

The impact of independent smallholder irrigation on rural livelihoods in Msinga Local Municipality, KwaZulu-Natal Province, South Africa

By

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ABSTRACT

Independent irrigation is becoming more recognised in the research community and policy worldwide, apart from South Africa. It is associated with improving rural livelihoods by boosting household incomes and reducing poverty and food insecurities. South African literature sources on these irrigators do not present enough evidence to consider independent irrigation a reliable investment for irrigation development. In filling this gap, this research aimed to describe the livelihoods of independent irrigators and their contribution to rural livelihoods in Msinga Local Municipality. The study collected survey data from 101 irrigators selected using snowball sampling and four Focus Groups Discussions with participants chosen using a homogeneous purposive sample technique. The data were analysed using descriptive statistics, inferential statistics, the Probit model, and Thematic Content Analysis.

The study revealed that irrigator households in this Msinga had a weak asset base. Irrigators had restricted access to agricultural land, and most irrigators suffered severe limitations in irrigation water availability due to the unpredictability of their irrigation water source, hampered by periodic droughts in the research region. Msinga's restricted land access meant crop production activities were limited to microscale production, and irrigation water shortcomings further hindered Msinga's independent irrigation land productivity. In Msinga, the study found that the crop production physical assets were limited to hand tools, implying that the physical assets were sufficient for independent irrigators' current production spaces but needed to be improved to engage in crop production on a larger scale. Typical of the livelihoods of rural households in South Africa, Msinga households were 'diversified' because they typically contained multiple ways of obtaining income but centred around claiming against the state. Production of independent irrigated land was the second most important income source. Despite all its shortcomings, independent irrigation increased average annual household income by R8 156.90, 15.3% of the total average household income. Crops harvested at the irrigation plot were also consumed at home, forming part of the food expenditure and the money from sales was used to purchase other food items. Even though the contribution was "limited", independent irrigation improved Msinga irrigator households' livelihoods through income generation and security of food. With relevant interventions in supporting these irrigators, independent irrigation could be an appropriate development path for rural households with proper interventions.

PREFACE

The candidate conducted the research for this thesis while based at the Discipline of Agricultural Extension and Rural Resource Management, School of Agricultural, Earth and Environmental Sciences, College of Agriculture, Engineering, and Science, University of KwaZulu-Natal, Campus Pietermaritzburg, South Africa. The National Research Foundation provided financial support for the study.

DECLARATION 1: PLAGIARISM

I, **S'nethemba Valencia Dube**, declare that:

- (i) Except where indicated or acknowledged, the research reported in this thesis is my original work.
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Date: 02 December 2022

Miss S'nethemba V. Dube (Candidate)

As the candidate's supervisor, I agree to the submission of this thesis:

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Date: 02 December 2022

Dr. Karen Caister (Supervisor)

DECLARATION 2: DISSEMINATION OF FINDINGS

The following publications (published or in the process of submission) form part of the research presented in this thesis.

Publication 1 – Chapter 4 of the thesis:

Dube, S.V. 2023. Independent smallholder irrigator's livelihood capitals, strategies, and outcomes: evidence from Msinga Local Municipality, KwaZulu-Natal Province of South Africa (Preparing for submission: *Journal of human ecology*)

Publication 2 – Chapter 5 of the thesis:

Dube, S.V. 2023. Institutional arrangement and support services for independent smallholder irrigators in Msinga Local Municipality, South Africa. *South African Journal for Agricultural Extension*, 51(1), 66-81

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Dube, S.V. and Caister, K. 2023. The effect of small pumping technology adoption on the household independent irrigation income in Msinga Local Municipality, KwaZulu-Natal Province. **Paper abstract under review** for presentation at the upcoming 56th South African Society for Agricultural Extension (SASAE) conference, 28-31 August 2023, Richards Bay, South Africa.

Signed:

A black rectangular box redacting the signature of the candidate.

Date: 02 December 2022

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LIST OF ABBREVIATIONS

CARE	Cooperative for Assistance and Relief Everywhere
DFID	Department for International Development
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GPS	Global Positioning System
HFCs	Household Food Consumption score
IDC	Industrial Development Corporation
IDP	Integrated Development Plan
IMT	Irrigation Management Transfer
KZN	KwaZulu-Natal
UKZN	University of KwaZulu-Natal
LED	Local Economic Development
LSD	Least Significant Difference
NDP	National Development Plan
NPC	National Planning Commission
NEF	National Empowerment Fund
NGP	New Growth Path
NYDA	National Youth Development Agency
PDAEA	Provincial Department of Agriculture and Environmental Affairs
PTO	Permission To Occupy
SEDA	Small Enterprise Development Agency
SEFA	Small Enterprise Finance Agency
TREP	Township and Rural Entrepreneurship Programme
USD	United States Dollars
OXFAM	Oxford Committee for Famine Relief
SLF	Sustainable Livelihood Framework
UNDP	United Nations Development Programme
WRC	Water Research Commission

CHAPTER 1. INTRODUCTION

1.1 Research background and problem statement

South Africa has high poverty, food insecurity and unemployment rates, which are severe and prevalent in rural areas. Irrigated agriculture continues to be a vital tool to tackle poverty, food insecurity, and unemployment, especially among the rural population in developing countries, including South Africa. Access to irrigation water leads to higher overall production and higher farm returns due to the adoption of modern technology by farmers and the intensification of cultivation (Hossain & Hanjra, 2004), leading to increased profits, better incomes, and lower food prices (Bhattarai, Sakthivadivel & Hossain, 2002; Hossain & Hanjra, 2004; Smith, 2004). Hence, smallholder irrigated agriculture has been a significant economic practice to drive the long-term objective of unemployment and poverty reduction in most developing countries. Historically, in developing countries, efforts have been made chiefly through investment in public irrigation schemes and have remained one of the most common strategies for improving rural livelihoods and quality of life (Thirtle et al., 2001; Hanjra et al., 2009; Mukherji et al., 2009; Turrall et al., 2010).

However, massive investments in irrigation have also had disappointing results (Thirtle et al., 2001; Hanjra et al., 2009; Mukherji et al., 2009). This study focuses on a phenomenon known as independent irrigation where the farmer is referred to as an independent irrigator. In places where public schemes have failed, independent irrigation has grown so that privately operated and owned irrigation is more extensive than public irrigation systems (De Fraiture & Giordano, 2014). For example, over 60% of India's irrigated areas are under independent irrigation. The phenomenon is also growing gradually in Africa, especially in Sub-Saharan Africa. For example, half a million smallholders in Ghana profit from privately irrigating 185 000 ha. This comprises an estimated 84% of the total irrigated land (Giordano et al., 2012; Delinthe & Zwart, 2022). In Nigeria, independent smallholder irrigators irrigate 75% (128 000 ha) of the country's total irrigated land, while they irrigate 15% of the total irrigated land in Kenya (Abrić et al., 2011). Apart from taking over the irrigation world by storm, their contribution to millions of households is of vital importance as they are also associated with providing income for millions of smallholders, creating jobs, and playing a crucial role in alleviating poverty (Shah, 2009; Hossain, 2009; Giordano, 2012; Giordano & De Fraiture, 2014, De Fraiture & Giordano 2014).

The agenda of Post-Apartheid South Africa developed smallholder irrigation by rehabilitating old and creating new public irrigation schemes with government resources (Van Averbeke & Mohamed, 2006; Van Averbeke, 2012). Van Averbeke et al. (2011) reported the South African government's investment of 2 billion Rands (R40 000/ha) worth of public resources to establish, revitalise and rehabilitate public irrigation schemes. According to Van Averbeke, Denison, and Mnkeni (2011), South Africa had 302 smallholder public irrigation schemes by 2010, covering 47 667 ha. Until now, the developmental effect of these investments has been minimal, and their evaluations have correlated them with generally poor performance (Bembridge, 2000; Machete et al., 2004; Tlou et al., 2006; Inocencio et al., 2007; Mnkeni et al., 2010; Woodhouse et al., 2017). The majority of evaluations of the performance of South African smallholder irrigation schemes relied on operational status, irrigation system condition, cropping intensity observations, and farm revenue in some cases (Van Averbeke, 2012). These smallholder irrigation schemes contributed far less to irrigation communities' social and economic growth than expected (Machete et al., 2004; Tlou et al., 2006; Fanadzo et al., 2010). Researchers have attributed the ineffectiveness of these publicly resourced schemes to low productivity and poor market participation (Vink and Van Rooyen, 2009; Fanadzo et al., 2010; Van Averbeke et al., 2011). Most others suggest that human (capacity) and social (institutional) resource problems were at the root of the below-expected performance (Machete et al., 2004; Tlou et al., 2006; Yokwe, 2009; Mnkeni et al., 2010).

Due to the poor performance of smallholder irrigation schemes in South Africa (Bembridge, 2000; Machete et al., 2004; Tlou et al., 2006; Inocencio et al., 2007; Mnkeni et al., 2010; Woodhouse et al., 2017), there is a need to consider an alternative irrigation development pathway that is likely to make a meaningful contribution to rural livelihoods. The question arises whether independent irrigators could be a viable development option for South Africa. However, data are scarce on this set of irrigators (Van Averbeke, 2008). A few studies confirm their existence in South Africa (De Lange, 1994; Vaughan, 1997; Du Plessis & Van Der Stoep, 2001; Oosthuizen et al., 2005; Van Averbeke, 2008; Tapela, 2012; Denison et al., 2016; Moyo & Machete, 2016; Dube, 2017; Chipfupa, 2017; Wale & Chipfupa, 2018). Most existing literature on smallholders in South Africa focuses on smallholder irrigation schemes, followed by home gardens. Among the research studies retrieved, independent irrigators are usually not the sole or main subject of the study. Secondly, their general knowledge has limited to no quantitative data and does not follow a logical methodology. Also, these studies are accidental and have a limited sample. For example, De Lange (1994) provides a general overview of independent irrigators. She pointed out the lack of statistical

data on independent irrigators since they do not receive financial aid from the government. In another general study by Vaughan (1997), the author refers to independent irrigators in the former Transkei region. This policy paper targeted contributing to poverty alleviation and lowering inequality through irrigation. She backs up De Lange's (1994) remark that these farmers generally manage profitable businesses despite a lack of financial aid from outside sources and a slew of other challenges. Research on guidelines for planning and design procedures for small-scale irrigators in South Africa by Crosby et al. (2000) described independent irrigators similar to De Lange's (1994). While these studies raise consciousness of the role of independent irrigators, the studies are general; no systematic methodology was followed during sampling, data collection, and analysis.

Early studies funded by the WRC have focused on specific efficiencies and impacts for independent irrigators. The experiences of three independent irrigators in the Limpopo Province concentrated on appropriate usage and management in the use of micro-irrigation systems (Du Plessis & Van Der Stoep, 2001). Oosthuizen et al. (2005) focused on the cost-estimating procedures for micro-, drip-, and furrow-irrigation systems and the economic analysis of the relevant irrigation systems for five large- and small-scale farmers in the Mpumalanga Province's Onderberg and Nkomazi regions. The report included information on the farmers' enterprises, risk factors, and strategies for improving them. Van Averbek (2008), who looked into the best management practices for farming on smallholder irrigation schemes in Vhembe, provided anecdotal information on three independent irrigators and how they extracted water from the Dzindi River. A detailed description of an independent irrigator who, in addition to benefiting from the Revitalisation of Smallholder Irrigation Schemes (RESIS) program implemented at the Makuleke irrigation scheme, also operated a second irrigation enterprise independently was provided in a PhD thesis that dealt with the commercialisation of agriculture on small-scale irrigation schemes in the Olifants River Catchment, primarily through the Resis Recharge Programme based on Joint ventures (Tapela, 2012). The number of respondents is specified in these studies, but the sample is too small. One cannot draw policy useful conclusions from a sample of three or five elements or perform statistics for generalisation. Evidence provided by Oosthuizen et al. (2005) indicated that independent irrigators seem to run successful independently irrigated enterprises, but this information is anecdotal. Besides, none of these studies has researched the impact of independent irrigation on rural livelihoods, which is the central area of the current research's contribution.

More recent studies funded by the WRC focused on smallholder irrigation entrepreneurial development pathways and livelihoods in two districts in Limpopo Province (Denison et al., 2016) and one in the KwaZulu-Natal Province (Wale & Chipfupa, 2018). Both studies were comprehensive and systematic, providing a comprehensive description of these irrigators through a livelihood analysis. Thulamela and Greater Tzaneen (Denison et al., 2016) included a sample of 98 and 26 independent (smallholder) irrigators, respectively, while there were 68 independent irrigators sampled in KwaZulu-Natal. These studies and those under their umbrella (dissertations, thesis and articles) were the first to have a bigger sample size and comprehensive sampling and data collection methodology from the retrieved literature. Hence methods drawn from these were adopted in the current study (Denison et al., 2016).

While the abovementioned investigations were comprehensive, independent irrigators were not the sole focus in both studies. In the case of the KwaZulu-Natal project, the studies included smallholders on irrigation schemes, home gardens, and outside of the scheme. Again, samples do not provide enough situations to consider them a reliable South African phenomenon. Therefore, the available literature on South African independent irrigators is ageing and insufficient to contribute to policy debate issues around these smallholder rural development roles. The current research will be the groundwork for filling these knowledge gaps. The study contributes answers to the following questions:

- Who are South African independent irrigators, and how do they make a living?
- Can independent irrigation contribute positively to rural livelihoods by improving household income and alleviating poverty for irrigator households?
- Can independent smallholder irrigators provide an appropriate alternative option for irrigation development?

1.2 Aim and objectives

The primary aim of this study was to determine the impact of smallholder irrigation on the rural livelihoods of independent irrigators operating within the boundaries of Msinga Local Municipality.

The study's specific objectives were to:

- Describe the livelihoods of independent irrigators concerning the resources they have access to and their strategies to make a living.
- Determine the role of organisations and institutions in supporting independent smallholder irrigators.
- Identify the external shocks and the constraints the independent irrigators face.
- Determine the impact of independent irrigation on the livelihoods of Msinga rural households.

1.3 Limitations of the study

A livelihoods approach guided the development of themes used in the research design, such as vulnerabilities, livelihood strategies, and institutional structures and processes. While resilience is a concept of sustainable livelihoods, this was not an analytical focus for this study. While water was a key resource for irrigators, this study did not extend to mapping out the surface and ground water sources. The research design is descriptive, and the overall design is a qualitative case study within a specific marginal farming context. Snowball sampling was utilised with the built-in subjectivity of individuals identified by the community as practising independent irrigators. The rationale for using this method was the lack of information on these irrigators, even from the local office of the Department of Agriculture, which usually has information on smallholders in their area. While statistical analysis is used, it shows similarities and differences within and between the Msinga sample and other independent irrigator observations. Therefore, there were limits in generalising the research results to the whole Province or country. Nonetheless, the study can serve as a foundation for future research conducted on a bigger scale and sampled using probability methods, if possible.

1.4 Study significance and contribution

This research addresses a gap in the literature on independent irrigators in South Africa, providing a detailed description of independent irrigators' livelihoods in rural Msinga. The current study is a comprehensive study specific to independent irrigators, providing much-needed quantitative data obtained through statistics and a much bigger sample than previous studies. Denison et al. (2016:362) described the research that featured Thulamela Local Municipality independent irrigators as “the first to describe this group of agricultural water users in considerable detail”. Another in KwaZulu-Natal (Wale & Chipfupa, 2018) followed this research project, providing the

same detail as the latter mentioned. Based on the assumptions, a dearth of literature on these irrigators indicates how much more research is needed.

More research is required to draw meaningful judgments about the economic contribution of independent irrigators. The current literature on independent smallholder irrigation in South Africa does not focus on rural livelihoods. Using a livelihoods approach allows us to include the complexity of social context through thematic and systematic attention to important relationships for sustainability. Evidence is needed for a much-needed debate in the research community on the appropriate irrigation development pathway for South Africa. We need to recognise these irrigators and realise their potential to provide households with income and reduce poverty and food insecurities.

1.5 The Study Site and Context

The study area was Msinga Local Municipality, one of four local municipalities in the South-Western part of the Mzinyathi District of KwaZulu-Natal Province of South Africa (Figure 1). Msinga shares boundaries with the Nkandla and Nquthu Local Municipalities in the East, Umvoti Local Municipality in the South, uThukela District municipality in the west, and Endumeni Local Municipality in the North.

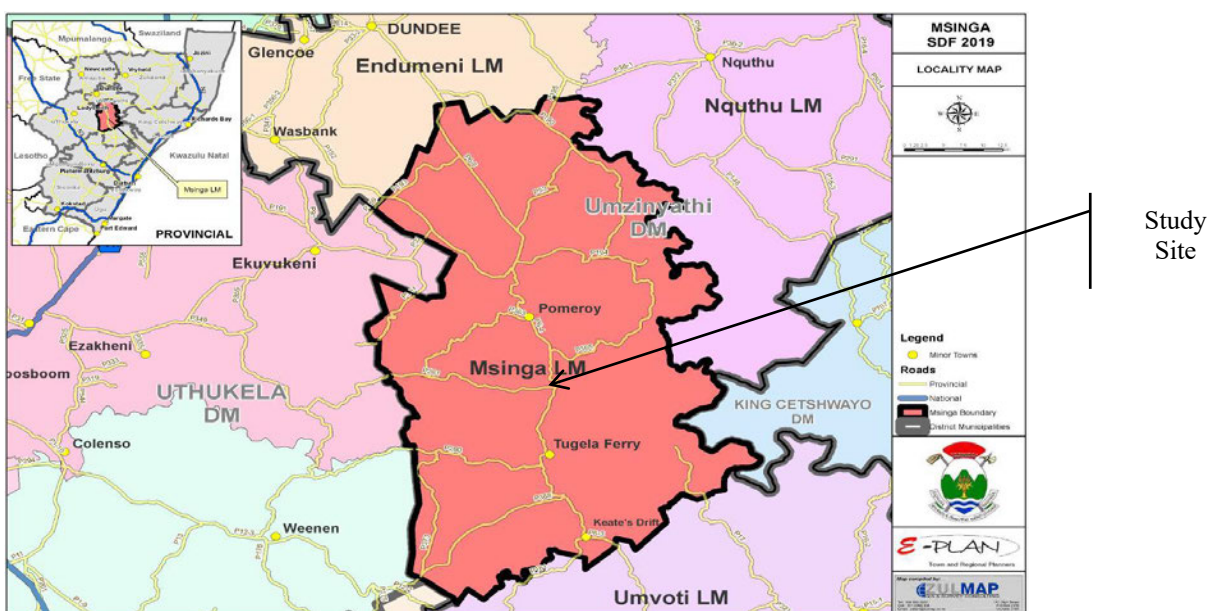


Figure 1. Study area locality map. Source: Msinga Local Municipality (2020)

Tugela Ferry, a small town in the study area, is considered the municipality's primary node, providing administrative and business services to the entire municipality. Pomeroy, another town in the municipality, is classified as a secondary node because it has fewer economic opportunities than Tugela Ferry. Msinga is highly rural, where 69% of the area is under traditional authority, held in trust by the Ingonyama Trust. The remaining Msinga area found North of Pomeroy is either state-owned or privately owned (Dearlove, 2007). There are six traditional authority areas in Msinga, including Qamu, Bomvu, Mthembu, Mabaso, Mchunu and Ngome. There are 18 political wards in the area, with 36 councillors.

1.5.1 Human environment and living conditions

Data from the latest South African national community survey done in 2016 (Statistics South Africa, 2016) shows that the population of Msinga was 184 494, with approximately 38 372 households and a 4.8 average household size. The population had 53.7% children (under 18 years), 41.6% economically active adults and 4.8% older people (65 years and over). Women (55%) dominate the municipality, while men are about 45%. Msinga is one of the poorest municipalities in KwaZulu-Natal. The municipality faces the highest rates of unemployment and poverty. Data from the last published South African census in 2011 showed that the unemployment rate at Msinga was 49.5%. This percentage of unemployment was higher than that reported in the district municipality and the KwaZulu-Natal Province, reported as 36.6% and 33.0%, respectively (Statistics South Africa, 2011). Most residents in Msinga had little income, with a dominant (28.9%) annual average ranging between R9 601 to R19 600, followed by 22.4% of incomes that ranges between R19 601 to R38 200. Msinga has a high economic and social dependence on social grants. The 2016 community survey shows that social grants contributed 88% to the household income of Msinga residents (Statistics South Africa, 2016). The low economic opportunities have led to almost half of the population's poverty. Statistics South Africa (2016) reported 43% and 44.1% poverty between 2011 and 2016 in this municipality.

Msinga's poverty levels also reflect this area's physical quality of life. The latest national community survey in 2016 found that most (88,6%) households used pit latrine toilets. Over half of the homes used wood as an energy source for cooking. At the same time, 38% of households use electricity. There were minimal households that used other sources of energy. Also, 36.3 % of the household had access to safe drinking water.

Most of the Msinga households depended on rivers, streams, and boreholes outside household boundaries. This data reflects the poor quality of life for the population of Msinga.

1.5.2 Natural environment

The soils in the Eastern part of the municipality are most suitable for agriculture and grazing. Well-drained, fine-textured soils tend to seep in higher rainfall areas above 800 mm annually. The land is mainly used for residential and grazing purposes, although some grow dryland crops. According to the Msinga Local Municipality spatial development framework 2020, Msinga has four principal rivers: Tugela, Mooi River, Umvoti, Buffalo, and Blood River (Msinga Local Municipality, 2020). According to the Msinga Local Municipality integrated plan 2017/20, the Blood River feeds into the Buffalo River. Buffalo River is the leading Northern tributary of the Tugela River, while the Buffalo River flows into the Tugela east of Ngubevu. The Mooi River flows into the Tugela River at Keate's Drift. The Tugela River is the largest in KwaZulu-Natal. Despite the enormous irrigation potential from the rivers, the area is subject to water shortages during dry seasons. The climate of Msinga Local Municipality can be described as subtropical and varies from the humid subtropical along the coast to the moderately dry subtropical in the west.

1.5.3 Farming systems

According to the data from the South African National latest community survey, more than half (55%) of the households in this municipality practice some agriculture (Statistics South Africa, 2016). In Msinga, agriculture is still predominantly used for subsistence (Mbatha, Mnguni, & Mubecua, 2021). Cattle, goats, and chickens are among the most reared livestock. The stock is held primarily for cultural ritual rather than as an economic asset (Msinga Local Municipality, 2012). Only in times of extreme financial need do families sell stock. Msinga households also practice dryland farming. Dryland farming is not a significant source of income in Msinga (Mkhabela, 2005). The land used for dryland farming varies between 0.4 and 1.3 hectares. Sorghum and maize are commonly grown crops in dryland plots (Alcock, 2003). Sorghum is grown mainly for beer production, while maize is grown for home consumption, feed for chickens, beer, and stover for cattle in winter (Mkhabela, 2005). In addition, many homesteads have small garden plots that provide vegetables for household consumption. Maize, beans, sweet potatoes, tomatoes, cabbage, spinach, beetroot, and onion are the most produced crops. At Msinga, community gardening is also a prevalent practice. According to the Msinga Local Municipality's 2012 Local Economic Development (LED) strategy, the municipality had 87 community gardens.

Consisting of 1 721 members with plots ranging from 0.5 to three hectares (Msinga Local Municipality, 2012). Irrigated farming is also widespread in Msinga and is an essential source of income for some residents. Most people in the area rely on farming more than in other parts of KwaZulu-Natal. Msinga is home to two of the Province's 36 irrigation schemes (Van Averbeke et al., 2011). Tugela Ferry and the Mooi River irrigation schemes are two of these irrigation schemes. Tugela Ferry is one of the Province's largest, with 840 hectares of high-potential soils. It is one of only four more significant than 500 ha in the Province. Between 800 and 1000 farmers cultivate around 540 hectares (EVN Africa, 2011). Tomatoes, butternut squash, spinach, sweet potatoes, potatoes, and onion are typical crops in winter and summer. Sorghum, millet, pumpkins, melons, beans, and cabbages are other crops grown at Msinga (Modi, 2003). The existence of smallholders and people's reliance on agriculture for their livelihoods in this area justifies its selection as an appropriate study site.

1.6 Thesis overview

This thesis has eight chapters. This first chapter argues for research objectives from a brief background and rationale. It locates the study in terms of geography and its contribution to the academic conversation to society, the research community, and policy.

Chapter 2 Is a review of the literature and the academic conversation to which the results of this study contribute. It begins with defining the independent irrigator as unique from the terminology used worldwide to describe these smallholders. This section discusses independent irrigation in global, African, and South African contexts. The chapter also describes the known traits of farmers who engage in independent irrigation—demographics, land, water, and irrigation technology, among the characteristics. A description of their importance to rural livelihoods follows this discussion. Eventually, the chapter concludes by identifying gaps in the literature on South African independent irrigators.

Chapter 3 Explains the overall methodology through a theoretical framework for understanding both the lens for interpretation, indicators and the variables used for data collection. It explains the process for implementing the design of the study, including sampling, data collection tools, techniques, and data analysis.

Chapters 4 to 7 each presents one objective of this study as a specific analysis of empirical data. Since these were also designed to be published papers, each has its own standard paper format,

literature focus, and reference list. Livelihoods are complex. Each of these analyses brings a specific set of conclusions to the overall discussion in Chapter 8. Repeating some methods and information is inevitable in this reporting. To reduce this, cross-referencing of method sections to Chapter 3 has reduced the repetition.

Chapter 4 addresses the first study objective drawing on survey data to describe the livelihoods of independent irrigators and their households in the study area. The chapter adopts descriptive statistics, a T-test and Pearson's correlation analysis to describe livelihood capitals, strategies, and outcomes of Msinga independent irrigators. Regarding capitals, the research focused on evaluating the physical (implements and equipment used in farming), natural (cultivation land and irrigation water) and financial capital (flows of cash, savings, and credit), social (groups and networks) and human (household demographics) capitals. The chapter also determines the livelihood strategies focusing on non-farm and farm activities.

Chapter 5 discusses the institutional arrangements and support systems which is the second objective of this study. Apart from determining access and security of critical resources such as agricultural land and water, institutional support and service systems influence the livelihood strategies of the Msinga independent irrigators.

Chapter 6 identified vulnerabilities in external shocks and the constraints the independent irrigators face, which is the third objective of this study. This chapter is crucial because it identifies measures that can assist independent irrigators in overcoming obstacles to more significant farming advantages, market participation and, as a result, livelihoods.

Chapter 7 integrates cultivation, irrigation water sources, physical irrigation resources, and irrigation income factors to illustrate the impact of independent irrigation on the rural livelihoods of irrigator households in terms of income and poverty. This chapter is an ongoing discussion from the identification of income sources in Chapter 4, but it focusses on the independent plot as a purposeful strategy for income generation.

Chapter 8 recaps the purpose of the study and draws together the objectives as a discussion of findings from a livelihood perspective. Conclusions about further research, policy recommendations and study limitations are also presented here.

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CHAPTER 2. INDEPENDENT IRRIGATORS, A REVIEW OF LITERATURE

2.1 Introduction

Irrigated agriculture continues to be a vital tool to tackle poverty, food insecurity, and unemployment, especially among the rural population in developing countries, including South Africa. Access to irrigation water leads to higher overall production and higher farm returns due to the adoption of modern technology by farmers and the intensification of cultivation (Hussain & Hanjra, 2004), leading to increased profits, better incomes, and lower food prices (Bhattarai, Sakthivadivel & Hussain, 2002; Hussain & Hanjra, 2004; Smith, 2004). Hence, smallholder irrigated agriculture has been a significant economic practice to drive the long-term objective of unemployment and poverty reduction in most developing countries. Historically, in developing countries, efforts have been made chiefly through investment in public irrigation schemes and have remained one of the most common strategies for improving rural livelihoods and quality of life (Thirtle et al., 2001; Hanjra et al., 2009; Mukherji et al., 2009; Turrall et al., 2010).

This chapter summarises available definitions and literature on independent irrigation and irrigators. This chapter identifies the knowledge gaps in the South African literature concerning independent irrigators. This section begins with a definition of an “independent irrigator”. Numerous terms have been used to refer to irrigators who independently irrigate in various parts of the world. The chapter continues with a brief global overview of the independent irrigation phenomena, then moves on to the African synopsis and South Africa. The chapter then describes independent irrigators’ characteristics, including their resources (land, water, financial and irrigation technology), activities they engage in for their livelihoods, and challenges they face. Independent irrigation’s contribution or impact on livelihoods follows their livelihood description. Finally, the chapter draws conclusions based on independent irrigators’ knowledge gaps in South Africa.

2.2 Defining an independent irrigator

Many terms and definitions refer to independent irrigators based on certain features, usually applicable to a specific region. Various identifiers in the literature include ‘informal irrigation,’ ‘atomistic irrigation,’ ‘private smallholder systems,’ ‘small private irrigation,’ individual micro-scale irrigation’, and ‘individual small-scale irrigation.’ These terms refer to farmers who irrigate

their crops using “privately-owned equipment.” Elsewhere in the world, private water supply to the plot is also the main factor that defines an independent irrigator (Faurés and Mukherji, 2009). In the international arena, some definitions included individuals and a group of farmers who “**initiated**” the independent plot enterprise without outside support. Faurés and Mukherji (2009) and Shah (2010) made use of the term “atomistic irrigation.” Faurés and Mukherji (2009) used this term to define irrigators who use mechanical pumps, wells, and PVC pipes to access irrigation water “individually”.

Shah (2009) differentiates irrigators as dissimilar to large communally managed schemes concerning how they access irrigation water. Individual farmers using small petrol and diesel pumps to extract water from nearby rivers and streams to their fields were described by Namara et al. (2010) as a “private smallholder system.” According to Takeshima et al. (2010) and De Fraiture and Giordano (2014) who used the term “smallholder private irrigation” or “small private irrigation”, refer to them as small farm holdings that are initiated, financed, and operated by individual farmers. Farmers usually have direct access to irrigation water, irrigating small areas of less than two hectares with low-cost technologies (Takeshima et al., 2010; Abric et al., 2011; De Fraiture & Giordano, 2014). Feibiger et al. (2010) identified independent irrigators using two terms, including “individual small-scale irrigation” and “individual micro-scale irrigation.” Irrigation plots ranging between 50 m² and 1 ha were ‘micro-scale,’ while ‘small-scale’ plots ranged between 1.25 ha and 13 ha in size (Feibiger et al., 2010). Nevertheless, these farmers started the irrigation independently and used their private irrigation infrastructure to access irrigation water.

The term “independent irrigator” is exclusively used in South Africa. Being part of a “group,” especially an “irrigation scheme,” disqualifies a farmer from being referred to as an independent irrigator. Having a private water supply when accessing irrigation water distinguishes independent irrigators from the rest of the smallholders. This study defines an independent irrigator as a smallholder directly accessing an irrigation water source who extracts, conveys, and applies this water using privately-owned equipment. In South Africa, “independent irrigator” is one of the four groups of smallholder irrigators. The other categories are plot holders on irrigation schemes, plot holders on irrigated community gardens, and home-garden irrigators (De Lange, 1994; Du Plessis, Van Averbeke & Van der Stoep, 2002; Van Averbeke, Denison & Mnkeni, 2011). What differentiates an independent irrigator from the other three categories is their control over irrigation

water. A report on small-scale irrigation in South Africa by De Lange (1994) described independent irrigators as farmers with a private water supply, such as pumping directly from a river or their own borehole. Crosby et al. (2000) referred to independent irrigators as “farmers who were not participating in an irrigation scheme or a gardening group” and as “irrigation farmers who have a private water supply, such as pumping directly from a river or an own borehole” (Crosby et al., 2000:1.9). These reports distinguished the category of independent irrigators from plot holders on irrigation schemes and irrigated community gardens by their control over irrigation water. Independent irrigators have a “private water supply,” while the other two categories share their irrigation water distribution system and control over the water supply. Apart from their private water supply, Wale and Chipfupa (2018) defined them as farmers who make a living out of farming with no capital and technical advice on irrigation and cropping support systems.

2.3 Global overview of independent irrigation

Most irrigation developments occurred during the twentieth century worldwide due to the increased need for food and other agricultural goods (Turrall et al., 2010). Thanks to genetic advancements in rice and wheat, the green revolution of the 1960s and 1970s saw a massive increase in food production. Higher yields necessitated more irrigation, fertiliser, and pesticides, all integral to the Green Revolution’s scientific package (Borlaug, 2007; Dethier & Effenberger, 2012). On the other hand, large-scale irrigation projects have a long history and a mixed track record of success and failure. Many large-scale irrigation projects built during and after the Green Revolution still thrive, while others face challenges and underperform. Factors contributing to these challenges were identified as corruption associated with irrigation development (Turrall et al., 2010), lower-than-expected benefits derived from capital-intensive irrigation schemes established during the boom era (Faurés & Mukherji, 2009), and declining food prices (Faurés et al., 2007). In addition, when urbanisation and modernisation took hold, public irrigation projects could not adapt to the changing needs of farmers, and as a result, they underperformed (Mukherji et al., 2009).

