Smallholder farmers' willingness and ability to pay for improved irrigation: A case of Msinga Local Municipality, KwaZulu-Natal Province

by

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Dedication

Zoo, Nsika and Neo…love you babies.

My dad, thank you for being my guardian angel… hope you are proud of your youngest.

Declaration 1

I, Sinenhlanhla Lethukuthula Njoko, declare that:

1. The research reported in this thesis, except where otherwise indicated, is my original research,

2. This thesis has not been submitted for any degree or examination at any other university,

3. This thesis does not contain other people's data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other people,

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   a. Their words have been re-written but the general information attributed to them has been referenced,

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As the candidate's main supervisor, I, Dr. M. Mudhara, agree to the submission of this thesis;

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Declaration 2- Publications

The following publications (submitted) form part of the research presented in this thesis.

Publication 1- Chapter 3 of this thesis

Njoko, S. and Mudhara, M. Determinants of willingness to pay for improved irrigation water supply in rural KwaZulu-Natal, South Africa (submitted, *Agrekon*).

Publication 2- Chapter 4 of this thesis

Njoko, S. and Mudhara, M. Determinants of ability to pay for improved irrigation water supply in rural KwaZulu-Natal, South Africa (submitted, *Water SA*).

The data collection, analyses and discussion of the empirical results for all the above listed publications were conducted in their entirety by S. Njoko, with advice from Dr. M. Mudhara. All figures and tables were produced by the same, unless otherwise referenced in the respective sections and publications.

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Abstract

Water is the essence of life for humankind. Due to water scarcity from increased population and increased demand for the resource, there is a need to allocate the water efficiently. Economists have proposed water pricing as a mechanism for allocative efficiency, arguing that this will prompt the farmers to use the water on crops with relatively high returns, as well as make farmers value the resource. Water can no longer be considered a free commodity, but rather an economic one. However, the willingness and ability of smallholder farmers to pay for water use in irrigation need to be an integral parts of policy formulation to enhanced agricultural production. This study sought to determine farmers' willingness to pay (WTP), and ability to pay (ATP), for improved irrigation in rural areas of KwaZulu-Natal, South Africa, using the farm gross margins and also to identify factors affecting farmers' WTP and ATP. The analysis was based on a sample of 161 irrigators. The binary and ordered probit models were used to investigate factors affecting WTP, which was generated through the contingent valuation method. Empirical results indicate that factors such as extension services, training, use of motorised pumps (diesel), farmer perceptions of scheme management, duration of the farmer in the scheme, livestock ownership and road conditions positively influence WTP. In contrast, factors such as conflicts, household size and total land holdings influence WTP negatively. Production data was collected from the irrigators and the residual imputation method (RIM) was then used to calculate gross margins/profits received by the farmers. An Ordinary Least Squares regression was used to investigate factors affecting ATP. Factors such as labour, training, household assets and road conditions were found to have a positive influence on ATP. The study concluded that farmers are willing and able to pay for improved irrigation water supply. A further conclusion was that support services and institutions could be manipulated through policy, to enhance both WTP and ATP. It is, therefore, recommended that if government had to formally introduce water charges, it could start with a charge of R50 per month per plot and then increase the charge gradually, over time.

List of acronyms

ATP	Ability to Pay
BTM	Benefit Transfer Method
CMA	Catchment Management Agency
CV	Contingent Valuation
CVM	Contingent Valuation Method
DAEA	Department of Agriculture and Environmental Affairs
DWA	Department of Water Affairs*
DWAF	Department of Water Affairs and Forestry*
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
HPM	Hedonic Pricing Method
IFPRI	International Food Policy Research Institute
IMT	Irrigation Management Transfer
IB	Irrigation Boards
KZN	KwaZulu-Natal
MRIS	Mooi River Irrigation Scheme
NDA	National Department of Agriculture
NEPAD	New Partnership for African Development
NWA	National Water Act
NWRS	National Water Resource Strategy
OC	Opportunity Cost
OLS	Ordinary Least Squares
PC	Payment Card

RIM	Residual Imputation Method
RVM	Residual Valuation Method
SA	South Africa
SIS	Smallholder Irrigation Scheme
SSA	Sub-Saharan Africa
TCM	Transfer Cost Method
TFIS	Tugela Ferry Irrigation Scheme
TLU	Tropical Livestock Unit
TP	Total Product
TVP	Total Value Product
US	United States
VMP	Value Marginal Product
WFD	Water Framework Directive
WRM	Water Resource Management
WRC	Water Research Commission
WTA	Willingness to Accept
WTP	Willingness to Pay
WUA	Water User Association

*Department of Water Affairs (DWA) was formerly known as the Department of Water Affairs and Forestry (DWAF), before 2010

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CHAPTER 1: INTRODUCTION

1.1 Background information

Water resources are the essence of life for mankind (Yokwe, 2006). The quality and availability of water affect national agricultural output level and economic growth. Water is a primary input to economic endeavour and is crucial for production activities in the economy (Rosegrant *et al.*, 2002). Water resources are under great threat and economic and natural resource studies have thus paid much attention to them (Speelman, 2009). Over the last 50 years, withdrawals from water reservoirs have more than tripled. This has emanated from factors like the increasing population and increased levels of economic development, leading to higher water demand. It is predicted that, by the year 2025, a large percentage of the world's population (1.8 billion people) will be living in regions with absolute water scarcity, while 66% of the world population will be living in water-stressed conditions (UNWATER, 2007).

The problem of water scarcity has placed much pressure on water sources and poses a severe and urgent challenge to many national governments. As the water scarcity increases, competition between different water uses also increases. In developing countries, water scarcity and the competition between different water uses threatens public health and food security and also, advances in poverty eradication (Ward, 2007). South Africa (SA) is by no means an exception, as water scarcity in the country is considered one of the biggest constraints to social development as it is an important input in production (DWAF, 2004). In most parts of the country, available water is already fully utilised or overdrawn. Since SA is drought prone and water is in deficit, water availability will determine the country's level of economic development (Nieuwoudt *et al.*, 2004).

Agriculture remains the most likely route to escape poverty (World Bank, 2007). This is supported by findings from several studies that reported a strong positive relationship between increased agricultural productivity and poverty reduction (Hartmann, 2004; World Bank, 2005; IFPRI, 2002; Irz *et al.*, 2001). Small-scale irrigation in SA is essential for rural development, job creation, income generation and food security enhancement.

However, a large number of small-scale irrigation schemes have been dysfunctional for years, due to infrastructural deficiencies. Most of the dysfunctional schemes are located in the Limpopo and Eastern Cape provinces (Perret & Touchain, 2002; Van Averbeke *et al*., 2011). An ambitious reform programme to revitalise small-scale irrigation schemes and reduce the financial burdens of their maintenance and operation costs was thus developed by central and provincial governments (Yokwe, 2006). Small-scale irrigation schemes in SA are now placed under the Irrigation Management Transfer (IMT) programme. This is a major objective of the National Water Resource Strategy (NWRS). Responsibility for and authority of water resource management is to be decentralised to Catchment Management Agencies (CMAs) and Water Users Associations (WUAs) (DWAF, 1999). CMAs have jurisdiction in defined water management areas to manage water resources and co-ordinate water-related activities (Backeberg, 2006). WUAs fall under CMAs; they are the co-operative associations of individual water users, operating in terms of formal constitutions.

Irrigated agriculture is under pressure to demonstrate water saving and improved performance. It is in this context that the need for efficient allocation and use of water in the irrigation sector emerges in the technical, managerial and institutional levels. The search for sustainable water policies is high on national agendas (Ward, 2007). Agricultural water pricing has been deemed one of the useful strategies in promoting water-use efficiency and cost recovery (Akter, 2006). In developing countries, appropriate water pricing will make consumers aware of the resource scarcity of the resource, creating value for the resource, leading to improved management efficiency. It will also stimulate farmers to shift to more profitable enterprises (Becker & Lavee, 2002).

1.2 Research problem

SA is extremely water scarce (Backeberg, 2006) and this has led to increased competition for water. The national water law has stipulated that water resources must be used efficiently to achieve long-term environmental sustainability for social and economic benefits (DWAF, 1996). The National Water Act (NWA) has proposed new approaches to Water Resource Management (WRM), one of which is to charge for the use of water (DWAF, 1999). The proposed water charges will be paid by individual water-users to their respective WUAs, which are at a lower level than the CMAs, mainly to co-ordinate water management activities at scheme, tributary, or sub-catchment level (Backberg, 2006). According to the Act, all water users, whether they are farmers or not, can form groups to become WUAs. In practice, the bulk of the WUAs tend to come from the membership of existing irrigation management organisations. Most importantly, however, WUAs are expected to be financially self-supporting because of these charges. There is therefore need to investigate whether or not farmers are willing and able to pay for irrigation water and also to determine the exact price that they are willing to pay, including the factors that influence their willingness and ability to pay.

1.3 Rationale of the study

The present study focuses on the small-scale irrigation sector, since it is the backbone of the rural economy, with an estimated number of participants of between 200 000 and 250 000 (Backeberg, 2006). Most smallholder irrigation schemes (SIS) are located in the former homelands, where poverty rates are high. The schemes present an opportunity to improve livelihoods. On the other hand, increasing water scarcity and competition for water among users underscores the need to improve water efficiency in irrigated agriculture.

Introducing water charges and achieving cost recovery are significant objectives of the NWA (DWAF, 1998). Increased cost recovery is a cherished goal in the water sector and is an objective of SIS in SA (Speelman, 2009). Government has invested substantially in smallholder irrigation and now wants to recover water supply costs and investment costs in these schemes (Backeberg, 2006). Cost recovery is related to the value generated by water use (Speelman, 2009), as the value determines the capacity of farmers to pay for water. Knowledge of water value therefore provides insight into the feasibility of cost recovery and its impacts on the profitability of irrigation. Insight into the profitability of irrigation is useful in supporting decision-making with respect to the rehabilitation of the irrigation system (Hellegers & Perry, 2004).

There is a need to assess the effectiveness of the cost recovery approach by evaluating how much farmers are willing to pay for water and water-related services (Rivera *et al.,* 2002). Although willingness to pay (WTP) is imperative for ex-ante evaluations, it is insufficient and begs the question of whether or not water-related services are increasing farmers' ability to pay (ATP) (Ulimwengu & Sanyal, 2011). Commonly accepted basic principles such as water-users paying for water services and the role of communities in managing their water supply have been previously directly and indirectly linked with cost recovery. It is therefore important to understand farmers' willingness and ability to pay for irrigation water for correct pricing, cost recovery measures, allocation decisions and policy support.

In Msinga Local Municipality, focus group discussions revealed that farmers in irrigation schemes are paying R20 for water and related services (fuel, infrastructural maintenance, etc.). However, given the condition of the scheme and water access, this fee seems to be insufficient. If water access and irrigation maintenance is to be improved, farmers will have to pay a higher fee per plot for water and related services. It is in this context that this study was conducted. The study was part of a project initiated, managed and funded by the Water Research Commission (WRC) (K5/2176), entitled "Empowerment of women in rural areas through water use security and agricultural skills training for gender equity and poverty reduction in KwaZulu-Natal (KZN) and North West Province".

1.4 Objectives of the study

The general objective of this study is to investigate smallholder farmers' willingness and ability to pay for irrigation water. The specific study objectives are to:

i. Elicit farmers' willingness-to-pay (WTP) for improved irrigation
ii. Investigate farmers' ability-to-pay (ATP) for improved irrigation
iii. Determine factors that influence WTP and ATP

1.5 Organisation of the thesis

This thesis is organised into five chapters. In Chapter 1, the background and research problem are stated and the objectives of the study are specified. The Chapter 2 is the literature review, which discusses water policy reform, smallholder irrigation in South Africa and factors affecting willingness and ability to pay, as well as approaches to irrigation water valuing, namely, Contingent Valuation Method (CVM) and Residual Imputation Method (RIM). Chapter 3 presents a paper on factors that influence WTP, while Chapter 4 presents another paper on ATP determinants. The conclusions drawn and policy recommendations made are presented in the final chapter, Chapter 5.

CHAPTER 2: WATER POLICY REFORM AND SMALLHOLDER IRRIGATION IN SOUTH AFRICA

Chapter 2 presents a literature review of theoretical and contextual issues related to this study. First, the Water Policy framework in South Africa is reviewed. The significant stages of the policy development are discussed and the most relevant outcomes are highlighted. Section 2.2 examines the SIS. The chapter explores roles that SIS play in improving rural livelihoods and poverty reduction. Thereafter, the theoretical factors that influence the willingness and the ability of farmers to pay for improved irrigation are discussed. The final section of this chapter deals with the importance of water valuation and the methodologies for valuing irrigation water.

2.1 Water policy reform for irrigated agriculture in South Africa

Since 1994, the democratic government of SA has devoted enormous effort to restructure the constitution, the legal system, policies and institutions to overcome the legacy of the apartheid system (Speelman, 2009). The water policy reforms in SA can be seen in this context (Speelman, 2009). The National Water Act (NWA) of 1998 (DWAF, 1998), National Water Resource Strategy-1 (NWRS-1) (DWAF, 2004) and the National Water Resource Strategy-2 (NWRS-2) (DWA, 2012) are among the important policy documents that shape the current water policy in SA (Sinyolo, 2013). Eliminating the disparities between various sectors of SA society with respect to access to water was one of the driving forces behind the policy changes (Mukheibir & Sparks, 2003).

A second driver for the significant transformations in water resources management policy in SA was the growing awareness that the increased exploitation of water resources, due to the rising water demands in South African catchments, as well as the intensification of associated impacts on water quality, needed to be addressed (Mukheibir & Sparks, 2003). A shift from the previous philosophy that water is a free commodity that can be used, regardless of its scarcity to one where it is considered an economic good was necessary. Moreover, the old centralised bureaucratic water allocation procedures, needed to be replaced by decentralised procedures introducing user participation and a role for a market mechanisms (Conningarth Economists, 2004).

Historically, water rights were linked to land tenure, which is known as the riparian system in which the right to use water was tied to the ownership of land along rivers; and because access to land was determined along racial lines under the apartheid system, access to water was thus similarly determined by skin colour. The Water Act (54 of 1956) distinguished between "private water" and "public water". Private water was determined by the riparian system and given precedence over public water rights (Malzbender *et al.*, 2005; Nieuwoudt *et al.*, 2004). The NWA (DWAF, 1998) abolished this and the state became the custodian of the entire nation's water resources. Water became a common resource (DWAF, 1998; Nieuwoudt *et al.*, 2004). The NWA emphasised the need for efficiency, equity and sustainability in the use of water resources. It represents a unique approach as it sought to incorporate issues of racial and gender equity in water reform, something that has not been done by many countries. The riparian system has been replaced by a system of water licences that are issued and valid for a specified period of time, which is less than 40 years, and are reviewed every five years (Backeberg, 2006). These licences give water-users the authority to access and use the water resource for beneficial purposes; giving preference to the disadvantaged, who previously had no access to it (Backeberg, 2006).

Due to the growing water scarcity, it has become evident that water supply sources for SA have become overstretched. There is a need to reconcile the imbalances between the supply of water and the demand for water (Backeberg, 2006). Water conservation and demand management strategies have been proposed to increase efficiency and reallocate water to higher benefit uses within or between water-use sectors (DWAF, 1998). For agriculture, the strategy provides a framework for regulatory support and incentives to increase efficiency towards reduction of wastage, convincing users to change water conveyance infrastructure in irrigation equipment to more water-saving equipment, putting in place preventative maintenance programmes and to follow water allocation processes that promote equitable and optimal utilisation of water (DWAF, 2004). Achievement of these outputs will be facilitated by requiring water-users in the agricultural sector who apply for water licences to develop and submit a water management plan to the responsible authority (DWAF, 2004). The feasibility of these goals, however, remains to be seen.

Whereas irrigating farmers were organised into irrigation boards (IBs) before, the NWA called for the transformation of all the IBs into WUAs (DWAF, 1998). The WUAs are expected to incorporate all users in the defined area of jurisdiction, whether they have a formal water entitlement or not (Faysse, 2004). It is through these WUAs that water user groups like smallholder farmers should secure water rights. It was also envisaged that the transformation from IBs to WUAs would enable better participation of historically disadvantaged individuals in the management of water resources (Faysse, 2004). Although incorporating smallholder irrigators into WUAs holds promise, there has, thus far, been little progress with the establishment of WUAs (Perret, 2002; Tlou *et al*., 2006; Speelman, 2009).

One important aspect of the WUAs is their role in irrigation schemes. Each irrigation scheme is to be managed by a WUA, which will take charge of both water management cost recovery for water services (Perret and Geyser, 2007). The WUA is expected to achieve financial sustainability by selling water and water services to farmers, who, it is assumed, are willing and/or able to pay (Perret, 2002; Backeberg, 2006). The NWA pointed to the need to introduce water pricing and full cost recovery. Although introducing water pricing and full cost recovery would be viable in the long-run, the NWA acknowledged the need to waive these water charges for a determined time, so that disadvantaged groups also access water for productive purposes such as agriculture (DWAF, 1998). Water use charges are specified to end user sectors. With regards to irrigated agriculture, there are two important charges; the first being for the funding of water resource management and the second for funding water resource development and the use of waterworks (DWAF, 2004).

2.2 Smallholder irrigation in South Africa

The agricultural sector is the highest consumer of water in SA, accounting for about 62% of the total water used, while it directly contributes only about 4% of gross domestic product (GDP) (NDA, 2007; Kanyoka *et al*., 2008). SA's agricultural sector, in general, is characterised by a dualistic production structure particularly the irrigation sector, however, efforts are being made to change this (Backeberg & Sanewe, 2010; Mudhara, 2010; Vink & Kirsten, 2003). This dualistic production structure consists of large-scale commercial and smallholder farmers (Mudhara, 2010). The large scale commercial farms are vast, well-resourced and mainly white owned; with the sector contributing to the whole value of agricultural production in the country. In this sector irrigation operations are undertaken by an estimated 28 350 farmers (Backeberg, 2006; Van Averbeke, 2008).

