GENDER-BASED ANALYSIS OF AGRICULTURAL WATER SECURITY IN LUVHADA COMMUNITY, LIMPOPO PROVINCE, SOUTH AFRICA

By

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Declaration

I, LOUISA RABELANG MULAUDZI, hereby declare that this research titled - **GENDER-BASED ANALYSIS OF AGRICULTURAL WATER SECURITY IN LUVHADA COMMUNITY, LIMPOPO PROVINCE, SOUTH AFRICA** - for Masters in Rural Development (MRDV) submitted to the Institute for Rural Development at the University of Venda, has not been submitted previously for any degree at this or another university. It is original in design and execution, and all reference materials contained therein have been duly acknowledged.

Signature **Date** **31/08/22**

L R MULAUDZI

Abstract

Women and men use water differently. A significant number of rural women and men rely on natural water resources for farming in irrigated schemes, as a key and common economic activity. Women undertake farming either together with men or alone (for example, when widowed or when the men migrate to look for greener pastures elsewhere). This suggests that more rural women are involved in farming than men and assumes a potential gender variations in water use and agricultural activities practiced by women, hence, differences in the impact on water security. Luvhada, the location for this study is between the Nzhelele River and Mphephu Resort; the Lulumba fountains are perennial and the main source of agricultural water for the irrigation scheme. The scheme comprises approximately of 79 associates, and the main crops grown include maize, beans, sweet potatoes and groundnuts. This study aimed to explore gender-based aspects of agricultural activities on water security in Luvhada. Data was collected from a sample size of 60 small-scale farmers in the Luvhada area and a telephone survey was used to collect data. Qualitative and quantitative data were collected simultaneously guided by the convergent research design together with closed and opened-ended questionnaires. Exploratory data were analysed thematically using Atlas Ti version 4.8.1 while quantitative data were descriptively analysed using SPSS Version 26. The results of the study indicated that female farmers own smaller pieces of land compared to their male counterparts, a fact that might influence their productivity. Also, a lack of equipment to pump water and to canals at the scheme pose a huge problem for accessing and delivery of water to the users. Farmers were also cultivating other crops for both marketing and household consumption and that the quantity of water supply is not matched by the time pattern of crop needs. Majority of the farmers revealed that the area experiences months without access to water; findings also shed light on gender-specific farming practices and water usage ways for rural farmers relying on irrigation. The results should be useful in devising and intervention strategies to address the challenge of agricultural water insecurity in the area. Improved irrigation systems and intensification techniques could drastically increase women farmers' productivity and the overall benefits of agricultural production in Luvhada

***Keywords*:** Gender, Water Security, Agricultural Practices, Luvhada.

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Dedication

This work is the fruit of countless and arduous sacrifices, therefore, this dissertation is heartily and proudly dedicated to my exceptional late loving mother, Linneth Thinawanga Mulaudzi and grandmother, Phophi Gladys Nemalamangwa, who emphasised that education is the key to unlock the doors of success.

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Abbreviations

DALRRD	Department of Agriculture Land Reform and Rural Development
DSI	Department of Science and Innovation
DWAF	Department of Water and Sanitation
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GIS	Geographic Information System
IDP	Integrated development planning
IFAD	International Fund for Agriculture Development
HFS	Household food security
PEER	Partnerships for Enhanced Engaged Research
SPSS	Statistical package for the social sciences
SSA	Sub-Saharan Africa
STATSSA	Statistics South Africa
SDG	Sustainable Development Goal
UN	United Nations
UNICEF	United Nations Children Fund
USAID	United States Agency for International Development
WUA	Women's University in Africa

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

South Africa is classified as a water-scarce country. It is estimated that by 2025, even with the highest feasible water efficiency and productivity, the country cannot meet its water requirements, including for agricultural production (Cocks *et al*., 2018). Majority of the subsistence and smallholder farmers bear the brunt since farmers in rural areas rely on both rain-fed water and use of irrigation systems for production. Like the rest of the world, climate change has resulted in low rainfall and its long-term effects has seen a decrease in the underground water table in South Africa (FAO, 2018). To support the growing food demand and to deal with the effects of low rainfall, there is more reliance on underground water to support agricultural activities (Ubisi *et al.*, 2017). Decreasing underground water and rainfall have also negatively impacted food security of rural communities in South Africa. These adverse weather conditions are expected to continue, and this poses a great threat to water supply and food security (De Amorim *et al*., 2018). Agriculture's contribution to household incomes and food availability is low in South Africa, yet it plays an essential role in reducing the vulnerability of rural households to food insecurity (Lam *et al.,* 2017).

In most sub-Saharan countries, women play a vital role in ensuring rural household food security (Dev, 2016). Rural women engage in land-based livelihood such as irrigated agriculture to increase household food security and reduce reliance on cash remittances and welfare support grants to feed their households. Ireson (2018) stated that a significant number of rural women engage in small irrigation schemes for food production and income generation for their families. Food Agriculture Organisation (2011), for example, found that women dedicate a lot of time in decision-making to maintain food and nutritional security of their households. Currently, amid climate change with less rainfall and growing hunger levels, agricultural activities by women directly impact water footprint or consumption and food wellbeing in rural communities (Choufani *et al.*, 2017).

Low-income women in agricultural communities are among the world's poorest people and are more vulnerable to the harmful impacts of climate variability and change, comparative to other groups of the population (Lambrou & Piana, 2006). Most rural women are highly dependent on natural water resources for household use and significantly, for farming. Women undertake farming either together with men or alone; when men migrate to look for greener pastures, or when women are single or widowed, they are left to engage in subsistence farming for family survival (Buechler, 2000). This suggests that women are more involved in farming and are, therefore, likely to utilise more water than men, in relative terms. Also, due to gender-assigned roles, women in farming are likely to pay more attention to crops, hence, they are likely to use more water in comparison to men, thus, agricultural activities practised by women and men impact differently on water security. This indicates that there are variations when it comes to water use in rural farming depending on gender (Jeil *et al.*, 2020).

Women and men play significant roles in agriculture, worldwide, including the developing world. In the developing world, most women participate in agriculture due to their concern for family welfare (Oladeji *et al*., 2006). To meet the herculean task of providing for the family needs, women and men tend to engage in all sorts of farming activities to raise income for the family. Farming activities mainly practiced by women range from the actual production to selling for food cash crops at the market. In Pakistan, for example, ordinary women are the main players sustaining life activities both at home and farm (Mumtaz & Salway, 2009). Women in China are more actively involved in agricultural activities particularly in crop production as compared to men (Zheng, S., et al. 2019). Crop production in China by rural women and men utilises 63% of total water use from the surface and groundwater (Laura, 2016).

In sub-Saharan Africa, women similarly, contribute significantly to agricultural production in rural areas. In Nigeria, women contribute to about 50% of the agriculture food production, more than men (Nakazi, 2017). Uganda's food insecurity has its roots in the challenges faced by women in engaging in small-scale irrigated rural agriculture (Sell & Minot, 2018). It is estimated that women are responsible for almost 90 percent of Uganda's total food output (Nakazi, 2017). Women in Kenya play an active role in agricultural production, which is the primary occupation of 94% of women compared to 85% of men (Oduol *et al.*, 2017). Empirical evidence from scholars show that women are the backbone of smallholder irrigation farming, hence, food security especially in the rural areas as compared to men (FAO, 2011; Ahmed *et al.*, 2012; Bhat *et al.*, 2012). Consequently, it is generally perceived that differences in agricultural water resource management arises from the gender division of labour and gender norms in society, which allocate many water-related responsibilities to women while conferring most water-related powers and rights to men. Studies from 45 developing countries show that women and children bear the primary responsibility for water collection in 76 percent of households, which is not the same for men (FAO., 2012; Coulter, 2019; Houweling, 2016).

One -fifth of farmers lose 90% of the produce due to water shortage in Kenya (Baiyegunhi, *et al*., 2016). Most rural women and men farmers in South Africa and sub-Saharan countries rely on rain fed agriculture, with little capacity to invest in irrigation (Asfaw *et al*., 2014; Bruinsma, 2017). This reveals that most women farmers, compared to male farmers, depend on the presently decreasing rainfall, hence, this has adverse effects on their agricultural productivity. In small food gardens where women farmers practice horticulture throughout the year, flood irrigation technique is commonly used (Tshwene & Oladele, 2016). In flood irrigation, buckets are commonly used to collect water from rivers, boreholes or wells and spread the water onto small food gardens. Such practices, amid the global water security challenges, threatens food security and undermines poverty-reduction efforts.

Global records show that the earth's freshwater resources are facing tremendous pressure due to erratic rainfall, increased consumption, and pollution. The Food and Agriculture Organisation, (2018) reports that at a global level, water withdrawal was short by 63 percent between 2012 and 2018. Florke *et al.* (2018) adds that more than 1.4billion people live in areas where the withdrawal of water exceeds recharge rates. The projected population growth is set to increase the pressure on water resources. For instance, it is estimated that in the coming decades, the global population will increase from the current 7.3billion to 9.7 billion by 2050 (Mcnabb, 2019). The world, therefore, needs to upsurge agricultural activities to meet the ballooning food demand and this impacts water security (Hilson, 2016). There is a growing body of evidence on the effects of water variability and scarcity on agriculture and rural livelihoods, however, research on how these activities, including, a gender perspective, aggravate or intercede the impacts of water security on rural livelihoods, is not extensive. It is also not known what this means for policy and future water management practices in agriculture. It is not clear whether policymakers should review their policies based on analyses of gender-based agricultural practices or not. Presently, water scarcity challenges indicate that more irrigation schemes need to be set up to improve crop production and sustain rural livelihoods in South Africa (Rooyen, 2017; Murugani & Chitja, 2019). Continuation in this trajectory, calls for clarity on gendered impact on agricultural water security. It is against this backdrop that the focus of the study intends to conduct a gender-based analysis of agricultural water availability, safety and management as well as accessibility to services in Luvhada community, Limpopo Province, South Africa.

1.2 Statement of the Research Problem

Agriculture is the largest consumer of surface fresh water reserves, and irrigation of croplands accounts for 70% of water withdrawals (Daniel *et al.,* 2017*).* Despite 95% of agricultural land being primarily rainfed (Hadebe *et al.*, 2016), declining water availability has a negative impact on cropland and pasture productivity. Failure to meet the water requirements of crops, for instance, has led to decreasing yields of staple crops such as maize in China (Meng *et al.*, 2017). Furthermore, Matiu *et al.* (2017) demonstrated that consecutive years with warm and dry weather reduced yields of some crops which impacts negatively on household food security. To maximise crop yields and ensure food security, it will be required to set up more irrigation schemes. Additionally, Davis *et al.* (2017) estimated that it would require about 146% increase in global irrigation water use to sustain food supply, however, agriculture water use was influenced by gender. This, therefore, means that there was a need to investigate gender-based factors on agricultural water security.

Agriculture is a source of employment for many women and men, but this differs across regions (FAO, 2011). Other industries, like exports and agro processing, afford men better opportunities compared to women. According to FAO (2011), contract farming and high-value products offer more opportunities to women than men, but the level of income is unknown. Luvhada village located at Makhado Local Municipality in Limpopo Province, consists of very limited employment and income opportunities. The main livelihood activity in the community is small-scale crop production, which is dominantly practised by women as compared to men. The crops cultivated by women and men at Luvhada Irrigation Scheme are mainly maize, sweet potato and groundnuts on 0.2 hectares of agricultural land allocated per household. Members of the Luvhada irrigation scheme access their water through canals and flood irrigation, however, effective crop production is constrained by inadequate resources, such as land and water access. Community members of Luvhada village tend to overuse available water for farming which is more likely to cause more water shortage. Due to global climate change, which has resulted in an increased frequency of droughts affecting various rural areas, irrigation is becoming a paramount technology to increase yield for maize production (Elliott, 2014). Water shortage in Luvhada village is mainly caused by overuse of water and poor irrigation systems including canal linkages and, commonly, droughts, therefore, improvements in water productivity for crops is critical for addressing the challenges of gender-based water security and sustainability. Cai & Rosegrant (2003) define water productivity as crop yield per cubic metre of water consumption, including 'green' water (effective rainfall) for rain-fed areas and both 'green' and 'blue' water (diverted water from water systems) for irrigated areas.

Studies have been done to test the impact of agricultural activities on water security and food security, however there is little evidence suggesting an investigation on the effect of gender-based analysis on agricultural water security. None of the studies have attempted to focus on how rural women and men different agricultural practices affect water use. For example, Tambi *et al.* (2017) investigated on the topic, Women in Agricultural Production on Food Security; Farid *et al.* (2009) undertook a study to determine and describe the role of income generation and the extent of rural women's participation in agricultural activities. Few studies have been conducted to explore challenges faced by small scale female farmers and their contribution to agricultural activity on household food security (Rockstrom & Barro,2017), thus, this study sought to investigate the effects of gender-based analysis of agricultural practices on water security.

1.3 Significance of the study

The study was influenced by the high level of poverty, water security challenges, and household food insecurity in Luvhada village (Thulamela IDP, 2018). Water is a critical input into agriculture in nearly all its aspects having a determining effect on the eventual yield. Good seeds and fertilisers fail to achieve their full potential if plants are not optimally watered. Agriculture faces the challenge of ensuring global food security by increasing yield without increasing freshwater consumption (Kijne, 2013) as worldwide agriculture accounts for 75% of freshwater withdrawals (Wallace, 2011). Irrigated agriculture remains the largest user of water, globally, a trend encouraged by the fact that farmers in most countries cannot pay the full cost of the water they use (Thangwana, 2009).

Globally, crop water consumption is expected to increase by 41%, from 6,400km^3 in 2000 to 9,060km^3 in 2050, if no gains in water productivity (WP) are achieved (Rosegrant *et al*., 2009). According to Tilma *et al.* (2011), maize production is anticipated to increase by 100% from 2015 levels to meet the growing demand by 2050. Many studies have reported that improvements in water productivity have positive benefits, including ensuring food security and reducing water consumption, however, no detailed global estimates have examined the benefits in terms of closing the water productivity gap in maize production. Given that growing water scarcity, and pressure is on increasing demand, it is extremely important to understand how much water is consumed by 2050, as well as how much of water consumption could be saved.

Various scholars have documented that woman are the backbone of food security especially in the rural areas compared to men (FAO, 2011; Ahmed *et al*, 2012; Bhat *et al*, 2012). Not only are women responsible for purchasing, preparing, and processing food but also play a focal role in national agricultural production. Women still make considerable contributions to agricultural production and food security in contrast to men. Regrettably, various researchers state that this contribution is often unrecognised, under-counted and undervalued especially in developing nations (Bhat *et al*, 2012; Farid *et al*., 2018). The findings of the study would assist both policy makers in finding effective and responsive intervention measures in addressing both agricultural water insecurity among subsistence farmers including both men and women as well as in improving household food security in rural communities. In addition, the study would contribute to the body of knowledge and literature in rural development.

