FARMERS' WILLINGNESS TO PAY FOR IMPROVED SUPPLY OF IRRIGATION WATER: THE CASE OF MESKAN DISTRICT IN GURAGHE ZONE, SNNPR

M.Sc. THESIS

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By

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DEDICATION

I dedicate this thesis manuscript to my family and my friends for their partnership and being always eager to see my success.

STATEMENT OF THE AUTHOR

I declare that this thesis is my work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfilment of the requirements for M.Sc. Degree at the Jimma University and is deposited at the University Library to be made available to borrowers under rules of the Library. I confidently declare that this thesis is not submitted to any other institution for award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The author was born in 1991 in Butajira, Guraghe zone of Southern Ethiopia. He attended his elementary education at Mekicho Elementary School in Butajira. He also attended his secondary and preparatory education at Butajira Secondary and Preparatory School. After successful completion of his preparatory school education, he joined Hawassa University in 2008/2009 and graduated with B.Sc. degree in Agricultural Resource Economics and Management in July 2011. After his graduation, the author was employed in Kolfe Keranio Sub city Trade and Industry Office in Addis Ababa City Administration and served for three years and five months. After that in August 2015, he joined Assosa University and served as graduate assistant from August 2015 to September 2016 in the faculty of Agriculture and Natural Resource. After one year of professional experience, he joined the School of Graduate Studies of Jimma University to pursue his MSc degree in Agricultural Economics in regular program.

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ACRONYMS AND ABBREVIATIONS

AMCOW	African Ministers' Council on Water
BoFED	Bureau of Finance and Economic Development
CSA	Central Statistical Agency
CVM	Contingent Valuation Method
DBDC	Double Bounded Dichotomous Choice
FAO	Food and Agriculture Organization
GTP	Growth and Transformation Plan
ISF	Irrigation Service Fee
MWTP	Maximum Willingness To Pay
MOA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
MWARDO	Meskan Woreda Agriculture and Rural Development Office
MWFEDO	Meskan Woreda Finance and Economic Development Office
NOAA	National Oceanic and Atmospheric Administration
NPC	National Planning Commission
O&M	Operation and Maintenance
OLS	Ordinary Least Squares
SBDC	Single Bounded Dichotomous Choice
TEV	Total Economic Value
UNESCO	United Nations Educational, Scientific and Cultural Organization
WTA	Willingness to Accept
WTP	Willingness to Pay

FARMERS' WILLINGNESS TO PAY FOR IMPROVED IRRIGATION WATER USE: THE CASE OF MESKAN DISTRICT, GURAGHE ZONE, SOUTHERN ETHIOPIA

ABSTRACT

The economic value of water is essential for rational allocation of scarce water resource as its availability has become a problem in many countries of the world. Even though there are four major water resources which could be suitable for irrigation purpose in Meskan district, there is no well-constructed irrigation scheme and regulation. However, there was demand for improved and sustained irrigation service in the area. The study was conducted in Meskan district, Guraghe Zone, Southern Ethiopia with specific objectives; to estimate farmers' willingness to pay for improved irrigation water use and to identify determinants of farmers' willingness to pay for improved irrigation water use. The study was based on primary data collected from 210 sample households selected through two-stage sampling technique while it was also supplemented by secondary data. Double bounded dichotomous choices with follow up open ended questions of contingent valuation methods were employed to elicit farmers′ willingness to pay for improved irrigation water use. Both descriptive and econometrics models were used for the analysis. Multiple linear regressions model was used to identify the major determinants of farmers' willingness to pay for improved irrigation water use. Whereas seemingly unrelated bivariate probit model was used to estimate the mean willingness to pay for improved irrigation water use. The result of multiple linear regressions showed that households' sex, age, educational level, credit use, distance to market and irrigation scheme, and dissatisfaction with the existing irrigation scheme significantly affected the willingness to pay for improved irrigation water use. On the other hand, the result of the seemingly unrelated bivariate probit model from double bounded dichotomous showed that households' mean annual willingness to pay amount was Birr 3317.84 per hectare of irrigable land, while open ended format was to be 2906.20 birr per hectare. The respective total aggregate value of improved irrigation water use in the study varies from 33,421,300 birr in open ended to 38,155,160 birr from double bound. The result of the contingent valuation survey revealed that all of the sample household heads have shown their willingness to pay for improved irrigation water use. Therefore, as the result of the study suggests good indicator for the concerned body to invest for expanding the current irrigation projects and introducing proper irrigation water pricing, policy and program intervention designed to implement improved irrigation water supply in the district should take in to account factors determining households' willingness to pay.

KEYWORDS: Contingent valuation method, Economic value, Irrigation water pricing, Seemingly unrelated bivariate probit

1. INTRODUCTION

1.1. Background of the Study

Water is a finite and vulnerable natural resource which is an essence of life on earth. It plays an important role in supporting life and maintaining human health and it ensures to have sustainable ecosystem development. When it comes in excess amount it led to flooding; while, a limited amount it can result in drought; It can be quoted as the reasons of destruction, misery or death globally (Bagatin *et al*, 2014; UNESCO, 2015).

Water resources in Africa have become a strategic commodity, with supply limited in terms of quantity and quality, and demand increasing due to population growth and economic development. Africa is home to about 13% of the world's population, but has only about 9% of the world's water resources. Per capita level of water availability in Africa is low due to a significant decline in the average rainfall, high evaporative losses and the high variability of supply, due to highly variable rainfall (AMCOW, 2012). This extreme variability of climate and hydrological conditions imposes high costs on livelihoods, and raises the riskiness of development interventions.

Ethiopia is described as the "water tower" of Africa. It has 12 river basins with an annual runoff volume of 125 billion m^3 (Seleshi *et al*., 2010; Eneyew, 2014). The ground water potential is estimated to be more than 2.6 m^3, a relatively large volume (Seleshi *et al*., 2010). Besides, it is often said that the amount of rain the country gets even in the driest times is much higher than the amount Israel gets in the wettest times. Despite the country's abundant rainfall and water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation (Gebremeskel and Kebede, 2015). The majority of rural dwellers in Ethiopia are among the poorest in the country, with limited access to improved irrigation water for agriculture. Specifically, developing the irrigation sector has many potential benefits in efforts to reduce vulnerability and improve productivity; via increasing productivity of land and labor, reducing reliance on rainfall and hence increasing exports (Awulachew *et al*., 2010).

The agricultural sector of Ethiopia is heavily rain-fed, which is characterized by high spatial and temporal differences. The vast majority (approximately 80%) of Ethiopia's population is concentrated in the highland areas, which in most cases, experiences inadequate rainfall during the main season (MOA, 2011). The country is also characterized by rapid population growth. So as to meet the growing demand or food of this growing population, the country needs to have the right optimal resource use, like improved irrigation water, to increase production and productivity. Irrigation will play a vital role to increase production to meet the growing food demand and stabilize agricultural production and productivity (ibid).

From the estimated irrigation potential to be about above 5.3 million hectares of arable land, the goal of Growth and Transformation Plan (GTP I) of Ethiopia was to reach the irrigation development to be 15.4%. However, the achievement of the area under irrigation development in 2012/2013 was 10.76%, including several irrigation development projects under construction like, Kesem-Tendaho, Koga, Rib, Gidabo, Megech-Sereba, Kobo-Girana, Raya-Azebo, and Adea- Betcho) (MoWR, 2013). This shows that, water resources have made little contribution towards the development of irrigated agricultural sector as significant irrigation potential of the country has not been much utilized to raise agricultural production and productivity.

In recent times, the Government of Ethiopia has designed policy and strategy to eradicate poverty in its five year plan called the Growth and Transformation Plan (GTP II) by maintaining agriculture as a major source of economic growth. In this regard, the government plan to give priority in the second Growth and Transformation Plan period by expanding small-scale irrigation to increase agricultural production and productivity, to enhance the economic contribution of water resources (NPC, 2016).

In Ethiopia, the pricing mechanism of irrigation water is based on non-volumetric measures and the existing irrigation policy of the country gives more emphasis on the construction of small scale irrigation projects rather than the valuation of the irrigation water. Water pricing can potentially raise significant financial resources to pay for the sustainable management of water resources. Revenues from water pricing are particularly important for developing countries in which funds from public budgets and from donor sources are unpredictable and may vary significantly from year to year (EC, 2012). With this regard, this study was conducted in Meskan district, Guraghe Zone, Southern Ethiopia to examine farmers' willingness to pay for improved irrigation water use as valuation of irrigation water based on users' willingness to pay is very essential to implement water pricing.

1.2. Statement of the Problem

Water resources play a vital role in people's daily lives as well as in agricultural irrigation, fish farming, and manufacturing. Water is not only an indispensable natural resource, but also an irreplaceable economic resource (Hoekstra, 2013). It has unique characteristics that determine both its allocation and use as a resource in agriculture which is very crucial for sustaining human life. Agricultural water use accounts for about three quarters of total global consumption; in many developing countries, irrigation accounts over 90% of the water used (Rezhen *et al.*,2015).

The growing demand for water in household, commercial and industrial sectors as a result of population and industrial growth combined with frequent occurrence of drought have raised increasing concerns about the conventional wisdom of perceiving irrigation water as a free gift of nature (World Bank, 2009). Irrigation is a vital component of agricultural production in many developing countries (Chandrasekaran *et al.*, 2009, Sadeghi *et al.* 2010). Empirical studies reveal that irrigation also increases farm level water use (Knap *et al*, 2018).

Due to rapid economic and population growth, many water sources have become depleted; and consequently, now water has become a scarce good (Omondi, 2014). Hence, the allocation of water among the main sector uses (i.e. domestic, industrial and agricultural) is today a critical issue for most countries in the world. As a result the increasing scarcity of water competition and conflicts among uses and users of water resource arise. So, it is necessary to make decisions on conservation and allocations of water that are compatible with social objectives such as economic efficiency, sustainability and equity (ibid).

However, implementing an effective water management system is a complex task; one important requirement for success is sufficient knowledge about farmers' demand or willingness to pay for irrigation water. Correct and accurate estimates of the economic value of water are essential for rational allocation of scarce water resource across locations, uses, users, and time periods (Hudu *et al.*, 2014).

In general principle, water pricing policies has the potential to mitigate water scarcity. Whatever the agricultural water use is concerned, it is argued that water pricing can play an important role in making this use more efficient, while at the same time reducing burdens on the environment and freeing water resources for other competing uses (Omondi, 2014). In this regard, the government of Ethiopia has water pricing policy which is reinforced the setting of site specific irrigation water users' fee based on cropping pattern, farm level profit, and scheme efficiency to develop the appropriate cost recovery systems and mechanisms for all irrigation schemes. Furthermore, the strategy recognizes the powerful impetus of the willingness to pay of the irrigation users for the financial sustainability of the scheme (MoWR, 2001).

As described in the policy, the effectiveness or the success of irrigation water fee for the sustainable development of the sector highly depends on a number of site specific factors. Thus prior to the introduction of irrigation water use fee, the examination of farmers' willingness to pay has a paramount significance. Different studies undertaken by Tadesse *et al*.(2017); Birhane and Geta (2016), Anteneh (2015), Angella *et al.* (2014) and Mezgebo *et al.* (2013) revealed that farmers' were willing to pay for irrigation water supply, however; their willingness to pay vary due to demographic and socio-economic conditions of the farmers in general. Therefore, undertaking studies on farmers' WTP for irrigation water supply in different localities help the policy makers and concerned bodies to design and implement an appropriate policy.

In the study area, Meskan district, there are four major water resources namely, - Erinzaf, Eresha, Jirbenas and Akamuja rivers, which could be suitable for irrigation purpose. However, there is no well-constructed irrigation scheme and regulation despite the demand for improved and sustained irrigation service in the area. This in turn resulted in limited opportunity for the rural households' to grow crops throughout the year. So introducing irrigation system which implements water pricing can contribute a lot in terms of efficiency and sustainability of water resource use in the area. However, such an effort could best be realized with the knowledge of the existing demand and willingness to pay for improved irrigation water service in the area. However, no attempt has been made in the past to impute farmers' willingness to pay for irrigation water in the study area. Thus, the aim of this study was to estimate the value of irrigation water which farmers would be willing to pay for the provision of improved irrigation water. Such scientific information is helpful to provide baseline for the local authorities', so that they can make an informed decision in the introduction of irrigation water fee.

1.3. Research Questions

The major research questions of the study were the following:

1. How much amount of money farmers willing to pay for improved supply of irrigation water?

2. What factors are determining farmers' willingness to pay for improved supply of irrigation water?

1.4. Objective of the Study

The general objective of the study was to assess farmers' Willingness to pay for improved irrigation water use in the study area. The specific objectives of the study were:

1. to estimate farmers' willingness to pay for the supply for improved irrigation water and
2. to identify the determinants of farmers' willingness to pay for improved supply of irrigation water

1.5. Significance of the Study

Knowledge about farmers demand for irrigation water is an important requirement to manage the scarce resource successfully.The information that would be generated from the study is crucially important for development practitioners and policy makers to design appropriate interventions and strategies that enable the sustainable utilization of the scarce water resources. Knowledge of the factors that determine individual households' WTP would also help rational decision making on the water management issues that is required in the implementing schemes which aims at efficient allocation of the water resource. In addition, the result of the study can be a benchmark for further research in the areas of water use for irrigation purpose.

1.6. Scope and Limitation of the Study

The concept of economic value of irrigation water provision is a very broad concept since it should include both the demand and supply of irrigation water. However, the scope of the study is limited to estimating households' willingness to pay and identify key factors that significantly affect the willingness of farmers' to pay for improved irrigation water use. Besides, it is difficult to extrapolate the result of the study for larger areas as the study was conducted in a given locality with a specific level and determinants of demand.

1.7. Organization of the Thesis

The thesis is structured in five main chapters. The first chapter has described the introduction of the study that includes the background, statement of the problem, objectives and scope of the study. Chapter 2 presents theoretical perspectives and empirical evidences related to the main themes of the thesis. Chapter 3 discusses the methodological approach of the study that includes the method of data collection, analysis and hypothesis of the study. Results obtained from the study are presented and discussed in detail in chapter 4. Finally, conclusions and recommendations of the study are presented in chapter 5.

2. LITERATURE REVIEW

In this chapter, an attempt has been made to provide a brief review of the works done on the subject of the study. The review includes concepts and definitions used in this study, over view of irrigation development, role of irrigation development, economic valuation, types of valuation, pricing of irrigation water, analytical review, empirical reviews on contingent valuation method and conceptual framework.

2.1. Concepts and Definitions

Valuation aims to confer accurate economic values on non-market goods and services, but in order to place an economic value on a non-marketable, say an environmental good or service, the various components that make up its total economic value (TEV) need to be identified (Bochstael *et al.,* 2005). The total economic value (TEV) of environmental goods consists of use value and non-use value (Abdullah *et al*., 2011)

Water pricing is more commonly used in the literature to be synonymous with water charging. The term “water price” includes the totality of payments that a beneficiary makes for the irrigation service (Omondi, 2014). A water charging system embraces all of the policies, practical actions and mechanisms required to set the level of recoveries, decide the basis on which a charge will be levied, levy the charge, and collect the revenue. In some cultural or political contexts it is unacceptable to place a price on water and therefore other terms such as irrigation service fee (ISF) are used, with the emphasis being that the charge is made for the service of supplying water to the user, not for the water itself (Ahmad, 2011).

Water price donates any charge or levy that farmers have to pay in order to access water to their irrigable land and user pay principle said that, those who benefit from the use of scarce resource should be paid for that limited resource. The adoption of the user pays principle provides a basis for pricing and allocating scarce water among different uses, which could help improve water use efficiency and reduce conflicts in sharing scarce water (Hugo, 2010).

Willingness to pay: The public does not possess property rights to the environmental improvement, and thus must purchase it from those who currently have the right to engage in pollution or other damaging activity. It refers to the economic value of a good to an individual or a representative of a household under given conditions (Gunatilake *et al*., 2007). It is defined as the amount that must be taken away from his/her income while keeping his/her utility constant.

Willingness to accept: The public already possesses property rights to the environmental improvement, and thus must be compensated in return for infringing upon those rights (Gunatilake *et al*., 2007). It is defined as the amount of money that must be given to an individual experiencing deterioration in environmental quality to keep his utility constant.

Contingent Valuation is a method of estimating the value that a person places on a good (Whittington, 2002). The approach asks people to directly report their willingness to pay (WTP) to obtain a specified good, or willingness to accept (WTA) to give up a good, rather than inferring them from observed behaviours in regular market places (Bochstael *et al.*, 2005).

2.2. Over View of Irrigation Development

According to Zewdie *et al*. (2007) irrigation has been practiced in Egypt, China, India and other parts of Asia for a long period of time. India and Far East have grown rice using irrigation nearly for 5000 years. Irrigation was practiced for thousands of years in the Nile Valley. Egypt claims to have the world's oldest dam built about 5000 years ago to supply water for drinking and irrigation. At that time basin irrigation was introduced and still plays a significant role in Egyptian agriculture. The Nile valley in Egypt, the plain of Euphrates and Tigris in Iraq were under irrigation for 4000 years. Irrigation is the foundation of civilization in numerous regions. Egyptians have continuously depended on Nile’s flooding for irrigation for a long period of time on a large scale. The land between Euphrates and Tigris, Mesopotamia, was the breadbasket for the Sumerian Empire. Civilization was developed from the centrally controlled irrigation system (Schilfgaard, 1994).

Studies also show that irrigation in China was begun about 4000 years ago. There were reservoirs in Sri Lanka more than 2000 years old. As far back as 2300 BC, the Babylonian Code of Hammurabi provided that 'If anyone opens his irrigation canals to let in water, but is careless and the water floods the fields of his neighbor, he shall measure out grain to the latter in proportion to the yield of the neighboring field.' Other indicator for irrigation development is found in the stony-gravel limestone desert of the Negev area in Israel. Remnants of these ancient irrigation systems date back from the Israelite period (about 1000 BC) and from the Nabataea- Roman-Byzantine era (300 BC to 600 AD). In the absence of permanent water sources, the ancient farmers developed 'runoff' farm systems that used sporadic flash floods for irrigating (Shanan, 1987).