Smallholder farms, conversely, are more traditional, and as mentioned above, include more subsistence irrigation activities, undertaken by an estimated 200 000 to 250 000 farmers whose majority are black women (Tlou *et al.*, 2006). The latter are resource-poor smallholder farms owned and operated by black farmers who mainly produce for subsistence and lack institutional support. This sector is dominated by farmers who are poor, food insecure and lack employment (Van Averbeke, 2008). The term "smallholder" is widely used on the assumption that there is a common understanding of what it means. Despite widespread reference to smallholder farming in agricultural and rural development literature, few analysts attempt to define or describe the smallholder farmer (Machethe *et al.*, 2004). According to Ellis (1998:19), "*The term 'smallholder' recognizes a characteristic of small farm size and a partially developed link to the larger economic system. Smallholders are affected by prices, subsidies, markets, etc., but the input and output markets are not fully formed and remain localized to some extent. This distinguishes smallholders from commercial enterprises both large scale and family farms, which have access to fully formed external markets*". In the South African context smallholder farmers are defined as black farmers, most of whom reside in the former homelands (Machethe *et al.*, 2004; Fanadzo, 2012). Terms used to describe smallholder farmers in SA include small-scale farmers, resource-poor farmers, peasant farmers, food-deficit farmers, household food security farmers and land reform beneficiaries (Machethe *et al.*, 2004).

The term 'smallholder' is problematic, as it suggests that small-scale farmers are relatively homogeneous and it conceals the causal processes through which inequalities emerge, often resulting in misleading assumptions of common interests in development planning (Cousins 2012). A class-analytic perspective, centred on the concept of petty commodity production, allows an understanding of the generalised tendency towards rural class differentiation in capitalist economies and diverse courses of small-scale agriculture. According to Cousins (2012), farmers can be classified into three categories, poor, middle and rich peasants. Poor peasants, who are unable to survive without 'squeezing' their capital, their labour power, or both. Over time they may be forced to rely almost entirely on the sale of their labour power in order to survive, becoming workers (if they continue to engage in some level of agricultural production). Middle peasants, who are able to meet the requirements of simple production from their own efforts are rich peasants. These farmers are able to engage in expanded reproduction and may transform themselves, over time, into capitalist farmers.

It is generally accepted that the divide between large-scale commercial farms and small-scale farms in SA is a legacy of the racially discriminatory policies of the past (Van Averbeke, 2008). Under apartheid, economic activities were heavily regulated and the allocation of resources, subsidies and state funds were politicised and based on racial classifications (Tren & Schur 2000; Van Averbeke & Mohamed, 2007). While white farmers were favoured politically, black farmers and their communities were actively discriminated against. Therefore, as highlighted by Denison and Manona (2007b), the word smallholder in SA not only recognises a characteristic of small farm size, but also a partially developed link to the larger economic system. While large-scale farmers have access to fully formed export markets, small-scale farmers do not (Denison and Manona, 2007b). The fact that the market-oriented part is dominated by white farmers and the subsistence part by black farmers is a cause for concern from a political perspective (Backeberg, 2006). There is, thus, a political desire to improve the productivity, profitability and sustainability of smallholder agriculture in SA, through investment in SIS (Backeberg, 2006; Denison & Manona, 2007b).

SA has about 1.3 million ha under irrigation, of which 0.1 million ha is held by smallholders (Backeberg, 2006). Smallholder irrigators have been categorised into four groups, namely: (i) farmers on irrigation schemes; (ii) independent irrigation farmers; (iii) community gardeners; and (iv) home gardeners (Van Averbeke & Mohamed, 2007; Van Averbeke, 2008). This study focuses on smallholder irrigators operating on irrigation schemes. According to Van Averbeke (2008), SIS in SA can be defined as multi-farmer irrigation projects larger than 5 ha in size that were established by black people or agencies assisting their development in the former homelands or in resource-poor areas. Key features of the SIS include the gravity-based supply system, the limited average farm size (about 1 to 2 ha per beneficiary), the subsistence orientation (maize being the major crop) and the significant area that is virtually never cropped (Perret & Geyser, 2007). This is probably due to the fact that smallholders are resource poor; sometimes farmers leave their plots idle because there is no money to buy inputs. Another reason may be poor land administration.

There are about 302 SIS in SA, covering approximately 46 000 to 47 500 ha (Speelman, 2009). Most of them are located in Limpopo province (about 56%), followed by the Eastern Cape province (about 23%), and then KZN province (about 12%) (Denison & Manona, 2007b; Van

Averbeke *et al.*, 2011; Sinyolo, 2013). These percentages indicate that above 80% of SIS in SA are located in these three provinces, while the remainder are scattered across the other provinces. As reported by Van Averbeke *et al*. (2011), smallholder irrigation sustainability is a major challenge in SA, as not all 302 smallholder irrigation schemes were operational and not all operational schemes were *fully* operational.

The majority of the non-operational schemes were located in the Limpopo and Eastern Cape provinces, with 69 and 16 non-operational schemes, respectively. In terms of operational status, the KZN province performed well, as most of the smallholder irrigation schemes with known status were operational in KZN (Sinyolo, 2013). Use of pumps was cited as the major cause of SIS collapse in SA (Van Averbeke *et al*., 2011). The majority of the non-operational smallholder schemes were those that involved pumping of water. According to Van Averbeke *et al*. (2011), about 84% of the 90 non-operational schemes used pumps for water conveyance, while only 16% of the non-operational schemes were gravity-fed. This implies that, as stressed by Van Averbeke (2012), there is a higher chance of gravity-fed smallholder schemes remaining operational compared to those involving pumping water. The overhead costs associated with pumps, and high maintenance pump costs, make them unsustainable for SIS (Van Averbeke, 2012).

Overall, however, the performance and economic success of the SIS in SA have been very poor. They fall far short of the expectations of planners, politicians, development agencies and the participants themselves, despite huge investment (Perret, 2002, Van Averbeke & Mohamed, 2007; Perret & Geyser, 2007). The schemes have not been financially viable or self-sustaining, since capital or operation costs were never covered by operation outputs and profit. Under-pricing and government subsidisation of water infrastructure and services, and management by the parastatal agencies, generated dependency and complacency on the farmers' side. In addition, the costs of infrastructure and the actual value of water as an input to production were mostly ignored (Perret & Geyser, 2007). These factors motivated a study investigating the willingness and ability of farmers to pay for water services.

2.3 Factors that affect farmers' willingness and ability to pay for improved irrigation

One important requirement for success in irrigation water management and sustainable financing of irrigation schemes is sufficient knowledge of farmers' demands or WTP for irrigation water (Hudu *et al*., 2014). It is also important to understand factors that influence that demand, or WTP, for the irrigation water. This section presents factors that have been empirically established to influence the willingness of farmers to pay for irrigation. Some of the most important factors that affect willingness and ability of farmers to pay are institutions, land tenure security, farmer participation in scheme designs and management, support services, market access and profitability. These factors are discussed in the following sub-sections.

2.3.1 Institutions

Numerous authors have reported that the poor performance of smallholder irrigation in SA is a result of poor institutions (Van Averbeke *et al*., 2011; Fanadzo, 2012; Sinyolo, 2013 and Machete *et al*., 2004). Van Averbeke (2008) emphasised that functional water institutions and organisations to guide collective action are essential for successful co-operation among smallholders in the management of their irrigation schemes. The term "institutions", used in economics, usually refers to the humanly devised rules of behaviour that shape human interactions (North, 1990, cited in Perret, 2002). According to Van Averbeke (2008), they are a set of formal and informal rules; they include the arrangement in which they are enforced. Broadly defined, water institutions include organisations and capacity; as well as governance, policies, laws and regulations and incentives in water management (Grey & Sadoff, 2007, cited in Sinyolo, 2013). Water institutions address issues such as water allocation, quality, pricing, rights, asset management and service delivery performance.

In the past, responsibility for the management and, at times, even the implementation of water sharing and maintenance of the canals on South African smallholder irrigation schemes was the responsibility of the State. The review of smallholder irrigation policy following the democratisation of SA in 1994 resulted in this responsibility being transferred to farmer communities through the adoption of the irrigation management transfer (IMT) programme (Perret, 2002; Shah *et al.*, 2002; Van Averbeke, 2008). The IMT programmes demand that there be clear institutions, that is, clear and enforceable rules of engagement with regards to water management, to reduce institutional uncertainty. This allows for behavioural changes in farmers, where greater risks are accepted and greater returns can be achieved by the irrigators (Sinyolo, 2013). This will make farmers more willing and able to pay for improved irrigation.

Canal irrigation creates linkages among farmers because resources have to be shared. Clear and enforceable rules are at the heart of successful resource sharing. For proper and functional irrigation schemes, it is necessary that management systems ensure that water is shared equitably among scheme farmers and that the scheme infrastructure is maintained effectively (Van Averbeke, 2008). This requires functional institutions.

2.3.2 Land tenure security

The question of land rights is problematic in smallholder irrigation and poses a great challenge to farmers (Machethe *et al*., 2004 and Bembridge 1999). Insecure tenure limits farmer incentives to make long-term development investments on their land, thus affecting farmer productivity and profitability. Farmers with secure land rights are expected to be both more willing and able to undertake investment in inputs and technology for three reasons: the assurance effect, the realisability effect and the collateral effect (Brasselle *et al.*, 2002 and Sinyolo, 2013). When farmers are more secure in their rights, returns on long-term land improvements are higher. Greater incentive to invest is thus the assurance effect. When land can easily be converted into liquid assets through sale, improvements made through investments can be better realised, thereby increasing its expected return and enhancing investment incentives; this is better known as the realisability effect. Lastly, farmers are more able to invest when freehold titles are established, as land acquired collateralisation value and easier credit access. This is known as the collateral effect and is particularly important regarding formal lending sources (Brasselle *et al.*, 2002).

The present arrangement, however, does not provide incentive, nor does it make allowance for uninterested farmers to sell out, and for interested and capable ones to expand their holdings (Machethe *et al*., 2004). Furthermore, it does not lead to the emergence of flexible rental markets in irrigated land, thus keeping it from achieving its full productive potential. As a result of tenure insecurity, smallholder farmers are unable to offer land as collateral for obtaining credit, thus further putting them at a disadvantage (Shah *et al.,* 2002). Often the lack of clarity among the plot-holders about their rights with respect to their plots seems more problematic than the absence of ownership. In Dingleydale and New-Forest Schemes in the Northern province of SA it was noted that some farmers do not know if they are allowed to rent their land, they are unwilling to discuss the issue of land in detail. A study in Niger by Abernethy *et al*. (2000) cited in Shah *et al.* (2002), found lack of clarity about land rights and noted unclear ownership rights on the irrigated lands.

Tekana and Oladele (2011) suggested that providing security of tenure is a pre-condition for intensifying agricultural production in rural SA. For farmers to be productive they should have ownership rights, so that they can sell or rent out their land, and also that their children can inherit the land. Perret (2002) and Denison & Manona (2007a) agreed, adding that scheme farmers should have a title deed to their irrigated plots. According to Perret (2002), the lack of a clear and secure land tenure system is one of the main reasons for the low productivity on irrigation schemes, as it hampers establishment of a land-leasing market. It has been reported that those farmers who currently have rights access to the irrigated land tend to avoid leasing their plots, as they are not sure if they would be able to claim back their land when they want it back (Perret, 2002; Denison & Manona, 2007a and Shah *et al.*, 2002). Consequently, most of the high-value irrigation land on the SIS is not being utilised in SA because of land tenure problems (Denison & Monona, 2007a).

2.3.3 Farmers' participation in scheme design and management

According to Backeberg & Sanewe (2010), farmer participation is a fundamental success factor in enhancing agricultural productivity. Experience in Sub-Saharan Africa (SSA) has shown that smallholder irrigation schemes can succeed if farmers participate in their design and management (FAO, 2000). However, numerous SIS in SA were planned and established following a centralised estate design (Fanadzo *et al*., 2010). Control and decision-making over farming activities was strictly enforced by central management, with little or no input from farmers (Perret, 2002), thus creating a high level of dependency among farmers in the schemes and poor performance when farmers were left to manage the schemes on their own.

Mnkeni *et al*. (2010) felt that the poor maintenance of irrigation infrastructure at SIS is a result of the fact that farmers do not own scheme infrastructure. To ensure that ownership is entrenched in the minds of the irrigators, Denison and Manona (2007b) and Mnkeni *et al*. (2010) suggested that all revitalisation and development initiatives at the irrigation schemes should be structured and implemented such that it involves the irrigators in a participatory way at all stages of the processes. The general expectation is that, if farmers participate more in the management of the irrigation schemes, their productivity will increase, thus increasing their gross margins. This should increase their WTP for improved irrigation water schemes.

2.3.4 Support services

Weak support services are a persistent problem in most SIS assessments (Bembridge, 1999; Machethe *et al*., 2004). Training of farmers in farm and scheme management is needed. The provision of support to develop reliable networks for the marketing of produce beyond the local environs is also critical (Van Averbeke *et al*., 2011). Provision of these support services to smallholders became the principal mandate of public agricultural extension some 18 years ago (Machethe *et al*., 2004), following the withdrawal of provincial Departments of Agriculture from active involvement in scheme management.

The government of SA has adopted a variety of initiatives to develop smallholder agriculture. One of these initiatives has included placing extension officers at ward level. The extension officers are mandated to implement government programmes primarily to develop the skills base of farmers (Sinyolo, 2013). Extension officers bridge the gap between available technology and farmers' practices, by providing technical advice, information and training (Treguetha *et al*., 2010). However, due to the low number of extension officers, their accessibility to small-scale farmers is limited in SA (Greenberg, 2010).

Hall and Aliber (2010), cited in Sinyolo (2013), reported that only about 11% of the rural households contact an extension officer in a year. This implies that only a small fraction of the farmers get advice and/or training on modern farming methods. As a result, limited knowledge of crop production among farmers has been cited as one constraint to improved crop productivity in SIS (Machethe *et al*., 2004; Fanadzo *et al*., 2010; Fanadzo, 2012). According to Fanadzo *et al*. (2010), low yield levels caused by poor crop and water management practices by farmers is arguably the main reason for the failure of many SIS in SA, as farmers are not producing enough to realise profits and are thus unwilling to pay for improved irrigation.

Legoupil (1985), cited in Van Averbeke *et al*. (2011), emphasised that irrigated farming could only become successful when farmers adopted new farming systems that were more intensive and productive than those they employed when they cultivated dry-land plots; pointing out that irrigated farming would not be sustainable if it was limited to the mere application of water to crops to avoid water stress, without simultaneously attending to issues of plant nutrition, cultivar choice, plant population and plant protection.

The paternalistic approach to farmer training and service provision that was used when white farmers were settled on irrigation schemes and on smallholder schemes during the 1950s has been criticised (Machethe *et al*., 2004; Tlou *et al*., 2006). Services were provided and, gradually, farmers developed the necessary capacity to assume responsibility over managing their farms and schemes and to become less dependent on public extension, but more on each other for the acquisition of new knowledge and the exploitation of marketing opportunities (Van Averbeke *et al*., 2011). On most SIS, farmers have not reached the necessary level of competency and confidence to optimally exploit their farms (Van Averbeke *et al*., 2011; Backeberg, 2006). The need for support services is universal, even though it varies across different schemes.

2.3.5 Market access

The literature records the importance of market access for smallholder farmers and for eradicating hunger and poverty through increased production, cash income generation and increased gross margins (Ostertag *et al*., 2005; Magingxa & Kamara, 2003; Sinyolo, 2013; Mudhara, 2010). Magingxa & Kamara (2003) stressed the significance crops have in rural growth and livelihood enhancement.

Prior to 1996, a variety of marketing boards existed and worked closely with large-scale producers to ensure efficient and orderly conduct of business in SA. They also ensured that the commercial farmers had sufficient margins to remain viable (Mudhara, 2010); smallholder farmers were, however, excluded from participating in such markets. The government liberalised the marketing environment through the Marketing of Agricultural Products Act of 1996. This policy shift abolished the marketing boards and vested the authority of regulating the marketing environment in those participating in the market. While some analysts have pointed out that this resulted in positive outcomes in the form of an increased value chain, others have reasoned that these benefits have largely eluded the smallholder farmers (Mudhara, 2010).

Pingali *et al.* (2005) pointed out that smallholder farmers face two major situations. First is the ability to commercialise, which often involves technical change. Second is the ability to choose a suitable enterprise at any given time and place. The inability to cope with both of the above makes it difficult for these smallholders to adapt to modern food marketing systems and they consequently fail to enter the food markets (Pingali *et al.,* 2005). Furthermore, production for the markets is dominated by the use of purchased technical inputs. In a situation where credit is missing, liquidity constrained farmers are likely to have difficulty in purchasing technical inputs and hiring labour (Bagamba *et al.,* 2005). Consequently, these farmers are forced into subsistence production, which leaves them with no or limited surplus for the market (Bagamba *et al.,* 2005).

Smallholder farmers produce a large part of their subsistence food requirements mainly to protect themselves from food insecurity arising from failure of the marketing system. A market failure means that farmers are unable to sell their produce and subsequently use the proceeds for buying other basic requirements (Mudhara, 2010). Market failure occurs largely due to poor infrastructure and institutions that may be at the development stage. Poor infrastructure is in the form of poor or non-existent roads and transport that is not readily available, or which tends to be expensive (Mudhara, 2010). Van Averbeke (2008) agreed with this and stated that the major constraints that affect access to markets by black smallholder farmers in SA are, amongst others, lack of transport and poor the roads. This means that benefits from interacting with the market are low, as transport and distribution constraints isolate smallholder farmers from markets. Without proper access to profitable markets, smallholder farmers are likely to remain poor and they may not be able to realise profits from their produce. This may result in them being unwilling to pay for improved irrigation services (Magingxa & Kamara, 2003).

Thorbecke (2000), cited by Van Tilburg (2004), compared SSA markets to Asian markets and found the unsatisfactory response of SSA agricultural markets to price changes. For instance, failure in “getting prices right” in SSA is often a result of lack of marketing infrastructure, research and institutions. There is a lack of effective, efficient and impartial markets, which subsequently became a disincentive to investment in agriculture and also widened the welfare gap between the smallholder and commercial farmers (Van Tilburg, 2004). In contrast, Asia has managed to develop its markets by, for instance, setting up marketing infrastructure (Van Tilburg, 2004).

Pingali *et al.* (2005) states that if smallholder farmers overcome constraints related to production, they are capable of entering markets considering their productive efficiency. Overcoming these constraints, however, is a difficult task, as smallholders in SA are generally known to be resource-poor and lack information.