It was, therefore, the intention of the study to provide information to fill the existing knowledge gaps by investigating gender-based analysis of agricultural practices on water security. Understanding the extent and intensity of rural women and men farmers' roles towards mitigating the phenomena of water insecurity is of a paramount importance in rural development

1.4 Main Research Objective

The main objective of this study is to undertake a gender-based analysis of agricultural practices on water security in Luvhada community, Limpopo Province, South Africa.

1.4.1 Specific Objectives

1. To identify agricultural water use patterns across the gender divide.
2. To analyse gender-based farming practices that affect water security.
3. To identify possible intervention strategies to enhance the efficiency of gendered agricultural water security.

1.4.2 Research Questions

1. What are agricultural water use patterns between males and females?
2. What are the unique gendered farming practices in the Luvhada community?

3. What is gender-specific intervention strategies for improving water usage in farming activities?

1.5 Conceptual framework

Women and men have different access to an/d control over land and water, and different responsibilities for agricultural production and water management (Bahauddin & Hug, 2019). Too often, however, policies and programmes focused on water for rural livelihoods that are gender blind and fail to consider both gender needs and experiences (Clancy, *et al*., 2007). Paying attention to gendered capabilities and constraints is critical to improving agricultural water management, and in turn, to the achievement of the Sustainable Development Goals (SDGs) on poverty, agriculture, gender and water (Lain *et al*., 2016). The conceptual framework for rural women and men on agricultural water security is characterised by key drivers, including climate variability and dependence on rainfed production, and low access to and control over resources and opportunities that could support more resilient livelihoods and mitigate the impacts of these drivers (Shiferwa *et al.,* 2014). These limitations are shaped by social relations and power dynamics. The framework emphasises the potential negative outcomes that result from the gendered impacts of water on agricultural security, however, it is important to recognise the urgency of both rural women and men to overcome water insecurity and achieve higher welfare for women and girls (Sharaunga *et al.,* 2019). This process can be facilitated and supported by gender-focused programmes. This implies that the negative picture of insecurity depicted in the framework can also be inverted to achieve water security and higher welfare for rural men and women. This is in sync with the aim of this study, to look at gender-based analysis for agricultural water security outcomes, hence, the study seeks to apply this framework in determining the influence on the selected facets of water security, as shown in Figure 1.1

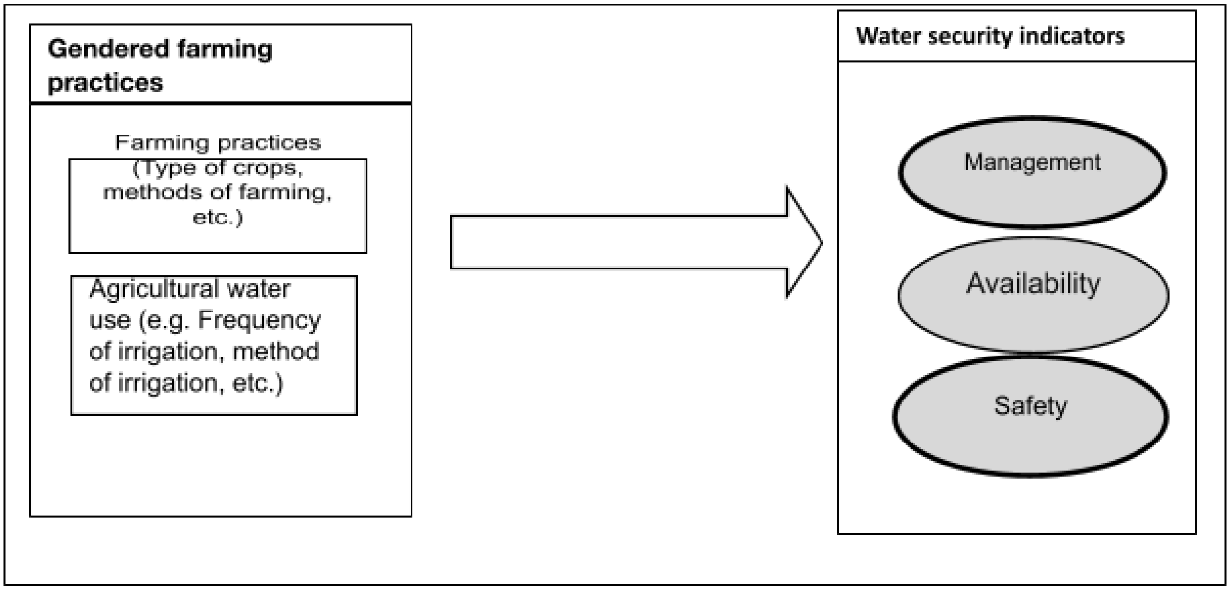

Figure 1. 1: A conceptual framework on the effects of gendered-farming practices on water security. Source: Johnson (2011)

1.6 Operational Definitions of Key Terms and Concepts

Crop production is defined as a branch of agriculture that deals with growing of crops for use as food (Mirzae *et al.,* 2019).

Food security refers to a situation whereby all people have physical, social and economic access to enough, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Savage *et al.,* 2020).

Gender is a concept used in social science analysis to look at roles and activities of men and women. The focus of a gendered analysis is not on biological differences between men and women but rather on their experiences as members of society (Manandhar *et al*., 2018).

Income-generating activities consist of small businesses managed by individuals or a group of people to increase their household income through livelihood diversification (Barlow & Clark, 2017).

Household food security (HFS) as a concept refers to the capability of people or households to have enough resources either to produce their food or buy to meet the dietary needs of their family members for healthy and active lives (Obe, 2013).

Water security is the capacity of a population to access enough water to meet all its needs and to limit the destructive aspects of water. It involves both the production and destruction of water (Staddon, 2016).

1.7 Outline of the Research Project

This research consists of seven interconnected chapters and are organised as given below. The dissertation is presentation in paper/article format where each specific objective forms a chapter with results presented and discussed.

Chapter one provides the background of the study, problem statement, justification of the study, research objectives, and definition of key concepts and terms.
Chapter two covers the literature review which helps in giving knowledge on findings on studies carried out explaining the effect of gender-based analysis of agricultural water security.

Chapter three addresses the research methodology, which includes the description of the study area, research design, population and sampling procedure, data collection tools and methods and data analysis. Research finding and results are presented per objective. Each objective forms a chapter consisting of a title, abstract, introduction, results, discussions and conclusion. Chapter four, five and six are results chapters. Chapter 7 is a summary of the key findings, general discussions, conclusion and recommendations. In addition, a list of refences and appendices form part this research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides background information on water and food security, gender dynamics and its architecture, and how it is influenced by agricultural activities around the world. In addition, literature sources from developing nations and South Africa, emerging trends, or new direction of research in the discourse of relationship between water security and rural agricultural activities were reviewed.

This analysis focuses on the interplay between gender and poverty dynamics. It is important to separate these aspects, as although poverty is a gendered experience, gender and poverty are distinct forms of disadvantage (Jonsson, 2011). The complex relations between men and women and the social norms that define their behaviour is particularly relevant to water (in) security (French, 2018). While men often dominate the decision-making process regarding water and land management for productive uses, women bear a disproportionate responsibility for water collection and provision, and inadequate access creates a burden in terms of labour and time, which has impacts on health, education, and security (Elum, 2021).

2.2 Definition of Gender

According to Pleck, (2018), gender is a concept used in social science analysis to determine roles and activities of men and women. The focus of gender analysis is not on biological differences between men and women but rather on their experiences as members of society. In most societies, historical, current, developing, and developed, men have certain roles and responsibilities while women have other roles and responsibilities (Jayachandran, 2021). Often, the biological differences between men and women are used to explain these different roles. Gender roles are defined within society and intersect with other social identifiers, such as age, religion, and ethnicity, and reflect what is deemed appropriate behaviour for men and women. Thus, the roles and relations of women and men are social constructs and thus can, and do, change. Given that patriarchy predominates, women have typically held a less privileged position relative to men, and thus attempts at gender equality typically involve concerted efforts in favour of women's empowerment (Pleck, 2018). Particularly in rural areas, gender inequality is reinforced by social norms (Greene *et al*., 2019). Acceptance of male authority over women is taught both implicitly and explicitly through various institutions, including in homes, many schools, churches and community gathering (Lipset, 2017) and whilst gendered practices are evident in many spheres, it is particularly important to address them within agriculture.

2.3 The concept of water security

Water security underlies all dimensions of human health and well-being (Venghaus & Denken, 2019); it is a fundamental resource for both food and energy production (Mo *et al*., 2019). Water security is further described as reliable water availability of acceptable quantity and quality for health, livelihoods, and production sustenance. It should also be coupled with an acceptable level of water-related risks (Grey & Sadoff, 2007). Water security is achieved when water scarcity is non-existent, decreased or eliminated; it is also realisable when the effects of floods, pollution and any other forms of freshwater contamination are not a threat to the current and future water needs (Meran *et al.,* 2019). The current spate of little rainfall, high temperatures and increasing population, threatens sustainability of water security. Climate variability is already inflicting high costs on rural communities, and it is poised to intensify in many regions as climate change accelerates (Uprety *et al*., 2019).

Water is a limiting natural resource for agricultural production (Beshir, 2017). It is well accepted that crop types differ in their water use efficiency, however, there is no consensus on the main factors affecting water use efficiency of main field crops (Cao *et al*., 2021). Irrigation development has been known to increases crop productivity in arid and semi-arid areas for decades, hence, water scarcity escalates costs of setting and managing the infrastructure which hinder further expansion of irrigation farming in developing countries (Bosch *et al*., 2018). Consequently, rising demand for water by mining, industries, the environment, and severe pressures from climate uncertainties, exacerbate water shortages for irrigation development (Olabanji *et al*., 2020). There is a need, thus, for new paradigms in agriculture to, at least, keep pace with rising demand for food while using the lowest possible amounts of water by both male and female farmers.

2.4 Agricultural water use patterns/differences between males and females

It is often assumed that men are farmers while women are recognized farmers' wives and helpers. This has been the case in many international and national agricultural development policies and programs in the past (Trauger, 2004; Beach ,2013). In some cases, such assumptions have led to the failure of targeting programs effectively or achieving program objectives. Women play a key role in agriculture, for example, in Malawi, producing 70% of food that is consumed locally (FAO, 2011), however, land rights and rules mean that only a third of agricultural holdings in Malawi are held by women compared to men and this is still higher than in many African countries (Djurfeldt *et al.,* 2018). Often, women's access to land is through the family head, who is typically a man, thus, although they perform 50–70% of all agricultural tasks, women rarely have control over the land or the yields (Horrel & Krishan, 2008). Female-managed plots are, on average, 12% smaller than those of their male counterparts and 25% less productive because of differing levels of knowledge and access to inputs for improving farming efficiency between the two genders (Palacious *et al,* 2011).

Agriculture is a significant contributor to the economy of a number of countries studied, ranging from 22% of the Gross Domestic Product (GDP) in Ghana, to 42% in Ethiopia (Abbeam *et al.,* 2017). Significant numbers of people are employed in the agriculture sector, the lowest being 45% of the total workforce in Benin and Ghana, while in Ethiopia, Mozambique, and Rwanda it is three quarters or more of the total workforce (Abidemi et al., 2019). Most of these farmers are women and men smallholders (Murray *et al*., 2016). Most of the water footprint in all the countries is used to grow agricultural crops and livestock (Mekonnen & Hoekstra, 2012). Many of the growing crops are primarily rain-fed by women compared to men (Karki *et al*., 2020). Improving the productivity of water and land used in crop production would improve food and economic security (Nhamo *et al*., 2016).

If key export crops were produced with lower levels of water and land resources, it would provide greater levels of export value for the same amount of water and land area used (Mancosu *et al.,* 2015). Sugarcane production in Kenya, for example, is more efficient than the global water footprint benchmark; in Mozambique, sugarcane consumes six times as much water per tons of production, compared to the global benchmark. If sugarcane production in Mozambique met the global water footprint benchmark, the same amount of water could produce four times as much sugar cane than is produced now (Paremoer, 2018). Areas of Ethiopia, Kenya, Mali and Mozambique experience severe blue water scarcity 12 months of the year whilst Benin, Ghana and Rwanda face blue water scarcity during the dry season (Steiner, 2019).

According to a study conducted by Zwart and Bastianssen (2014), in a global meta-analysis, water use efficiency has increased from 0.6–1.7kg m^{-3} for wheat, 0.6–1.6kg m^{-3} for rice to 1.1–2.7kg m^{-3} for maize. Water use efficiency varies with crop type; maize and sorghum tended to have higher water use efficiency than wheat and barley and the gender of the farmer. According to Zwart (2014), the first main conclusion using data from 514 sites across the globe was that rural women and male crop farmers differed significantly in their abilities to efficiently use water for grain yield; plants such as maize exhibit significantly higher water use efficiency than crops such as wheat.

Olawepo and Fatulu (2014) conducted a study on constraints affecting women and men's agricultural productivity. Specifically, the study examined the socio-economic characteristics of the women farmers, estimated farm size, identified estimated production level of the women, and identified factors influencing their agricultural productivity. Thirty women and 120 men farmers were randomly chosen, making 150 respondents. The results of the study revealed that the major livelihood activities of the women compared to men were farming with cassava as their major crop, with differentiated plots size of between 0.5 – 4.9 with 42% of the respondents having between 0.5 – 0.9 hectares of land. The major constraints faced by more women than men farmers were - land tenure system, ownership of land, access to extension services, high cost of inputs.

2.5 Gender-based farming practices or habits that affect agricultural water security

According to Jambo *et al.,* (2021), water for agriculture can come directly from rainfall, or be secured through irrigation technologies of different scales, ranging from rainwater harvesting to large-scale schemes with extensive infrastructure. When water is captured and stored for productive uses, women tend to be excluded from formal mechanisms for planning, control and use of that water (Fauconnier *et al.,* 2018). Key factors that limit women's access to water for production include – restricted-land ownership, farming contexts favouring men's involvement in large-scale irrigated cash crop production and limited participation due to social or structural constraints (Quisumbing & Pandolfelli, 2010).

