credit in the past two years	29.5	36.2 [a]	20.2 [b]	5.974

Source: Survey 2012, n = number of households reporting. Numbers in parentheses are standard errors. Different superscripts mean statistically significant differences between the categories. Same superscripts indicate no statistically significant differences between the categories.

From Table 5 above, it can be observed that, the average age of a typical rice-farmer at Doho rice irrigation scheme is was 42.1 years which is an indication that most of the farmers were of middle age, with no statistically significant difference in the average age between the farmers willing to pay Ush. 15,000 or more (43.3years) and those willing to pay below Ush. 15,000 (40.4years). Formal education of the farmer was found to be 7.3 years of schooling for the entire sample. The number of years of formal education of farmers willing to pay Ush. 15,000 or more (8.5years) was significantly (p=0.000) higher than their cohorts willing to pay below Ush. 15,000 (5.6years). The average household size for the entire sample was 7.3persons but was significantly (p=0.000) higher among those willing to pay Ush. 15,000 or more (8.1persons) than those willing to pay less (6.3persons). On average, households at the scheme had practical irrigation farming experience of 13years. At (p=0.000), the irrigation experience is significantly higher among the households willing to pay Ush. 15,000 or more (15.8 years) compared to their cohorts willing to pay below Ush. 15,000 (9.3years). The average farm size for the entire sample is approximately 2.7 acres, with the category that was willing to pay Ush. 15,000 and above having a significantly (p=0.000) higher farm size (3.3 acres). The overall mean distance from the household to the nearest rice market is 1.5Kilometres; with no significant difference in distance from the household to the nearest market between the two categories of farmers. The average number of plots of land owned at the scheme does not differ significantly across the two farmer categories and is estimated at 1.7 for the entire sample.

At (p= 0.003), the percentage of male headed households was significantly higher in the group that was willing to pay Ush. 15,000 and more (98.3%) compared to that whose willingness to pay was less than Ush. 15,000 (88.1%). However for both farmer categories, the majority of the sampled households are male headed. This is consistent with the Uganda National Household survey of 2009/2010 which reported that, the biggest percentage (69.9%)

of households in the whole of Uganda and 71.1% in the eastern region of Uganda, where the scheme is located, are male headed (UBOS, 2010). Similarly the Uganda census of agriculture of 2008/2009 conducted by UBOS (2010) reported that 87.8% agricultural households in the district of Butaleja, where the scheme is particularly located are headed by males. With regard to marital status, the majority of the household heads are married, with no significant difference in marital status between the two farmer categories.

More than half (58%) of the sampled households participated in training related to soil and water conservation, rice growing or irrigation water management, but the percentage of trained households is significantly (p=0.000) higher among those that were willing to pay Ush. 15,000 and above (76.7%). The survey results also show that 53.5 % of all the households had access to extension services in the past two years. The percentage of households who had access to extension services in the group willing to pay Ush. 15,000 or more was significantly higher (61.2%) at (p=0.010) compared to their cohorts willing to pay below Ush. 15,000 (42.9%). Over one quarter (29.5%) of the sampled farmers had at least engaged in off-farm activities, with no significant difference between the two farmer categories. A similar proportion of households (29.5%) at the scheme had access to credit in the past two years, but this was significantly (p=0.015) higher among those who were willing to pay Ush. 15000 and more (36.2%) than their cohorts willing to pay less (20.2%). These results on credit access are consistent with the findings of the agriculture census (2008/2009) which shows that 10% of agricultural households country wide and 24.2% of agricultural household members in the eastern region where the scheme is situated accessed credit in 2008/2009 (UBOS, 2010). The results from characterization discussed above suggest a significant relationship between socio-economic characteristics of farmers at Doho rice irrigation scheme and their willingness to pay.

4.4 Factors influencing farmers' willingness to pay to maintain supply of irrigation water at Doho rice irrigation scheme

This section represents the results of the regression model showing the different factors influencing farmers' willingness to pay to maintain supply of irrigation water at Doho rice irrigation scheme. The results of the model are presented in Table 6.