2.3.6 Profits/gross margins

Burke *et al.* (2011) define gross margins as the revenue per hectare of planted crop, minus the costs incurred on the same area over the growing season. Johnson (1982) defines gross margin as the difference between the value of an enterprise's gross output and the variable cost of production. Gross margins are used to evaluate the economic viability of an enterprise. They are used in agriculture for farm planning and comparing different farms with similar characteristics or different enterprises on the same farm (Chamdimba, 2007, cited in Nyekanyeka, 2011).

The productivity of smallholder farmers in most African countries is often considered to be low and has been declining during the past two decades (Machete *et al*., 2004). Low smallholder agricultural productivity implies low smallholder agricultural profitability. The value added per worker in agriculture in the 1990s was 12 percent lower than in 1980 and average incomes in the 1990s were 16 percent lower than in the 1980s (Machete *et al*., 2004). Agricultural output has been falling or levelling off in many African countries. Low productivity of smallholder farmers is one of the most important reasons for the failure of most African countries to achieve food security. Raising agricultural productivity is necessary if African countries are to overcome the problems of poverty and food insecurity. This will require a significant increase in investment in all the factors that contribute to agricultural productivity and in lifting the constraints thereon (Machete *et al*., 2004).

Increasing smallholder agricultural productivity requires that smallholder farmers gain access to reliable and good quality farmer support services such as extension, finance and marketing.

2.4 Approaches to irrigation water valuing

In the past, water in SA was provided free of charge to users, because it was considered a basic necessity, and was a relatively cheap and abundant resource (Rogers *et al.*, 2002). In the most recent decades, however, the subject of sustainable water resource management, due to increased demand from much larger communities, the subject of sustainable water resource management, has increasingly attracted more attention from the international community, including Africa. According to Gbadegesin *&* Olorunfemi (2007), the sustainable management of water resources was addressed at the Millennium Summit in 2000, which produced the Millennium Development Goals, the World Summit on Sustainable Development and the 3rd World Water Forum in Kyoto. In 2003, the Africa Ministerial Council on Water and the programmes and actions were articulated under the New Partnership for African Development (NEPAD) framework. One of the 21 targets in the Millennium Development Goals is to decrease the proportion of people without sustainable access to safe drinking water and basic sanitation by 50% by 2015. Not only has the scarcity impacted on water for basic needs, but also on agricultural production, resulting in increased food security concerns, worldwide, as irrigation water is an essential input in agricultural production (Esmaeili & Vezirzadeh, 2009).

The economic value of water, which has been underestimated or regarded as free on the conventional market, has been increasingly recognised; this is per requirement brought forward at The Dublin Conference, where one of the four Dublin principles stated that “water has an economic value in all its competing uses and should be recognised as an economic good” (Esmaeili & Vezirzadeh, 2009; Rogers *et al.*, 2002). The value of natural resources often does not exist in the market, and therefore are considered as non-market values. However, although the markets do not clearly exhibit the price of natural resources, different types of values can be determined. The natural resources possess direct use values, indirect use values, option values and non-use values such as existence value and bequest value.

The values of natural resources, including water resources, are often measured by the WTP and the willingness to accept (WTA) (Mayor *et al.,* 2007). The WTP is the maximum amount of money that a person would be willing to pay in return for receiving a benefit (Mburu, 2005). It reflects the amount of the benefit or utility that the goods or services give to a person. Conversely, WTA is the minimum amount of money that a person would be willing to accept as compensation for foregoing a benefit (Mburu, 2005). The WTP and WTA can be used for evaluating the same commodity. Studies have, however, observed a tendency that WTA becomes higher than WTP. This tendency shows that people are more sensitive to the cost incurred to them than the benefit they receive (Turner *et al*., 1994). In evaluating the value of the natural resources, two types of approaches have been commonly used.

The first type emphasises the Revealed Preference Methods, of which the Travel Cost Method (TCM) and the Hedonic Price Method (HPM) are the common ones (Asafu-Adjaye, 2000). The Revealed Preference Methods rely on actual expenditure choices for environmentally-related private goods made by consumers from which their preferences can be deduced via statistical analysis (Young 2005). The TCM estimates the value of a recreational site from each respondent's information relating to the various travel expenditures, places they travelled from and the number of trips to the site they make annually (Young, 2005; Mayor *et al.*, 2007). HPM, of which application of the property values is a very common approach, estimates the value of the natural resources or environmental qualities from the values of property or housing that are located in different environmental settings. The difference of environmental qualities is reflected on the difference of property values. According to the classification by Asafu-Adjaye (2000), the Benefit Transfer Method (BTM) is included in the Revealed Preference Methods. The BTM estimates economic value by transferring the value that has been estimated for similar goods at similar locations. Because this method avoids the need to collect new primary data, it tends to be less expensive and time-consuming. The BTM is favoured when there are limitations in time, budget, and analytic skills to conduct a full-scale research (Young, 2005).

The other group of evaluation approach is the Expressed Preference (Stated Preference) Method (Asafu-Adjaye, 2000). The method estimates the values by asking people directly about how much they would be willing to pay or accept for the goods or services at the hypothesised situation. Because these methods use the hypothetical market, an advantage is that it can be applied to the valuation of more goods or services, even to the non-use values such as existence value. There are other techniques that are used to value water, one of them being deductive techniques. This technique derives an accounting price or financial value from postulated empirical models of individual economic decisions made. One of the most frequently used deductive technique to approximate Value Marginal product (VMP) is the RIM, used particularly for evaluating policies on the irrigation of agricultural crops (Young and Loomis, 2014). The model calculates the value of water as the remainder or net income, after all other relevant costs are accounted for.

This section has briefly introduced the water valuation methods; greater detail of the evaluation methods will be given under the following sub-headings.

2.4.1 Contingent Valuation Method (CVM)

The stated preference approach is frequently referred to as contingent valuation (CV), especially when it is used in the context of environmental amenities. The CVM is used to determine individuals' demand for a non-market commodity (Tang *et al.*, 2013). It asks the respondents directly for their WTP or WTA for clearly defined goods or services (Alhassan, 2012, Alhassan *et al.*, 2013). In a hypothesised scenario, the respondents are asked how much they would be willing to pay for the goods/services or whether they would agree to make payment of an offered or suggested amount or bid amount for the goods/services. Since the respondents are able to show their preference on the hypothetical market, the method is useful when there is no real market or actual consumer expenditure to utilise for the valuation (Mburu, 2005).

In order to obtain the respondents' WTP by CVM, different types of elicitation formats have been used. Those include open-ended question, the bidding game, payment card, and the dichotomous choice approach. The early studies of CVM tended to have the open-ended question format, which simply asked the respondents to state how much they would be willing to pay for the goods or services. However, this format experienced many problems, such as high rates of non-responses and unreasonably high or low valuations (Young, 2005).

In the bidding game format, a respondent is asked if he or she would be willing to pay a specific bid amount of money for the goods/services. If the respondent answered "yes", he or she is asked the same question for an increased bid amount, and increased bid amounts are asked continuously until the respondent says "no". Similarly, if the answer to the initial bid amount was "no", decreased bid amounts are continuously asked until the respondent says "yes". The problem with this format is that the estimated WTP tends to have correlation with the initial value, which is called starting point bias (Cummings *et al*., 1986).

In the payment card (PC) format, a range of potential bid amounts is prepared and the respondents are asked to choose the value that was the closest to their WTP. This approach experiences the starting bias, although the bias is not as strong as it is in bidding games (Young, 2005). The dichotomous choice approach includes single-bounded and multiple bounded choices. It was developed to overcome the limitations of the elicitation formats that were used at the early stages of CVM studies (Young, 2005). In the single-bounded dichotomous choice approach, a randomly selected single amount of bid is offered to the respondent and the respondent provides an answer of "yes" or "no". The "yes" or "no" answers from the respondents are converted to a variable and WTP is estimated from the statistical models based on the probability of "yes" or "no", the bid amount and other socio-economic variables. The approach is thought to have less bias because it is simple enough that respondents have no incentive to strategically bias their answers toward the desired outcome (Young, 2005).

The double-bounded dichotomous approach, which is one of the multiple-bounded dichotomous approaches, is similar to the single-bounded dichotomous approach, but offers each respondent the bid twice. If the respondent answers "yes" when the initial bid is offered, a higher bid is offered and the respondent who answers "no" to the initial bid is offered a lower bid. Since this approach gains more information from each respondent, it reduces the need for a large sample size compared to that which is needed when using the dichotomous choice (Young, 2005). The double-bounded format has, however, been thought of to be the most efficient in minimising the tendency for the respondent to say "yes" continuously (Mburu, 2005).

Although the CVM has its weaknesses, as it suffers from potential biases, it has proven the most popular of the available methods for monetary valuation of the environmental services, because, more than anything, of its simplicity and its applicability in all situations (Assefa, 2012). Secondly, the method is able to quantify some types of benefits, such as non-use or passive use benefits. Thirdly, CVM was given official recognition by the US Water Resources Council as a recommended valuation technique and, lastly, CVM is able to measure passive use values and this has led to its use by many applied environmental economists (Hanemann *et al.,* 1991).

Akter (2006), Alhassan (2012) and Mezgebo *et al.* (2013) used this method. Akter (2006) determined the economic value of irrigation water in a government-managed small-scale irrigation project by eliciting farmers' WTP using CVM in the form of single-bounded closed-ended WTP questions. The estimated WTP for use of irrigation water was equivalent to 12% of the average agricultural income of household per cropping season. The study concluded that ground water irrigation water was highly under-priced in Bangladesh. Alhassan (2012) estimates farmers' WTP for improved irrigation services in the Bontanga Irrigation Scheme in Northern Ghana and the mean WTP was found to be US$ 8.50 per ha per year and the median was US$ 7.29 per ha per year. The study identified household characteristics as determinants of WTP.

Mezgebo *et al.* (2013) conducted a study in Wondo Genet District, Ethiopia, to determine the economic value of irrigation water. The study employed CVM in the form of double-bounded closed-ended questions to elicit households' WTP. He applied bivariate probit and ordered probit models to determine the mean and factors affecting WTP for irrigation water, respectively. A sample of 154 households was randomly selected and the survey was conducted using face-to-face interviews. Empirical results from the study revealed that total annual WTP for irrigation water from double-bounded elicitation method was greater than from the open-ended elicitation method. This study empirically proved that selected households' socio-economic characteristics are key determinants of demand for irrigation water. Therefore significant household socio-economic variables should also be considered when designing irrigation water-related projects at household level. It is recommended that policy-makers should target the double-bounded elicitation method rather than the open-ended elicitation method to elicite the WTP for irrigation water, which is what has been done in the present study.

All studies noted that specific household characteristics determine the WTP of the surveyed households (Akter, 2006; Alhassan, 2012; Mezgebo *et al.*, 2013). Accordingly, based on the empirical evidence from the literature, it is implied that CVM is a best and widely used tool for measuring the economic benefits of the provision of non-marketed goods, such as, improved irrigation water services in developing countries, including SA.

2.4.2 Residual Imputation Method

RIM, also called Residual Value Method (RVM), is a technique applied to water used as an intermediate input to production (Berbel *et al*., 2011). Valuation of water in production is based on the idea that a profit-maximising firm will use water up to the point where the net revenue gained from one additional unit of water is just equal to the marginal cost of obtaining the water (Lange 2006). The RIM determines the incremental contribution of each input in a production process. If appropriate prices can be assigned to all inputs but one, the remainder of total value of product is attributed to the remaining or residual input, which in this specific case is water (Young, 1996; Lange & Hassan, 2007; Speelman *et al*., 2008). Rather interestingly, the number of studies that have employed the RIM are quite limited (Calatrava & Sayadi, 2005; Grimes & Aitken, 2008) and it is hard to find studies that have recently employed the approach.

Bate & Dubourg (1997) estimated the residual value of water used for irrigation of five crops in East Anglia, from 1987 to 1991, using data from farm budget surveys. Data about actual water use was unavailable, so the residual value was calculated for the amount of water needed to cultivate a hectare of a given crop. Moran & Dann (2008) applied this technique to value water for Water Framework Directive (WFD) implementation, using a range of secondary data sources to derive economic values for water on a sector basis. They suggested that valuation of water should be used to support the WFD implementation. Speelman *et al*. (2008) assessed irrigation water values at small-scale irrigation schemes in SA using RIM and found that water could be valued at US\$0.188/m^3, on average, in line with expectations for vegetable crops. Furthermore, the crop choice and the irrigation scheme design and institutional setting were shown to significantly influence the water value, whilst individual characteristics of farmers proved to be less important. Esmaeili & Vazirzadeh (2009) utilised the same approach to irrigation to compare marginal value product of irrigation water applied to grow the selected crops in Southern Iran. Their results indicated that, among selected crops, cucumber and lime had the highest return for water use. The most important management implication of this study, however, was the reallocation of irrigation water according to its economic value in various crops.

According to Young (1996), the use of the RIM is beset by several difficulties. The main problem is the need to take into account each and every one of the costs unrelated to material inputs, which makes it difficult to get a good estimate of the value of the water. In addition, if by any chance the crop production function is not known, the residual value or the shadow price of the water calculated is independent of the quantity of water used. Similarly, the residual method can be unwieldy in the case of multi-output production systems. Nevertheless, this methodology is frequently used around the world by public agencies to establish tariffs on water for irrigation use.

2.5 Summary

Smallholder irrigation development in SA began in the nineteenth century; however, it has generally performed below expectation. Previous water policies did not favour farmers in smallholder irrigation, hence the introduction of the water policy reform, one of the government's attempts to address the injustices of the past. The transformation was to increase awareness on increased water demand by different sectors, agriculture being the largest consumer. The increase in demand calls for measures that ensure efficient allocation to be put in place. One such measure in putting a value on water by assessing farmers' WTP. The study would be incomplete, however, without evaluating the farmers' ATP. Various studies determine that institutions, land tenure security, farmer participation in scheme design and management, support services, market access and profits/gross margins were identified and discussed, as studies have concluded that these factors have an impact on farmers' WTP and ATP and smallholder irrigation.

Chapter 2 explored the different approaches used to value natural resources, focusing more on CVM and RIM. The CVM, which directly asks the respondents for their WTP or WTA for clearly defined goods or services, has different types of elicitation formats. The double-bounded format, however, is considered most efficient. A vast amount of literature was found on CVM, but this was not the case for RIM, which determines the incremental contribution of each input in a production process.

This chapter has presented some evidence based on the available literature. The succeeding empirical chapters give more evidence for SA, based on the survey data analysis done in this study.

CHAPTER 3: DETERMINANTS OF WILLINGNESS TO PAY FOR IMPROVED IRRIGATION WATER SUPPLY IN RURAL KWAZULU-NATAL, SOUTH AFRICA

3.1 Abstract

In this chapter, farmers' WTP for improved irrigation water supply in rural areas of KZN, SA, was determined. The analysis was based on a sample of 161 irrigators in Msinga Local Municipality. Both binary and ordered probit models were used to investigate factors affecting WTP, which was generated through the contingent valuation method. Empirical results indicate that factors such as extension services, training, motorised pump (diesel), scheme management, duration in the scheme, livestock ownership and road conditions positively influence WTP, while factors such as conflicts, household size and total land holdings influence WTP negatively. The study concludes that farmers are willing to pay for improved irrigation water supply and highlights the importance of support services in determining WTP. The study recommends that government should formally introduce water charges which may start from R50 per month per plot, with the possibility of increasing the charge gradually over time.

Keywords: Irrigation water pricing, Contingent Valuation Method, Willingness to pay, Probit model, Smallholder irrigation.

3.2 Introduction

Water has increasingly come to be recognised as a scarce economic commodity (Tang *et al.*, 2013) and increasing priority is therefore being given to the development of mechanisms for water management. Globally, irrigation has been found to be the largest consumer of water, accounting for about 62% of the total water used (Kanyoka *et al.,* 2008) and in this regard SA is no exception (Le Gal *et al*., 2003; Speelman, 2009).

In SA, smallholder irrigation is seen as important for rural development, creating employment opportunities, generating income and enhancing food security (Speelman, 2009). Huge investment has been made in the sector, rehabilitating and revitalising existing schemes (Perret & Geyser, 2007). However, water scarcity is creating increasing pressure for irrigators to release water for other uses and to find ways to improve water productivity (Kanyoka *et al.,* 2008). Efficient use of water resources has thus become a fundamental target for farmers and water management (Kanyoka *et al*., 2008). It is in this context that economists have advocated for water pricing as an efficient tool for water management (Le Gal *et al*., 2003; Assefa, 2012; Tang *et al*., 2013; Speelman, 2009).

Irrigation water pricing is often regarded as a good tool for managing use and allocation. Pricing of water makes consumers aware of the resource scarcity, thus creating a new respect for water. When the resource is respected, it is valued and this should improve efficiency in its utilisation. Water pricing provides incentives to farmers to rethink crop choices, encouraging a shift to more profitable crops (Speelman, 2009). The water pricing strategy also helps in cost recovery, which is generally considered a basic requirement for sustainability (Bogale & Urgessa, 2012). In terms of new water policy in SA, water subsidies currently received by farmers will gradually decrease to a point where farmers will have to pay for the water they use (Speelman, 2009; Liao *et al.*, 2007).

The question, however, is whether or not the rural farmers will be willing to pay for irrigation, given the extent of poverty in rural areas of SA. If indeed they are willing to pay for irrigation water, the next question is, at what price? It is against this background that the present study was undertaken. Even though several studies have been done on WTP for irrigation water in other countries, (e.g. Lema & Beyene, 2012; Tang *et al.,* 2013; Alhassan *et al.,* 2013; Akter, 2006), few have been done in SA, such as Speelman, 2009 and Yokwe, 2006. No such study has been done in the KZN province, to the authors' knowledge. Given that irrigation schemes and farmer profiles are not homogeneous between (and even within) countries, there are constant changes in smallholder socio-economic circumstances. There is now a need for the assessment of the willingness of SA's smallholder farmers to pay for irrigation water. The study informs the government and other development agencies about the perceptions of farmers regarding water pricing and also determines the monetary value that households are willing to attach to improved irrigation water supply. The study aimed to examine the determinants of farmers' WTP for irrigation water in SA, using farmers in two SIS, Tugela Ferry and Mooi River irrigation schemes, as case studies.

3.3 Theoretical framework: utility function

CVM is frequently applied to discrete survey responses to elicit options on various matters (Assefa, 2012; Bacha *et al*., 2011; Bateman & Turner, 1992). The theoretical foundations of CVM are in the random utility theory (Kanyoka *et al.*, 2008). The respondent households are initially asked whether or not they would be willing to pay a specific amount for improved irrigation water supply service. When a respondent is asked one dichotomous choice question, the response is usually "yes" or "no", depending on the individual's WTP the proposed bid value. It is assumed that respondents know which choice maximises their utility.