In Alto Piura, Peru, female farmers complained that they always had to irrigate at night, despite the official rule that night turns should be equally distributed among irrigators (Zwarteveen, 2012). Male irrigators had better relations with the irrigators' committee and with the water delegate, therefore, they were often more successful in negotiating day turns (Berry & Jackson, 2018). If a project aims to provide all irrigators and farmers with equitable access to water resources, then strategies are required to deal with this specific difficulty faced by women and not men (Imburgia *et al.,* 2020). When thinking about water management, gender is probably the last thing on many people's minds, but in fact, the whole process of water management technology choices, decision-making, implementation, benefits and risks are all gendered (Earle & Bazilli, 2013).

Research in Kenya on smallholder rice irrigation in the Kano Plains revealed similar inequities (Apind *et al*., 2015). Most women were not active members of the water users' associations in the rice schemes, and those who did attend meetings were not allowed to speak before men or to express opinions in opposition to those expressed by men, even though women performed up to 61% of the requisite labour on their own and their husbands' plots (Marlene *et al*., 2018). Even when both men and women participated in irrigation schemes, their needs and priorities sometimes differed. As supported by Najjar *et al.* (2019), women were less interested in night irrigation because cultural norms made it difficult for them to work after dark. These different perspectives were not effectively represented by the Water Users Associations (WUA) because women were underrepresented and were not given an equal voice in decision-making (Marianna, 2011).

The study also found that the water guards in the rice-irrigation area were exclusively male, and generally tended to receive more water from the irrigation schemes (Moris & Thom, 2019). Likewise, because there is considerable evidence to suggest that women compared to men are not equal partners and beneficiaries in smallholder irrigation schemes, it is not surprising to find that women may sabotage irrigation efforts or withhold labour as a form of protest. In Kenya, Cameroon, Burkina Faso, and Gambia, there is evidence that women have withheld their labour from or reduced their labour input to their husbands' irrigated plots if they felt that they were receiving insufficient compensation for their work (Bryceson, 2019). Similarly, Adenle *et al*. (2019) pointed out that women in contrast to men often withdraw from irrigation schemes because the cash benefits from participation go to their husbands who are the official holders of the land and the official participants in the schemes.

Thagwana’s (2009) study on the participation of women in agriculture at Tshiombo Irrigation Scheme in South Africa showed that women were the key players of agricultural production at the scheme whilst most men migrated to the cities in search of better job opportunities. Women engaged in farming in order to curb food insecurity. The study revealed that the main challenges faced by women and men at the scheme were water shortages, time constraints and insufficient funds to finance inputs. Thagwana also reported that due to water shortages some women and men preferred to irrigate at night, since at that time water was in abundance, however, this was difficult for women who feared working at night. Some women had to hire men to irrigate for them and thereby spent their meagre farm income to pay the men.

Madembwe (2005) also carried out a study to examine women's access to land at the Ngondoma irrigation scheme, Zimbabwe. This study established that rural women and men farmers who had land, irrespective of size and who participated in agriculture contributed significantly to household food security, income, and welfare. This current study intended to examine the effect of gender-based analysis of agricultural activities on water security.

A study conducted by Kaylan *et al (*2011) in India to determine tribal women's participation in agriculture concluded that tribal women's income from commercial farming is a major contribution to household income. These women and men were from poor backgrounds, hence, had limited access to resources needed to effectively undertake agricultural production, for example, adequate water access for crop production. Despite their noticeable contribution to household income, research findings revealed that women's overall rate of participation in agriculture was lower compared to men's participation due to various constraints.

The sustainable use of water in agricultural production and processing in rural areas remains unclear, particularly on gendered variables (Garcia & Krishna, 2021), however, signs exist of growing water depletion, with lower water levels in the underground water-fed irrigation channels and greater pressure on water resources mainly in the dry season (Kalair *et al*., 2019). This causes greater dependence on limited water resources in underground water for agricultural production and household use. Agricultural practices such as the use of fertilisers and pesticides, as well as investments on different types of irrigation equipment add more pressure on the sustainability of freshwater water resources (Tsani *et al.,* 2020).

A study conducted by Sharaung & Mudhara (2016) investigated factors influencing water use security among irrigating men and women smallholder farmers. It was found out that the water-use security status of farmers was highly influenced by the irrigation scheme in which they were operating. Canal leakages and conflicts over water were reported in the study, thus, the selected irrigation schemes were excellent case studies to assess socioeconomic factors influencing levels of water use surety among rural women farmers. However, across the schemes, rural farmers in the head-end of the irrigation canal were more water-users than those in the tail end. In addition, those who spent more years in the irrigation schemes and were members of water use associations perceived themselves to be more water secure.

2.6 Gender specific intervention strategies to improve water security for agricultural activities

Agricultural water management is a central pillar to achieving Sustainable Development Goal 1 (SDG1), SDG2 and SDG6 on poverty reduction, sustainable agriculture, and water management (Salmora *et al.,* 2020). In most developing countries, particularly, in rural areas, women are historically and increasingly responsible for farming as men seek greener pastures in the cities (Bhawana & Race, 2020). Arguably, the effects of climate change such as drought, loss of livestock and poor harvests push poorer households into food insecurity and distress; migration also exposes women and children more to water insecurity (Mutekwa, 2009). Equally, due to gender-assigned roles and dimensions, women are more likely to influence water security more than men. Studies have shown that women have varying levels of access to and control over land and water (Parker *et al*., 2016). Lankford (2013) states that water professionals should critically emphasise developed and promote agricultural water management techniques, such as rainwater harvesting and flood control. This indicates that in many places, planners, engineers, extension staff and decision-makers still fail to perceive women as farmers. Consequently, policies, programmes and projects frequently overlook the knowledge, tasks, needs and requirements of women and other vulnerable groups (for example, ethnic groups) in agricultural water management.

According to Gowlland-Gualtieri (2007), although the implementation of the right to water has resulted in the development of a policy of free entitlement to productive and domestic water, huge disparities in access to basic water services remain. They attribute these disparities partly to the application of an economic approach to water policy. Indeed, the integration of such concepts as cost recovery and privatisation in water policy have contributed to maintaining the poorest segments of the population, mainly women, and children, with little or no access to water for agricultural production, household needs and sanitation, and limited water infrastructure (Gowlland, 2007).

Current water-use patterns in South Africa show not only a racial bias but also a gender bias. Even though, in many rural households, women are the primary decision-makers and have the responsibility for raising crops to feed the family, land ownership is often in the hands of the male members of the household. Gender inequality may therefore be further entrenched by linking water use to property rights over land. The water reform process must recognize and correct these gender inequities in water use (Bruns *et al.,* 2005).

The distribution and adjustment of water uses, and rights are processes entailing harsh confrontations among individual users and among collective sectors, which are not based on harmonious, consensual negotiation. The less powerful groups, especially both men and women, although also facing internal conflicts among themselves, have almost always suffered the consequences of reorganisation of rights and uses by other, stronger players. Many studies in South Africa have shown how certain interest groups, such as men and women, and poor users are denied access to decision-making positions and negotiation platforms (Moreyra, 2001; Boelens & Hoogendam, 2002).

2.7 Conclusion

Agricultural water management has been effective in increasing yields and food production worldwide. Water professionals have developed and promoted agricultural water management techniques such as rainwater harvesting and flood control. In many places, however, planners, engineers, extension staff and decision-makers still fail to perceive women as farmers compared to men. Consequently, policies, programmes and projects frequently overlook the knowledge, tasks, needs and requirements of female and male farmers in managing agricultural water security, hence, the impetus to conduct the current study on gender-based analysis of agricultural activities on water security.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

Chapter 3 presents the methodology adopted by the researcher for this study. It outlines the design and techniques used to ensure the attainment of the stated objectives in a rigorous and scientific way. Specifically, the present chapter provides detailed discussions of the study area, research design, study population, and data collection techniques. This chapter also discusses data analysis techniques employed in this study and concludes by giving an overview of the relevant ethical considerations.

3.2. Description of the Study Area

The study was conducted at the Luvhada irrigation scheme, located at Nzhelele Ha-Mphaila village approximately 65kms from Thohoyandou town and 50kms from Louis Trichardt. It is about ±7 kilometres away from Siloam hospital and ±12km from Biaba shopping Centre. The GPS coordinates of Luvhada irrigation scheme are 30°9'0"E & 22°54'0"s. Moreover, Luvhada is located between the Nzhelele River and Mphephu Resort. The Lalumba fountains are the main water suppliers to the scheme and Women in Luvhada village dominantly engage in agricultural crop production, and the produce is sent to various markets, however, areas such as Dzanani, Thohoyandou, Louis Trichardt and Musina are the largest recipients. The following map (Figure 3.1) shows that Luvhada village at Ha-Mphaila, out of the 18 schemes in Nzhelele is the less developed, hence, its selection.

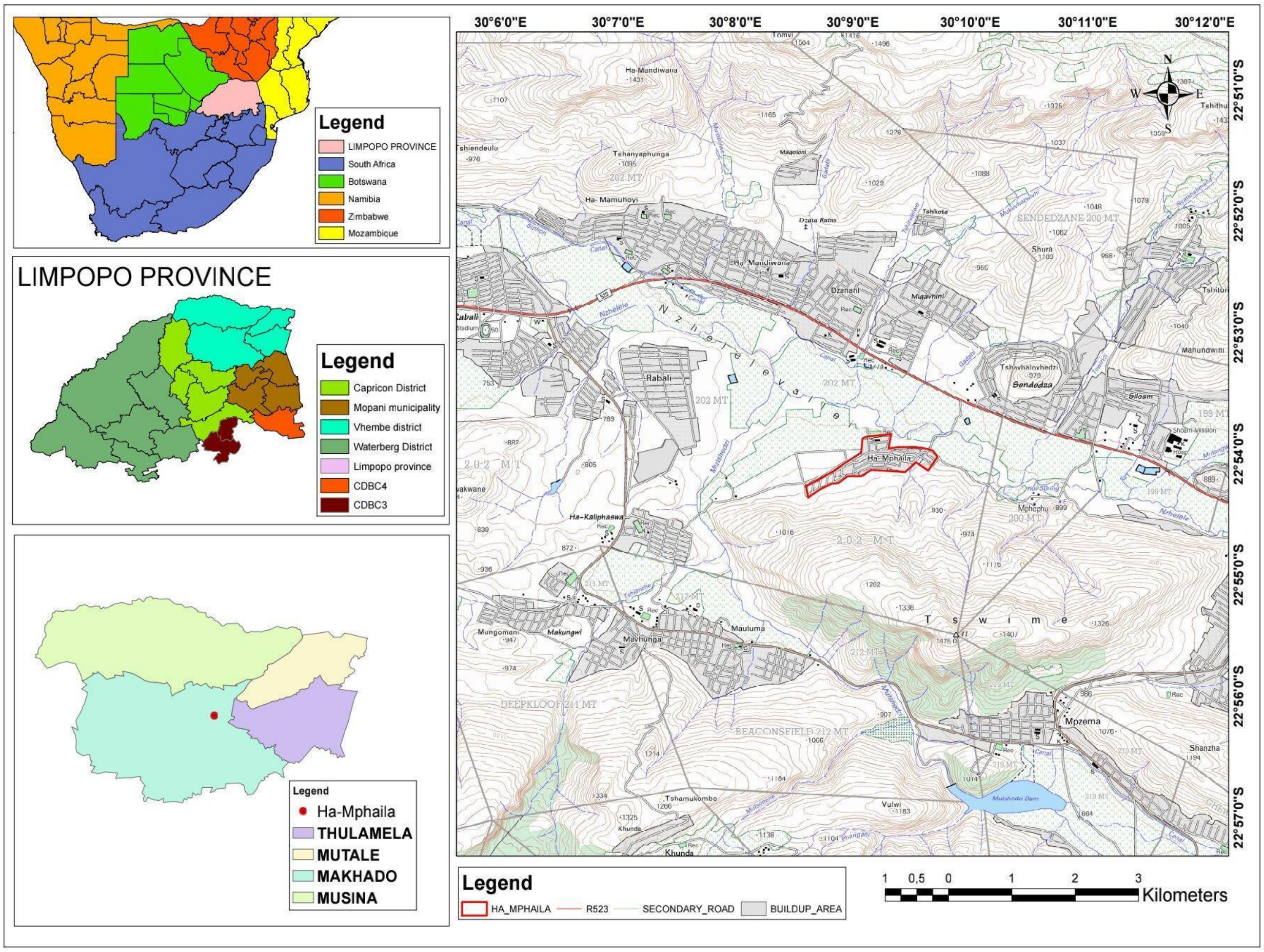

Figure 3. 1: Map of the study area (Source: STATSSA, 2019 UNIVEN GIS)

3.3. For the research Design, a convergent parallel mixed method design was used in this study. This refers to a study technique where both qualitative and quantitative data are collected concurrently, and the data is analysed and integrated (David, 2018). A research design refers to a careful set of plans developed to provide criteria and specifications for research (Williams., 2014). It constitutes the blueprint for the collection, measurement, and analysis of data (Kothari, 2013).

In the mixed design, two data sets were analysed separately, and results were combined during interpretation. The approach was considered appropriate as both the data sets provide equal value in understanding the research problem (Creswell, 2014). This study is aimed at describing and understanding gender-based analysis of agricultural activities on water security in Luvhada community, hence, utilising this method allowed for a thorough interrogation of the effects of crop production on water security. A combination of both exploratory and descriptive data provides a conclusive picture from both narrative stories and as well as descriptive statistics to establish definitive conclusions about the research focus.

The qualitative exploratory approach was utilized to map and identify farming practices for both male and female. Furthermore, the explorative study shed more light on the types of crops commonly planted by women and men, water consumption, seedling germination and crop maturity. Specifically, this approach was used to respond to the objectives of the study. On the other hand, the quantitative study was descriptive in nature to estimate and describe the effects of gender variables, such as frequency of irrigation, farming practices for water availability, management, income, safety and quality and access to services. Also, descriptive data was used to test the relationship between output per hectare against water security gender variables.

3.4 Population and Sampling Procedures

3.4.1 Population of the study

All the women and men farmers in Luvhada irrigation scheme formed part of the study population. Population is defined as a total set from which the individual participants or units of the study are chosen (De Vos *et al*., 2005; Welman *et al*., 2008). Creswell (2014) defines it as the total of items about which information is desired. In this study, the population comprised of the total number of female and male farmers, exceeding 100 potential survey participants.

3.4.2 Sampling procedures

The snowball technique was desirable for the selection of women and men involved in agricultural activities in Luvhada. Data saturation was used to decide the total number of women and men to include in the explorative study; this refers to a systematic data collection technique in which the process stops when the respondents are no longer giving any newer insights about the research phenomenon (Creswell, 2014). Data saturation is the most used technique in determining sample size for explorative qualitative studies (De Vos *et al.,* 2016), hence, it was considered appropriate for this study.