Consequently, individual farmers took matters into their own hands, which saw an expansion in the irrigated area (Faurés & Mukherji, 2009). This expansion resulted from the rapid rise in private groundwater extraction by individual farmers in Asia, adding 61.5 million ha to the total irrigated land from 1980 to 2003 (Faurés & Mukherji, 2009; Turrall et al., 2010). Since then, private water

extraction by farmers has drastically grown and already dominates the irrigation landscape in South Asia, where smallholders with privately-owned wells outnumber those relying on public irrigation facilities (Shah, 2009). The transition from a group-based (scheme) to individualistic irrigation is fundamental. This trend is evident from extensive pumping technology operating in some Asian countries. In India, atomistic motorised-pump irrigation makes up more than 60% of the nation's irrigation, despite ongoing investments in government irrigation schemes (Shah, 2009).

However, such massive growth in Asia's smallholder private irrigation has come with over-abstraction of the groundwater resulting in sustainable management and water resources governance challenges (Shah, 2007). Irrigation in Africa is not as widespread as in Asia. In 2000, a total area of 12.75 million was under irrigation on the African continent (Frenken, 2005), of which about 5.22 million ha (41%) was in Sub-Saharan Africa (Molden et al., 2007). At that time, three Sub-Saharan countries that had irrigated areas exceeding 1 million ha were Sudan (1.73 million ha), South Africa (1.49 million ha), and Madagascar (1.09 million ha) (Frenken, 2005). As in Asia, the past decades have witnessed an intensifying focus on irrigation development in Africa, mainly through public irrigation schemes. However, this was followed by years of disappointing irrigation performance during the 1970s and 1980s (Woodhouse et al., 2017). As a result, even international financial institutions became increasingly reluctant to invest in large irrigation projects (Shah, 2013).

Until the 1980s, smallholders throughout Sub-Saharan Africa took the initiative to access irrigation water by pumping, either by using manual or motorised pumps (Lankford, 2009). According to Brown and Nooter (1992), independent irrigation flourished in the late 1980s in Niger, Nigeria, Mali, Mauritania, Chad, Senegal, Burkina Faso, and Cameroon. Independent irrigators' dominance in the irrigated landscape, which sometimes exceeds one of the public irrigation initiatives, shows how this phenomenon has evolved over the years. In Zambia, independent irrigators now irrigate 50% of the 200 000 ha of total land under irrigation in this country (GoZ, 2010). According to Abric et al. (2010), independent irrigators cultivate between 45% and 75% of 128 000 ha under irrigation in Nigeria. In Ghana, 185 000 hectares were in the hands of independent irrigators, 150 000 hectares in Tanzania and 350 000 hectares in Ethiopia (Giordano et al., 2012). Due to the nature of independent irrigation, Beekman, Veldwisch, and Bolding (2014) pointed out the lack of

precise statistics in Mozambique regarding how much land these irrigators cover. However, they estimated that 115 000 ha of land is in the hands of independent irrigators.

2.4 Independent irrigators in South Africa

The South African agricultural sector comprises a large-scale commercial and small-scale subsistence sector. The large-scale, rainfed, irrigated commercial sector holds most of the land and includes predominantly white farmers (Vink & Kirsten, 2003; Kirsten, 2005). South African small-scale agriculture also consists of farmers cultivating rain-fed and irrigated land.

In 2002, only 0.1 million hectares of the 1.5 million ha of land under irrigation (Frenken, 2005) were in the hands of small-scale irrigators. FAO (2016) reported an increase of irrigated land from 1.5 to 1.6 million hectares by 2012, though they did not specify how it affected the 0.1 million ha irrigated by South African smallholders. According to De Lange (1994), Du Plessis and Van Der Stoep (2001), and Van Averbeke et al. (2011), there are four categories of smallholder irrigators in South Africa. These include plot holders on irrigation schemes, irrigated community gardens, home gardeners, and independent irrigators. Almost half (47 667 ha) of land irrigated by smallholder irrigators in SA was under the hands of plot holders on irrigated schemes, and in 2010 there were 206 operational schemes and 90 non-operational (Van Averbeke, Denison & Mnkeni 2011). Estimated land size of between 10 000 and 20 000 ha was in the hands of irrigated community gardens (Van Averbeke et al., 2011). That left two of the four categories, home gardens and independent irrigators, with 30 000 to 40 000 ha. However, with the nature of independent irrigators, the exact share held by each group is challenging to determine, and that presents another knowledge gap in the South African independent irrigation sector. Unlike in Asia and some African countries, no research has been conducted in South Africa to determine the exact total land irrigated by these irrigators and the number of pumps in use.

2.5 Characteristics of independent irrigators

2.5.1 Human characteristics

In irrigated agriculture, factors like age and gender determine the quality of labour an individual can provide. While variables like household size usually measure the quantity of labour available in the household, considerable research has been done on independent irrigators in Asia. However, limited information is presented in those studies referring to such variables.

Most independent irrigator studies in these regions focus on land, water, and irrigation technologies. Nevertheless, in South Africa, independent irrigators appeared to be primarily men over 50. For example, the independent irrigator's average age was 60 in the Thulamela and the Greater Tzaneen municipalities in the Limpopo Province. Concerning gender, only 31% of the irrigators were females in both regions. In contrast, Jozini (KwaZulu-Natal) independent irrigators were primarily females (57.9%) with an average age of 50.7 years (Wale & Chipfupa, 2018).

2.5.2 Land and irrigation water

In Asia, independent irrigators farm on less than two hectares and often on much smaller lands (Giordano et al., 2012). These findings were confirmed by De Fraiture (2012), who reported that the farms of independent irrigators in Asia are typically less than a hectare in size. In West Africa (Burkina Faso, Mali, Niger, and Nigeria), independent irrigators farm plots of about 0.1 ha (Abric et al., 2011). The detailed study of independent irrigators in Namibia revealed that the size of the irrigation farms in that country ranges between 50 m² and 13 ha (Fiebiger et al., 2010). The average size of the 'small-scale farms' category is 3.95 ha, and that of the 'micro-scale farms' is 450 m² (Fiebiger et al., 2010). As in Namibia, the size of the plots by South African independent irrigators tends to vary considerably. The evidence indicates a wide distribution of land sizes in South Africa. For example, Du Plessis and Van Der Stoep (2001) reported plot sizes ranging between 5 and 70 ha, while Oosthuizen et al. (2005) reported plots ranging between 4 and 80 ha. A study conducted between 2013 and 2014 in Limpopo Province revealed average land sizes of 6.1 ha in the Greater Tzaneen and 2.1 ha in the Thulamela Local Municipality (Denison et al., 2016). While in Makhathini and Ndumo of Jozini Local Municipality in KwaZulu-Natal, a study reported that irrigators owned an average of 1.44 ha and 1.97 ha (Wale & Chipfupa, 2018).

Independent irrigators extract irrigation water wherever they find access as long as there is a piece of land in the vicinity. Asian independent irrigators extract water mainly from groundwater (Mukherji et al., 2009; Turrall, Svendsen & Faurés, 2010). For example, over 70% of the irrigation water in India comes from this source, while this is 79% for Bangladesh (AQUASTAT, 2010; AQUASTAT, 2012). Surface water extraction is not as common as groundwater extraction for irrigation but is practised. For example, in Madhya Pradesh, a state in central India, irrigators collect surface runoff in individually owned water harvesting ponds, which they use to provide water for irrigation in the dry season (Malik et al., 2013). Shah (2009) reports how tens of thousands of farmers installed their individual privately owned pumps to draw water in India's

newly constructed Sardar Sarovar Irrigation Project. In contrast to Asia, independent African irrigators mostly rely on surface water bodies for irrigation. In Africa, independent irrigators extract irrigation water from various sources, including shallow hand-dug wells, streams, lakes, small reservoirs, and water harvesting ponds (Giordano et al., 2012; De Fraiture et al., 2013). For example, Takeshima et al. (2010) reported that independent irrigators in Ghana extract water mainly from nearby rivers, streams, and lakes. In Namibia, micro-irrigators and small-scale irrigators rely on surface water for irrigation (Fiebiger et al., 2010). Additionally, as in Asia, independent irrigators use the canals meant for public scheme irrigation. Canal water use was found in Ghana and Burkina Faso (De Fraiture et al., 2013).

In South Africa, the available evidence shows various irrigation water sources used. However, rivers seem to be the most common source of irrigation water (De Lange, 1994; Crosby et al., 2000; Du Plessis, Van Averbeke & Van Der Stoep, 2002; Oosthuizen et al., 2005; Van Averbeke 2008; Denison et al., 2016; Dube, 2017; Wale & Chipfupa, 2018). In Thulamela and Tzaneen local municipalities in the Limpopo Province, 69% and 57.1% of independent irrigators extract water from this source, respectively (Denison et al., 2016). Groundwater in the form of spring or hand-dug wells and a borehole was of secondary importance to independent irrigators in the two municipalities. Springwater was found in 22.5% of the 98 independent irrigators in Thulamela, while 28.6% of the study participants in the Greater Tzaneen area used the borehole (Denison et al., 2016).

2.5.3 Physical assets

Water extraction technologies are a vital physical asset in the independent irrigation enterprise. An irrigation pump is the most common water-lifting technology (De Fraiture & Giordano, 2014). A significant number of independent irrigators in Asia use it to extract water, and its use has grown. The rapid growth of pumps as the preferred technology in this region is because of their declining purchase price and local accessibility (Molle et al., 2003). The rapidly growing use of pumping technologies like treadles and petrol pumps has earned this phenomenon high recognition in Asian countries. For instance, Faurés & Mukherji (2009) and Shah (2009) reported that between 1998 and 2002, pump use increased from 1.17 million to 2.17 million in Indonesia.

Not at the same pace as Asia, but the use of low-cost pumping technologies in Africa is growing steadily. The adoption of these technologies has recently taken off. However, before the growth in

motorised pump usage, human-powered pump treadle pumps were the technology of choice after manual lifting systems (Abric et al., 2011; Giordano et al., 2012). According to Giordano et al. (2012), 80% of independent irrigators in Sub-Saharan Africa still use manual lifting, while the remaining use treadle pumps or motorised pumps to extract irrigation water (Table 1). In Zambia, buckets still irrigate 75% of the 100 000 ha total area in the hands of independent irrigators, and motor pumps irrigate 15% (Colenbrander, Kabwe, & Van Koppen, 2011).

In Tanzania, 70 000 pumps were reported to be in use, with sales of motorised pumps increasing to more than 7 000 purchases annually (Keraita, 2010; Giordano et al., 2012). A total of 170 000, 20 000 and 15 000 motor pumps were estimated to be in use in Ghana, Burkina Faso, and Zambia, respectively (Namara et al., 2013; De Fraiture et al., 2013; Colenbrander & van Koppen, 2012).

Table 1. Estimates of water lifting techniques by independent irrigators in Sub-Sahara Africa

	Water-lifting technology users			Number of motor pumps
	Buckets (%)	Motor pumps (%)	Treadle pumps (%)	
Burkina	85	13	2	20 000
Ethiopia	84	15	1	>400 000
Ghana	80	30	<1	170 000
Tanzania	91	8	1	70 000
Zambia	85	13	2	15 000
Sub Saharan Africa	80	15	<1	>1 million

Source: De Fraiture & Giordano (2014)

Namara et al. (2014) pointed out that official import data in Ghana show that over 65,000 pumps and accessories were imported between 2003 and 2010, worth more than US\$ 8 million. While about 400 000 pumps were estimated to have been imported into Ethiopia (Gebregziabher, 2012). Abric et al. (2011) pointed out that private ownership, as opposed to collective ownership in public schemes, makes these technologies more attractive. Hence, they do not encounter similar problems or conflicts as public irrigation schemes. Despite so much growth use in Africa, the fraction of irrigators using them to the total population of smallholders is very little.

Available evidence in South Africa indicates that pumping is not the most common (Du Plessis & Van Der Stoep, 2001; Van Averbeke, 2008; Denison et al., 2016). A comprehensive study of smallholders in the Limpopo Province provided evidence that supports this notion. Of the 98 independent irrigators in Thulamela, 46% extracted their irrigation water by petrol, diesel, or electric pump (Denison et al., 2016). Thirty-eight per cent of the independent irrigators in the Greater Tzaneen also extracted water by pumps (Denison et al., 2016). Van Averbeke (2008) and Denison et al. (2016) also reported a case of independent irrigators extracting water using river diversion, using a weir made of sandbags, stones, and wooden poles. The extracted irrigation water was conveyed from the source to the field. Irrigation pipes and unlined earthen furrows were most common in conveyance, while short furrows were the most used method of applying water to the plots (Oosthuizen et al., 2005; Van Averbeke, 2008; Denison et al., 2016).

Over 80% of independent irrigators in Thulamela in the Limpopo Province used this method (Denison et al., 2016). Du Plessis and Van Der Stoep (2001) provided an account of independent irrigators in Limpopo Province who used drip or micro-jet irrigation. In Bululwane, located in Nongoma Municipality of KwaZulu-Natal Province, a survey in 2016 found that 50% of sampled independent irrigators used sprinklers while the other 50% used flood irrigation (Wale & Chipfupa, 2018).

2.5.4 Resource access for independent irrigators

In irrigated agriculture, institutions, policies, and laws govern access to land and water. These policies and institutions can either hinder or promote access to these resources. In this regard, independent irrigators mainly operate outside the view of policymakers, donors, and the research community (Molle et al., 2003). Strategy documents and irrigation development plans still exclude these irrigators, and their focus is still on public irrigation schemes despite their poor performance (Faures et al., 2007; Turrall et al., 2010). One example is the South African NDP 2030 (National Planning Commission, 2011). Concerning land, little has been done regarding how independent irrigators access their land. Giordano et al. (2012) reported that farmers in Sub-Saharan Africa faced difficulties accessing land without details on the nature of these difficulties. They did not indicate how independent irrigators had accessed the land they were using. In most African countries, farmers usually obtain user rights. It is often impossible to privatise land. For example, in Nigeria, all land is vested in the state and is occupied for use by individuals, with legal rights given to them by a “Certificate of Occupancy” (Takeshima et al., 2010).

In a study of independent irrigators in Namibia, farmers pay authorities to access land (Fiebiger et al., 2010). They receive the right to use the land once they have delivered this single payment. Accessing land this way is also common in South Africa; most lands by independent irrigators were allocated to them by traditional authorities. Accessing land through traditional authorities was mentioned in studies by Oosthuizen et al. (2005) and Tapela (2012), which mentioned independent irrigators. The research by Denison et al. (2016) supports this evidence, where 51% of the 98 independent irrigators in Thulamela's Local Municipality of the Limpopo Province accessed land this way. Some indicated to have paid a certain once-off amount, while others did not pay anything. In Thulamela, unregistered ownership of the independently irrigated land where irrigators just cleared and used the land without anyone's permission was also common. Of the 98 independent irrigators in Thulamela, 36.7% accessed land this way.

Independent irrigators have individual irrigation systems that an individual farmer controls instead of a scheme where the irrigation system and decisions regarding that system are shared. They also fall outside institutional recognition, as the public government focuses on public irrigation schemes, including water institutions. In Asia, irrigators extract irrigation water privately wherever they find access (Giordano et al., 2012). They often do not pay for the water but for fuel to pump it (Mukherji et al., 2009). Shah et al. (2008) reported that groundwater costs were 1.5 to 8 times the cost of surface water in India. In Sub-Saharan Africa, payment for water was rare, and irrigators extracted as much as possible (Giordano et al., 2012). The extraction depended on the physical capabilities of farmers who irrigate manually and the affordability of pumping costs for those who extract by pumping (Abric et al., 2011; Fiebiger et al., 2010). It appears that in South Africa, independent irrigators access water free of charge. However, there was a case in Maluleke in the Limpopo Province, where an independent irrigator paid a fixed fee of R500 per annum for water regardless of consumption (Tapela, 2012).

Farmer's access to agriculture education and extension services relates to increased productivity. In the case of independent irrigators, they have limited to non-existent access to these services. Agricultural extension services tend to focus on public irrigation schemes, and it is so globally. The lack of information and knowledge on different aspects of farming can negatively affect farm success because access to these services allows farmers to make informed decisions. It includes information and knowledge of production, irrigation, appropriate inputs (seed, fertiliser, agrochemicals), equipment, and markets (Giordano & De Fraiture, 2014). In Asia, independent

irrigators do not enjoy institutional support and have no financial support. Irrigation Departments in Asia tend to oversee large-scale irrigation schemes, while agricultural Departments are mainly concerned with rain-fed farming (Giordano et al., 2012). Independent irrigators fall between the two and lack an institutional 'home'. As in Asia, African independent irrigators have received little attention. Namara et al. (2011) reported that independent irrigators in Ghana received inadequate public support because there was no centralised effort to monitor and regulate their development, and extension services were insufficient.

According to research in Ghana, just 10% of male irrigators received visits from extension officers, while only 1% of their female counterparts did (Giordano & De Fraiture, 2014). In Tanzania, farmers claimed they have never received any extension support or seen an agricultural extension worker in their farming years (Giordano & De Fraiture, 2014). In Namibia, about a third of interviewed small-scale independent irrigators had received some training in agriculture or horticulture. In contrast, the micro-scale category of farmers had received no training. However, the policy outlook on independent irrigators in other regions is evolving. In West Africa, governments have started to include independent irrigators in their strategies and support their development by promoting innovative low-cost irrigation technologies (Abric et al., 2011).

In South Africa, agricultural extension is a potential tool to fight against food insecurities and poverty. However, this has focused only on smallholder irrigated schemes for decades, giving limited to no attention to the other smallholder categories. As in Asia and Sub-Saharan Africa, South African independent irrigators lack an institutional home to administer agricultural extension and advisory services. As elsewhere in Africa, South African independent irrigators have not received government or formal institutional support (De Lange, 1994; Crosby et al., 2000). Limited to non-existing support for independent irrigators was also the conclusion reached by Vaughan (1997). In the former Transkei, factors of production, assistance and farmer support, appropriate and sufficient land, capital, inputs, and labour, technical advice on irrigation systems, and information on crop water requirements and scheduling were all inadequate (Vaughan, 1997). In a livelihood study of independent irrigators in Limpopo, only 38.8% claimed to have received some production advice, while only 28.6% received irrigation advice (Denison et al., 2016). Like in the Greater Tzaneen Local Municipality, only 27.6% had received some production advice and 24.1% on irrigation training. Grant assistance was non-existence in both studies (Denison et al., 2016).

2.5.5 Challenges facing independent irrigators

In independent irrigation, it appears that an irrigation pump is the most valuable physical capital and contributes to the enterprise's success. Since independent irrigators primarily depend on or fund themselves to initiate their irrigation enterprise, access to irrigation technologies depends on the household's affordability or socioeconomic status. This puts a constraint on poor and female farmers.

In Ghana, Adeoti et al. (2009) and Namara et al. (2013) indicated that irrigation technologies in motorised pumps are suitable for better-off farmers. These are unaffordable for farmers who irrigate small plots of land and operate on small capital. Gender seems to be associated with access to resources, where male irrigators have access to more resources than their female counterparts. For example, Ghana and Ethiopia pump owners tended to be the better-off male farmers, representing 20% of the wealthiest segment in the community (Colenbrander & van Koppen, 2012; Namara et al., 2013). Namara et al. (2013) also pointed out that these are better-educated farmers and males, while females form part of the poor segment who do not have access to these technologies and use buckets to irrigate their plots (Namara et al., 2013; Colenbrander & Van Koppen, 2012).

Independent irrigators have difficulty accessing credit, especially the poor and female irrigators. There are limited or non-existent financial institutions for these female farmers, which in turn require one to invest money from their household savings (Malik et al., 2013; Van Koppen et al., 2012; Colenbrander & Van Koppen, 2012). In addition to financial constraints, policies also hinder access to irrigation technologies. For example, in Sub-Saharan Africa, including Zambia, Ghana and Ethiopia, trade policies, taxes and duties affect the availability and prices (and hence uptake) of imported irrigation equipment (Colenbrander & Van Koppen, 2012; Namara et al., 2013; Gebregziabher, 2012)

2.5.6 Independent irrigation contribution to rural households

Globally, there is growing recognition of the vital contribution independent smallholder irrigation makes to rural development. Independent irrigators have been widely acknowledged for their significant contribution to alleviating poverty, improving food security, improving household cash income, and creating employment opportunities among rural households (De Fraiture & Giordano, 2014). Independent irrigation is significant in Africa since it provides cash income, especially

during the dry season. During this time, agricultural income is limited, and irrigation is essential for full agriculture production potential. For example, small private irrigation production in Ghana contributed between USD 175 and USD 840 more to annual household income than dry-land production (Giordano et al., 2012; De Fraiture, 2012).

In Tanzania, smallholders involved in private irrigation got 50% more in cash income from dry-season vegetable cultivation (Keraita, 2010). In Burkina Faso, private irrigators made between US\$2500 and US\$ 5000 a hectare per season (De Fraiture & Giordano, 2014). Much of the contribution is associated with an investment in small irrigation technologies. These technologies are also said to positively impact land, labour productivity, and critical indirect economic benefits (Adeoti et al., 2007; Shah et al., 2000; Kumar et al., 2005; Burney & Naylor, 2012). In South Asia, Hossain et al. (2006) and Hossain (2009) found a positive relationship between the increase in privately owned irrigation equipment and agricultural production, cash income, and food security. Hence, this form of irrigation is an ideal poverty alleviation tool (Hossain, 2009; Burney & Naylor, 2012). Manual lifting, including buckets and watering, can irrigate up to 0.1 ha, while treadle pumps (human-powered) can irrigate 0.1–0.2 ha (Giordano et al., 2012; Giordano & De Fraiture, 2014). On the other hand, the holdings irrigated by motor pumps (petrol or diesel) are, on average, four times larger (De Fraiture & Giordano, 2014). Watering with buckets limits the size of irrigated areas due to the high labour requirement, the limited availability of family labour, and the relatively high cost of hired farm labour (De Fraiture & Giordano et al., 2014). Also, irrigating manually by bucket or watering cans takes more hours daily to irrigate just a tiny piece of land. Woltering et al. (2010) estimate it takes 9 hours to irrigate 1000 m² from a nearby source per day. In Ghana (Volta and Ashanti region), Adeoti et al. (2009) found that irrigators using pumping technology had an average net income of US\$952.43, while those who did not have a net income of US\$608.89. Brabben and Kay (2000) and Mangisoni (2008) drew similar conclusions in Kenya, Zambia, and Malawi. In Kenya, the income for no technology users was 8.6 times less than those who used manual lifting technologies.

2.6 Conclusion

This discussion revealed a significant scarcity and ageing literature on independent irrigators in South Africa. To begin with, most of these investigations that reported independent irrigators were general in scope. No independent irrigators were sampled, making them too general. One example

is De Lange (1994), who wrote the first report retrieved by the researcher. Second, there is a shortage of proper methodology for sampling and collecting information about these irrigators, particularly older sources. Most of the independent irrigators are primarily identified by chance. Third, most independent irrigators' studies had a small sample size, often as low as one element. As a result, that research can never be applied to the vast majority of SA independent irrigators.

The Water Research Commission's recent work on entrepreneurial pathways has offered some detail on these irrigators. However, the evidence is insufficient to draw judgments about the whole of South African independent irrigators. There is much comprehensive work on these irrigators that needs to be done. There is a need to determine the land area irrigated independently. Independent irrigators must be understood in various socio-economic settings. Research should focus on the factors that make independent irrigation successful in those settings, their contribution to livelihoods, the interventions required to be influential in rural development, the sustainability of these enterprises, and the negative impact of their booming.

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CHAPTER 3. THEORETICAL FRAMEWORK AND METHODOLOGY

3.1 Introduction

In developing countries, irrigated agriculture and rural livelihoods have long been connected. As a result, understanding the relationship between rural livelihoods and irrigation is critical, especially in rural development. Depending on the study's goals, researchers have employed a range of theories, including theoretical frameworks, to make sense of this link; this current research is no exception. The first component of this chapter introduces the adopted theoretical framework and how this framework was operationalised to answer the study's objectives-through identifying a set of indicators representing various framework components. The second section of this chapter describes the study site and its characteristics, including location, human and natural environment, living conditions and farming systems. The section also describes the study design, empirical data-gathering methods, data transformation, and analysis techniques. Ethical approval for this investigation was provided by the HSSRC (**Appendix A**).

3.2 Theoretical consideration of the study

3.2.1 The livelihood concept

In its general sense, a livelihood is how people make a living. Various definitions contributed to the understanding of the concept of livelihoods. For example, the concept of livelihoods was defined by Chambers and Conway (1992) as "comprising the capabilities, assets (stores, resources, claims, and access) and activities required for a means of living." Elasha et al. (2005) defined the concept as the means, activities, entitlements, and assets people make a living. It was described by Ellis (2000) as the "assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household." According to these definitions, various factors must interact for a livelihood to exist. These factors include capital or assets, activities influenced by the vulnerability context, and transforming structures and processes. All these interactions yield an outcome that can be negative or positive. Independent irrigation, for example, is the subject of the current study and is a source of income for irrigator households.

To engage in independent irrigation, one needs a variety of capital (land, water, irrigation technology, skills). Specific laws and policies (land tenure, Water Use Authorisation) passed by

institutions (municipalities, traditional authorities, Water and Sanitation Department and others) regulate access and exchange for these assets. Additionally, independent irrigation is prone to specific vulnerabilities resulting from floods, droughts, soil erosion, and high input prices, which may affect the outcome (cash returns from crop production). Hence, this research adopts the concept of investigating if independent irrigation positively affects irrigator households' livelihoods.

3.2.2 Livelihood approach and framework

This study follows a sustainable livelihood approach and framework developed by the Department for International Development (DFID) (Figure 2). A livelihood approach is a way of thinking when engaging in research, policy analysis, intervention planning, and evaluating development projects (De Haan, 2005). A livelihood approach also engages policymakers and development practitioners to ensure that policies and development initiatives target the key issues and actively contribute to livelihood security (De Satgé et al., 2009). Organisations and institutions have adopted a livelihood approach to guide their development interventions. Some of these organisations are the DFID, Oxfam (The Oxford Committee for Famine Relief), CARE (Cooperative for Assistance and Relief Everywhere), and the UNDP (United Nations Development Programme).

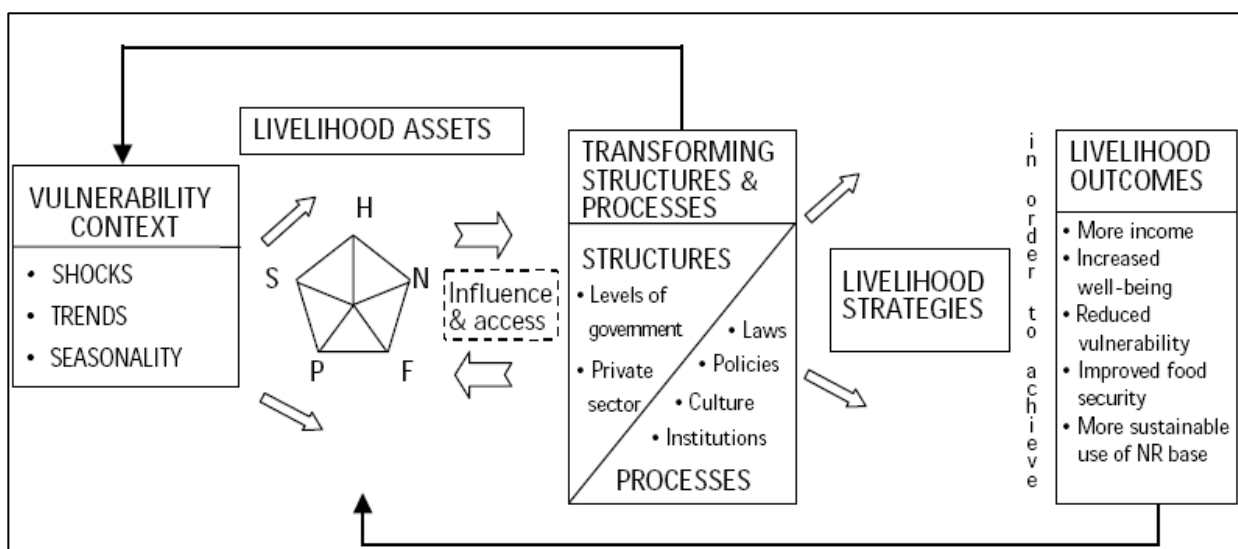


Figure 2. Sustainable livelihood framework adopted in this study (DFID,1999)

The application of livelihood analysis is associated with adopting a livelihood approach to development. Sustainable livelihoods frameworks serve as a tool for examining poor people's livelihoods while visualising the primary elements that influence them (Kollmair & Gamper, 2002). Various academics have devised several frameworks to aid in analysing livelihood (Scoones, 1998; Carney, 1998; DFID, 1999; Drinkwater & Rusinow, 1999; Carney et al., 2000; Hussein, 2002; Ellis & Freeman, 2005). The DIFID framework provides an analytical foundation for a broad and systematic analysis of the numerous factors limiting or promoting livelihood options among Msinga independent irrigator households and how they relate. As a result, it will aid in addressing the impact of independent irrigation on smallholder independent irrigators and their households' livelihoods in Msinga.

3.2.2.1 Vulnerability context

The vulnerability context represents the external environment in which people exist (DFID, 1999; Devereux, 2001). Shocks, trends, and seasonality are all part of the external environment, which affects the human asset base (Erenstein, Hellin & Chandna, 2007). Human, livestock, or crop health shocks; natural disasters such as floods or earthquakes; economic shocks; conflicts such as national or foreign wars; and agricultural challenges such as pests and diseases are examples of shocks. Demographic trends, resource trends, trends in governance at national and international levels of economics, politics, and technology, decreasing farm sizes, and growing pest and disease levels are all thought to have a detrimental impact on livelihoods and examples of trends (DFID, 1999; Chambers & Conway, 1991; Erenstein, Hellin & Chandna., 2000). Seasonality can be seen in pricing, goods, job opportunities and the effects of weather patterns on agricultural production, livestock nutrition, and disease (DFID, 1999; Erenstein, Hellin & Chandna., 2000).

3.2.2.2 Livelihood capitals

Human capital comprises skills, knowledge, labour capability, and good health, all of which help people build diverse livelihood strategies and attain their goals (DFID, 1999). Skills and knowledge are directly tied to formal or informal education (Winters, 2011).

Informal education can relate to experiences, such as "learning by doing" (Weir, 1999) or transmitting traditional knowledge (Mango, 2002). Formal education allows people to get official recognition for their educational accomplishments and skills, which can help them get better jobs

(Ellis, 2000). Formal education can help people obtain work and maximise the value of their current assets (Njagi, 2005). Labour capability varies according to household size, skill levels, leadership potential, and health status (DFIF, 1999). The size of the labour pool within the household is determined by the household size (Badisa, 2011). The household size determines the size of the labour pool within the household (Badisa, 2011). Age and gender contribute to the quality of labour, particularly in activities that require physical labour; older people and females tend to be less capable of performing physical activities than young people and males (Howley, Donogue & Heanue, 2012; Ramroka, 2011). Regarding health status, labour as an asset is more effective when the person providing the labour is free of illness or debilitating health problems (Ellis, 2000).

Social capital is the social resources that people rely on to achieve their livelihood goals, such as networks and connectedness, which increase people's trust and ability to cooperate, or membership in more formalised groups with their own set of rules, norms, and sanctions (Kollmair and Gamper, 2002). Social capital is defined by Moser (1998, cited in Ellis, 2000) as reciprocity within communities and between households based on trust derived from social links. It strives to capture the communal and broader social claims that people and households can make because of their membership in social groups with varying degrees of inclusivity (Ellis, 2000).

Natural capital refers to the natural resource base humans rely on to survive (Kollmair & Gamper, 2002; Erenstein, Hellin & Chadna, 2007; Timalsina, 2012). These resources include land, water, forests, air quality, erosion protection, biodiversity degree, and rate of change, to name a few. Some resources that make up natural capital are intangible public goods like the atmosphere and biodiversity and divisible assets like land and trees used directly for production. Natural capital has different meanings for people depending on their reliance on the natural environment (Bell, 2012). For example, natural capital is significant among poor rural people as they derive most of their livelihood from natural-based activities (Kollmair & Gamper, 2002). Collecting and harvesting wood, as well as crop production, are examples of such activities.

Physical capital refers to the infrastructure and producer products required to secure livelihoods (DFID, 1999; Kollmair and Gamper, 2012). Economical transportation, secure shelter and structures, adequate water supply and sanitation, clean, affordable electricity, and information access are all examples of infrastructure (Kollmair & Gamper, 2012). Also, changes in the physical

environment that enable individuals to achieve their basic needs and be more productive are a form of infrastructure. Roads, for example, reduce the spatial costs of resource and output transactions in various ways. They also enable people to migrate between locations offering multiple income sources (Ellis, 2000). On the other hand, producer goods are tools and equipment that, when employed, allow people to work efficiently (DFIF, 1999).