The assumption underlying this approach is that households are to choose between the existing irrigation water supply system and the hypothetical improved irrigation water supply system, based on maximising two conditional indirect utility functions (Akter, 2006). The first is the utility derived from the improved irrigation and the second is the utility derived from the current irrigation water supply system. If the probability that the conditional indirect utility function for the new improved irrigation water supply system is greater than that of the current irrigation supply system, then a household is most likely to use the new and improved irrigation supply system, rather than the current (Fishburn, 1968; Baral *et al*., 2007).

The utility that individual i will realise after choosing an alternative j can be expressed as follows:

$$U_{ij} = V_{ij} + e_{ij}$$

Where U_{ij} and V_{ij} represent the indirect and deterministic utility individual *i* receives on choosing alternative *j* respectively, and e_{ij} is random component of utility function. The random component is assumed to be identically, independently distributed with zero mean. The marginal utility of payment depends on an expected improvement in irrigation water supply.

Let *Pi* be a specific amount that a respondent is willing to pay to get the improved irrigation water supply *k*. That is, an individual will choose alternative *k* over alternative *j* if utility from *k* is greater than from *j* (Hanemann, 1984; Akter, 2006). That is;

$U_{ik}\ ((Y-P_i)|\ x_i) > U_{ij}\ (Y|x_i)$

Where *Y* is income and X_i represents a vector of socio-economic characteristics of individual *i*. An individual will be willing to pay an amount of P_i, if the utility gained from the situation with improved irrigation water supply is larger than the utility with the current irrigation water supply system, taking into account the change in income.

3.4 Research methods

3.4.1 Study area description

Primary data collection for the study was carried out in Msinga Local Municipality, which is a largely rural area, where 69% (1 725 km^2) is traditional authority land (Dearlove, 2007). The remaining 31% is commercial farm land. Much of the terrain is located in deep gorges of the Tugela and Buffalo Rivers. This effectively isolates the municipal area from the immediate surrounding municipal areas.

Msinga has very limited employment opportunities. Although agriculture is one of the most important economic sectors in Msinga, it provides employment for just 12.5% of the population (Dearlove, 2007). Most households nonetheless depend, to some extent, on generally low-level subsistence cultivation (Sinyolo, 2013). One opportunity that does exist for some of these rural people to increase their incomes and participate in the local economy is provided by irrigation farming, specifically the Tugela Ferry and Mooi River irrigation schemes, which together play an important role in the local economy of Msinga as a source of food, employment and market for agricultural inputs (Sinyolo, 2013). Figure 3.1 shows the location of Msinga local municipality in SA.

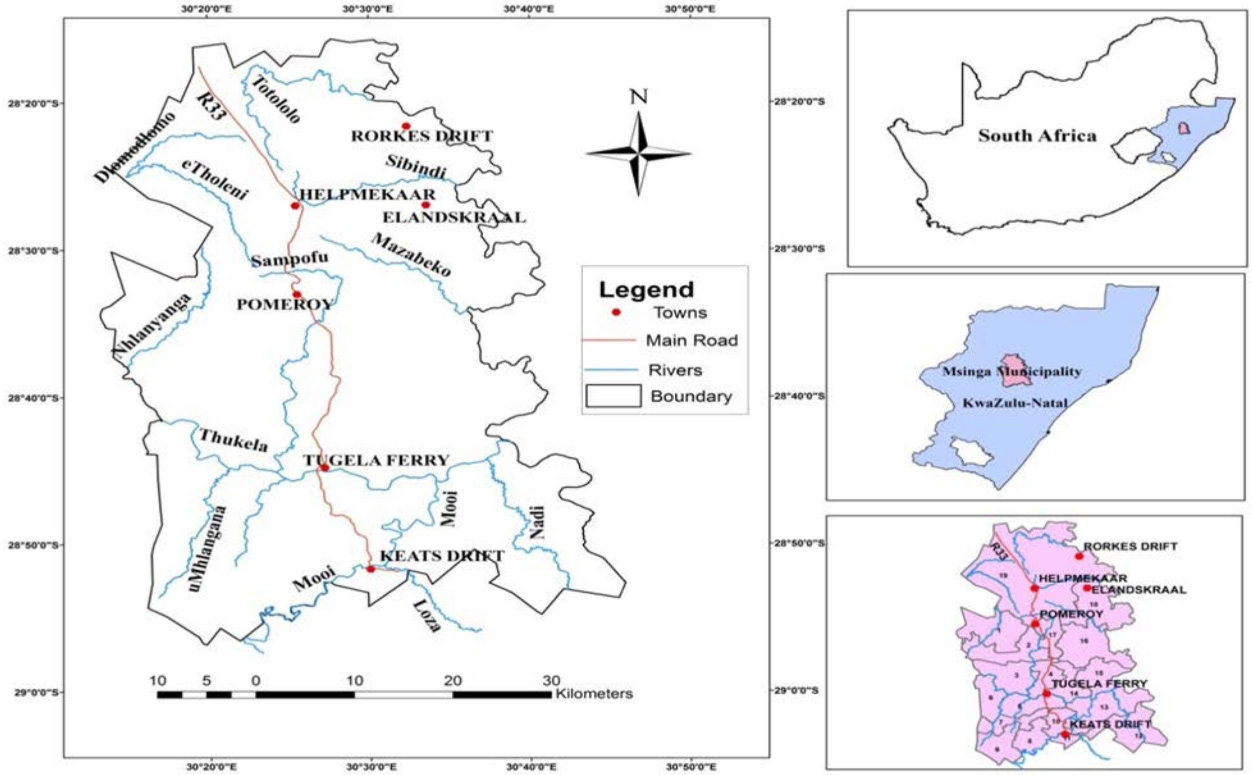

Figure 3.1 Location of the Tugela Ferry and Mooi River irrigation schemes in Msinga local municipality, South Africa.

The Tugela Ferry Irrigation Scheme (TFIS) is located on both banks of the Tugela River, which supplies the scheme with water. The scheme was planned and constructed by the Natal Native Trust, between 1898 and 1902, and has been operational ever since (Cousins, 2012). The scheme consists of seven blocks of irrigable land covering 837 ha (Cousins, 2012; Fanadzo, 2012). A total of about 1 500 irrigators participate in the scheme, growing various crops. According to Cousins (2012), the Tugela Ferry irrigators comprise about 15 percent of all smallholder irrigation farmers in KZN province, showing the importance of the scheme.

Farmers in the irrigation scheme were initially allocated two plots, each of 0.1 ha in size. Over time, some farmers acquired more plots through leasing or borrowing from neighbours. The main access to land is through the traditional authorities, who allocate land to households. Selling of land is not permissible under the current traditional land tenure system. A canal, 31 km in length, is used to draw water under gravity to four blocks, i.e. 1-3 and 5. A diesel pump is used for one block (4B) and electric pumps for two blocks (4A and 7). Initially, all the blocks obtained water from the main canal, fed by gravity, but water shortages due to dilapidation of the canal have meant that only four blocks benefit from the gravity-fed canal, while other blocks use motorised pumps.

In the Mooi River Irrigation Scheme (MRIS), water is abstracted from a weir constructed across the river into a parabolic canal which runs for a distance of 20.8 km, from the abstraction point to the end of the scheme (DAEA, 2011). The scheme has a total of 15 blocks, of different sizes, for better scheme management and ease of water distribution.

The year of establishment of the scheme is not known. However, it may have been early in the 20th century and most of the farmers grew up with their parents participating in the scheme. Essentially, the scheme is meant to improve the livelihoods of those in the surrounding areas through food production and job creation (Gomo, 2012). In total, the scheme covers an area of 600 hectares, divided into plots approximately 0.1 hectare in size. These plots are locally known as “beds”. There are 824 farmers in the scheme, each occupying at least one plot, but some farmers occupy more than one (DAEA, 2011).

The management of the scheme is through block committees, who, amongst other things, see to the distribution of water. As a whole, the scheme is managed by the irrigation management committee, which ensures equitable water distribution, resolves conflicts, etc. (Gomo, 2012).

Water is distributed from the weir to various plots by means of distributive concreted canals, which vary in size, as the size depends on the area to be irrigated in the block (Gomo, 2012). Blocks 1-11 draw water under gravity; Blocks 12-15 use a diesel pump. Initially, all the blocks obtained water from the main canal, but water shortages and increased number of participants have meant that only the first set of blocks benefit from the gravity-fed canal, while the other set uses pumps.

3.4.2 Data collection methods

A pre-testing of the questionnaire was conducted before the actual survey. Five randomly selected households in different blocks of the irrigation scheme were interviewed. From the responses obtained from the questionnaire, questions that were not clear or ambiguous were modified appropriately. Possible response options that were not captured in the closed-ended questions were added, to reduce the number of responses falling into the category ‘other’. Pre-testing was used to improve the reliability and validity of the questionnaire and to improve the translation from English to the local language, isiZulu. Pre-testing was also useful in the identification of the initial bid and the design of the hypothetical market scenario that could be proposed for improving the existing irrigation water supply system. During pre-testing, the starting bid value was obtained through an open-ended WTP question. The five households surveyed were willing to pay R0, R20, R50, R50 and R150 per month. The R50 was selected as the starting bid as it is the most frequent and it is the median.

After the adjustments emanating from the pretesting exercise were made, the actual data collection process began. Data were collected over a period of three weeks in November 2013 by three enumerators fluent in isiZulu. The enumerators were trained on data collection methods and the contents of the questionnaire before performing the survey. The sampling procedure and data collection tools that were used are discussed below.

Field data was collected from two irrigation schemes, the MRIS and the TFIS. A random sampling procedure was employed to select a total of 161 respondents, where 131 were from the MRIS and 30 were from TFIS. The 15 blocks in the MRIS were divided into three sections, the upper (block 1-7), middle (8-11) and lower blocks (12-15). The upper and middle sections of the scheme receive their water by gravity and the lower section uses a diesel pump to get water. Classifying the farmers by their irrigation systems assisted in capturing the differences in the willingness to pay. In each of the sections, the aim was to sample 10% of the total population, as suggested by Terre-Blanche *et al.* (2006). The MRIS has a total of 824 farmers (Gomo, 2012), of which a sample of 131 respondents is well above 10%.

The TFIS is being revived, limiting the number of blocks that could be surveyed, as most blocks stopped operating when the revival process began. Block 4B and 7 were, however, still operational, so a total number of 30 respondents were surveyed. Similar to the lower section blocks of the MRIS, these blocks were also using a motorised pump to get water. The sample of 30 respondents was above the conventional level of 10% of the total population of farmers for both blocks combined.

Primary data were collected using structured questionnaires, focus group discussions and key informant interviews (see Appendix A for the questionnaire, Appendix B for the focus group discussion guide and Appendix C for the key informant interview). Demographic information such as sex, age, marital status and education level was collected using the questionnaire. The questionnaire included measures of household wealth such as household assets, livestock and type of house; agricultural production activities; household expenditure, income amounts and sources. The questionnaire sought to elicit farmers' perceptions of the sufficiency and reliability of the irrigation water, their willingness and ability to pay for the water and the security of their rights to the water. The same questionnaire was used for both study sites.

Key informant interviews and focus group discussions were carried out to obtain explanations to issues captured in the questionnaires. One key informant interviewed was the chairperson of block 15 who was very well informed on matters concerning the Mooi River scheme. One focus group discussion was used to collect data on people's knowledge and perceptions about water charges and their WTP.

3.4.3 Empirical models

CVM was used to capture the farmers' WTP and the amounts they are willing to pay for improved irrigation. Two models were estimated, a binary probit model and an ordered probit model. The first analysis was done with the simple discrete choice model to explain whether or not a respondent is willing to pay for an improved irrigation water supply service over the existing water supply service. The sampled household is either willing or not willing to pay the initial bid value offer for improved rural water supply service. The variable WTP for improved rural water supply was used as a binary dependent variable, taking a value of *one* to indicate the respondent's WTP for the service and zero otherwise. A binary probit model was estimated as follows:

$$WTP^*_i = \beta x_i + u_i \,,$$

$$WTP_i = 1 \text{ if } WTP^*_i > 0, \text{ and } 0\text{=Otherwise.}$$

Where: WTP^*_i is the latent endogenous variable such that WTP_i takes a value of 1 when WTP^*_i is greater than zero; x_i is a vector of household characteristics that influence household's willingness to pay; β is a vector of the coefficients to be estimated; and u_i is the residual term.

The second model estimated was an ordered probit model. Ordered probit models are used to estimate models which involve qualitative dependent variables which have categories of natural order or ranking that reflect the magnitude of some underlying continuous variable.

The respondents were first asked if they are willing to pay for an improvement, given the hypothetical scenario. Those who respond "no" were not asked to bid. Those who respond "yes", indicating that they were willing to pay, were then asked if they were willing to pay the initial bid value of R50. If the initial bid value is accepted, a premium was asked of R25; while if the initial offer is rejected, a discount of R25 was offered. Answers to the two sequential questions were sorted into four intervals; [0] when the respondent was not willing to pay at all, [0,R50-R25] when a discount offer was accepted at the second bid, [R50, 0] when the initial bid was accepted and the premium was rejected and [R50,R50+R25] when the respondent was willing to pay the premium.

Since respondents' WTP is a latent variable that is not subject to direct observation, the sequential questions serve to place upper and lower bounds of the true WTP. The responses were ordered into the following indices for WTP: Z=0 if WTP =0; Z=1 if WTP<R50; Z=2 if WTP=R50 and Z=3 if WTP>R50. The proportions are illustrated in Table 3.1.

Table 3.1: Frequency distribution of bid responses

	Description	**Frequency**	**Percentage**
Z=0	Not willing to pay	61	37.89
Z=1	WTP<R50	45	27.95
Z=2	WTP= R50	26	16.15
Z=3	WTP>R50	29	18.1

Source: Household survey (2013)

The model can be specified as follows:

$z_i^* = X'\beta + u_i \qquad where\ \varepsilon_i \sim N(0,1)$

$z_i = 0\ if\ z_i^* \leq \varnothing_0$

$z_i = 1\ if\ \varnothing_0 < z_i^* \leq \varnothing_1$

….

$z_i = 3\ if\ z_i^* > \varnothing_{j-1}$

Where *z** is an unobservable index and *x* is a vector of independent variables. The observed counterpart to *z** is *z*. The ₡'s are unknown threshold parameters that have been estimated along with the other parameters in the model.

Then the probability of observing *z* given *x* can be expressed as:

$Prob\ (z=0) = \Phi(-X'\beta)$

$Prob\ (z=1) = \Phi(₡_1 - X'\beta) - \Phi(-X'\beta)$

$Prob\ (z=2) = \Phi(₡_2 - X'\beta) - \Phi\ (₡_1 - X'\beta)$

$Prob\ (z=3) = 1 - \Phi(₡_2 - X'\beta)$

Where Φ(.) is the standard normal cumulative distribution function such that the sum of probabilities is equal to 1.

The variables that were used in the two econometric models are presented and described in Table 3.2. The variable were selected after viewing studies similar to the present study and selecting those that significantly affected WTP and those that had no effect but were expected to affect WTP because outcomes differ across different geographical locations and each case study is different in its own right.

3.5 Empirical Results

3.5.1 Household demographics and socio-economic characteristics

The results revealed that the household heads for both MRIS and TFIS were predominantly female, as 88.82% of the household heads were female and only 11.18% were male. The average age of household heads was 58 years. The minimum was 18 and the maximum was 88 years. Most of the household heads are illiterate, as their education levels range from those who have never had any form of schooling (57.14%) to the minority, who have received tertiary/college education (1.86%); the illiteracy is confirmed by Mnkeni *et al.* (2010), who reported that the illiteracy rate among the farmers was reported to exceed 80% in the Msinga Local Municipality. The low education levels among farmers might have an adverse effect on their decision-making and financial management.

Table 3.2: Description of the variables

Variable	Variable description	Expected sign
Dependent Variables		
Willingness To Pay (WTP)	Yes=1, No=0	
Bid responses (Z)	The bid categories according to amounts that the respondents are willing to pay for improved irrigation	
Independent Variables		
Gender	Gender of household head: Male= 0, Female=1	+
Age	Age household head (years)	+
Household size	Number of people in the household	+
Household distance from scheme	The approximate distance from the irrigation scheme to the household (km)	+
Duration	Number of years that the household has been involved in the irrigation scheme	+
Access to credit	Access to credit in the past year: Yes=1, No=0	+
Access to extension	Access to extension services in the last year (number of visits in the last 12 months)	+
Training	Agricultural skills training: Yes=1, No=0	+
Conflicts	Has respondent been involved in conflicts within the scheme: Yes=1, No=0	-
Total land	Total land holdings of household (ha)	-
Household assets	The value of household assets (Rands)	+
Livestock size	Livestock size in Tropical Livestock Units (TLU)	+
Association member	Household head a member of a farmer's association: Yes=1, No=0	+
Off-farm income	Off-farm income (Rands)	+
Place	Irrigation scheme the respondent belongs to: Mooi River=0, Tugela Ferry=1	+
Pump_1	Pump used: Electric pump=1, Gravity or otherwise=0	+
Pump_2	Pump used: Diesel pump=1, Gravity or otherwise=0	+
Education_1	Education level of respondent: No education=1, Primary education or otherwise=0	-
Education_2	Education level of respondent: Secondary education=1, Primary education or otherwise=0	+
Scheme management	Farmers' perceptions on the management of the scheme: Good=1, Poor=0	+
Road conditions	Farmers' perceptions on the road conditions: Good=1, Poor=0	+

The average family size of the sampled households is seven people, which is relatively small, given that these are rural households; the size ranges from one person to 20 people per household. About 38.51% of the respondents indicated that they are Christians and 61.49% reported that they held other religious views (Shembe, traditional, ancestors, etc.).

Most of these findings are in line with the sentiments of Speelman (2009), who stated that the most common characteristics of the state-founded type of schemes aged beneficiaries with a large proportion of female farmers. The large proportion of female farmers and the old age of the beneficiaries reflect the fact that, over time, irrigation smallholders have diversified their activities and that the livelihood system has changed through massive outmigration of male labour to the industrial and mining sectors, leaving households headed by women and pensioners behind at the irrigation schemes.