The results of the regression analysis show that farmers' willingness to pay is influenced by formal education; farm size; experience in practical irrigation farming; participation in training related to soil and water conservation, rice growing or irrigation water management; and accessibility to credit and markets. The coefficient for formal education was 0.39 implying that an increase in education by one year increases willingness to pay by 0.39 %. Farm size had a coefficient of 0.25 which indicates that an increase in farm size by one acre increases willingness to pay by 0.25%. For farmers' experience in practical irrigation agriculture, the coefficient is 0.15 meaning that an increase in irrigation experience by one year increases willingness to pay by 0.15%. The coefficient for distance of the farm from the nearest market where rice is sold is negative so that willingness to pay decreases with increase in distance from the market. The coefficient indicates that when distance of the farm from the nearest market increases by one kilometre, the willingness to pay decreases by 0.34%. The coefficient for farmers' participation in training related to soil and water conservation, rice growing or irrigation water management is positive implying that access to training increases willingness to pay. Similarly access to formal credit increases farmers' willingness to pay. The adjusted coefficient of determination (Adjusted R-Squared) of 0.51 means that 51% of the variation in farmers' willingness to pay is explained by the variables included in the model.

Table 6 Factors influencing farmers' willingness to pay to maintain supply of irrigation water at Doho rice irrigation scheme

Variable	Coefficient	Robust standard Error	T-Value
Constant	7.985	0.264	30.22
ln education of farmer	0.391***	0.060	6.56
ln household size	0.088	0.092	0.96
ln farm size	0.246***	0.058	4.23
ln Practical irrigation farming experience	0.154**	0.070	2.19
ln Distance from farm to the nearest rice market	-0.336*	0.194	-1.73
Training in soil/ water conservation/ rice growing	0.366***	0.114	3.21
Access to extension services	0.144	0.116	1.24
Access to credit	0.217**	0.086	2.51
Engagement in off-farm income activities	0.003	0.092	0.04
Positive attitude towards payment of user fees	0.120	0.122	1.98
Proximity to irrigation water source	-0.120	0.095	-1.26
Number of observations	200		
R-Squared	0.5136		
Prob>F	0.0000		
F(11, 188)	26.49		
Breusch-Pagan test for heteroskedasticity Prob> chi2	0.0455		
Mean VIF	1.46		

Source: Survey 2012, * indicates significance at the 10 percent level, ** at the 5 percent level, and *** at the 1 percent level.

The results of the regression imply that more educated farmers are willing to pay a higher price to sustain the irrigation water. This can be attributed to farmers with higher education levels having a better understanding of the benefit of adequate supply of irrigation water in agricultural production. Education is believed to increase farmers' ability to obtain, analyse and assimilate information that helps them to make prudent decisions related to the management of their farming enterprises. Also, education is a good proxy for off-farm income because it enables agricultural households to pursuit alternative income opportunities outside agriculture for example salary or business, which increases their ability and willingness to pay of the irrigation fees. These results are consistent with findings of Alemayehu (2014); Adepoju & Omonona (2009); Akter, 2007; Akankwasa (2007); Mezgebo *et al*. (2013); Mwaura *et al.* (2010); Ogunniyi *et al.* (2011); Wendimu& Bekele (2011); Va´squez *et al.* (2009) who found a positive relationship between formal education and willingness to pay.

The positive relationship between farm size and willingness to pay implies that farmers with larger farm sizes are willing to contribute more towards the maintenance of the supply of irrigation water at Doho rice irrigation scheme. This may be because farmers with larger land endowment also cultivate larger rice plots at Doho rice irrigation scheme and earn higher income from rice when the supply of irrigation water is adequate. These findings are consistent with those of Mezgebo *et al*. (2013); Rohith & Chandrakanth (2011); Ulimwengu & Sanyal (2011); and Nakano & Otsuka (2011); and illustrate the prime importance of private benefits conferred by farm size in collective irrigation water management (White & Runge, 1994).