Financial capital refers to the stock of money a household can access, like savings and credit in loans (Timalsina, 2012). Money savings and loans are not immediately productive forms of capital because they owe their place in a household's asset portfolio on their ability to be converted into other kinds of capital or straight into consumption (Ellis, 2000). Available stock and regular money flows are the primary forms of financial capital highlighted by DIFD (1999). Bank deposits and liquid assets such as cattle and jewellery are available money stocks free of liabilities and usually not reliant on third parties. Regular inflows of money, such as wages, pensions, other government transfers, and remittances, are mainly dependent on others and must be dependable (Kollmair & Gamper, 2002; DFIF, 1999).

3.2.2.3 Transforming structures and processes

Institutions, organisations, policies, and legislation shaping livelihoods are transforming structures and processes in the SLF (Kollmair & Gamper, 2002). Structures are the “hardware” (private and public organisations) that “create and implement policy and legislation, deliver services, purchase, trade, and perform a variety of other operations that influence livelihoods” (DFID, 2000). In addition to structures, processes are the “software” that determines how structures and individuals operate and interact. These institutions and processes determine access to, use, and exchange between different types of capital and returns on any given livelihood strategy.

3.2.2.4 Livelihood strategies

Livelihood strategies are activities that generate the means of household survival (Timalsina, 2012). According to Scoones (1998), there are three types of rural livelihood strategies: agricultural intensification or extensification, livelihood diversification, including paid jobs and rural enterprises, and migration (including income generation and remittances). Carney (1998) divides livelihood strategies into two categories: natural resource-based and non-natural resource-based, including migration, remittances, and other transfers. Their place within the framework

reveals their reliance on asset status and transforming structures and processes. Depending on the policies and institutions at work, a change in asset status may help or hinder other efforts. When thinking about livelihood strategies and challenges related to the SLA in general, it is vital to remember that people compete (for jobs, markets, and natural resources), making it impossible for everyone to enhance their livelihoods simultaneously.

3.2.2.5 Livelihood outcomes

The accomplishments or outputs of livelihood strategies are known as livelihood outcomes (DFID, 1999). The livelihood outcomes are more income, increased well-being, reduced vulnerability, food security, and sustainable use of natural resources. Income in cash and kind is widely used in assessing livelihood outcomes (Machethe et al., 2004; Devereux, 2006; Mohamed, 2006). However, according to Bérenger and Verdier-Chouchane (2007), money alone is insufficient to determine whether people's livelihood activities are sufficient to provide them with an acceptable standard of living.

3.2.3 *Application of the SLF to the current research*

The framework operationalisation for the current study is discussed in this section. The section also includes a brief on how other researchers studied these components in the smallholder irrigated agriculture fields and what hypothesised relationships emerged from these studies. Table 2 lists the SLF components, indicators, and measurements used in this study to operationalise these SLF components. The study included age, gender, educational level, occupation, household size and labour as human capital indicators at the household level. The quality and quantity of available labour in a rural agricultural household is a building block in pursuing livelihood objectives and achieving good outcomes (Bhandari, 2013). Age and gender contribute to the quality of labour, particularly in activities that require physical labour. Older people tend to be less capable of performing physical activities than young people (Howley, Donoghue & Heanue, 2012). Good health is another aspect contributing to physical labour on a farm; chronic health problems might limit or remove this potential (Ellis, 2000). The study did not include questions on irrigators' health since they are too intimate. Regarding the quantity of labour, Badisa (2011) indicated that homestead size determines the size of the labour pool within the household.

Table 2. Variables selected for use in the current study

	Indicators	Measurement
Human capital	Education	Continuous – years
	Gender	Categorical - female=0 male=1
	Age	Continuous - years
	Occupation	Categorical – nominal scale
	Household size	Continuous- number
	Labour (availability for labour)	Continuous- number
	Farming experience	Continuous- years
Physical capital	Household assets ownership	Categorical- owned=1, otherwise =0
	Equipment for irrigation ownership	Categorical- owned=1, otherwise=0
	Infrastructure and equipment in farming	Categorical- owned=1, otherwise=0
Social	Groups and networks membership	Categorical-member=1, otherwise=0
	Relationship of trust	Categorical-ordinal scale
	Farming information access	Categorical-ordinal scale
Natural	Cultivation land size	Continuous- hectares & m ²
	Adequacy of current land holdings	Categorical- ordinal scale
	Irrigation water sources	Categorical- nominal scale
	Adequacy of water source	Categorical- ordinal scale
Financial	Income sources	Continuous-South African Rands
	Loans	Continuous- South African Rands
	Savings	Continuous- South African Rands
Strategies	Income generating activities	Categorical- involved=1, otherwise=0
Transforming structures and processes	Land access	Categorical – nominal scale
	Water access	Categorical- nominal scale
	Agricultural support systems access	Categorical – received=1, otherwise=0
	Access to markets	Categorical-nominal
Outcome	Household income	Continuous-South African Rands
	Food consumption	Continuous- number
	Food expenditure	Continuous- South African Rands
Vulnerability	Household shocks	Categorical- yes=1, otherwise=0
	Farming shocks	Categorical-yes=1, otherwise=0
	Farming constraints	Categorical- ordinal scale

In farming, it is hypothesised that an increase in household size increases the chances of success for the farming enterprise, and this applies mainly if all household members are willing and old enough to perform farm work (Masuku, Raufu & Malinga, 2015). Farmer education, it is hypothesised, has a beneficial effect on-farm productivity. It is hypothesised that educated farmers will absorb innovations more quickly, comprehend and evaluate new products and processes, and understand scientific advances, which is challenging for illiterate farmers (Okpachu et al., 2014). The education of household members is hypothesised to have a favourable effect on the home if they find employment that matches their qualifications. According to Mohamed (2006), the income of plot holder homesteads along the Dzindi canal scheme was positively associated with the level of formal education attained by the residents of these homesteads. However, this general correlation held only at the farmstead level, when individuals with relatively high formal educational credentials could acquire employment similar to their academic credentials.

This study's indicator of natural capital includes farming land and irrigation water. When considering the capacity of cultivated land to produce things that meet human requirements, the amount of land (area) available is crucial. Similar to Sharp (2003), Li et al. (2007), and Yang and Zhao (2009), the current study uses the total area (m²) of farming land owned by all household members as the first indicator of natural capital. The second indication of land access is the area cultivated by the household during the period under consideration. Frequently, cultivated land is distinct from owned land. As a result, the amount of land farmed reflects a household's access to land (through ownership or other institutional frameworks) and its capacity to cultivate it. Households with access to land can produce diverse agricultural products consumed or sold (Bury, 2004). Apart from land, water can be a critical natural resource in agroecosystems, particularly in areas with water scarcity. Under such circumstances, water availability for crop irrigation can significantly increase the capacity of cultivated land to produce goods that meet human needs. Access to water for livestock and, more specifically, crop irrigation is critical for reducing poverty and food insecurity (Maponya, 2008). Therefore, this research indicated natural capital as a source of irrigation water and adequacy.

Physical capital includes producer goods and infrastructure that allows households to support livelihoods. The study included essential tools and equipment for agricultural production to indicate producer goods. These are very important as they facilitate the success of the farming enterprise.

For example, power from draft animals, tractors, and equipment allows more land cultivation. The study also included physical capital for irrigation. The technology used to access irrigation water positively affects irrigated land and productivity in irrigated agriculture. (De Fraiture & Giordano, 2014). The amount of cash obtained from the different sources indicated regular cash flows, including but not limited to pensions, wages, and remittances. At the same time, savings and loans were also included as variables to indicate stocks of money.

In this investigation, households' membership in community and farming groups and access to social support networks like friends, families and neighbours in times of crisis (Sharp, 2003) indicate social capital. Membership in farming groups is usually related to reduced transaction costs, greater access to information, and increased bargaining power among smallholder farmers (Randela, 2005; Ramoroka, 2012). Guided by the studies focused on irrigated agriculture, social capital also includes the dimension of information and communication (Dudwick et al., 2006). For example, access to farm information through contact with extension staff is more likely to promote appropriate agricultural practices (Badisa, 2011).

Information indicating transforming structures included data on public organisations (e.g. Department of Water and Sanitation, Department of Agriculture, traditional authorities) that determine access to rural household assets, including land and irrigation water, for this study. Processes are policies and laws to make access more accessible (e.g. land tenure, Water Use Act). For example, rural areas' policies and land tenure structures mediate access to land (a vital natural resource) (Scoones, 1998; Ellis, 2000). Land tenure, or how individuals or groups control land, impacts land access (Van Auerbeke, 2008). Data on irrigators' access to support services (i.e. extension, grants, loans, and training services) were complemented with output market information. Livelihood strategies are activities that generate means of livelihood. The current study will indicate strategies by various monetary income sources, including salaries, remittances, social grants, local economic activities (service provision, making and selling and buying and selling goods) and agriculture. Livelihood strategies result in livelihood outcomes or outputs. In this study, variables to indicate outcomes include household income and food security indicators. The study also included physical quality of life indicators, including water source for drinking, the energy source for cooking, and toilet type, indicating household well-being. Shocks indicated the vulnerability context, including natural disasters such as floods and drought, conflict over water use, and household and farming constraints.

3.3 Methodology

3.3.1 Snowball sampling and entry to the field

The survey phase of this investigation adopted a sampling procedure used in a study that formed part of the WRC Project K5/2179, conducted in the Thulamela Local Municipality (Denison et al., 2016; Dube, 2017). A similar situation in the current study site motivated the decision to adopt similar techniques. As indicated by the Department of Agriculture and Rural Development's local agricultural office, there was no formal documentation or database of these irrigators in Msinga. The absence of formal records or a database of these irrigators that could serve as a sampling frame disqualified any probability sampling method. In the probability sampling plan, one should know the size of the parent population or universe from where they are selecting the sample, it allows specification of the desired sample size, and each element or group of elements has a known chance of being included in the selection (Turner, 2003). In non-probability sampling, selecting the inclusion elements in the sample relies on the researcher's or field interviewer's judgment.

Therefore, for those reasons, a non-probability sampling technique known as snowball sampling was employed to select the study elements for the survey. Snowballing produces homogeneous samples, focusing on respondents with similar traits or specific characteristics (Etikan, Musa, & Alkassim, 2016). This method involves contact with an element with information of interest, leading to other participants with similar knowledge, thus creating a respondent trail. Accordingly, the first sampling attempt involved contacting the Msinga Department of Agriculture and Rural Development and the Msinga local office manager on 10th May 2019 to request their assistance in identifying independent irrigators they might know of in their working wards. Subsequent to this, the researcher and field assistants were invited to a meeting at the local agricultural office on 15th July 2019. The researcher explained the research purpose to the staff present and described "independent irrigators" and their characteristics in the study context. Only 25 independent irrigators were identified during this exercise by the extension staff present.

3.3.2 The survey sample

The sampling process started with the 25 known independent irrigators. They, in turn, led the researcher and the field assistants to others with similar information, thus creating a trail of respondents until a size of 101 participants were identified and confirmed as included. Independent irrigators were found in various villages, including Mbabane (1), Ngubo (2), Paraffin

(5), Nseleni (1), Nxamalala (3), and Mashunka villages (89). There was no attempt to find equal numbers from the six villages, as irrigators were selected based on their characteristics and referrals obtained from contacted irrigators. The indications were that there were other independent irrigators in nearby villages; however, due to limited time and financial constraints, the researcher could not include them in this study. The sample size decision represented a compromise between the need for a large enough sample to warrant statistics (Turner, 2003) and the limited financial resources available to conduct the study.

3.3.3 Phasing the investigation.

The current study used mixed methods in a qualitative case study design (Creswell & Clark, 2007). This study's design is shown in Figure 3. Two strategies were deliberately used in sequence to provide depth and confirm the findings. A face-to-face survey collected data in November and December 2019. The data was analysed to determine a factual overview and statistical analysis of how irrigator livelihoods were utilising resources to achieve livelihood outcomes. The second phase used Focus Group Discussions (FGD) in July 2020 to probe more deeply the patterns raised in the survey and confirm understanding and interpretation. Using mixed methods is advantageous because it explains the research problem rather than either approach alone or with statistical results by exploring independent irrigators' views in more depth.

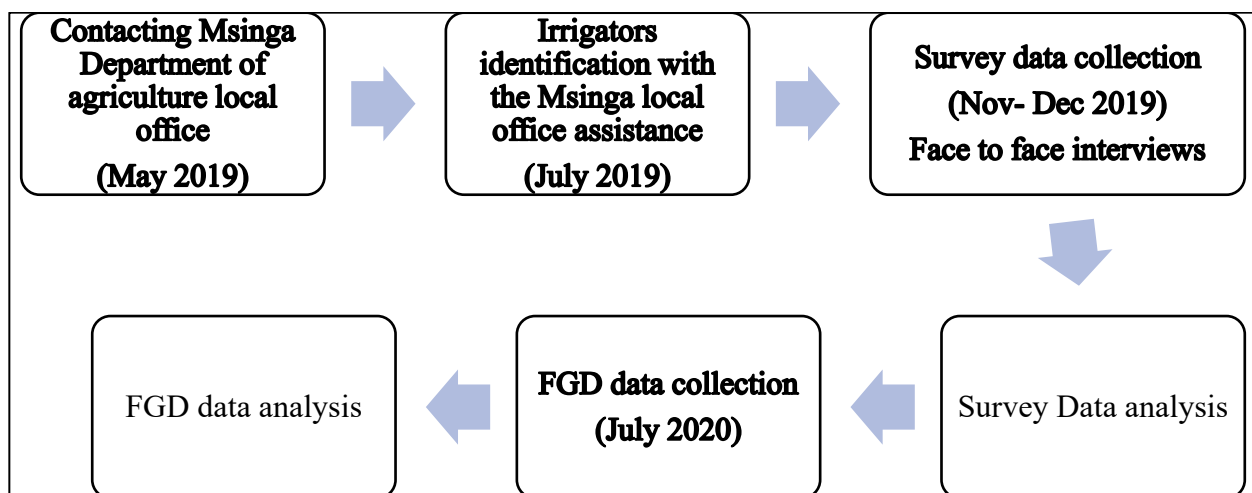


Figure 3. Schematic overview of mixed-method design describing the phases used in this study.

The study elements are independent irrigators operating within Msinga Local Municipality. In this study, an independent irrigator is a “smallholder who has direct access to a source of irrigation

water and extracts, conveys, and applies this water using privately-owned equipment” (Dube, 2017:44). Inclusion included “private” or “individual” water supply, which discriminated them from scheme irrigators and holders of allotments on irrigated community gardens. These two categories share an irrigation system and irrigate collectively. While understanding and interrogating the household organisation of independent irrigators is a complexity that may need further research for policy, it is essential to note that when an irrigator has a plot on an irrigation scheme or community garden but uses their own individually operated and managed irrigation system (e.g. own pump), this study regards them as an independent irrigator. In addition, independent irrigators differed from irrigated home gardens based on their plot location, which is outside residential boundaries. Once a plot is inside the homestead, it is a home garden and no longer an independently irrigated field in this study context.

3.3.4 Focus groups as a sub group of the sample

A purposeful subset was chosen from the surveyed sample to select participants for the Focus Group Discussions. The way these irrigators were set up, one will find pump users close to each other. Hence location was the first characteristic used to find homogenous groupings. This was more convenient cost-wise and practical. Other traits considered for grouping included irrigation water extraction method (pumping or not pumping), intended for irrigators to be comfortable because of sharing the same experiences. The irrigator’s willingness to reflect and share their experiences prompted inclusion, irrigator availability on the phone and availability for that planned date for the scheduled FGD. In total, 42 of the survey respondents participated in the FGDs.

The FGD allowed the researcher to discuss and gather group opinions on vital thematic issues in this study. In addition to the survey, FGD. The purposive sampling technique is widely used in qualitative research to identify and select information-rich cases related to interest phenomena (Cohen et al., 2007). According to Brink (1996), purposive sampling entails picking individuals informed about the topic due to their direct involvement and experience with the subject. Also, purposive sampling refers to selecting venues or individuals to best assist the researcher in understanding the problem and the study topic (Creswell, 2003). The FGDs allowed the researcher to discuss and obtain group opinions (agreements and divergent views), concentrating on these similarities and how they inform the relationships under consideration (Etikan, Musa & Alkassim, 2016).

3.3.5 Data collection methods and tools

Survey data were collected using two structured questionnaires, a cell phone device Samsung J2 Core for crop production field and household GPS coordinates and plot size measurements. The questionnaire aimed to obtain quantitative data on the livelihoods (Appendix B) and agricultural practices (Appendix C) of independent irrigators in Msinga. The questionnaire was constructed and modified from interview schedules used in other South African studies that investigated livelihoods and agriculture in a rural setting ((Manyelo (2011); Mohamed (2006); Denison et al. (2016); Dube (2017); Wale & Chipfupa (2018))). It was adjusted to focus on variables selected in this current study (**Table 2**). Using an existing, widely used data collection tool limits the need for extensive pre-testing for the validity and reliability of the instrument (Van den Ban & Hawkins, 1988; Anderson, 1990).

Variables (**Table 2**) included demographic data, income sources, networks and groups, tools and equipment used in farming, land, and irrigation water as livelihood capital indicators. Each household's different activities to make a living and institutions and policies determining their access to assets were indicators of livelihood activities and transforming structures and processes. Vulnerability context data indicators included farming shocks and constraints on irrigators. Four FGD collected qualitative data using semi-structured interviews guided by a checklist of themes (Appendix D). The focus group discussions aimed to understand irrigators' perspectives on access to irrigation water, land, finance, and agricultural extension. The discussions were also to understand the constraints irrigators face on their livelihoods and farming.

3.3.6 Data collection process

The researcher and two field assistants trained before data collection conducted the interviews. This training occurred on 06th July 2019 at the University of KwaZulu-Natal CEAD boardroom. The researcher conducted the training, and two field assistants were present. This session reviewed each variable from both questionnaires and ensured they understood what the question required and how it was asked. After the training, a refresher training was done a few days before the data collection to ensure everyone still understood their expectations. The field assistants were both agricultural graduates and residents of Msinga. The researcher needed someone more familiar with the villages and the people and with a farming background.

Between November and December of the year 2019, the survey was undertaken. The researcher scheduled appointments ahead of time. The researcher described the study's aim and objectives to the respondents during these visits. The researcher also informed respondents of their rights and then sought their participation. The respondents were asked to sign an informed consent form once they consented to participate in the study. IsiZulu, the respondent's mother tongue, was used to conduct the face-to-face interviews. Translation of the questionnaire into isiZulu took place before data collection. The participants decided on the interview venue, either the respondent's home or the farmland, but most interviews took place on the farmland. Any household member could respond if the irrigator consented when gathering livelihood information. For example, if old irrigators do not know their grandchildren's ages, the older children would pitch in, and the family would assist at home. When collecting data on farming, the questionnaire stated that only a person responsible for agriculture should answer. Hence, the first question (**Appendix C**) asked about the person responsible for decisions on the independent irrigation enterprise. A critical lesson from this was that the household head was not always the most closely involved in agriculture.

During the interviews, all information was recorded on the interview schedule. Each household was visited twice, once for the livelihood interview and a second for the agriculture interview, including the field measurements. Ten households received a third visit after data cleaning due to missing information or ambiguities in the data. The livelihood interview lasted 30 minutes. The agriculture interview lasted 45 minutes because of the field measurements taken afterwards. Field measurements determined the plot size and the area cultivated during the year under consideration. These measurements involved using an area-distance app from the google play store. Walking around the plot holding a cell phone determined the total and cultivated area size. The google play store app is the same one that the local office of the Department of Agriculture suggested and uses. Before beginning the agriculture data collection, an agricultural advisor assisted the field assistant with instructions and a demonstration of using this application.

Between 29 and 30 July 2020. The researcher conducted FDG (Figure 4) with those irrigators who had volunteered for discussion. There were four groups: collectors/bucket users (3) and pumpers (1). From Mashunka village, the first two groups consisted of collectors, with a third group of pumpers. From Paraffin, one group consisted of collectors.



Figure 4. Focus Group Discussion with independent irrigators at Mashunka (A) and Paraffin (B) villages, Msinga

Pumpers were also selected from this area because they were closer together, while the other pumpers were spread throughout the villages; like in Mbabane, there was only one. So, getting them together was not viable. The Mashunka collector groups had ten each, while Paraffin had 12. The pumper group had nine participants. A set of questions or checklists guided the discussions (Appendix D). The researcher conducted the FGD; however, one of the two field assistants was present as he assisted with directions to all the locations identified by irrigators as suitable for the FGD. Responses were recorded on the phone as a voice recording, a Huawei P30 light and later digitised for analysis.

3.3.7 Data transformation for Analysis

The processing of the survey data began with coding the content of questionnaire responses as numerical representations of variables, as shown in Table 3. A Microsoft Excel spreadsheet was used to capture all responses and ultimately uploaded into SPSS for the convenience of running statistical explorations (**Appendices E-W**). The qualitative responses from Focus Groups were translated and recorded as text in tables (**Appendix X**)

Table 3. Variables and their transformation for data analysis purposes

Variables	Indicators and transformation
Natural capital	The adequacy of the land was transformed into five ordinal scale responses, including too small, small, somewhat significant, and too big. Water adequacy was transformed using four ordinal scale descriptors: never enough, mostly enough, and always enough.
Financial capital	Responses on financial capital, savings, and loans were transformed to a 12-month (annual) basis.
Social capital	Data about the likelihood of households successfully claiming money, food, and labour against selected networks used five descriptors: Strongly agree, Agree, Neutral, Disagree, and Strongly disagree. Information access rating on different sources included a five-response ordinal scale: unimportant, moderately unimportant, neutral, important and very important.
Physical capital	Farming implements adequacy was transformed into an ordinal scale response, including inadequate where farmers lack the necessary implements. Adequate where they had adequate working implements they needed, but there were no excess implements, and the last one, where irrigators have more than is needed (excessive).
Human capital	Household members were separated into economically active and inactive people (Tait, 1996). Tait (1996) defined an economically active person as a person aged between 15 and 64 years and an economically inactive person as a person younger than 15 years or older than 64 years old.
Vulnerability	Responses of irrigators rating how a constraint applies to their farm were transformed to a five ordinary response scale, including never, rarely, sometimes, most of the time and always.
Household outcomes	<p>Household income and food expenditure: Similar to financial capital, all household income and household expenditure were also transformed to an annual basis, enabling the calculation of the total yearly value of the income and expenditure. Dividing total household income by household size gave household income per person.</p> <p>Income poverty: The food, lower-bound, and upper-bound poverty levels evaluated household income adequacy. During the period under consideration in this study, the food poverty line was R547. The lower- and upper-bound poverty thresholds are R785 and R1183 per capita per month, respectively (Statistics South Africa, 2018).</p> <p>Total food expenditure was obtained by adding household expenditure on food purchases and the rand (ZAR) value of food produced and consumed by the household.</p>

3.3.8 Survey and FGD data analysis

This study used an independent irrigator and household as units of analysis. The household is commonly used for rural livelihood studies (Baber, 1996; Leibbrandt & Sperber, 1997; Van

Averbeke et al., 1998; Ellis, 2000; Fraser, Monde & Van Averbeke, 2003). Ellis (2000) pointed out that the household is the social unit most appropriate for investigating livelihoods and for a better understanding of the policy implications of different livelihoods. He also pointed out that social and economic interdependence occurs between individuals. Those actions by individuals cannot be interpreted separately from the social and residential spaces they inhabit. Therefore, in this study, a “household” was a person or a group of people (**including the independent irrigator**), *related or not*, who live in the same physical space or dwelling unit, make common food provisions, frequently eat from the same pot, and pool their income together for the sustenance of the home. On the other hand, cash transfers from people who do not share the same physical place were included in household income as remittances.

The study employed the Statistical Package for Social Science Volume 27 and 28 and Stata 17 for data analysis. This section discusses the procedures utilised to analyse the data in general. Each empirical chapter gives much more critical information about the analysis procedures that apply to the variables addressed in that chapter.

The statistical approaches for categorical and continuous data used descriptive statistics, including means, standard deviation, minimum, maximum, counts, and percentages. Correlation tests assessed the link between variables without presuming a cause-and-effect relationship. In the case of two categorical independent variables, an independent sample t-test was performed to compare group means. For example, this test compared the difference in land size (continuous variable) between males and females (categorical variable with two groups) for mean differences. The means were evaluated for the least significant difference (LSD) at the 1% or 5% significance level. A simple regression tested the relationship between two or more quantitative variables. The purpose of regression testing was to find cause-and-effect relationships between variables. A Probit regression model was used to identify the determinants and pump use among the independent irrigators in Msinga (Appendix W).

Thematic content analysis analysed the qualitative data collected from the focus groups. Thematic analysis is “a method for identifying, analysing, and reporting patterns (themes) within data” (Braun & Clarke, 2006). Handling this information began with themes guided by the Livelihoods Framework. Codes for variables of interest were grouped under these themes. Codes identified responses from the discussions. The coded responses were collated from all four groups.

Common themes were identified from the interview transcripts, and their details were interpreted insofar as they related to this study; the analysis is attached in Appendix X.

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CHAPTER 4. INDEPENDENT SMALLHOLDER IRRIGATORS' LIVELIHOOD CAPITALS, STRATEGIES AND OUTCOMES: EVIDENCE FROM MSINGA LOCAL MUNICIPALITY, KWAZULU-NATAL PROVINCE, SOUTH AFRICA

4.1 Abstract

Livelihood analysis in a rural setting is critical in developing intervention strategies for rural livelihood improvement. This paper describes the livelihood capitals, strategies, and outcomes of independent smallholder irrigators in the Msinga Local Municipality of KwaZulu-Natal Province. In November and December 2019, a survey was done with 101 independent smallholder irrigators from different villages in Msinga to collect primary data. The findings revealed that independent irrigators had a limited asset endowment, particularly land, irrigation water, and irrigation technologies. Labour from household members was a significant asset for these households and correlated with household size ($p=0.005$). On-farm activities, including crop production on independent land and livestock production, contributed to households' food availability. These activities also contributed to household food access through income, contributing 26.5% to the average annual household income. As a strategy, sale of livestock provided the most cash. The results from the multiple regression model revealed that explanatory variables, including the number of household members, non-agricultural income, farm income and the use of an irrigation pump, were significant predictors of irrigator households' average annual income. This research is a step toward a better understanding of these often-unnoticed irrigators. This research recommends larger-scale research on these overlooked irrigators to create a firm foundation and concrete evidence justifying their support. Furthermore, it should be robust enough to develop official databases and inclusion in policy documents.

Keywords: Independent irrigation, Livelihoods, Smallholder irrigation, Sustainable Livelihoods Framework

4.2 Introduction

Agriculture in South Africa is a dual sector consisting of large-scale commercial and small-scale subsistence. The large-scale commercial sector, dominated by white farmers, holds most of the land (Vink & Kirsten, 2003; Kirsten, 2005).

The small-scale industry consists of rain-fed and irrigated cropping. There are four smallholder irrigators: irrigation scheme plot holders, irrigated community gardens, home gardeners, and independent irrigators (Du Plessis & Van Der Stoep, 2001; Van Averbeke, Denison & Mnkeni, 2011). Small-scale farmers that are irrigators hold only 0.1 million hectares of the 1.5 million ha of the irrigated area under irrigation (Frenken, 2005). In 2010, scheme plot holders had nearly half (47 667 ha) of the land irrigated by smallholder irrigators. Irrigated communal gardens are in charge of an estimated 10 000 to 20 000 ha of land (Van Averbeke et al., 2011). Two of the four categories, home gardens and independent irrigators, were left with 30 000 to 40 000 hectares each. However, determining the actual amount held by each group is difficult because of the nature of independent irrigators, presenting a knowledge gap in the South African independent irrigation sector.

After apartheid, there was a long history of irrigation development, primarily in rural regions, to alleviate poverty, create jobs, and improve food security. One way of accomplishing this was by investing in and enhancing smallholder irrigated farming through public irrigation projects (Woodhouse et al., 2017). However, such significant investments have been dismal, and their reviews have linked them to bad performance in general (Machete et al., 2004; Tlou et al., 2006; Inocencio et al., 2007; Mnkeni et al., 2010; Woodhouse et al., 2017). Households and individuals in the former homelands and rural areas where most of these developments occurred suffer the most from poverty (Mtshali, 2002; Aliber, 2003). Former homelands include the Provinces of the Eastern Cape, KwaZulu-Natal, and Limpopo. In 2015, 72.9% of the Eastern Cape's population was poor, compared to 70.1% and 68.1% in Limpopo and KwaZulu-Natal, respectively (Statistics South Africa, 2017). In the same year, eight out of ten (81.3%) people in rural areas lived below the Upper Bound Poverty Line (UBPL), twice as high as in urban areas. Despite this, the South African government continue promoting smallholder irrigation projects for poverty reduction and job creation. The National Development Plan (NDP) confirms this, stating the expansion of irrigated agriculture as part of a strategy to create one million employment opportunities by 2030 by developing new "irrigation schemes" (National Planning Commission, 2011). South Africa's history of irrigation schemes necessitates a different development trajectory. Independent irrigation offers attractive investment opportunities, but there is insufficient data on this group in South Africa to create a solid foundation for supporting these irrigators.

Most research studies in South Africa are neither systematic, random, or have a small sample size, and independent irrigators are not the primary focus of the research (De Lange, 1994; Vaughan, 1997; Du Plessis & Van Der Stoep, 2001; Oosthuizen et al., 2005; Van Averbeke, 2008; Tapela, 2012; Denison et al., 2016; Chipfupa, 2017; Wale & Chipfupa, 2018). While there is little current knowledge of these irrigators in South Africa, at least dating back to the last five years. The phenomenon has grown so much that it now outnumbers public irrigated land, smallholders involved, and output on other continents such as Asia and Sub-Saharan Africa (Shah, 2009; Hossain, 2009; Giordano et al., 2009; De Fraiture & Giordano, 2014; Giordano & De Fraiture, 2014; Abric et al., 2011; Giordano et al. 2012; Colenbrander & van Koppen, 2012; Namara et al., 2013; De Fraiture et al., 2013). Furthermore, the research suggests they have significantly impacted rural livelihoods by improving household income, reducing food insecurity, and creating employment in rural areas. The specific objective of this paper was to describe livelihood capitals that Msinga independent irrigators have access to and describe their livelihood strategies and outcomes, to provide groundwork contributing to filling the knowledge gap.

4.3 Methodology

A sustainable Livelihood lens was adopted in this paper. Chapter 3 (3.2 Theoretical consideration of the study) presented the detail of the concepts and relationships of the Livelihood Framework. For this paper, the theoretical focus is on three elements of livelihood relationships, including livelihood capitals, activities, and outcomes. Survey data was collected between November and December using a standardised questionnaire (Appendix B and Appendix C). The data collection methods and process has been described in detail in Chapter 3 (3.3 Methodology).

Statistical Package for Social Science software (SPSS) was used to analyse data for this paper. The analysis included descriptive statistics, a Pearson's correlation, and a T-test. For a Pearson's correlation, household members contributing to labour, household size and the number of economically active adults, all continuous variables, were the variables put to the test. For the independent T-test, two nominal variables represented gender, where the grouping and land size was the test variables. This paper used linear regression modelling to identify significant factors influencing average annual household income (dependent variable for the regression modelling). Annual household income was used as a proxy for the livelihood outcome of households based on their various livelihood capitals and livelihood strategies.

Selected variables, including household size, age of household head, total irrigated land size (m²), non-farm income, farm income, gender of the head, access to social grants, irrigation pump usage, access to farmer group and cattle ownership, were included as explanatory variables in the regression modelling because they are assumed to affect annual incomes of households in the study area.

4.4 Results and discussion

4.4.1 Independent irrigators and their household's livelihood capitals

The observations from the analysis of livelihood capitals for irrigators and their households are in Tables 4 and 5. Table 4 shows continuous variables, while Table 5 presents categorical variables.

Table 4. Livelihoods capitals (continuous variables) for Msinga irrigator households (n=101)

Variable	Mean	Std. Dev.
Household size	5.6	2.7
Age of the household head	54.4	10.7
Age of the irrigator	53.0	11.9
Formal education of irrigator (years)	2.3	3.8
Farming experience (years)	17.8	11.8
Irrigation experience (years)	17.8	11.8
Total production land size	762.5	1587.5
Cultivated land	549.2	1376.5
No of the household members who assist on the plot	2.1	1.3
Regular flows of income	34 991.3	33646.0
Self-employment income	4 062.2	16879.0
Farming income	14105.8	21343.6
Total savings	3750.3	15280.4
Insurances total	46.3	280.4
Loans total	164.4	550.9

Source: Survey (2019)

Msinga independent irrigator households had an average of 5.6 members. Among households practising smallholder irrigated agriculture, the household size typically determines the size of the

labour pool available within the household (Badisa, 2011). Masuku, Raufu, and Malinga (2015), on the other hand, argued that this would only apply if members of that household were able or old enough to work on the farm.