Total sampling technique was used to select respondents for the quantitative data collection. Total sampling techniques (also known as 'census sampling') is used where it is possible to collect data from all the respondents and they were in a well-organized environment. Census sampling is appropriate when there is a need to establish definitive conclusions about the population (Creswell, 2014). A telephone survey was deployed for collecting data from the specific targeted population. A telephone survey was appropriate to collect data for this study to avoid close contact with participants as it was critical to follow COVID-19 measures to minimise the chances of contracting and/or spreading the virus among respondents.

3.5 Data Collection Procedures

Qualitative data was collected using open-ended questions. A questionnaire was used as the tool for the collection and was done telephonically with the respondents. Interviews in this study were used to and solicit and understand information about the current irrigation water practices, their perceived impacts as well as experienced effects on the water resources. Interviews built an understanding on the perceived short and long-term impact of the current water practices in the irrigation scheme.

The quantitative data was collected using a questionnaire with close ended questions. A tool was developed based on the existing literature to estimate and measure the respondents' views on the impact of their activities to water and food security. A questionnaire enabled the respondents to estimate values on items, such as the amount of water used and frequency of irrigation.

3.6 Validity and Reliability

Validity and reliability were ensured in this study.

3.6.1 Validity

Creswell (2017) defined validity as the ability of the instrument to measure that which it is intended to measure. In this study, two types of validity were used, namely - face validity and content validity. To ensure face validity, the instrument was constructed following an intense review of literature on the role of gender in patterns of agricultural water use, land ownership and agricultural management practices.

To ensure content validity, the preparation of data collection instruments was guided and assessed by people who are knowledgeable about gender and water security issues in agricultural activities. For instance, the design of research instruments was guided by promoters who had expertise in assessing the authenticity of the questions on the variables under study. Further, this work was presented to the University's Higher Degrees Committee (UHDC), Faculty, School and the Department for quality assurance.

3.6.2 Reliability

Creswell (2013) explains that reliability responds to the question of dependability; that is, whether the instrument will yield the same results if it is administered in the same manner as it was previously administered. In this study, reliability was ensured through pre-testing the research instruments on a small sample of respondents before a full-scale study was done (Bryman 2015). Pre-testing was done to check for the presence of any form of ambiguities that could potentially compromise the reliability of the research instrument. To reiterate, the developed research instruments were referred to experts and pre-tested to ensure reliability and trustworthiness of the data prior to administering it to the target population. Open and quick coding techniques were applied.

3.7 Data Collection, Management and Analysis

Qualitative data was analysed thematically. Atlas. Ti software version 8.1 was used to build and group emerging themes from the empirical evidence in conjunction with the literature information. The software allowed for a systematic analysis and review of qualitative data with more clarity enabling the building of themes and the visual inspection of the themes and sub-themes using network diagrams (Vaughn & Turner, 2017). Specifically, open coding was used; this is the grouping of discrete variables that broadly explain a phenomenon, hence, in this study emerging concepts on gender-based analysis of agricultural water security was categorized into themes using the software (Smit, 2002). Atlas Ti is recommended in the analysis of large pieces of information such as texts, audios, and photographic material (Smit, 2002). As such, it was relevant for this study as data was collected using interviews.

Quantitative data was analysed descriptively using Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics was used to calculate frequencies and mean scores, standard deviations, and percentiles to explain and interpret the extent of the impact of the current water practices in Luvhada irrigation scheme on water security. The Spearman's rank correlation coefficient (r) was used to determine the degree of correlation between the gender, water consumption, seedling germination effects on crop production, income among others.

The qualitative data analysis was analysed using an Atlas Ti software package, however, the whole process can be summarised by Tech's 8 steps open-coding method for thematic content analysis which, according to De Vos., (2011) are guided by the following steps:

Participant's responses were carefully selected from one subject and read carefully to understand and describe the gender and water security issues in agricultural activities.
This was followed by arranging similar topics on potential gender and water security issues in agricultural activities in groups by forming columns labelled with major topics. Topics as codes were abbreviated and written next to the appropriate segment of the text. An overview of how the data was organized, and re-checked for new categories or codes which had emerged was appropriately done.
After that the researcher found the most descriptive wording for the topics on gender and water security issues in agricultural activities and turned them into categories. This was followed by abbreviating each category and putting in one place and performing a preliminary analysis. Lastly, there was a recording of the data in the form of a report.

3.8 Ethical Considerations

In research, ethical consideration is one important point that deserves attention. This is mainly because of the necessity to strictly respect the right of the respondents whether they are willing to participate in the research or not. The researcher will explain the aims, purpose of the study, the implications, and possible risks for involvement in the study to the respondents.

It was important that before conducting the study, an ethical clearance certificate be obtained from the University Research Ethics Committee. After that, a meeting was sought with the farmers at Luvhada, and community leaders to seek permission to conduct this study in the area. This was done before commencement of the data collection process in general. The meetings were held to present and explain what the research entailed. After that, the permission to conduct the study was granted. In addition, the meetings with the agricultural extension officers paved the way for engaging the wider community specifically to make the people aware of the study and gauge their readiness for the study.

Due to Covid 19 pandemic, telephonic interview was considered a suitable method to collect data. Prior to interviewing respondents using open and close ended questions, the details of the research were explained. Data collected was treated with strict confidence and professionalism. It was emphasized to the respondents that the results would be used for academic purposes only. The right of respondents to withdraw at any stage of the research was made known to them prior to starting any interview. Collected data were safely kept in electronic devices and would remain accessible only to the researcher and the supervisors. Upon completion of the study, the findings would be presented back to the community at Luvhada.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND RESULTS

Abstract

According to the latest FAO (2018), estimates, women account for an average of 43 percent of the agricultural labor force in developing countries but despite this, water policies related to agriculture continue to wrongly assume that farmers are men, thus marginalizing women in water resource management. This study, thus, investigated agricultural water-use patterns across the gender divide in Luvhada village. A convergent parallel mixed-method design was applied using a single sample size for both qualitative and quantitative strands of the study. A telephone survey was endorsed to collect data using a questionnaire consisting of closed and open-ended questions. Atlas -ti was employed to analyze the qualitative data using thematic content analysis whilst quantitative data were examined descriptively using Statistical Package for Social Sciences (SPSS) version 26. The study results have revealed that both female and male farmers in the Luvhada area depend on irrigation schemes to access water for agricultural practices and four main crops which included spinach, maize, sweet potatoes, and butternut were grown in the area. The results of the study also indicated female farmers own smaller pieces of land compared to their male counterparts, a fact that might influence their productivity. Also, a lack of equipment to pump water and broken canals at the scheme posed a huge problem for them in terms of accessing and delivering of water to the users. Farmers were also cultivating other crops for both marketing and household consumption. The study aimed at understanding the nature of the relationships between farmers' dependent variables such as land ownership, type of farming and nutrient management practices and gender as an independent variable. The tests revealed that gender did not influence the distribution of variables ($p > 0.05$). The findings, however, suggested that the influence of gender could become visible upon increasing the sample size.

***Keywords*:** Atlas-ti, Gender, Luvhada, Scheme, SPSS.

4.1 Introduction

Water is a critical input for agricultural production and plays an essential role in food security (Karabulut, *et al.,* 2018). Irrigated agriculture represents 20% percent of the total cultivated land and contributes 40 percent of the total food produced worldwide. Irrigated agriculture is, on average, at least twice as productive per unit of land as rainfed agriculture, thereby allowing for more production intensification and crop diversification. Women play an important role in both irrigated and non-irrigated agriculture, and a larger number of women than men are engaged in rain-fed agriculture producing two-thirds of the food in most developing countries. The purpose of this chapter was to analyse data and present results. Data were collected from women and men small-scale farmers to capture their agricultural water use patterns across the gender divide, in other words, gender-based farming practices that affect water security. The detailed methodology was presented in Chapter 3. This first section presents the biographical information of the surveyed participants.

4.2 Biographical Information of the Surveyed Participants

Results reflect that a total of 61 farmers participated in the study - both male and female farmers. Table 4.1 indicates that 60% of the participants were male while 40% were female. Regarding education levels, 58% have attained Grade 10; 23% have matric, 17% have no educational qualification and the remaining 2% had a diploma. Most farmers on the scheme, had low education levels which may jeopardize their knowledge capacity. In terms of marital status, 80% were married, 10% single, 7% divorced and 3% widowed. The number of dependents varied across households as 35% had between 5-6 dependents, 27% had more than 7 dependents, 25% had either 1 or 2 dependents while the remaining 13% had between 3 and 4 dependents. Most families were relatively large among the farmers.

4.2.1 Age of Survey Participants

Results indicate that participants were drawn from different age groups (Table 4.1). The highest proportion (45%) were between the ages of 35-45, years followed by those who were above 46 years old at above 43% and lastly farmers between the ages of 26-30 contributed 12%. This highlights that youth were not involved in farming at the irrigation scheme.

Table 4. 1: Participants' demographic information

Variable	Categories	Frequency	Percentage
Age	26-30	7	12
	31-35	27	45
	36+	26	43
	Total	60	100
Gender	Male	36	60
	Female	24	40
	Total	60	100
Education level	None	10	17
	grade 10	35	58
	Matric	14	23
	Diploma	1	2
	Total	60	100
Marital status	Single	6	10
	Married	48	80
	Divorced	4	7
	Widowed	2	3
	Total	60	100

Variable	Categories	Frequency	Percentage
Number of household children	1-2	15	25
	3-4	8	13
	5-6	21	35
	7+	16	27
	Total	60	100

4.3 Irrigation land ownership

As shown in Figure 4.1, 98% of the farmers owned the land they were using while only 2% had leased the land for agricultural purposes. As further indicated in Figure 4.1, majority (45%) of the farmers possessed and irrigated small pieces of land equivalent to 0.2 hectares, however, far less than the combined proportion of farmers who possessed at least 1.5ha (54%) (refer to the graph for detailed results). This shows that the irrigated land in the area is small, a feature that characterizes small-scale farmers.

4.3.1 Gender and land ownership

A crosstabulation test was performed to understand the relationship between gender and the total irrigation land ownership in the area. As highlighted in Table 4.2, most (13) of the women at the scheme owned small land sizes of 0.2ha. In contrast, most men (16) owned 2.4ha as compared to only 3 women who owned the same size of land, confirming that female farmers own small pieces of land compared to their male counterparts, a fact that might influence their productivity. There was, however, no association between gender and land ownership ($\chi^2 = 9.408$; $p > 0.05$), although, gender and land ownership variables were related at a 10% level of significance, but the existing statistically insignificant relationship between gender and land ownership at a 5% level of significance could be due to the small sample size.

4.4 Current source of water

The data analysis showed that all participants obtained water from a local river and irrigation scheme to irrigate their crops.

4.5 Crops grown

Figure 4.3 is a network diagram designed from the Atlas ti Version 8 software package showing crops that are grown in the study area. Four main crops - spinach, maize, sweet potatoes, and butternut - were grown in the area. Maize and spinach were used for local trading and household consumption, especially, to make pap and relish (local main dish) while butternuts and sweet potatoes were also used for income generation and as a delicacy for breakfast. From observation, apart from butternuts, the other crops were drought resistant. Farmers were also cultivating other crops for both marketing and household consumption - tomatoes, okra, groundnuts, leafy “mushaina” vegetables and green pepper.

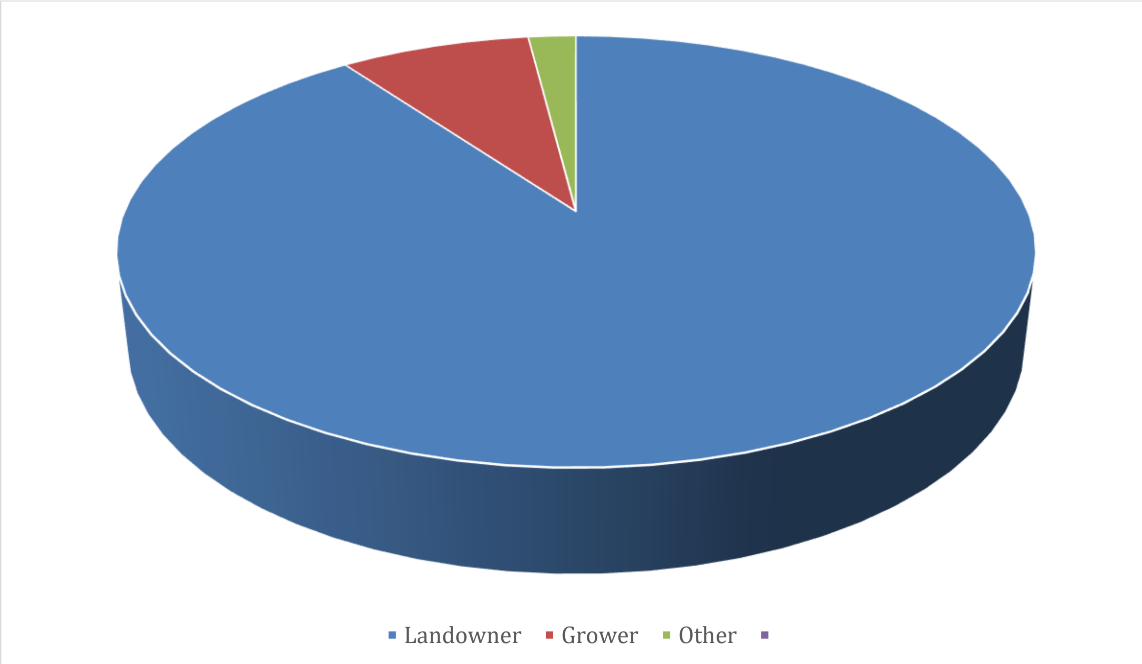

Figure 4. 1: Distribution of participants by land ownership

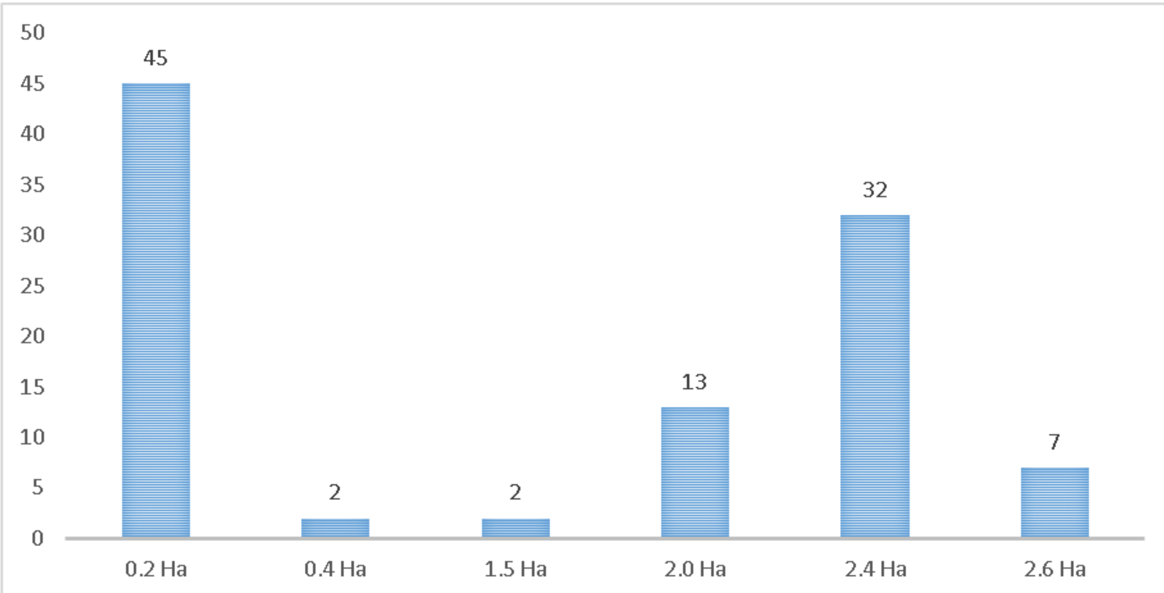

Figure 4. 2: Distribution of participants by total irrigated hectares

*Table 4. 2: Total hectares Irrigated * Gender Crosstabulation*

Variable		**Gender**		**Total**
		Male	**Female**	
Total hectares Irrigated	0.2	14	13	27
	0.4	0	1	1
	1.5	1	0	1
	2.0	3	5	8
	2.4	16	3	19
	2.6	2	2	4
Total		**36**	**24**	**60**
Chi-Square Tests				
		Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square		9.408[a]	5	.094