Farmers with long experience in practical irrigation farming are willing to invest more money in the sustainability of the irrigation scheme compared to their cohorts with relatively shorter experience. This is probably because farmers with longer experience are more familiar with the benefits of irrigation enjoyed when Doho rice irrigation scheme was still properly maintained and have also observed the decline in rice output through the years as the scheme deteriorated. This enables them to better appreciate the importance of their contribution towards improved water supply, hence the higher willingness to pay. This result is consistent with Addis (2010); Kassahun (2009); and Latinopoulos (2001) who found a positive relationship between willingness to pay and experience.

Participation in training related to soil and water conservation, rice growing or irrigation water management is associated with higher willingness to pay of the user fee, likely because training tends to increase farmers' awareness of the dangers of unabated siltation of the irrigation channels and appreciation of their role in abating these dangers through payment of user fees, as well as appreciation of the ensuing benefits. This finding is consistent with Calatrava & Sayadi (2005) who found that farmers who attended agricultural training courses were significantly more willing to pay for water in tropical fruit production in South Eastern Spain.

Access to credit was also found to positively impact farmers' willingness to pay, likely because credit enables cash constrained farmers to invest in complementary inputs to irrigation, thereby increasing their output and income; and thus their willingness to pay. The need to earn money to pay back the acquired credit also likely contributed to the higher credit, with the hope that this will lead to increased rice output and income to enable them to pay back the credit. This result corroborates the findings of Addis (2010) and Illukpitiya & Gopalakrishnan (2004) who found that access to credit increases willingness to pay.

Distance to the rice market and willingness to pay the user fee are negatively correlated probably because farmers closer to the markets incur less transaction costs compared to those further, hence higher returns from their outputs and thus more willingness to pay to ensure adequate supply of irrigation water. This finding is consistent with Ulimwengu & Sanyal (2011) who found a negative impact of travel distance on the willingness to pay for agricultural services.

The F-test of the model was statistically significant at 1%, implying that the model fit was reasonably good.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

- Farmers' willingness to pay was higher than the estimated cost of maintaining the supply of irrigation water. Actually more than half of the farmers were willing to pay the required maintenance cost implying that several farmers would willingly pay the cost amount without coercion.

- Training in soil and water conservation, rice growing and irrigation water management is likely to increase farmers' willingness to pay for irrigation water at Doho rice irrigation scheme. Access to credit is also likely to increase the farmers' willingness to pay for the irrigation water. Farmers with larger farm sizes are likely to contribute more money towards the cost of maintaining the irrigation scheme. Likewise are more educated farmers and farmers with more experience of irrigation farming likely to have a higher willingness to pay. However, farmers further from the rice markets are likely to have a lower willingness to pay to maintain the supply of irrigation water at Doho rice irrigation scheme.

5.2 Recommendations

The study recommends charging Ush. 15,000 per acre per season, which not only generates sufficient revenue to cover the costs, but also lies below the average willingness to pay, implying that several farmers would willingly pay this amount without coercion.

Appropriately targeted interventions that address the factors influencing farmers' willingness to pay are recommended. For example, the positive relationship between willingness to pay and participation in training related to soil and water conservation, rice growing or irrigation water management implies that intensifying training in these areas is important if the scheme is to be maintained sustainably. Hence efforts should be directed towards intensifying training of farmers through appropriate training programs. This will increase their awareness of the dangers of unabated siltation of the irrigation channels and appreciation of the importance of their contribution towards the cost of de-silting to ensure adequate supply of irrigation water.

Interventions that promote farmers' access to affordable credit are also recommended, based on the positive relationship between having had access to credit and willingness to pay. These may include establishment of an agricultural bank or micro-credit schemes where farmers can access credit at more affordable rates compared to commercial banks. This will increase the farmers' ability to invest in the inputs that are complementary to irrigation, receive better returns and willingly pay to maintain the flow of the irrigation water.