A Pearson correlation statistical test between household size and household members contributing to farm labour was done, and it showed that the two variables have a significant relationship ($p=0.004$). These findings indicate that household size is an essential human asset positively affecting farm labour among Msinga irrigator households.

Table 5. Livelihood capitals (categorical variables) for Msinga irrigator households (n=101)

Variable	Categories	Frequency (%)
Gender of the household head	Female	41.6
	Male	58.4
Gender of the irrigator	Female	63.4
	Male	36.6
Occupation	Full-time farmer	86.1
	Temporary job	2.0
	Self-employment	10.9
	Student	1.0
Access to tools	Wheelbarrow	25.7
	Hand hoe	100.0
	Knack sap sprayer	5.9
	Rake	26.7
	Spade	27.7
	Irrigation pump	28.7
	Vehicle	2.0
Group membership	Farmer association or cooperative	2.0
	Savings group	23.8
	Burial society	19.8

Source: Survey (2019)

Regarding gender patterns, four out of every ten Msinga independent irrigator households were headed by women, with an average age of 54.4. Most Msinga independent irrigators were old, with an average age of 53.3 and 18 to 87 years. The findings were consistent with existing data on independent irrigators, suggesting that South African independent irrigators are middle-aged or older than 50 (Vaughan, 1997; Oosthuizen et al., 2005; Tapela, 2012; Denison et al., 2016; Dube, 2017). More than half (63.4%) of the Msinga independent irrigators were women contradicting the male dominance found in other South African studies (Denison et al., 2016; Dube, 2017). The overwhelming majority of Msinga's independent irrigators were illiterate. In this study, illiterate irrigators were those who had never attended school. The education level of irrigators ranged from no education (66%) to matriculation. None of them had tertiary education. Irrigators had an average of 2.3 years (grade 2) of formal education. This percentage of illiteracy is similar to that recorded by Dearlove (2007), who stated that illiteracy was 68% in Msinga.

On the other hand, independent irrigators have operated their farm for 17.8 years. In this study, this is regarded as a farming experience. These findings are consistent with Greater Tzaneen (Limpopo Province), where independent irrigators had 17.9 years of experience (Denison et al., 2016). In contrast, Bululwane, KwaZulu-Natal Province, had an average of 11 years (Wale & Chipfupa, 2016). Most smallholder farmers (86.1%) regard themselves as full-time farmers—a few work full-time or part-time salaried jobs.

Land for cultivation and irrigation water represented the natural capital in this research. Independent irrigators held an average of 762.5 m² of the “independently” irrigated land. It is important to note that land location does not define an independent irrigator. An independent irrigator can occupy land on the irrigation scheme or in a communal garden. It is, however, the equipment used by the farmer to extract, carry, and apply irrigation water on this land that defines them. This equipment is used individually or privately rather than being shared as it is in the scheme. The land sizes ranged from as little as 41 m² to 12277 m². Du Plessis and Van Der Stoep (2001) reported plot sizes ranging from 5 to 70 ha, while Oosthuizen et al. (2005) indicated plot sizes ranging from 4 to 80 ha in the Nkomazi region of the Mpumalanga Province. According to a more depth investigation in the Limpopo Province, the average land size in Greater Tzaneen was 6.1 ha, while in Thulamela Local Municipality, it was 2.1 ha. These results suggest a great deal of variation among South African independent irrigators. Msinga's independent irrigator land size analysis was consistent with a Namibian independent irrigator study. The study by Fiebiger et al. (2010), which grouped independent irrigators into two categories, including individual small-scale

irrigation and individual micro-scale irrigation, reported land sizes ranging between 50 m² and 10 000 m² (micro-scale) whilst small-scale covered plots that ranged between 1.25 ha and 13 ha.

Regarding irrigation water, groundwater from springs or shallow hand-dug wells was the most common source of irrigation water (69%) in Msinga (Figure 5). Another important source was direct extraction from the river, used by one-third (31%) of the irrigators.



Figure 5. (A). river and (B) a hand-dug well presenting the two common irrigation water sources found during the survey among Msinga independent irrigators.

This study is contrary to previous studies, which have suggested that South African independent irrigators mainly extract their irrigation from rivers (De Lange, 1994; Du Plessis & Van Der Stoep, 2001; Oosthuizen et al., 2005; Van Averbek 2008; Denison et al., 2016; Dube, 2017). Irrigators were requested to rate the adequacy of their water sources during the period when they planted. Most (48.5%) of irrigators rated their adequacy to water as rarely enough and never enough (8.9%). Less than half of the sampled irrigators in Msinga rated water adequacy as mostly enough (29.7%) and consistently enough (12.9%). These findings indicate a substantial need to consider water access to improve the livelihoods of independent smallholder irrigators and help them deal with the dry season.

Irrigator households receive cash from various sources, and transfers from the state were the most significant, contributing 45.8% of all income sources. The most crucial state transfer was child support grants (22.1%) and old-age pensions (20.5%). The remaining 3.2% was from other state grants like foster care grants. These results indicate the significance of economically inactive persons among Msinga irrigator households. Economically active people are between the ages of 15 and 64, while economically inactive people are younger than 15 or older than 64. (Tait et al.,

1996). Economically inactive people are not involved in the labour market or working or actively seeking employment (Maguire, 2017). A Pearson correlation statistical test between the number of economically inactive persons and household income showed that the two have a significant relationship ($p=0.017$) at a 0.05 significant level. The overwhelming state's contribution to household income in rural communities is no surprise. According to the latest South African national community survey in 2016, Msinga households obtained 88.0% of their income from grants and subsidies, which was higher than all other local municipalities in the uMzinyathi District. Msinga households also engaged in local economic activities, accounting for an average of 7.7% of the total income sources. Non-farm sources, including employment and remittances, contributed 20.1%, and farm income sources contributed 26.5%.

Most households had no cash savings and had limited access to loans. Four out of ten (40%) irrigator households, built savings through informal institutions, including burial societies and stokvel groups. At the same time, 12% saved in registered formal institutions such as banks. The annual average value of the total saved was R3 750. However, the amount held in formal organisations was twice as much as in informal forms. Irrigators in this study invested in livestock, specifically cattle, as non-cash savings to cope with household vulnerability situations associated with challenging periods. The survey participants indicated that they sell cattle in times of need or emergency, which is typical of Msinga. This observation implies that livestock is a form of savings and insurance for irrigator households, as the sale of animals provides immediate cash to deal with significant or unexpected expenditures. Of the 16% of households that had livestock, only 1% sold a portion of their stock in the year under consideration, which confirms that livestock sales are uncommon among irrigator households. Livestock owners also had more cash savings than non-owners in the study area. The sixteen cattle owners saved R8 660 compared to R2 826 for non-owners. Again, goat owners saved R4 857 while non-owners had R1 469 average annual savings.

In a rural setting, households usually affiliate in groups or associations to obtain support for their livelihoods. Independent irrigator households in Msinga were affiliated with burial societies (20%) and savings groups (24%). Stokvels were the most common form of savings group among these households, where households paid a monthly fee and then purchased equal and bulk groceries for each member in December (Festive season). These results were consistent with other Msinga studies that identified burial societies and savings groups (stokvel) as dominant community groups (Sithole, 2000; Baiyegunhi, 2013). Farmer groups, on the other hand, allow farmers to access

resources collectively and cooperate to reach a common goal. There was, however, an indication of limited collective action among Msinga irrigators. A mere 2% of sampled irrigators had membership in farmer's associations, like a cooperative. This finding is no surprise from the limited information on independent irrigators. Evidence indicates that they operate individually in all aspects of their farming. In Thulamela Local Municipality, membership of networks dedicated to agriculture or irrigation, such as farmers associations (16.3%), cooperatives (18.4%), or water users associations (2.0%), was also low (Dube, 2017).

Physical capital is crucial to a farming enterprise, affecting enterprise productivity. In this study, ownership of physical assets used in farming was limited to simple hand tools. The results show that all households owned at least a hand hoe. Over twenty households in the sample owned a spade (28%), rake (27%), and wheelbarrow (26%). Ownership of these tools is no surprise, considering the land sizes of these irrigator plots. The assets were adequate for their current plot sizes. South African studies investigating independent irrigators drew similar conclusions to the current research regarding ownership of physical capital limitation to simple hand tools (Denison et al., 2016; Dube, 2017). Ownership of draught animals and animal-drawn implements was limited. In Msinga, 16% of households owned cattle, while 4% and 1% owned donkeys and horses. In line with donkey ownership, 4% owned animal-drawn ploughs and 1% disk. Ownership of mechanised cultivation was almost absent, as only 1% of the irrigator owned a tractor.

4.4.2 Irrigator household's livelihood strategies

Rural households typically engage in various activities as part of their livelihood strategies. Msinga irrigator households involved in a variety of activities, indicating diversification. Diversification is defined by Malek and Usami (2009) as an increase in the number of household income components.

4.4.2.1 Non-farm and off-farm activities

The off-farm and non-farm activities include all economic activities in rural areas other than agriculture, livestock, fishing, and hunting (Lanjouw & Lanjouw, 2001). Off-farm and non-farm incomes are significant components of total income in the study area's rural households. In the respondent group, 96.0% received income from the states as claims. In line with this paper, Zaca (2018) found that in Tugela Ferry and Bululwane smallholder households (KwaZulu-Natal

Province), 92.1% and 97.3% claimed from the state a social grant. The state's claims included old age, child support, foster care, and disability grants.

Eight (83.2%) in ten participating irrigator households in the study area received child support grants, which was the most dominant. Two of ten (19.8%) families received cash from remittances, the second notable source of income-after state claims. Remittances consist of money, both in cash and kind (e.g., clothing, food), claimed from family members not residing in the same homestead where the irrigator and other family members are based. These household members work in different locations outside of the village and regularly send money to their families. Salaries and wages, which consisted of permanent or temporary employment, were found in 10.9% of households—a limited number of independent irrigator households engaged in local economic activities other than farming. Only 16.8% of households engage in these activities, including trading, making and selling goods and rendering services. These activities included selling snacks, grass mats weaving, car trailer rental, buying and selling vegetables, traditional attire making, bakkie rental, egg selling, Zulu cow traditional skirt (isidwaba) weaving, and grass cutting. Among these activities, grass mat weaving and buying and selling vegetables were the most common, found in seven and six of the studied irrigator households in Msinga. De Lange (1994) and Crosby et al. (2000) reported that most South African independent irrigators were shopkeepers and other entrepreneurs, while Oosthuizen et al. (2005) indicated that several sampled independent irrigators in Nkomazi (Mpumalanga Province) were covered by their study owned shops or bottle stores.

4.4.2.2 Crop and livestock production

Independent irrigators from the survey participated in crop and livestock production. By default, all were involved in crop production from the independent irrigation land. Independent irrigators from Msinga grew 12 crops, including spinach, onion, maize, cannabis¹, beans, peanuts, butternut, pumpkin, potatoes, sweet potatoes, cabbage, and tomatoes (Figure 6). Spinach (59%) and cannabis (54%) were the dominant crops grown by over half of the sample.

¹ Insangu is the Zulu word for cannabis

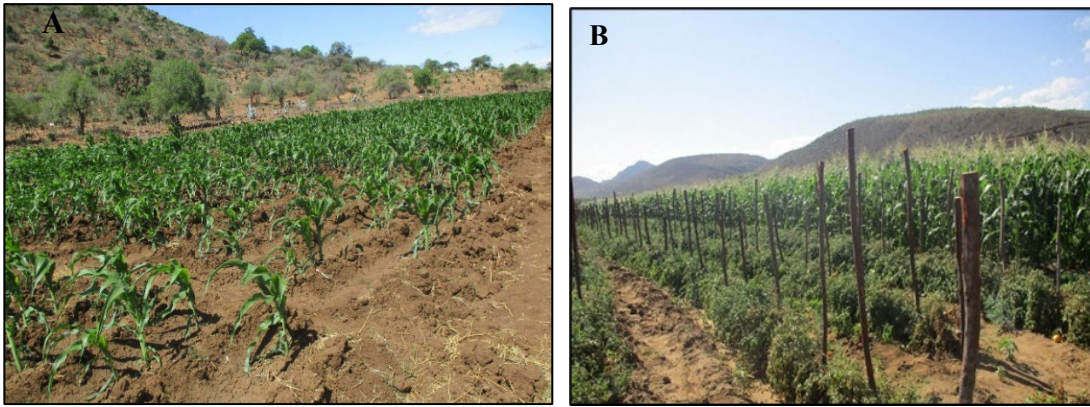


Figure 6. Maize (A) and tomatoes(B)grown by some independent irrigators in Msinga

This research enquired from irrigators about their purpose for farming, specifically crop production on independent land. The majority indicated that they farm as the main source of food (43.6%) and an extra source of income (24.8%). When comparing means (consumption and sales) based on the participant’s responses to the purpose of their farming, the responses correspond with household income and consumption data. The households who stated that farming is their primary income source earned the most from crop production. At the same time, irrigators who stated it was their primary food source had the highest average consumption value. Irrigator households also engage in livestock production, including cattle, goats, and chickens. Among livestock, goats (69%) and chickens (69%) were dominant, and the fewest were cattle (16%). Livestock production accounted for 11% (R5948.9) of the average annual household income. For the period under consideration, only one household sold cattle for cash, nine sold goats, and 13 sold chickens for income.

4.4.3 Livelihood outcomes for irrigator households

4.4.3.1 Independent irrigation in food security

According to FAO (1996), food security exists when all people have physical, social, and economic access to adequate, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life at all times. The level of food production, stock levels, and net trade determines food availability. It addresses the “supply side” of food security (Desta, 2016). The observation from this study shows that independent irrigation contributed to the food availability of Msinga independent irrigators.

Msinga households were requested to indicate how often per week the household consumes food from the eight pre-determined food groups, which also was identified along with where these foods come from. The frequency of foods consumed from eight food groupings was estimated for seven days, as shown in Table 6.

Table 6. Frequency of food consumption on a seven-day recall for Msinga irrigator households (n=101)

Outcomes		Frequency
Food consumption (7 days)	Main staples	6.9
	Pulses	2.2
	Vegetables (all vegetables)	3.6
	Fruits (all fruits)	2.0
	Animal products	3.0
	Milk and other dairy products	4.7
	Sugar and sugar products	7.0
	Oil	6.8

Source: Survey (2019)

The eight food groups include grains, legumes, vegetables, fruits, animal products, milk, sugar, and oils and fats. Independent irrigators consumed legumes twice a week. The main staples, sugar and oil, were more frequently consumed six times a week, while vegetable consumption was more frequent overall at four times per week. The former was purchased, forming part of the groceries, while vegetables were purchased or harvested at the irrigation plot as part of their production. The monetary value of household consumption of own output determined own production. Own production includes food produced on the farm for crop and livestock production. The household had an annual production value of R5 771, making 30% of the average yearly food expenditure. However, the proportion consumed produced from irrigation was much lower than livestock production, contributing a massive portion (94% of the R5 771) to own production.

Accessibility implies that the food can reach the consumer (transportation infrastructure) and that the consumer has sufficient funds to purchase it (Ver Ploeg, Breneman, Farrigan, Hamrick, Hopkins, Kaufman & Tuckermanty, 2009). A portion (5%) of the produce was consumed at home,

and the bulk of production was sent to the market. Independent irrigation income contributed to the average annual household income in the study area. This way, it enables household access to food by improving purchase power. Though it could not be determined how much of the income from agriculture was used for food, the household had an average annual food expenditure of R19 203, where R13 432 was purchased foods.

There is a stability indicator in food security, which deals with a household’s ability to withstand shocks to the food chain system caused by natural disasters (climate, earthquakes) or man-made disasters (wars, economic crises such as unemployment or increased food prices) (Peng & Berry, 2019). Various factors affect food security negatively within Msinga irrigator households. Figure 7 shows the distribution (%) of vulnerability factors among Msinga irrigators in their homes.

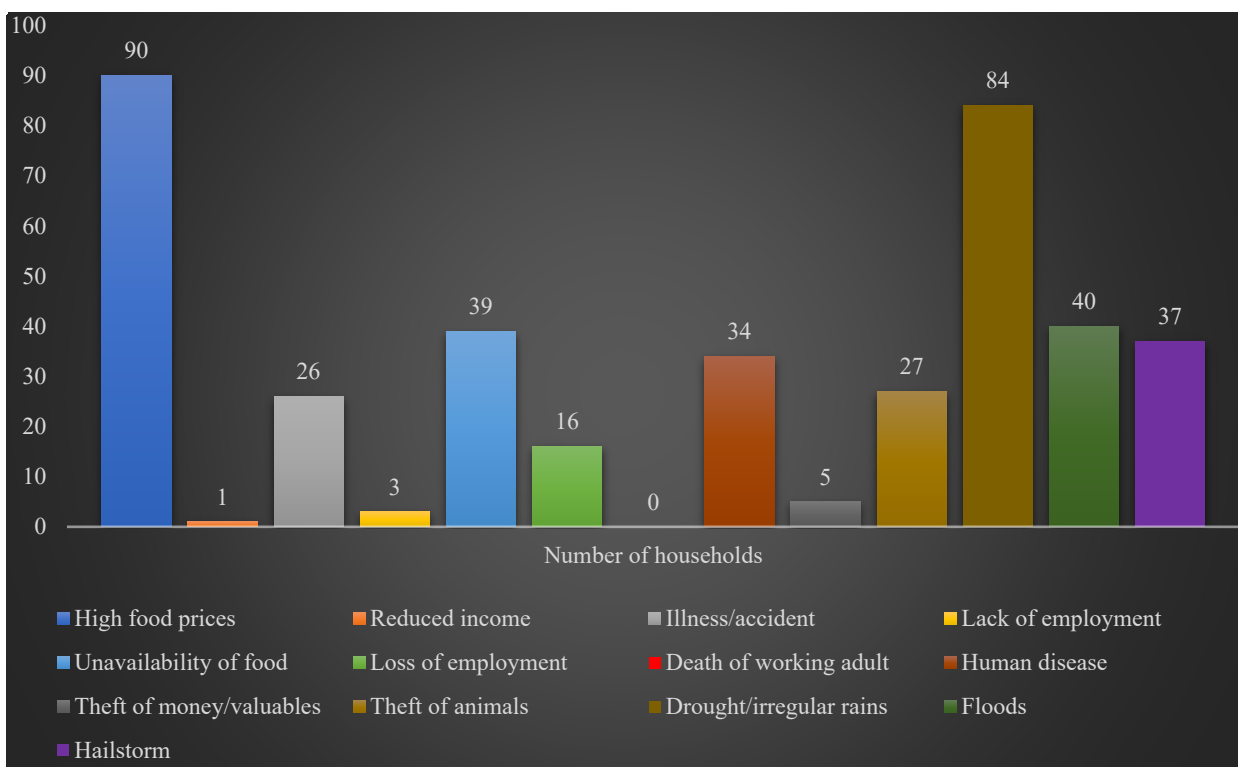


Figure 7. Relative distribution (%) of vulnerability factors among Msinga irrigator households

The patterns in Figure 7 show that most households (90%) from the survey faced high food prices. High food prices negatively impact food access. In addition, 84% of households in Msinga encounter drought or irregular rainfall, a critical constraint in agriculture, affecting physical food availability and stability since crops fail or land is not utilised at all times. Irrigators who source

their irrigation water from groundwater in the form of Spring are the ones who were affected by these droughts because this source dried out during the drought period. A detailed discussion of constraints that irrigators faced, including the drought, is explained in Chapter 6 (6.4.1 External shocks). The chapter also describes how irrigators choose not to plant during these times and wait until they have water because Msinga is a very dry area, and irrigation is needed.

4.4.3.2 Household income as a livelihood outcome: regression model results

A variety of socioeconomic factors influence the livelihood outcomes of rural households. The total annual income of Msinga irrigator households was an indicator of their livelihood outcomes, thus serving as the dependent variable in the regression modelling (Table 7).

Table 7. Effect of household capital on the outcome: SPSS Regression model results (n=101)

	Unstandardised Coefficients		Standardised Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-32086.244	33320.554		-.963	0.338
Household size	3867.378	1286.636	.217	3.006	0.003**
Age of head of household (years)	197.195	312.867	.044	.630	0.530
Total crop production area (m ²)	3.483	2.608	.115	1.335	0.185
Non-farm income (R)	1.434	.230	.504	6.225	0.000**
Farm income	.925	.186	.411	4.971	0.000**
Gender of household head (f=1, m=0)	2279.221	6750.133	.024	.338	0.736
Access to social grant (yes=1, no=0)	634.127	17183.787	.003	.037	0.971
Access to pumping (yes=1, no=0)	16825.840	8315.847	.148	2.023	0.046**
Farmer group member (yes=1, no=0)	12611.603	20120.607	.051	.627	0.532
Cattle ownership (yes=1, no=0)	5811.254	10946.543	.044	.531	0.597

** Significant at 0.05; F=13.843; df=10; p<000; R= 0.778; R²=0.606, Source: Survey (2019)

A total of ten variables in Table 7 are explanatory variables. The multiple regression model revealed that household size, non-agricultural income, farm income, and access to pumping when irrigating land were significant and positive predictors of average annual household income and livelihood outcome. The regression coefficient was 0.606, indicating that the model captured approximately 61 % of the average total yearly income variation. Household size correlated positively and significantly ($p=0.003$) with an annual household income at a 5% significance level. This finding may be so because many children (under 18 years) and older persons dominated Msinga irrigator household and contributed mainly to household income with their child support and old age grants. Tasié et al. (2012) found a positive and significant relationship between family size and annual household income, which agreed with this study's findings. Non-farm income was positively and significantly correlated with yearly household income ($p=0.000$). Non-agricultural activities such as state claims, employment, remittances, and farm income had a positive and significant relationship with average household annual income. These results indicated that the more activities household engages in, the higher their total household income.

Access to pumping for irrigating independent land positively and significantly correlated with an annual household income ($p=0.046$). This finding indicated that using an irrigation pump translates to higher production and revenue. In this study, irrigators who pump had more gross enterprise income since they cultivated larger land sizes. Previous research in different countries has found that increasing privately owned irrigation affects household income (Hossain et al., 2006; Hossain., 2009).

4.5 Conclusion and recommendations

The analysis in this paper describes the livelihood asset, strategies, and outcomes of independent smallholder irrigators in the Msinga Local Municipality of KwaZulu-Natal Province, adopting the Sustainable Livelihood Framework (SLF) as a guiding theoretical framework. This investigation concludes that Msinga has a relatively poor asset base. Irrigators have restricted access to agricultural land, and most irrigators suffered severe limitations in irrigation water availability due to the unpredictability of their irrigation water source, hampered by periodic drought in the

research region. This limitation primarily confined their agricultural efforts to micro-scale² production. With regards to crop production on the independent plot, it is recommended that government and other stakeholders interested in smallholder development improve water access. The regression results showed that as pump availability increased among these households, average yearly household income also increased. By zooming in on the financial assets of these irrigators, who rely heavily on social grants, the conclusion is that pumping is not the initiative to be replicated on a larger scale in this area. However, the government could capacitate and promote the adoption of water-harvesting strategies that are also environmentally friendly. Most households' livelihood strategies were based on claims against the government. A minority of irrigator households had engaged in local economic activities such as weaving, selling grass mats, and purchasing and reselling vegetables. Based on what they already have, the government could reach out to these rural residents and provide information on organisations and other government Departments that support small businesses in rural areas.

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² In the Namibian context, micro-scale irrigators were described by land sizes of approximately of 450m² (Fiebiger et al., 2010)

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CHAPTER 5. INSTITUTIONAL ARRANGEMENTS AND SUPPORT SYSTEMS FOR INDEPENDENT SMALLHOLDER IRRIGATORS IN MSINGA LOCAL MUNICIPALITY, KWAZULU-NATAL PROVINCE, SOUTH AFRICA

5.1 Abstract

This paper aims to describe the institutional arrangements for irrigators' resource access, agricultural support systems accessible to irrigators, and the various constraints irrigators experience. For the quantitative phase of the study, the survey acquired data from 101 respondents, selected using a snowball technique. The qualitative phase gathered information from four purposively selected focus group discussions. According to the findings, irrigators commonly gained access to production land through traditional authority (81.2%). Gender was a barrier to land access, where male-headed families had larger land sizes than female-headed ones ($t=4.993$, $p=0.028$). Concerning irrigation water, irrigators abstract it wherever they find access without any institutional arrangement or restriction. The main limitations to irrigators' water availability were competition between irrigators and the drying out of the water source, particularly spring water. Government assistance was rare among independent irrigators. Smallholder support services tend to be distributed unevenly among South African smallholders, usually leaving independent irrigators unsupported. Lastly, irrigators experience constraints in their farming that government existing services have the potential to address. Therefore, this study proposes that the government recognize independent irrigators as possible drivers out of poverty and food insecurities. The study recommends institutional inclusion and the extension of support systems to independent irrigators.

Keywords: Independent irrigation, Agricultural extension, Irrigation development, Land access

5.2 Introduction

Historically, investment in smallholder irrigation has been one of the national strategies to improve livelihoods by reducing poverty and food insecurity in South Africa, particularly in rural areas. Post-apartheid, part of these investments included transferring management of existing irrigation schemes to farmers, and the process was called Irrigation Management Transfer (IMT) (Van Averbeke & Mohamed, 2006; Van Averbeke, 2012). In addition to the IMT and revitalising of these schemes, additional irrigation schemes were built to improve livelihoods and quality of life for informal urban settlement dwellers and rural people (Van Averbeke, 2012).

In these projects, smallholders were given access to a plot of land and irrigation water. In addition to such investments, the South African government extended agricultural extension and training services as institutional support systems for these smallholders. The support systems provide farmers with training, information, and links to input and output markets (Rivera, Qamar & Van Crowder, 2001; Ortmann & King, 2007).

Despite such support and a massive investment of public funds, these public irrigation schemes continue to perform poorly, failing to meet the goals for which they were designed (Tlou, Mosaka, Perret, Mullins, & Williams, 2006; Fanadzo, Chiduza & Mnkeni, 2010). The inability of irrigation schemes to accomplish such goals necessitates the consideration of other irrigation pathways. In South Africa, there four categories of smallholder irrigators are identified in the literature: irrigated home gardens, independent irrigators, plot holders on irrigation schemes and irrigated community gardens plot holders (De Lange, 1994; Du Plessis, Van Averbeke & Van der Stoep 2002; Van Averbeke, Denison & Mnkeni, 2011). Independent South African smallholder irrigators are defined as “smallholders who have direct access to a supply of irrigation water and employ privately owned equipment to collect, transport, and apply this water” (Dube, 2017). Worldwide, these independent smallholder irrigators lift millions of households out of poverty, reduce food insecurity and create jobs, notably in Asia and Sub-Saharan Africa (Giordano, 2012; Giordano & De Fraiture, 2014, De Fraiture & Giordano, 2014). As a result, these regions recognise independent irrigation as an appropriate poverty reduction tool.

One thing that independent irrigators worldwide have in common is that they generally fund and develop the irrigation initiative independently, with no government assistance. Namara, Hanjra, Castillo, Ravnborg, Smith and Van Koppen (2010) pointed out that independent irrigators usually operate beyond the eyes of policymakers, donors, and the scientific community; hence they are excluded from most official irrigation data, governmental policy, or agricultural support systems. Consequently, data on independent irrigators is limited (Van Averbeke, Denison & Mnkeni, 2011; Beekman, Veldwisch, & Bolding, 2014; De Fraiture & Giordano, 2014). Independent irrigators exist in South Africa, but the research community and government continue to overlook them (Van Averbeke et al., 2011), as their focus remains on state irrigation schemes, despite their dismal performance. This study seeks to bridge this information gap by adding to the limited literature and creating awareness for policymakers.

This paper focuses on institutional arrangements since they significantly determine smallholders' access to resources, especially land and water. Institutional arrangements, organisational issues, and power dynamics influence access to resources (Scoones, 1998). For example, policies and land tenure institutions mediate access to land in rural regions (Scoones, 1998). The security of access, often known as tenure security, is a crucial aspect of access to land. Registration of tenure rights provides a degree of security (Masiya & Van Averbek, 2013). On the other hand, land tenure uncertainty prevents farmers from making long-term decisions on land, including investments (Tenaw, Islam & Parviainen, 2009). Access to inputs, finance, agricultural extension, and training support for smallholder farmers is crucial to their success and contribution to addressing poverty, unemployment, and food insecurity. Access to support services, particularly extension advice and training, is a major determinant of agricultural production (Purcell and Anderson, 1997). At the same time, data on constraints is essential for policymakers in designing bottom-up intervention strategies to deal with the challenges smallholders face. Therefore, the paper will address the following questions:

- What institutional arrangements are in place for independent irrigators to access production land and irrigation water?
- Are there agricultural support systems and mechanisms in place to support independent smallholder irrigators?
- What are the challenges and constraints faced by independent smallholder irrigators?

5.3 Methodology

The data collection methods and process has been described in detail in chapter 3 (3.3 Methodology).

The study site was Msinga, a Local Municipality of KwaZulu-Natal Province in South Africa. The municipality is in the South-Western part of the uMzinyathi district and covers 2500 km², and has an estimated population of 184 494 (Statistics South Africa, 2017). The area experiences a subtropical climate in most parts, with an average annual rainfall of 600 mm, ranging from 400 mm-900 mm yearly (Mkhabela, 2005; Sinyolo et al., 2018). In the Province, Msinga is one of the

poorest municipalities, with high unemployment and poverty levels. Agriculture is crucial in the livelihoods of Msinga residents, but most are still subsistence farmers. Statistic South Africa (2017) found that 55% of the 38 372 households practised agriculture in 2016. However, agriculture in the area is subject to the limited capacity of the land due to low soil quality, climatic conditions, and overstocking (Msinga Local Municipality, 2020).

5.4 Results and discussion

5.4.1 Demographic characteristics of the independent irrigators

The results from the analysis of the demographic characteristics of independent irrigators are in Table 8. The table shows that the majority of Msinga independent smallholder irrigators were old. On average, irrigators were 53.0 years old, the youngest irrigator was 18, and the oldest was 87. The average age from these results (Table 8) aligns with other South African independent irrigator studies, demonstrating that irrigators are middle-aged or older than 50 (Oosthuizen, Botha, Grove, Meiring, Monkhei & Pretorius, 2005; Tapela, 2012; Denison, Dube, Masiya, Moyo, Murata, Mpyana, Van Averbeke, Van Averbeke, 2016; Dube, 2017). Table 8 also shows that 63.4% of independent irrigators in Msinga were females, contradicting studies reporting that independent irrigation is male-dominated (Oosthuizen et al., 2005; Tapela, 2012; Denison et al., 2016; Dube, 2017).

Table 8: Independent irrigator’s demographic characteristics (n=101)

Variable	Mean	Std. Deviation
Age of irrigator (years)	53.0	11.93
Gender (% female)	63.4	-
Formal education of irrigator (years)	2.3	3.78
Farming experience (years)	17.8	11.77
Irrigation experience (years)	17.8	11.77
Occupation (%)		
• Full-time farmer	86.1	-
• Temporary job	2.0	-
• Self-employment	10.9	-
• Student	1.0	-

Source: Survey (2019)

Sampled independent irrigators had low levels of formal education. On average, independent irrigators went to school for two years (Table 8). Their formal education years ranged from none (66%) to grade 12. None of the sampled irrigators in Msinga acquired tertiary education. Independent irrigators were experienced in irrigated agriculture, as indicated by their years of practising irrigated farming. On average, irrigators had 17.8 years of experience in irrigated agriculture. About 84.1% had been practising irrigated farming for more than five years.

The current study's findings align with Greater Tzaneen independent irrigators, who had an average of 17.9 years of irrigated farming experience (Denison et al., 2016). Over four-fifths of the sample considered themselves full-time irrigators, while 10.9% were self-employed in activities other than farming. Temporary job-holders were rare, and there was only one student.

5.4.2 Institutional arrangements

5.4.2.1 Access to land and irrigation water

Land and water are crucial resources in irrigated agriculture and essential for the success of the irrigation enterprise. Regarding land, Msinga independent irrigators had four arrangements to access land for crop production. These arrangements included registered ownership, unconditional usufruct, sharecropping and unregistered ownership. In registered ownership, the land was registered in the name of any household member. When ownership lay with a person who was not a household member but had the right to use land without compensation, it was called unconditional usufruct. A sharecropping arrangement defines ownership of the land by a person who was not part of the household. Still, a sharing agreement existed between the irrigator and a member of that household. Unregistered ownership refers to using the land without permission from the authorities or the owner if it belonged to a household. In the current study, registered ownership was the most common, found in 81.2% of the 101 households. This type of access was granted by traditional authorities and through inheritance. Accessing land through traditional authorities reported in this study was consistent with other independent irrigator studies in South Africa (Oosthuizen et al., 2005; Tapela, 2012; Denison et al., 2016; Dube, 2017). Other land access arrangements, including unconditional usufruct (8.9%), sharecropping (6.9%) and unregistered ownership (3.0%) were rare.