Ethiopia has a long history of traditional irrigation systems; simple river diversion is still the dominant irrigation system. According to Gebremedhin and Peden (2002), the country's irrigation potential ranges from 1.0 to 3.5 million hectares but the recent studies indicate that the irrigation potential of the country is higher. According to MoWR, 2013 estimates as large as 5.3 million hectares of arable land. The traditional irrigation schemes cover more hectares than the modern small-scale irrigation covers. The total area under irrigation development was 10.76% in 2012/2013. Irrigation use in Ethiopia dates back several centuries, and continues to be an integral part of Ethiopian agriculture. Traditional small-scale irrigation development in Ethiopia has a history of antiquity; while "modern" irrigation development was started only in the 1950s' by the commercial irrigated farms established in the Awash Valley through the joint venture of the then Government of Ethiopia and a foreign company. However, the irrigation sub-sector has not yet well developed and thus is not contributing its share to the overall economic development of the country as required (MOA, 2011).

2.3. Role of Irrigation Development

In Africa, agriculture forms the backbone of most of the continent's economies, providing about 60% of all employment. During the last decade, per capita agricultural production has not kept pace with population growth. Irrigation is a very old practice, dating back to the earliest civilizations of humankind. It served as one of the key drivers behind growth in agricultural productivity, increasing household income and alleviation of rural poverty, thereby highlighting the various ways that irrigation can impact poverty. These may require large water storage facilities, further irrigation development, and improvements in the operation of existing schemes (Molden, 2007).

The development of new irrigation systems and improvement on existing schemes increase agricultural productivity. The rise in productivity stimulates input suppliers and agro processing industries, which in turn stimulate employment in urban areas; higher farm incomes mean more household expenditures, which stimulate retail trade: wholesale expanded; manufacturing industries encouraged; service industries like transportation get more business; import and export market stimulated; and so on. Thus, it contributes to overall economic growth by inducing secondary benefits, like boosting agro industry (MOA, 2010).

The stimulated agro-industries in urban areas reduce pressure on urban employment and increase the real wage of urban laborers and hence, it extends the benefit to urban dwellers beyond the rural poor. It also involves land distribution and promotes both seasonal and permanent settlement of landless families to newly irrigated area. However, the success of irrigation has also often come at the environment's expense, degrading ecosystems and reducing water supplies to wetlands. It has also had impact on human health associated with higher prevalence of malaria, schistosomiasis, and other waterborne diseases (Svendsen and Turra, 2007).

Even though Ethiopia has abundant water resources, the agricultural system has not yet fully benefited from the technologies of water management. The majority of rural dwellers in Ethiopia are among the poorest in the country, with limited access to agricultural technology and with limited possibilities to diversify agricultural production. In addition to increasing degradation of the natural resource base, these constraints aggravate the incidence of poverty and food insecurity in rural areas. Thus improving water management for agriculture has many potential benefits in efforts to reduce vulnerability and improve productivity (MoWR, 2005).

Irrigation is one means by which agricultural production can be increased to meet the growing demands of food in Ethiopia (Seleshi *et al*., 2010). In addition, agricultural water development is crucial to improve smallholder livelihood and income in Ethiopia, since irrigation can help farmers increase their crop production, increase crop variety, and lengthen their agricultural seasons (Mekala *et al.*, 2008). Besides, development challenges such as overpopulation, climate variability, land degradation, farmer productivity**,** and gender equality are the primary rationales for developing the irrigation sector in Ethiopia (Seleshi *et al*., 2010).

2.4. Economic Valuation of Irrigation Water

Measuring the economic value of irrigation water involves various methodological and practical issues. The first issue concerns the application of available methods for determining the economic price of water; the stated valuation methods (contingent valuation method) or the revealed valuation methods (Hedonic pricing, travel cost), should be used for determining economic value of water (Tiwari, 2005).

The next issue concerns on the basis for pricing water. From the standpoint of economic efficiency, water prices should relate to the marginal value product or the opportunity costs (Easter, 1993; Howe, 1993; Sampath, 1992). From the government's viewpoint, water price should at least cover capital costs as well as operation and maintenance expenses (Rogers, 1993). From the farmers' viewpoint, prices should not exceed maximum ability to pay; and from the standpoint of feasible revenue collection, water charges depend highly on farmer's willingness to pay. In addition, the increasing environmental degradation costs of water resources development such as upper watershed degradation, water logging, potential ground water and surface water pollution due to excessive use of agrochemicals impose additional costs to the society. From the societal viewpoint, these external costs have also to be considered while determining the economic value of water (Tiwari, 2005).

The third issue is related to the unit of pricing, which largely depends on the available physical structures and existing institutional mechanisms for water distribution. Increasing water scarcity requires volumetric pricing for increasing water use efficiency (Sampath, 1992). However, lack of measuring devices, clearly defined water rights and knowledge of exact quantity of water applied at the farmer's plots present problems for volumetric pricing (Omondi, 2014). Issues related with the method of valuing and the unit of pricing will be briefly discussed in subsequent section.

2.5. Types of Valuation Methods

There is wide interest in, and support for, the idea of treating water as an economic good. However, the application of price-based instrument is particularly difficult in the case of water. This is so because the flow of water through a basin is complex and provides wide scope for externalities, market failure, and high transaction costs (Hudu *et al.* 2014). While judiciously applied market tools can be expected to have benefits in many cases, the necessary and sufficient conditions that defines and enforce water rights are not yet in place (Perry *et al.,* 1997). Well-defined market institutions that could generate prices that could serve to allocate water resources are lacking (Hudu *et al.* 2014). Thus irrigation water is a classic non- marketed resource (Dinar *et al*., 1997; Hudu *et al.,* 2014).

There are two broad categories of non-market valuation techniques for valuing the value of public environmental resources. These are revealed preference valuation methods and the stated valuation method (Hudu *et al.,* 2014). Appropriate valuation techniques are based upon either observed behavior toward some marketed good, somehow connected to the non- marketed good in question called revealed preference approach, or on stated preferences in surveys with respect to the good in question (Garrod and Willis,1999; Agudelo, 2001).

2.5.1. The revealed preference methods

Revealed preference methods are those that are based on actual observable choices that allow resource values to be directly inferred from those choices. These methods are "observable" because they involve actual behaviour and are "indirect" because they infer a value rather than estimate it directly (FAO, 2004). Some of the revealed preference methods that are in use in relation with water resource valuation are hedonic pricing method and the travel cost method.

Hedonic pricing

The hedonic pricing method is the most commonly used revealed preference valuation technique. It is derived from the characteristics theory of value and seeks to explain the value of commodities as a bundle of valuable characteristics (Young, 2005). Hedonic pricing employs differences in the prices of marketed goods to derive the value of environmental characteristics. Marketed goods can be viewed as comprising a bundle of characteristics; for some goods, these include environmental characteristics. The differential prices that individuals pay for such goods reflect their preferences for environmental quality. Statistical analysis of the prices and characteristics of the goods is employed to derive an implicit value for environmental quality (FAO, 2004).

Hedonic methods assume that the price of a marketed good, (such as housing) is dependent on that good's characteristics- such as location, size, and the number of years since the house was built and environmental amenities (FAO, 2004). Theoretically, by comparing data on house prices for which all variables, except the environmental good in question, are held constant, it would be possible to estimate willingness to pay for some quantity (quality) of the environmental good. In practice, this is done using multiple regression analysis on cross section data (Rosen, 1974; Palmquist, 1991).

The application of hedonic pricing method is straight forward and uncontroversial for it is based on actual market price (Young, 2005). The main shortcoming of the method is that it does not capture non-use values of environmental resource and requires real property markets (Bockstael *et al.*, 2005). For this reason, hedonic pricing is rarely applied in developing countries (FAO, 2004).

Travel cost method

The travel cost approach takes the costs of travel that are incurred by individuals in visits (the costs of transport plus the value of time) made to recreational sites as implicit prices to value of the service provided and changes in its quality. Travel costs measure only the use value of sites and are usually limited to recreational use values. Further, a fundamental criticism centers on the inclusion of a value for time spent traveling to the amenity. Whilst it is theoretically correct to account for time spent in travel, assigning a value to it is somewhat arbitrary (ibid).

2.5.2. The stated valuation methods

The stated preference methods are the direct valuation methods used to elicit value measures by asking individuals hypothetical questions. In the stated preference techniques individuals are directly asked to state their willingness to pay (WTP) and/ or willingness to accept (WTA) compensation for change in public environmental resources from hypothetical market scenario (Frey *et al*., 2004). Direct valuation method involves direct estimation of environmental value based on the responses of individuals to the hypothetical valuation questions and hence it does not depend on market information (Freeman, 1993).

Contingent Valuation Method (CVM)

CVM is survey method and most preferred environmental valuation method, which uses a hypothetical market to appraise consumer preferences by directly asking their **willingness to pay or willingness to accept** for change in the level of environmental good or services. It is the original and the most commonly used stated preference method and it can be used for valuing both use and non-use values of environmental resources (Bockstael *et al.,* 2005). It is Ciriacy-Wanstap who first proposed the CVM as a method of valuation for non-marketed environmental public goods in 1947. However, it is Robert K. Davis who did the first empirical research in 1961 in valuing outdoor recreation. Since then the method become one of the widely used valuation approach in water and sanitation services, urban air pollution, soil erosion, deforestation, biodiversity, watershed management and ecosystem valuation (Whittington, 2002).

Advantages of Contingent Valuation Method (CVM)

The CVM uses survey techniques to obtain individuals' willingness to pay for the hypothetical provision of a public good or (willingness to accept compensation for its hypothetical loss). These monetary values are taken to represent the benefit to the individual of the proposed change and may then be aggregated for use in making public decisions that potentially improve social welfare (Cooper *et al.,* 2002). CVM has been increasingly advocated by economists and some specialists as a useful tool for gathering reasonably accurate data about how much a household can afford and is willing to pay and sanitation options presented to them (Yuying and Roberto, 1996).

The primary attraction of CVM is that it can measure the economic benefits or damages of a wide assortment of beneficial or adverse effects in a way consistent with economic theory (Bockstael *et al.,* 2005). The most important part of contingent valuation methodology is creating a realistic contingent valuation scenario, which has accurately priced water supply 'options' that reflect the levels of prices that the water service provider would have to charge in order to provide the service. The respondent is asked about their preferences and is effectively asked at what price they would be willing to 'buy' the water, based on the level, quantity and quality of services (Perman *et al.*, 2003).

CVM has two advantages over indirect methods. First, it can deal with both use and non-use values, whereas the indirect methods cover only the former, and involves weak complementarity assumptions. Second, in principle, and unlike the indirect methods, CVM answers to WTP or WTA questions go directly to the theoretically correct monetary measures of utility changes. While the CVM can be used for use and nonuse values, its actual use has mainly been in regard to the latter. Particularly, most CVM applications have concerned existence, or passive-use values (Perman *et al*, 2003). Specifically, CVM was seen both as an alternative method of valuation to travel-cost (TC) and hedonic pricing (HP) models and as being able to quantify some types of benefits, such as non-use or passive-use benefits, which lie outside the scope of TC and HP studies (Cooper *et al.*, 2002). Given this, and the fact that indirect methods cannot address non- use/existence values, the study shall employ the CVM in the context of trying to ascertain nonuse/existence values.

Elicitation methods used in CVM

There are different ways to ask willingness to pay questions in contingent valuation surveys, which are known as elicitation methods (Ahmed and Gotoh, 2006). Presently five types of elicitation methods are commonly used in CVM studies. These are open-ended (OE), bidding game (BG), Payment Card (PC), single-bound dichotomous-choice (SBDC) and double-bound dichotomous choice (DBDC) (Chanel *et al*., 2015). Dichotomous choice contingent valuation questions have gained popularity over the last several years. This is due primarily to their purported advantages in avoiding many of the biases known to be inherent in other formats used in the contingent valuation method (Cameron and Quiggin, 1994). However, all these methods of asking questions have their relative advantages and disadvantages and none is free from criticisms (Ahmed and Gotoh, 2006). A summary of the most commonly used elicitation methods are, as follows (Ahmed and Gotoh, 2006; Chanel *et al*., 2015).

In the open ended question**,** the respondent provides a monetary value that directly corresponds to a change in utility. This method can provide more accurate WTP values compared with other methods, as it is not prone to "anchoring" or "starting point" bias. Yet, it may be difficult to answer especially in cases where the purchasing decision involves unfamiliar (non-market) commodities. Besides, it may lead to a higher non-response rate, and a larger number of "Don't know" and extreme responses compared with other formats

(Ahmed and Gotoh, 2006; Chanel *et al*., 2015). In the open ended elicitation methods, the respondent is asked the question "How much are you willing to pay?" The respondent is therefore free to state any amount (Chanel *et al*., 2015).

In the bidding game, respondents face several rounds of discrete choice questions involving increasing/decreasing bids (or both) with a final question being an Open Ended WTP question. Advantages of such method are that it eases the respondents' cognitive process and encourages them to carefully consider the valuation task while the final Open Ended question provides more accurate monetary values than other formats. However, such method can be subject to higher extreme responses, to "anchoring" or "starting point" bias, and to a tendency to "yeah-saying" for avoiding answering "No" (Ahmed and Gotoh, 2006; Chanel *et al*., 2015).

In dichotomous choice model, respondents are asked the question "Are you willing to pay a specific amount of money for a pre- specified change?" (Cameron and Quiggin, 1994). In the single-bounded question, the respondent gives a "Yes" or "No" answer to a proposed bid. Such method is easy to implement and much more familiar to the respondents because of the similarity to the market condition. Thus, it minimizes non-responses and decreases outliers. However, a large sample size may be required to get a sufficient level of accuracy in WTP estimation. Thus, the method increases the cost of the survey.

The double-bounded question is an extension of the single-bounded version. Accordingly, a second bid is introduced conditional to the answer given to the first bid. Thus, in this method more statistical efficiency can be achieved than that of SBDC as additional information can be elicited on each respondent's WTP. However, similar to the single-bounded method, the double-bounded question method may require a large sample size to reduce the risk of feeble information on the WTP distribution (Cameron and Quiggin, 1994, Chanel *et al*., 2015).

Finally, in the payment card, respondents are required to choose a bid as close as possible to their true WTP in a list with several bids. The PC has become popular since it better mimics real life decisions compared to the Open Ended (setting the price). Besides, it offers a visual aid that facilitates the construction of evaluation and avoids a high rate of non-response and overestimated values. But biases due to starting values and the range and centring of the bids may arise. Besides, it requires direct individual interviews, which are costly (Ahmed and Gotoh, 2006; Chanel *et al*., 2015).

Limitation of contingent valuation method

The CVM, despite its wide application, as compared with indirect methods it is suffering from the problem that it asks hypothetical questions, whereas indirect methods exploit data on observed, actual behaviour. The major concern with the use of the contingent valuation method has been the potential for survey respondents to give biased answers. Four types of potential bias have been the focus of a large amount of research (Tietenberg, 2012).

Strategic Bias: This occurs when a respondent does not reveal his/her true preference of the good or service; he/she behaves strategically with the hope to “free ride” (Tietenberg, 2012).

Starting Point Bias: This occurs when the respondent’s WTP amount is influenced by a value introduced by the scenario. The bidding game elicitation techniques pose the most obvious threat of this kind since it directly confronts the respondent with a proposed amount that the respondent is asked to accept or reject. Thus, the choice of a low (high) starting point leads to a low (high) mean WTP (Bateman and Turner, 1993). While the use of starting points may reduce non-response and variance in open ended questionnaire, “bidding hints” might lead respondents to take cognitive short-cuts to arrive at a decision rather than thinking seriously about their true WTP (Mitchell and Carson, 1989).

Hypothetical Bias*:* The potential error induced by confronting the individual with an imaginary situation, i.e., people would not behave the same way in actual market. Respondents are confronted by an artificial set of alternatives rather than actual choices. Since the respondents are not actually expected to pay the estimated values, the respondents may treat the survey by providing ill-considered answers (Tietenberg, 2012).

Information Bias: The problem of information bias may arise in the situation where respondents are asked to value attributes with which they have no or little experiences. Thus, if respondents have no experiences about attributes of resources they are asked to value, the valuation will be based on an entirely false perception (Tietenberg, 2012). However, when surveys are properly planned and executed, most of the CVM problems can be eliminated, thus offering the best hope for estimating environmental benefits (Whittington *et al.*, 1993).

According to Hoevenagel (1994), the CVM has the following strong advantages over the other methods.

a) The applicability of this method is better compared with other valuation methods in terms of completeness.
b) It is able to measure a wide range of goods, including those not yet supplied in a manner consistent with economic theory.
c) The method can measure non-use values.
d) CVM has been judged to be superior due to its potential validity and ease with which the method can be implemented.

Furthermore according to FAO (2004), careful use of CVM can elicit both use and nonuse values for an amenity. In addition, CVM focuses on *ex ante* (forecasted) behaviors before some change occurs whereas the travel cost and hedonic pricing methods produce values *ex post*. Thus, estimates of changes in welfare of interest to the policymaker are theoretically better approached using CVM than using the observed-indirect methods.

The steps involved in applying the CVM can be stated as follows (Perman *et al*, 2003):

1. Creating a survey instrument for the elicitation of individuals' WTP/WTA. This can be broken down into three distinct, but related, components:
    a. Designing the hypothetical scenario,
    b. Deciding whether to ask about WTP or WTA,
    c. Creating a scenario about the means of payment or compensation.
2. Using the survey instrument with a sample of the population of interest.
3. Analyzing the responses to the survey. This can be seen as having two components:
    a. Using the sample data on WTP/WTA to estimate average WTP/WTA for the Population,
    b. Assessing the survey results so as to judge the accuracy of this estimate.
4. Computing total WTP/WTA for the population of interest.

2.6. Pricing of Irrigation Water

The effectiveness of the financial and economic roles of water pricing policies depends on the pricing method and its objective. Volumetric water pricing is used where the objective is to reduce water demand in the agricultural sector. It is the most favored pricing mechanism among economists and environmentalists, by which water is charged according to directly measured volumes of consumed water (Omondi, 2014).

However, there is little practical evidence from the field to support the view that volumetric pricing changes farmers' water demand patterns. Even in countries facing extreme water scarcity, like Jordan, Israel and Morocco, the aim of water pricing is to recover service delivery costs. In all of these countries water is priced on a volumetric or approximate volumetric basis to indicate its value to users and discourage wasteful use (Berbel *et al.*, 2007).

In most cases, it is difficult and expensive to enforce installment of measurement devices and to monitor legal and/or illegal users. If agricultural income is low, water costs may outweigh the revenues of many farmers. In addition, in developing countries, given the poor level of "aggregated" service now observed the challenge to administration and management volumetric pricing would be unrealistic (Perry, 2001).