In light of the findings that market accessibility increases farmers' willingness to pay for irrigation water, there is need to bring markets closer to the farmers. This will reduce the transaction costs involved and enable farmers to receive better returns; which will in turn enhance their willingness to contribute towards maintenance of irrigation water supply.

Since the study has established that farmers with larger farm sizes are willing to contribute more towards the supply of irrigation water, there is need to have in place active land rental markets to enable interested farmers to expand the sizes of their rice farms; which will in turn increase their income and ability to pay.

Based on the positive relationship between willingness to pay and education, there is need for government to invest in education to improve willingness to pay.

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APPENDIX A

QUESTIONNAIRE

FARMERS' WILLINGNESS TO PAY TO MAINTAIN THE SUPPLY OF IRRIGATION WATER: A CASE OF DOHO RICE IRRIGATION SCHEME

Introduction:

This interview is made to undertake a research for the partial fulfilment of the award of the Master of Science degree in Agricultural and Applied Economics. I kindly request you to provide me with the appropriate information to fill in the interview guide. Please tick the answer that applies to you or answer as necessary. All information provided will be treated with the highest degree of confidentiality.

SECTION A: SOCIO-DEMOGRAPHIC

Date of Interview…………………...start time……………….Ending time……………………

Name of respondent…………………………………………………………………………….

County……………………………………. Sub-county……………………………………….

Village…………….....................................Questionnaire number…………………………….

Sex of the respondent: Male ☐ Female ☐

Marital status of the respondent

1. Single 2. Married 3. Widowed 4. Divorced

Block number…………………………………………………………………………………..

Name of farmer…………………………………………………………………

Age of the farmer…………………………………………………………………

Gender of the farmer……………………………………………………………

Level of education of farmer…………………………………………………

Main occupation of the farmer………………………………………………….

Average income of the farmer per month in Uganda shillings…………………

Question 1: Please list the members of your household

No.	**Names**	**Relationship to household head**	**Age** **(Years)**	**Gender:** **1=Male** **2=Female**	**Education** **Level** **(Years)**	**Main occupation**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

16						
17						
18						
19						
20						

Relationship to household head codes: 1= Spouse, 2= Child, 3= Grand Child, 4=Sister, 5=Brother, 6 =In-Law, 7=Father, 8 =Mother, 9 =Other (Specify).

Question 2: Please tell us about your farm, in general

A. Land holdings

Parcel name or number	**Location of parcel**	**Size of parcel (Acres)**	**Land use**	**Methods of land acquisition**	**If rented, how much per season? (Ush.)**
Total					

Land use codes: 1= Crops, 2= Natural pasture, 3 =Improved pasture, 4 = Forested, 5= Swamp, 6= Settlement, 7=others (specify).

Land acquisition codes: 1= Purchase, 2=Gift or inheritance, 3= government administration, 4= Rented, 5= lease 6=others (specify).

B. Please list all the crops that were grown during the last six months on your different land parcels

Crop name	Area planted (Acreage)

C. Other holdings

	Number	Price per unit if sold today (Ush.)		Number	Price per unit if sold today (Ush.)
Local cattle			Radio		
Cross-breed cattle			Bicycles		
Exotic cattle			Motorbikes		
Goats			Furniture		
Sheep			(specify)		
Pigs					
Chicken					
Ducks					

D. Type of house

Type of house (1=Iron sheets, 2=Grass thatched, 3= other specify)	Who owns (1=respondent owns, 2= Rented, 3=other specify)	If rented, how much amount of rent per month (Ush.)