The results show that the allocation of land in Msinga favours males. The study results show that irrigation land sizes for male-headed households ($M=981$, $SD=2015.68$) and female-headed

households ($M=455$, $SD=483.33$) were different, whereas the male-headed households had larger plots than women. The results are confirmed by a t-test analysis, showing statistical significance ($t=4.993$, $p=0.028$) at a 95% confidence level (Appendix K).

In line with the current study, Sinyolo, Sinyolo, Mudhara and Ndinda (2018) pointed out that land distribution in Msinga benefits men. Women in that region access land through inheritance, an internal female-only system in which unmarried women are assigned land within the family plot (Sinyolo et al., 2018). The same study also pointed out men within the irrigation scheme are more likely than women to own upper-end plots. In the upper-end plots, water reaches the top plots before the scheme's tail end, which women occupy. It is a limiting factor for smallholders in this irrigation scheme as the water reaches the upper plots before the scheme's tail end. Men occupying these upper-end plots meant that women in the irrigation scheme also faced limited access to irrigation water.

In contrast, there were no limitations by gender regarding water access by independent irrigators. Independent irrigators also did not pay for the water but only for the extraction in the case of the pumping irrigators. In South Africa, irrigated agriculture is one of the water uses described by the National Water Act 36 of 1998. Consequently, the users need to obtain legal authorisation to use water from the Department of Water and Sanitation. These irrigators had no knowledge of such laws and regulations concerning legal water use rights. On the contrary, some irrigation scheme farmers knew about the laws to the extent of having water use licences. For example, in Limpopo Province, Van Averbek (2012) reported that 27 of the 48 irrigation schemes in the Vhembe District had water use licenses they had obtained from the Water and Sanitation Department (formerly known as the Department of water affairs). However, the Department of Agriculture officials usually assist smallholders with those legal requirements. The situation is different for independent irrigators, as they operate outside the view of such institutions or Departments.

5.4.3 Support services

5.4.3.1 Agriculture extension and training support

Institutions not only determine access to resources but render support to smallholders to improve production. Support may be advice, training, input support, infrastructure, or output market support. In South Africa, the Department of Agriculture assigns agricultural advisors to

smallholder farmers for such purposes. The agricultural advisors assist smallholder farmers with farming advice on their varied farming practices, production inputs, and training.

In the case of Msinga independent smallholder irrigators, access to these services was limited. Agricultural support services tend to focus on public irrigation schemes or projects. In the current study, only 20.8% of the sampled independent irrigators indicated that they had received agricultural advice from the Department's Agricultural advisors. Only 7.9% indicated that they had received training in production. Advice on other aspects such as irrigation (e.g. appropriate irrigation methods and equipment), marketing, business, financial was rare to non-existent. Also, none of the sampled irrigators had received equipment and production loans or grants.

These patterns are consistent with other independent irrigator studies in South Africa, demonstrating that South African irrigators rarely received assistance from the government or other institutions. Evidence in Limpopo Province for Thulamela (Dube, 2017) and Greater Tzaneen independent irrigators (Denison et al., 2016) indicated that 38.8 % and 27.6 % of irrigators in these regions indicated that they had received some production advice, respectively. At the same time, only 28.6 % and 24.1% claimed that they had received irrigation assistance.

In contrast, irrigators on South African irrigation schemes including, but not limited to, Dzindi (Van Averbek, Letsoalo, Mohamed, & Khosa 2004; Denison et al., 2016), Tugela Ferry (Sinyolo, Mudhara & Wale 2014; Wale & Chipfupa, 2018) and Bululwane (Wale & Chipfupa, 2018) have had high-level access to these services. This evidence supports the study's conclusions that agricultural support services tend to focus on public irrigation schemes or projects. The uneven distribution of support and focus of government on projects resulting in support benefiting a few individuals were also indicated by Sinyolo et al. (2018). The government built the irrigation schemes, which could explain the disparity in access to agricultural support services between independent and scheme irrigators, or it could be motivated by the state's investments in these projects.

Apart from uneven distribution, government Departments tend to duplicate support to similar groups instead of identifying new beneficiaries. For example, the Agri-park initiative by the Department of Rural Development and Land Reform (Now known as the Department of Agriculture, Land Reform and Rural Development) provides projects or cooperatives with agricultural support. The programme offers smallholders the support of agricultural extension,

production inputs, infrastructure, and output markets. Each district has a Farmer Production Support Unit (FPSU) or two as part of this initiative.

The FPSU is a one-stop location where all produce storage, packaging, farmer training and other services are delivered. Surprisingly, some irrigation schemes (e.g., Nsuze irrigation scheme, Tugela Ferry, Shinga irrigation scheme) are identified as FPSUs. Irrigators on those schemes benefit from the existing Department of Agriculture support programmes and the new FPSU initiative by Rural Development. If included, this initiative could also benefit many goal-driven individual farmers, especially the youth who may be interested but face resource limitations.

5.4.4 Irrigators constraints

The flexibility of choice lies in the strength of the capital endowment, household strategies employed, and available support systems. On a four-response Likert scale, independent irrigators were asked to rate their experience with constraints they face in their farming. Table 9 shows the relative distribution (%) of constraints faced by respondents with respect to production.

Table 9: Relative frequency distribution (%) of constraints for production faced by irrigators (n=101)

	Never	Rarely	Sometimes	Most of the time	Always
	Irrigators (%)				
High increase in input prices	4	6	19	67	4
Lack of capital	3	1	23	54	20
Lack of support services	8	3	6	47	37
Production below normal	4	4	53	39	1
Lack of access to inputs	8	14	41	36	2
Water availability	8	7	54	25	6
Insufficient land	38	21	23	19	0
High pump and maintenance cost	81	1	5	13	0
Declining output market prices	8	26	55	11	0
Land tenure is not secure	92	6	2	0	0
Local and political conflict	89	10	1	0	0

Source: Survey (2019)

We note that lack of support services is felt by 90% of the respondents (sometimes, most of the time, always). Capital for farming is a challenge for all but 4% (rarely or never). The cost of inputs is the single most frustrating challenge tested. These constraints shape the perceived livelihood options and are significant for the success of an irrigated enterprise.

Water issues were prevalent in all four FG discussions but differed in several aspects. We noted earlier (Figure 7) that 84% of the irrigators were impacted by drought and irregular rain fall. The first two FGDs in Mashunka village voiced concern over the drying out of the water source. As a result, the competition for water was high, and one had to get up early to access irrigation water. Fortunately, no confrontations have resulted from this, simply intense competitiveness. Regrettably, irrigators could not utilise two seasons of the year for growing due to water drying. Irrigators who extract irrigation water by pumping were the third FGD in the same village. The pumper group had no problems accessing water because they extracted it from the river, but they complained about the high price of petrol, which limited them to irrigating once a week. The last group in Paraffin village extracted water from the Tugela River; the source was not an issue, but manually transporting the water from the river to their plots by buckets was a more significant constraint. The irrigators in this area were mostly older women. Finally, through FGD, it was learnt that fencing of the plots was a major constraint. Irrigators utilise tree branches to keep livestock from entering their plots. These efforts were often ineffective since they lost their crops to cattle anyway.

5.5 Conclusion and recommendations

This paper aimed to describe institutional arrangements, support systems, and challenges independent smallholder irrigators face in Msinga Local Municipality. The study results suggest that independent irrigators usually operate outside the view of the government. Independent irrigators are not registered for authorised water use and fall outside the water management department. However, it is not because independent irrigators are unwilling to acquire legal authorisation to use water but because they lack access to such information. The absence of interaction between irrigators and the Department of Agriculture and Rural Development extension services could be one of the reasons this is so. Their unofficial water abstraction did not hinder or affect their irrigation enterprises. However, the means of extracting water from the source is exacerbated by limited resources. These limitations include the financial resource to procure

physical capital. The drying of their irrigation water sources, particularly the spring, hinders full utilisation throughout the year. Many independent irrigators are females, and current land access practices limit women irrigators' access to far smaller plots than male irrigators. Existing land access arrangements for all genders should be prioritised on the policy agenda. It is proposed that the existing land tenure and land administration systems be improved. Another finding from this study is that support systems are limited to a few independent irrigators. However, the lack of support is not a matter of lacking resources or capabilities by the South African government but rather one of identifying and extending support services to other beneficiaries. Independent irrigators' existence should be made known among the different support services since, with the proper resources, they might significantly contribute to agricultural productivity and address poverty and food insecurity. Providing extension and training support should be prioritised. Independent irrigators' access to physical resources, such as pumping technology for manual lifters, should be prioritised. This study's findings significantly contribute to the limited literature on "South African independent smallholder irrigators". However, further broad research needs to be done to shed more light on the issues faced by independent irrigators. This study provides groundwork about what could be used to develop targeted interventions for independent irrigators. Lastly, systematic research on who these irrigators are and how they make a living is necessary to understand their impact on rural development and thus justify investment.

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CHAPTER 6. AN ANALYSIS OF AGRICULTURAL SHOCKS AND CONSTRAINTS FACED BY INDEPENDENT SMALLHOLDER IRRIGATORS IN MSINGA LOCAL MUNICIPALITY, KWAZULU-NATAL PROVINCE, SOUTH AFRICA

6.1 Abstract

Smallholder farmer's market participation is an effective vehicle to secure better incomes, reduce poverty and enhance household food security, especially for rural smallholders. However, smallholders face various challenges preventing them from benefiting from the opportunities of agriculture markets. This research aimed to identify the agricultural-related shocks and constraints that independent smallholder irrigators in the Msinga Local Municipality face and recommend several techniques to help tackle these challenges, improving their livelihoods. The 101 survey participants were chosen using snowball sampling, while the four Focus Group Discussion participants were purposively selected. The findings suggest that the primary issues facing Msinga irrigators were drought, inadequate access to production inputs and the infestation of pests and diseases. Due to the issues mentioned above, crop failure affecting nine out of ten irrigators was unavoidable among these smallholders. If smallholder farmers can access comprehensive agricultural support services, they may tackle these issues and boost farm production and market participation. Creating an enabling environment to improve irrigation water access could assist in mitigating drought difficulties. While including independent irrigators in the government's existing extension support services could help with pest and disease awareness and control.

6.2 Introduction

The number of agricultural households in South Africa in 2016 was 2.3 million, with over two-thirds of those living in KwaZulu-Natal, Eastern Cape, and Limpopo (Statistics South Africa, 2016). According to the 2016 South African national community survey, KwaZulu-Natal recorded the country's highest number of agricultural households (23.0%) (Statistics South Africa, 2016). Within KwaZulu-Natal, slightly over two-fifths (44.0 %) practised agriculture as a secondary source of income, while two-fifths (40.8%) practised agriculture as a primary source of income. In the study area, Msinga Local Municipality, agriculture is still mainly used for subsistence (Dearlove, 2007) due to unfavourable climatic conditions and poor soil quality (Msinga Local Municipality, 2020).

Hence, most farm produce is for domestic consumption rather than market involvement. At the same time, evidence shows that the smallholder battle against rural poverty and food insecurity has success potential through increased smallholder market participation (Jagwe et al., 2010; Zanella et al., 2012). Producing for the market necessitates using resources such as land, water, on-farm and off-farm infrastructure, labour force, capital, and sound resource management (Baloyi, 2010). Smallholder farmers' ability to benefit from opportunities in agricultural markets is disadvantaged by a lack of access to these resources, particularly the quality and quantity of these assets. As a result, they cannot meet the high-quality standards set by fresh produce marketplaces, retailers, and food processors (Bienabe et al., 2004). Therefore, smallholders' poor participation in the crop market leads to low incomes, exposing them to food insecurity and a vicious cycle of poverty. The main question now is how smallholders can be supported to become market-driven. However, assessing smallholders' challenges and constraints is crucial before one can answer this and suggest possible interventions. Therefore, this paper aims to identify farming shocks and constraints encountered by independent smallholder irrigators in the Msinga Local Municipality. Possible strategies are recommended that policymakers can use in designing bottom-up intervention strategies to improve the challenges faced by independent irrigators.

6.3 Methodology

This paper employed a mixed-method approach, described in Chapter 3 (3.3 Methodology). The statistical analysis of the survey and Focus Group Discussion detail is provided in (3.3.7 Survey and FGD data analysis).

6.4 Results and discussion

6.4.1 External shocks

Independent irrigators in Msinga faced various external shocks in their agricultural production, as shown in Figure 8. The common shock to agricultural production irrigators experienced dating two years prior to the interview (2017 and 2018) in Msinga was the lack of access to production inputs, the infestation of pests and diseases and droughts, resulting in crop failure. Irrigators in Msinga reported high prices for agricultural inputs and cannot afford to purchase them. Figure 8 shows that 80% of the 101 survey respondents in the study have had difficulties accessing production inputs, especially seedlings.

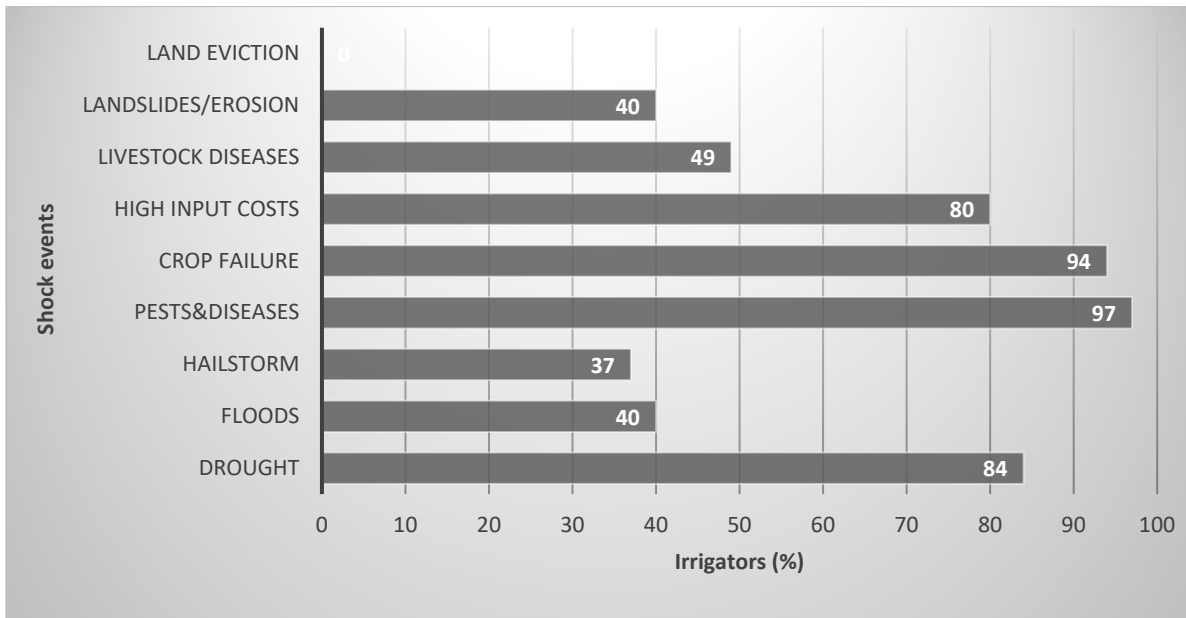


Figure 8. Relative distribution of production shocks experienced by irrigators

Access was exacerbated because smallholder farmers are typically poor and have restricted financial stability. The government has been mainly assisting irrigation schemes and projects to enhance smallholder agricultural productivity through inputs, mechanisation, and other forms of assistance (Mudhara, 2010; Sinyolo, Mudhara & Wale, 2014; Denison et al., 2016; Wale & Chipfupa, 2018). In their study, Wale and Chipfupa (2018) argued that scheme farmers in Ndumo-B indicated that although they receive support from the government regarding seeds and fertilisers, this support is inappropriate since they are never consulted on what they need.

Farmers report receiving inputs they have already purchased, while others indicated that the inputs they are given have a limited shelf life with approaching expiry dates. Also, they cannot use them before the expiry date of seasonality issues. The survey observations show this was a rare to non-existent gesture to the Msinga independent irrigators because none have received such support in recent years. The 20.8% that once had contact with the Msinga local office agricultural advisor indicated only receiving some agricultural advisory services.

The FGD participants confirmed the survey data on limited support for independent irrigators. The second and fourth focus groups reported having previously met with an agriculture advisor or extension officer. They were given hand hoes on both occasions, and FGD three was given spinach seeds. However, they could not recall the year because it had happened years before. Concerning

the input access challenge, the distance to the input market fueled independent irrigators' difficulty in accessing inputs.

Input purchases are made in small shops in Tugela Ferry (e.g. Mike's Agric). Some farmers indicated purchasing in Greytown, approximately 47.7 km from the Tugela Ferry town. At least in Greytown, there are various shops, including CPS (seedlings), TWK, and farmers' Agri care. Again, the limited financial base poses a travel limit to accessing these various shops for production inputs. Travelling to Greytown requires two taxis, one from the village to Tugela Ferry and Tugela Ferry to Greytown. Pests and diseases have been reported by almost all (97 %) independent irrigators in Msinga as one of the biggest shocks they previously encountered in their farming operations. Most of the time, these outbreaks result in crop failure. The primary issue raised was a lack of knowledge about precautions, such as which agrochemicals to use. Additionally, agrochemicals are very expensive, and their limited financial resources made footing the bill challenging. When irrigators bought the inexpensive ones from a Tugela Ferry town, they were ineffective because they had damaged produce that could not be sold.

Droughts are another common problem for irrigators that have been detrimental to their production. More than eight (84%) in ten irrigators reported this. Drought in the area affected their crops greatly, and irrigators ended up not getting any return on their investment. The Northern region of KwaZulu-Natal, including Msinga, usually experiences dry conditions. Droughts strike Msinga regularly, with the most recent officially reported drought occurring in 2015-2016 (Vetter, Goodall & Alcock, 2020). Formally recognised or not, villages in Msinga continue to be affected by drought, and the effects are severe. In 2015-2016, cattle farmers in the study area lost 43% of their herd, while goat farmers lost 29%. Cattle numbers remained low three years after the drought, whereas goat numbers recovered (Vetter, Goodall & Alcock, 2020). Larger herds had lower mortality rates, implying that herd owners had better resources to support their herds. Droughts have, without a doubt, had complex socio-economic implications for residents of Msinga communities and generated vulnerability in these communities' livelihoods (Rumeki & Umubyeyi, 2019).

Independent irrigators have lost crops due to drought, and their livelihoods have suffered. Especially irrigators sourcing water from springs felt significantly affected as their water source dried out. Aside from the drought, independent irrigators who participated in the focus groups

(FGDs one and four) expressed concerns about irrigation water. These two groups were non-pumpers. Non-pumpers are irrigators who do not use pumps; they abstract irrigation water in buckets or cans. These irrigators stated that it was difficult to carry water on their heads from the source to the irrigation land, especially since they were old. According to Howley, Donoghue & Heanue (2012) and Ramoroka (2011), age and gender influence labour quality, particularly in physical activities where older people and females are less capable of performing physical activities than young people and males. This finding suggests that age affected irrigation activity since it limited their physical capability to irrigate their independent land. Also, due to groundwater scarcity, participants from FDG One described how they have to take turns irrigating and alternate days so everyone can access water. These patterns indicate intense competition for accessing this water source. As a result, irrigators occasionally use water intended for domestic use, which they purchase from vendors. Since the Tugela River is always full of water, even during droughts, the researcher enquired why irrigators do not use a petrol pump. Participants stated that they could not afford a pump due to financial constraints. One of the participants in the second FGD describes her failure to keep the pump running. She stated that she used to have one, but it broke and could not be repaired, so she now relies on buckets to extract irrigation water.

6.4.2 Farming constraints

Irrigators face a variety of challenges and constraints in their farming operations. Independent irrigators rated their experience with agricultural constraints on a five point Likert scale ranking. Table 10 shows the relative distribution (%) of production constraints faced by respondents. From a production perspective, high input prices was the most important perceived barrier to cultivation. Lack of capital followed by a lack of inputs due to high prices and a lack of support services ranked as the next highest barriers to production. Water availability was a fluctuating challenge for all but 15% (never or rarely) of the respondents. Having sufficient land appears to be an issue (sometimes and most of the time) for 42% of the respondents. There was a high confidence in socially governed factors such as land access and security with little perceived threat to production strategies.

In South Africa, smallholder agricultural advisors or extension officers aid them in farming (Denison et al., 2016; Wale & Chipfupa, 2018), which draws attention to the lack of support in the study area. This assistance tends to focus on group projects, such as irrigation schemes and cooperatives (Sinyolo, Mudhara & Wale, 2014). Due to this bias, independent irrigation farmers

are typically left ignored. Irrigators pointed out that new pests and diseases are one of the most severe shocks to their farming operations. There is little understanding of how to deal with them, and agricultural advisors may be the best people to help them control them. However, there is little or no interaction between the two.

Table 10. Relative frequency distribution (%) of constraints faced by irrigators (n=101)

	Never	Rarely	Sometimes	Most of the time	Always
	Irrigators (%)				
High increase in input prices	4	6	19	67	4
Lack of capital	3	1	23	54	20
Lack of support services	8	3	6	47	37
Production below normal	4	4	53	39	1
Lack of access to inputs	8	14	41	36	2
Water availability	8	7	54	25	6
Insufficient land	38	21	23	19	0
High pump and maintenance cost	81	1	5	13	0
Declining output market prices	8	26	55	11	0
Land tenure is not secure	92	6	2	0	0
Local and political conflict	89	10	1	0	0

Source: Survey (2019)

Most independent irrigators rated agricultural extension officers (or advisers) as an unimportant source of information when rating information sources (Figure 9). This is not because they do not require them but rather that there is no communication between the two, implying that independent irrigators do not receive information from them. Only a few irrigators received support from them or were in contact with them, which could explain this rating. According to the findings, farmers also regard fellow farmers (56%) as essential knowledge sources. There are lots of reasons why farmer-to-farmer transmission is useful. There is legitimacy, familiar language, and contextualisation of information into the spreader's experience, 'I tried it this way'. Creative thinking and problem-solving come with discussion amongst individuals who have equal power in the discussion.

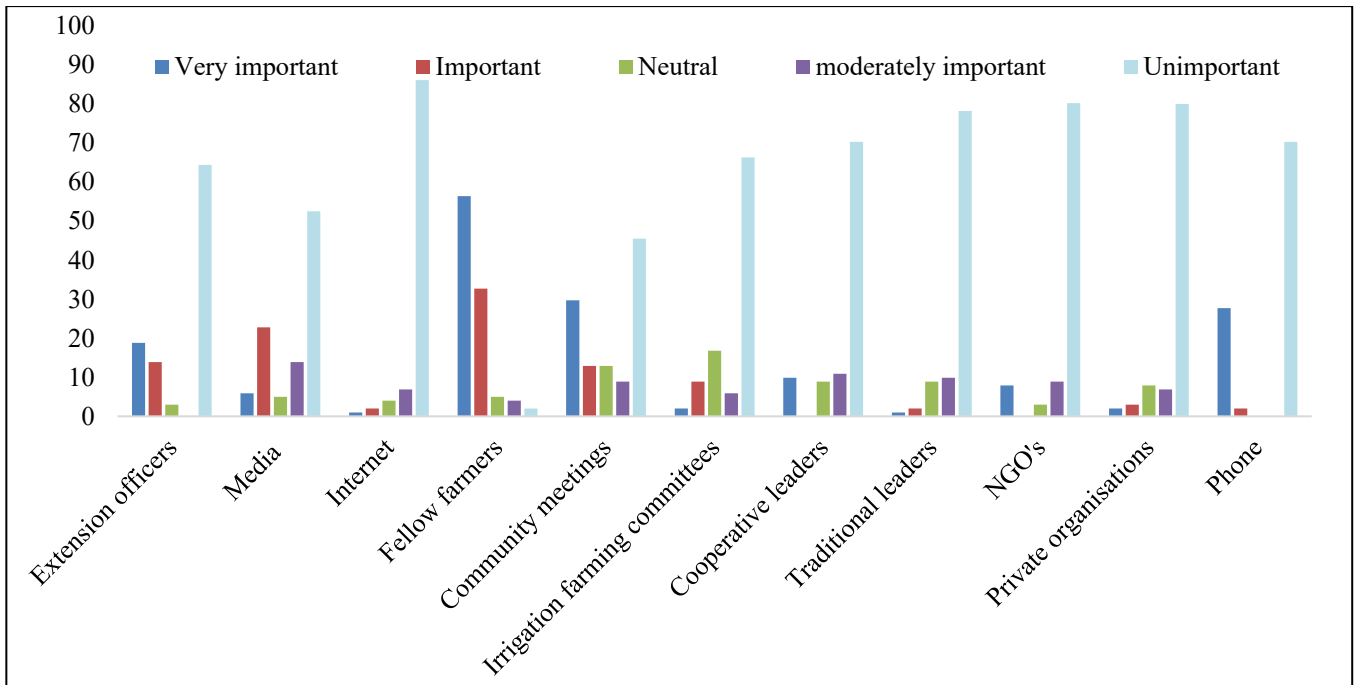


Figure 9. Importance of sources of information among Msinga independent irrigators

Finally, through conversations in the FGDs, the researcher learned that the need for fence plots was a significant constraint for irrigators (Appendix X). Irrigators used tree branches (Figure 10) and bed springs to keep livestock from entering their fields, which over time, deteriorated. These efforts were often ineffective since they lost their crops to cattle anyhow.



Figure 10. Independently irrigated plots fencing using bedsprings (right) and dry tree branches (left)

6.4.3 Produce markets

The output market distribution of Msinga independent smallholder irrigators is depicted in Figure 11. Smallholder farmers usually participate in lower-value markets, such as farmgate and local markets, due to the high transaction costs of reaching high-value food markets (World Bank, 2007). In Msinga, independent irrigators face a similar predicament, with market access as a significant barrier. Over half of Msinga irrigators (58.4%) had the bulk of their produce sold. Sold produce is accounted for 95% (R7 7861) of the total produce. Most independent irrigators in the studied area sell their produce to local community consumers off-farm (52%), local consumers at the farm gate (39%), and bakkie street traders (39%). It was challenging to sell to any formal market (1%) because of the quality and quantity required in these product markets. In addition, other growers in the area, smallholders from the irrigation project and commercial producers compete fiercely (Cousins, 2012). Irrigators also confirmed the high competition among producers in FGD two, indicating that at some point, they return home with the produce that was not all sold and, once spoiled, feed it to animals.

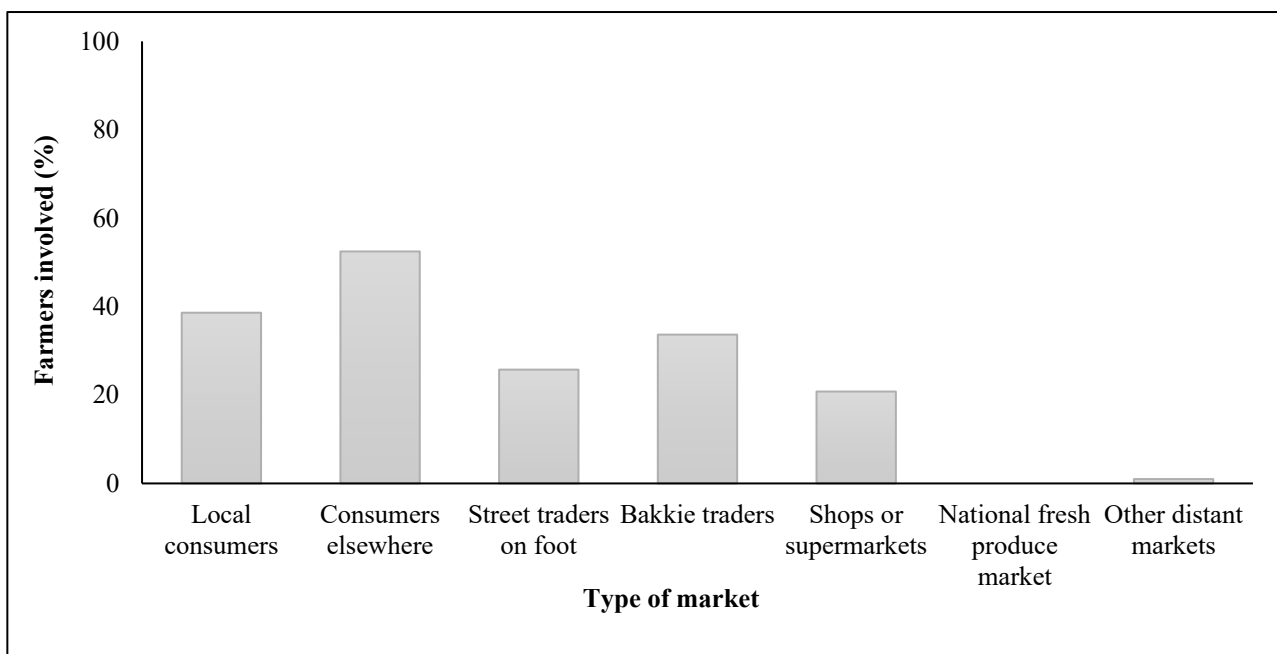


Figure 11. Relative frequency distribution for independent irrigator's output markets

6.5 Conclusions and recommendations

This paper aimed to identify agriculture shocks and constraints faced by independent irrigators in the Msinga Local Municipality and intervention approaches that could help them overcome these obstacles. The findings revealed that a significant challenge was access to inputs, exacerbated by a lack of financial capital. Irrigators faced pests and diseases, and a lack of funds and knowledge about dealing with them resulted in crop loss. Access to water was also a significant issue for these irrigators. Irrigators in the area lacked adequate irrigation infrastructure, so they mainly used buckets, which limited their ability to perform at their best due to the physical requirement of carrying a bucket from the source to the household. Drought was another concern for irrigators, particularly those relying on spring water. Droughts in Msinga cause water sources to dry up, limiting productivity, and some irrigators choose not to plant. This shock is one of the primary shocks that has harmed the livelihoods of irrigators. Aside from drought, irrigators who use springs for water face the challenge of water running out from the source.

The South African government and other stakeholders could prioritise providing appropriate systems, services, and support to independent irrigators from the existing farmer support services. Literature indicates that government programs prioritise group projects over individual farmers. The government could extend the input (seeds) support to independent irrigators. However, as a once-off initiative to give them a head start and avoid dependency syndrome, also these programs should not fund or focus on the same beneficiaries for a lengthy period. While assisting with inputs, designed farmer programs like input support should teach them to be self-sufficient while remaining independent. For example, when providing farmers with input such as seeds. Financial and business skills should form part of the support provided by agricultural advisors and extension. These financial skills are for teaching irrigators to save money from their profits for their next planting rather than spending it all and waiting for the next government effort or handout. Existing programmes, particularly those from the Department of Agriculture, as the smallholder's primary government Department, could encourage collective action (social capital). An example would be buying inputs in a collaborative effort rather than having one person spend their money to buy seeds from Grey Town individually. They would form an association and hire a single car to purchase seeds for everyone.

It is recommended that the government work with other stakeholders with water harvesting and savings techniques concerning drought and water access issues. In other countries, a pump is one of the initiatives adopted to assist independent irrigators with water access issues. However, among Msinga irrigators who participated in this study, support in the form of petrol or diesel pumps does not have a chance of sustainability. There are a lot of financial responsibilities associated with owning a petrol or diesel pump, and most irrigators in these areas do not have adequate financial capabilities to buy, run and maintain these pumps. Another option to cut running costs is solar pumps. Solar pumps could be a low-cost alternative for supplying irrigation water. Solar irrigation eliminates the hassles associated with intermittent access to electricity or expensive fuel and labour for water delivery. However, there is still the issue of maintenance. The applicability of solar pumps to a larger scale requires rigorous research to test if these could work with less resourceful irrigators like that of Msinga.

The findings presented here shed new light on the challenges independent smallholder irrigators face in South Africa. They also contribute an emic view to the literature for resource-constrained independent irrigating. This paper provides the groundwork for future research into issues faced by these overlooked irrigators. More information on these constraints from a larger sample would aid us in establishing a higher level of accuracy on this subject. This information could assist in identifying entry points and developing targeted interventions to remove the constraints that independent irrigators face, improving their participation in formal markets and positively impacting their livelihoods.