With regards to land endowment, the average land holding per farmer is 0.6ha, with the majority of the households (57.87%) having acquired their plots as an inheritance from their parents and some through redistribution which had taken place over the years. In summer, the dominating crops are maize and potatoes, where 38.06% of the total harvest is maize and 30.32% is potatoes. The remaining 31.62% of the harvest is made up of other crops such as cabbage, garlic and beetroot. In winter, however, it is a different case, where the more dominant crops produced are beans (26.28%), cabbage (18.25%), potatoes (18.25) and tomatoes (10.22%).

Of the total number of households that were interviewed, 62.11% were willing to pay for improved irrigation and 38.89% were not. Analyses of both continuous and categorical variables indicated that there were no significant differences between those who are willing to pay for improved irrigation water supply and those who are not willing to pay, in terms of their demographics. The results of descriptive analyses are presented in Tables 3.3 and 3.4. Table 3.3 presents the results from continuous variables, while Table 3.4 presents the results from categorical variables.

The t-test results, presented in Table 3.3, indicate that there were no statistically significant differences between household head age and household size between those willing and those unwilling to pay for improved irrigation. It is to be expected that the demographics will not vary significantly, as these households are from one community. The age statistics for both groups (willing and not willing to pay) suggest that it is the older farmers who are most involved in the scheme. This is because the younger generation is moving to cities in pursuit of better opportunities outside of agriculture. It emerged in the focus group discussions that the younger generation is shunning the agricultural sector because it pays less compared to other sectors like mining and manufacturing.

There is a statistically significant difference in terms of livestock sizes, as those irrigators who were willing to pay had greater livestock sizes (7.24). This is more than double the livestock sizes of those who are unwilling to pay (2.96). Livestock is a sign of wealth, implying that those with bigger livestock sizes can afford to pay for improved irrigation.

Table 3.3: Continuous variable description according to willingness to pay

Variable definition	WTP (n=100)		Not WTP (n=61)		T-test
	Mean	Std. Dev.	Mean	Std. Dev.	
Age (years)	59.51	13.81	56.67	14.62	-1.24
Household size in numbers	7.27	7.35	6.46	2.78	-0.83
Total land holding (ha)	0.54	0.59	0.62	0.65	0.81
Number of livestock in TLU	7.24	15.50	2.96	4.48	-2.10**
Annual off-farm income per year (000'Rands)	27.34	15.20	24.80	19.57	-0.93
Annual farm income per year('000 Rands)	6.82	12.64	4.89	12.92	-0.93
Value of assets ('000 Rands)	94.43	84.04	66.67	86.59	-2.01**
Duration (years in scheme)	30.37	2.14	21.90	22.79	-2.38**
Distance from irrigation scheme (km)	3.12	3.33	2.74	3.26	-0.71
Extension access (nr of visits per year)	1.47	2.04	0.31	1.06	-4.10***

Notes: ***, ** and * means significant at 1%, 5% and 10% levels of significance, respectively

Source: Household survey (2013)

Also highlighted in Table 3.3 is that those farmers with higher valued assets (see Appendix A, Table 7.2 for assets) are more willing to pay compared to those with relatively lower valued assets. The difference is statistically significant at 10%. This means that farmers with more assets are more willing to pay compared to those with fewer assets.

Concerning the duration of participation in the scheme, there is a statistically significant difference in the scheme between those who are willing to pay and those that are not indicates that experience influences the farmers' decisions. Farmers that have been in the scheme for a long period of time (30.37 years) are more willing to pay for improved irrigation water supply than those who have been in the scheme for relatively fewer years (21.9) years. The farmers who have been in the scheme longer know how well the scheme used to perform. They have experienced inconsistent supply of water and perhaps, have suffered losses in production and, as a result, are willing to pay to prevent such situations.

The results presented in Table 3.3 also indicate that there is a statistically significant difference in extension access between the farmers who are willing to pay and those who are not willing. Those that are willing to pay, on average, engage more with extension officers in a year (1.47 times) than those that are not willing to pay (0.311). When asked why the farmers had engaged the extension officers, most of them responded that it was in connection with inputs or crop production issues. This could be a further explanation for their WTP.

The study shows that women are more dominant in the agricultural sector. In the focus group discussion, it was mentioned that most males are not interested in anything to do with their plots. Many households in SA are female-headed, where the male (husband) may be deceased or has moved to urban areas that offer lucrative job opportunities, eg. Johannesburg (Speelman, 2009). This is evident in Table 3.4, which reveals that woman dominate both groups, those willing to pay and those not willing to pay. There is a statistically significant difference between the religious beliefs of those willing and those that are unwilling to pay.

The results presented in Table 3.4 indicate a statistically significant difference between those who are willing to pay and those unwilling to pay, as determined by the water supply system. The table reveals that those farmers receiving water by gravity are generally not willing to pay and those who are using the diesel pump are more willing to pay. This is expected, since those receiving the water by gravity are not used to the concept of paying for water-related services. Moreover, they have not suffered any water shortages and will therefore resist paying. However, those who have been using a diesel pump have experienced water shortages, as sometimes there is not enough money for the purchase of diesel fuel. Hence, such farmers are willing to pay for an improvement in the water service.

A statistically significant difference between those willing to pay and those not willing to pay, as determined by the respondent being a member of the association, was noted. It is expected that those who are members of the association are more informed and may know the importance of paying for improvements and the consequent gains. There is a statistically significant difference between those not willing to pay, as determined by agricultural training. The majority of farmers who are prepared to pay are those that have received training, implying that training has a positive influence on farmers' WTP.

Table 3.4: Categorical variables description according to willingness to pay

Variable definition	Categories	WTP (%) n=100	Not WTP (%) n=61	χ^2-test
Gender of respondent	1= Male	7.50	3.75	ns
	2= Female	55.00	33.75	
Marital status	0= Single or otherwise	31.68	22.98	ns
	1= Married	30.43	14.91	
Place	0= Mooi River	52.80	34.78	ns
	1= Tugela Ferry	9.32	3.11	
Highest education level of respondent	1= No education	35.40	21.74	ns
	2= Primary education	16.15	11.18	
	3= Secondary education	10.56	4.97	
Religion of respondent	0= Other (Muslim, African tradition and Shembe)	34.16	27.33	***
	1= Christian	27.95	10.56	
Water supply system	0= Gravity	22.36	31.06	***
	1= Electric pump	3.11	9.32	
	2= Diesel pump	30.43	3.73	
Is the respondent a registered association member?	0=No	22.98	20.50	***
	1= Yes	39.13	17.39	
Credit access	0= No	46.58	29.81	ns
	1= Yes	15.53	8.07	
Training	0= No	38.51	30.43	***
	1= Yes	23.60	7.45	
Road condition	0= Poor	46.58	4.97	***
	1= Good	15.53	32.92	

Notes: ***, ** and * means significant at 1%, 5% and 10% levels, respectively

Source: Household survey (2013)

Table 3.4 also captures the statistically significant difference between those willing to pay and those not willing to pay, as determined by the farmers' perceptions of the condition of the roads. This implies that access to good infrastructure, which improves market access, positively influences farmers' willing to pay for the improvement in irrigation water supply.

The 61 respondents who were not willing to pay were subsequently asked in a follow-up question why they were not willing to pay. Figure 3.2 graphically shows the various reasons given by the respondents.

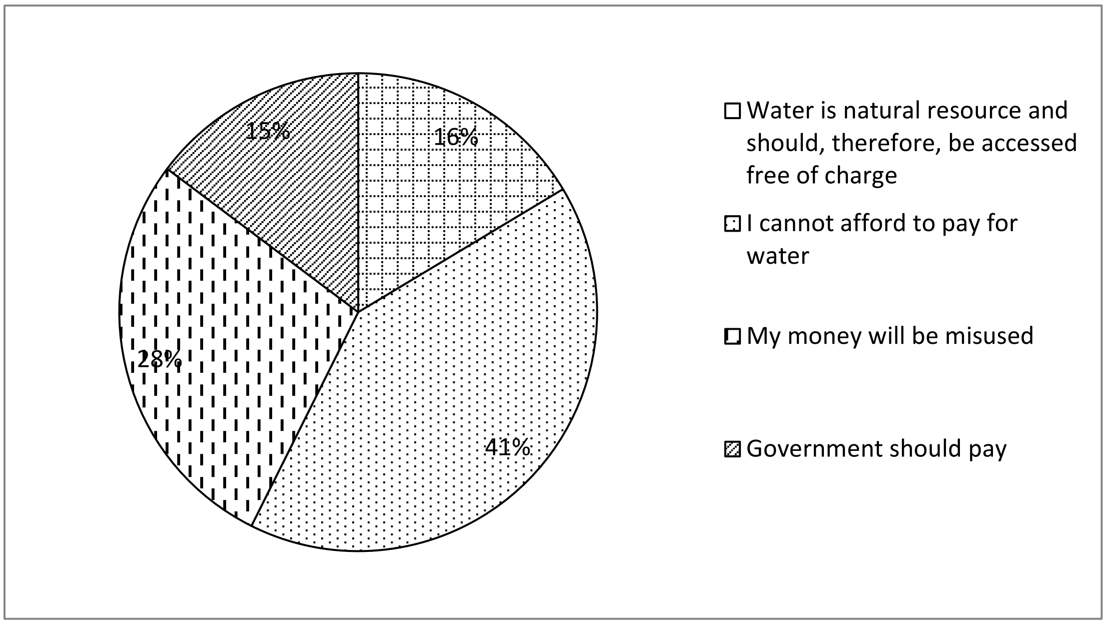

Figure 3.2: Reasons for not beingwilling to pay

Source: Household survey (2013)

The majority (41%) of the farmers responded that they cannot afford to pay for the water. While 28% said that they felt their money would be misused. About 16% of the respondents see water as a natural resource and therefore see no need to pay for it. The minority (15%) said that it is the duty of government to pay for water. According to Akter (2006), respondents who refused to pay because of the reason 'I do not believe that my money will be used properly' are known as protest bidders in CV surveys. In this study, protest bidders comprised more than 10% of the total sample, which may result in bias WTP.

3.5.2 Determinants of Willingness to Pay

A binary probit model was estimated to determine the household characteristics and resource endowments that predict households' WTP for improved irrigation water supply. The results are presented in Table 3.5.

Table 3.5: Determinants of Willingness to Pay for improved irrigation: Probit regression results

Explanatory Variables	Coefficient		Marginal effects	
	Value	Std. Error	Value	Std. Err.
Gender	-0.033	0.558	-0.006	0.099
Age	-0.007	0.013	-0.001	0.002
Household size	0.028	0.024	0.005	0.004
Household distance	-0.008	0.041	-0.001	0.007
Duration	0.0248***	0.008	0.004***	0.001
Access to credit	0.247	0.373	0.043	0.066
Access to extension	0.188**	0.081	0.033**	0.014
Training	0.990***	0.313	0.175***	0.054
Conflicts	-0.086	0.338	-0.015	0.060
Total land holdings	-0.474*	0.257	-0.084*	0.046
Household Assets	3.6E-06**	1.8E-06	6.3E-07**	3.2E-07
Livestock size in TLU	0.038**	0.019	0.007**	0.003
Association member	0.095	0.318	0.017	0.056
Off-farm income	0.001	0.001	1.93E-06	1.99E-06
Place	-0.495	0.614	-0.088	0.107
Pump_1	0.293	0.786	0.052	0.138
Pump_2	1.096***	0.398	0.194***	0.063
Education_1	0.060	0.322	0.011	0.057
Education_2	-0.413	0.446	-0.073	0.080
Scheme management	1.400***	0.350	0.248***	0.058
Road conditions	0.439***	0.104	0.078***	0.017
Constant	-3.233**	1.442		
Correctly predicted	83.13%			
LR chi2(22)	108.18***			
Pseudo R^2	0.5110			
n	160			

Notes: ***, ** and * means significant at 1%, 5% and 10% levels, respectively

Source: Household survey (2013)

The results indicate that, collectively, all estimated coefficients are statistically significant, since the LR statistic has a p-value less than 1%. The pseudo R^2 value is about 51.10%, which is high considering this is cross-sectional data. The model also correctly predicted about 83.13% of the cases, confirming that the model fits the data well.

Among the 21 explanatory variables included in the analysis, nine were found to have a significant impact on respondents' WTP for improved irrigation water supply under the hypothesised scenario at the 1%, 5% and 10% probability levels, respectively. The model indicates that variables such as duration in the scheme, extension access, training, total land holdings and the value of household assets, livestock sizes, pump, scheme management and road conditions are all statistically significant in explaining household WTP for improved irrigation.

As depicted in Table 3.5, the number of years in the irrigation scheme (duration) is found to be significant at the 1% level of significance, with an expected positive sign. This suggests that a one-year increase in time spent in the scheme will result in the probability of the farmers' WTP increasing by 0.40%.

Table 3.5 also shows the positive influence that access to extension services has on the willingness of the farmers to pay for an improvement in the provision of irrigation water. Farmers who have engaged more regularly with extension officers have a 3.30% more chance of being willing to pay for improved irrigation than those who have engaged less with extension. This could be attributed to the former being more aware of issues and policies of water for irrigation schemes, compared to those with less contact or no contact with extension services.

There is a positive relationship between receipt of training and WTP for improved irrigation water service. Farmers who have received some training on agricultural-related skills have a 17.50% more chance of being willing to pay, compared to their counterparts who have not received any agricultural-related training. Trained farmers are expected to be more aware of the functioning of the sector and may be more aware of the risk of reduced water supply/access on crop production and may thus understand the importance of paying for the improvement.

A hectare increase in the size of land operated on by a household statistically significantly reduces the chances of the respondents' WTP for improved water service by about 8.40%. These results indicate that the value of the household assets and livestock sizes significantly impact positively on farmers' WTP for the improvement. Households with relatively higher value assets have a higher chance of being willing to pay for improved irrigation. Similarly, the households with larger livestock herds have a higher chance of being willing to pay for the improvement.

The farmers that are using a diesel pump have a 19.44% more chance of being willing to pay for the improvement, compared to those using gravity or electric pump driven water. This is expected, since the former know the changes in water supply they experienced when they started using a motorised pump which they paid for.

There is a positive relationship between the farmers' perceptions of the management of the scheme (Scheme Management) and their WTP. The farmers who perceive the management of the scheme to be good have a 24.78% higher chance of being willing to pay for improved irrigation compared to those who perceive the management of the scheme to be poor. If farmers perceive the management of the scheme to be good, they will have confidence in the running of the scheme and will be more prepared to invest in the scheme and thus improved WTP.

Good roads are a proxy for infrastructure and may potentially mean better access to markets and other services. The results in Table 3.5 show that if road conditions are good, there is a 7.80% higher chance that farmers will be willing to pay for improved irrigation compared to those who perceive road conditions to be poor.

3.5.3 Determinants of Level of Willingness to Pay

In Table 3.6, the parameter estimates and marginal effects of the ordered probit model are presented. The results indicate that, collectively, all estimated coefficients are statistically significant, since the Wald Chi square statistic has a p-value less than 1%. The pseudo R^2 value is about 23.15%, which is acceptable, considering this is cross-sectional data.

The results reveal that the coefficient estimate for extension access is positive and significant ($p<0.1$). This implies that farmers who have engaged more with extension officers are willing to pay higher prices than those who have engaged less. The results indicate that, at the base level ($Z=0$), farmers who have had access to extension are less willing to pay compared to their counterparts who have not had access to extension services. A 1.40% chance of being more willing to pay is observed for farmers prepared to pay the starting bid price of R50 and a further 1.40% more chance of being willing to pay of farmers prepared to pay R75.

Table 3.6: Parameter Estimates and Marginal Effects of Ordered Probit Model

Y	Coefficient	Std. Err.	Marginal Effects			
			Z=0	**Z=1**	**Z=2**	**Z=3**
Gender	-0.516	0.449	0.187	-0.018	-0.085	-0.084
Age	-0.008	0.009	0.003	-0.002	-0.001	-0.001
Household size	0.024	0.016	-0.009	0.001	0.004	0.004
Household distance	-0.013	0.029	0.005	-0.001	-0.002	-0.002
Duration	0.002	0.004	-0.0009	0.001	0.001	0.004
Access to credit	0.063	0.261	-0.023	0.002	0.010	0.011
Access to extension	0.0868*	0.045	-0.031*	0.003	0.014*	0.014*
Training	0.707***	0.218	-0.236***	0.010	0.108***	0.138***
Conflicts	0.426	0.273	-0.146*	-0.0001	0.068	0.079
Total land holdings	-0.287	0.216	0.104	-0.010	-0.047	-0.047
Household Assets	-3.58e-07	1.2e-06	-3.58e-07	0.004	1.63e-07	1.62e-07
Livestock size	0.001	0.007	-0.000	0.001	0.001	0.002
Association member	0.266	0.228	-0.097	0.011	0.044	0.042
Off-farm income	-3.33e-06	7.76e-06	-3.33e-06	0.003	1.51e-06	1.50e-06
Place	-0.019	0.392	0.007	-0.001	-0.003	-0.003
Pump_1	0.840	0.608	-0.248*	-0.062	0.112*	0.199
Pump_2	0.681***	0.248	-0.230***	-0.003	0.105**	0.128***
Education_1	0.087	0.219	-0.032	0.003	0.014	0.014
Education_2	-0.099	0.311	0.036	-0.005	-0.016	-0.015
Marital status	-0.168	0.226	0.061	-0.006	-0.028	-0.027
Scheme management	0.720***	0.208	-0.251***	0.011	0.113***	0.126***
Road conditions	0.296***	0.078	0.134***	.0101	0.049***	0.048***
/cut1	0.621	1.087				
/cut2	1.692	1.090				
/cut3	2.401	1.082				
Wald chi^2(22)	85.48***					
Pseudo R^2	0.2315					
N	160					

Notes: ***, ** and * means significant at 1%, 5% and 10% levels, respectively

Source: Household survey (2013)

Similar to extension, the coefficient estimate for training is positive and significant ($p<0.01$). The results indicate that the farmers who have received agricultural skills-related training are willing to pay for improved irrigation, compared to those that have not received any training. That is, at base, those farmers that have received training have a 23.60% chance of being less willing to pay than their counterparts who have not received any training. There is a 10.80% higher chance of being willing to pay the starting bid price of R50 and a 13.80% higher chance of being willing to pay R75. This means that when a farmer moves from receiving agricultural training to not receiving it, the odds of being willing to pay fall.