E. Household expenditure on major items per month (Ush.)

Food	
Education	
Paraffin	
Telephone	

SECTION B: PLOTS OPERATED AT THE SCHEME

3. How many years have you been involved in rice growing?..

4. How many years have you been growing rice at the scheme?..

Question 5: Number of plots operated at the scheme

Plot number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Size of plot(Acreage)											
Distance from nearest irrigation sub-canal (meters)											
Distance from main irrigation canal(meters)											
Method of land acquisition											
If renting, how much?											

Land acquisition codes: 1= Purchase, 2=Gift or inheritance, 3= government administration, 4= Rented, 5= lease 6=others (specify)

SECTION C: WILLINGNESS TO PAY TO PAY TO MAINTAIN THE SUPPLY OF IRRIGATION WATER

6. After the rehabilitation of the scheme is complete, the scheme operation and maintenance will be handed over to the farmers. Maintaining the health of the irrigation canals and the scheme in general from silt is required to get year round irrigation water supply. Therefore to optimize long and short- term benefits from irrigation water, you and other households that farm at the scheme are expected to contribute money per acre per season. If you were requested to pay Ush. 5000 per acre per season, would you be willing to pay it?

a) Yes b) No

If yes; the interviewer keeps increasing the bid until the respondent says no. Then the maximum willingness to pay is elicited as Ush………………........per acre per season. If No; the interviewer keeps decreasing the bid until the respondent says yes. Then the maximum willingness to pay is elicited as Ush……………...per acre per season. If the willingness to pay response is zero; why?

(i)..

(ii)……………………………………………………………………………………………

7. In your opinion, how well do you think this community will be willing to pay for irrigation water if asked?

(a) Very well (b) Well (c) Not so well

8. Why?...

9. In your opinion, do you think that, paying to maintain the supply of irrigation water should be the responsibility of the farmers? a)Yes b) No

10. How do you rate rainfall in this area?

a) Reliable b) Average c) Unreliable

11. Do you think irrigation increases rice output compared to rain fed agriculture?

a) Yes b) No

12. Have you been advised about irrigation farming?

a) Yes b) No If yes, by whom?………………………………………………...

13. Apart from the scheme, do you have anywhere else to grow rice?

a) Yes b) No

14. Distance from water source/ reservoir to farm…..(kilometres)

SECTION D: RICE PRODUCTION AT THE SCHEME

Question 15: Please tell us about your rice production at the scheme

A. Rice output last season

Area under rice production (acres)	
Quantity harvested last season (kilograms)	
Output last season per acre (kilograms)	
Quantity sold last season (kilograms)	
Price last season (Ush. per kilogram)	
Distance to nearest market where you normally sell your rice (Kilometres)	

B. Fertilizer usage

Did you use fertilizers in your rice farming last season?

a) Yes b) No

If yes, which ones did you use and how much did you apply?

Type of fertilizer	Name	Quantity applied last season (kilograms)	Quantity applied per last per acre (kilograms)	Unit cost (Ush. per kilogram)
Organic				
Inorganic				

C. Labour input requirements for rice production in the last season

Activity	**Type of labour**	**Family labour**			**Hired labour**				
		Number of workers	Number of days worked	Hours Per day	Number of Workers	Number of days worked	Hours Per day	Wage rate per day	Total cost (Ush.)
Land prep	Children								
	Adult male								
	Adult female								
Nursery prep	Children								
	Adult male								
	Adult female								
Planting	Children								
	Adult male								
	Adult female								
Fertilizer application	Children								
	Adult male								

	Adult female								
weeding	Children								
	Adult male								
	Adult female								
Spraying	Children								
	Adult male								
	Adult female								
Scaring birds	Children								
	Adult male								
	Adult female								
Harvesting	Children								
	Adult male								
	Adult female								
Threshing	Children								
	Adult male								
	Adult female								

D. Other inputs used in rice last seasons

Type of rice seeds used last season

a) Indigenous b) Improved c) both

Quantities of seed and chemicals used in last season

Input	Quantity used last per acre (Kilograms)	Quantity used last season per acre (Kilograms)	Unit cost (Ush.)
Seed			
Spraying chemicals			

SECTION E: EXTENSION AND TRAINING

16. Have you had a visit from any extension officer in the past two years? a) Yes b) No

If Yes, fill in the questions in the table below

Subject of extension				
Provider of extension				
No. of contacts with Extension agent				

Extension subject codes: l=Soil & water conservation, and irrigation water management2= Value addition, 3=Fertilizer Application, 4=Disease and Pest control, 5=other (specify)…………………………..