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CHAPTER 7. THE IMPACT OF INDEPENDENT SMALLHOLDER IRRIGATION ON THE INCOME AND POVERTY OF IRRIGATOR HOUSEHOLDS IN MSINGA LOCAL MUNICIPALITY, KWAZULU-NATAL PROVINCE, SOUTH AFRICA

7.1 Abstract

This paper aims to determine whether independent smallholder irrigators could be an alternative irrigation development pathway to improving smallholder's livelihoods in South Africa. The sample included 101 respondents selected through a snowball sampling technique in Msinga's Local Municipality. The findings indicate that crop production on the independent irrigation enterprise was the second most crucial income source, contributing 15.3% to the average annual household income. Notable, irrigators using an irrigation pump irrigated larger areas than non-pumpers, resulting in higher gross income. Poverty headcount showed that adding independent irrigation income to total household income allowed only limited irrigator households to escape being below the poverty lines. These results imply that independent irrigation plays a role by contributing to household income. However, the contribution is limited at this stage by the financial incapacities and other constraints irrigators face in the study area. The government could be one of the structures playing a part in improving the benefits of crop production on their independently irrigated land. However, this does not mean handing out equipment to farmers but capacitating them on alternative ways to expand their irrigated area and improve their water access. Government and other stakeholders could create an enabling environment for independent irrigators to access irrigation equipment, including equipment leasing with purchase options, rural credit services, and microfinance. Therefore, given the support, independent irrigation could be an alternative to irrigation development with government and stakeholder support.

Keywords: Household income, poverty, irrigation development, pumping, independent irrigation

7.2 Introduction

Irrigated farming remains critical for combating poverty, food insecurity, and unemployment in rural areas. The latter is evident from the New Growth Path, which aims to create 300,000 jobs by establishing smallholder irrigation schemes as part of the rural strategy to tackle poverty and unemployment. Simultaneously, the National Development Plan (NDP) sought to create one million jobs among smallholder farmers by extending irrigated land by 500 000 hectares by

constructing new irrigation schemes (National Planning Commission, 2011). There have been various irrigation development attempts, especially after the apartheid era. Post-1994, the South African government employed multiple reforms to address the legacy of apartheid's rural poverty and inequality. These reforms focusing on smallholders included revitalisation, rehabilitating old irrigation schemes, and building additional irrigation schemes (Perret & Geysler, 2007). According to Denison and Manona (2007), rehabilitation and revitalisation relate to existing scheme investment, with the latter being a people/systems/market-centred approach and the other being an engineering-centred approach. The state implemented revitalisation through the failure of rehabilitation to achieve the desired results. The goal of rehabilitation was to secure the water supply and repair the irrigation distribution system by reconstructing deteriorating infrastructure (hardware components) (Fanadzo, 2012). For example, the Makhathini Flats received an R1.1 billion investment from the KwaZulu-Natal cabinet to revamp agriculture and improve agricultural infrastructure in the Jozini and Umhlabuyalingana municipalities of the rehabilitation initiative (KZN PDAAEA, 2014). The revitalisation intervention covered a much broader range of smallholder irrigated agriculture activities, such as enterprise planning, human capital development, empowerment and access to information, and infrastructure repair and redesign. Denison & Manona, 2007; Veldwisch & Denison, 2007). In the financial year 2011/2012, five irrigation schemes were revitalised, one of which was Makhathini, with a total investment of R62.8 million (KZN PDAAEA, 2012).

Despite enormous public funding for these smallholders, most research has associated them with unsatisfactory performance (Machete et al., 2004; Tlou et al., 2006; Inocencio et al., 2007; Mkeni et al., 2010; Woodhouse et al., 2017). According to Machete et al. (2004), Tlou et al. (2006), & Fanadzo et al. (2010), they have performed below expectations and contributed very little to the social and economic development of the irrigation communities. In regions like Asia and Sub-Saharan Africa, the public irrigation sector's failure, most particularly irrigation schemes, has led to conversations around independent smallholder irrigation being a feasible investment alternative that may serve as a substitute for irrigation schemes (Molden, 2007; Namara et al., 2011; Dittoh et al., 2011).

Independent irrigators in these regions help rural households alleviate poverty, improve food security, increase household cash income, and create employment opportunities for rural residents (Giordano et al., 2012; De Fraiture, 2012). Small private irrigation agriculture, for example,

generated between USD 175 and USD 840 more in annual household income in Ghana than dryland agriculture (Giordano et al., 2012; De Fraiture, 2012). Smallholders in Tanzania who used private irrigation received 50% of the cash income from dry-season vegetable growing (Keraita, 2010). Private irrigators in Burkina Faso earn between US\$2500 and US\$5000 per hectare every season (De Fraiture & Giordano, 2014). Research has also shown that yields are better when employing a pump to irrigate than buckets or watering cans, resulting in a higher total revenue per hectare. In Ghana (Volta and Ashanti region), Adeoti et al. (2009) found that irrigators using pumping technology had an average net income of US\$952.43, while those who did not have a net income of US\$608.89. Brabben and Kay (2000) and Mangisoni (2008) drew similar conclusions in Kenya, Zambia, and Malawi. In Kenya, the income for no technology users was 8.6 times less than those who used lifting technologies. Treadle pumps can irrigate 0.1–0.2 ha, whereas manual lifting, including buckets and watering, can irrigate up to 0.1 hectares (Giordano et al., 2012; Giordano & De Fraiture, 2014). The average size of the land irrigated by motor pumps is four times larger (De Fraiture & Giordano, 2014). Irrigating a tiny amount of land manually with a bucket or watering can take several hours daily. Woltering et al. (2010) state that irrigating 1000 m² from a local source takes 9 hours daily.

There is a dearth of such knowledge in South Africa, which is critical because it determines whether the investment in these irrigators is worthwhile from the perspective of public funding and extension services. Therefore, insufficient concrete evidence exists to advocate for them as an important investment. The specific objectives of this paper were to (i) determine the effect of independent irrigation on household income and poverty and (ii) determine the effect of pumping on the income from the independently irrigated land.

7.3 Methodology

This paper used a survey, where data was collected between November and December 2019 using a standardised questionnaire and face-to-face interviews. This process has been described in detail in Chapter 3 (3.3 Methodology). This paper employed Statistical Package for Social Sciences (SPSS) 27.0 and StataSe17 for data analysis.

The analysis in this paper divided independent irrigators into two groups based on their irrigation water extraction method: pumpers and non-pumpers. Pumpers used pumps to collect water, whereas non-pumpers included irrigators who extracted irrigation water with buckets and those

who diverted a water flow to a pipe or a furrow. The data were analysed using SPSS descriptive statistics, which calculated means and standard deviations for quantitative data and percentages and frequencies for categorical variables. An SPSS independent t-test analysed independent irrigation characteristics and irrigator household income differences between pumpers and non-pumpers. SPSS simple linear regression examined the effect of independent irrigation on household income. The dependent variable was total annual household income, while the independent variable was income from the independently irrigated plot. An independent t-test examined the differences between pumping irrigators and non-pumpers' gross plot income (productivity) and cultivated land. The irrigation water extraction method served as a proxy for a grouping variable, while the revenue from the irrigation enterprise proxied the test variable. Probit modelling on StataSe 17 software identified significant factors influencing pumping technology adoption (dependent variable) among Msinga independent irrigators. Household size (number), irrigator gender (m=1, f=0), irrigator age (years), irrigator education level (grade number), total production land (m²), access to production advice (y=1, n=0), access to markets (y=1, n=0), household income excluding irrigation (ZAR), self-employment (ZAR), and household savings (ZAR) were included explanatory variables for the Probit modelling as because they are assumed to influence pump adoption.

This paper used the South African poverty line as an absolute (money-metric) approach to measure poverty among irrigator households. This method represents the required income level to purchase a basket of essential survival items or the point at which a person's food energy intake is adequate to meet a predetermined food energy requirement, such as 2100 calories per day (energy intake method) (Ravallion, 1998; Haughton & Khandker, 2009). A headcount index, which measures the share of people classified as poor, is one of the most widely used poverty measures to date. The headcount index is usually determined by looking at who has an income or consumption less than the poverty line (Coudouel et al., 2002). As a result, it depicts the prevalence of poverty. Similar to the Msinga study by Sinyolo et al. (2014), who determined the impact of income from irrigation on a household's poverty status, this paper compared a poverty situation where average annual household income includes independent irrigation income and a poverty situation where independent irrigation income was not included. The food poverty line (FPL) was R547 in 2018 prices. The lower and upper bounds poverty lines (LBPL and UBPL) were R785 and R1183 per capita per month, respectively (Statistics South Africa, 2018).

7.4 Results and discussion

7.4.1 Independent irrigation plot as a livelihood asset

Summary statistics of the irrigator characteristics grouped into the pump and non-pump users are shown in Table 11.

Table 11. Characteristics of pumpers and non-pumpers (n=101)

Variables	Pumpers (n=23)		Non-pumpers (n=78)		Total sample (n=101)		t-test/ x ² value
	Mean	SD	Mean	SD	Mean	SD	
Irrigator gender (1=f, 0=m)	0.9	0.3444	0.6	0.499	0.6	0.484	0.008
Irrigator age (years)	48.7	11.863	54.2	11.870	53.0	11.931	0.051*
Education (years)	2.78	4.000	2.1	3.731	2.3	3.784	0.460
Farming experience (years)	16.7	11.399	18.1	11.939	17.8	11.775	0.641
Total land size (m ²)	1453.6	1981.7	558.7	1402.273	762.5	1587.545	0.017*
Cultivated land (m ²)	1034.9	1239.885	406.0	1389.3	549.2	1376.5	0.054*
Water source (1=river, 0=otherwise)	1.0	0.000	0.1	0.305	0.31	0.464	0.000*

Note: for the t-test/x² value followed by *, the means differed significantly ($p \leq 0.05$).

Source: Survey (2019)

Msinga sampled irrigators were primarily females (63.4%) and dominated by older people with an average age of 53.0 years, ranging between 18 to 87 years. Non-pumpers were older than pumpers, and the difference was significant. The level of education was similar for pumpers and non-pumpers, while the average farming experience was slightly higher but not significant for non-pumpers. Concerning their independently irrigated land, the average space for irrigated crop production was 762.5 m². Most (38%) of irrigators had plots larger than 500 m², while 26% had plots smaller than 200 m². Pumpers had significantly larger total crop production land and cultivated land than non-pumpers. Irrigation water was mainly from groundwater (69%) in springs

or hand-dug wells. Another important source was direct river extraction, found in one-third (31%) of the irrigators. There were three irrigation water extraction methods found among Msinga irrigators. Figure 12 shows the two most prevalent of the three methods.



Figure 12. A- Small petrol pumps used by other irrigators to extract irrigation water in Tugela River, B-buckets and watering cans used by irrigators who manually extract irrigation water

The picture (figure 12-B) shows a typical asset, buckets and watering cans which most irrigators use to extract and transport irrigation water from the source to the plot. The method of collecting and conveying irrigation water was found on 74 of the sampled 101 irrigators. All the irrigators collecting and conveying water this way used buckets to apply water into short furrows. In four cases, independent irrigators redirected the water flow into a pipe or an uncovered trench. All the irrigators diverting a water flow applied irrigation water through surface irrigation in short or long furrows. Twenty-three irrigators drew irrigation water using a small petrol pump (Figure 12-A). All these irrigators conveyed the irrigation water using a pipe (Figure 13) but applied the water to the crops using different methods. The majority (74%) applied irrigation water using short or long furrows (Figure 13), while the remaining 26% used drip irrigation.



Figure 13. Irrigation water is transported by a pipe (left) and tools used to manage the field (right)

7.4.2 The impact of independent irrigation on household income

Msinga irrigator households obtained income from various sources shown in Table 12. The average annual income for irrigator households was R53 159, ranging from R5 950 to R234 220. The average household yearly income for pumping irrigators was slightly higher than that of non-pumpers. However, the difference between these two groups' income was insignificant ($p \leq 0.424$). Remittances were the only income source statistically significant among the two groups ($p = 0.007$). All farming enterprises, including irrigated land and livestock, contributed 26.5% to the average household income.

The average annual contribution of R5 948.9 was livestock production gross income, and R8 156.9 came from the production of the planted independent irrigated land. Independent irrigation made an average 15.3% contribution to the average yearly household income. This contribution's gross income denotes cash and in-kind income (consumed). This observation indicates a significant impact of independent irrigation as a livelihood activity on irrigator households. A simple linear regression test also confirmed this effect of independent irrigation income on average annual household income (Appendix U). Independent irrigation income was positively and significantly correlated with the annual income of households ($p = 0.001$). The average revenue generated by independent irrigation in Msinga was almost comparable to the R10 166 earned by independent irrigators in Ndumo-B and Makhathini (Wale & Chipfupa, 2018).

Table 12. Distribution of total average annual household income for irrigator households (n=101)

Income source	Pumper	Non-pumper	All sample	Contribution	t-test
	Annual mean (Rands)			%	
Salaries & Wages	3391.3	8969.2	7699.0	14.5	0.410
Remittances	730.4	3635.4	2973.9	5.6	0.007*
Old age grant	10215.7	11098.5	10897.4	20.5	0.823
Child grant	13111.3	11321.5	11729.1	22.1	0.486
Other grants	1857.4	1643.1	1691.9	3.2	0.877
Trading	9443.5	183.1	2291.9	4.3	0.150
Making and selling goods	260.9	1353.9	1105.0	2.1	0.472
Rendering services	0.0	861.5	665.4	1.3	0.547
Independent irrigation	13888.9	6466.7	8156.9	15.3	0.076
Livestock	7339.1	5539.0	5948.9	11.2	0.627
Total	51071.8	46509.7	53159.3	100.0	0.424

Note: for t-test value followed by *, means differed significantly ($p \leq 0.05$)

Source: Survey (2019)

Independent irrigators in Thulamela, on the other hand, made an average of R14 481 from the independent plot, while those in Greater Tzaneen generated R16 607 per hectare from their independent plot (Denison et al., 2016; Dube, 2017). The smaller irrigated land sizes may explain the enormous disparity between Msinga and Limpopo (Thulamela and Tzaneen) irrigator revenues. Income and expense analyses were done on irrigators who used pumps and those who did not. Table 13 shows the enterprise economic analysis for the two independent irrigator groups.

The average annual gross revenue of pump irrigators was 2.2 times more than that of non-pumpers per total cultivated area (Table 13). However, the average gross revenues per 1 000m² were higher for non-pumpers. Non-pumper's gross revenue was R6 466.6 per actual cultivated area and R29 159.5 per 1 000 m², while this was R13 888.9 per cultivated area and R17 389.4 per 1 000 m² for

pumpers. The average cultivated area under non-pump irrigators was tiny, which explains why the average revenue was lower than that of pump irrigators.

Table 13. Cash expenditure and gross revenues by Msinga irrigators

	Pumper (n=23)		Non-pumper (n=78)		t-test
	Mean	SD	Mean	SD	
Land cultivated (m ²)	1034.9	1239.9	406.0	1389.3	0.054*
Gross irrigation income	13888.9	18292.9	6466.6	11407.0	0.076
Irrigation expenditure	4309.9	5620.9	1078.8	994.7	0.012*
Irrigation cash in-kind	375.0	436.9	369.5	860.6	0.967
Cash receipt	13513.9	18149.1	6097.2	11472.7	0.075
Net operating income	9579.0	13795.8	5387.8	11161.1	0.138
Net cash operating income	9204.0	13694.3	5018.4	11252.6	0.139

Note: for the t-test value followed by *, the means differed significantly ($p \leq 0.05$).
Source: Survey (2019)

These results indicate that technology allows the irrigation of much larger spaces, resulting in higher returns. This way, it does increase their chances of engaging in productive farming operations. The FGD (Appendix W) supports these conclusions, where irrigators pointed out that they are older and collecting and transporting water to their plot strains their old age and health. Irrigation by bucket indeed requires physical labour or strength, especially with the transportation of irrigation water. A study in Sub-Saharan Africa by Giordano et al. (2012) confirmed conclusions that pumping facilitates irrigation of larger land sizes than manual irrigation, like buckets. Their study reported that buckets enabled less than 0.1 ha of irrigation, and human-powered treadle pumps could irrigate 0.2 hectares. In comparison, a motorized one can irrigate 1-2 ha.

Non-pumpers also expressed how they wish to irrigate using the pump; however, purchasing, running, and maintaining costs are too much for them to bear. Figure 14 shows some of the broken pump's irrigators failed to repair due to financial constraints.



Figure 14. A pump has broken beyond repairs (left) and one that needs fixing (right) but is kept in the house until there are funds

Regarding running costs, Mashunka pumpers indicated how they irrigate only once a week due to high petrol prices. Worse, they do not live near where they are planting. Every week, they must hire a Bakkie to work on their farm. This finding supports studies by De Fraiture and Giordano (2014), which implied that only better-off irrigators could purchase pumps, excluding poorer households.

7.4.2.1 Factors influencing pump adoption

Table 14 summarises the Probit model results for the factors influencing pump adoption by Msinga independent irrigators. Pump adoption significantly correlated with household size, land holding size, self-employment income, and household savings. Pump adoption significantly positively correlated with household size ($p=0.048$). These results implied that larger households are more likely to adopt pumps than smaller ones, which could be due to the positive role of household size on the annual average household income, enabling pump purchases. In Msinga, larger households had a positive and significant correlation with yearly household income ($p=0.003$), with average annual household income increasing for every increase in household size. Pump adoption and self-employment income were positively correlated ($p=0.003$), indicating that increased households participating in local economic activities are more likely to adopt pumps.

Table 14. Factors that influence the adoption of irrigation pumps in Msinga: StataSe 17 Probit model results (n=101)

	Coefficient	Std. err	Z	P> z	[95% conf.	interval
Household size	0.1511518	0.0764352	1.98	0.048	0.0013416	0.3009621
Irrigator gender	-0.7142863	0.4815132	-1.48	0.138	-1.658035	0.2294622
Irrigator age	-0.037846	0.0226763	-1.67	0.095	-0.0822908	0.0065989
Irrigator education level	0.0104948	0.0599883	0.17	0.861	-0.1070801	0.1280696
Total production land	0.0011434	0.0003552	3.22	0.001	0.0004471	0.0018396
Access to production advise	-0.7432348	0.5949669	-1.25	0.212	-1.909349	0.422879
Access to markets	-0.1202359	0.3778967	-0.32	0.75	-0.8608998	0.6204279
Household income, excluding irrigation	-6.81E-06	6.51E-06	-1.05	0.295	-0.0000196	5.94E-06
Self-employment	0.0000743	0.0000279	2.66	0.008	0.0000197	0.000129
Household savings	-0.0001371	0.0000464	-2.95	0.003	-0.0002281	-0.0000462
Constant	0.1998309	1.286085	0.16	0.877	-2.320849	2.720511
N	101					
LR chi2(10)	40.81					
Prob > chi2	0.000					
Pseudo R2	0.3766					

Source: Survey (2019)

According to the findings, as the size of independently irrigated land increases, so are the chances of adopting pumping technologies ($p=0.001$). The implication is that households with larger farm sizes are more likely to generate more income, providing a better capital base and the ability to invest in new agricultural technologies.

7.4.3 Impact on irrigator household poverty

Without a control group (non-irrigators) to investigate the significance of irrigation in reducing poverty among irrigator households, a comparison was made between poverty situations where: the average annual household income includes independent irrigation income and those where independent irrigation incomes is not included. In other words, the analysis is what would have happened if the households did not earn income from independent irrigation. Figure 15 indicates the poverty incidence proportion of irrigators below the three poverty lines, including the Food Poverty Line (FPL), Lower Bound Poverty Line (LBPL) and Upper Bound Poverty Line (UBPL), for the two income scenarios.

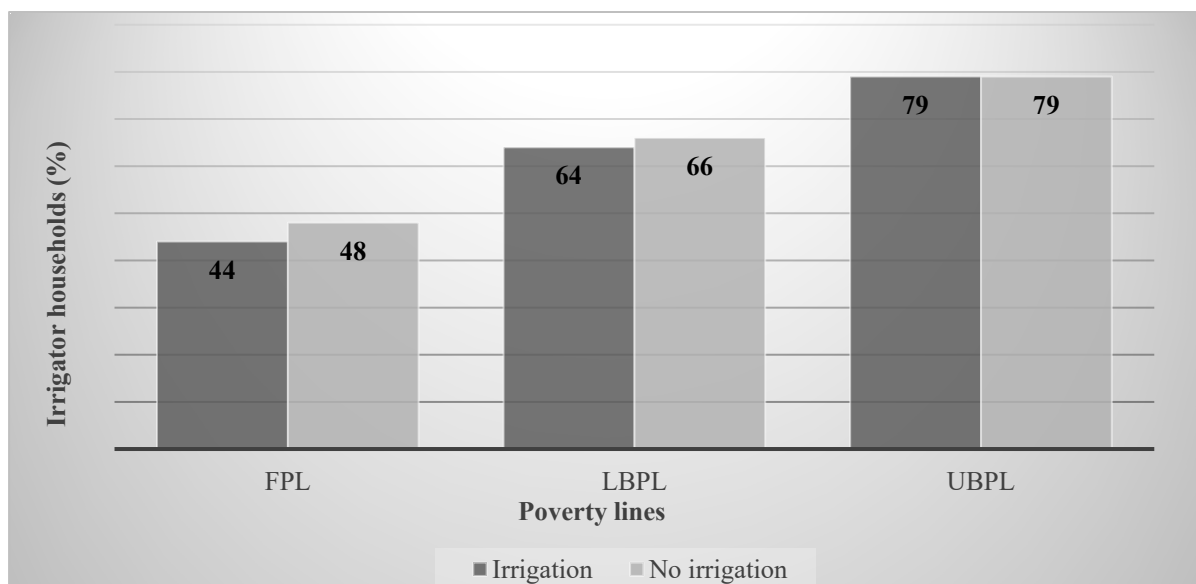


Figure 15. Comparisons of Msinga poor irrigator households (%) for income scenarios with and without irrigation income

The FPL applied to the study period was R6 564 per capita per year (Statistics South Africa, 2018). The results showed that 4% more households were in poverty without irrigation income. For the LBPL of R9 420 per capita per year (Statistics South Africa, 2018), only 2% more of the irrigator household were poor without irrigation income. There was no change in the UBPL of R14 196 per capita per year (Statistics South Africa, 2018). When measured using the SA poverty lines, there was a slight change in the percentage of irrigator households lifted from poverty. These results indicate a minimal contribution of irrigation., The poverty results also suggest considerable variability in independent irrigation income when looking at the average income from independent irrigation. It also shows how irrigators with larger returns skew the average to appear larger. Figure

16 shows the extent of variability in irrigator incomes. Slightly over one-third (36%) of the irrigators made more than R5000 per year per average actual area planted (1 097 m²) on the independent irrigation enterprise, while 15% earned less than R500 per year.

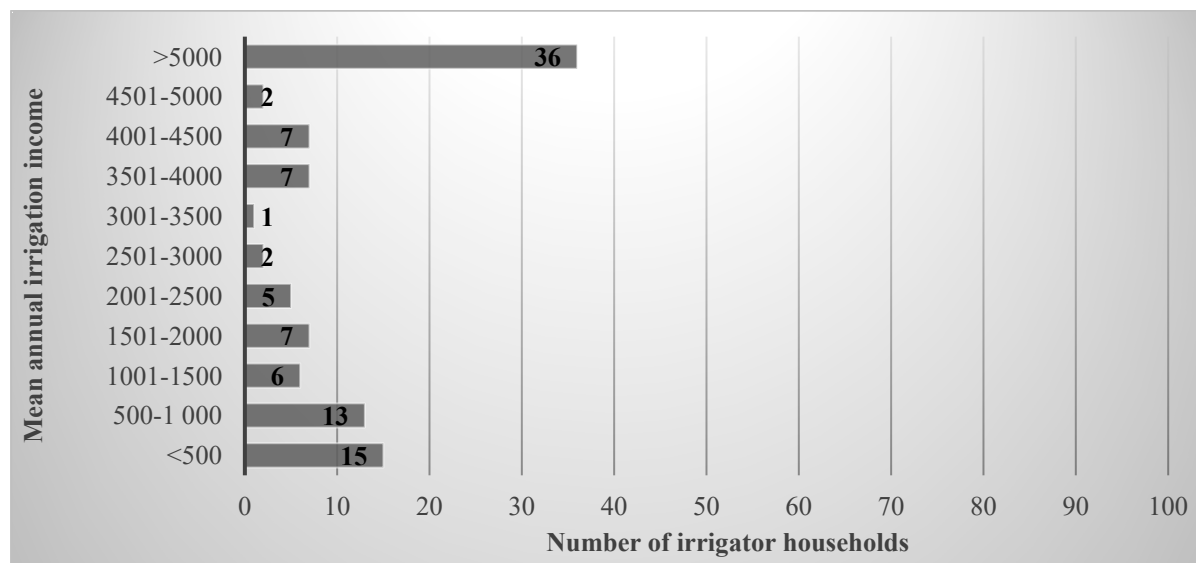


Figure 16. Independent irrigation income distribution per actual area cultivated (n=101)

The rest were non-uniformly spread through the income band of R1001 and R5000. The study demonstrates the inconsistency of irrigation plot income covered by the overall average and the need for further investigation into motivations for persistence in irrigating. On the other hand, social grants continue to be the most consistent source of income for these irrigators, accounting for 46 % of their total household income. Social grants play an important role in agricultural households' livelihoods and, in some cases, have surpassed the importance of irrigation among households, particularly the resource-poor. Then again, irrigated farming is inconsistent in the study area, primarily due to common drought occurrences. Drought results in the irrigation water source, specifically the groundwater drying out plots and left fallow because they cannot survive without irrigation.

7.5 Conclusion and recommendations

This paper aimed to determine whether independent irrigation would be an appropriate development path for rural households based on their contribution to household income and poverty reduction. Independent irrigators could be an alternative irrigation pathway for irrigation development. However, much intervention must occur for independent irrigators to be more

productive and effective in rural households for income generation and poverty reduction. Irrigators in Msinga are poorly asset endowed, with limited crop production land, irrigation water, and physical irrigation assets; land sizes were much smaller, while the source of irrigation water used by many needed to be more reliable.

Hence only a little would come from their independent irrigation enterprises. The findings highlight the significance of pumping technology in improving independent irrigation benefits; however, access to pumps depends on financial assets. In Msinga, irrigator households rely heavily on social grants and can seldom afford pumps. The study recommends that the government consider independent irrigation as another national strategy for improving rural livelihoods and support and improve these irrigators. However, the government should not hand out equipment to farmers but capacitate them on alternative ways to improve their water access, especially the one that uses sources like springs, which tends to dry out. Existing farmer support programmes could promote water harvesting strategies and use cost-effective and environmentally friendly soil and water conservation practices. Government and other stakeholders could create an enabling environment for independent irrigators to access irrigation equipment—for example, by exploring and developing financial instruments to purchase pumps and other necessary inputs to overcome financial constraints. These could include equipment leasing with purchase options, rural credit services, and microfinance. The independent irrigation phenomenon is not a one-size-fits-all phenomenon. The limited literature in South Africa portrays these irrigators differently from this research. Future independent irrigation studies should investigate systematic data on irrigated areas, farmer participation, technology use and economic indicators.

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CHAPTER 8. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

8.1 Recap of the purpose of the study

Irrigated smallholder agriculture has been linked to improved rural livelihoods. As a result, significant investments in smallholder irrigated agriculture have been made to resolve socioeconomic issues like unemployment, food insecurities, and poverty in rural South Africa. The South African government has implemented several reforms to address these concerns through smallholder development. Still, one intervention that has received much attention is building, revitalising, and rehabilitating public irrigation schemes. Research shows that smallholder irrigation schemes in South Africa perform poorly despite previous investments and continuous support. The sector has made no significant to limited contributions to the problems it was created to address. Because of the reliance on and call for measures such as the National Development Plan to develop smallholder irrigation as a crucial component of creating jobs, boosting incomes, and ensuring food security in South Africa. There is a need to investigate alternative irrigation development strategies that could significantly improve rural livelihoods. Independent irrigators could be another irrigation development option under consideration by the government. However, unlike in other countries, there is insufficient evidence in the South African research community to confirm these irrigators as the best option for irrigation development yet. This study contributes to the discussion by describing the characteristics and enabling environments as a background for the impact of independent irrigation on household income and poverty status for independent irrigators.

The study location is Msinga Local Municipality of KwaZulu-Natal Province of South Africa. This study's overall goal was to analyse the impact of independent smallholder irrigation on rural livelihoods. The study's specific objectives were to (i) identify the livelihoods of independent irrigators concerning the resources they have access to and their strategies to make a living; (ii) determine the role of organisations and institutions, if any, in supporting independent smallholder irrigators; determining access to resources (iii) identify the vulnerabilities in external shocks and the constraints the independent irrigators face and (iv) determine the impact of independent irrigation on the livelihoods of rural households by investigating how they contribute to household income and poverty.

8.2 Conclusions

The initial objective of this research was to describe the livelihood capitals of Msinga independent smallholder irrigators. In this research, households' human capital had a quantitative dimension, primarily concerned with labour availability and household size. Household size is essential because it indicates the (potential) size of the labour pool within the household. The situation at Msinga essentially confirmed this because household size significantly correlated with the number of members contributing to farm labour. From these results, this research concludes that the relatively large size of the households in the study area did translate into superior availability of family labour for farm work.

Regarding natural capital, the study's findings revealed that households in this region had a weak natural asset base. Independent irrigator households portrayed the cultivation of small farming spaces. From this evidence, this research concludes that Msinga's independent irrigator's crop production activities were limited to microscale production. In this research, seven of ten irrigators used groundwater, primarily through springs or shallow hand-dug wells, for irrigation in their independent land. Severe water access shortcomings in this water source further hindered Msinga's independent irrigation land productivity. During the dry winter season, households in Msinga could not use their cultivated land due to a lack of water for irrigating their crops. The study area's water shortages were exacerbated by frequent droughts, again preventing irrigated land from being cultivated. Based on these findings, the livelihoods of Msinga independent irrigators could not have been centred on this activity. This is true; their livelihoods were centred on claims against the state since they were these households' most consistent and reliable income source. For these reasons, this study concludes that, compared to South African literature on independent irrigators, Msinga irrigators lacked adequate access to natural resources regarding both arable land and irrigation water.

It is worth noting that the source itself and nearby access to alternative sources, such as the river restricted irrigation water access. For example, irrigators from the paraffin village faced limitations in accessing irrigation water due to infrastructure rather than the water source. Irrigation resources, including pumps used for water extraction, were limited to one-fifth of the sample. Irrigators using irrigation pumps had no restrictions to accessing water.

All these irrigators drew their water directly from the river, which had not dried out on them, so it was consistent throughout all planting seasons. The only issue was the high pump running cost, preventing them from irrigating as frequently as they preferred. Due to limited financial capital, most irrigator households in Msinga could not afford these pumps. Even those who had them struggled with maintenance; some were left broken for good. At the same time, pumps allowed the irrigation of larger plot sizes. This observation implied that Msinga irrigators without access to pumping had production limited to smaller land sizes.

As the ability to irrigate crop-production land is essential, the ability to cultivate land is also critical. In Msinga, the study found that the crop production physical assets were limited to hand tools. Other farming implements were rare. Among these rare implements were mechanised draught and tractor-drawn cultivation implements, transportation assets, and immovable fixed assets used in farming. However, given the small irrigation plots, the lack of ownership of these resources was not surprising. Concluding these findings, the physical assets were sufficient for independent irrigators' current production spaces but inadequate to engage in crop production on a larger scale.

Msinga irrigator households or any households involved in crop production require financial capital to procure physical assets. The study shows that social grants had comprehensive coverage, benefiting almost all households interviewed. Among these households, state transfers, including old age pensions and child support grants, were the most important, contributing nearly half the average annual household income. This study adds to the growing body of research that indicates that rural households are becoming more state transfers based and shifting away from the agrarian economy. This shift could be due to the various constraints and the unreliability of agriculture as an economic activity. For example, as mentioned in chapter six, irrigators face multiple challenges, including the lack of water access or recurring drought. These constraints resulted in the land not being utilised all year through.

In this research, savings were limited to an inquiry into how much money irrigator households saved each month in 2018. According to the survey findings, almost half of the 101 Msinga households saved money during the survey period. These households put money aside in both formal and informal institutions. While saving money in formal institutions was uncommon (one of ten) among study participants, many invested in community-based burial societies and stokvels,

which is typical of the study area. This finding emphasises the importance that households place on being able to finance the burial of family members. The result that emphasises the importance that households place on being able to finance the burial of family members is also confirmed by household membership in these groups. In Msinga, two of ten independent irrigator households were most likely to belong to burial societies or savings groups in the form of stokvel. Farmer groups, on the other hand, enabling farmers to share resources and work together to achieve a common goal was nonexistent among these irrigators. This finding indicated the non-existence of collective action among the irrigators.

The other study objective was to describe the livelihood strategies of Msinga irrigator households. In Msinga, irrigator households engaged in multiple activities to obtain income. Typical of the livelihoods of rural households in South Africa, Msinga households were ‘diversified’ because they typically contained multiple ways of obtaining income. In Msinga, most irrigator households centred around claiming against the state, and the inclusion of claiming against the state appears to be characteristic of rural areas of South Africa because other studies produced similar findings.