The coefficient estimate for diesel pump (pump_2) is positive and significant ($p<0.01$) implying that those farmers using a diesel pump are most likely willing to pay more for improved irrigation, compared to the farmers using gravity driven water or an electric pump. At the base level, farmers using diesel pumps have a 23% lower chance of being willing to pay compared to their counterparts who use gravity or an electric pump. There is a 10.50% and 12.80% higher chance of being willing to pay for farmers at the bid price of R50 and R75, respectively.

The coefficient estimate for scheme management is positive and significant ($p<0.001$). Results presented in Table 3.6 reveal that at the base level, farmers who perceive the management of the scheme to be good were 25.10% less willing to pay, compared to their counterparts who perceived the management of the scheme to be poor. The table further revealed a 11.30% higher chance of WTP of farmers at the bidding price of R50 and a 12.60% higher chance of WTP of farmers who were willing to pay R75.

Farmers’ perceptions of the condition of the roads are positive and significant ($p<0.01$). Farmers who perceive the road condition to be good are willing to pay more than farmers who perceive it to be bad. There was an unexpected turn of events in road condition perceptions, as farmers in the base scenario who perceived road conditions to be good were found to have 13.40% more chance of being willing to pay, compared to their counterparts who perceived road conditions to be poor. Farmers who perceive the road conditions to be good have a 4.90% more chance of being willing to pay the starting bid of R50 and a 4.80% more chance of being willing to pay R75.

3.6 Discussion

The significance of duration is expected because the longer the farmers are involved in the scheme, the more experience gained on how to make effective use of the irrigation systems and they are more aware of the full value of the facility; they would rather pay for the water. These findings are in line with the findings of Hudu *et al.* (2014) and consistent with those of Assefa (2012), who suggests that household with longer irrigation farming experience can easily realise the benefit from it and hence are more likely to attach high value to irrigation agriculture than those who have none or fewer years of irrigation farming experience.

This agrees with the findings of Ndetewio *et al.* (2013). Farmers who reported to have had agricultural training have a 17.50% more chance of being willing to pay, compared to their untrained counterparts. The findings of the present study concur with those of Hudu *et al.* (2014) who reported that availability of a ready market had a significant influence on farmers' WTP for irrigation services. It is also in line with Mudhara (2010), who considered that, amongst other things, market failure occurs largely due to poor infrastructure, where poor infrastructure is in the form of poor or non-existent roads and transport that is not readily available or which tends to be expensive. This means that benefits from interacting with the market are low. Transport and distribution constraints isolating smallholder farmers from markets dictate that they can be working at a loss, or not making the profits that they otherwise would have made, and thus are unwilling to pay.

This study highlights the importance of strengthening farmer participation in the management of the scheme, as it was found that well-managed schemes enhance the willingness of farmers to pay for improved irrigation water. Farmers who were members of well-managed blocks, with lower incidence of conflicts, were more willing to pay for improved irrigation than those in conflict-prone blocks. According to Sinyolo (2013), harnessing the collective voice of smallholders at various levels is imperative and could contribute positively to farmers' WTP.

The farmers at the base level (not willing to pay at all) seem to be moved by most of the variables included in the model. No matter the services provided, if anything, the service provision seems to irritate them further, increasing their level of unwillingness to pay. They were found only to be moved by road conditions, as they were willing to pay if they perceived the road conditions to be good. Perhaps different interventions are needed for different farmers in different blocks.

Unlike the existing literature on contingent valuation of irrigation water, the present study failed to find a significant relationship between income and WTP for irrigation water. Even though income was shown to be insignificant, it was highly expected to have a positive significant influence on WTP, as has been reported in various studies such as those of Adepoju & Omonona, (2007) and Akter (2006), who found that income had no significant effect on WTP. This could perhaps be due to the large-scale damage of crops by erratic and destructive weather conditions experienced in the area, where farmers made huge losses.

3.7 Conclusion

The main aim of this paper was to determine farmers’ WTP for improved irrigation water supply in rural KZN and the factors affecting their willingness. Farmers are generally willing to pay given appropriate improvement in irrigation water supply. The study highlights that support services such as extension services and training do influence their WTP. This suggests that government should encourage more interaction between farmers and extension officers. This will allow the farmers to learn more on crop production but should also teach the farmers the importance of using water efficiently and value it as an economic resource. The study recommends that government should formally introduce water charges, which may start from a charge of R50 per month per bed, as selected by a majority of the bidders (farmers); with future possibilities of increasing the charge gradually, over time.

CHAPTER 4: DETERMINANTS OF FARMERS' ABILITY TO PAY FOR IMPROVED IRRIGATION WATER SUPPLY IN RURAL KWAZULU-NATAL, SOUTH AFRICA

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4.1 Abstract

The aim of this chapter is to determine smallholder farmers' ATP for improved irrigation water supply using their gross margins in rural KZN, SA. The analysis was conducted on a sample of 161 irrigators in Msinga Local Municipality. Production data was collected from the irrigators and the residual imputation method was used to calculate gross margins/profits received by the farmers. An ordinary least squares regression was used to determine factors affecting ATP. Empirical results indicate that factors such as labour, training, household assets and road conditions positively influence ATP. The study highlights the importance of farmer support and institutions. The study concludes that farmers are making profits from their irrigated crops, especially tomatoes, and therefore recommends that farmers start paying for the water used for their crop production.

Keywords: Smallholder irrigation, Ability to pay, Residual imputation method (RIM), Gross margins, OLS regression

4.2 Introduction

Smallholder irrigation is an important rural development factor, creating employment opportunities, generating income and enhancing food security in Africa, in general, and in South Africa, in particular (Bacha *et al*., 2011; van Averbeke *et al*., 2011; Denison & Manona, 2007a; Speelman, 2009). As a result, South Africa has made enormous investments in the sector by rehabilitating existing schemes (Perret & Geyser, 2007). On the other hand, the agriculture sector, being the largest water user, is under pressure to release water to other sectors (Kanyoka *et al.*, 2008). The growing water scarcity continues to put pressure on farmers to allocate water more efficiently. A growing area of interest in SA is that of finding a balance in effective resource management strategies for allocating water among the key sectors (Speelman, 2009; Yokwe, 2006).

Effective water resource management requires that water be treated as an economic commodity. Making rational decisions about water resource management requires reliable estimates of the economic value of water (Speelman, 2009; Hellegers & Perry, 2006). Knowledge of this value contributes significantly to designing fair, informed and rational pricing systems, providing incentives to irrigators to use water sparingly and efficiently and allowing recovery operations and maintenance (Perret & Geyser, 2007). Moreover, understanding water values plays an important role when making investment decisions in the development of water resources, policy decisions on sustainable water use and water allocation.

In SA, the issue of water valuation among small-scale irrigation schemes is topical, following the new water policy released by the Minister of Water Affairs and Forestry in April, 1997. According to the new policy, water subsidies currently received by farmers will gradually decrease and they will increasingly have to pay for their water use (DWAF, 2004). It is in this context that studies investigating WTP and ATP have been undertaken by authors such as Adepoju & Omonona, 2007; Akter, 2006; Alhassan, 2012; Bogale & Urgessa, 2012; Futija *et al*., 2005; Kanyoka *et al*., 2008; Moffat *et al*., 2011; Ndetewio *et al*., 2013; Nyekanyeka, 2011. ATP studies are important because, while irrigators may be willing to pay for improved water services, the question of their ability to do so still remains. While WTP concerns the maximum amount which water-users are willing to pay for a hypothetical service, it is difficult to directly use this as a basis for setting tariffs. It is necessary to set the irrigation water fee/price at a level that the majority of irrigators can actually afford to pay, considering that most of these farmers depend on irrigation for their livelihoods. For that purpose, ATP is frequently referred to and used.

The ATP is considered as the amount which irrigators can pay for water for their cropping needs and is calculated with reference to gross margins (Fujita *et al.*, 2005). Charging farmers for irrigation water should be done carefully, because if prices are set too low, revenues may not be sufficient to cover the full costs of supplying the water. If they are set too high, irrigators may not be able to afford the new improved irrigation water supply. Therefore, to set the required water price, information on the ability of irrigators to pay for such services is essential. Since pricing of water is a key component of an appropriate incentive for efficiency, sustainability and accountability, there is a need to study the demand for the service in order to understand the fundamental value that irrigators place on the improved water service, so that the price that reflects the ability of the irrigators to pay for the improved water services can be established (Alebel, 2002). This study aims at estimating the amount farmers are able to pay for improved irrigation service, using farmers' gross margins. The study investigates the factors that determine farmers' ATP for improved irrigation in Msinga Local Municipality.

4.3 Research Methodology

4.3.1 Study area description

Primary data for the study was collected in Msinga Local Municipality, Mzinyathi District, South Africa. Over 69% of this land (1 725 km^2) is under traditional authority (Dearlove, 2007). The remaining 31% is commercial farm land. Much of the terrain is located in deep gorges of the Tugela and Buffalo Rivers. This effectively isolates the municipal area from the immediate surrounding municipal areas.

Msinga has very limited employment opportunities. Agriculture is one of the most important economic sectors in Msinga, with most households engaged in smallholder farming (Cousins, 2012; Sinyolo, 2013). Rain-fed crop production, however, is very challenging in Msinga, because the area is hot and dry. The area is characterised by frequent droughts, making irrigation the main mode of household food production (Cousins, 2012). One opportunity that exists for some of the rural people to increase their incomes and participate in the local economy is provided by irrigation, specifically from the Tugela Ferry and Mooi River irrigation schemes. The two irrigation schemes play an important role in the local economy of Msinga as sources of food, employment and markets for agricultural inputs (Cousins, 2012; Gomo, 2012; Sinyolo, 2013).

The distinctive features of irrigation farming in the Msinga schemes are very similar to those found in other low-cost, gravity-fed system schemes in South Africa. They are similar in plot sizes, which are small. The systems of production are highly labour-intensive and common cash crops include green maize, tomatoes, cabbage, potatoe, and leafy green vegetables. The production of specialised types of fresh produce for niche markets is absent or very limited (Denison & Manona, 2007; van Averbeke & Khosa, 2011; Cousins, 2012).

The Tugela Ferry irrigation scheme is located on both banks of the Tugela River, which supplies the scheme with water. The scheme was planned and constructed by the Natal Native Trust between 1898 and 1902 and has been operational ever since (Cousins, 2012). The scheme is made up of seven blocks of irrigable land, covering 837 ha (Cousins, 2012; Fanadzo, 2012). A total of about 1 500 irrigators participate in the scheme, growing various crops. According to Cousins (2012), the Tugela Ferry irrigators comprise about 15 percent of all smallholder irrigation farmers in KZN province (Sinyolo, 2013).

Farmers in the irrigation scheme were initially allocated two plots, each of 0.1 ha in size. Over time, some farmers acquired more plots through leasing or borrowing from neighbours. The main access to land is through the traditional authorities, who allocate land to households. Selling of land is not permissible under the current traditional land tenure system.

Initially, all the blocks were to receive water from the main, gravity-fed canal. However, over time, water shortages have persisted, leaving only four blocks to benefit from the canal, while other blocks use motorised pumps (Sinyolo, 2013). The four blocks receiving water under the gravity system are blocks 1 to 3 and 5; this system uses a canal that is 31 km to draw the water. Block 4B uses a diesel pump, whilst the remaining two blocks, 4A and 7, use electric pumps.

In the Mooi River irrigation scheme, a weir constructed across the Mooi River abstracts water into a canal, which runs for a distance of 20.8 km, from the abstraction point to the end of the scheme (DAEA, 2011). The scheme has 15 blocks, of different sizes. The exact year that the scheme was established is not known but it is speculated that it may have been early in the 20^{th}

century. Most of the farmers grew up with their parents participating in the scheme. Essentially, the purpose of the scheme is to improve the livelihoods of those in the surrounding areas through food production and job creation (Gomo *et al.*, 2012). The scheme covers a total area of 600 hectares, divided into plots which are approximately 0.1 hectare in size. The scheme is made up of approximately 824 farmers, each occupying at least one plot; however, some farmers occupy more than one plot (DAEA, 2011).

The scheme is managed through block committees; who, among other things, see to the distribution of water. As a whole, the scheme is managed by the Irrigation Management Committee, which ensures equitable water distribution, resolves conflicts, etc. (Gomo, 2012). The first 11 blocks (blocks 1-11) draw water under gravity and the last four (blocks 12-15) are receiving water with the aid of a diesel pump. Initially, all the blocks received water from the main canal, but water shortages due to leakages and multiple uses, and increased number of participants, has meant that only the first 11 blocks benefit from the gravity-fed canal (Gomo, 2012). (Refer to Figure 3.1 for the map of the Tugela Ferry and Mooi River irrigation schemes in Msinga Local Municipality, South Africa)

4.3.2 Data collection methods

A structured questionnaire was used to interview the farmers who were household heads. Information captured in the questionnaire include household characteristics, land, crop systems, market, sources of off-farm income, credit, water management aspects and problems associated with agricultural practices, in general. The questionnaire was pre-tested and modified appropriately to improve its reliability and validity. Field data was collected in November 2013 over a period of three weeks, from two irrigation schemes, the Mooi River and Tugela Ferry. A random sampling procedure was employed to select a total of 161 respondents; where 131 were from Mooi River and 30 were from Tugela Ferry.

4.4 Empirical Methods

4.4.1 Residual imputation method (RIM)

RIM was used to measure the return to water out of the gross margin obtained from all the production inputs employed. The RIM is the most frequently used approach to applied shadow pricing of producers' goods, particularly for irrigation water (Young, 1996; Speelman, 2009; Yokwe, 2006). For the RIM, the incremental contribution of each input in the production process is determined. If appropriate prices can be assigned, presumably by market forces to all inputs but one, the remainder of the total value of the product is attributed to the remaining or residual input, which, in this case, is water (Young, 1996; Lange & Hassan, 2007).

The residual valuation assumes that if all markets are competitive, except the one for water, the Total Value Product (TVP) equals exactly the opportunity costs (OC) of all the inputs:

$$TVP = \sum VMP_{i*}Q_i + VMP_{w*}Q_w$$

Where TVP= total value of the commodity produced; VMP_i= value of marginal product of input i, VMP_w= value of marginal product of water, Q_i= quantity of input i used in production and Q_w=quantity of water used in production.

It is assumed that the opportunity costs of non-water inputs are given by their market prices (or their estimated shadow prices). Therefore the shadow price of water can be calculated as the difference (the residual) between the total value of production (TVP) and the costs of all non-water inputs to production. The residual, obtained by subtracting the non-water input costs from the total annual crop revenue, equals the gross margin (GM) and can be interpreted as the maximum amount the farmer could pay for water and still cover costs of production.

$$GM = TVP - \sum P_i Q_i$$

Where: GM = gross margin and P_i= price of input i.

The technique is based on two principles, as discussed in Young (1996) and Speelman (2009):

i) The prices of all resources should equal returns at the margin. This is a well-known condition for competitive equilibrium, i.e. as would occur if perfectly competitive markets were to exist for all agricultural inputs; and ii) The total value of production (TVP) can be divided into shares; in such a way that each resource is paid according to the value of its marginal productivity (VMP) and the total product (TP) is completely exhausted (Young, 1996; Lange & Hassan, 2007).

The RIM has the advantage of being relatively easy to implement. However, it is very sensitive to small variations in the specification of the production function and assumptions about market and policy environment. The RIM is, therefore, only suitable when the residual input contributes a large fraction of the output value. This is the case for irrigated agriculture in water-scarce regions (Speelman, 2009; Yokwe, 2006). If an input to production is omitted or underestimated, its contribution is wrongly attributed to water. To overcome this problem, all relevant inputs should be included in the model. Some important inputs, such as, farm labour, including family labour, are often unpaid. A shadow price is then estimated, usually in terms of the opportunity cost of the workers (Young, 1996).

In the present study, the revenue earned by the farmers for each crop was calculated by multiplying their production by individual market prices. The portion of total production that was consumed by the household was excluded, as it was impossible to calculate. On the input side, costs of fertilizers, pesticides, fuel, tillage and labour were taken into account. These were considered the relevant inputs in the production process. For fertilizers and pesticides, the competitive market prices were used to determine costs. The inputs provided to farmers by extension services were also valued and added to input costs. For inputs and the output, market and individual prices are considered to equal shadow price.

Most farmers in Msinga employ family labour. According to Van Averbeke (2008), one of the important advantages of using family labour is flexibility. Individual family members are often faced with the choice between working on the farm and engaging in other economic activities, which might be more rewarding financially. Motivating family members to work on the farm is thus a critical management factor. To calculate labour costs, a shadow price of R20 per day per person was used. This value was estimated using the discussions with farmers and extension officers during focus group discussions and key informant interviews. Following the focus group discussions and key informant interview, labour is employed in the plots twice a week, for four weeks a month, over a cropping season. To calculate the number of labour per household, respondents were asked about their household sizes and the number of people younger than 14 years old and the number of people who are disabled, within the household. The number for the disabled and those below 14 was subtracted from the total household size. The remaining number of people was considered the available household labour. To calculate the gross margins, the total costs were subtracted from the total revenue and then divided by the land occupied by the farmer, in order to get gross margins per hectare.

4.4.2 OLS regression

The Ordinary Least Squares (OLS) method was employed to determine the factors that influence farmers' ability to pay. The OLS regression model was estimated as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + \beta_i X_i + e_i$$

Where Y is the dependent variable, which is gross margins; βs are the parameter estimates, Xs are the explanatory variables. The variables used for the OLS estimation are presented in Table 4.1.

4.5 Empirical Results

4.5.1 Descriptive Statistics

The schemes have some distinctive features: the great majority of plot holders are women (88.75%) rather than men (11.25%). The age of the farmers in the schemes ranges from 18 years to 88 years, the average being 58 years. This shows that the more elderly are more interested in agriculture. This could be indicative of the fact that the males and the younger population have moved to the cities, perhaps hoping to explore better opportunities. Where household size is concerned, the minimum is one person in a given household and the maximum is 20, the average household size is 6.57. This could potentially indicate fairly good family labour, especially when labour availability is dependent mainly on the family size. Of the sampled population, 57.14% had no education and 15.53% had obtained secondary education. This shows very low levels of literacy in Msinga. This is disappointing, especially because the gross margins and productivity of the farmers are expected to be influenced by their education level. When regarding at duration in the scheme as a proxy for experience, the minimum is one year and the maximum is 40 years. The mean duration is 19.3years. Experience is also very important as it is expected to aid farmers in increasing both their productivity and their profitability.