17. Have you ever received any training on soil & water conservation, rice growing and irrigation water management?

a) Yes b) No

If yes, how many times have you received this training? ....

SECTION F: CREDIT ACCESS AND OFF FARM INCOME

18. Has you or any of your household members had access to credit in the past 2 years?

a) Yes b) No

19. If yes, (Formal sources include banks, cooperatives, NGOs, government and other programs, while informal sources include money lenders, 2= relative or friend, 3=farmer group, traders, intermediaries).

Source of credit						
How much?						
Purpose						

Source of credit: 1= money lenders, 2= relative or friend, 3=farmer group, 4=NGO, 5= government, 6=commercial bank, 7= MFI, 8= other (specify)

Purpose: 1= Rice production, 2=Other farm production, 3= General household purchase, 4 other (specify)

20. Do you have other source of income (you or your family) other than agriculture (off-farm activities) to support your livelihood?

a) Yes b) No If yes, specify the income sources and amounts obtained from those sources.

Income source	**Income per month**	**Income source**	**Income per month**

21. What are the three major problems that you encounter as a farmer in the production of rice? Please rank them according to the order of intensity of the problem.

1) ……………………………………………………………………….
2) ………………………………………………………………………….
3) ……………………………………………………………………………

22. In your opinion, do you think a rice farmer at the scheme is better off than one not on scheme?

a) Yes b) No

23. Why? Please rank them according to the order of importance.

1) ……………………………………………………………………….
2) ………………………………………………………………………….
3) ……………………………………………………………………………

THANK YOU VERY MUCH FOR YOUR VALUABLE TIME

Appendix B: Multi-collinearity test using the Variance Inflation Factor (VIF)