This study sought to ascertain structure and process roles in assisting independent smallholder irrigators in gaining access to land and water. Structures are represented by the “organisations”, including traditional leadership and government, while processes are represented by the “institutions” and “societal norms and beliefs”. Structures answer the who while processes the how. In Msinga, traditional authorities who represented the organisation granted access to crop production land through the tribal chief and irrigators were given “Permission To Occupy” (PTO) certificates. Eight out of ten households in the study area had this land access arrangement. Other forms of land access, such as unconditional usufruct, sharecropping, and unregistered ownership, were uncommon among these irrigators. According to the study findings, land distribution in Msinga benefited and favoured males, forming part of societal norms and beliefs. Irrigation land sizes for male-headed and female-headed households differed, with male-headed households having larger plots than female-headed households, which is typical of the study area.

Concerning access to irrigation water, independent irrigators were not registered for authorised water use and thus fell outside the Department of Water and Sanitation jurisdiction. However, it is not because independent irrigators are unwilling to obtain legal permission to use water but because they lack access to such information.

One of the reasons for this could be a lack of interaction between irrigators and the agriculture department's extension services. However, their unofficial water abstraction did not impede or affect their irrigation enterprises. It was only affected by drying the spring water, and the method of extracting water from the source was hampered by limited resources, including financial resources, to acquire physical capital. Another significant result of this study is that support systems were limited to a few independent irrigators. The limited support is not due to a lack of resources or capabilities by the South African government but instead to a failure to identify and extend support services to other beneficiaries. Also, the South African government for smallholders prioritises support for group projects rather than individual enterprises.

This study also sought to identify external shocks and independent irrigators' constraints. The findings revealed that access to inputs was a significant challenge, exacerbated by a lack of financial capital. Pests and diseases overwhelmed irrigators, and a lack of funds and knowledge about dealing with them resulted in crop loss. Drought was another concern for irrigators, particularly those who relied on groundwater as spring for irrigation. Droughts in Msinga resulted in spring water drying up, limiting productivity and irrigators cultivating the land. The latter suggests that these shocks affected the livelihoods of irrigators. The findings presented here shed new light on the challenges of South African independent smallholder irrigators. More information from a larger sample on these constraints would help establish a higher level of accuracy on this subject. That data could assist in developing targeted interventions to alleviate independent irrigators' constraints, increasing their participation in formal markets and positively impacting their livelihoods.

The study's ultimate goal was to determine the impact of independent irrigation on rural households' livelihoods by investigating how they contribute to household income and poverty. Irrigating households generally grow crops for sale or consumption at home. Crop production on independently irrigated land was the second most important source of income in the study area. Independent irrigation increased annual household income by approximately R8 156.90, 15.3% of the total average yearly household income. Based on these results, it is possible to conclude that independent irrigation is an essential component of a livelihood trajectory that allows rural people to improve their living conditions through income generation. Crops harvested at the irrigation plot were also consumed at home, forming part of the food expenditure. The average household's annual agriculture production value accounted for 30% of yearly food expenditure.

Contribution from crop production on the independent plot accounted for 6% of the own output. Even though it was a small fraction, this research concludes that independent irrigation contributes to food security through physical food access. When investigating the significance of irrigation in reducing poverty, a poverty headcount showed that independent irrigation enabled only a tiny fraction of the households to escape the FPL and LBPL. In conclusion, the findings show that the irrigated plot in Msinga had a minor effect on the poverty status of irrigator households when measured using this money-matrix index. As a result, these findings question small-scale irrigation's impact on poverty reduction. It also implies that agriculture alone could never alleviate poverty among rural smallholder householders, but their development requires an integrated approach, including improving assets, strategies, and resource access.

The findings also revealed that independent irrigators who use petrol pumps to extract irrigation water outperform those who collect water by hand using mostly buckets. Irrigators who pump irrigation water had higher gross revenues (per cultivated area) than non-adopters, credit to larger land sizes cultivated. Access to pumping for irrigating independent land had a positive and significant correlation with annual household income, with annual household income increasing by 0.148 (coefficient) for every unit increase in pump availability. This finding implies that physical capital investment increases the benefit of independent irrigation.

Even though the contribution is “*limited*”, independent irrigation improved Msinga irrigator households’ livelihood. With relevant interventions in supporting these irrigators, independent irrigation could be an appropriate development path for rural households with appropriate interventions.

8.3 Policy recommendations

Independent smallholder irrigators have the potential to resolve rural life concerns and may be an essential instrument for improving rural lives. However, they must first overcome certain constraints to realise their full potential. This study suggests a few recommendations for policy for the benefit of rural lives. The study explicitly recommends the following:

It is critical to establish public-private partnerships to support farmer development initiatives. The private sector should become integral to developing smallholder producers by, for example, local procurement of their inputs, equipment, and credit for smallholder irrigators.

Collective action by all relevant role players with a shared agenda of improving rural livelihoods is required. The various role-player activities and processes must be coordinated, synchronised, and integrated, and all stakeholders must be involved throughout the value chain of developing and implementing interventions. There is also a need for a transparent public-public partnership within the government. As stated in Chapter 5, government departments often support similar beneficiaries with the same intervention. One example is the Department of Rural Development and Land Reform and the Department of Agriculture (recently merged into the Department of Agriculture, Land Reform and Rural Development), continuously providing seeds or seedlings to the same smallholders or projects. This could be extended to other beneficiaries in need of assistance.

The South African government already has an extension division support for smallholder farmers. However, in the case of independent irrigators in Msinga, the study affirms that existing agricultural support programs mostly neglected independent smallholder irrigators. These programmes include but are not limited to agriculture advisory, training, input support and financial assistance. While for their counterparts, irrigation scheme irrigators, an agricultural advisor is available to a certain extent, and this is evident from several studies, including ones on the Tugela Ferry irrigation scheme, located in the current study area. The study recommends developing the independent irrigator's human capital through existing extension support. Capacity-building programs and training workshops could improve independent irrigators' human capital.

In addition, the study suggests that smallholder government initiatives be tailored to help assure sustainability. This training should enable them to augment productivity and profitability. To enhance productivity, individuals need to enrol in training programs and acquire knowledge of modern and innovative methods and strategies. Support programmes should also encourage business and financial management skills instead of a culture of dependency through the interventions such as continuous input support.

The findings highlight irrigation water issues, especially for groundwater (spring) users. Water scarcity has hampered crop production activities by irrigators in Msinga owing to frequent droughts and increasing dry spells. As a result, it is suggested that irrigation water access be identified as a critical livelihood asset nurtured among independent smallholder irrigators.

In response to these water access issues, particularly during the dry season, the study recommends that, with existing government farmer support, the government could promote water harvesting strategies for farmers far from the rivers to prepare for dry seasons. Another recommendation is that farmers use cost-effective and environmentally friendly soil and water conservation practices to maximize the benefits of crops grown on their farms. This way, instead of handing out things to farmers, we teach them alternative and affordable ways to improve their water problems.

The other issue for independent smallholder irrigators is not the availability of irrigation water but rather the ability to collect and transport it to their plots. Included in this equation is also the affordability of power. For example, the irrigators near the river lack the financial resources to obtain and manage a pump. At the same time, the findings emphasise the importance of technology in providing irrigation water to Msinga independent irrigators. According to the study findings, pumps, which appeared to be an essential physical asset for profitability in the independently irrigated operation, were out of reach for most irrigators. Irrigators without access to water pumps were unable to increase agricultural productivity. Also, a viable option is needed for those who struggle with running and maintaining pumps. This study recommends that government and other stakeholders should not resort to distributing resources whenever there is a gap. Government and other stakeholders should create an enabling environment for independent irrigators to access and operate such equipment.

For example, exploring and developing financial instruments designed to purchase pumping equipment and other necessary inputs are some possible entry points for overcoming financial constraints. Financial instruments include equipment leasing with purchase options, rural credit services, and microfinance. Access to loan capital for construction costs or linking rainwater harvesting programs to existing rural development programs can help farmers overcome the constraint of high initial investment costs for more significant investments (e.g., on-farm hand-dug wells). Another option is to rent a pump. Irrigators who cannot afford to buy a pump could rent one by the day or season from the irrigators who own them. This provides an opportunity for poor irrigators to gain access to irrigation water. This effort could be a farmer or a non-farming individual going from farm to farm with small pumps to irrigate land for a fixed fee per hour or day. Poor farmers gain access to motorised pumps, while farmers or individuals profit from renting pumping equipment and providing paid irrigation services to others. The recommendation could not work for the current study participants. Still, it is not a one-size fit, meaning it could work for

others in the same municipality who were not part of the study or for others in different municipalities. Obviously, it could also be implemented after much research is done on it.

Access to physical capital is dependent on the availability of financial assets. The study revealed that Msinga irrigator households rely heavily on social grants. These households have survived on social grants for several years, which is common among South African smallholder households. Changing this dependency mindset will not happen overnight, but it will take years to correct if done correctly. There is a need for coordinated efforts to transform the income structure of smallholders so that their livelihoods rely more on various earned incomes rather than social grants. Multiple institutions in South Africa can help with capacity building and financial assistance to expand their small businesses. Among those providing such assistance are the Small Enterprise Development Agency (SEDA), the Department of Small Business and Development (DSBD), the Small Enterprise Finance Agency (SEFA), the Industrial Development Corporation (IDC), the National Youth Development Agency (NYDA), and the National Empowerment Fund (NEF). For example, SEDA, DSBS, and SEFA collaborate on the Township and Rural Entrepreneurship Programme (TREP), which assists small businesses in rural and township areas. Also, SEDA helps with business plans to secure business funding, capacity-building training, and business branding (signboards, flyers, business cards). Lack of access to such information is the main reason why people in rural areas like Msinga do not access or do not even know the existence of such organisations. A significant constraint is a lack of knowledge, awareness, and preparedness among smallholders who participate or wish to participate in local economic activities.

This study recommends raising awareness among independent smallholder irrigators or the community about available rural enterprise development and financial services and bringing the services closer to the smallholders by opening outlets near their communities. This initiative could improve income earnings from various local economic activities while improving skills to benefit from non-agricultural income sources through training and capacity-building programs. To accomplish this, the government should include independent irrigators in existing farmer support programs (e.g., extension and advisory programs) from which they are currently primarily excluded, according to available literature (2.5.4 Resource access for independent irrigators) and the current study results. Then establish a link between various government departments, such as the Department of Agriculture, Land Reform and Rural Development, and Small Businesses and Development.

Establishing links and networks (groups) among farming communities would allow more farmers to receive support services, increasing their social capital. Irrigators identified input and travel costs to buy seeds as a constraint in this study. There is a need to reduce the high transaction and travel costs associated with input procurement. Farmers must group to address the issue of input access through collective purchasing. The government and other stakeholders could assist irrigators in realising the benefits of formal and informal collective action in their farming enterprises through cooperatives and farmer groups, organisations or associations. The government Departments (Economic Development, Tourism and Environmental Affairs, Small Business and Development, Agriculture, Land Reform and Rural Development) could collaborate in a public-public partnership to ensure the intervention's implementation and success. This collective action will help farmers access inputs and encourage the farmer-to-farmer transmission of information or knowledge about all aspects of their farming. Irrigators in the study area identified fellow farmers as an essential source of information; therefore, the study recommends that farmer-to-farmer information transmission be recognised and promoted as a necessary extension model in smallholder irrigated agriculture.

In the study area, many independent irrigators are women. Current land access rules guided by societal norms and beliefs made by traditional authorities restrict women irrigators to far smaller holdings than male-headed houses. Existing land access arrangements should prioritise women on the policy agenda. As a result, development strategies should address gender inequalities that disadvantage women. This study recommends changing existing land tenure and administration systems to respond to the willingness to farm or grow rather than gender.

8.4 Study limitations and suggested areas of further research

Snowball sampling was utilised in the study, and this sample procedure had a limitation. The rationale for using this method was the lack of information on these irrigators, even from the local office of the Department of Agriculture, which usually has information on smallholders in their area. Therefore, there were limits in generalising the research results to the whole Province or country. Nonetheless, the study can serve as a foundation for future research conducted on a bigger scale and sampled using probability methods, if possible.

This study shows that the independent irrigation phenomenon is not a one-size-fits-all phenomenon. The premise is based on the limited literature available in South Africa that portrayed these irrigators differently from what was found in the current study. The current study was restricted by financial resources and could include 101 independent irrigators sampled from a few parts of the Msinga municipality. It will be interesting to see whether the study's significant results reflect other independent smallholder irrigators in rural areas and South Africa. It would be beneficial to observe if the impact of independent irrigation on Msinga irrigator household incomes reflects the reality of most independent smallholder irrigators in South Africa. Future studies should also investigate the impact of independent irrigation on rural livelihoods. However, the first stages are recognising independent smallholder irrigation and collecting systematic data with information on irrigated areas, farmer participation, pump adoption and socio-economic indicators.

The three South African poverty lines measured poverty among the rural Msinga irrigators. Other indicators in poverty analysis that do not only consider income could be used to determine the household's poverty status. The study recommends that future research on independent irrigators should expand this analysis and consider these measures that could establish the contribution of poverty among irrigator households beyond. Future research should explicitly determine the contribution of independent irrigation to poverty using monetary and non-monetary metrics and simultaneously observe a control group for comparison. Future studies could adopt multi-dimensional index indicators for poverty analysis. This analysis will assist policymakers in looking at other areas to improve that can decrease poverty levels within irrigator households.

Chapter 1 and Chapter 2 showed the growth of pump use in other countries, so as the benefits from its use. Future research should determine whether such a situation could work in South Africa. Also, the statistics of such intervention by independent farmers are essential, including the number of private pumps used, the land irrigated by pumps and independent irrigators, bucket users, diverters or other methods users. Additionally, it could benefit both the research community and policy environment if future research could answer these questions arising from this research. The questions or concerns that require a comprehensive investigation are as follows:

- (i) Which water harvesting techniques are most appropriate at an independent irrigator level?

- (ii) Do independent irrigators who use manual (buckets) irrigation methods want to expand, or are they satisfied with what they have?
- (iii) What obstacles hinder the adoption of irrigation technologies such as pumps?
- (iv) What determines the adoption of pumping technology?
- (v) Will enterprise profitability rise if pumping technology is replicated to a larger population of independent irrigators, particularly bucket users?
- (vi) What impact would replication of pumping use have on the environment?
- (vii) What is the impact of pumps and other water extraction methods on the profitability of the independent irrigation enterprise?
- (viii) Would impoverished homes, such as Msinga's, afford the energy required to power the pumps, and how will they maintain them?
- (ix) Are solar pumps more viable for rural households than petrol or diesel pumps since they would struggle with maintenance and running costs? More importantly, can they be replicated on a bigger scale in a rural farmer?

APPENDICES

Appendix A: Ethics Approval

UNIVERSITY OF
KWAZULU-NATAL

INYUVESI YAKWAZULU-NATALI

31 October 2019

Ms S'nethemba Valencia Dube (219039837)

School of Agricultural, Earth & Environmental Sciences
Pietermaritzburg Campus

Dear Ms Dube,

Protocol reference number: HSS/0419/019D

Project title: The impact of independent smallholder irrigation on rural livelihoods in Msinga Local Municipality, KwaZulu-Natal Province, South Africa

Approval Notification - Expedited Application

This letter serves to notify you that your application received on 25 May 2019 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/Department for a period of 5 years.

This approval is valid for one year from 31 October 2019.

To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

Yours sincerely,



Professor Urmilla Bob University Dean of Research

/ms

Humanities & Social Sciences Research Ethics Committee Dr Rosemary Sibanda (Chair)

UKZN Research Ethics Office Westville Campus, Govan
Mbeki Building Postal Address: Private Bag
X54001, Durban 4000

Website: <http://research.ukzn.ac.za/Research-Ethics/>

Founding Campuses: • **Edgewood** **Howard College** Medical School • **f'letennaritzburg** • **WesMe**

INSPIRING GREATNESS

Appendix B: Livelihood survey questionnaire



THE IMPACT OF INDEPENDENT SMALLHOLDER IRRIGATION ON RURAL LIVELIHOODS IN MSINGA LOCAL MUNICIPALITY, KWAZULU-NATAL PROVINCE, SOUTH AFRICA.

Notes to enumerator:

- *The field interview number should consist of the initials of the enumerator followed by the interview number in the order it was conducted by the enumerator. For example SVD1 is the first interview conducted by Snethemba Valencia Dube, SVD2, the second by her, etc.*
- *The questionnaire number is a three digit number. For example, the first interview will have questionnaire number 001, followed by 002, etc.....*

Field Interview No.

Questionnaire No.

1. QUESTIONNAIRE INFORMATION

Name(s) of interviewer(s)	
Date of interview	
Location of household	
• Ward	
• Village	
• GPS coordinates Home	S E (decimal degrees)
• GPS coordinates Plot (field)	S E (decimal degrees)
Time of interview	[:] to [:]

2. DEMOGRAPHIC DETAILS OF THE HOUSEHOLD

Note to enumerator: first fill in columns 2 and 3 (first name and relation to HoH. Once these are completed, fill in each row in sequence.

2.1 Who is part of the household? Please can you provide information on your household composition?

No	First name	Relation to head of household	Age	Gender	Marital status	Occupation ²	Education level ³	Availability for labour(<i>days per week</i>)
1								
2								
3								
4								
5								
6								
7								

³ School grade + (no. of years in tertiary study i.e. if less than a degree equivalent then enter years in study, Degree/National Diploma = 3, Hons=4, Masters=5, PhD=6)

8								
9								
10								
11								
12								

Head of household first Head=1 Age in years Female=1 Single=1 Fulltime farmer=1 Grade no If zero, indicate reason

 Father=2 Male=2 Married=2 Reg. salaried job=2 Tertiary qualification
 Mother=3 Divorced=3 Temporary job=3

 Grandfather=4 Widowed=4 Unemployed⁴=4
 Grandmother=5 Cohabit=5 Retired=5
 Child=6 Student=6
 Grandchild=7 Child (<15 years old)
 Other (specify)

⁴ When dealing with the unemployed under occupation, distinguish between those actively seeking work (A) and those who are not (N)

3. SOURCES OF INCOME

Note to enumerator: Consult information on household members provided in 2.1 to probe about possible sources of income

3.1 Income from employment (salaries, wages, private pensions, etc.)

For each of the members of your household who was employed during the previous year, could you please inform us of their gross earnings?

Source	Cycle (e.g. week, month, year)	Income per cycle (R)	Income per annum (R) ⁵	Comments
Salaries or wages				
Other (specify)				

3.2 Income from remittances

During the previous year, did you or other members of your household who are permanently residing here at home receive any income support, child support, durable goods or food from members of your household who are residing elsewhere or from friends or relatives? **Yes** **No**

If yes, could you provide details please?

⁵ Income per annum – to be completed after the interview

Source	Cycle (e.g. week, month, year)	Income per cycle (R)	Income per annum (R)
Remittances (Cash)			
Remittances (in Kind) ⁶			
Child support from parent outside household			
Other (specify)			

3.3 Income from social grants⁷

During the previous year, did you or other members of your household who are permanently residing here at home receive any income support in the form of old-age pension, disability grants, child support grants, bursaries or other social grants? **Yes** **No**

If yes, could you provide details please?

Source	Cycle (e.g. week, month, year)	Income per cycle (R)	Income per annum (R)
Pensions (old age)			
Disability grant			
Child support grant			
Bursary			
Other government grants			
Other (specify)			

⁶ Specify the broad group (e.g., furniture, food, clothing, etc.)

⁷ Check pg 1 and compare if all who are eligible do in fact get grants. If not, enquire why and make a note).

3.4 Income from trading (buy and sell activity)

During the previous year, did your household earn any income by **trading**? Yes No

If Yes, what types of trade did you practise and what **net income** was derived from this activity? (e.g. *Vending (food, vegetables, other goods)*, *Vending (other)*, *Spaza shop*, *Shop*, *Shebeen*, *Tavern*, *Lending money*).

Type of trade	Cycle (e.g. week, month, year)	Income per cycle (R)	Income per annum (R)

3.5 Income from making goods for sale

During the previous year, did your household earn any income by **producing and selling goods**?
Yes **No**

If Yes, what type of goods did your household produce and sell what **net income** was derived from this? (e.g. *Brick making, Sewing and selling clothing, Preparing and selling traditional medicines, Making shoes, Making glasses, Brooms and baskets, Furniture making, Plumbing, Arts and craft, Traditional beer, Making candles, etc.*)

Goods produced and sold	Cycle <i>(e.g. week, month,..)</i>	Income per cycle (R)	Income per annum (R)

3.6 Income from service provision⁸

During the previous year, did your household earn any income by **provision of services**? **Yes**
No

If Yes, what type of services did your household provide, and what **net income** was derived from this activity? (e.g. *Tractor services, Building houses, Cleaning, Car wash, Day care, Making toilets, Renting of rooms, Repairs, Hair dressing, Electrical installation, ...*)

Type of service	Cycle <i>(e.g. week, month, year)</i>	Income per cycle (R)	Income per annum (R)

⁸ Important to give examples and explain to people what you mean and are looking for information about

3.7 Income from farming

3.7.1 Which of the following choices best describes the purpose of farming (**Including all farming practices, e.g. home gardening, animal rearing etc.....**) that your household is practicing? (*Tick only one that predominates*)

As an extra source of food=1

As the main source of food=2

As an extra source of monetary income=3

As the main source of monetary income=4

As a leisure activity or a hobby=5

4. SAVINGS AND LOANS

4.1 Savings

4.1.1 At present, how much money does your household save in formal and informal ways?

- *Formal institutions include all registered financial service providers, such as banks and insurance companies that sell policies and plans).*
- *Informal savings vehicles include local burial societies and stokvels)*

Formal institution	Amount per month (R)	Total amount per annum (R)

Informal institution		

4.2. Loans and debt

4.2.1 During the previous year, did your household borrow any money from people or lending institutions? *Yes=1 No=0*

If Yes, please specify the institution that lent you the money, the reason for the loan, the duration of the repayment period and the instalment amount per cycle (e.g. Rand per week or Rand per month).

Formal sources (registered financial service provider)	Loan amount (R)	Reason for loan	Repayment period	Instalment amount per cycle (specify cycle)
Informal sources (e.g. money lenders, savings clubs)				

4.2.2 During the previous year, did your household have accounts with furniture, clothing or other types of stores? *Yes=1 No=0*

If Yes, please specify the type of store, the type of goods purchased on account, and the monthly instalment amount that applied.

Type of store	Type of good(s) purchased on account	Monthly instalment amount (Rand)

5. HOUSEHOLD ASSETS

5.1 Does your households own any of the assets in the table below? (*Indicate number owned in the appropriate box, zero if not owned*)

Asset	Own <i>Yes=1 No=0</i>	Number
Bed		
Dining room suite		
Lounge suite		
Refrigerator		
Kitchen units		
Stove (electric)		
Stove (gas)		
Stove (paraffin)		
Solar-electric panel/battery		
Generator		
Cell phone		
Computer or laptop		

TV		
DVD player		
Radio (hand-held radio)		
Bicycle		
Motorbike		
Car		
Van (bakkie)		
Truck (>1.5 ton load capacity)		
Other (specify)		
Other specify		

6. MEMBERSHIP TO GROUPS AND SOCIAL NETWORKS

6.1. What groups/organizations/associations are you either a member of your household affiliated with?

Type of institution	Member <i>Yes=1 No=0</i>	Any fee (Rands)	Description of activities
Farmers' association			
Farmers' cooperative			
Other farm-related group (specify)			
Water Users Association			
Professional organisation (specify)			
Village committee			
Burial society			
Credit or saving group			
Other group or association (specify)			

6.2 Please tick the appropriate box indicating the likelihood of receiving assistance in time of need.

6.2.1 When an emergency arises and I need money urgently, my family will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.2 When an emergency arises and I need money urgently, my friends will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.3 When an emergency arises and I need money urgently, my neighbours will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.4 When an emergency arises and I need money urgently, the group I am a member of will assist me.

(State the name of the group(s) in cases where the response is neutral to strongly agree)

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.5 When an emergency arises and I need food, my family will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.6 When an emergency arises and I need food, my friends will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.7 When an emergency arises and I need food, my neighbours will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.8 When an emergency arises and I need food, the group I am a member of will assist me.

(State the name of the group(s) in cases where the response is neutral to strongly agree)

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.9 When an emergency arises and I need additional labour, my family will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.10 When an emergency arises and I need additional labour, my friends will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.11 When an emergency arises and I need additional labour, my neighbours will assist me.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

6.2.12 When an emergency arises and I need additional labour, the group I am a member of will assist me.

(State the name of the group(s) in cases where the response is neutral to strongly agree)

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	2	3	4	5

7. HOUSEHOLD EXPENDITURE

7.1. On average, how much does your household spend on the following items per month?

Expenditure item	Average amount per month (Rands)
1. Groceries (incl. all items)	
1.1 What proportion of groceries expenditure is for <u>food</u>	
2. Housing/Rent	
3. Electricity	
4. Water	
5. Transport (incl. all vehicle/fuel costs)	
6. Education (incl. fees, books, student support, transport)	
7. Medical expenses	
8. Clothes	
9. Furniture	
10. Remittances	
11. Entertainment (includes liquor, tobacco)	

8. HOUSEHOLD WELLBEING

8.1. Please indicate the household source of energy for cooking (tick)

Source	Electricity	Gas	Coal/Paraffin	Dung	Wood
	1	2	3	4	5

8.2. Please indicate the household source of water (tick)

Source	Piped in dwelling	Piped on premises	Public tap	Borehole	Open source (dam, river)	Roof water tanks
	1	2	3	4	5	6
Other (specify)						

8.3. Please indicate the type of dwelling in which the household resides and write the number of rooms in the appropriate space

Dwelling type	Brick house (any roof type)	Soil brick and corrugated iron roof	Traditional house (mud walls and thatch or corrugated iron roof)	Zinc or wooden shack	Other (describe)
Number of rooms					

8.4. Please indicate the presence of outbuildings, their function and their number

Function of outbuilding	Number

8.5. Please indicate the type of toilet your household has (tick)

Toilet type	Water borne sewerage	French drain (Flushing toilet)	Enclosed pit latrine	Open pit	The veld
	1	2	3	4	5

8.6 Which statement best describes the food situation in your household? (tick)

Never enough	Not enough most of the time	Enough half of the time	Enough most of the time	Always enough
1	2	3	4	5

8.7 On average, how often **per week** does your household eat the following types of food?

Food type	Frequency	Source of the food¹
Main staples (maize, maize porridge, rice, sorghum, pasta, bread and other cereals)		
Pulses (beans, peas, groundnut and cashew nuts)		
Vegetables (all vegetables)		
Fruits (all fruits)		
Animal products (beef, goat, poultry, pork, eggs, fish, etc.)		
Milk (milk, yoghurt and other dairy)		
Sugar (sugar and sugar products, honey etc.)		
Oil (oils, fats and butter etc.)		

1. **Food source codes:** Purchase=1 Own production=2 Traded goods=3 Borrowed=4 received as gift=5 other (specify) =6

8.8 Have your household experienced any money shortages to hinder purchase/access to food?

8.9 Do all members of your household get two square meals (enough food) a day all year round?
Yes=1 No=0

8.10 If not, which calendar month did you and your family not have two square meals per day?
 (Write a 1 for a month this occurred)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

8.11 Have your household been exposed to any of the shocks in the past year? If yes, how did you cope or respond?

Vulnerability issues	<i>Yes=1</i> <i>No=0</i>	Response to cope with issue
High food prices		
Reduced income		
Serious illness/accident		
Lack of employment		
Unavailability of food		
Loss of employment		
Death of working adult		
Human disease		
Theft of money/valuables		
Theft of animals		
Any other (specify)		
Any other (specify)		
Any other (specify)		



THE IMPACT OF INDEPENDENT SMALLHOLDER IRRIGATION ON RURAL LIVELIHOODS IN MSINGA LOCAL MUNICIPALITY, KWAZULU-NATAL PROVINCE, SOUTH AFRICA.

Notes to enumerator:

- *The field interview number should consist of the initials of the enumerator followed by the interview number in the order it was conducted by the enumerator. For example SVD1 is the first interview conducted by Snethemba Valencia Dube, SVD2, the second by her, etc.*
- *The questionnaire number is a three digit number. For example, the first interview will have questionnaire number 001, followed by 002, etc.....*

Field Interview No.

Questionnaire No.

1. QUESTIONNAIRE INFORMATION

Name(s) of interviewer(s)	
Date of interview	
Location of household	
• Ward	
• Village	
• GPS coordinates Home	S E (decimal degrees)
• GPS coordinates Plot (field)	S E (decimal degrees)
Time of interview	[:] to [:]

In this household, who makes the decisions on farming, specifically the independently irrigated plot? (in relation to head of household)

Note to enumerator: Ask the following questions from the person identified

--

1. IRRIGATOR DEMOGRAPHICS

Question	Response
Gender of irrigator <i>1 = male 2 = female</i>	
Marital status of irrigator <i>1 = Single 2 = Married 3 = Divorced 4 = Widowed 5 = Cohabiting</i>	
Age of irrigator (<i>years</i>)	
Relationship of the irrigator with the household head <i>1 = self 2 = spouse 3 = child 4 = relative 5 = other (please specify)</i>	
Level of education of farmer (<i>highest grade attained</i>)	
Main occupation <i>1 = Fulltime farmer 2 = Regular salaried job 3 = Temporary job 4 = Unemployed 5 = Self-employed 6 = Student</i>	
7.1 How many years have you been operating your farm? (<i>years</i>)	
Where applicable, how many years have you been using irrigation on your farm?	
Where did you learn how to farm?	

2. LAND AND WATER

2.1 Please provide us with the following information on the different types of land you have access to and the water you use for irrigation, if any:

Type of land	Type of access ¹	Total area of the land (m ²)	Area cultivated The previous year (m ²)	Was any irrigation used? (Yes or No)	If yes, fill in the details in each column where applicable					
					Source(s) of water ²	Distance to source(s) (m)	Method of collection or extraction ³	Method of conveyance ⁴	Application method ⁵	Level of irrigation ⁶
Residential plot										
Dryland plot 1										
Dryland plot 2										
Dryland plot 3										
Irrigation plot 1										
Irrigation plot 2										
Irrigation plot 3										
Other (specify)										

¹Coding for access

1 = ownership (indicates that land is registered in the name of (someone in) the household irrespective of tenure system)

2 = unconditional usufruct (ownership lies with a person outside the household, who has given the household user rights without stipulating compensation)

3 = renting in of land (ownership is with a person outside the household and access to land is subject to the payment of a fee to that person)

4 = sharecropping (ownership is with a person outside the household and access to land is subject to a sharing agreement)

² Record the source(s) of water, which could be the roof, standpipe, tap on site, river (direct extraction), canal, groundwater, etc.

³ Record how water is obtained from the source (pumped, diverted, etc. Write 'collected' in case of roof water, tap water, small on-site storage structures and livestock dams)

⁴ Record how water is brought from source to plot (carried, wheelbarrow, piped, gravitated, etc)

⁵ Record how water is applied to the soil (bucket, watering can, hosepipe, surface irrigation, sprinkler, drip, micro-sprayer, etc)

⁶ Select one of three options: 1=only during sensitive stages (e.g. seedling establishment) and extreme water stress; 2 = full irrigation throughout the season; 3 = in between 1 and 2

2.2 How do you rate the adequacy of your current land holding (*tick the appropriate box*)

Way too small	Somewhat small	Exactly right	Somewhat big	Way too big
1	2	3	4	5

2.3 Generally, are you satisfied with the present security of ownership of your own land?

1=Strongly dissatisfied 2=Dissatisfied 3=Neutral 4=Satisfied 5=Strongly satisfied

a) Dryland..... b) Irrigated.....

2.4 Do you find it difficult to make land use decisions due to the land tenure system?

Yes=1 No=0

If yes, please give details

2.5 On average how many days per week do you irrigate your crops? (***Indicate number***)

2.6 What are the average irrigation hours per day?

2.7 Do you pay for water used for irrigation (cross)? *Yes=1 No=0*

If Yes, please specify amount paid (rands) per month/season/year?