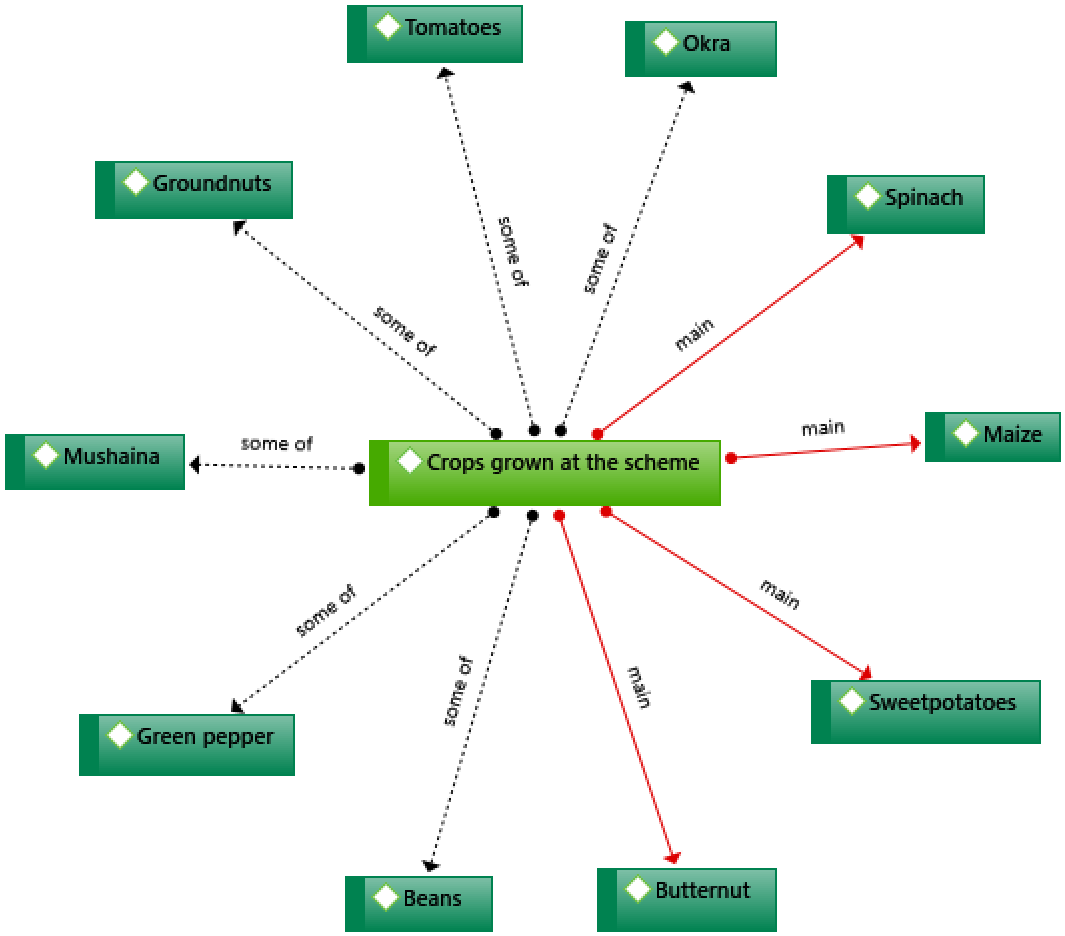

Figure 4. 3: Crops grown at the scheme

4.6 Farm type

This subsection provides insight into the type of farming and whether gender disparities exist in the type of farming. It was revealed that 60% of the farmers were in agriculture for commercial reasons while the remaining were subsistence farmers (see Figure 4.4 below). The Crosstabulation test further indicated that a proportionately high number of females (16) were into commercial farming as compared to only 8 who were farming for subsistence reasons. Male farmers practised both farming types, although a slightly larger number (20) was into commercial farming (see Table 4.3). It was observed that the distinction between the preferred farming type between males and females was statistically significant ($\chi^2 = 9.408$; $P > 0.05$). This means that being a female or male farmer has nothing to do with whether farming was done for commercial or subsistence reasons.

4.7. Water use records

Data analysis showed that all participants did not have any means of tracking water use, hence, were not able to track water use on their plots.

4.8 Preference for an upgraded irrigation system that improves water efficiency

In this subsection, farmers were asked to indicate if they preferred an upgraded irrigation system that improves water efficiency or not. As shown in Figure 4.6, an overwhelming majority (87%) of participants revealed they preferred upgraded irrigation systems like drip while 13% preferred to continue using their current irrigation systems that included flood irrigation systems. Those who were in favour saw them as water-saving and efficient mechanisms that can transform their farming, however, the few farmers who did not prefer the upgraded irrigation systems were deterred by the high start-up and maintenance costs required to install and operate such mechanisms. Further tests to ascertain the significance of differences in preferences for new irrigation systems were performed using crosstabulation. Table 4.4 clearly shows that there were no significant differences in preferences for upgraded irrigation systems between male and female farmers ($\chi^2 = 0.877$; $P > 0.05$). This means that gender does not influence farmers' interest in upgrading their irrigation systems that improve the water efficiency of their plots.

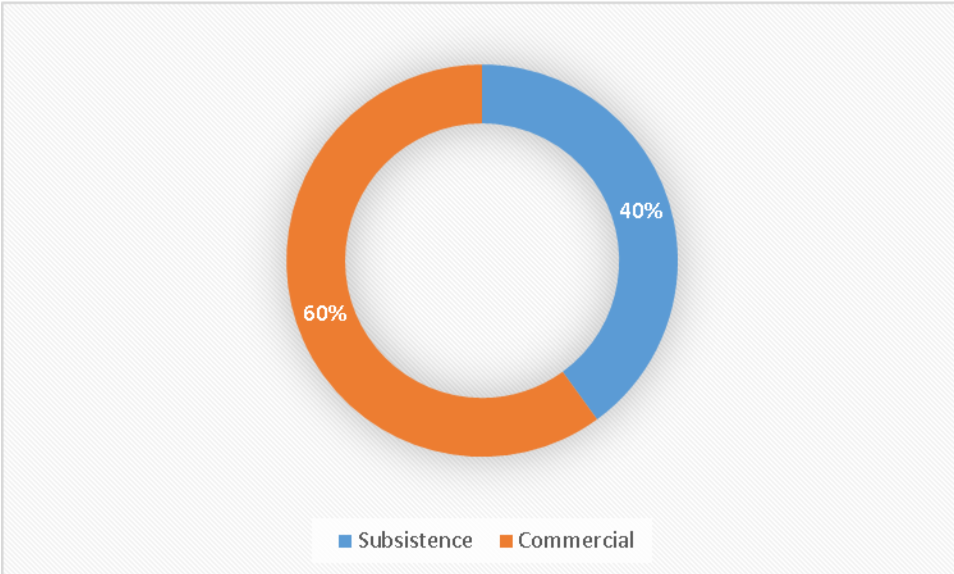

Figure 4. 4: Distribution of participants by type of farming

*Table 4. 3: Farm Type * Gender Crosstabulation*

		Gender		**Total**
		Male	**Female**	
Farm Type	Subsistence	16	8	24 (40%)
	Commercial	20	16	36 (60%)
Total		**36**	**24**	**60**
Chi-Square Tests				
		Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square		0.741[a]	1	0.389

*Table 4. 4: Interest in Upgrading irrigation system that improves water efficiency * Gender Crosstabulation*

Question		**Gender**		**Total**
		Male	**female**	
Are you interested in an Upgraded irrigation system that improves your water efficiency?	Yes	31	21	52 (87%)
	No	5	3	8 (13%)
Total		**36**	**24**	**60**
Chi-Square Tests				
		Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square		0.024^a	1	0.877

4.9. The main obstacle to installing a new irrigation system

Data analysis revealed that the main obstacle to the installation of new irrigation systems in the area was financial inadequacy. New irrigation technologies required start-up capital as well as high maintenance costs, such as for electricity and maintenance fees, thus, smallholding farmers who often earn little from their farming activities are not able to fund such irrigation systems without the assistance of government and private institutions.

4.10. Agricultural activities undertaken at the scheme

Table 4.5 shows the agricultural activities undertaken by men and women at the Luvhada irrigation scheme. It was clear that men and women largely practiced crop farming as indicated by the 97.2% male farmers and 95.8 % female, thus, only 2.8% male and 4.2% female were practicing livestock production, respectively. There were no distinctions in the preferred farming activities between male and female farmers ($P > 0.05$). This means that the proportion of men and women farmers who engaged in crop farming could not be significantly differentiated from each other. The same conclusion was reached between the proportions of men and women who practised livestock farming.

4.11. Water requirements for farming activities

In terms of water requirements, most farmers (97%), regardless of the gender, were not satisfied with the water supply for crop production in the area. Majority of farmers revealed that the area would spend months without access to water, which was also shared with the nearby villages hence, there is a schedule for water access.

4.12 Frequency of the Irrigation System’s Maintenance

Regarding the frequency of maintenance of the irrigation system, results in Table 4.6 showed that most of the male farmers (69.4%) reported that no regular maintenance was being undertaken, while only 30.6% revealed that maintenance was normally undertaken when necessary. Similarly, most female farmers, (79.2%) reported that maintenance work was not undertaken, while only 20.8% believed that maintenance was done when necessary. Conclusively, the irrigation system’s maintenance was hardly done while the little which was done, was only undertaken when necessary. It depicts that the irrigation infrastructure is likely to be dilapidated and damaged.

Table 4. 5: Agricultural activities practiced by men and women

Gender		Frequency	Percentage
Male	Crop farming	35	97.2
	Livestock	1	2.8
	Total	36	100.0
Female	Crop farming	23	95.8
	Livestock	1	4.2
	Total	**24**	**100.0**

Table 4. 6: Frequency of Irrigation System Maintenance Practices

Gender		Frequency	Percentage
Male	When necessary	11	30.6
	None	25	69.4
	Weekly	0	0
	After each irrigation event	0	0
	Total	**36**	**100.0**
Female	When necessary	5	20.8
	None	19	79.2
	Weekly	0	0
	After each irrigation event	0	0
	Total	**24**	**100.0**

*Table 4. 7: Nutrient Management Practices * Gender Crosstabulation*

Question		Gender		Total
		Male	Female	
Which nutrient Management Practices apply to your crop production	Fertilizer	9 (25%)	6 (25%)	15 (25%)
	Manure	27 (75%)	16 (67%)	43 (72%)
	Mulching	0	2(8%)	2 (3%)
Total		36	24	60
Chi-Square Tests				
		Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square		3.140[a]	2	0.208

4.13 Nutrient management

This subsection sought to understand the nutrient management strategies used by farmers on their plots. Table 4.7 reflects that most of the farmers (72%) were utilizing manure followed by 25% who preferred fertilizer while only 3% utilized mulching, however, gender comparisons using cross-tabulations show a large distinction between male (75%) and female (67%) farmers who were utilizing manure; only females (8%) utilized mulching. Further investigation indicated that these distinctions were insignificant ($\chi^2 = 3.140$; $p > 0.05$), therefore, there are insignificant differences between the nutritional management practices utilized by male and female farmers at the Luvhada irrigation scheme.

4.14 Conclusion

The purpose of this chapter was to present analyzed quantitative data's results for 60 participants. The results showed that gender played a statistically non-significant role influencing land ownership, type of farming and nutrient management practices among farmers. The researcher suspects that this could be due to the small sample size used in generating the results. The next chapter presents results on challenges faced by farmers in the Luvhada irrigation scheme.

CHAPTER FIVE

CHALLENGES FACED BY WOMEN AND MEN FARMERS IN LUVHADA

Abstract

The objective of this chapter was to analysed gender-based farming practices that affect water security. A convergent mixed parallel research design was deployed to understand gender-based farming practices that affect water security. The study adopted a mixed method design and utilized structured and semi structured questions to solicit answers from the respondents. The results of the study revealed that the quantity of water supply was not matched with the time pattern of crop needs. Majority of farmers revealed that the area would spend months without access to water; this was also shared with the nearby villages, hence, there is a schedule for water access. Farmers in the Luvhada area are confronted with challenges as there are inadequate rainwater storage facilities, competition for water between users, loss of water by infiltration, as well as damage to canals and furrows. Additionally, most (60%) of surveyed smallholder farmers in central Limpopo report challenges in accessing water, mainly through groundwater boreholes. A lack of irrigation water pipes was commonly experienced by both men and female farmers, hence the shortage was not gendered. The findings showed the extent to which farmers require assistance in overcoming the challenges that continue to threaten the survival and growth of their livelihoods.

Keywords: Atlas-ti, Gender, Farming, Water security.