Table 4.1: Description of the variables

Variable	Variable description	Expected sign
Dependent Variables		
Ability to Pay (ATP)	Gross margins realised by farmers from their production	
Independent Variables		
Gender	Household head gender: Male= 0, Female=1	-
Age	Household head age (years)	+
Land Security	Farmer perceptions of their land tenure security	+
Household Labour	Number of household members available to work in the plots	+
Household Labour^2	Number of household members available to work in the plots	-
Duration	Number of years that the household has been involved in the irrigation scheme	+
Access to credit	Access to credit in the past year: Yes=1, No=0	+
Access to extension	Access to extension services in the last year in numbers (Number of visits in the last 12 months)	+
Training	Agricultural skills training: Yes=1, No=0	+
Total land	Total land holdings of household (ha)	-
Household assets	The value of household assets (Rands)	+
Livestock size	Livestock size in Tropical Livestock Units (TLU)	+
Off-farm income	Off-farm income (Rands)	+
Pump_1	Pump used: Electric pump=1, Gravity or otherwise=0	+
Pump_2	Pump used: Diesel pump=1, Gravity or otherwise=0	+
Education_1	Education level of respondent: No education=1, Primary education or otherwise=0	-
Education_2	Education level of respondent: Secondary education=1, Primary education or otherwise=0	+
Scheme management	Farmers' perceptions on the management of the scheme: Good=1, Poor=0	+
Road conditions	Farmers' perceptions on the road conditions: Good=1, Poor=0	+

The production of food crops for home consumption is limited as, according to the farmers, approximately a quarter or less is consumed at home, whilst the bulk of production is for sale; almost all crops use costly fertilizers and crop chemicals; use of hired labour is not common and most farmers employ household labour. An active, informal plot rental market makes it possible for many farmers to gain access to additional plots. About a third (30.43%) of farmers responded "yes" when asked if they were leasing any land. This land rental market means that most plots are cultivated in most years.

The present study found that the most popular crops in summer were maize, which is grown by 67.08% of the population, potatoes, grown by 62.73%, and tomatoes, grown by 37.89% of the total sampled population. In winter, beans and cabbage were the dominant crops, where beans were grown by 38.51% of the sampled population and cabbage by 27.33%.

Table 4.2 reveals crops that were most popular in the summer and winter seasons. The yields in the tables are those realised in the schemes. However, according to Mnkeni *et al.* (2010), the actual yields obtained fall far below the potential yields that could be obtained for a particular crop when not limited by technology, i.e., when the best cultivars, fertilizer, machinery and labour, including knowledge, are all available and applied in the best possible ways. An average of 3.56 tons per ha of maize is produced by the farmers in the schemes and the mean gross margin is R3 497.57 per ha. According to Mnkeni *et al.* (2010), maize could potentially have yielded 8.20 tons per ha.

Potatoes yielded 21.35 tons per ha, with a mean gross margin of R3 501.79 per ha. This yield is achieved from the majority of plantings by the average grower. Mnkeni *et al.* (2010), however, found the potential yields to be greater once again than those achieved and reported in this study, as he found that some farmers yielded 45.30 tons of potatoes per ha. Tomatoes had the least number of growers in summer. This may be due to the costly nature of tomato production, from the fertilizers to the herbicides and pesticides that are used. On average, the yield of tomatoes was 28.94 tons per ha, with an average gross margin of R17 249.41 per ha. Mnkeni *et al.* (2010) reported an average potential yield of 47.10 tons per ha for tomatoes. From these results it can be concluded that tomatoes are the most profitable crops in the summer season.

With the winter crops, the average production of beans was 0.87 tons per ha, with an average gross margin of R2 913.14. Cabbage production was unsatisfactory. According to Mnkeni *et al.* (2010), the average potential production per ha is expected to at least be 64.80 tons per ha for small-scale irrigators. However, in these schemes, the average yield was 19.50 tons per ha and the gross margin was a low R1 909.19 per ha per season.

Table 4.2: Crop yields for crops dominant in summer and those dominant in winter.

Crop	Number of growers	Percentage of growers (%)	Mean production (tons per ha)	Gross Margin Range (per ha)		Gross Margin (mean)
Dominant summer crops				**Min**	**Max**	
Maize	108	67.08	3.56	-R5 500.00	R14 700.00	R3 497.57
Potatoes	101	62.73	21. 35	-R2 900.00	R10 700.00	R3,501.79
Tomatoes	61	37.89	28.94	-R5 4201.00	R39 500.00	R 17 249.41
Dominant winter crops						
Beans	66	41.00	0.87	-R2 593.00	R9 970.00	R2 913.14
Cabbage	44	27.33	19.50	-R1 600.00	R6 489.00	R1 909.19

Source: Household survey (2013)

The yields reported in this study fall far below the potential yields reported by Mnkeni *et al.* (2010) but this was expected. It emerged in focus group discussions and key informant interview that there had been a hailstorm known as Hurricane Irene, which swept away most of the crops that were almost ready for harvest. The area had also experienced the worst drought ever. Storage dams were without water, resulting in devastating crop yields.

Table 4.3 makes comparisons of gross margins across categorical variables. The statistics in Table 4.3 show that male farmers have relatively higher gross margins than their female counterparts. This difference in gross margin between genders is statistically significant. This result, which was expected, indicates that male-headed households realise higher gross margins than female-headed households, probably because males have better access to resources, resulting in higher productivity.

A comparison of gross margins reveals that there is a statistically significant difference between the gross margins of those who feel that they are land secure and those who are not. On average, those who are land insecure have gross margins of R13 464.69 and those who are land secure have average gross margins of R10 485.90. There were statistical differences between gross margins between farmers relying on gravity or motorised pumps, as well as between farmers from the two irrigation schemes.

Table 4.3: Gross margin comparisons across different categorical variables

Variable Definition	Category 0		Category 1		T-test significance
	Mean	Std. Dev.	Mean	Std. Dev.	
Gender (0=Female, 1=Male)	R11 898.01	13 743.35	R18 880.73	18 058.25	**
Place (0= MRIS, 1=TFIS)	R13 502.38	14 705.06	R9 314.64	12 838.23	Ns
Irrigation system (0=Gravity, 1= Motorized pump)	R13 464.69	16 149.44	R11 951.22	12 455.86	Ns
Land security (0=Insecure, 1=Secure)	R10 485.90	13 031.27	R16 693.16	15 986.95	***
Road conditions (0=Poor, 1=Good)	R10 561.06	14 073.41	R13 237.37	14 520.18	Ns

Notes: ***, ** and * means significant at 1%, 5% and 10% levels of significance, respectively

Source: Household survey (2013)

4.5.2 Factors affecting Ability to Pay for water

An OLS model was estimated to determine the household characteristics and resource endowments that predict households' ATP for improved irrigation. The results of the model are presented in Table 4.4. The results show that, collectively, all estimated coefficients are statistically significant, since the F statistic has a p-value less than 1%. The R^2 value is about 30.88% and is acceptable, considering this is cross-sectional data.

Among the 19 explanatory variables included in the model, seven had a significant impact on respondents' ATP. Empirical results from the estimated model reveal that gender, land security, household labour, square household labour, training, household assets and road conditions significantly impact on farmers' ATP.

ATP (P<0.1). The results indicate that if the household head is female, the ATP is R6 400.56 less than that of male-headed households, *ceteris paribus*.

The parameter estimate for land security is negative and significant (p<0.05). This implies that the ATP of farmers who do not feel secure with their land is R4 776.26 less than that of those who feel secure, *ceteris paribus*.

Table 4.4: Determinants of farmers' ability to pay for improved irrigation

Gross Margin (Y)	Coefficient	Std. Err.
Gender	-6 400.56*	3 324.14
Age	-113.17	81.64
Land security	-4 776.26**	2 341.61
Household labour	3 187.98***	1 071.52
Household labour squared	-208.37**	108.44
Duration	7.00	49.48
Credit access	-545.73	2 507.21
Extension service access	-254.9	570.06
Training	6 590.72**	2 129.12
Total land holdings	2 088.71	1 763.82
Household assets	0.03**	0.01
Livestock size	-36.29	83.88
Off-farm income	0.12	0.17
Pump_1	9 078.06	5 519.16
Pump_2	1 111.27	2 488.54
Education_1	4 368.7	2 358.14
Education_2	-285.14	3 336.54
Scheme management	-3 415.6	2 244.71
Road conditions	1 598.91**	752.47
Cons	16 964.1	9 410.87
F statistic	2.67***	
R-squared	0.3088	
N	160	

Notes: ***, ** and * means significant at 1%, 5% and 10% levels of significance, respectively

Source: Household survey (2013)

The household labour coefficient estimate is positive and significant ($p<0.01$). This implies that if the household labour increases by one person, the ATP will increase by R3 187.98, *ceteris paribus*. However, the relationship between labour and gross margin is not linear, but increases at a diminishing rate. When household labour squared, the coefficient estimate thereof is negative and significant ($p<0.05$). As household labour increases, the households' ATP for improved irrigation initially increases, but decreases at higher levels of household labour, *ceteris paribus*.

The coefficient estimate for training is positive and significant ($p<0.05$). This implies that farmers/household heads who have received some form of agricultural-related training have R6 590.72 more, an indication of ATP for irrigation water compared to those who have not received any form of training, *ceteris paribus*. This was expected, as training can equip farmers with the information that will help them to increase their productivity, which improves their ATP.

The parameter estimate for household assets is positive and significant ($p<0.1$). This implies that an increase in the household assets will result in an increase in the ability of the household to pay for the improved irrigation, *ceteris paribus*. Household assets are a sign of wealth, such that families with high-valued assets are expected to have invested in more capital and production technologies which would allow them to produce more, realise higher gross margins and, consequently, be able to pay for improved irrigation. Household assets in the present study include houses, cars, water tank and motor cycles, which were all valued and added together to get their total value at household level.

According to the model, farmers' perceptions of the conditions of the roads impact on their ATP for improved irrigation. The parameter estimate for road conditions is positive and significant ($p<0.05$). If farmers perceive the road conditions to be good, their ATP for irrigation water will be R1 598.91 more than that of their counterparts. Good road conditions could mean better access to markets. If farmers are able to reach markets, they are able to sell their produce with ease and realise gross margins. Increased profits result in increased ATP for water.

4.6 Discussion

The findings that male-headed households earn higher gross margins suggest that male-headed households generally have better access to resources, which is expected to aid increased profits and therefore the ability to pay. These findings are in line with the findings of Quisumbing (1996) and Udry *et al.* (1996), who found that, in SSA, women have less access to education, labour, fertilizers and other inputs. That is, women are more subjected to the "learning by doing" process, because most of them are illiterate and agricultural practices are often transmitted from one generation to another. This differs, however, for males, because of higher literacy rates, access to resources and consequent higher productivity and gross margins. Kyomugisha (2009) found similar results, where land security is one of the factors that influence investment to enhance land productivity, and increase gross margins. Farmers who are land secure are more likely to invest in improved production practices than those who are not land secure. Farmers who are land insecure may not invest much to keep the land in good condition eg. adopting practices such as crop rotation to ensure that the land is always productive. They may be trying to extract as much as they can, in the process reducing the quality of the soil and reducing the productivity thereof. Kyomugisha (2009) concludes that land security impacts positively on the level of production investment made, which increases the productivity and gross margins, and the ability of the farmers to pay for water.

There are a number of organisations which train farmers. These organizations are from the government, non-government organizations and private sector. The government is the major player in providing training through its various agricultural development programmes (Kinambuga, 2010). The government also collaborates with non-governmental organisations to train farmers. The proportion of farmers who access training is low and this has a bearing on their production abilities, gross margins and their ATP for irrigation water. Only 31.06% of the respondents had received training related to agriculture and agricultural production. Training is important in giving farmers production information and technologies that would help increase their productivity. Therefore those farmers who had not received any training risk having low production because of lack of knowledge. The average asset base of the farmers in the present study was found to be R83 916.34. The expectation is that households with higher valued assets have relatively higher production and make good gross margins and should be able to pay for irrigation water. This concurs with the findings of Kinambuga (2010).

According to Arias *et al.* (2013), where the integration of producers into markets is limited, interventions to reduce barriers to market participation will often have a greater payoff. One such intervention is improving connectivity to markets, through improved market information systems, by improving feeder roads or reducing the fees that traders need to pay to move products between markets. Farmers' perception of their roads is thus one way to determine their access to market (Arias *et al.*, 2013). In the present study, farmers' perceptions have been used as a proxy for market access and 80.75% of the sampled population perceived the roads to be in good condition, thus implying that they are able to sell their produce and realise profits.

4.7 Conclusion

The main aim of this study was to determine the ability of farmers to pay for improved irrigation water supply in rural KZN, Msinga Local Municipality, and to determine factors that determine their ATP for improved irrigation. Results show that farmers are realising positive gross margins from their plots. Some, however, made negative gross margins due to harsh weather conditions, but there usually are gains that are realised from the irrigation schemes. The study shows that support services such as training play a vital role in improving farmers' understanding of agricultural related issues, influencing their cropping patterns and thus their ATP for water. Furthermore, the study brings forth the importance of institutions, particularly issues such as land tenure security that also influence the ability of farmers to pay for irrigation water. The study therefore recommends increased farmer training to expose farmers to agricultural knowledge. The study further concludes that, given the gross margins of the farmers, the farmers generally have the ATP for improved irrigation. Government policies to ensure sustainability of irrigation smallholder irrigation schemes should recognise the opportunity to recoup running costs directly from farmers.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Recap of research objectives and methodology

The first objective of the study was to estimate farmers' willingness and ability to pay for improved irrigation and to determine factors affecting their willingness and ability to pay for improved irrigation. The second dimension of the study aimed at generating the ability to pay variable. The study reasoned that if farmers are making sufficiently high gross margins, then they should be able to pay for water or improvements to irrigation.

Using a sample of 161 irrigators, generated through a stratified random sampling procedure, data analysis involved both descriptive and econometric techniques. Descriptive analysis made use of the t-tests and $\chi 2$ tests, while econometric analysis involved binary and ordered probit models, as well as the OLS model. Data from qualitative sources (key informant interviews and focus group discussions) were used to improve interpretation of the results from the econometric models. Chapter 5 presents the main conclusions of the study. Based on the empirical results, the chapter also draws several policy recommendations. The last section of this chapter presents suggested areas of further investigation, in the future.

5.2 Conclusions and summary of key results

The study found that, although all the irrigators had the same demographic patterns, there was a mixed response on the question of willingness and ability to pay. While 38% of the farmers were not willing to pay, a larger portion of 62% were willing. Factors such as duration in the scheme and extension access, amongst others, played a significant role in the differences in WTP. It was concluded that participation in the scheme and access to extension are essential in order to improve farmers' WTP. These findings idicate the importance of support services provided by government and NGOs to smallholder farmers. The study found that 62.91% of the farmers responded that they had not been in contact with an extension officer in the past year. This means that farmers had either not taken full advantage of these services offered to them, or they were not aware of them. Government therefore needs to continue providing these services and strengthen them, by perhaps investing in awareness campaigns, where farmers are alerted on all the services available.

The χ^2-tests confirmed the vitality of support services towards smallholder irrigation in improving gross margins. Training was found to be a significant factor in differentiating those that were willing to pay for improved irrigation and those that were not. These tests found that infrastructure such as roads also impact on WTP, as farmers who perceived the road conditions to be good were generally WTP, compared to those who perceived them to be bad. One of the biggest constraints to farmers' access to markets has been poor road conditions. If farmers are able to access markets, they should be able to earn higher gross margins and this would be expected to make them more willing to pay for improved irrigation. There is thus a need for government to invest in rural infrastructure.

Farmers have many different cropping patterns and crop choices. The study found that the most dominant crops in the summer season were maize, potatoes and tomatoes whilst beans and cabbage were the most dominant in winter. In terms of profitability across all the five crops, farmers realised the highest gross margins from tomatoes and the least from cabbage. Perhaps, to encourage the farmers to grow more tomatoes, government could, for one season, subsidise farmers with tomato seeds or pesticides as tomatoes are relatively expensive to grow. With regards to ATP, the study found that farmers who are insecure with their land tenure realised lower gross margins, compared to the irrigators who had tenure security. The appropriate policy to increase land tenure security remains uncertain. Land administration intervention is needed from government, in order to improve land utilisation and productivity on smallholder irrigation schemes by increasing security of tenure.

Empirical model results indicated that factors such as extension services, training, motorised pumps (diesel), scheme management, duration in the scheme, livestock ownership and road conditions positively influence WTP, while factors such as labour, training, household assets and road conditions increase ATP. Whilst all these factors are important, special mention of the motorised pump has to be made. Although the farmers in six blocks (block 1-6) of the MRIS receive water through gravity, and in abundance, the farmers in the middle blocks (block 7-11) receive very little water, because those in upper blocks irrigate even on days when they are not meant to irrigate. This has implications, as lack of water means that their crop production is very low, such that some even stop crop production. Even in the last blocks (block 12-15), where a motorised diesel pump is being used, only one pump is available for use and it is meant to be used by approximately 200 farmers in that block. Thus far, this system has not been feasible, as there are too many farmers. The pump is overworked and breaks frequently. There is a need, therefore to introduce more motorised pumps in the aforementioned blocks for better access to water, as this will have positive implications for both ATP and WTP.

5.3 Policy recommendations

Based on the findings of this study, it is recommended that:

- There is an urgent need for farmer empowerment through education. One of the greatest challenges faced during the study was that farmers are not equipped with record-keeping abilities; be it in their production data or simple accounting of their costs, incomes and gross margins. Most farmers are not even aware that tomatoes earn the highest gross margins. They could be diversifying into other crops, and could be concentrating on the highest paying crop, earning more income and, in the process, allocating the water resource efficiently, in line with the objectives of the new water policy.
- There is a need to educate farmers on water factors, more so on the concept of water scarcity as they are oblivious to such issues. Until they are made aware of these issues, overexploitation and misallocation of the resource will persist. Moreover, they will never value the resource, nor be willing to pay for it. Farmers are not entirely comfortable with paying for improved irrigation, let alone paying for the water resource. They perceive it as offensive as this resource appears naturally; some even believe that the water is from their forefathers.
- Farmer participation in scheme design and management should continue to be promoted. The farmers who participate in scheme management and in block committees were more successful in their crop production. It is recommended that farmer associations be promoted in the scheme, particularly at block level. The formation and running of these associations should be farmer-led and farmer-driven, with outsiders only involved at a co-ordination level and offering technical support as it is needed.
- The study recommends that government should formally introduce water charges which may start from a charge of R50 per month per bed, with the possibility of increasing the charge, gradually over time.