On the other hand, area-based charges could serve as a starting point to reduce opposition. It is also the most widely used and the most popular pricing method, which is adequate where the sole objective is cost recovery. Supply cost recovery includes investments cost in infrastructure, O&M costs and administrative costs. Farmers are charged a fixed price per unit of irrigated land. In some cases this may vary according to crop type, with higher charges for more water demanding crops **(**EC, 2012). The prevailing water policy of Ethiopia for both urban water and irrigation investment is cost recovery (UNESCO, 2004). Hence, because of problems related with volumetric pricing coupled with the country's prevailing policy, area based pricing method is advisable for Ethiopia.

2.7. Analytical Review

The WTP decision made by farmers for irrigation water use depends on the expected level of satisfaction they could attain both from productive and non-productive uses (Anteneh, 2013). In this study, farmers are expected to reasonably show their WTP or not decision for irrigation water they would use in line with the objective of improving their yield or income and other benefits they could derive from the water supplied.

According to Siglman and Zeng (1999), when there exist a linear relationship between the dependent and the independent variables, OLS and Tobit are the most appropriate models. Additionally, they said that OLS can be used if the dependent variable is continuous, while Tobit will be appropriate if the dependent variable has some censored value.

There are different types of elicitation methods used to estimate willingness to pay from a sample of households in contingent valuation surveys. The most commonly and widely used elicitation formats are open-ended, payment card, bidding game, single, and double-bounded dichotomous choice methods. Among these especially dichotomous-choice (DC) format is the most widely used one (Ahmed and Gotoh, 2006; Tadesse *et al*. (2017); Birhane and Geta (2016), Anteneh (2015)). In this study, double bounded dichotomous choice approach with an open-ended follow-up question was used.

According to Hanemann (1989), in the dichotomous choice method, individuals are assumed to have utility functions, U, income (Y), and a set of conditioning factors (S):

$$U(Y;S) \tag{1}$$

If a farmer is willing to pay for improved irrigation water use, the farmer's utility is given by:

$$U_1 = U(1, Y, S) \tag{2}$$

Whereas, if the farmer is not willing to pay for improved irrigation water, the farmers' utility will be given by:

$$U_0 = U(0, Y, S) \tag{3}$$

With the introduction of a proposed improved irrigation water use, each farmer is confronted with a specified bid amount, WTP, i.e. initial bid, discounted bid, and premium bid which he/she could contribute toward assuring of a year-round improved irrigation water supply. It is assumed that the individual would accept a suggested WTP to maximize his/her utility under the following condition and reject it otherwise (Hanemann, 1989):

$$U(1, Y - WTP; S) + \varepsilon_1 \geq U(0, Y; S) + \varepsilon_0 \quad (4)$$

Here, ε_0 and ε_1 are identically and independently distributed random variables with zero means, U is the indirect utility function, Y is households' income, and WTP is willingness to pay bid values. Thus, in this study, OLS and seemingly unrelated bivariate probit models were used to identify the major determinants of farmers' willingness to pay and to estimate mean willingness to pay for improved irrigation water use, respectively.

2.8. Empirical Studies on Willingness to Pay Using the Contingent Valuation Method

Angella *et al.* (2014) attempt to estimate Willingness to pay for irrigation water and its determinants among rice farmers using data gathered from 200 rice farmers in 2012 at Doho Rice Irrigation Scheme (DRIS) in Uganda. They used contingent valuation (CV) bidding game approach and Ordinary Least Squares (OLS) methods to elicit WTP and analyse the determinants of WTP, respectively. The study findings showed that while farmers are willing to pay Ush 20,000 ($8)/acre/season on average, Ush 15,000 ($6) acre/season is actually needed to cover maintenance costs as per the 2013/2014 work plan for DRIS. The authors recommend charging Ush 15,000/acre/season, however, which not only generates sufficient revenue to cover the maintenance costs, but also lies below the average WTP, which several farmers should be willing to pay without coercion. However, because not all farmers are willing to pay Ush 15,000, it is necessary to incentivize voluntary payment and strong enforcement of penalties against non-payment among those with low WTP. The OLS regression results suggested need for additional intervention that enhances private benefits to farmers, such as improved access to credit, markets and training in soil/water management and rice growing.

Shantha and Ali (2014) tried to determine the economic value of irrigation-water for government managed irrigation project in Sri Lanka using contingent valuation method followed by single bounded dichotomous choices. Logistic regression model was used to measure WTP and to determine the factors that influence the variation in WTP. Primary data was obtained from 367 farmer households in Nagadeepa irrigation schemes in dry zone. The Authors estimated that value of irrigation water was Rs. 5,275 ($40) per hectare per season. They found that farm income, existing knowledge of water management, location of paddy(a field in which rice growing) field, ownership of paddy land, extent cultivated of paddy, irrigation scarcity, main income source were significant variables which influence the variation of farmers' WTP. One of the most important policy implications of this study was the possibility of restructuring the existing irrigation pricing system by taking into account the economic value of irrigation water to use irrigation resources efficiently by motivating improvement in water management practices.

Omondi (2014) estimated the economic value of irrigation water in Kenya. Both Contingent Valuation Method and Residual Value Method were used to estimate the economic value of irrigation water while the Ordinary Least Square was used to assess the factors influencing farmers' WTP for irrigation water. The author estimated production function to determine which factors influence rice output and whether water is a significant input in rice production. Participation in off-farm income generating activities, access to credit and satisfaction with the management of water supply positively influence farmers' WTP for irrigation water. Volume of irrigation water, quantity of fertilizer and labor were also found to influence rice output positively. The author's findings revealed that irrigation water is a significant input in rice production and irrigation water at Ahero Irrigation Scheme should be charged at appropriate price relative to its economic value of Ksh.7.54/m^3 to avoid its wasteful use.

Karthikeyan *et al. (*2009) studied the factors contributing to WTP for irrigation water in south India in the dry and wet seasons. The Logit model results revealed that the mean WTP of farmers for irrigation water was INR 218.50/ha/year (Indian currency) and family size, age of the respondent, educational level of the head of the household, family labor force, area under cultivation, and water requirement at farm level as the main determinants of farmers' WTP.

Tiwari (2005), studied on the economic value of irrigation water using both direct and indirect valuation techniques. The results indicated that the opportunity cost of irrigation water was considerably greater than the maximum willingness to pay. He concluded that there is unsustainable use of irrigation water at present. The author used both the open and closed-ended questions elicitation methods to identify the factors that affect respondents' WTP. From the closed ended question, the result found that WTP was related to respondents' gender, agricultural income, perceived water sufficiency, education, family size and landholding. While the WTP from open ended question was significantly varying with the farmers' attitude towards paying fee, sex, education, migrating family members, family size and access to credit.

There are also some studies on economic valuation of irrigation water in Ethiopia. Anteneh (2015) study on economic valuation of irrigation water in Bahirdar Zuria Woreda: the case of chilal abay, negida and upper andasa irrigation schemes. Probit and bivariate probit model was used to measure WTP and to determine the factors that influence the variation in WTP. To identify the basic determinants of maximum WTP, he also used Tobit model. In the Tobit model households' income, family size, land size, and having pumping motor are found to positively and significantly affect households' maximum willingness to pay. In the Bivariate Probit model result, off farm income, initial bid and follow-up bid were found to have a negative and significant effect on the households' probability of accepting that bid. In this model variables such as income, land size, having pumping motor and dissatisfaction with the existing irrigation water supply have a positive effect on the households' probability of WTP. The mean willingness to pay for the provision of improved irrigation water is found to be 674.5 and 579 Birr per year/0.25 ha from the double bounded dichotomous and open-ended questions, respectively.

Another study which was conducted by Birhane (2014) tried to obtain the farmers willingness to pay for uses of irrigation water using 120 randomly selected households in two kebeles of Agarfa district, Bale zone of the Oromia National Regional State, Ethiopia. The result of tobit model showed that sex of the household, educational level of the household head, total annual income, credit utilization, and perceived trend in rain fed agricultural productivity were positively and significantly related to the probability of willingness to pay while, family size and initial bid were negatively and significantly related to the probability willingness to pay. On the other hand, the result of the seemingly unrelated bivariate probit model showed that households' mean annual willingness to pay amount was Birr 4018.02 per hectare per year.

Tesfaye (2013) applied CVM to estimate the economic value of irrigation water for sustainable use of resource in Koga Irrigation Project. He employed single bounded, logit model and 383 randomly selected irrigation beneficiary households was used to estimate respondents' willingness to pay (WTP) for irrigation water to support operation and maintenance program. The mean WTP value was 86.88 ETB/*timad*/year. The aggregate mean WTP value was 444,999.36 ETB/*timad*/year. He found out respondents' age, farm input expense, and predetermined bid price had a statistically significant negative impact on WTP while number of family labor, education level, number of oxen owned, experience in irrigated agriculture, expectation towards irrigated agriculture, per capita income, fairness of output price, type of crop grown, extension support, perception on water sufficiency, satisfaction with the management of water delivery all had a statistically significant positive impact on WTP.

Mezgebo *et al.* (2013) conducted a study to determine the economic value of irrigation water in Wondo Genet area by eliciting households' willingness to pay using contingent valuation method (CVM) in the form of double bounded closed ended WTP questions with open ended follow up questions. By using 154 randomly selected households, they applied bivariate Probit and Probit models to determine the mean and factors affecting willingness to pay for irrigation water, respectively. The result of the study showed that the total willingness to pay from double bound elicitation method was computed at 156,785.1 birr (1 US$=17 birr) per annum for five years, while the willingness to pay from open ended elicitation method was computed at 128,264.55 birr per year. The study found that households' income, age, cultivated land, initial bids, awareness and educational level are the key determinants of demand for irrigation water.

Nega (2012) study conducted on the economic benefit of irrigation water by using contingent valuation and choice experiment methods in the case of Ribb irrigation and drainage project in South Gonder, Ethiopia. He employed a single bounded value elicitation format with an open ended follow up question for the CVM and four attributes were identified with three environmental attributes (irrigation water availability, fish stock abundance and productivity) and a monetary attribute (annual payment). Probit, multinomial logit and random parameter logit models were used to analyze the factors influencing households' willingness to pay and estimate measures of welfare change for farm households. He identified important variables that determine households' WTP for irrigation water include practical irrigation experience of households, average annual income, participation in off-farm activities, and market access. Irrigation farming experience, income of the household, land size, education, number of ox were positive while bid value, participating in off farm activity, households market access, female headed households, the quantity of fertilizer used in the previous crop season and age have negative impact on the probability of households WTP for irrigation water supply.

Teshome (2010) conducted a study on Economic Valuation of Irrigation Water for Erere Woldia Irrigation Project in Harari Regional State. A contingent valuation method was employed to elicit farmers' willingness to pay for improved irrigation water. The OLS method was used to determine the factors that affect the maximum price farmers are willing to pay. The study found size of cultivable land, access to credit, experience with irrigation, land fertility, perception about water scarcity and dissatisfaction with the existing project have a positive effect while age, household size and cultivating water demanding crops have a negative effect. He also employed logit model to determine the factors that affect the willingness to pay (accept) the bid price. Frequency of DA visit, experience with irrigation, income and perception about water scarcity were found to have a positive effect, while the size of cultivable land, amount of fertilizer used and dissatisfaction with the existing project have a negative effect.

Habtamu (2009) employed CVM to analyze irrigation beneficiary households' willingness to pay for watershed management to value irrigation water to enhance agricultural productivity using 210 randomly selected household heads in the Koga Watershed of the Upper Blue Nile Basin in Ethiopia. The study analyzed the magnitude and determinants of labor supply behavior of farm households for the routine management and maintenance of irrigation infrastructure in the Upper Blue Nile basin of Ethiopia. For the total irrigable land area it was estimated that households could contribute an estimated 468,784 person labor days per year and the aggregate expected WTP for the total of 7,000 hectares of irrigable land was 964,320 birr per year. The logit model analysis based on single dichotomous elicitation format showed that households' willingness to contribute labor 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 household's dependency ratio and randomly assigned bid working days. The study proposed "any plan for generation of financial resources from irrigation beneficiary households should consider factors that influence the productivity of this system".

Dagnei (2008) study on determinants of farmers' WTP for irrigation water in Amhara Region used CVM to value the water resource, by using probit and interval regression models to identify the determinants of farmers WTP decision and the amount of cash payment for irrigation water they use, respectively. The result of probit model showed that access to credit services and perception of users about the maintenance problems were positively and significantly related to the farmers' WTP for irrigation water whereas age of the household head, total family size and irrigable land-to-total land ratio owned by the household were negatively and significantly related to the probability of the WTP for irrigation water. On the other hand, the interval regression model for amount of cash payment for irrigation water showed that proximity to the water source, farming experience and existence of labor shortage were positively and significantly related to the intensity of payment while family size and access to extension contact were negatively and significantly related with the amount of cash the farmers would be willing to pay. The CVM result indicated that the mean amount of payment that sample farmers willing to pay was Birr 453.82 per hectare per year.

By using CVM, Bane (2005) attempted to obtain the valuation of peasants for non-agricultural uses of irrigation water in two peasant associations in Bure district of west Gojam, Ethiopia. He used probit and bivariate probit models to analyse the economic values of multiple uses of irrigation water emphasizing its non-agricultural uses. He employed single-bounded and double-bounded referendum style elicitation format with open ended follow up questions. And he estimated the annual total WTP for improved irrigation water. The result was birr 217,832, 204,168 and 151,716 in single bounded, double bounded and open ended questions, respectively. The study identified the determinants of WTP as,:

income, age, sex, family size, irrigation water management, choices of water use rights, quantity of irrigation water consumption, distance from current sources (in meters), wealth, land tenure, Peasant Associations (Sites), quality of water, location and starting point bid.

2.9. 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, economic factors, as well as farmer attitudes and perceptions. From different studies, 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 general 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 describes the variables expected to influence willingness to pay in the irrigation schemes of Meskan district.

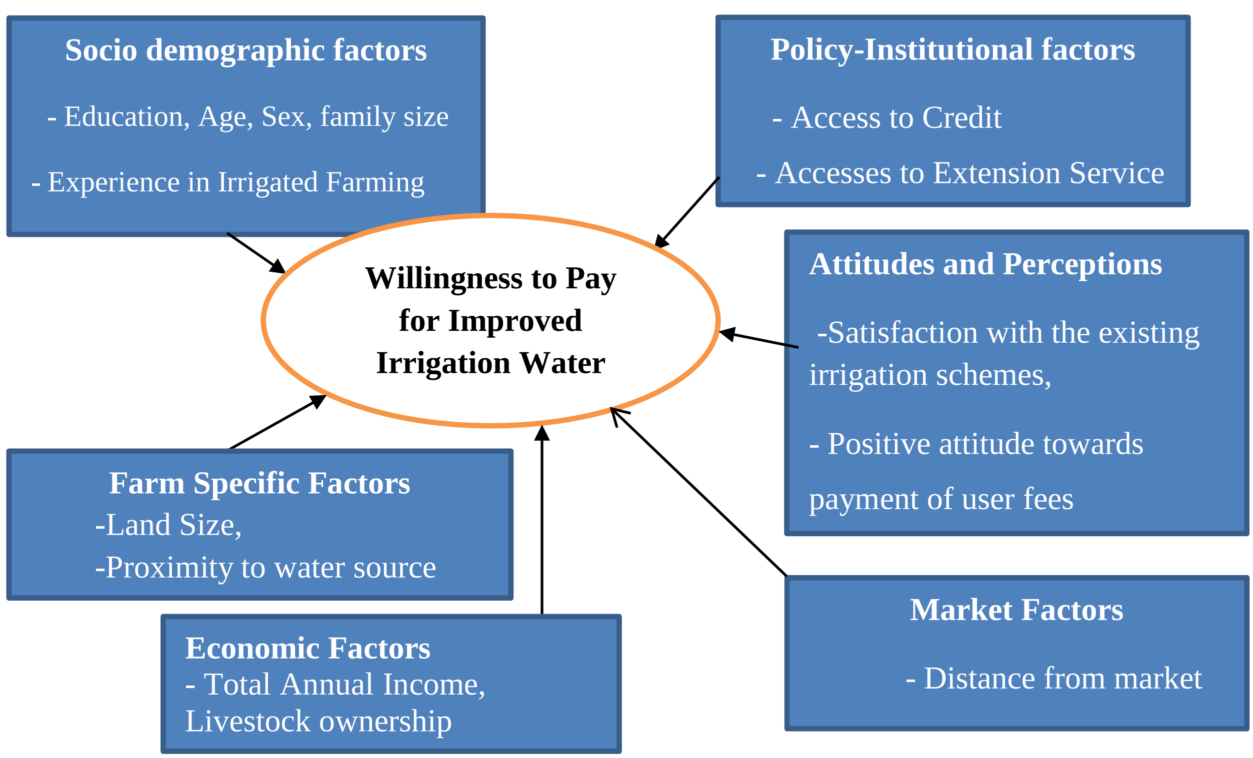


Figure 1 : Conceptual framework
Source: Modified from Angella *et al*. (2014).

3. RESEARCH METHODOLOGY

In this chapter, description of the study area, sampling technique, data sources and method of data collection, methods of data analysis and hypothesis of the study are presented.

3.1. Description of the Study Area

3.1.1 Physical characteristics

This study was conducted in Meskan district, which is found in Guraghe zone of the Southern Nations, Nationalities and Peoples Regional State, Ethiopia. It is one of the 15 districts of the Zone. Butajira is the capital of the district and it is located at 133km south of Addis Ababa, 165 km from Hawassa and 97 km from Welkite. The district is bordered by Sodo district in the north, Silte zone in the south, Mareko and some part of Sodo district in the east, and Muhere Aklile, Silte zone and Gedebano Gutazer Welene district in the west. The district has 43 kebeles: 37 are rural and 6 urban (MWCPO, 2015).

Meskan district covers 50,177 hectares. Almost 31.3% of the area is covered by annual crops, 9.9% by perennial crops, 25.22% by forest and 26.73% by others (grazing land, uncultivated land, wet land...etc). The total irrigable area is estimated about 11,500 ha. (MWARDO, 2018). Astronomically, it is situated between 7.993515-8.278101^{o}N Latitude and 38.26-38.5786^{0}E Longitude. Agro-climatically, the district is classified into *Weina-Dega* (mid altitude- 80%) and *Dega* (high land- 20%) in which the average temperature ranges between 22^{0}C to 25^{0} C. Its elevation ranges from 1501-3500 m.a.s.l and the mean annual rainfall range between 1001-1200 mm. The topography of the area is dominated by rugged terrain 35%, about 10% mountainous and the remaining 55% is plain. The major soil types include 22% red, 25% brown and 53% is black soil (MWFEDO, 2012).