5.1 Introduction

Agricultural water is used to grow fresh produce and sustain livestock. According to the Geological Survey (2018), water used for irrigation accounts for nearly 65 percent of the world's freshwater withdrawals, excluding thermoelectric power (Muhammed,2021). When agricultural water is used effectively and safely, production and crop yield are positively affected. A decrease in applied water can cause production and yield to decrease. In rural settings, small-scale farmers are more likely to experience several agricultural water security challenges which hinder sustainable agricultural production, thus, this chapter explores farming practices by women and male farmers that affect water security in Luvhada.

Luvhada is between the Nzhelele River and Mphephu Resort; the Lulumba fountains are perennial and the main source of agricultural water for the scheme. The water is cool when it reaches the field after flowing the distance from the source to the irrigation scheme. The scheme comprises approximately of 79 associates, each with 0.4 ha of farming land. The main crops grown include maize, beans, sweet potatoes and groundnuts.

This chapter presents the challenges associated with water security among farmers practicing farming at the Luvhada irrigation scheme and whether these challenges were gendered. The detailed methodology to gather relevant data is provided in Chapter 3.

5.2 Challenges faced by men and women farmers

Figure 5.1 below presents a network diagram summarising agricultural water security challenges as well as how men and women farmers are impacted by these different forms of challenges, although, we observe that both male and female farmers are affected by the lack of water reservoirs. The remaining challenges include - outdated infrastructure, canal and furrow water leakages, insufficient primary canals, droughts, lack of water pump and lack of irrigation water pipes - were experienced by both men and female farmers, hence, were not gendered.

5.3 Major agricultural water security challenges

The results of the study have revealed that the 80% of farmers in the Luvhada area are confronted with several challenges (Figure 5.1 below). The major challenges identified included - outdated water infrastructure, canal and furrow water leakages, insufficient primary canals, and droughts - while minor challenges such as - floods, lack of irrigation pipes, lack of water reservoirs and lack of water pumps - were also mentioned. These challenges cut across gender and age dimensions and thus, affected every farmer in the area. The major challenges are further explained in the following subsections.

5.3.1 Outdated water infrastructure

All participants unanimously complained about the outdated irrigation infrastructure in the area. The farmers at the scheme sorely rely on flood irrigation, which is labour-intensive. The system also results in the misuse of limited water resources as some water is lost along the canal and furrows. This is made worse by the lack of reservoirs to store water and use it when necessary. No gender disparities were revealed as the findings show that both men and women were equally affected by this challenge.

5.3.2 Canal and furrow water leakages

The canals and furrows were also worn out due to limited maintenance. Farmers at the scheme did not have the financial capacity to renovate the broken canals as well as construct concrete furrows, hence, the canals spill a lot of water before it reaches the fields. This results in water scarcity at the scheme and thus reduces crop production. When the scheme was established, the Lalumba fountain became a foundation of attraction as far as water supply to the scheme was concerned. The only easy way to get water from the fountain to the scheme was the construction of canals, thus, a secondary canal was constructed from the fountain into the scheme where primary canals were constructed to supply water into the furrows. The canals carry large amounts of water and are exposed to different kinds of weather leaving them vulnerable to damage such as cracks and the development of fungi on the canal walls. According to the results, men and women farmers were equally affected by this challenge.

5.3.3 Insufficient primary canals

Beside the dilapidation, there is a shortage of supply canals from the fountain, which supply water to the scheme as the only existing canal cannot supply all the plots. This forces the farmers to schedule their irrigation to share the water equally, therefore, crops that require water regularly suffer in most cases, as the schedules limit farmers from irrigating when it is necessary. The findings of this study revealed that this challenge was not gendered.

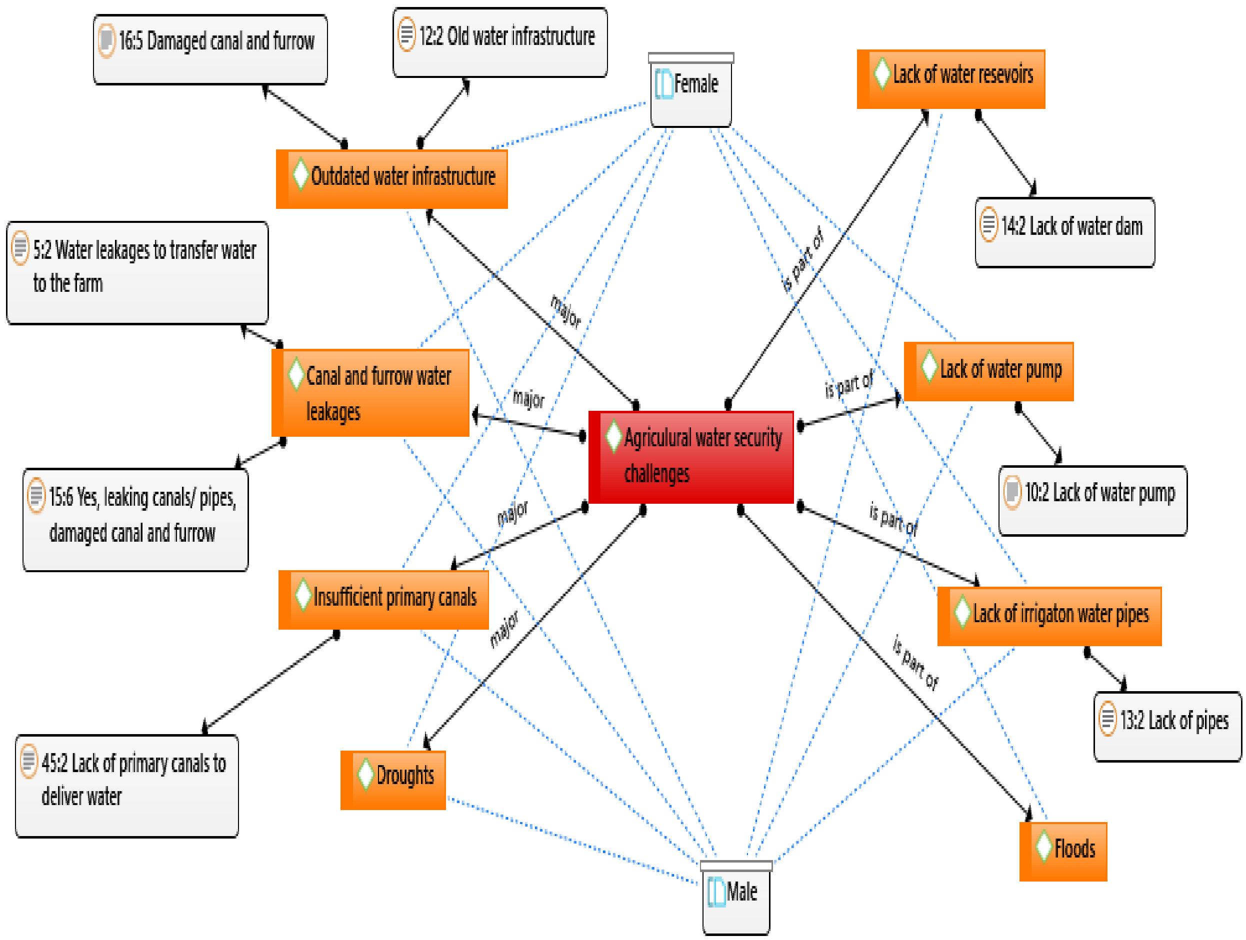

Figure 5. 1: Agricultural water security challenges faced by farmers

5.3.4 Droughts

It was reported that the Luvhada irrigation scheme has become vulnerable to regular droughts in recent years. The droughts have been caused by limited rainfall per farming season. This also results in reduced water availability in summer as the fountain and nearby river levels dwindle. This is what one farmer said to illustrate the above fact:

"*I used to produce my whole 4 hectares, however, in the last 2 to 3 years, as you can see here; no longer use the whole field. Our major problem on this farm is water scarcity caused by erratic rain. We are working on improving our irrigation system that can cover the whole area and until then we will use this small portion*" (Farmer).

5.3.5 Lack of Reservoir

The respondents indicated that the reason for the shortage of water in the scheme is that there are no water storage facilities to store water from the Lalumba fountain since they share the fountain with the Mphephu Resort and residents who do their washing at the fountain.

5.3.6 No water storage and dam

The Respondents revealed that since the establishment of the scheme, nothing has been done to try and store water for irrigation. They said that it is an expensive move to construct a dam or a reservoir if they have no help from other stakeholders. They previously attempted to build a water storage facility but failed to acquire land rights from the local chief.

5.4 Discussion of findings

The findings of this study identified 8 challenges that are faced by farmers in Luvhada. These challenges are like those reported by Mengistie & Kidane, (2016). These include - low yield due to shortage of water and insecticides, lack of moisture in the soil and underground pests, need for high care of pests control, lack of water and high-water requirements. In this study, most of the respondents listed water security challenges facing farmers of the Luvhada irrigation scheme as indicated in Figure 5.1, for example, no water storage and dam, lack of reservoir, droughts and insufficient primary canals. The challenge of floods was unique to female farmers while the lack of water reservoirs was unique to male farmers. This finding opens new avenues for investigating how floods are impacting on the day-to-day agricultural activities. Similarly, the role of water reservoirs in promoting agricultural productivity could also be investigated following these findings. According to the World Bank, floods and droughts constitute two devastating consequences of the climate crisis. The observation that women farmers were able to overcome these dire consequence of climate change, points to the extent to which women have noticed these changes being the chief caretakers of the land, yet with limited land ownership rights.

The findings of this research showed the extent to which farmers require assistance in terms of overcoming the challenges that continue to threaten the survival and growth of their livelihoods. Mengistie & Kidane, 2016 report how irrigation remains one of the possible means of feeding the rapidly-growing population due to its ability to promote agricultural diversification, enhance food self-sufficiency and increase rural incomes. The authors add that low rainfall and continuous drought occurrence cause less-developed crop production methods.

The problem of droughts and floods is not unique to this study. Kruger and Sekele (2012), as well as Musetha (2017), also reported that rainfall in the Limpopo Province has become erratic and occasionally delayed. Zengeni *et al.,* (2016) mention that the same trends have also been observed globally and in the sub-Saharan continent; for example, herders in the Asian Pacific are clear that rainfall has become patchier and delayed and this has negatively impacted crop production, water resources, as well as plant biodiversity (Rankoana, 2016). Zwane (2019) in South Africa, observed that dams had low water levels in the period of 2016/2017, therefore, crop yields significantly reduced for both small and commercial farmers. Both excessive and limited rainfall reduce the productivity capacity of farmers. It is, therefore, critical that farmers develop and/or are supported to mitigate water challenges. All these studies agree well with the findings reached in this study.

Some farmers use irrigation of shallow wells and deep wells which is not common in the area, the reason is dependence on rivers, as the role of rainfall is very important for the development of the scheme (Abid, 2018). At the Luvhada irrigation scheme, both male and female farmers experience high agricultural production challenges due to water security, among other factors. Resolving the challenges of the future requires a thorough reconsideration of how water is managed in the agricultural sector, and how it can be repositioned in the broader context of overall water resources management and water security. Irrigation and drainage schemes, whether large or small, represent prominent spatially-dispersed public works in the rural spaces, thereby, also representing a logical vehicle for mobilizing employment opportunities in communities.

5.5 Conclusion

This chapter identified 8 challenges that are faced by farmers in agricultural water security. The challenge of droughts was unique to female farmers while the challenge of lack of reservoirs was unique to male farmers. This means that, despite the existence of several challenges that affect the agricultural activities of farmers in Luvhada, there were also gendered challenges. The next chapter discusses intervention strategies for addressing the challenges that have been reported in this chapter.

CHAPTER SIX

INTERVENTION STRATEGIES FOR ENHANCING GENDERED AGRICULTURAL WATER SECURITY

Abstract

The main objective of this chapter is to explore intervention strategies for enhancing the efficiency of gendered agricultural water security. An exploratory study approach was followed to understand the intervention strategies for enhancing the efficiency of gendered agricultural water security by small-scale farmers in Luvhada, to address agricultural water-security challenges. Sixty farmers were chosen to participate in this study; the size was determined by the data saturation principle. Due to COVID 19 protocols and regulations, telephone survey was an appropriate method to collect data. ATLAS – ti version 8 software (network diagram technique) was utilized to analyse qualitative data. The software permits coding and systematically synthesis themes emerging from responses. The study results revealed that strategies such as the construction of dam reservoirs and the installation of a central water supply pump, water tanks, and pipes should be implemented. Additionally, the development of modern irrigation techniques and the adoption of drip irrigation and modern irrigation techniques were considered appropriate solutions.

Keywords: Atlas-ti, Gender, Efficiency, Strategies, Water security

6.1 Introduction

The previous chapter discussed the challenges faced by men and women farmers in Luvhada. In this present chapter, the researcher discusses suggested strategies for enhancing the efficiency of gendered agricultural water security. The detailed methodology for collecting data to respond to the objective of the current chapter is presented in Chapter 3.

Water is of fundamental importance to human development, the environment, and the economy. Access to water security is paramount to improving food security, agricultural production, incomes and livelihoods of rural communities (Jeremy, 2011). Reliable access to water not only remains a major constraint for millions of poor male and female farmers, mostly those in rainfed areas, but also those involved in irrigated agriculture (Muhammad, 2021). Climate change and the resulting changing rainfall patterns pose a threat to many farmers, who risk losing water security and slipping back into the poverty trap (Borgadi, *et al.,* 2012). The main objective of this chapter was to explore intervention strategies for enhancing gendered agricultural water security. An exploratory study approach was followed to understand the intervention strategies for enhancing the efficiency of gendered agricultural water security by small-scale farmers in Luvhada to address agricultural water security challenges. Sixty farmers were chosen to participate in this study and the size was determined by the data saturation principle. Due to covid 19 protocols and regulations, telephone survey was an appropriate method to collect data and an ATLAS – ti version 8 software (network diagram technique) was utilized to analyse qualitative data. The software permits coding and systematically synthesises themes emerging from the responses. The study results revealed that strategies, such as the construction of dam reservoirs, installation of a central water supply pump and installation of water tanks, pipes should be implemented. Additionally, the development of modern irrigation techniques and the adoption of drip irrigation and modern irrigation techniques were suggested solutions.

6.2 Intervention Strategies for Addressing Agricultural Water Insecurity

Figure 6.1 presents a network diagram that summarises the intervention strategies for remedying gendered agricultural water insecurity. As clearly shown in the Figure below, strategies such as the construction of dam reservoirs, installation of a central water supply pump and installation of water tanks were gendered with the first two (2) strategies biased towards female farmers while the third strategy was biased towards male farmers.