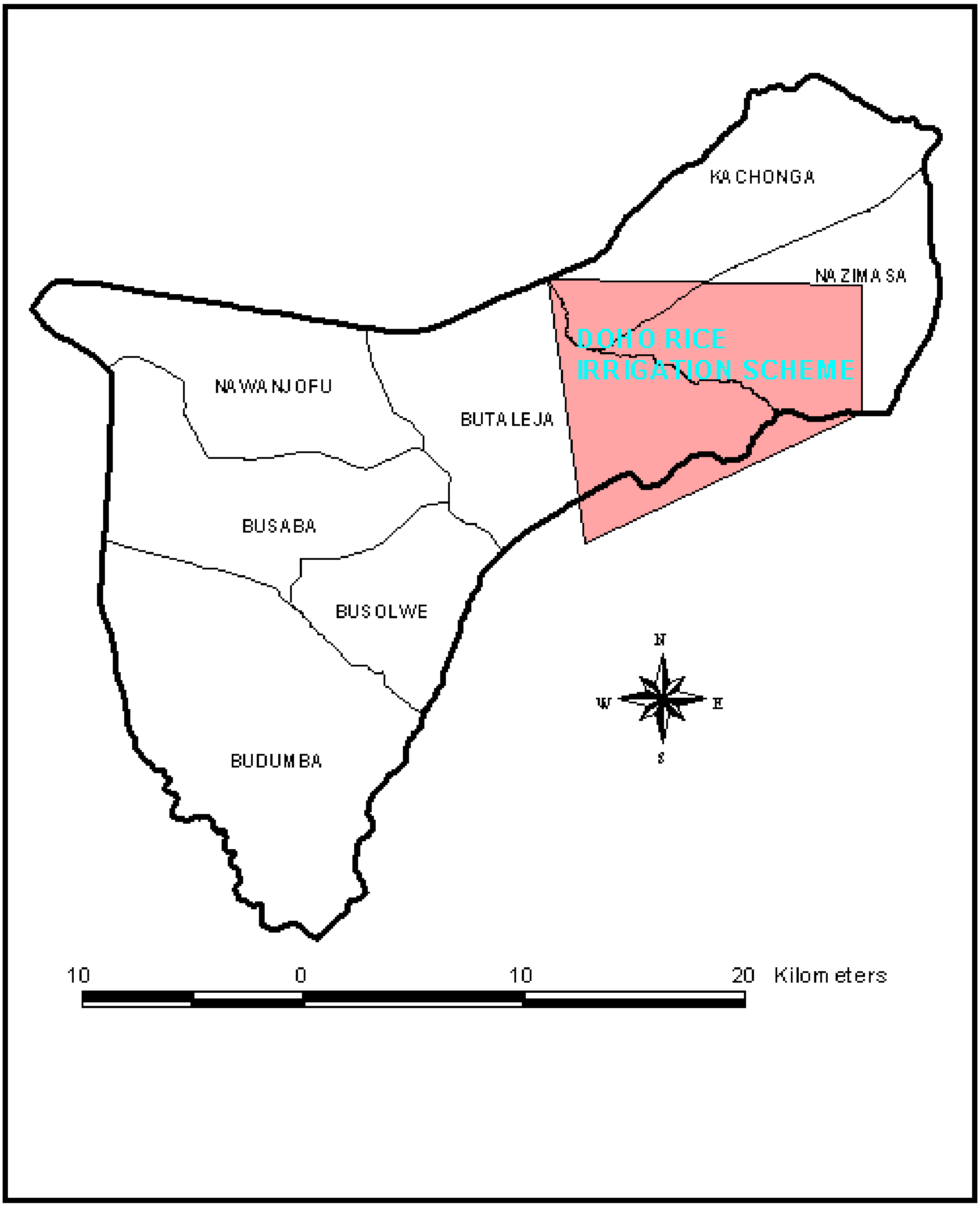
Variable	VIF	1/VIF
Training in soil/ water conservation/ rice growing	2.10	0.475540
ln practical irrigation farming experience	2.09	0.478409
ln distance from farm to the nearest rice market	1.88	0.531744
Access to extension services	1.69	0.593149
ln farm size	1.32	0.758887
Proximity to irrigation water source	1.30	0.766647
ln household size	1.27	0.787624
Positive attitude towards payment of user fees	1.15	0.871057
ln number of years of formal education	1.12	0.894970
Engagement in off-farm income activities	1.08	0.925328
Access to credit	1.06	0.939835
Mean VIF	**1. 46**	

Source: Survey 2012

Appendix C: Breusch-Pagan test for heteroskedasticity

Hettest
Breush-Pagan/Cook-Weisberg test for heteroskedasticity
Ho:Constant variance
Variables: fitted values of log wtp
Chi2(1) =3.89
Prob> chi2 = 0.0455

Appendix D: Map of Butaleja district showing location of study area



Appendix E: Estimated Budget for the maintenance of Doho rice irrigation scheme for each season as extracted from the Annual work plan of 2013-2014

Activity	Cost per season (Ush.)	Cost per acre per season (Ush.)
Excavator maintenance(servicing)	3000000	
Maintenance of all canal gates(main gates, medium gates and small gates)	2000000	
Maintenance of farm roads	7500000	
Maintenance of irrigation canals	10000000	
Maintenance of drainage canal	5000000	
Maintenance of broken pedestrian or foot bridges	2000000	
Servicing of machines	5250000	
Meetings	2570000	
Total	**37320000**	**15000**

Source: Doho rice irrigation scheme annual work plan for 2013-2014, total scheme acreage is 2500acres