Perennial rivers (Erinzaf, Eresha, Jirbenas, and Akamuja.) and springs are found in the district. The rivers are major source of irrigation water (MWARDO, 2018). The district has a long history of traditional irrigation practices and indigenous knowledge. River diversion irrigation systems are practiced in the district using the rivers which are the main source of water for irrigation system in the sampled kebeles. That is, Yetebone irrigation project was constructed by diverting the rivers Erinzaf and Jirbenas while Eresha and Akamuja rivers are the source of water for the Dobena Gola and Wita diversion project. However, all of these diversions are not well constructed and proper canal construction is the major and severe problem in the study area.

3.1.2. Population, religion and culture

According to the regional statistical abstract report in 2012/13, Meskan district has a total population of 179,719, of which 87,933 (48.92%) are male and 91,796 (51.08%) are female. It also consists of a total of 36,377 households with a male headed of 23,004 households (63.24%) and female headed of 13,373 households (36.76%), around 7% of the population dwell in urban and the remaining 93%are residents of rural areas. The major ethnic group of the district is the Guraghe, sub-divided into the Sodo, Meskan, Silte and Mareko clans.

Most of the population is Muslim. Polygamy is an aspect of marital life among the Muslim population. The majority among the Sodo practice Orthodox Christian.

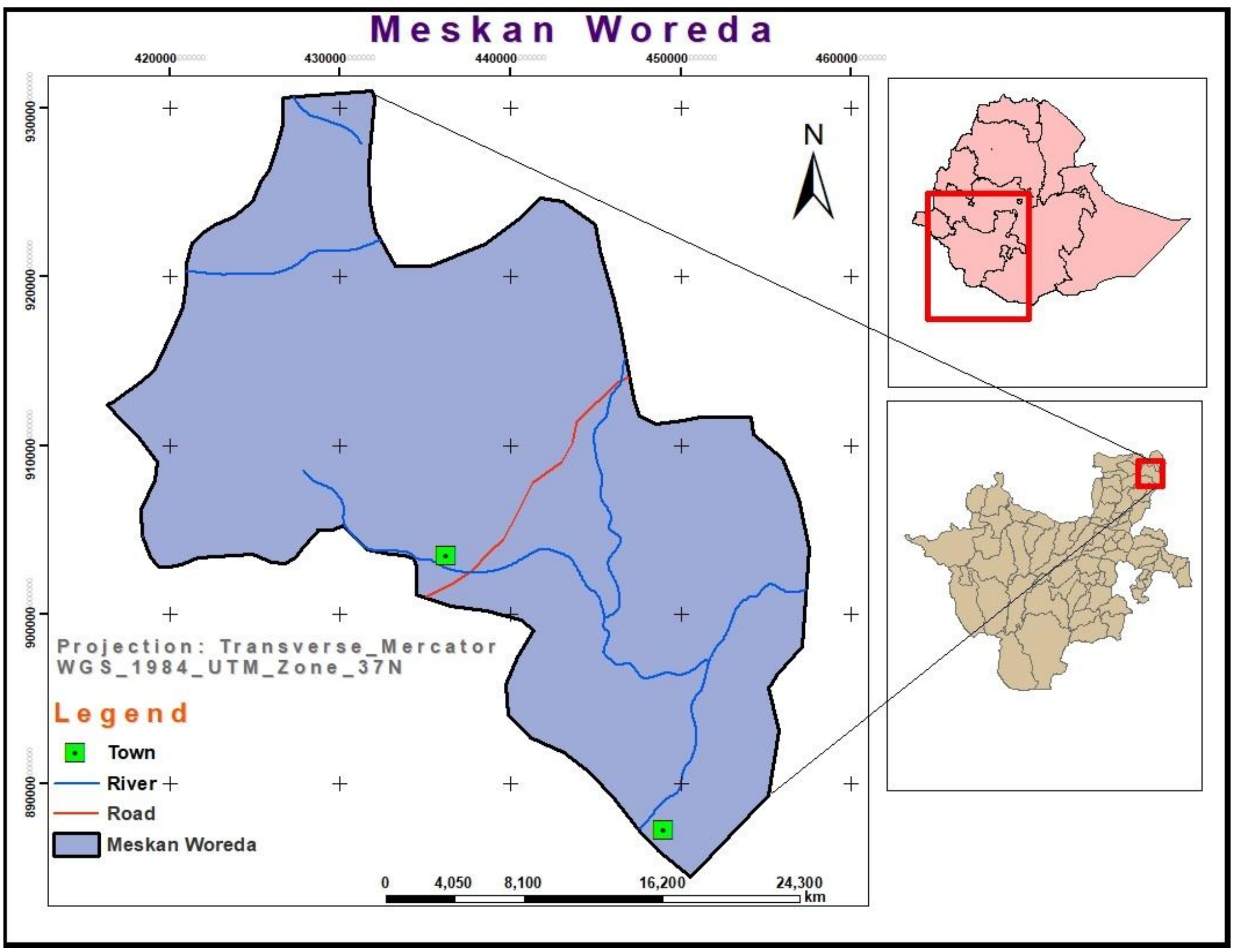


Figure 2 : GIS Map of the Study Area

3.1.3. Socio-economic profile

Rural households live in *tukuls* (traditional round houses) made of wood and plastered with clay, covered by thatched roofs. The majority of rural households share their living quarters with their domestic animals. Water (both human and animal use) is fetched from rivers, springs and well.

The majority of the rural people are engaged in subsistence agriculture. Cereal such as maize and sorghum are the major staples in the district. Some households often engage in non-farm activities such as petty trade and other sources like sale of fire wood, non-farm employment, *etc.* are important sources of non-farm income and hired labor to supplement meagre incomes derived from farm activities (MWFEDO, 2012).

3.2. Sampling Technique

3.2.1. Sampling design

For this study, a two-stage sampling procedure was employed to select the sample irrigation water user households. In the first stage, three *Kebeles*-Yetebone, Dobena Gola, and Wita *Kebeles* - were purposively selected on the basis of the availability of irrigation water schemes.

In the second stage, Irrigation water user farm households were selected randomly from each sample kebeles using probability proportional to size

According to Meskan Woreda agricultural development office (2018), there are a total of 865 irrigation water user household heads in the three administrative Kebeles. Among this number of households, specifically, 352 were in Yetebone, 302 were in Dobena Gola and the remaining 211 were in Wita.

3.2.2. Sample size determination

Representative sample size was determined using the formula which was developed by Yamane (1967):

$$n = \frac{N}{1 + N(e)^2} \quad .$$

Where;

n = the sample size the research uses;

N= total number of irrigation users household heads in the three administrative Kebeles

e = maximum variability or margin of error 6 %;

1= the probability of the event occurring.

Based on the above formula, a total of 210 sample household head irrigation users were selected and distributed to the three kebeles based on the proportion of irrigation users in each sample kebeles.

Table 1: Distribution of sample households by representative Kebeles

Study area	Sampled Kebeles	Total Irrigation Users	Sample Size*(n)
	Yetebone	352	85
Meskan District	Dobena Gola	302	73
	Wita	211	52
	Total	**865**	**210**

*Sample ratio=0.24277

Source: Own design from sample survey of (2018)

3.3. Data Sources and Methods of Data Collections

The study used data that were gathered from both primary and secondary sources. The primary data was collected directly through face to face interview of the sample household heads using structured questionnaire and personal observations with focus groups while secondary data was collected from the district Agriculture and Water, mineral and Energy Offices experts. Furthermore, data were collected through review of other relevant literatures. Both quantitative and qualitative methods were used to clarify concepts, characteristics, descriptions, counts and measures to demonstrate implications of the issue under question.

Value elicitation formats

There are different types of elicitation methods used to estimate willingness to pay from a sample of households in contingent valuation surveys. The most commonly and widely used elicitation formats are open-ended and payment card which are incentive compatible, bidding game, single, and double-bounded dichotomous choice methods. Among these especially dichotomous-choice (DC) format is the most widely used one (Ahmed and Gotoh, 2006). The NOAA blue ribbon panel of the US advocated DC method as the most appropriate one in most circumstances (Arrow *et al*., 1993).

Bidding game, single, and double-bounded dichotomous choice methods have been shown to suffer from incentive compatibility problems in which survey respondents can influence potential outcomes by revealing values other than their true willingness to pay. Both single and double bounded dichotomous choice approach has become most widely adopted, despite criticisms and doubts, in part because it appears to be incentive-compatible (Haab and McConnell, 2003). Incentive compatibility means that the properties of the value elicitation format assure that there is no advantage in answering strategically: the truthful preference revelation is an optimal (and the dominant) strategy for the respondent (Chanel *et al*., 2015).

Single bounded dichotomous choice method is easy to implement and much more familiar to the respondents because of the similarity to the market condition. Thus, it minimizes non-responses rate and avoids outliers (Chanel *et al*., 2015). In double bounded dichotomous choice method more statistical efficiency can be achieves than that of SBDC. Moreover, additional information can be elicited on each respondent's WTP (Ahmed and Gotoh, 2006). According to Haab and McConnell (2003) it increases efficiency over single bounded dichotomous choice method in three ways. First, the answer sequences *yes-no* or *no-yes* yield clear bounds on the WTP. Second, efficiency gains for the *no-no* pairs and the *yes-yes* pairs; finally, the number of responses is increased.

Thus, in this study, double bounded dichotomous choice approach was applied. Moreover, an open-ended follow-up question was also used to increase the precision of the estimate with dichotomous choice questions.

The questionnaire design and survey implementation

In this study, in order to generate primary data, the field survey was under taken. Before the final survey implemented, the focus group discussion and pilot survey were carried out. The focus group discussion was useful in providing some information to make some modification in the design of the main survey questionnaire based on the responses so as to make it understandable for respondents. It also provides important information for descriptive analysis and to decide on the appropriate initial bids. The pilot survey was made to set the bids price for the contingent valuation elicitation part of the questionnaire. The data were collected by seven experienced and competent enumerators. The enumerators were trained on how to conduct and manage CV questions and how to approach farmers during the interview. A pre-test of the draft questionnaire was done on 30 selected respondents who were assumed to be representative of the households living in the three *Kebeles*. All the seven enumerators and the researcher have participated in the pre-testing. The main purpose of the pre-test was to determine sets of bids, and to select appropriate wording and ordering of questions. Moreover, it was targeted to enable the enumerators to develop experience in conducting CV survey. After the necessary adjustments were made to the draft questionnaire and setting bid prices, the final questionnaire was developed.

Accordingly, five most frequently stated values were then selected as a starting value (price) for the double bounded dichotomous choice format. These values were 300, 400,500, 600 and, 700 Birr per year per *timad* (0.25hectare.) of irrigable land. Following Cameron and Quiggin (1994), sets of bids were determined for double bounded dichotomous choice format by making twice the initial bid if the first response is "Yes" and half of it if the response is "No". These sets of bids were (300, 150, 600), (400,200,800), (500, 250, 1000), (600, 300, 1200), and (700, 350, 1400) Birr per year per *timad* (0.25 hectare) of irrigable land. These bids set were assigned randomly across the respondents to avoid starting point bias (Mitchel and Carson, 1989).

3.4. Methods of Data Analysis

3.4.1. Descriptive statistics

Descriptive statistics such as mean, standard deviations, frequency and percentage were computed to explain different demographic and socio-economic characteristics of the sample households.

3.4.2. Econometrics models specification for contingent valuation method

Econometric models were used to estimate the relationship between the variables of our concern and to test the hypothesis regarding these variables. It is hypothesized that the socioeconomic and other factors expected to have effect on the amount of price that farmers´ WTP for improved irrigation water use. The goal of estimating econometric models from dichotomous choice CV responses is to calculate willingness to pay for the services described (in this case, improved irrigation water). In addition, the models allow for the incorporation of respondent characteristics into the willingness to pay functions.

Multiple Linear Regressions Model

According to Siglman and Zeng (1999), when there exist a linear relationship between the dependent and the independent variables, OLS and Tobit are the most appropriate models. Additionally, they said that OLS can be used if the dependent variable is continuous, while Tobit will be appropriate if the dependent variable has some censored value. Since the dependent variable is continuous and positive, this study employed the multiple linear regressions model, to identify the major determinants of farmers' maximum willingness to pay for improved irrigation water use per 0.25 *ha* in a year.

According to Maddala (1992), the multiple linear regression equation is specified as:-

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... \beta_n X_n + .\varepsilon$$

Where Y = the dependent variable, X_n = the independent variables, β_o = the constant (intercept) β_n= the regression parameter, ε = the error term. Based on the above theoretical background, we can specify the multiple linear regression models for this study as:

$$MWTP = \beta_0 + \beta_1 SEX + \beta_2 AGE + \beta_3 EDU + \beta_4 EXP + \beta_5 FSIZE + \beta_6 EXT + \beta_7 CRDT + \beta_8 DMKT + \beta_9 INCOME + \beta_{10} DIRS + \beta_{11} TLU + \beta_{12} LAND + \beta_{13} DISSAT + \beta_{14} BID + \varepsilon$$

Where: MWTP = the price that households maximum willing to pay. X_i= explanatory variables of the regression and described in the variable description section. β_o = intercept, β = regression parameters and ε = the error term. To fit the regression model, the estimation of the values of the unknown parameters, constant and coefficients are required. The OLS method is used to estimate the parameters of the model, values of a constant and coefficients of explanatory variables, which minimize the sum of squared deviations of the observed values of dependent variable from the predicted values, are determined. Under the assumptions of linear regression, the method of OLS yields with a number of desirable statistical properties (Hosmer and Lemshow, 1989; Gujarati, 2004). For the econometric estimation to bring about best, unbiased and consistent result, it has to fulfil the basic Gauss-Markor assumptions. The variance inflation factor was used to check multicollinearity of continuous variables and contingency coefficient was used for checking of multicollinearity of dummy variables. As the value of VIF increases it indicates as there is multicollinearity of the explanatory variables.

According to (Gujarati, 2004), as a rule of thumb if the VIF is greater than 10, the variable is said to be highly collinear. The variance inflation factor of the explanatory variables is given as

$$\text{VIF} = \frac{1}{1 - R^2}$$

Whereas X_k is regressed on other explanatory variables, R^2 is the coefficient of determination. As it has been said a value inflation factor greater than 10 is the signal of strong multicollinearity (Gujarati, 2004).

Contingency coefficient is used to check the existence of multicollinearity among discrete variables. And this measure shows how the relationship between the raw and column variables of a cross tabulation. It indicates that if the value is 0 it shows as there is no relation between column and raw variables. But if the value approaches to 1 it indicates as there is association among the variables.

The contingency coefficient can be computed by; $C = \sqrt{\frac{x^2}{N + x^2}}$

Where, C= coefficient of contingency, $\chi 2$ = a Chi-square random variable and n = total sample size. And if C is greater than =0.75 the variables are said to be collinear

Homoscedasticity**:** an important assumption of the OLS is that the disturbances Ui appearing in the regression function is homoscedastic. If the errors do not have a constant variance, it is said that assumption of homoscedasticity has been violated. This violation is termed as heteroscedasticity. In this study, the Breusch-Pagan / Cook-Weisberg test was employed to test the heteroscedasticity.

Seemingly Unrelated Bivariate Probit Model

The bivariate probit model is used to estimate the mean WTP from the double bounded dichotomous elicitation method. But, when the estimated correlation coefficient of the error terms in bivariate probit model are assumed to follow normal distributions with zero mean and distinguishable from zero, the system of equations could be estimated as Seemingly Unrelated Bivariate Probit (SUBVP) model (Haab and McConnell, 2002). Therefore, in this study SUBVP was employed to estimate the mean WTP of the respondents from the double bounded elicitation method.

$y_1 = \beta_1 x_1 + \varepsilon_1, y_1 = 1$ If $y_1 > 0, 0$ otherwise

$y_2 = \beta_2 x_2 + \varepsilon_2, y_2 = 1$ If $y_2 > 0, 0$ otherwise

$$E(\varepsilon_1) = E(\varepsilon_2) = 0$$

$$Var(\varepsilon_1) = Var(\varepsilon_2) = 1$$

$$Cov(\varepsilon_1, \varepsilon_2) = \rho$$

Where, y_1 and y_2 are WTP responses corresponding to the initial bid and second bid price. ρ (Rho) is the covariance between the errors term. The double-bounded version of discrete response CV follows up on the initial question with a second question, again involving a specific bid to which the respondent can respond with a "yes" or a "no." Let B^1 denote the amount of the first bid. The amount presented in the second bid depends on the response to first bid; if the individual answered "no" to B^1 , the second bid is some lower amount, $B^2 < B^1$, while if respondent answered "yes" it is some higher amount, $B^2 > B^1$. Thus, there are four possible response sequences: (a) both answers are yes; (b) both answers are no; (c) a yes followed by a no; and (d) a no followed by a yes (Hanemann and Kanninen, 1998).

According to (Haab and McConnell, 2003), the bounds on WTP are

1. $B^1 \leq WTP < B^2$, for the yes-no responses;

2. $B^1 > WTP \geq B^2$, for the no-yes responses;

3. $B^1 < WTP \geq B^2$, for the yes-yes responses;

4. $B^1 > WTP < B^2$, for the no-no responses;

Where, B^1 be the first bid price and B^2 be the second. Hence, the probability of the responses is given by

$$pr\{Yes / Yes\} = P^{YY} = pr(WTPi^1 > B^1, WTPi^2 > B^2)$$

$$pr\{No / No\} = P^{NN} = pr(WTPi^1 < B^1, WTPi^2 < B^2)$$

$$pr\{Yes / No\} = P^{YN} = pr(WTPi^1 > B^1, WTPi^2 < B^2)$$

$$pr\{No / Yes\} = P^{NY} = pr(WTPi^1 < B^1, WTPi^2 > B^2)$$

Following Haab and McConnell (2003), the econometric modelling for the formulation of double-bounded data is given as:

$$WTP_{ij} = u_i + \varepsilon_{ij}$$

Where, WTP_{ij} represents the j^th^ respondents willingness to pay, and i=1 and 2 represent, the first and second answers. The u_1 and u_2 are the means for the first and second responses.