6.2.1 Adoption of drip irrigation system

85% of respondents suggested that constructing pipelines and drips will help them to face out a furrow irrigation system and introduce scheme members to water conservation methods. As shown in Figure 6.1, farmers strongly indicated the need to adopt a drip irrigation system. The system was preferred due to its water-saving capacity as well as its efficiency in supplying water across large and small plots. Farmers indicated that they were mainly relying on old irrigation systems such as flood irrigation, which were laborious and often resulted in the loss of water in the furrows and canals. Two of the participants said the following when articulating the need for farmers to adopt drip irrigation systems:

"There is need to adopt drip irrigation as it saves water and nutrients by allowing water to drip slowly to the roots of plants"

(*Female farmer)*

"Drip irrigation systems deliver water and nutrient directly to the crop root zone at the right amount"

(Male farmer).

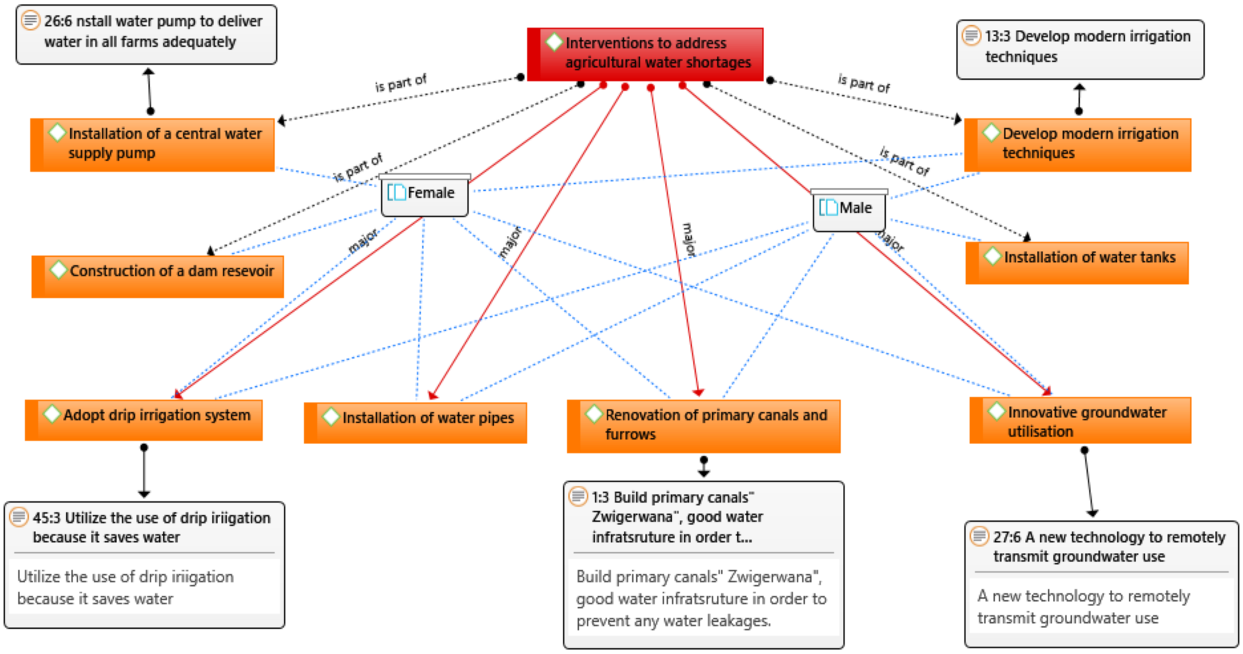

Figure 6. 1: Intervention strategies for addressing agricultural water shortages

6.2.2 Installation of water pipes

Farms reported that pipes are the main components of irrigation systems and are required to function in many capacities in delivering water to the farm plots. Farmers had stated that the installed water pipes were outdated and leading to leakages of water resulting in the water's inability to reach other farm plots, thus, one of the growers had this to say:

"Installation of water pipes it is crucial because superior grade pipes like Ori-Plast UPVC pipes helps farmers to maximize water use efficiency "

(Male Farmer)

6.2.3 Renovation of primary canals and furrows

Farmers revealed that the absence of primary canals is the main challenge to accessing water in the farm plots, therefore, the reconstruction of canal systems in Luvhada farms will enable farmers to increase the productivity of their lands through better irrigation.

6.2.4 Develop modern irrigation techniques

As highlighted by farmers, the current existing irrigation schemes are outdated, therefore, farmers in the Luvhada area must develop modern irrigation techniques to improve productivity as such would make effective and sustainable use of ecosystem services. Some services, such as social, come from man-made infrastructure, however, these come from the green infrastructure of healthy rivers and watersheds that filter out pollution, mitigate floods and droughts, recharge groundwater, and maintain fisheries. Technologies that maintain and enhance such services build resilience into water delivery systems and water use. What technology should be adopted, is a key question, but it is not the only aspect that should be considered. It must be posted in the context of where it is being used, by whom, and how it is introduced and implemented.

6.2.5 Installation of water tanks

Lack of water storage in the Luvhada area has become one of the causes of agricultural water insecurity, thus, the availability of water storage could be the only solution to water insecurity. Water storage has a great potential to deliver improvements in water management and is often associated with dams, the environmental and social problems. Storage makes more water available by capturing water when it is plenty and making it available for use when there are shortages. Storage can also be used to balance supply and demand over much shorter periods such as storing water from river flows during the night and making it available for farmers to use during the day in Luvhada. This not only makes available water that would have otherwise gone to waste, but it also increases the flexibility of irrigation systems by improving the reliability and timeliness of supplies so that farmers can better schedule their irrigation and reduce water losses.

6.2.6 Installation of central water pump

Majority of farmers (85%) stated that the pipe joints themselves and where pipes join with structures showed defects and needed repairs. For the proper operation of an irrigation system depends on an organizational structure that will ensure equitable water delivery; there must also be water measurement, good conveyance systems and positive controls. This will ensure the installation of a vital water pump that will transfer water through primary canals to the farms without leaking. Additionally, water for agriculture can come directly from rainfall, or be secured through irrigation technologies of different scales, ranging from rainwater harvesting to large-scale schemes with extensive infrastructure.

6.2.7 Innovative groundwater utilization

The Department of Agriculture and Land Reform has responsibility for agriculture, managing the revitalization of irrigation schemes and ensuring support and establishment of schemes in rural areas, such as the Luvhada area. Access to groundwater, therefore, will allow farmers in Luvhada village to intensify and diversify their cropping systems, and to shield against droughts. The use of groundwater can improve agricultural production, improve rural income and strengthen farmers' ability to withstand climate shocks and water variability in Luvhada. For groundwater to contribute to sustainable intensification of agriculture, it is essential to know where to invest in groundwater development and how to sustainably manage groundwater resources.

6.3 Interventions and responsible authorities

6.3.1 Renovation of primary canals and furrow (Department of Water Affairs and Forestry)

Majority of farmers highlighted that the current existing primary canals in Luvhada needed renovations, therefore, respondents have proposed that the Department of Water Affairs and Forestry could intervene by renovating primary canals to avoid leakages of water before it arrives at the farms and prevent blockage of the furrow. Additionally, the respondents suggested there is a need for water storage facilities in the form of dams, a reservoir, or tanks because if the irrigation scheme can manage to acquire a storage facility, some challenges, such as the need to work during the night and blocked furrows, may be resolved. Respondents contend that good maintenance of the irrigation systems and structures was necessary to ensure the successful delivery of water to the farms.

6.3.2 Drip Irrigation system (Extension Officers and Traditional Leaders)

With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants. Survey respondents revealed that a low volume of water contributes to situations in which some members, especially women, irrigated their crops during the night. This may arise because if farmers fail to work during the night, they may lose some of their crops as it takes a month to get a chance to irrigate. The best solution, therefore, according to farmers at Luvhada village, is to adopt an irrigation system method, and this is possible with the assistance of community Traditional Leaders and Agricultural Extension Officers.

6.3.3 Installation of water pipes (Local Municipality)

The poor furrow irrigation system was another challenge that was identified. The respondents suggested that constructing water pipelines would help to phase out a furrow irrigation system and introduce scheme members to water conservation methods. The local municipality can mitigate this issue by means of construction and erection of pipelines and irrigation systems that would come in handy for the scheme to phase out the furrow irrigation system, which significantly contributes to the slow development of the scheme.

6.3.4 Innovative Groundwater Utilisation (Department of Agriculture, Land Reform and Rural Development)

The respondents highlighted that the scheme in Luvhada should come up with some innovative strategies to expand the use of efficient irrigation and agricultural water management technologies to deal with water supply challenges.

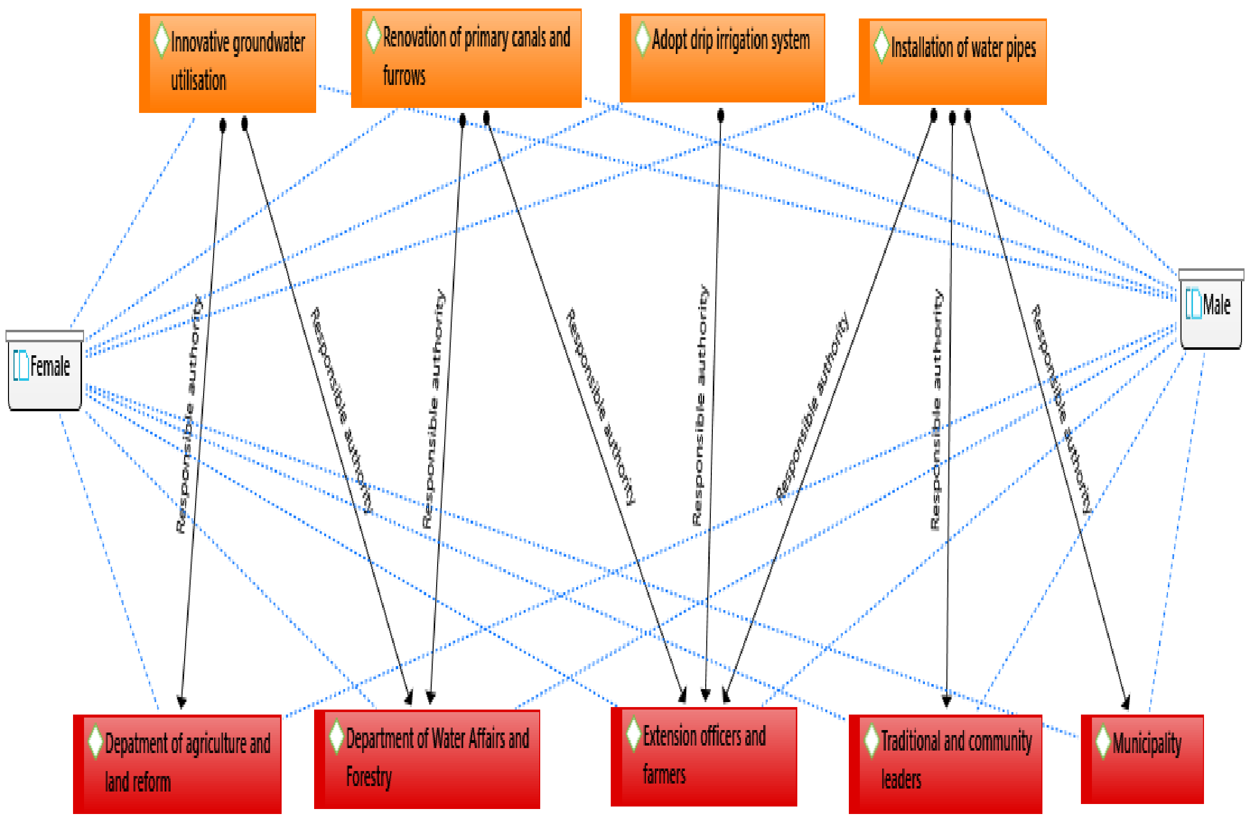

Figure 6. 2: A network diagram summarising Interventions and Responsible authorities

6.3 Discussion of findings

Data analysis revealed 8 strategies for addressing agricultural water insecurity. Three of these strategies were gendered in that men believed the installation of water tanks would solve the problem while women farmers believed the installation of a central pump and construction of a dam reservoir would solve the water insecurity challenges. In addition, both farmers suggested strategies like adopting drip irrigation systems, installation of water pipes, renovation of primary canals and furrows, innovative groundwater utilization, and modern irrigation techniques.

According to Li *et al.* (2018), canal water conveyance is an essential part of irrigation, and the distribution characteristics of canal systems have noticeable influence on irrigation water use efficiency. Irrigation is an artificial application of water to the soil that usually assists in growing crops using canals as a crucial means of irrigation (Pandey, 2013). Further, canals provide perennial irrigation and supply water as and when needed. Unfortunately, at Luvhada most of the existing canals are old and broken and this challenge is exacerbated by the Luvhada irrigation scheme's limited resources and funds, which makes repairing broken canals an almost impossible task.

The findings of this study revealed that the installation of water pumps, construction of dam reservoirs, renovation of existing water canals and furrows, among others could help address agricultural water insecurity. This finding contrasts with the observation made by Koech & Langat (2018) who reported that extending existing technologies alone, however, does not address unsustainable water use, rather appropriate technological solutions must be combined with improved water management and efficient water use. The authors add that decision-makers often respond to water needs by building larger versions of familiar technologies, for example, larger dams, deeper wells, bigger pumps, or water transfer from one catchment to another. Koech & Langat (2018), hence, proposed the use of water management strategies as one of the most effective ways of addressing water security issues in dry areas, particularly when water management is allowed to go hand-in-hand with opportunities to capture more water locally.

The other finding of this study relates to how farmers believe adopting modern irrigation techniques can be a panacea to the challenge of agricultural water security issues. This finding concurs with those of Mengistie & Kidane (2016) who also acknowledged the role of modern irrigation techniques. According to them, modern irrigation techniques is a term that describes an irrigation system that applies a motorized pump for groundwater extraction, uses drip, and pipelines in their command areas. The benefits of modern irrigation technologies include saving water, time and money (Mengistie & Kidane (2016). Well-designed irrigation control structures are essential to successful farm water management including good structures for surface irrigation and the benefits of modern irrigation techniques include more efficient water application, water savings, labour reduction, and higher crop yields, according to Laura, (2016).

6.4 Conclusion

In this chapter, the researcher presented the strategies for addressing agricultural water insecurity. Eight strategies emerged from the findings of which 5 emerged from both male and female farmers. Two strategies were proposed by women farmers (construction of a dam reservoir, installation of a central water supply) while the remaining one was unique to male farmers (installation of water tanks). These findings may be used to emphasize the contribution by female farmers in coming up with unique ideas and strategies for promoting agricultural productivity and growth. In summary, farmers reported that some of the strategies for managing agricultural water security in Luvhada village were - to link primary canals "*Zwigerwana*", installation of water pipes to sufficiently transport water to farm plots, installation of water tanks as well as a dam to store rainfed water. Farmers, for instance, mentioned that it is valuable that, as farmers, they develop modern irrigation techniques to remotely transmit groundwater use. Drip irrigation systems were mentioned as an essential component to decrease water loss, as it is the most efficient water and nutrient delivery systems for growing crops.

