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SOCIO-ECONOMIC IMPACT OF SMALLHOLDER IRRIGATION PROJECTS ON HOUSEHOLD FOOD SECURITY IN VHEMBE DISTRICT OF LIMPOPO PROVINCE, SOUTH AFRICA

BY

OBADIRE, OLUSEGUN SAMSON
(11560229)

A Thesis submitted to the Centre for Rural Development and Poverty Alleviation, School of Agriculture, University of Venda In partial fulfilment of the requirements for Masters in Rural Development Degree

JULY 2010

SUPERVISOR: PROF. S. A. ONI
CO-SUPERVISOR: PROF. L. L. MALIWICHI

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DECLARATION

I, OBADIRE OLUSEGUN SAMSON solemnly declare that this research project for the degree of Masters in Rural Development submitted to the School of Agriculture, University of Venda has not been submitted previously for any degree at this or any other University. This is my own work in design and execution through the professional guidance of recognised supervisor and co-supervisor, Prof. S. A. Oni and Prof. L. L. Maliwichi, respectively.

Approved by

Prof. (Emeritus) S. A. Oni
Academic Supervisor
10-08-2010

Prof. L. L. Maliwichi
Academic Co-Supervisor
10.8.10

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To

Harvest-Time Eri-IyanuOluwadara and,

Shalom AnjolaJesu

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The aim of this study was to assess the impact of smallholder irrigation projects on household food security. It has been found that access to water for livestock and for the irrigation of crops, including food crops, is one of the ways poverty and food insecurity can be reduced in rural areas.

This study used both primary and secondary data to analyse the impact of smallholder irrigation projects on household food security. The primary data was collected by using a pre-tested questionnaire administered to selected farmers in the study area. A probability sampling method (i.e. pure or simple random sampling technique) was used to select the respondents. From a total population of 3,236 small-scale irrigators in Vhembe District, 150 irrigation farmers were randomly selected while 50 dryland farmers were selected adjacent to the selected irrigators. A logistic regression model was used to analyse the impact of smallholder irrigation projects on household food security. A comparison of the variables in the model was carried out between irrigators and dryland farmers in order to assess the impact of both on household food security of farmers in the Vhembe District Municipality.

The results obtained showed that the proportion of food secured households was higher among farmers who were on the irrigation projects that is, 86.3% as compared with 53.0% for those on dryland farming. From the analysis, irrigation and per capita aggregate production were found to have a positive influence on the probability of households being food secured. This means that the likelihood

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of food security increases when farmers increase agricultural output and have access to a piece of land on the irrigation project. The food security of households is also dependent on other factors such as household size and farm size. These two variables were found to have negative and significant effects on household food security meaning that the likelihood of a household being food secured decreases with an increase in household size and farm size, even though, increase in farm size was expected to affect food security positively but was not due to larger farm sizes on dryland farms. Irrigation is a major contributor to household food security as water is the most limiting factor to agricultural production in the area. Water has obvious advantages in that it increases farmer's yields, promotes diversified farming and increases household incomes.

Farmers who are on irrigation projects are more likely to be food secured than dryland farmers. Therefore, with concerted support from government, and all stakeholders, food security can be enhanced at the household levels. Also, education and extension training are essential for farmers so that they are able to adopt new technologies. The study suggests that households that need to be targeted for food aid are those with large families, and those without access to irrigation projects. Also to be included are those families with few assets, and those without access to agricultural land and implements.

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Finally, I wish to state that I owe my wife, Funmi and the children for the sacrifices they made during my absence in a foreign land pursuing further studies.

Obadire, OS

Louis Trichardt

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LIST OF ABBREVIATIONS

AU	African Union
CGAP	Consultative Group to Assist the Poorest Poverty Assessment Tool
DoA	Department of Agriculture
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
HELPFUL	High-frequency, Efficient, Low-volume, Partial-area, Farm-unit, Low-cost
HIV	Human Immune Virus
IFPRI	International Food Policy Research Institute
IFSS	Integrated Food Security Strategy
MDGs	Millennium Development Goals
POST	Parliamentary Office of Science and Technology
RESIS	Revitalisation of Smallholder Irrigation Scheme
SASIX	South African Social Investment Exchange
SMMEs	Small Micro-Medium Enterprises
SPSS	Statistical Package for Social Scientists
Stats SA	Statistics South Africa
USAID	United States Agency for International Development
VDM	Vhembe District Municipality
UNDP	United Nations Development Programme
WFS	World Food Summit
WUAs	Water User Associations

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CHAPTER 1

INTRODUCTION

1.1 Background

Agricultural growth offers possibilities for reducing risks of food shortages at all levels, increasing overall supply of food, creating economic opportunities for vulnerable people and improving dietary diversity and the quality of food consumed by farm households (Lyne et al, 2009). In South Africa, food security is not a failure of agriculture to produce sufficient food at the national level, but it is a complex failure of households to access guaranteed sufficient food.

Food insecurity and malnutrition are highest in provinces with large rural populations, such as KwaZulu-Natal, Limpopo, Eastern Cape and the Free State (Department of Agriculture, 2007a). The demands of the colonial and apartheid eras for male labour in urban areas have resulted in the erosion of the fundamentally agrarian existence of Black Africans, and a subsequent increased reliance on non-farm and non-rural incomes. There is a greater reliance on purchased food as opposed to own-produced food which exposes vulnerable households to the adverse effects of price fluctuations. For example, the 17% inflation on food prices between 2001 and 2002 had a disproportionate and devastating impact on the living standards of the predominantly rural ultra-poor, which spent more than 50% of their income on food (Stats SA, 2004).