This general model incorporates the idea that, for an individual, the first and second responses to the CV questions are different, perhaps motivated by different covariates, perhaps by the same covariates but with different response vectors, and with different random terms.

To construct the likelihood function, we first derive the probability of observing each of the possible two-bid response sequences (yes-yes, yes-no, no-yes, no-no). It is given by;

$$L_j(u / B) = pr(u_1 + \varepsilon_{1j} > B^1, u_2 + \varepsilon_{2j} \geq B^2)^{YY}, \; pr(u_1 + \varepsilon_{1j} \geq B^1, u_2 + \varepsilon_{2j} < B^2)^{YN},$$
$$pr(u_1 + \varepsilon_{1j} < B^1, u_2 + \varepsilon_{2j} \geq B^2)^{NY}, \; pr(u_1 + \varepsilon_{1j} < B^1, u_2 + \varepsilon_{2j} < B^2)^{NN},$$

Where; YY = 1 for a yes-yes answer, 0 otherwise, YN= 1 for a yes-no answer, 0 otherwise, NY = 1 for a no-yes answer, 0 otherwise and NN= 1 for a no-no answer, 0 otherwise.

This formulation is referred to as the bivariate discrete choice model. If the errors are assumed to be normally distributed with means 0 and respective variances of $\sigma_1{}^2$ *and* $\sigma_2{}^2$ then WTP_{1j} and WTP_{2j} have a bivariate normal distribution with mean u_1 and u_2 variances $\sigma_1{}^2$ and $\sigma_2{}^2$ and correlation coefficient ρ.

The likelihood function for the bivariate probit model can be derived as follows. The probability of a no-no response, is

$$pr(u_1 + \varepsilon_{1j} < B^1, u_2 + \varepsilon_{2j} < B^2) = \phi\varepsilon_1\varepsilon_2\left(\frac{B^1 - u_1}{\sigma_1}, \frac{B^2 - u_2}{\sigma_2}, \rho\right)$$

Where, $\Phi_{\varepsilon 1 \varepsilon 2}$ is the standardized bivariate normal cumulative distribution function with zero means, unit variances and correlation coefficient ρ. Similarly, the probability of a no-yes response is

$$pr(u_1 + \varepsilon_{1j} < B^1, u_2 + \varepsilon_{2j} \geq B^2) = \phi\varepsilon_1\varepsilon_2\left(\frac{B^1 - u_1}{\sigma_1}, -\frac{B^2 - u_2}{\sigma_2}, -\rho\right)$$

The probability of a yes-no response is

$$pr(u_1 + \varepsilon_{1j} \geq B^1, u_2 + \varepsilon_{2j} < B^2) = \phi\varepsilon_1\varepsilon_2\left(-\frac{B^1 - u_1}{\sigma_1}, \frac{B^2 - u_2}{\sigma_2}, -\rho\right)$$

And the probability of a yes-yes response is

$$pr(u_1 + \varepsilon_{1j} > B^1, u_2 + \varepsilon_{2j} \geq B^2) = \phi\varepsilon_1\varepsilon_2\left(-\frac{B^1 - u_1}{\sigma_1}, -\frac{B^2 - u_2}{\sigma_2}, \rho\right)$$

Defining y_{1j} = 1 if the response to the first question is yes, and 0 otherwise, y_{2j} = 1 if the response to the second question is yes, and 0 otherwise, $d_{1j} = 2y_{1j} - 1$, and $d_{2j} = 2y_{2j} - 1$, the j^{th} contribution to the bivariate probit likelihood function becomes

$$L_j(u/B) = \phi\varepsilon_1\varepsilon_2\left(d_{1j}\left(\frac{B^1 - u_1}{\sigma_1}\right), d_{2j}\left(\frac{B^2 - u_2}{\sigma_2}\right), d_{1j}d_{2j}\rho\right)$$

After running regression of dependent variable (yes/no indicator), on a constant and on independent variable consisting of the bid levels, the mean WTP value is determined as follows depending on the normality assumption of WTP distributions (Haab and McConnell, 2002):

$$MeanWTP = -\frac{\alpha}{\beta}$$

Where, $MeanWTP$ = the mean willingness to pay for improved irrigation water use, α = the intercept of the model, β = slope coefficient of the bid values.

For the open ended contingent valuation survey responses the maximum willingness to pay figures reported by the respondents can be simply be averaged to produce an estimate of mean willingness to pay:

$$MeanWTP = \frac{\sum_i^n Y_i}{n}$$

Where n is the sample size and each y is a reported maximum willingness to pay amount by surveyed households (Haab and McConnell, 2003).

3.5. Definition of Variables and Working Hypotheses

Dependent variables

Maximum willingness to pay (MWTP): This is the Maximum willingness to pay that farmers will be asked to state their maximum willingness to pay for improved irrigation scheme in Birr/*0.25 ha* per year (open ended question). CVM was applied to elicit the maximum willingness of the respondents to pay for improved irrigation water use. In this case, the dependent variable MWTP takes a continuous value and it is used in the OLS regression.

Willingness to pay (WTP): This variable is farmers' willingness to pay for the provision of improved irrigation water use in Birr/ *0.25 ha* per year. In this case also, CVM was applied to elicit the willingness of the respondents to pay for improved irrigation. This variable is a dummy variable which takes the value of 1 if the respondent is willing to pay the offered bid and 0 otherwise (double bounded question). It is used in Seemingly Unrelated Bivariate Probit model.

Independent variables

The independent variables for the study were identified and listed based on previous theoretical and empirical works. The following explanatory variables were hypothesized to influence the willingness and amount of payment for improved irrigation water use in the study area.

Sex of the Household Head (SEX): It is a dummy variable which takes 1 if the household head is male and 0 if female. The coefficient can be positive, as male headed households are expected to be financially better than female headed households and they have more decision power so that they can be more willing to pay. According to the study by Birhane and Geta (2016), male households were more willing to pay than female households. Therefore, it is hypothesized that male headed households are more willing to pay for improved irrigation water.

Age of Household Head (AGE): This is a continuous variable which measures the age of the household head in number of year at the time of interview. It is believed that older people prefer to keep tradition and therefore they may not be willing to pay or to pay more since they are traditionally using the service for free and may have low preference for a new source that require fees. A study conducted by Teshome (2010) revealed that an increase in the age of respondent decreases WTP of the farmer. Thus, it was expected to affect the WTP decision of farmers for improved irrigation water use negatively.

Education Level of the Household Head (EDU): This is a continuous variable measured in formal schooling years of household heads during the survey time. It is assumed that educated households have more ability to obtain and utilize information. A study done by Mezgebo *et al.* (2013), Habtamu (2009), and Karthikeyan *et al. (*2009) showed that education level of the household head had a positive relationship with his/her WTP decision. Thus, it was hypothesized that this variable affects WTP for improved irrigation water positively.

Experience in Irrigated Farming (EXP): This is a continuous variable which indicates the number of years of irrigated farming experience of the household head during interview. Farmers who have an experience in irrigated farming were expected to understand the benefit of irrigation water supply. Household heads with long irrigated farming experience are more willing to pay for irrigation water than those with relatively shorter experience or non-experienced farmers (Chandrasekaran *et al*., 2009). Thus, this study hypothesized that irrigation experience affects WTP for improved irrigation water use positively.

Family Size (FSIZE): This variable is a continuous variable which refers to the number of family members in a household. In the case of irrigation farming, households with large family size will have more labor input that can utilize the increased water availability. On the other hand, large family size requires relatively large amount of money to feed the family and in such situation the household will be resistant to the idea of paying for the improved irrigation water provision. Thus, it was difficult to determine a prior sign between family size and households' WTP for improved irrigation water supply.

Frequency of Extension Contact (EXT): This is a continuous variable which refers to the number of times that the farmer has contact with extension agents within a month. Extension intervention is expected to enhance farmers' awareness regarding improved and modern agricultural technologies. Teshome (2010) found positive relationship between access to extension and WTP for irrigation water use. Therefore, it was hypothesized that frequency of extension contact increases farmers' WTP for improved irrigation water.

Credit Use (CRDT): This is a dummy variable which refers to whether or not the farmer received credit and it takes 1 if the farmer received credit and 0, otherwise. Credit may solve financial constraints and enables the farmer to purchase productive inputs on time, access technologies and enhance farm production. In this case credit would positively affect WTP for irrigation. Omondi (2014) in his study on investigation of the economic value of water as used by smallholder farmers confirmed that credit is positively related to the WTP decision of users for irrigation water. On the other hand, Tiwari (2005) in his/her study of factors that determine the economic value of water found that credit was negatively related to the WTP decision of users. In this study, it was hypothesized that credit and WTP have a positive relationship for improved irrigation water supply.

Distance to Market Centre (DMKT): This is a continuous variable measured in kilometre. It refers to the distance between the household's farm and the nearest market centre. It is hypothesized that the farther the market centre is the lesser the income from the sale of farm produce. If the market place is located far away from the farm, the commodity may perish, especially for perishable commodities, before reaching the market. Habtamu (2009) came up with a negative relationship between WTP for environmental protection and distance to market centre. Thus, it was expected that this variable has negative effect on WTP for irrigation water use.

Total Annual Income (INCOME): It is a continuous variable measured in ETB. An increase in total annual income of the household will increase his/her financial position and affect the willingness of the farmer to pay for irrigation positively. Chandrasekaran *et al.* (2009) found that income affected WTP for irrigation positively. Therefore, it was expected that income will affect WTP positively.

Distance to Irrigation Scheme (DIRS): This is a continuous variable that measured in metre. It refers to the distance between the farms of the household to the nearest irrigation scheme. It is hypothesized that the farther the irrigation scheme the lesser benefit from the irrigation scheme. If the irrigation scheme place is located far away from the farm, the farmer may not be willing to pay for the irrigation scheme. Thus, it was expected that this variable has negative effect on WTP for improved irrigation water use.

Livestock Ownership (TLU): This is a continuous variable measures the households' ownership of livestock in Tropical Livestock Unit (TLU). This refers to the total number of animals possessed by the household. Livestock is considered as another asset which is liquid and a security against crop failure. Farmers owning more livestock can settle their debts and they even neutralize crop failure by selling out their animals and animal products. Research result reported by Karthikeyan *et al. (*2009) income from different sources increases the farmers likely to pay more for the irrigation water. Therefore, in this study it was hypothesized that higher TLU will have positive influence on the willingness to pay for improved irrigation water use.

Land Size (LAND): This is continuous variable which measures the size of potential irrigable land that particular household owns and it is measured in hectares. An increase in the size of land has a positive effect on farmer's willingness to pay by providing an opportunity to generate cash either from land rent or the sale of crops. Nega (2012) found that land size affected WTP for irrigation positively. Therefore, it was expected that land size affect WTP positively.

Dissatisfaction with the Existing Irrigation Project (DISSAT): This is a dummy variable which refers to dissatisfaction with the existing irrigation project. It takes 1 if the farmer is unsatisfied with the existing project and 0, otherwise. Households who are dissatisfied by the existing project will pay more for the improved irrigation water provision. Thus, the expected sign of this variable was positive.

Bid Value (BID): This is a categorical variable and randomly assigned price for irrigation beneficiary households that potentially reflect households' willingness to pay for 0.25 ha of irrigable land per year. An increase in bid value should have a negative influence on households WTP for improved irrigation water service (Nega, 2012). As theory suggests bid value has a negative relationship with WTP if the good or service going to be valued is a normal good.

Table 2: Summary of definition of variables and working hypotheses

Variables	Description of variables	Type	Unit of measurement	Sign
Dependents				
Bid 1 answer	Willingness to pay when price is Bid1	Dummy	1= yes; 0=no	-
Bid 2 answer	Willingness to pay when price is bid2	Dummy	1= yes; 0=no	-
MWTP	Maximum willingness to pay	Continuous	Ethiopian Birr	-
Independents				
SEX	Sex of the household head	Dummy	1 if male, 0 female	+
AGE	Age of the household head	Continuous	In year	-
EDU	Educational level	Continuous	Grade level	+
EXP	Irrigation farming experience	Continuous	In year	+
FSIZE	Family size	Continuous	Number of member	+/-
EXT	Frequency of extension contact	Continuous	Number of times/ month	+
CRDT	Credit use	Dummy	1 if receive, 0 otherwise	+
DMKT	Distance to market centre	Continuous	In kilometre	-
INCOME	Total annual income	Continuous	Ethiopian Birr	+
DIRS	Distance to irrigation scheme	Continuous	In metre	-
TLU	Livestock ownership	Continuous	Tropical livestock unit	+
LAND	Potential irrigable land size	Continuous	Timad (0.25 ha)	+
DISSAT	Dissatisfaction with the existing irrigation schemes	Dummy	1=dissatisfied; 0= otherwise	+
bid1	Initial bid amount	Categorical	Ethiopian Birr	-
bid2	Follow up bid amount	Categorical	Ethiopian Birr	-

Source: Own design (2017).

4. RESULTS AND DISCUSSION

This chapter presents the results and discusses in comparison with similar studies conducted elsewhere. Accordingly, in the first part of this section, household's characteristics are analysed. Moreover, the contingent valuation survey results and the means of money payment for the improved irrigation water use are also presented and discussed. In the second part, econometric results were made to estimate farmers' willingness to pay for improved irrigation water use and to identify the factors that determine farmers' willingness to pay for the provision of improved irrigation water. Finally, the aggregate willingness to pay for improved irrigation water is estimated.

4.1. Descriptive Results

4.1.1. Summary of households' characteristics

The basic information obtained in the survey is presented below. It was found that among the total surveyed households, 184 (87.62 %) were male headed households and the remaining 26 (12.38 %) respondents were female headed households (Table 3). The mean age of the sampled respondents were 40.36 years with the minimum age of 25 years and a maximum of 65 years old. Family size with age composition is important to carry out different agricultural activities like irrigation farming. So it is necessary to see family size with their active labor. The mean family sizes of the total sample respondents were about 5.25 persons, ranging from 1 to 9 persons.

From the total household heads, about 52.86 % of them did not attend any formal education (illiterate) and the remaining 47.14 % household heads attended formal education or they are literate. Educational background is believed to be an important feature that determines the readiness of household heads to accept new ideas and innovations. Also it affects technology adoption decision. It plays major role to decision-making processes that change people life process. In the study area, more educated farmers were high maximum willingness to pay for improved irrigation water use compared to low educational level. These is because, more educated farmers are expected to adopt new technologies to increase their land and labor productivity. The mean grade level for the total sample respondents was about 3.42 ranging from illiterate or zero to a maximum of 12 years of schooling.

Irrigation farming experience is taken to be the number of years that an individual was engaged in irrigation farming. The mean practical irrigated farming experience of the entire sample was 7.25 years ranging from 1 to 15 years.

Table 3 : Socio-demographic characteristics of the respondents

Variables	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Age(years)	40.357	8.317	25	65
Family size	5.247	2.160	1	9
Education(schooling years)	3.424	4.159	0	12
Irrigation experience(years)	7.252	3.582	1	15
Sex of household head	**N**		**Percent**	
Male	184		87.62	
Female	26		12.38	
Total	210		100	

Source: Own survey, 2018

Resource ownership and access to services

Regarding to resource ownership, land is one of the most important factor of physical input of agricultural production for rural households whose primary means of livelihoods is farming and measure of wealth in the study area. It is the main source of income and increases the status of people in the community and potential irrigable land holding shows how farmers intended to produce irrigated commodities. The local unit of measurement for land size in the study area is "*timad*" which is one *timad* equal to 0.25 hectare or one hectare equal to 4 *timad*. Table 4 shows that the mean potential irrigable land holding size of the sample households was 1.037 ha, ranging from 0.25 to 3.985 ha. Besides this, livestock ownership is an important factor. In the study area, having large number of livestock is seen as a dignity or store of value. The mean livestock ownership in terms of TLU for the total sampled households was 3.97 with the minimum and maximum being 0 and 13.40, respectively.

Access to agricultural extension services is expected to have direct influence on the production and productivity behavior of the farmers. Making contact with agricultural information services makes farmers to be aware of and get better understanding and ultimately leads to decision to take risk for improved agricultural practices. In addition, proper contact with agricultural extension agents helps to facilitate dissemination and adoption of improved technologies and ensure the local availability of these technologies for the majority of smallholders. In the study area, the mean extension contact for the total sample respondents was about 4.6 ranging from 1 to a maximum of 12 per month.

Distance from producer's house to proximity market was also the other factor which determines farmer's willingness to pay for improved irrigation water use. The more the farmer is nearest to the district market the more the farmer is able to have quality information and earns better price. If the market place is located far away from the farm, the commodity may perish, especially for perishable commodities, before reaching the market. Table 4 shows that the mean amount of walking distance to the market center was 7.67Km with a minimum of 2 and a maximum of 22 Km. On the other hand, the mean amount of walking distance to the irrigation schemes was 1.94 Km with a minimum of 0.2 and a maximum of 4 Km.

Table 4 : Resource ownership and access to services

Variables	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Land size (ha.)	1.037	0.639	0.25	3.985
Livestock (TLU)	3.966	2.463	0	13.4
Extension contact	4.595	2.3667	1	12
Distance to market(km)	7.667	3.874	2	22
Distance to irrigation scheme(km)	1.938	9.046	0.2	4

Source: Own survey, 2018

Credit use

Credit is an imperative source for financing the agricultural activities of smallholder farmers. It is one way of improving smallholder farmers' production and productivity. Farmers having better access to credit can minimize their financial constraints and buy inputs more readily than those with no access to credit. Table 5 shows that, 87.5% of the respondents have access to credit. However, only 35.2 % of the respondents have taken credit from the available sources in the study area. Out of those who did not receive credit service, 41.2% respondents were answered for the reasons of religion (interest free), 39.7% for having sufficient capital, 12.5% for no access and the remaining 6.6% for the reasons of collateral problem. In the study area, the major source of credit service is Omo Microfinance and; others sources such as cooperatives, local money lenders, friends and relatives are less contributors of credit provision for farmers in comparison to Omo Microfinance. In addition, 34.3% of the respondents received the credit for livestock rearing and fattening, 20.9% for the purpose of petty trade, 18.7% of the respondents received the credit to purchase fertilizer, and, yet only 17.9% received credit to purchase irrigation facilities. The remaining 8.2% used credit for the purpose of home consumption.