CHAPTER SEVEN

GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This chapter presents the study's integrated results. It brings together the objectives and shows how the overall purpose of the study was achieved. The main objective of this study was to undertake a gender-based analysis of agricultural practices on water security in Luvhada community, Limpopo Province, South Africa. The key findings per objective are therefore presented and discussed in this chapter. The overall conclusions for the study are given before providing up with the recommendations.

7.2 Study objectives and questions

The findings pertaining to each objective are abridged and presented in the next sections.

7.2.1. To identify agricultural water use patterns across the gender divide

The results revealed that the women at the scheme owned smaller land size of 0.2ha; in contrast, most men-owned 2.4ha size plots. Female farmers, thus, owned smaller pieces of land, a fact that might influence their productivity as compared to males. There was, however, no association between gender and land ownership ($\chi2 = 9.408$; $p > 0.05$). Four main crops - spinach, maize, sweet potatoes, and butternut - were grown in the area. Maize and spinach were used for local trading and household consumption, especially to make pap and relish (a common local dish) while butternuts and sweet potatoes were also used for income generation and as a delicacy for breakfast.

From observations, apart from butternuts, the other crops were drought resistant; farmers were also cultivating other crops for both marketing and household consumption. Additionally, findings revealed that water was obtained from a local river and irrigation scheme to irrigate the crops which led to water insecurities. It is necessary that to enhance agricultural production, there should be the installation of water tanks, installation of a central pump and the construction of a dam reservoir would solve the water insecurity challenges.

7.2.3. To analyse gender -based farming practices that affect water security

The results revealed that the quantity of water supply is not matched with the time pattern of crop needs. Majority of farmers revealed that the area would spend months without access to water as it is shared with the nearby villages, hence, there is a schedule for water access and irrigation. Also, farmers in the Luvhada area are confronted with challenges - inadequate rainwater storage facilities, competition for water between users, loss of water by infiltration, damage to canals and furrows.

Most (60%) of surveyed smallholder farmers in central Limpopo report challenges in accessing water, mainly through groundwater boreholes. A lack of irrigation water pipes was commonly experienced by both men and female farmers; these challenges cut across gender and age dimensions and thus, affected every farmer in the area. Unfortunately, farmers at the scheme did not have the financial capacity to renovate the broken canals as well as construct concrete furrows, hence, the canals spill a lot of water before it reaches the fields. This results in water scarcity at the scheme and reduced crop production. When the scheme was established, the Lalumba fountain became a foundation of attraction as far as water supply to the scheme was concerned.

These findings present options to farmers, and policymakers on how to attempt to address agricultural water security challenges. Some of the recommended strategies were the adoption of drip irrigation as it saves water and nutrients by allowing water to drip slowly to the roots of plants and the reconstruction of canal systems on Luvhada farms to enable farmers to increase the productivity of their lands through better irrigation. Also, farmers in the Luvhada area must develop modern irrigation techniques to improve productivity as these would make effective and sustainable use of ecosystem services.

7.2.4 To provide intervention strategies for enhancing the efficiency of gendered agricultural water security.

The results revealed that interlinked were water-saving strategies that can improve agricultural production and water security challenges at Luvhada. Installation of pipes is the main component of irrigation systems and these pipes are required to function in many capacities, delivering water to the farm plots. Farmers had stated that the installed water pipes were outdated and led to leakages of water, preventing the water from reaching other farm plots, therefore, this is a crucial strategy. The development of innovative strategies to expand the use of efficient irrigation and agricultural water management technologies to deal with water supply challenges was one of the major findings of the study.

7.3 Discussion

The main objective of this study was to undertake a gender-based analysis of agricultural practices on water security in the Luvhada community, Limpopo Province, South Africa

It was clear that both female and male farmers in Luvhada dominantly practised crop farming, however, gender comparisons show some distinctions, such as female farmers preferring the use of manure. Farmers revealed that the area would spend months without access to water as it was shared with the nearby villages hence, there is a schedule for water access. The canals and furrows were also worn out due to limited maintenance. Farmers at the scheme lacked the financial capacity to renovate the broken canals as well as to construct concrete furrows. As a result, the canals spill a lot of water before it reaches the fields. Other challenges identified included - outdated water infrastructure, canal and furrow water leakages, insufficient primary canals, and droughts while minor challenges such as floods, lack of irrigation pipes, lack of water reservoirs and lack of water pumps. In summary, these challenges hindered full agricultural production and water security.

7.4 Conclusion

The findings of this research showed the extent to which farmers require assistance in terms of overcoming the challenges that continue to threaten the survival and growth of their livelihoods. Mengistie & Kidane, 2016 reports how irrigation remains one of the possible means of feeding the rapidly growing population due to its ability to promote agricultural diversification, enhance food self-sufficiency and increase rural incomes. According to Mengistie & Kidane 2016, low rainfall and continuous drought occurrence cause less-developed crop production methods. From the data, the irrigation system’s maintenance was hardly done at the scheme, the little which was done was only undertaken when necessary. It depicts that the irrigation infrastructure is dilapidated and not functioning, optimally.

7.5.1 Recommendations for policy formulation

Stakeholders such as DALRRD and DWAF and the local municipality must engage themselves on issues of policy formulation or review regarding water conservation, water supply and utilization, in a broad sense. It is in this context, that it is highly recommended for the scheme to join other associations and organizations which are engaged in similar or related activities. This will assist scheme members to implement targeted solutions for increasing irrigation productivity.

Farmers' associations, farmers' cooperatives and individual farmers must be trained and capacitated on how to supply and conserve water effectively. This will help to transmit information on the importance of saving water to all people concerned. As the state seeks to achieve its goals, a thorough consideration must be given to the farming household for their inputs, and experiences and suggestions of what could be happening in their daily activities. During droughts and natural disasters, the state must compensate the affected farmers reasonably, considering the cost of their loss and to keep them running their farms.

The government must build more water storage facilities to supply fresh water to its people and the agricultural sector, without failing. The Department must continue funding the communities until they are independent enough to stand by themselves, that is, there must be more training carried out to achieve this. For the government to strike a balance between development and growth, it must introduce a pricing mechanism that will help in water system maintenance and water infrastructure development.

7.5.2 Adoption of gender-sensitive programming

All rural development programs must consider women's unique needs and experiences, with targeted programmes to provide credit, secure land and water rights and facilitate access to inputs and machinery for women. Training and cooperatives should recognise women's farming activities, time constraints and obligations, and the tensions around women's empowerment.

7.5.3 Plan and provide for seasonality

Program interventions and water resource development must consider how agricultural activities and water calendars interact, and help women and men deal with tensions around water use by, for example, demarcating allocations for different uses across seasons, and providing resources to facilitate water transport and storage. Farmers indicated that this intervention could be provided by DALRRD.

7.5.4 Gender transformative change

The use of irrigation services as a platform to question, challenge and ultimately remedy deep gendered inequalities, for example in addressing attitudes around gender roles and working with male champions of change. The local municipality should take a role in mitigating gender inequalities among smallholder farmers

7.5.5 Recommendations for Luvhada Irrigation Scheme Members

Members of the scheme must efficiently utilize all the water sources available at their disposal; for example, the scheme is situated between the Nzhelele River which is a perennial river and the Lalumba fountains which is an all-seasoned fountain. The scheme could consider devising ways to outsource water from both sources so that they can operate productively. It is recommended that the scheme moves away from the old system of irrigation (canal and furrow irrigation). This system is outdated and too expensive to maintain and is associated with a lot of disadvantages. It will be essential for the scheme to embark on pipe and drip irrigation systems as this will help to save water, time, and money. Water-pumping machinery may be used to drive water directly from the Nzhelele River into the scheme through pipelines, then into drips.

7.6 Recommendations for future study

Further research should be carried out to determine factors contributing to the underdevelopment of Luvhada village and what could be done to improve progress at the scheme for female and male farmers to access agricultural water, effectively.

Another recommendation is for this study to be repeated under non-lockdown conditions to allow data collection through face-to-face interviews which would allow the researcher to capture emotions and feelings of the men and women farmers.

7.7 Limitation of the research findings

The limiting factor in this study experienced by the researcher was the inability to conduct face-to-face interviews with the participants, due to Covid19 protocols and procedures. The lack of opportunity to carry out face-to-face interviews meant that data collection failed to fully capture participants' feelings during interviews.

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Appendix A: Agricultural Water Use Efficiency Questionnaire

University of Venda

School of Agriculture

Institute for Rural Development

RESEARCH QUESTIONNAIRE

TOPIC: GENDER-BASED ANALYSIS OF AGRICULTURAL WATER SECURITY IN LUVHADA COMMUNITY, LIMPOPO PROVINCE, SOUTH AFRICA.

Introduction

My name is Mulaudzi Louisa Rabelang. I am currently pursuing Masters in Rural Development. I am conducting a study on **Gender-based analysis of agricultural water security in Luvhada Limpopo Province, South Africa**.

Kindly give your consent in participating in the study by reading through this document and ticking the boxes below. If you agree, Tick "YES" if you disagree tick "NO" in the box. The information you give during this interview is for academic purpose only and will be treated as strictly confidential.

I **have read all information in this questionnaire and all related documents; I understand them completely. All my questions regarding this study have been answered to my complete satisfaction.**

I agree to participate in this research.

YES ☐ NO ☐

Signature…………………………………………………… Date………………………………

SECTION A: DEMOGRAPHIC CHARACTERISTICS

1. Age:15-20 years 21-25 years 26-30 years 31+ year

2. Gender: Male Female

3. Highest level of education: Grade 10 Matric Diploma Degree

4. Marital status: Single Married Divorced Widow

5. Number of children: None 1-2 3-4 5-6 7+

6 Are you a landowner, farmer, grower/field operator?

Landowner

Grower/Operator

Other ____

7. Total hectares farmed ________

8.Total hectares Irrigated _____________

9.Crop Types

Maize

Potatoes

Spinach

Butternut

Tomatoes

Sweet potatoes

Other____

Comments:

____

10: Irrigation Water Source

Municipal water

Nearby river or dam

Recycled Water

Surface Diversion

Private Well

Recycled Water

Other

11 **Farm Type**

Conventional

Organic

Both

Comments:

____

9. Water Use Records/Tracking (tick all that apply)

Water Bills

Flow meter

Other ____

10: Irrigation System Types (tick all that apply)

Drip

Hand Watering

Micro -Sprinkler

Overhead Sprinkler

Surface

Drag Lines

Furrow

Other ____

11: Are you interested in an upgraded irrigation system that improves your water efficiency?

Yes /No /Maybe

12: If answered Yes or Maybe above, what is the main obstacle to installing a new irrigation system?

Cost

Complicated to use

Often not reliable

Other ____

13: Months Irrigated [tick all that apply]

January

February

March

April

May

June

July

August

September

October

November

December

14. Information Used to Determine When to Irrigate [tick all that apply]

Soil moisture sensors

Weather data

Field observation (soil probe and/or feel/appearance)

History/traditional schedule

Water availability (district scheduling, don't control pump, etc.)

Other

15. Soil Moisture Sensor Types, (if applicable)

____

16. Weather Data Used (if applicable)

On site Weather Station

SA weather services

Subscription

Other ____

17. Information Used to Determine How Much to Irrigate [tick all that apply]

Soil moisture sensors

Weather data

Field observation (soil probe and/or feel/appearance)

History/traditional schedule

Maximum Allowable Depletion *MAD & Field Capacity

Harvest schedule

Water availability

Other ____

18. Are you interested in using soil moisture sensors, weather station data and/or other technology that could improve your water use efficiency?

Yes / No

19. If answered Yes above, what is the main obstacle to adopting these tools? [Tick all that apply]

Cost

Complicated to use

Often not reliable

Data interpretation not always easy to understand

Other __________________________________

20. Irrigation System Maintenance Practices [tick all that apply]

Every irrigation event

Weekly

Annually

Distribution Uniformity (DU) tested regularly

Other ____

21. Erosion/water management control Practices (tick all that apply)

Mulch

Cover crop

Irrigation timed to control runoff and sediment movement

Soil amendments

Other ____

22. Runoff Control Practices [tick all that apply]

Irrigation management

Soil amendments

Grading or contouring

Other

23. Nutrient Management Practices [tick all that apply]

Tissue test

Soil test

Crop advisor

Fertilizer Sales Representative

Other ____

24. Sediment Management Practices [tick all that apply]

Filter strip(s)

Sediment basin(s)

Other

____

25. What are your ideas for improving water efficiency for your operations? Or, briefly describe the improvements you would like to implement and/or install.

____

____

____

____

____

27. Do you have other information that would help in evaluating your operations for water efficiency improvements?

____

____

____

____

Thank you for completing this survey. You may be contacted with follow up questions. Meanwhile, if you have any questions, please email louisamuvhuso8@gmail.com

Appendix B: Ethics Approval Certificate

ETHICS APPROVAL CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Ms LR Mulaudzi

STUDENT NO:
15018152

PROJECT TITLE: **Gender-Based Analysis of Agricultural Water Security in Luvhada Community, Limpopo Province, South Africa.**

ETHICAL CLEARENCE NO: FSEA/21/IRD/14/1309

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Ms GB Oloo	University of Venda	Supervisor
Dr M Manjoro - Mwale	University of Venda	Co - Supervisor
Dr B Muchara	University of Venda	Co - Supervisor
Ms LR Mulaudzi	University of Venda	Investigator – Student

Type: **Masters Research**
Risk: **Minimal risk to humans, animals or environment (Category 2)**
Approval Period: **September 2021 – September 2023**

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.

General Conditions
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following.

- The project leader (principal investigator) must report in the prescribed format to the REC:
  - Annually (or as otherwise requested) on the progress of the project, and upon completion of the project
  - Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
  - Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date; a new application must be made to the REC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the REC retains the right to:
  - Request access to any information or data at any time during the course or after completion of the project,
  - To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process.
  - withdraw or postpone approval if:
  - Any unethical principles or practices of the project are revealed or suspected.
  - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented.
  - The required annual report and reporting of adverse events was not done timely and accurately,
  - New institutional rules, national legislation or international conventions deem it necessary

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: July 2021

Name of the RESSC Chairperson of the Committee: Prof Takalani Mashau

Signature:

UNIVERSITY OF VENDA
OFFICE OF THE DIRECTOR
RESEARCH AND INNOVATION
2021 -09- 15
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