5.4 Limitations of the study

Production data was very difficult to collect from the farmers. The majority of farmers from both schemes are illiterate and live on a hand-to-mouth basis, making it difficult for them to have a record of their production and the income they earn from the produce. During the year the survey was conducted, the municipality had experienced harsh weather conditions (hailstorms and severe droughts). It is therefore recommended that, in future, production data for such a study be collected over several seasons. Panel data would show the produce and gross margins that the farmers earn in different weather conditions.

5.5 Suggested areas of further studies

A larger sample should also be used in future, to strengthen the study. Researchers might also want to consider estimating WTP for the two different seasons (summer and winter), because the level of water utilisation depends on the season and this might create variations in WTP across seasons.

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APPENDICES

Appendix A: Questionnaire

Farmers' willingness and ability to pay for improved irrigation in Tugela Ferry, KwaZulu-Natal Province

Name of interviewer: …………………………………………………………..

Date: …………………………………………………………………….....

Area (Block): ……………………………………………………………...

I would like to ask you some questions that would assist you, other farmers and the government in determining how to improve the Tugela Ferry Irrigation System. These questions usually take about 30 minutes. We are interviewing a sample of about 200 farmers of the Tugela Ferry Irrigation Scheme, so your input is considered very valuable to this survey. The information you give will be treated as confidential.

Household name: …………………………………………………………

SECCTION 1: HOUSEHOLD DEMOGRAPHICS

Table 1.1: Household composition and characteristics

1.1 Are you male or Female?		
1.2 What is your age?		…….. years
1.3 What is your highest level of education? (*Please choose one of the following*) 1. No formal education 2. Primary school 3. Middle school/ Junior high school 4. High school 5. Post-secondary		
1.4 What is your marital status? (*Please choose one of the following*) 1=Single 2=Married 3=Divorced 4=Widowed		
1.5 What is your occupation? (*Please choose one of the following*) 1=Fulltime farmer 2=Permanent job 3=Temporary job 4=Unemployed 5=Self-employed 6=Student 7=Retired 8=Aged/permanently sick 9=Other (specify)		
1.6 What is the highest level of education for the most educated member of your household? (*Please choose one of the following*) 1. No formal education 2. Primary school 3. Middle school/ Junior high school 4. High school 5. Post-secondary		
1.7 How many people (Children and adults) live in your household?		
1.8 How many people in your household contribute to the household income?		
1.9 Are any of your household members receiving a government grant? Yes=1 No=0		
1.10 If yes in 1.9, how many are on the following:	Old Age grant	
	Child grant	
	Disability grant	

SECTION 2: HOUSEHOLD INCOME AND FOOD SECURITY STATUS

Table 2.1: Sources of household income over the past 12months

Source of household income	Amount per given time (R)	How often (monthly, quarterly etc.)	Number of times in the past 12 months	Total amount (R)
Permanent employment				

Temporary employment					
Hawking/petty trading					
Remittances					
From agricultural Activity	Irrigation farming				
	Dry land farming				
	Livestock production				
	Hiring out farming equipment				
Arts					
Other (specify)					

Table 2.2: Household Food security status

2.3 Taking all means into consideration, how would you describe your household food consumption in the last 12 months? Food shortages throughout the year=0 Food shortages for most of the months=1 Occasional food shortages=2 No food shortages, no surplus=3 Food surplus=4	
2. 4Answer questions 2.31-2.39 using the answers below. 0=Never 1=Rarely= Once or twice in the past month 2=Sometimes= Three to ten times in the past month 3=Often= More than ten times in the past four weeks 4=Always= All the time In the past month, did you:	
2.4.1 Worry that your household would not have enough food?	
2.4.2 Or any of your household member experience not eating the kinds of foods you preferred because of lack of resources?	
2.4.3 Or any of your household member(s) have to eat limited variety of foods due to lack of resources?	
2.4.4 Or any of your household member(s) have to eat some foods that you really did not want to eat because of lack of resources?	
2.4.5 Or any of your household member(s) have to eat less than you felt because there was not enough food?	
2.4.6 Or any of your household member(s) have to eat fewer meals in a day because there	

was not enough food?	
2.4.7 Experience not having any food of any kind to eat in your household because of lack of resources to get food?	
2.4.8 Or any household member(s) go to sleep at night hungry because there was not enough food?	
2.4.9 Or any of your household member(s) go a whole day and night without eating anything because there was not enough food?	

SECTION 3: LAND USE, CROPPING PATTERNS AND MARKET SYSTEM

3.1 What is the total area of land your household owns/operates?	Irrigated land	ha
	Dry land	ha

Table 3.1: Plot sizes and means of ownership

Plot ID	Size of plot (ha)	Means of ownership	Farming Practice	Land fees per year
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
*Key		Means of ownership 1=Allocated 2=Inherited 3= Borrowed 4=Leased 5=Bought 6= Other (Specify)	Farming Practice 1= Irrigated 2= Dry land	

3.2 Generally, are you satisfied with your present security of land?	(a) Irrigated land	

1=Yes 2=No	(b) Dry land	
3.3 Rate the quality of your land for crop production 0=Poor 1=Good	(a) Irrigated land	
	(b) Dry land	

3.4Generally, how do you perceive the profitability of your irrigated agriculture crops? (*Please choose one of the following*) 1= very unprofitable 2= unprofitable 3= break-even 4= profitable 5= very profitable	

Table 3.2: Crop inputs, output and production costs incurred in the past summer (rainy) season in a particular plot

Type of Crop	Area planted (ha)	Quantity harvested *(kg, tons, buckets etc.)*	Quantity sold *(kg, tons, buckets etc.)*	Price per unit	Inputs used	Quantity purchased (and used)	Cost per unit

*Key

Crops	Inputs used
1=Maize	1=Fertilizers
2=Tomatoes	2=Herbicides
3=Potatoes	3=Labor
4=Sugarcane	4=Transport
5=Spinach	5=Marketing
6=Cabbage	6=Seeds
7=Beans	7=Pesticides
8=Onions	8=Tillage
9=Butternut	9=Packaging
10=Other (specify)	10=Other(specify)

Table 3.3: Crop inputs, output and production costs incurred in the past winter (dry) season in a particular plot

Type of Crop	Area planted (ha)	Quantity harvested *(kg, tons, buckets etc.)*	Quantity sold *(kg, tons, buckets etc.)*	Price per unit	Inputs used	Quantity purchased (and used)	Cost per unit

*Key

Crops	Inputs used
1=Maize 2=Tomatoes 3=Potatoes 4=Sugarcane 5=Spinach 6=Cabbage 7=Beans 8=Onions 9=Butternut 10=Other (specify)	1=Fertilizers 2=Herbicides 3=Labor 4=Transport 5=Marketing 6=Seeds 7=Pesticides 8=Tillage 9=Packaging 10=Other(specify)

3.3.1 Where do you normally buy your inputs?	1=Local shop 2=Town (specify) 3=Co-operative 4=Donation/ friend 5=Other (specify)	3.3.2 Where do you normally sell your produce	1=Local shop in town 2=Neighbors 3=Contractor 4=Hawkers 5=Shops 6=Other(specify)

SECTION 4: IRRIGATION WATER, WILLINGNESS AND ABILITY TO PAY FOR WATER

Table 4.1: Current state of water supply

4.1 How far away is your household from the scheme?	km
4.2 How long have you been a member of the Tugela Ferry irrigation scheme?	years

4.3 How is water pumped to reach your irrigation plot(s)? Gravity=1 Electric pump=2 Diesel pump=3	
4.4 Do you pay any fee for water or water related services (diesel or electric pump, maintenance of canals etc.) Yes=1 No=0	
4.5 If yes in 4.4, how much do you pay monthly per plot?	R
4.6 Have you always been able to pay this fee? Yes=1 No=0	
4.7 If no in 4.4, do you still access the water? Yes=1 No=0	
4.8 How many times per week do you have access to water in your plot(s)?	days
4.9 How do you know when your crops need to be irrigated? 0=irrigate when it's my turn 1=when the soil is dry 2=when crops are stressed	
4.10 Have you ever had a shortage of water in your block? Yes=1 No=0	
4.11 If yes in 4.10, how severe was the problem? Slightly=0 Strongly=1 Very strongly=2	
4.12 When was this problem of water shortage last experienced? 1=it is currently there 2= a few days ago 3=a few weeks ago 4=a few months ago.	

4.13 Please rate the extent to which you agree with the following statements pertaining to water access to your irrigation plot(s) (*Tick appropriate box*). Strongly disagree=0 Disagree=1 Neutral=2 Agree=3 Strongly agree=4	
Water source reliable (never dries up)	
Water supply to my plot(s) is consistent (I always get water in my plot(s) when I should get it)	
Water is sufficient for my cropping requirements	
I am satisfied with the quantity of water I receive in my plot(s)	
I am satisfied with the quality of water I receive in my plot(s)	
I am happy with the current water supply	
I would be happy if there were improvements in the current water supply and water related services	
My right or claim to water is secure	
I am a registered water user	
I am satisfied with the maintenance of the canal	

4.14 Do you face conflicts in water sharing in your block? Yes=1 No=0	
4.15 If yes in 4.13, how frequently? 0=Rare 1=Often 2=Always	

4.16 What do you do if you don't receive water on your irrigating day? 0=Nothing 1=Report to the irrigation committee 2=Talk to farmers upstream myself 3=Report to extension officers 4=other (specify)…………………………..	
4.17 If you report to the committee or talk to other farmers yourself in 4.15, how often has your problem been heard and resolved? 0=Never 1=Sometimes 2=Always	
4.18 Do you participate in the maintenance and cleaning of the canal? Yes=1 No=0	
4.19 How often do you perform such activities in your block Never=0 Sometimes=1 Always=2	

Table: 4.2 Willingness to pay

4.20 If the irrigation scheme was to be improved such that, regular maintenance of the scheme was maintained and a pump with greater capacity was used to ensure that the water supply is reliable and there is enough water for your cropping needs; would you be willing to pay for the water and water-related services? Yes=1 No=0	
4.21 If no in 4.20, please state the reason why.	
4.22 If yes in 4.21, what is the highest charge per 0,1ha that you would pay for the improvement in water and water-related services? *Please choose only one of the following:* [R50-R25] [R50] [R50+R25]	

5 SCHEME MANAGEMENT

Table 5.1: Scheme management

5.1 Is there a farmer association in your block? Yes=1 No=0	
5.2 If yes in 5.1, are you a member of the farmer association? Yes=1 No=0	
5.3 If no in 5.1, explain why…………………………………………………………………………….. ………	
5.4 How would you rate the overall scheme management Very poor=0 Poor=1 Average=2 Good=3 Very good=4	
5.5 Do you participate in management of the scheme? Yes=1 No=0	
5.6 If yes in 5.4, are you satisfied with your participation in the management of the	

scheme? Not at all=0 Somewhat=1 Absolutely=2	
5.7 Do you know about water user associations? Yes=1 No=0	
5.8 If yes in 5.6, are you a member of a water user association Yes=1 No=0	
5.9 If no in 5.6, would you be interested in joining a water user association? Yes=1 No=0	
5.10 Generally, do you thing the scheme has improved your life? Yes=1 No=0	

6 SUPPORT SERVICES

Table 6.1: Farmer support services

6.1 Did you use any credit or loan facility in the past 12 months? Yes=1 No=0	
6.2 If yes in 6.1, what was the main source of credit/loan? Relative or friend=1 Money lender=2 Savings club (stokvel)=3 Input supplier=4 Financial institution=5 (Specify name of financial institution…………………………) Output buyer =6 Other=7(Specify)……………………)	
6.3 What was the purpose of the loan/credit? Family emergency=1 Agricultural purposes=2 Other (specify…………………………………….)=3	
6.4 Were you able to pay back the loan/credit in time? Yes=1 No=0	
6.5 Did you receive funding or any other sources of credit support from government in the past 12 months? Yes=1 No=0	
6.6 If yes in 6.5, how often? Sometimes=1 Always=2	
6.7 Did you have any contact with an extension officer(s) in the past 12 months? Yes=1 No=0	
6.8 If yes in 6.7, how often did you contact extension officers? Once a week=1 Twice a week=2 Once a fortnight=3 Once a month=4 Once in 6 months=5	
6.9 If yes on 6.7, did you invite the extension officers? Yes=1 No=0	
6.10 Are the extension officers from: 1=Government/parastatal? 2=Non-governmental organisation (NGO)? 3=Private company?	
6.11 Did you receive any free inputs in the past 12 months? Yes=1 No=0	
6.12 If yes in 6.11, what was the source? 1=Government 2=Non-governmental organisation (NGO) 3=Private company	

6.13 If yes in 6.11, please specify the type of inputs received and their quantities	
6.14 What is your main source of farming information 0=None 1=Radio/television 2=Extension officer 3=Cell phone/SMS 4=Internet 5=Newspaper 6=Other farmers 7=Other (specify)……………………………….	

Table 6.2: Infrastructural support

Please rate the extent to which you agree with the following statements (*Tick appropriate box*).

	Strongly disagree=1	Disagree=2	Neutral=3	Agree=4	Strongly agree=5
a) Road access is good					
b) Communication infrastructure is good					
c) Electricity is reliable					
d) Storage dams are well maintained					
e) Domestic water supply is reliable					

7 ASSETS AND LIVESTOCK OWNERSHIP

Table 7.1: Livestock Ownership

Do you own the following livestock? (*Indicate number owned in the appropriate box, zero if not owned. Complete table below*)

Livestock type	Number currently owned	Money spent on feeds, chemicals, vet services, etc in the past 12 months	Number sold in the past 12 months	Price per unit	Number slaughtered for family purpose in the past 12 months
Cattle					
Goats					
Sheep					
Pigs					
Chickens					
Other (specify)					

Table 7.2: Asset Ownership

Do you own the following assets? (*Indicate number owned in the appropriate box, zero if not owned. Also indicate the price you would charge if you were to sell the asset*)

Asset	No.	Asset value	Asset	No.	Asset value	Asset	No.	Asset value
Block, tile house			Car			Cell phone		
Block, zinc house			Motor-cycle			TV		
Round, thatch house			Bicycle			Radio		
Round pole and mud or shack house			Tractor			Plough		
Tap			Wheel-barrow			Knapsack sprayer		
borehole			Spades			Other (specify)		
Protected well			Hoes			Other (specify)		
Water tank			Telephone			Other (specify)		

8 FARMER TRAINING AND SKILLS

Table 8.1: Farmer training and skills

8.1 Do you take individual decisions on what to produce? Yes=1 No=0	
8.2 If yes, how confident are you in deciding what to produce? Not confident=1 Moderate confidence=2 Very confident=3	
8.3 Did you or a member of your household receive any training from government or any other organization? Yes=1 No=0	
8.4 If yes in 8.1, what was the gender of the person who received training? Male=1 Female=2	
8.5 If yes in 8.1, please specify the training provided………………………………………………	
8.6 How would you describe the usefulness of the training in farming? Not useful at all=1 somewhat useful=2 Useful=3 Very useful=4	
8.7 Which type of fertilizer do you use in your field? Manure=1 Inorganic fertilizer=2 Both=3	
8.8 If you use inorganic fertilizer, how do you determine the type of fertilizer to apply?	
8.9 Do you use mulching? Yes=1 No=0	

Table 8.2: Farmer competence

Please indicate your level of competence in the following farming activities (*Please tick next to each skill*)

Skill	Not competent	Competent	Very competent
Determining seed depth			
Selecting appropriate planting methods for various crops			
Determining inter and intra row spacing			
Irrigation scheduling and frequency			
Application of herbicide and fungicide			
Planning and carrying out harvesting appropriately for various crops			
Determining the amount of fertilizer to apply for various crops			
Soil and water conservation measures for specific farm lands			
Farm record keeping			
Packaging of produce			
Determine nutrient deficiency symptoms in crops			
Calibration and use of sprayer			
Maintenance of a water pump			
Storage of produce			
Financial management			
Knowledge of marketing contracts			
Price determination for your produce			
Knowledge of the market for your produce			

9 CONCLUDING REMARKS

……………………………………………………………………………….……………………

……

……

……

……………

THANK YOU!!

Appendix B: Focus group discussion guide

1. What are the opportunities, challenges and constraints faced by the irrigators?

2. How would you describe water security/supply/access? Do you have rights/entitlements to the water?
3. Which is better, those receiving water by pump or those receiving by gravity?
4. What do you think can be done to improve water access?
5. How many days per week do u and/or your labour work in the plots?
6. Which crops do you deem as the most profitable in:
    i) Summer
    ii) Winter
7. If the irrigation scheme was to be improved such that, regular maintenance of the scheme was maintained and a pump with greater capacity was used to ensure that the water supply is reliable and there is enough water for your cropping needs; what is the maximum amount that you would be willing to pay for the water and water-related services?
8. Do irrigators employ labour in their plots? Is yes, How many days, on average are they in the field? What is the average wage per day?

Appendix C: Key informant interview

Name: Mr Zuma

Role in scheme: Chairman of the whole scheme and the co-operative in KwaNxamalala

1. How is water accessed in your section (kwaNxamalala)? And are you getting adequate supplies thereof?
2. According to your understanding, what is a co-operative and what are the advantages of being a member of a co-operative?
3. How often do you engage an extension officer? What issues for you usually consult for? And have you found extension services to be useful in your production enterprise?

4. According to the rules of the scheme, those own plots or “beds” but don’t use them are supposed to rent/lend the plots out to those farmers who would put them to better use. Have the members of the scheme been able to adhere to those rules?
5. Across the different co-operative blocks, is there a difference in production? If yes, what are the possible reasons for such?
6. If the irrigation scheme was to be improved such that, regular maintenance of the scheme was maintained and a pump with greater capacity was used to ensure that the water supply is reliable and there is enough water for your cropping needs; would you be willing to pay for the water and water-related services? If yes, what is the highest charge per 0,1ha that you would pay for the improvement in water and water-related services
7. How is your access to the market?
8. Do irrigators employ labour in their plots? Is yes, How many days, on average are they in the field? What is the average wage per day?

Appendix D: Tropical livestock units (TLU) scales

Animal	**Scale**
Cattle	1
Sheep	0.10
Goats	0.10
Pigs	0.20
Chickens	0.01

Source: Peden *et al.* (2007) cited in Sinyolo (2013).