Table 5 : Credit use by respondents

Variables	**Answer**	**Frequency**	**Percent**
Accessibility of credit	Yes	184	87.5
	No	26	12.5
Credit use	Yes	34	35.2
	No	136	64.8
Total		210	100

Reasons for not using credit	**Frequency**	**Percent**
Religion(interest free)	56	41.2
Having sufficient capital	54	39.7
No access	17	12.5
Collateral problem	9	6.6

Total	136	100

Source: Own survey, 2018

Income structure of the sampled households

In the questionnaire households were asked to specify their source of income. Income from agricultural activities was the most important source of income for the farmers interviewed. Of the total respondents, 59.05 % of them claimed that their only source of income is Agricultural activities. The remaining 40.95 % obtained their livelihood both from agriculture and non-agricultural activities. According to the survey results, the main non-farm activities in the study area are Trade, Carpenter, and Daily labourer on construction or other non- farm activities. The mean annual income of the respondents was about 45,134.88 ETB per household with a maximum and minimum income of 158,770 and 7,400 ETB, respectively. From the total mean annual income of a sampled household, vegetables contribute the highest (22,048.33) and poultry share the lowest income (81.64).

Table 6 : Income sources of the respondents

Income sources	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Cereal Crops	3943.29	5493.40	0	25200
Vegetable*	22048.33	27629.42	0	150000
Fruit****	255.71	1354.06	0	10900
Woodlot**	317.39	2398.12	0	20000
Cash crop***	9301.90	11972.26	0	75000
Sold Livestock	3841.62	7561.90	0	29100
Dairy	1546.29	4763.47	0	28700
Poultry	81.64	296.36	0	2100
Honey	135.52	525.16	0	3000
Off farm Income	3518.76	7076.71	0	35000
Total income	45134.88	29801.60	7400	158770

Source; own survey, 2018

* (Onion, Tomato, Cabbage, Potato, and Pepper), ** (eucalyptus tree, Gesho), *** (chat, coffee and sugarcane,), **** (avocado, mango, papaya)

Maize, Sorghum, Wheat and Teff were the main cereal crops grown by the sampled households in the study area.

4.1.2. The contingent valuation survey results

In the questionnaire, households were asked whether they are willing to pay for the improved irrigation water supply in the command area. Consequently, all of the sample household heads were willing to pay if there is an improvement in the service of the existing irrigation schemes. This indicates that the improvement of the existing irrigation schemes is supported by all households. In order to determine households' willingness to pay for the provision of improved irrigation water, they were offered with five initial bid values (300, 400, 500, 600, and 700) and the corresponding follow up bids for one *timad* (0.25 ha) of irrigable land per year. Hence, given the randomly assigned initial bids, Table 7 shows that out of the total household heads who are willing to pay, 73.3 % of them said "yes" or they are willing to accept the initial bids. And the remaining 26.7 % said "no" or they are not willing to accept the initial bids. The follow up bids were doubled for those households who were willing to pay the given initial bids and halved for those households that were not willing to accept the initial bids. Thus, there are four possible response sequences in the double-bounded dichotomous choice model: these are; both answers are yes (Yes-Yes); both answers are no (No-No); a yes answer followed by a no answer (Yes-No); and a no answer followed by a yes answer (No-Yes) (Haab and McConnell, 2003). Therefore, given the randomly assigned follow up bids, 72.9 % households said "yes" or they are willing to accept the follow-up bid and 27.1 % household heads said "no" or they are not willing to accept the follow-up bids. The result is summarized in the Table below.

Table 7 : Distribution of yes and no responses for initial and /or follow up bid value

Bid value	**Responses At**			**Percentage**		
	initial bid	**initial and follow up bids**		**Single**	**Double**	
1st / 2nd bid level	Yes No	YY NY	YN NN	%Yes %No	%YY %NY	%YN %NN
300 /(600/150)	40	36	4	95.2	85.7	9.5
	2	2	0	4.8	4.8	0
400/(800/200)	37	30	7	88.1	71.4	16.7
	5	4	1	11.9	9.5	2.4
500/(1000/250)	33	24	9	78.6	57.2	21.4
	9	7	2	21.4	16.6	4.8
600/(1200/300)	25	13	12	59.5	30.9	28.6
	17	13	4	40.5	30.9	9.6
700/(1400/350)	19	8	11	45.2	19	26.2
	23	16	7	54.8	38.1	16.7
All bids	154	111	43	73.3	52.8	20.5
	56	42	14	26.7	20.1	6.6

Source; own computation, result based on the survey data, 2018

The distribution of "Yes" and "No" answers to the corresponding initial and follow up bids are given in Table 7. When the initial bid was Birr 300 per *Timad* (0.25 ha) of irrigable land per year, 42 respondents were randomly offered this bid and only 2 of them did not accept the initial bid. However, when the initial bid was doubled (600 Birr), 4 respondents did not accept it. As shown in Table 7, for the first initial and its follow up bids, 36 respondents answer "YY" (Yes to both the initial and the follow up bids);2 respondents answer "NY" (No to initial and Yes to the follow up bids)but no one answers "NN" (No to both the initial and the follow up bids).

In the second initial and its follow up bid values 400/(800/200), 30 household heads answer "YY" and 7, 4 and 1 answer for "YN", "NY" and "NN", respectively. The third initial bid, which is Birr 500, 24 out of 42 respondents answer "YY" (yes to both the first bid and the follow up bids) and 2 households answer "NN" (No to first and No to the follow up bids). But, only 9 respondents answer "YN" (Yes to first and No to the follow up bids) and 7 of them answer "NY" (no to first and yes to the follow up bids). The above trends are the same in the fourth and fifth initial and follow up bid levels. Generally, as the initial and follow up bids increased, the responses to "YY" (Yes to both the initial and follow up bids) decreased whereas "NN" (No to both the initial and follow up bids) answer increased. At the 1st bid, there are 36 "YY" (85.7 %) answer which reduced continuously up to the last bid level and reached at 8 (19 %). Therefore, this result is consistent with the economic theory of demand which states as the price of the product increases, the quantity demand of that product decreases, keeping other things constant. The distribution of "yes" and "no" responses along the initial bid level also approve the argument that the probability of 'yes' responses decline with increased bid price. When the initial bid value 300 Birr, 40 respondents accept it. However, as the bid level rise, 'No' response become increased while 'yes' response decreased.

4.1.3. Means of money payment for the improved irrigation water supply

Out of the total sample households, majority of the total households (60.5%) were willing to make direct cash payment for the improved irrigation water use while 32.8%, 3.8% and 2.9% of the total households were willing to pay through social associations, on-tax and labor, respectively.

Table 8 : Means of money payment for WTP

Means of payment for WTP	**Frequency**	**Percent**
On cash(direct payment)	127	60.5
Social associations (Ikub, Edir…..)	69	32.8
On-tax	8	3.8
Labor	6	2.9
Total	210	100

Source: Own survey, 2018

Problems in the existing irrigation schemes

Households were asked in the structured questionnaire whether they are satisfied with the current irrigation water supply system. Consequently, out of the total respondents, 81.9 % of them were dissatisfied with the existing irrigation water supply. After asked whether they are satisfied with the existing scheme, households were asked to specify any challenges and problems they have faced/observed in the existing irrigation schemes. Attempt has been made to rank the major constraints of irrigated schemes from the most severe problems to the least. The following problems were listed/specified by the sampled respondents:

1. **Insufficient water supply**; the most frequently mentioned problem by the household heads was insufficient water supply. Among the sampled respondents, 63.4 % of them have shortage of water which forced them to produce partially or grow crops that are not sensitive for water shortage for short period of time like chat, mango, and avocado.

2. **No access to irrigation water;** from the total sample household heads, 19.8 % of the respondents told us that they have still no access to irrigation water. Even if these respondents were found in the command area, they can't access to water due to shortage of water, and unsuitable topography.

3. **Canal problem**; Lack of proper canal in which irrigation water flows into farm lands was another major problem mentioned by about 14.5 % of respondents. In the study area, the canals were constructed from the diversion up to some distances. After that, water is flows with the side of the road and the way that farmers directed. During the survey, it has been observed that the irrigation water sank in to the soil before it reached the irrigable land which was also been confirmed by sample survey respondents. This leads to a higher water wastage and distribution problem. That is why, most of the farmers use pumping motor to irrigate their land. This forced farmers to spend a higher fuel costs for pumping water. This problem is severe especially in Wita and Dobena Gola irrigation schemes and lower in Yetebon irrigation scheme.

4. **Other constraints**; these include water distribution and infrastructure constraints. Moreover, the water user committee were not well organized and found to be weak to run the irrigation systems. That is why some farmers do not respect the distribution program.

Table 9 : Dissatisfied with and problems in the existing irrigation schemes

Dissatisfied with the existing irrigation schemes	Frequency	Percent
Yes	172	81.9
No	38	18.1
Total	210	100
Problems in the existing irrigation schemes	**Frequency**	**Percent**
Insufficient water supply	109	63.4
No access to irrigation water	34	19.8
Canal problem	25	14.5
Other constraints	4	2.3
Total	172	100

Source: Own survey, 2018

4.2. Econometric Results

The result of households' WTP for improved irrigation water use from descriptive analysis as discussed above showed that, all households were willing to pay for improved irrigation water supply. Therefore, as indicated in the previous section, the OLS method is employed to identify the determinants of farmers' willingness to pay for improved irrigation water use in CV survey responses and Seemingly Unrelated Bivariate Probit model for estimating the mean willingness to pay for improved irrigation water use.

4.2.1. Determinants of Households' WTP for improved irrigation water use

Before taking the selected variables into the OLS model, some assumptions were tested among the explanatory and dependent variables and there was no serious problem of OLS assumption to be violated as described below.

Multicollinearity: In this study, there was no serious multicollinearity. VIF was used to test possible correlation among continuous independent variables while coefficient of variation was used to test possible correlation between discrete variables (Appendix 3 and 4). Thus, all hypothesized explanatory variables were included in the econometric analysis.

Heteroscedasticity: If the errors do not have a constant variance, it is said that assumption of homoscedasticity has been violated. This violation is termed as heteroscedasticity. According to Wooldridge (2002), when the p-values are greater than 0.05, no heteroscedasticity problem, he argues that heteroscedasticity does not affect the consistency of the estimator, and it is only a minor trouble for inference. Even in the presence of heteroscedasticity, more efficient estimation is possible. In this study, the Breusch-Pagan / Cook-Weisberg test was employed to test the heteroscedasticity and the result indicates that absence of heteroscedasticity (Appendix 5).

The OLS model was used to estimate the parameters of the variables that are expected to determine farmers' maximum WTP for improved irrigation water use (Table 10). Out of 14 explanatory variables, 7 variables were found to be significant.

Sex of the household head was significant at 1% level of significance and positively related to willingness to pay for improved irrigation water use. Male headed households were found to be more willing to pay for improved irrigation water use than female headed households. The result of OLS model revealed that keeping other factors constant, male headed households would pay an average of maximum of 329.34 birr more than female headed households for improved irrigation water use. This is mainly because; female headed households have less resources possession endowment as well as some cultural constraints than male headed households. Birhane and Geta (2016), reported the same result.

Age of household heads was significant at 5% significance level and negatively related with farmers WTP for improved irrigation water use in the study area. This implies that, other things remaining the same, as a one year increase in age of the household head, maximum willingness to pay for improved irrigation water use will decrease by an average of 4.94 birr. This may be old people faced labor shortage to use the irrigation water resource and old people demanded less water resource than the young people. The negative relationship between WTP and Age is in consistent with the findings of Tesfaye (2013) and Nega (2012).

Education level of household heads was significant at 1% level of significance and has positive influence on WTP for improved irrigation water use. Holding other factors constant, a unit increase in education level (grade) of household head will increase household's maximum WTP for improved irrigation water use by an average of 23.93 birr. The possible justification for this finding could be due to the possibility that more educated household heads may have more knowledge and awareness about the economic benefit which results from improving the existing irrigation water supply. These are central to increase agricultural production, which makes rural households to be more aware about irrigation agriculture is one of the means to increase productivity. The other possible reason could be that literate individuals are more concerned about water resource than illiterate ones. This is consistent with the findings of Mezgebo *et al.* (2013), Habtamu (2009), and Karthikeyan *et al. (*2009). Thus education level of the household head is one of the major determinants of price that the households' are willing to pay for improved irrigation water use.

Distance to the nearest market was significant at 1% level and has negative influence on WTP of household heads. The coefficient indicates that when distance of the farm from the nearest market increases by one kilometre, maximum willingness to pay decreases by an average of 15.50 birr, keeping other things constant. This is 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 similar with Nega (2012) and Angella *et al.* (2014) who found a negative impact of travel distance on the willingness to pay for agricultural services.

Credit use showed unexpected negative sign and significant at 5% significance level. Keeping all other factors constant, as the household head use credit, the maximum amount of price that he/she is willing to pay for improved irrigation water use will decrease by an average of 76.39 birr. The implication is that as the household heads in using credit increase, the household heads will have more understanding about the benefit of other farm income activities (animal fattening and rearing, poultry, honey…etc.) and non-farm/off farm activities apart from irrigation agriculture. Similar study results from Tiwari (2005) on determining the economic value of irrigation water found that credit use is negatively and significantly affect WTP of farmers' for irrigation water supply, thus credit use of the farmers with irrigation is one of the major determinants of the maximum amount of price that the farmers' are willing to pay for improved irrigation water use.

Distance to the nearest irrigation scheme was significant at 5% significance level and has negative influence on WTP of household heads. The coefficient indicates that when distance of the farm from the nearest water sources increases by one kilometre, the maximum willingness to pay decreases by an average of 4.76 birr, ceteris paribus. This is because, farmers closer to the water source get the water freely and incur low 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 similar with Dagnei (2008) and Bane (2005) who found a negative impact of distance from water sources on the willingness to pay.

Dissatisfaction with the existing irrigation scheme was significant at 1 % level of significance and has positively influenced farmers' WTP for improved irrigation water provision. Farmers who are not satisfied with the current irrigation water supply system were found to be more willing to pay if there is an improvement as compared to those satisfied with the existing irrigation water supply. The OLS result shows that keeping all other factors constant, dissatisfied households with the existing irrigation service are willing to pay an average of maximum of 139.42 birr more than those who are satisfied with the service of the existing scheme. This may be due to the problems which are prevailed in the existing irrigation schemes that make farmers to seek improvements in irrigation schemes in order to be benefited well. Similar results from Anteneh (2015) and Teshome (2010) showed that households' willingness to pay was influenced by dissatisfaction with the existing irrigation scheme.

Table 10 : Result of OLS estimation for MWTP

Variables	Coefficient	Standard Error	t-value
Sex	329.343***	51.559	6.39
Age	-4.941**	2.032	-2.43
Education	23.934***	4.815	4.97
Family size	9.767	7.624	1.28
Land size	18.093	26.285	0.69
Livestock(TLU)	-6.867	6.822	-1.01
Income	0.00017	0.0005	0.31
Experience	6.290	4.965	1.27
Distance to market	-15.508***	4.4962	-3.45
Credit use	-76.389**	31.997	-2.39
Extension contact	9.838	6.407	1.54
Distance to irrigation scheme	-4.759**	2.005	-2.37
Dissatisfaction in existing irrigation scheme	139.417***	35.011	3.98
Bid1	0.165	0.116	1.43
_cons	522.997	130.970	3.99
Number of observations = 210		R-squared = 0.6707	
F(14, 195) = 28.37		Adjusted R-squared = 0.6471	
Prob > F = 0.0000			

Source: Own computation- result based on the 2018 survey data

******* Significant at 1%, and ****** Significant at 5%

4.2.2. Users' Mean Willingness to Pay for Improved Irrigation Water

Table 11 presents the descriptive statistics of households' responses to the offered bids in the double bounded dichotomous format. The result shows that the average initial bid was Birr

501.43 per year per timad (0.25ha.). Whereas, the average second bid for improved irrigation water use was Birr 736.43 per year per timad (0.25ha.).

Table 11 : Descriptive Statistics of the Dichotomous Choice Format

Variable	Observation	Mean	Std. Dev.	Min	Max
Bid1	210	500	142.26	300	700
Bid2	210	736.43	373.42	150	1400

Source: Own Survey, (2018)

4.2.2.1. Estimation of Mean WTP from Double Bounded Dichotomous Format

The main objective of the double bounded dichotomous was to estimate the mean WTP from responses of both bids offered. The mean WTP of the respondents for the improved irrigation water use was calculated using the formula specified by Haab and McConnell (2002). The coefficients α and β were estimated by running the Seemingly Unrelated Bivariate Probit model using the first bids and second bids as explanatory variables as shown in Appendix 9. Accordingly, the mean WTP estimated from the initial bid and the follow up bid values ranged from 681.27 to 977.65 Birr per year per 0.25 hectare of irrigated land.

In the double-bounded estimates reported in Table 12, the initial bid and the second bid have the expected signs and both are statistically significant at 1 % level of significance. Both results imply that higher initial bid and second bid lead to lower probability of accepting that bid. In the Seemingly Unrelated Bivariate Probit Estimates (SUR) Rho (ρ), coefficient of correlation of error terms of the double-bounded model, is positive and statistically significant at 1% level of significance. This basically shows that there is positive linear relationship between the random components of the responses to the initial bid and the second bid. The fact that Rho (ρ) is unity indicates that the correlation between the random components of the responses to the initial bid and the second bid is perfect. This implies that there is perfect positive correlation between the two responses. Using the coefficients of bid and constant in Table 12, the mean WTP for improved irrigation water use from the double bounded probit estimate was estimated using the formula by Haab and McConnell (2002) and was found to be

Birr 829.46 per year per 0.25 hectare of irrigable land. At 95% confidence interval, the WTP varies between 681.27 and 977.65 birr per year per 0.25 hectare of irrigable land.

Table 12 : Estimates of the Double Bounded Dichotomous Choice Format

Variables	**Coefficient**	**Standard Error**	**Z-Value**	**P>z**
Bid1	-0.0181622***	0.0036375	-4.99	0.000
Constant	12.37342***	2.827335	4.38	0.000
Bid2	-0.0056947***	0.0007111	-8.01	0.000
Constant	5.567382***	1.246339	4.47	0.000
Rho	1	1.38e-12		

Number of Observations = 210; Log- likelihood= -95.955789

Wald chi2 (2) =110.99; Prob > chi2=0. 000

Likelihood-ratio test of rho=0: chi2(1) = 6.88369 Prob > chi2 = 0.000

******* Significant at 1% significance level.

Source: Own computation-result based on the 2018 survey data

4.2.2.2. Analysis of the Open Ended Format

In the open ended question, respondents were asked to state the maximum amount they would like to pay for improved irrigation water use. The maximum amount of Birr that the households were willing to pay for the improved irrigation water use ranges from Birr100 to 1600 per year per one *timad* (0.25ha.) of irrigable land. Table 13 shows that all of the farmers were willing to pay for improved irrigation water use. The frequency distribution of the responses of the sampled households of the open ended responses is also presented below.