2.8 How do you rate the adequacy of your access to water? (*tick the appropriate box*)

Never enough	Rarely enough	Mostly enough	Always enough
1	2	3	4

3. PHYSICAL ASSETS USED IN AGRICULTURE

3.1 How many of each of the following farm implements/farm equipment does your household own?

Implement/equipment/fixed assets	Own Yes=1 No=0	No owned	Implement/equipment/fixed assets	Own Yes=1 No=0	No owned
Hand hoe			Tractor-drawn plough		
Spade			Tractor-drawn disk		
Rake			Tractor-drawn ridger		
Knapsack sprayer			Tractor-drawn planter		
Wheelbarrow			Tractor-drawn cultivator or tine implement		
Cattle			Tractor-drawn trailer		
Horses			Irrigation pump		
Donkeys			Irrigation pipes		
Animal-drawn plough			Irrigation system (specify)		
Animal-drawn harrow			Bakkie/truck		
Animal-drawn ridger			Poultry production facility		
Animal-drawn planter			Farm shed (used to store farm-related assets)		
Animal-drawn cultivator			Grain storage facility (describe)		
Animal-drawn cart			Grain mill		
Tractor			Water storage facility (specify)		

3.2 How do you rate the adequacy of your farming implements, equipment and infrastructure (*tick the appropriate box*)

Inadequate (lacks what is needed)	Adequate (has what is needed but no excess)	Excessive (has more than is needed)
1	2	3

4. AGRICULTURE PRODUCTION, MARKETS AND LABOUR

4.1 All animal enterprises

4.1.1 Which types of livestock did you keep during previous year? (*Indicate number owned in the appropriate box, zero if not owned. Complete table below*)

Livestock	Total no of animals	No of animals consumed/given away	No of animal sold	Value (Rands)	Expenses (Feed, labour, medicine etc)
Cattle					
Goats					
Chickens					
Pigs					
Other (specify)					
Other (specify)					
Other (specify)					

4.1.2 Which products were derived from animal husbandry?

Product	Total obtained	Units	No consumed	No sold	Price/unit
Eggs					
Milk					
Fertiliser					
Other (specify)					

4.1.3 For each livestock species and product that was sold, indicate the markets used in order of importance (1= most important market; 2 = second most important market etc. Cover all markets used accordingly).

Livestock species	Direct to local consumers	Direct to consumers elsewhere (implies transportation)	Street traders (operate on foot)	Bakkie traders (operate using a van)	Shops or supermarkets	Other (specify)

4.2 All crop enterprises

Note to enumerator: List all the crops grown during the previous year on each type of land in the table below. Then for each type of land that was used to produce crops, do an enterprise budget for each crop that was produced on that land.

4.2.1 Which crops did you grow during the previous year on the different types of land you used for crop production?

Residential land	Dryland plot(s)	Independent irrigated plot	Other irrigated plot (e.g. scheme)

4.2.2 For each crop grown the previous year, please fill in the income statement attached at the end of this questionnaire (*indicate the name of the farmers and the interview reference number on top of each*)

4.2.3 For each crop that was sold, indicate the markets used in order of importance (1= most important market; 2 = second most important market etc. Cover all the markets that were used accordingly).

Crop	Direct to local consumers	Direct to consumers elsewhere (implies transportation)	Street traders (operate on foot)	Bakkie traders (operate using a van)	Shops or supermarkets	Other (specify)

4.2.4 How often do you go to the market?days a week/month/season

4.2.5 Did you sell your produce collectively as a group or individually?

4.2.6 What is the distance from your household to the nearest market?Minutes

4.2.7 Is the transportation available to reach the market (*specify the type available to access the market*)?

4.2.8 Do you employ labour outside family? *Yes=1 No=0*

If yes, please complete the table for each crop and operation on the independently irrigated plot?

Crop	Ploughing/ Land preparation		Planting		Weeding		Fertilizer application		Irrigation		Pest control		Harvesting		Packaging		Marketing	
	Days	People	Days	People	Days	People	Days	People	Days	People	Days	People	Days	People	Days	People	Days	People

4.2.9 On average how much did you pay your hired labour per day?

	Ploughing/ Land preparation	Planting	Weeding	Fertilizer application	Irrigation	Pest control	Harvesting	Packaging	Marketing
Rands per day									

5. SOCIAL CAPITAL

5.1 Can you rank the following sources of information relevant for your farming activities, based on how you have used them in the past year (e.g. where to sell, market prices, etc...)

Unimportant=1 Moderately unimportant=2 Neutral=3 Important =4 Very important=5

Information Source	Rank of source of information
Extension officers	
Media (newspapers, radio, TV)	
Internet (emails, websites, etc.)	
Fellow farmers	
Community meetings	
Irrigation farming committees	
Cooperative leaders	
Traditional leaders	
Non-governmental organisations (NGOs)	
Private organisations	
Phone (sms, text)	
Other (Please specify)	

6. SUPPORT SERVICES

6.1 Have you ever received any of the following types of assistance in support of your farming enterprise?

Support service	<i>Yes=1 No=0</i>	If Yes, which agency provided the service	Were you satisfied with the service? (<i>Yes=1 or No=0</i>)
Production advice			
Production training			
Irrigation advice			
Irrigation training			
Marketing advice			
Marketing training			
Business advice			
Business training			
Financial advice			
Financial training			
Farm equipment grant			
Farm equipment loan			
Farm production grant			
Farm production loan			
Farm inputs free of charge			

7. VULNERABILITY

7.1 Have you experienced any of these shocks in the past two year? If so, how did you respond/cope?

Vulnerability issues	<i>Yes=1 No=0</i>	Response to cope with issue
Drought/irregular rains		
Floods		
Hailstorm		
Crop pests and diseases		
Crop failure		
High input costs		
Livestock diseases		
Landslides/erosion		
Land eviction by.....		
Any other (specify)		
Any other (specify)		
Any other (specify)		

7.2 To what extent do the following constraints apply to your farming operation?

Never =1 Rarely=2 Sometimes=3 Most of the time=4 Always =5

Constraints	Response
Lack of capital	
Insufficient land	
Lack of access to inputs	
Large unaffordable increase in input prices	
Production below normal	
Declining market prices for outputs	
Increasing food prices	
Land tenure not secure	
Local and political conflict	
Lack of support services	
High pump and maintenance cost	
Water availability	
Other (specify)	
Other (specify)	
Other (specify)	
Other (specify)	
Other (specify)	

CROP ENTERPRISE BUDGET

Farmer: Interview reference no:

Commodity	Income + expenses	Unit	Quantity	Cost per unit	Total cost
	1 Area planted (use m ² or ha)				
	2 Land preparation (Rand)				
	3 Fertilisers (Rand)				
	4 Seed (Rand)				
	5 Agrochemicals (Rand)				
	6 Water (Rand)				
	7 Labour ¹ (Rand)				
	8 Pumping (Rand)				
	9 Other costs (specify) (Rand)				
	10 Rand value of crop harvest ² (Rand)				
	11 Rand value of sales ⁴ (Rand)				
	12 Rand value of consumption (Rand)				
	1 Area planted (use m ² or ha)				
	2 Land preparation (Rand)				
	3 Fertilisers (Rand)				
	4 Seed (Rand)				

	5 Agro-chemicals (Rand)				
	6 Water (Rand)				
	7 Labour ¹ (Rand)				
	8 Pumping (Rand)				
	9 Other costs (specify) (Rand)				
	10 Rand value of crop harvest ² (Rand)				
	11 Rand value of sales ⁴ (Rand)				
	12 Rand value of consumption (Rand)				

² To estimate the Rand value of the harvest, identify a suitable unit of quantity (e.g. bunch or 20L bucket or bag) of which the Rand value is known, and then obtain the number of these units that were harvested.

⁴ Rand value of sales and Rand value of consumption must add up to Rand value of crop harvest

Appendix D: Focus Group Discussion Themes

- Why do you farm (and irrigate) independently? How important is this compared to other sources of income?
- How was your independently irrigated plot funded?
- What type of technology do you use to extract irrigation water? If not using a pump, what is the reason for not using a pump or other technology that is not labour-intensive?
- Since you have started the independent irrigated plot, how has it impacted your livelihoods?
- What are the challenges that you face in farming? Natural hazards? How do you cope with these challenges?
- What are challenges with institutional arrangements on land and water access?
- Have you ever experienced any conflicts related to water use? What were the points of conflict?
- What are the challenges faced when marketing?
- Who are the individuals or organisations (stakeholders) that are linked to your independently irrigated land? This includes but is not limited to offering support services, determining access to resources (e.g. land, water etc.)?
- What is their role in the independently irrigated enterprise?
- What interest do they have on the outcome of your independent irrigated plot?
- What opportunities and challenges do these stakeholders present?
- Do they have influence in any decision you make regarding the independent plot (e.g. traditional authority on land access) how?

Appendix E. **Human capital continuous variables characteristics, SPSS descriptive statistics result** from the survey

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Household size	101	16.00	1.00	17.00	5.5941	2.69139	7.244
Number of economically active adults (15-64 years)	101	7.00	.00	7.00	3.0792	1.67740	2.814
Number of aged adults (≥65 years)	101	3.00	.00	3.00	.3564	.62585	.392
Number of children (<15 years)	101	10.00	.00	10.00	2.1584	1.79851	3.235
Number of household members who completed secondary education	101	4.00	.00	4.00	.9208	.98674	.974
Number of household members who completed tertiary education	101	2.00	.00	2.00	.0396	.24169	.058
Number of household members who are in school	101	6.00	.00	6.00	2.1089	1.53558	2.358
Age of head of household (years)	101	60.00	27.00	87.00	54.3762	10.73951	115.337
Age of irrigator (years)	101	69.00	18.00	87.00	52.9604	11.93057	142.338
Formal education of irrigator (years)	101	12.00	.00	12.00	2.2673	3.78389	14.318
Farming experience (years)	101	53.00	1.00	54.00	17.7525	11.77489	138.648
Irrigation experience (years)	101	53.00	1.00	54.00	17.7525	11.77489	138.648
Valid N (listwise)	101						

Appendix F. **Human capital categorical variables**, SPSS frequency statistics results from the survey

Gender of the head of household					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	42	41.6	41.6	41.6
	Male	59	58.4	58.4	100.0
	Total	101	100.0	100.0	
Gender of farmer					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	37	36.6	36.6	36.6
	Female	64	63.4	63.4	100.0
	Total	101	100.0	100.0	
Marital status					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	41	40.6	40.6	40.6
	Married	23	22.8	22.8	63.4
	Widowed	2	2.0	2.0	65.3
	Cohabiting	35	34.7	34.7	100.0
	Total	101	100.0	100.0	
Relationship of irrigator to the household head					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Self	85	84.2	84.2	84.2
	Spouse	7	6.9	6.9	91.1
	Child	9	8.9	8.9	100.0
	Total	101	100.0	100.0	

Appendix G. Household labour vs Household size, SPSS Spearman's correlations result from the survey

		Household size	Number of household members working on the farm	
Spearman's rho	Household size	Correlation Coefficient	1.000	
		Sig. (2-tailed)	.	
		N	101	
	Number of household members working on the farm	Correlation Coefficient	.286**	1.000
		Sig. (2-tailed)	.004	.
		N	101	101
**. Correlation is significant at the 0.01 level (2-tailed).				

Appendix H: Number of economically active adults vs labour, SPSS Pearson correlation results from the survey

		Number of economically active adults (15-64 years)	Number of aged adults (≥65 years)	Number of children (<15 years)	No household members who contribute to labour on the farm
Number of economically active adults (15-64 years)	Pearson Correlation	1	-.037	.135	.435**
	Sig. (2-tailed)		.716	.178	.000
	N	101	101	101	101
Number of aged adults (≥65 years)	Pearson Correlation	-.037	1	.029	.094
	Sig. (2-tailed)	.716		.771	.348
	N	101	101	101	101
Number of children (<15 years)	Pearson Correlation	.135	.029	1	-.027
	Sig. (2-tailed)	.178	.771		.788
	N	101	101	101	101
No of household members who contribute to labour on the farm	Pearson Correlation	.435**	.094	-.027	1
	Sig. (2-tailed)	.000	.348	.788	
	N	101	101	101	101
**. Correlation is significant at the 0.01 level (2-tailed).					

Appendix I. Farming experience vs age of the irrigator, SPSS Pearson correlation results from the survey

		Farming experience (years)	Age of irrigator (years)
Farming experience (years)	Pearson Correlation	1	.540**
	Sig. (2-tailed)		.000
	N	101	101
Age of irrigator (years)	Pearson Correlation	.540**	1
	Sig. (2-tailed)	.000	
	N	101	101
**. Correlation is significant at the 0.01 level (2-tailed).			

Appendix J: Natural capital indicators, SPSS descriptive statistics results from the survey

	N	Minimum	Maximum	Mean	Std. Deviation
Total area (m2)	101	41.00	12277.00	762.5050	1587.54465
Cultivated area (m2)	101	.00	12277.00	538.4356	1380.01981
Cropping intensity (%)	101	.00	100.00	60.0990	29.96381
Distance from source to plot (m)	101	1.00	709.00	118.2277	145.47288
No of irrigation days per week	101	1.00	6.00	2.8119	1.11097
Average irrigation (hours) per day	101	1.00	9.00	5.1584	2.33552
Amount paid (year)	101	.00	.00	.0000	.00000
Valid N (listwise)	101				

Appendix K. Comparison of land sizes between males and females, SPSS T-test results from the survey

Group Statistics					
	Gender of farmer	N	Mean	Std. Deviation	Std. Error Mean
Total area (m2)	Male	37	427.6486	497.35552	81.76474
	Female	64	956.0938	1937.83336	242.22917

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Total area (m2)	Equal variances assumed	3.956	.049	-1.625	99	.107	-528.44510	325.20899	-1173.73029	116.84008
	Equal variances not assumed			-2.067	76.438	.042	-528.44510	255.65689	-1037.58276	-19.30744

Appendix L. Financial capital indicators, SPSS descriptive statistics results from the survey

	N	Minimum	Maximum	Mean	Std. Deviation
Salaries & Wages (R)	101	.00	174000.00	7699.0099	28388.69668
Remittances (R)	101	.00	48000.00	2973.8614	7413.04026
Old age grant (R)	101	.00	64080.00	10897.4257	15544.56038
Child grant (R)	101	.00	60480.00	11729.1089	10752.71855
Other grants (R)	101	.00	21360.00	1691.8812	5797.31674
Regular flows of income total (R)	101	.00	196320.00	34991.2871	33645.95505
Trading (R)	101	.00	120000.00	2291.8812	14521.87927
Making and selling goods (R)	101	.00	60000.00	1104.9505	6360.41471
Service provision (R)	101	.00	60000.00	665.3465	5993.93753
Other flows of income ex agric total (R)	101	.00	120000.00	4062.1782	16879.02601
Savings total-Formal (R)	100	.00	124320.00	2537.7600	14304.03076
Saving-Informal (R)	101	.00	30000.00	1237.6634	3233.73930
Total savings (R)	101	.00	124320.00	3750.2970	15280.38390
Insurances total (R)	101	.00	2280.00	46.3366	280.38446
Loans total (R)	101	.00	3000.00	164.3564	550.92362
Valid N (listwise)	100				

Appendix M. Physical capital indicators (animal related), SPSS frequency statistics results from the survey

Donkeys					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	97	96.0	96.0	96.0
	Yes	4	4.0	4.0	100.0
	Total	101	100.0	100.0	
Animal-drawn plough					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	97	96.0	96.0	96.0
	Yes	4	4.0	4.0	100.0
	Total	101	100.0	100.0	
Animal-drawn ridger					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0
Animal-drawn cultivator					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0

Appendix N. **Physical capital indicators, SPSS frequency statistics results** from the survey

Tractor					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	100	99.0	99.0	99.0
	Yes	1	1.0	1.0	100.0
	Total	101	100.0	100.0	
Irrigation pump					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	72	71.3	71.3	71.3
	Yes	29	28.7	28.7	100.0
	Total	101	100.0	100.0	
Irrigation pipes					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	68	67.3	67.3	67.3
	Yes	33	32.7	32.7	100.0
	Total	101	100.0	100.0	
Farm shed					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	100	99.0	99.0	99.0
	Yes	1	1.0	1.0	100.0
	Total	101	100.0	100.0	
Grain storage facility					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0
Grain mill					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0

Appendix O. Msinga household strategies (activities), SPSS frequency statistics results from the survey

Salaries & Wages (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	90	89.1	89.1	89.1
	Yes	11	10.9	10.9	100.0
	Total	101	100.0	100.0	
Remittances (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	81	80.2	80.2	80.2
	Yes	20	19.8	19.8	100.0
	Total	101	100.0	100.0	
Old age grant (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	61	60.4	60.4	60.4
	Yes	40	39.6	39.6	100.0
	Total	101	100.0	100.0	
Child grant (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	17	16.8	16.8	16.8
	Yes	84	83.2	83.2	100.0
	Total	101	100.0	100.0	
Other grants (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	93	92.1	92.1	92.1
	Yes	8	7.9	7.9	100.0
	Total	101	100.0	100.0	
Other grants (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	93	92.1	92.1	92.1
	Yes	8	7.9	7.9	100.0
	Total	101	100.0	100.0	
Trading (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	93	92.1	92.1	92.1
	Yes	8	7.9	7.9	100.0

	Total	101	100.0	100.0	
Making and selling goods (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	93	92.1	92.1	92.1
	Yes	8	7.9	7.9	100.0
	Total	101	100.0	100.0	
Service provision (R)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	98	97.0	97.0	97.0
	Yes	3	3.0	3.0	100.0
	Total	101	100.0	100.0	

Appendix P. Purpose of farming, SPSS frequency statistics results from the survey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extra source of food	5	5.0	5.0	5.0
	Main food source	44	43.6	43.6	48.5
	Extra monetary income source	25	24.8	24.8	73.3
	Main source of monetary income	14	13.9	13.9	87.1
	Leisure or hobby	13	12.9	12.9	100.0
	Total	101	100.0	100.0	

Appendix Q. Social capital indicators, SPSS frequency distributions results from the survey

Farmers' association (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	99	98.0	98.0	98.0
	Yes	2	2.0	2.0	100.0
	Total	101	100.0	100.0	
Farmers cooperative (yes=1 no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	99	98.0	98.0	98.0
	Yes	2	2.0	2.0	100.0
	Total	101	100.0	100.0	
Other farm related group (yes=1 no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0
Water user association (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0
Professional organisation (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0

(continued)

Village committee (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	101	100.0	100.0	100.0
Burial society (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	81	80.2	80.2	80.2
	Yes	20	19.8	19.8	100.0
	Total	101	100.0	100.0	
Credit or saving group (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	77	76.2	76.2	76.2
	Yes	24	23.8	23.8	100.0
	Total	101	100.0	100.0	
Other group or association (yes=1; no=0)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	98	97.0	97.0	97.0
	Yes	3	3.0	3.0	100.0
	Total	101	100.0	100.0	

Appendix R. Rating importance of source of information among Msinga independent irrigators, results from the survey

Extension officers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	65	64.4	64.4	64.4
	Neutral	3	3.0	3.0	67.3
	Important	14	13.9	13.9	81.2
	Very important	19	18.8	18.8	100.0
	Total	101	100.0	100.0	
Media (newspapers, radio, TV)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	53	52.5	52.5	52.5
	Moderately important	14	13.9	13.9	66.3
	Neutral	5	5.0	5.0	71.3
	Important	23	22.8	22.8	94.1
	Very important	6	5.9	5.9	100.0
	Total	101	100.0	100.0	
Internet (emails, websites, etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	87	86.1	86.1	86.1
	Moderately important	7	6.9	6.9	93.1
	Neutral	4	4.0	4.0	97.0
	Important	2	2.0	2.0	99.0
	Very important	1	1.0	1.0	100.0
	Total	101	100.0	100.0	
Fellow farmers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	2	2.0	2.0	2.0
	Moderately important	4	4.0	4.0	5.9
	Neutral	5	5.0	5.0	10.9
	Important	33	32.7	32.7	43.6
	Very important	57	56.4	56.4	100.0
	Total	101	100.0	100.0	
Community meetings					

		Frequenc y	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	46	45.5	45.5	45.5
	Moderately important	9	8.9	8.9	54.5
	Neutral	13	12.9	12.9	67.3
	Important	30	29.7	29.7	97.0
	Very important	3	3.0	3.0	100.0
	Total	101	100.0	100.0	
Irrigation / Scheme committees					
		Frequenc y	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	67	66.3	66.3	66.3
	Moderately important	6	5.9	5.9	72.3
	Neutral	17	16.8	16.8	89.1
	Important	9	8.9	8.9	98.0
	Very important	2	2.0	2.0	100.0
	Total	101	100.0	100.0	
Cooperative leaders					
		Frequenc y	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	71	70.3	70.3	70.3
	Moderately important	11	10.9	10.9	81.2
	Neutral	9	8.9	8.9	90.1
	Important	10	9.9	9.9	100.0
	Total	101	100.0	100.0	
Traditional leaders					
		Frequenc y	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	79	78.2	78.2	78.2
	Moderately important	10	9.9	9.9	88.1
	Neutral	9	8.9	8.9	97.0

	Important	2	2.0	2.0	99.0
	Very important	1	1.0	1.0	100.0
	Total	101	100.0	100.0	
Non-governmental organisations (ngos)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	81	80.2	80.2	80.2
	Moderately important	9	8.9	8.9	89.1
	Neutral	3	3.0	3.0	92.1
	Important	8	7.9	7.9	100.0
	Total	101	100.0	100.0	
Private organisations					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	81	80.2	80.2	80.2
	Moderately important	7	6.9	6.9	87.1
	Neutral	8	7.9	7.9	95.0
	Important	3	3.0	3.0	98.0
	Very important	2	2.0	2.0	100.0
	Total	101	100.0	100.0	
Phone (sms, text)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unimportant	71	70.3	70.3	70.3
	Important	2	2.0	2.0	72.3
	Very important	28	27.7	27.7	100.0
	Total	101	100.0	100.0	

Appendix S. Multiple regression model analysis for income determinant, SPSS results from the survey

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-32086.244	33320.554		-.963	.338	-98283.341	34110.852
	Household size	3867.378	1286.636	.217	3.006	.003	1311.250	6423.506
	Age of head of household (years)	197.195	312.867	.044	.630	.530	-424.369	818.760
	Total area (m ²)	3.483	2.608	.115	1.335	.185	-1.699	8.665
	Other flows of income excluding agric total (R)	1.434	.230	.504	6.225	.000	.977	1.892
	Total gross	.925	.186	.411	4.971	.000	.555	1.295
	Gender of household head=male	2279.221	6750.133	.024	.338	.736	-11131.096	15689.538
	Access to grants=no	634.127	17183.787	.003	.037	.971	-33504.466	34772.719
	Group=not pumping	16825.840	8315.847	.148	2.023	.046	304.958	33346.721
	Farmer group=no	12611.603	20120.607	.051	.627	.532	-27361.495	52584.701
Cattle=No	5811.254	10946.543	.044	.531	.597	-15935.965	27558.472	

a. Dependent Variable: Total household income (R)

Appendix T. Vulnerabilities (shocks), SPSS frequency distributions results from the survey

High food prices					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	10	9.9	9.9	9.9
	YES	91	90.1	90.1	100.0
	Total	101	100.0	100.0	
Reduced income					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	100	99.0	99.0	99.0
	YES	1	1.0	1.0	100.0
	Total	101	100.0	100.0	
Serious illness/accident					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	75	74.3	74.3	74.3
	YES	26	25.7	25.7	100.0
	Total	101	100.0	100.0	
Lack of employment					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	98	97.0	97.0	97.0
	YES	3	3.0	3.0	100.0
	Total	101	100.0	100.0	

(continued)

Unavailability of food					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	62	61.4	61.4	61.4
	YES	39	38.6	38.6	100.0
	Total	101	100.0	100.0	
Loss of employment					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	85	84.2	84.2	84.2
	YES	16	15.8	15.8	100.0
	Total	101	100.0	100.0	
Death of working adult					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	101	100.0	100.0	100.0
Human disease					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	67	66.3	66.3	66.3
	YES	34	33.7	33.7	100.0
	Total	101	100.0	100.0	

(continued)

Theft of money/valuables					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	96	95.0	95.0	95.0
	YES	5	5.0	5.0	100.0
	Total	101	100.0	100.0	
Theft of animals					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NO	74	73.3	73.3	73.3
	YES	27	26.7	26.7	100.0
	Total	101	100.0	100.0	

Appendix U. The impact of independent irrigation income on average annual household income, SPSS Simple Linear Regression results from the survey

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.371 ^a	.138	.129	44819.12318	.138	15.847	1	99	.000
a. Predictors: (Constant), Independent plot gross income									

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31833026250.338	1	31833026250.338	15.847	.000 ^b
	Residual	198866626418.969	99	2008753802.212		
	Total	230699652669.307	100			
a. Dependent Variable: Total household income (R)						
b. Predictors: (Constant), Independent plot gross income						

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	42418.583	5212.324		8.138	.000	32076.201	52760.965
	Independent plot gross income	1.317	.331	.371	3.981	.000	.660	1.973
a. Dependent Variable: Total household income (R)								

Appendix V. The impact of technology on irrigation income, SPSS independent T-test results from the survey

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Independent plot gross income	Pumping	23	13888.9130	18292.89989	3814.33330
	Collecting or diverting	78	6466.6667	11406.99588	1291.58795
Cultivated area (m2)	Pumping	23	1034.9130	1239.88526	258.53395
	Collecting or diverting	78	392.0385	1392.38912	157.65702

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Independent plot gross income	Equal variances assumed	6.537	.012	2.361	99	.020	7422.24638	3143.91013	1184.04661	13660.44614
	Equal variances not assumed			1.843	27.232	.076	7422.24638	4027.07561	-837.33814	15681.83089
Cultivated area (m2)	Equal variances assumed	1.654	.201	1.992	99	.049	642.87458	322.68693	2.59371	1283.15545
	Equal variances not assumed			2.123	39.831	.040	642.87458	302.81271	30.78630	1254.96286

Appendix W. Probit model results for determinants of pumping, StataSe results

Parameter Estimates										
Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	1.490	2.0471	-2.522	5.502	.530	1	.467	4.437	.080	245.218
Gender of farmer	1.456	.6825	.118	2.793	4.549	1	.033	4.288	1.125	16.338
Marital status	-.306	.6732	-1.626	1.014	.207	1	.649	.736	.197	2.755
Age of irrigator (years)	-.074	.0414	-.155	.007	3.182	1	.074	.929	.857	1.007
Formal education of irrigator (years)	-.038	.0789	-.192	.117	.229	1	.633	.963	.825	1.124
Irrigation experience (years)	.046	.0400	-.032	.125	1.341	1	.247	1.047	.968	1.133
Total area (m2)	.001	.0015	-.002	.004	.214	1	.644	1.001	.998	1.004
Cultivated area (m2)	.004	.0024	-.001	.009	2.644	1	.104	1.004	.999	1.009
Distance from source to plot (m)	-.014	.0066	-.027	-.001	4.283	1	.038	.986	.974	.999
Total household income (R)	-2.900E-5	1.3744E-5	-5.594E-5	-2.062E-6	4.452	1	.035	1.000	1.000	1.000
Total number of activities	1.017	.5367	-.035	2.069	3.593	1	.058	2.766	.966	7.917
Production advise	-1.159	.9317	-2.985	.668	1.546	1	.214	.314	.051	1.949

(continued)

Production training	-.804	4.4073	-9.442	7.834	.033	1	.855	.448	7.933E-5	2525.860
are any produce markets accessed? (yes = 1; no = 0)	-1.829	.8458	-3.486	-.171	4.673	1	.031	.161	.031	.843
Total Grants	-.717	.8785	-2.439	1.005	.666	1	.414	.488	.087	2.732
(Scale)	1 ^a									

Dependent Variable: Group
Model: (Intercept), Gender of farmer, Marital status, Age of irrigator (years), Formal education of irrigator (years), Irrigation experience (years), Total area (m2), Cultivated area (m2), Distance from source to plot (m), Total household income (R), Total number of activities, Production advise , Production training , Are any produce markets accessed? (yes = 1; no = 0), Total Grants

a. Fixed at the displayed value.

Appendix X. Thematic Content Analysis results from the FGD (themes, corresponding code names for variables under discussion with illustrative direct quotes from the different groups, examples)

Themes	Codes	Direct quotes
Capital endowment and constraints irrigators face on their independently irrigated land	Limitations	<p>F1 “It is challenging working and carrying water by the head without any support to make things easier.”</p> <p>F4 “Transporting water to the plot is challenging because we do it by the head while we are very old.”</p>
	Plot size	<p>F1 “The plot helps in the household though it is small, but we can eat, sell some, and buy other necessities. However, if the plots were much bigger, they would be able to have more output. Especially since we use buckets to irrigate”</p>
	Buckets	<p>F1 “The plot helps in the household though it is small, but we can eat, sell some, and buy other necessities. However, if the plots were much bigger, they would be able to have more output. Especially since we use buckets to irrigate”</p> <p>F1 “irrigating by buckets is a major problem for us, and the fact that we are old makes it worse.”</p> <p>F1 “Also, health-wise, this carrying of buckets is not good for us.”</p> <p>F4 “We carry buckets by the head, which is very difficult; hence we cannot produce enough to sell but to eat.”</p>
	Fencing	<p>F1 “even the fencing of our plots is a problem. We use tree branches as our fence.”</p> <p>F1 “In that type of fencing, cattle are a major problem, they can get inside, and they eat out produce all the time.”</p> <p>F1 “Imagine coming to your field, and you find nothing. You feel like fainting when you come to the plot, and you find nothing” “yey, you feel like ding when you get to the plot after you left it beautiful, and you find nothing.”</p> <p>F2 “We fence using tree branches, and it is something we must renew occasionally. We do not have the financial means to buy the fence.”</p> <p>F3” We use tree branches where goats and cows come and eat our produce, and that is very difficult for us.”</p>

		<p>F4 “We have an old fence, but it is worn out now, and we do not have the financial means to fix it.”</p>
<p>Capital endowment and constraints irrigators face on their independently irrigated land</p>	<p>Water and pumping</p>	<p>F1“The is no money to buy pumps.” “This area is dry, so obtaining water for irrigating is very difficult. We even share this water with the cattle that eat our produce. If only we could be assisted with drawing water from the river because the water there is always available.”</p> <p>F1“There is high competition regarding water access from the spring. So now we must take turns; if you irrigated yesterday, I also have to the next day.”</p> <p>F2 “There is no water here. We buy water now; even this car you see is selling water. Each drum is R30. They fetch it from the river and resell it to us.”</p> <p>F2“At some point, you have to take the same water we buy for domestic use and use it at the plot.”</p> <p>F2“We have no financial means to buy the irrigation pumps.”</p> <p>F2“Even if you buy it, they break, and it becomes complicated to fix.”</p> <p>F2“Even the ones who have them do not want to rent to us; they complain about what if it breaks? Who will fix it.”</p> <p>F2“I used to have a pump a long time ago, it was broken, and I could not fix it. I am left with pipes now.”</p> <p>F2 “There is high competition for water; you have to wake up early to find access because you want to be first.”</p> <p>F2 “We have water in summer when it rains a lot.”</p> <p>F3 “We bought pumps with the money from creditors (mashonisa)”</p> <p>F3“Yeah, it is very expensive, for a pump you pay R6 000. Imagine the interest also that you must pay to the creditor.”</p> <p>F3“Do not forget to count the pipes and petrol to power the pump.”</p> <p>F3 “We all use petrol pumps. Petrol is expensive; for these 5 litres, you pay R100, and it finishes one day, so we irrigate once a week.”</p>

		F3 ” We have never had any water issues, competition, and conflict; we use the Tugela River, where water is abundant.”
	Pest and diseases	F1 “There are difficulties in our plots, like our crops being affected by diseases; we don’t even know where they come from.” F2 “We are struggling with diseases that we don’t even know where we will get the money to buy agrochemicals to cure. Worse, we do not even know what they are”
	Land	F3 “We have to hire a car to take us from our place to the plot, where everyone pays R20 per day.”
Areas to improve for a successful crop production enterprise	Interventions	F1 “We wish to have an assistant with fertilisers, agrochemicals, and access to water.” F3 ” fencing is the main issue; if we could get assistance in fencing. We can’t even put peanuts after this because the goats will eat the produce. We leave the plots fallow until we plant these trees again.” F3 “The cows are even worse; they just destroy everything we plant.”
Benefits derived from the independently irrigated land	Contribution of plot	F1 “The plot helps in the household though it is small, but we can eat, sell some, and buy other necessities. However, if the plots were much bigger, they would be able to have more output. Especially since we use buckets to irrigate” F1 “The are many changes due to the plot because we harvest, eat, also sell where we can” F2 “The main benefit of the independent plot is that at harvest, we can sell and buy other foodstuffs we don’t have at home or we do not plant. We are also able to buy inputs for replanting.” F3 “Crop production at the plot is significant, and it is our source of livelihood.” F3 “It is our bread. If we do not get anything from it, we struggle at the house” F4 “The plot assists us a lot in getting food like cabbages and tomatoes, and we do not sell much.”
Independent irrigators output markets	Markets	F2 “People come to buy at the farm.” F2 “We sometimes hire a car to take produce to Tugela Ferry. However, there is much competition there to the

		<p>point that you come back with your produce not all sold; if it is spoilt, you give it to animals.”</p> <p>F3 “It is selling <i>insangu</i> that is a problem if we have no customers. For vegetables like cabbages, it is better because we also eat at home.”</p> <p>F4 “We sell here to our neighbors who are not planting, and since it’s not a lot, it is no problem.”</p> <p>F4 “We do face challenges with cabbage, where it ends up being spoilt from the plot.”</p>
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Notes: F1-FGD 1 (non-pumpers); F2-FGD 2 (non-pumpers); F3-FGD 3 (pumpers); F-FGD 4 (non-pumpers);
 XXXXX-replacing advisor name for anonymity