Table 13 : Frequency distribution of the open ended format

Birr per year per 0.25hac.	Frequency	Percent (%)
100-400	41	18.52
401-700	55	25.19
701-1000	66	31.43
1001-1300	42	20
1301-1600	6	2.86
Observations	210	100
Mean	726.55	
Standard Deviation	343.05	
Maximum	1600	
Minimum	100	

Source: Own computation, result based on the 2018 survey data

All of the sample respondents were willing to contribute Birr for improved irrigation water use. The average Birr that farmers were willing to contribute for improved irrigation water use was 726.55. The result shows that the mean WTP from double bound format was greater than the mean value from the open ended response which was computed at Birr 829.46 per year per 0.25 hectare of irrigated land. Thus, from the double bounded format, households' mean annual willingness to pay amount was Birr 3317.84 per hectare, while open ended format was to be 2906.20 birr per hectare. This result is consistent with the findings of Tadesse *et al* (2017) and Mezgeb *et al* (2013) who suggested a possible reason that respondents may want a free service from the government or become free riding in the open ended questions.

4.3. Estimating Aggregate Willingness to Pay (Aggregate Economic value)

Aggregation of benefit (TEV) of conservation work is the final step in the contingent valuation research. An important issue related to the measurement of welfare using WTP is aggregation of benefit (Alemu, 2000). The aggregate willingness to pay for improved irrigation water supply can be estimated by taking total number of beneficiary households and total irrigable land in the command area. According to the Meskan district Agricultural development office (2018), the total number of beneficiary households in the district were estimated at about 10,094 and the total irrigable area is estimated about 11,500 ha. Based on this figures, Table 14 shows the expected aggregate willingness to pay for improved irrigation water supply using the DBDC and open ended question was estimated to be 38,155,160 and 33,421,300 birr per year, respectively.

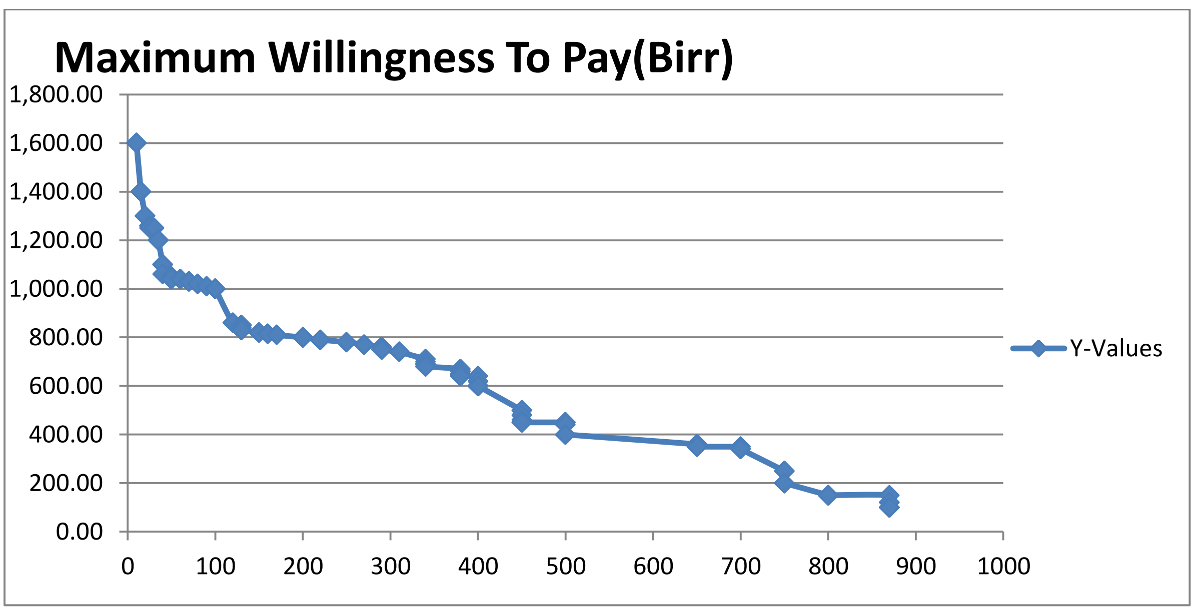
Table 14 : Summary of WTP and its Aggregate values

Elicitation Format	Method of Analysis	Mean WTP per hectare per year	Aggregate WTP for about 11,500 ha. Land
Double Bounded	Seemingly Unrelated Bivariate Probit	3317.84 Birr	38,155,160 Birr
Open Ended	Descriptive statistics	2906.20 Birr	33,421,300 Birr

Source: own computation, result based on the survey data, 2018

4.4. Estimated Demand for the Improved Irrigation Water Use

The demand for the improved irrigation water supply at different price level is shown diagrammatically in figure below. This relationship can be more easily observed by deriving a demand curve for the improved irrigation water use. To this end, one should measure the midpoint of maximum WTP along the vertical axis and the number of households who are willing to pay per timad (0.25 ha.) per year along the horizontal axis.



Total number of households

Figure 3 : Estimated demand curve for improved irrigation water supply
Source: Own survey result, 2018

As shown in Figure 3, the demand curve has a negative slope and convex to the origin; it is in line with the economic theory of demand, that is similar to most economic goods under normal conditions. This implies an increase in the price of the improved irrigation water, decreases the quantity demanded for the improved irrigation water, ceteris paribus.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

Water is a limited and vulnerable natural resource which is an essence of life on earth and it plays a vital role in economic development; making the development of water pricing mechanisms got high priority among various tools for efficient water management. This study attempted to elicit farmers´ WTP for improved irrigation water use in Meskan district, Guraghe Zone, Southern Ethiopia. The specific objectives of the study were to estimate farmers' willingness to pay for improved irrigation water use and to identify the determinants of farmers' willingness to pay for improved irrigation water use. The primary data were collected from 210 sample households from three *Kebeles* of Meskan district while it was also supplemented by secondary data. Both descriptive and econometrics models were employed for the analysis.

A contingent valuation method (CVM) was used to analyze farmers' WTP for improved irrigation water use. Double-bounded dichotomous format followed with open ended format were used to elicit farmers' WTP for improved irrigation water use. Five sets of bid prices which were identified from the pilot survey were used for the study. These are (300, 150, 600), (400, 200, 800), (500, 250, 1000), (600, 300, 1200) and (700, 350, 1400) Birr per *timad (0.25 ha)* per year which were proportionally distributed to the survey questionnaire. The result of the CVM survey showed that all of the sampled respondents were willing to pay for improved irrigation water use.

Out of the total respondents, majority (81.9 %) of them were dissatisfied with the existing irrigation water supply. This may be due to the problems found on the existing irrigation schemes. Attempt has been made to rank the major constraints of irrigated schemes from the most severe problems to the least ones specified by the sampled respondents. These are insufficient water supply (63.4 %), irrigation water access problem (19.8%), absence of proper canals (14.5%), and other constraints (2.3 %).

In this study, two econometrics models were employed; OLS and Seemingly Unrelated Bivariate Probit. From a total of fourteen explanatory variables used in OLS model, sex, education, age, distance to market, credit use, distance to irrigation scheme and dissatisfaction with the existing irrigation scheme were found to be significant in influencing the maximum willingness to pay for improved irrigation water use.

The seemingly unrelated bivariate probit model revealed that the mean WTP for the respondents was Birr 829.46 per year per *timad* (0.25ha.) which is estimated to be about 3317.84 Birr per hectare per year. On the other hand, the mean willingness to pay from open-ended questions was Birr 726.55 per year per *timad* (0.25 ha.) which is estimated to be about 2906.2 Birr per hectare per year. The respective total aggregate value of improved irrigation water use in the study varies from 33,421,300 ETB in open ended to 38,155,160 ETB from double bound CVM. Thus, in this study, the mean willingness to pay from open-ended questions is lower than the dichotomous choice questions.

5.2. Conclusions

The scarcity of water is on the rise as urban areas and population grow combined with increased demand for water in agriculture, industries and households. Agriculture is the largest consumer of fresh water among the economic sectors in many regions of the world, and a sector characterized with intense water use with low efficiency. In order to achieve water use efficiency, the water must be treated as economic good and appropriate price relative to its economic value be charged. Pricing of water resources, therefore, require valuing of water. Irrigation water is generally regarded as non-market good.

Pricing of agricultural water and cost recovery is important in promoting water use efficiency. If there are no water charges, people tend to use water carelessly. Better water allocation could be achieved if the economic value of water is known by use, region and season. Knowledge of water value can play a significant role for cost benefit analyses of investments in irrigation and formulation of water pricing policies.

Despite the demand for improved and sustained irrigation service in the area, insufficient water supply, irrigation water access problem, absence of proper canals, water distribution problem and lack of well-organized water user committee were major challenges in the provision of irrigation water in the district. That is why all of the respondents are willing to pay for the improvement of the existing irrigation water supply.

Being male headed household, having more education and dissatisfied with the existing irrigation scheme have a positive and significant influence on the maximum willingness to pay for improved irrigation water use. Variables such as age of household head, distance to market, credit use, and distance to irrigation scheme have a negative and significant effect on the maximum WTP for improved irrigation water use.

From double bounded dichotomous showed that households' mean annual willingness to pay amount was Birr 3317.84 per hectare per year, while open ended format was to be 2906.20 birr per hectare per year. This showed that the value of improved irrigation water use from open ended format was underestimated. All of the sample household heads have shown their willing to pay if there is an improvement in the service of the existing irrigation water supply. Thus, the participation of the community should be ensured in every decision making and formulation of policies and strategies which are related to the improved irrigation water use. This encourages the commitment of the community for the conservation programs and helps them to develop a sense of ownership which has its own contribution for the sustainability and effectiveness of improved irrigation water use.

5.3. Recommendations

The empirical findings of the study revealed that several socio-economic variables are key factors influencing households' WTP. Therefore, a well understanding of factors governing farmers' willingness to pay for improved irrigation water use significantly is a necessary and first step for the concerned body to achieve improved irrigation water and then to implement irrigation water pricing. And would help to implement effective irrigation plans, or improve the management of existing irrigation projects to utilize the resource optimally in a sustainable manner. Based on the finding of this study, the following policy recommendations were drawn.

The study finding indicates that households in the study area were willing to pay an amount of birr 2906.20 to 3317.84 per hectare per year. Therefore, this shows that there is opportunity for improving irrigation water services through a cost recovery mechanism. Thus, it is better to exploit this opportunity by expanding coverage of irrigation water schemes with the potential of implementing irrigation water fee as supplement to public budget.

Sex of the household head had a positive effect on willingness to pay decision. This shows that female headed households were less willing to pay for improved irrigation water use than male headed households. This is because female headed households have limited resource possessions as compared to male headed households. Hence, respective government offices and stakeholders should enhance the capacity and resources possession of female headed households to enhance their willingness to pay for improved irrigation water use.

Farmers who have been educated have higher demand for irrigation water use and higher willingness to pay for improved irrigation water use than those who are not literate. Thus, policy makers should take into account an educational program to enhance their knowledge on the importance of improved irrigation water use is required. On the other hand older people should get attention as their participation may influence the program positively due to having reputation in the community and useful indigenous knowledge and experience about irrigation. Thus, it is vital to increase the awareness of the old aged households by teaching them about the use and non-use value of water for their own consumption and for the future generation which may increase their WTP for improved irrigation water use.

Credit use negatively and significantly affected household willingness to pay. This imply that as the household head use credit, the amount of price that he/she is willing to pay for improved irrigation water use will decrease. Therefore, the district agricultural office should focus on increasing the level of farmers' awareness about the importance of credit use in relation to irrigated crops production through financial training that will help them to develop a positive attitude towards irrigation water use. In addition, micro finance institutions should encourage farmers to use credit for irrigation farming as other farm and non-farm enterprises based on farmers need.

The findings indicate that market accessibility increases farmers' willingness to pay for improved irrigation water. Therefore, it is needed to establish suitable marketing system along the value chain for the commodities which are produced by irrigation and easily perishable by their nature. Hence, the district trade and market development should provide market information. 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 improved irrigation water supply.

The results from the study also showed that distance to irrigation scheme significantly and negatively affected household willingness to pay. Adding to that, dissatisfaction with the existing irrigation scheme significantly and positively influenced WTP. Therefore, the district agriculture and natural resources and irrigation authority office should target those areas where there is insufficient water supply, irrigation water access problem and water distribution canal problem. In the study area, there is a problem of proper water distribution canal especially in Wita and Dobena Gola irrigation schemes; irrigation water sank in to the soil before it reached the irrigable land. This leads to a higher water wastage and distribution problem. Additionally, this forced farmers to spend a higher fuel costs since they use pumping motor to irrigate their land. Therefore, the district agriculture and irrigation office should give attention for proper canal construction and improvement in a better way so as to increase the utilization of irrigation water.

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7. APPENDICES

Appendix 1: Appendix Tables

Appendix Table 1 : Conversion factors used to estimate man equivalent

Age group	Male	Female
<10	0	0
10-13	0.2	0.2
14-16	0.5	0.4
17-60	1	0.8
>60	0.7	0.5

Source: Bekele Hundie (2001)

Appendix Table 2 : Conversion factors used to estimate Tropical Livestock Units (TLU)

Livestock Type	TLU-equivalent
Ox /Cow	1
Heifer	0.75
Bull	0.75
Calf	0.25
Adult Sheep or Goat	0.13
Young Sheep or Goat	0.06
Donkey adult	0.7
Donkey young	0.35
Horse/Mule	1.1
Chicken	0.013

Source: Storck *et al.* (1991)

Appendix Table 3 : Multicollinearity test for discrete variables

	SEX (1)	CRDT (2)	DISSAT (3)
(1)	1.000		
(2)	-0.177	1.000	
(3)	0.186	0.041	1.000

Appendix Table 4: Multicollinearity test for continuous variables

Variable	VIF	1/VIF
EDU	2.02	0.495610
DIRS	1.66	0.604159
EXP	1.59	0.628355
DMKT	1.53	0.655123
AGE	1.44	0.695643
TLU	1.42	0.703865
LAND	1.42	0.704272
FSIZE	1.36	0.732750
BID1	1.36	0.733281
INCOME	1.35	0.742232
EXT	1.16	0.864307
Mean VIF	1.48	

Appendix Table 5 : Heteroskedasticity test

.hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of MWTP

chi2(1) = 3.40

Prob > chi2 = 0.0653

Appendix Table 6 : Omitted variables test

.ovtest

Ramsey RESET test using powers of the fitted values of MWTP

Ho: model has no omitted variables

F (3, 192) = 1.28

Prob > F = 0.2814

Appendix Table 7: Model specification test

.linktest

Source	SS	df	MS	
				Number of obs =210
Model	16540375.7	2	8270187.87	F (2, 207) = 212.50
Residual	8055996.28	207	38917.8564	Prob > F = 0.0000
Total	24596372	209	117685.991	R-squared = 0.6725
				Adj R-squared = 0.6693
				Root MSE = 197.28

Appendix Table 8: OLS regression

regress MWTP SEX AGE EDU FSIZE LAND TLU INCOME EXP DMKT CRDT EXT DIRS DISSAT BID1

Source	SS	df	MS	
				Number of obs =210
Model	16540375.7	2	8270187.87	F (14, 195) = 28.3
Residual	8055996.28	207	38917.8564	Prob > F = 0.0000
Total	24596372	209	117685.991	R-squared = 0.6705
				Adj R-squared = 0.6471
				Root MSE = 203.8

MWTP	Coef.	Std. Err.	T	P>|t|	[95% Conf.	Interval]
SEX	329.3427	51.55893	6.39	0.000	227.658	431.0275
AGE	-4.941014	2.032182	-2.43	0.016	-8.948892	-.9331352
EDU	23.93406	4.814731	4.97	0.000	14.43842	33.42969
FSIZE	9.766851	7.624391	1.28	0.202	-5.270005	24.80371
LAND	18.09327	26.2855	0.69	0.492	-33.74711	69.93364
TLU	-6.867218	6.821623	-1.01	0.315	-20.32085	6.586415
INCOME	.0001715	.0005491	0.31	0.755	-.0009114	.0012543
EXP	6.290009	4.964914	1.27	0.207	-3.501814	16.08183
DMKT	-15.50766	4.496269	-3.45	0.001	-24.37522	-6.640101
CRDT	-76.3897	31.99714	-2.39	0.018	-139.4946	-13.28482
EXT	9.838325	6.407309	1.54	0.126	22.47485	2.798196
DIRS	-4.758817	2.004986	-2.37	0.019	-8.713058	-.8045746
DISSAT	139.4174	35.01064	3.98	0.000	70.36931	208.4656
BID1	0.1657486	.1157257	1.43	0.154	-.0624861	.3939833
_cons	522.9967	130.9705	3.99	0.000	264.6962	781.2972

Appendix Table 9: Seemingly Unrelated Bivariate Probit regression

biprobit (BID1ANS =SEX AGE EDU FSIZE LAND TLU INCOME EXP CRDT EXT DMKT DIRS DISSAT BID1) (BID2ANS =SEX AGE EDU FSIZE LAND TLU INCOME EXP CRDT EXT DMKT DIRS DISSAT BID2)

Fitting comparison equation 1:

Iteration 0: log likelihood = -129.1175
Iteration 1: log likelihood = -46.46309
Iteration 2: log likelihood = -37.175562
Iteration 3: log likelihood = -36.077107
Iteration 4: log likelihood = -36.064462
Iteration 5: log likelihood = -36.064456
Iteration 6: log likelihood = -36.064456
Fitting comparison equation 2:
Iteration 0: log likelihood = -127.42283
Iteration 1: log likelihood = -68.432055
Iteration 2: log likelihood = -63.46172
Iteration 3: log likelihood = -63.333466
Iteration 4: log likelihood = -63.333178
Iteration 5: log likelihood = -63.333178
Comparison: log likelihood = -99.397634
Fitting full model:
Iteration 0: log likelihood = -99.397634
Iteration 1: log likelihood = -98.118418
Iteration 2: log likelihood = -97.189215
Iteration 3: log likelihood = -96.279796
Iteration 4: log likelihood = -96.0351
Iteration 5: log likelihood = -95.98673
Iteration 6: log likelihood = -95.977033
Iteration 7: log likelihood = -95.969178
Iteration 8: log likelihood = -95.962373
Iteration 9: log likelihood = -95.959547
Iteration 10: log likelihood = -95.957298
Iteration 11: log likelihood = -95.957099
Iteration 12: log likelihood = -95.957067
Iteration 13: log likelihood = -95.956864
Iteration 14: log likelihood = -95.956859
Iteration 15: log likelihood = -95.956829
Iteration 16: log likelihood = -95.95579
Iteration 17: log likelihood = -95.955789

Seemingly unrelated bivariate probit   Number of obs. = 210
Wald chi2 (28) = 110.99

Log likelihood = -95.955789   Prob > chi2 = 0.0000

	Coef.	Std. Err.	Z	P>|z|	[95% Conf.	Interval]
BID1ANS						
SEX	1.288287	.8225999	1.57	0.117	-.3239788	2.900553
AGE	-.0688124	.030268	-2.27	0.023	-.1281366	-.0094882
EDU	.2690693	.0897171	3.00	0.003	.0932271	.4449115
FSIZE	-.027418	.0944399	-0.29	0.772	-.2125167	.1576807
LAND	1.1111	.5012927	2.22	0.027	.1285846	2.093616
TLU	-.0422624	.1001375	-0.42	0.673	-.2385282	.1540035
INCOME	4.85e-06	7.20e-06	0.67	0.500	-9.27e-06	.000019
EXP	.1132154	.0706686	1.60	0.109	-.0252924	.2517232
CRDT	-1.817654	.4974441	-3.65	0.000	-2.792627	-.8426819
EXT	-.2577946	.0802307	-3.21	0.001	-.4150439	-.1005452
DMKT	-.1437017	.0659045	-2.18	0.029	-.2728721	-.0145313
DIRS	-.0894647	.0262558	-3.41	0.001	-.1409251	-.0380043
DISSAT	1.771382	.6480593	2.73	0.006	.5012089	3.041555
BID1	-.0181622	.0036375	-4.99	0.000	-.0252916	-.0110328
_cons	12.37342	2.827335	4.38	0.000	6.831941	17.91489
BID2ANS						
SEX	2.808256	.5051751	5.56	0.000	1.818131	3.798381
AGE	-.0541088	.018753	-2.89	0.004	-.0908641	-.0173535
EDU	.2772409	.0584821	4.74	0.000	.1626181	.3918638
FSIZE	.0419503	.0653597	0.64	0.521	-.0861523	.170053
LAND	.966108	.2940576	3.29	0.001	.3897657	1.54245
TLU	-.1077842	.056204	-1.92	0.055	-.217942	.0023736
INCOME	-6.22e-06	5.95e-06	-1.05	0.296	-.0000179	5.44e-06
EXP	-.0688911	.0471984	-1.46	0.144	-.1613982	.023616
CRDT	-1.003484	.3038287	-3.30	0.001	-1.598977	-.4079905
EXT	-.0451269	.0522409	-0.86	0.388	-.1475172	.0572633
DMKT	-.1651345	.0393458	-4.20	0.000	-.242251	-.0880181
DIRS	-.0280876	.0180897	-1.55	0.120	-.0635428	.0073675
DISSAT	1.171171	.3604256	3.25	0.001	.4647503	1.877593
BID2	-.0056947	.0007111	-8.01	0.000	-.0070884	-.0043011
_cons	5.567382	1.246339	4.47	0.000	3.124604	8.010161
/athrho	17.57863	689.753	0.03	0.980	-1334.312	1369.47
Rho	1	1.38e-12			-1	1

Likelihood-ratio test of rho=0:   chi2 (1) = 6.88369   Prob > chi2 = 0.000

Appendix 2: Data collection tools

JIMMA UNIVERSITY

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS MANAGEMENT

Survey Questionnaire on Farmers' Willingness to Pay for Improved Irrigation Water Use: The Case of Meskan District, Guraghe Zone, Southern Ethiopia

Farmer's (household's) name: ___________________________

Questionnaire no.______

Irrigation Scheme (Kebele): _________________

Enumerator: ________________

Date of interview: _________________

Part I: General Information

Hello, how are you. I am ________________. This interview is used for the research of Mr. Mahmud Aman who is currently studying his MSc at Jimma University. This research is a partial fulfillment for the awarded of MSc in Agricultural Economics. He is conducting a survey which focuses on your Willingness to Pay for Yetebon, Dobena Gola and Wita Irrigation Schemes and their improvement. Now you are randomly selected and asked to give information about your socio economic characteristics, your experience in irrigation, and others as well as your support (willingness to pay) for the improvement of these irrigation projects. The result of this study will help different stakeholders and policy makers to make appropriate measures on irrigation development in the future. Whatever information you provide will be kept strictly confidential. Therefore, you are kindly requested to provide genuine responses.

Part II-Socio- economic characteristics of the household

1. General Households Characteristics

Ser ,	Name	Sex	Age	Religion	Education	Marital status	Relation	Occupation	Health Condition
1									
2									
3									
4									
5									
6									
7									
8									
9									

Note: Codes: Sex: 1 =Male 0= Female, Religion:1= Muslim 2= Orthodox 3=Protestant 4=Other(specify}

Education Status: 0=Illiterate, RW= Read and Write, and Others their respective Grades 1, 2, 3…N,
Marital Status 1= Single 2=Married 3=Divorced 4=Widowed 5=Others, Relationship 1 =

Wife 2= Husband 3= Son 4= Daughter 5 = Father 6= Mother 7= Others

Occupation 1= Agriculture 2=Trader 3 = Student 4=Others (Please Specify)

Health Condition**:** 0 = sick; 1 = healthy

2. **Number of oxen _____**

3. **Total farm size of household in *timad***

Type	Cultivated land		Grazing land	Fallow land	Forest land	Rented in	Rented out	Other	**Total**
	Annual crops	Perennial crops							
Size/ *timad*									

4. Income source

4.1. Income from Farm activities

4.1.1. Income from crop production and vegetable, fruit and others harvesting during last year (use the following two Tables).

Household Crop production and Sales						
No.	Type of Crops	Plot Size (Timad)	Total Production (quintal,	Consumed at home (quintal, Kg)	Sold	
					Amount (quintal, kg)	Value (ETB)
1	Maize					
2	Sorghum					
3	Wheat					
4	Barley					
5	Bean					
6	Pea					
7	Teff					
8	Chickpea					
9	Haricot bean					
10	Other crops					
Sub Total 1						

Vegetable, Fruit, cash crops and woodlot production						
	Type of Crop grown	Plot Size (Timade)	Total production (quintal, Kg)	Consumed at home (quintal, Kg)	Sold	
					Amount (quintal, kg)	Value (ETB)
Vegetable						
1	Tomato					
2	Potato					
3	Pepper					
4	Onion					
5	Cabbage					
6	Spinach(kosta					
7	Others					
Fruit						
1	Avocado					
2	Papaya					
3	Mango					
4	Lemon					
5	Banana					
6	Others					
Woodlots						
1	Eucalyptus					
2	Gesho					
Cash crops						
1	Chat					
2	Coffee					
3	Others					
Sub Total 2						

4.1.2. Income from livestock sales and livestock by products during the last year (use the following two Tables).

Livestock Production					
	Type of Animal	No. of Animals	Total Owned	If there is any sold animal	
				Sold	Income gained
1	Cow				
2	Ox				
3	Heifer				
4	Calf				
5	Bull				
6	Mules				
7	Horse				
8	Donkey				
9	Goat				
10	Sheep				
11	Poultry				
12	Bee colony				
13	Other				
Sub Total 3					

Livestock output				
	Commodity type	Amount produced (liter, Kg, no)	Consumed (liter, Kg, no)	Sold (Birr)
Dairy output				
1	fluid milk			
2	Butter			
3	Yoghurt			
4	Cheese			
2. Poultry				
1	Egg			
2	Chicken			
3. Honey bee				
1	Honey			
2	Bees wax			
3	Bee colony			
4. Animal by-products				
	Hide/skin			
	Manure/Dung			
Sub Total 4				

4.2. Income gained from non-farm activity in last year

	Type of non-farm activity	Total Income from each activity
	Petty trade	
	Handicraft	
	Carpenter	
	Weaving	
	Remittance	
	Others, specify	
Sub Total 5		

4.3. Income gained from off-farm activity in the year

No.	Type of off farm activity	Total Income from each activity
1	Daily labor	
2	Sale of charcoal	
3	Sale of firewood	
4	Sale of forest	
5	Sale of grass	
6	Rent of land &pack animal	
7	Others, specify	
Sub Total 6		

Part III: Households' Experience

1. Farming Experience

1.1. How long have you been in farming in years?

1.2. How many *timad* potential irrigable land you have?

1.3. Do you have irrigated farming practice? 1=Yes 0=No

1.4. If yes to Q1.3, how many years of experience do you have?

1.5. If Yes to Q1.4. How many *timad* of irrigated land you have in the last year?

2. Vegetable crops growing using irrigation

2. 1.Are you growing vegetable crops using irrigation water? 1. Yes 0. No

2.2. If yes to Q # 2,1. Which vegetable crop you are growing?

1. Tomato 2.onion 3. Cabbage 4.Other (specify) _______________.

3. Credit use

3.1. Did you receive credit in the last year? 1=Yes 0=No

3.2. If No to Q3, 1. What was the reason?

1) No access 2) Collateral 3) I have sufficient capital 4) Others, specify________

(If your answer to Q1. is yes, answerQ3.3-3.7)

3.3. What was/were the credit source/s from which you usually borrow money?

1) Cooperatives 2) Micro Finance Institutions 3) Banks 4) Merchants

5) Friends and relatives 6) Money lenders 7) others, specify_________

3. 4. What was the amount you borrowed?

3.5. Was the credit adequate to your demand? 1=Yes 0=No

3.6. For what purposes did you use the credit?

1) To purchase irrigation facilities 2) To buy fertilizer 3) To buy seed

4) To buy oxen 5) Petty trade 6) Livestock rising 7) Consumption 8) others, specify_______

3.7. Have you paid back your loan on due date? 1=Yes 0=No

3.8. If No to Q3.7, why did you not pay full? 1) Due to insufficient return 2) the date of return is not over 3) Lenders do not collect on time 4) others, specify____________

4. **Access to Extension Contact**

4.1. Did you have contact with Development Agent in last year? 1=Yes 0=No

4.2. If Yes to Q4.1, how many times per month did you contact have with extension agents? _

4.3. What was the extension advice? 1) Seeding 2) Chemical application 3) Compost preparation

4) Resource conservation 5) Post harvesting 6) Irrigated farming 7) others (specify) ________

5. Access to Market and Labor Supply

5.1. How many kilometers do you normally travel to reach the nearest market from your residence? __________________ Km

5.2. Did you have labor shortage for crop and livestock farming in last year?

1=Yes, 0=No

5.3. If Yes to Q5.2, did you try to solve the problem? 1=Yes 0=No

5.4. If Yes to Q5.3, how did you solve the shortage?

1) Hiring 2) Support (friends and relatives) 3) Communal labor 4) Other (specify) _________

5.5. Did you get labor to be hired when you are on demand? 1=Yes 0= No

6. How many kilometers or meters do you normally travel to reach farm to the nearest irrigation schemes? ___________

7. Rain-Fed and Irrigated Agriculture

7.1. How can you explain the trends in your agricultural output over the last four year per timad of land in rain-fed agriculture? 1=Decreasing 0 =Not Changed (increasing)

7.2. If 1 (decreasing) to Q7.1, what do you think the causes of decrease in crop productivity?

1) Low fertility of the soil 2) Lack of improved seed

3. Lack of fertilizer 4) Rainfall variability 5) others, specify_________

7.3. Did you encounter the problem of water scarcity for farming due to variability of rainfall? 1=Yes 0=No

7.4. If yes to Q7.5, Did you try to solve the problem?1=Yes 0=No

7.5. If Yes to Q7.6, how did you solve the problem?

1) By rain water harvesting 2) pumped ground water 3) using gravity irrigation

4) Pumping from the River 5) others, specify

8. Dissatisfied with the existing Irrigation schemes

8.1. Are you dissatisfied with the current irrigation water supply system?

1. Yes 0. No

8.2. If Yes for Q #8.1, what kind of challenges and problems you have faced/observed in the existing irrigation schemes? Specify all bellow

1. ____________________________ 2. _________________________________

3. ____________________________ 4. _________________________________

9. **Major types of crop produces or grow under irrigated**

9.1. What are the major types of crops you produce or grow under irrigated?

1 __________________ 2 __________________ 3 __________________ 4____________

9.2. Why you prefer to produce the crops you mentioned above as your major choice?

____

9.3. Which type of crop you produce is high source of your income? ______________

9.4. Do you get enough water for your irrigational and livelihood activities from this irrigation project?

1. Yes 0. No

9.5. If you had a shortage of irrigation water, what do you do?

1. Uses only part of the irrigation, 2. Plant crops that require less water 3. Producing partially

Part IV: Contingent Valuation survey

Willingness to pay questions

Background

As you know that the Yetebone, Dobena Gola, and Wita irrigation schemes are found in Meskan District area. The source of water for the irrigation schemes are the River Eresha, Erinzaf, Akamuja and Jirbenas. They have enough amount of discharge in the rainy season. However, the rivers seem to decrease their flow in the dry season in large amount. None of these irrigation schemes have water storage capacity since water comes out of the command area from the rivers by diversion. This will create a problem at the time of the dry season at which more water for irrigation is needed. Hence, in order to improve the existing water supply of these irrigation projects, the water capacity of the Rivers should be enhanced through developing water storage capacity. Therefore, construction and rehabilitation of the schemes benefit the rural households´ by enabling them to produce crops more than two times a year, to provide year round irrigation water, for domestic water supply and for livestock water supplies. The Ethiopian water sector development strategy considered water as an economic good and emphasis on the establishment and implementation of norms and procedures for financial sustainability and viability of irrigation schemes and currently, the MoWE is needed to solve the shortage of irrigation water supply, by constructing a reservoir dam. To provide irrigation water sustainably, it requires money for water service and managerial cost and this should be covered by the beneficiary households´. So, you will be required to pay annually for irrigation water service and managerial cost based on your irrigable land and volume of irrigation water consumed. However, the high cost of construction of a dam makes it difficult to implement proper provision of improved irrigation water without people paying for it. Dam construction is a prerequisite to reserve/ store water, which enables farmers to get sufficient water flow throughout the year. Suppose the dam is constructed in your community. The dam and resulting reservoir will provide numerous benefits. Once the dam has been built, people will be able to irrigate their land throughout the year, without this, irrigation scheme will become dysfunctional within a few years. Farmers are expected to pay water fees to cover the operation and maintenance costs of irrigation schemes. Therefore, an effective and sustainable provision of improved irrigation water will be implemented if the households in the community pay a sufficient amount of money.

Based on the above information, now you will be asked some questions regarding an improved irrigation water provision that may be implemented in your community.

1. Are you willing to participate in this program to get year round water supply?

1. Yes 0. No

If you answer No, please respond to questions #2; otherwise answer question #3.

2. If no, what is your reason?

A. Irrigation Water should be freely provided

B. I am satisfied with the existing source

C. It is the responsibility of the government to provide

D. I don't have enough money

E. Other reasons ___________________

3. Are you (would you be) willing to pay _______ (300,400,500,600,700) birr per Timad (0.25 ha) of irrigable land per year? Based on the randomly assigned initial bid

1. Yes 0. No

If the answer for this question is yes, proceed for question 4 and otherwise go to question 5.

4. Are you willing to pay _____ 2B (600, 800, 1000, 1200, 1400) birr per Timad (0.25 ha) of irrigable land per year? Based on the randomly assigned initial bid

1. Yes 0. No

5. Are you willing to pay ______ 0.5B (150,200,250,300,350) birr per Timad (0.25 ha) of irrigable land per year? Based on the randomly assigned initial bid 1. Yes 0. No

6. What is the maximum amount that you are willing to pay for one Timad (0.25 ha) of irrigable land per year? _____________ Birr.

7. In what form should the money be collected?

1) On cash (Direct payment) 2) with social association payment like ikub, idir, and etc 3).On-tax 4)With water bill 5)With electric bill 6)On labor 7)other(specify)______________________

Focus Group Discussion Checklist

Name of sampled kebele _____________

FGD member: Male: Female:

Date: _______________

1. What kind of irrigation methods are practiced in the area? How much it is effective and efficient? How much (on average) one incurs a cost for irrigating timad of farm per year?
2. Water resource can be depleted if the amount of recharged is less than the discharge (used) amount. How can you manage the usage for sustainable use? Who would be responsible?
3. What is/are the existing problem in water distribution in the area? Is there any dispute (conflict) among water users in the area?
4. What is/are the existing rules and regulations practiced on water usage in the area?
5. Do you think that water is free good?
6. What do you comment if the district office set up a legal frame work governing the distribution of the water?
7. Since developing or constructing irrigation scheme requires lot finance, it is important to consider which sources of financing are available. Who do you think the source of finance?
8. If the government constructs a scheme how can you maintain sustainability of the resource? How the cost of maintenance and operation will be covered? And who will be responsible?
9. What do you comment if the government construct irrigation scheme in the area and impose a charge on water users that covers the initial investment cost and/or operation and maintenance costs?
10. If the government impose payment for irrigation water use, would you be willing to pay? If yes how many birr would you pay per timad per year?

Key Informant Interview Checklist

Name of organization:________________________________

Name of interviewee:_____________________________

Position:_______________________________

1. What is the irrigation potential of the water resource (both in terms of farm area and number of households)?

2. How many hectares of land currently irrigated by using different methods?_______________

3. What is the prevailing (current) management system of the water resource in the area?

____

4. What is/are the potential challenges in using the water resource? Are there formal or informal rules and regulations for managing the water resource in the area?

____

____

____

5. Who is/are the most user of water resource of the area?_______________________________

6. What is/are the roles of your office in managing and controlling the water resource?

7. Did the office educate farmers in relation to the water resource? If yes, in what area(s)?____

____

____

____

____