Food insecurity and poverty are locked into the same destructive cycle. Poverty is the leading cause of food insecurity, and food insecurity is a major contributor to

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the continuity of poverty. Several studies have been carried out to assess household food insecurity in the semi-arid areas of Southern Africa. Most of these studies have shown that there are many factors that are involved in enhancing food security such as irrigation, land quality, incomes, size of household, wealth of farmers and land size. Among these factors water has been highlighted as the most limiting factor to food security in rural communal areas (FAO, 1997a). Thus, this study concentrated on selected irrigation projects and dryland farming in the Vhembe District of Limpopo Province with the aim of assessing the socio-economic impact of smallholder irrigation projects on household food security. So far it has been shown that smallholder irrigation has a number of benefits which include crop diversification, better incomes, good nutrition and employment opportunities to local people and the farmer can achieve household food security (Makombe & Meinzen-Dick, 1993).

The outlook for the food security of many developing nations is cause for serious concern. Widespread denudation and accelerated erosion diminish the productivity of both cultivated and grazed rain-fed lands. Semi-arid regions are especially vulnerable to climatic instability and frequent droughts. At the same time, depletion and pollution of limited freshwater resources and competing demands for water - among neighbouring states as well as between different sectors within each state - constrain further expansion of irrigation.

The problem of food security is exacerbated by the rapid growth of population and hence of the demand for food (FAO, 1997a). In fact, the prices of foodstuffs in the world market have recently begun to rise. Beyond that looms the spectre of a fundamental change in climate (a consequence of the enhanced greenhouse

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effect), that may increase the severity and variability of weather and thus disrupt established systems of production. Such a change could require expensive investments in modifying existing systems and establishing new ones (FAO, 1997a). All these problems are particularly acute on the continent of Africa, parts of which are already in the throes of a severe population-environment crisis. The population of sub-Saharan Africa, now nearing 600 million, is projected to double by the year 2020 (FAO, 1997a). Therefore, a much greater effort must be made first by the region also by the international community to assist the African nations in the difficult task of improving their prospects for food security.

In South Africa the term 'smallholder' or 'small-scale irrigation' is mainly used when referring to irrigated agriculture practised by black farmers, because the majority of African farmers operate agricultural enterprises that are small in size relative to those of white farmers. Schmidt (2005) reported that 5% of South African households engaged in farming to produce staple food for the family, and more than a million households used farming to supplement food access. However, smallholder agriculture is not exclusive to African people. There are white people who hold small farms, often referred to as plots, particularly around cities, such as Pretoria and East London. Conversely, there are African people who hold large farms (Laker, 2004).

Access to water for livestock and particularly for the irrigation of crops, including food crops, is one of the ways poverty and food insecurity can be reduced in rural areas. South Africa has about 1.3 million ha under irrigation, of which 0.1 million ha is in the hands of smallholders (Backeberg, 2006a). Smallholder irrigators

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have been categorised into four groups (De Lange, 1994; Crosby et al., 2000; Du Plessis et al., 2002), namely,

- farmers on irrigation schemes;
- independent irrigation farmers;
- community gardeners; and
- home gardeners.

Backeberg (2006a) estimated the number of South African smallholder irrigators to range between 200,000 and 250,000, but most of these were farming very small plots, primarily to provide food for home consumption. This study was concerned with the first group of smallholders only, namely farmers on irrigation schemes and it assessed the socio-economic impact of irrigation on household food security in Vhembe District, Limpopo Province.

Irrigated agriculture produces almost 90% of South Africa's fruit (deciduous, subtropical, citrus, etc) and vegetables (Department of Agriculture, 2008). Thus, irrigation plays a pivotal role in raising and stabilizing food production. There are, many obstacles to the rapid development of irrigation in the southern African region as large parts of the region have only limited freshwater resources. Even where water resources are known to be substantial, prevailing conditions may not be conducive to irrigation development. Such conditions may include unfavourable topography and soils, distant markets, inadequate infrastructure, coupled with lack of credit facilities, labour, information and other vital services to farmers (FAO, 1997b). These problems, while real, do not entirely explain the historical failure to develop the full irrigation potential of sub-Saharan Africa.

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1.2 Problem Statement

Why is it that irrigated farming in some areas fails to achieve its potential benefits? The problem is not inherent in the principle of irrigation as such, but in the frequently inappropriate practice of it. More often than not the fault lies in the unmeasured and generally excessive application of water to land, with little regard either for the real cost of extracting the water from its source and delivering it to the farm, or for the cost of restoring the water resource after it has been depleted or polluted (FAO, 1997a).

From the point of view of water use, some large-scale irrigation projects operate in an inherently inefficient way. Where water is delivered to farmers on a fixed schedule and charges are set per delivery regardless of the actual amount used, irrigators tend to take as much water as they can while they can. This typically results in over-irrigation, which not only wastes water but also contributes to project-wide problems associated with the disposal of return flow and elevation of the water-table. Management practices that lead to waste are especially difficult to change, not necessarily because of insurmountable technical problems or lack of knowledge, but simply because it appears more convenient or economical in the short term to waste water rather than to conserve it. Such situations occur when the price of irrigation water is lower than the cost of the labour or of the equipment needed to avoid over-irrigation.

It is quite understandable that smallholder irrigation is an important factor in improving household food security and the livelihood in the rural areas of South Africa as opposed to dryland farming which absolutely depends on erratic and

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inadequate rainfall for crop production. This study attempted to establish the extent to which household food security has been achieved under smallholder irrigation schemes in the study area.

1.3 Rationale and Significance of the Study

Smallholder irrigation has been reported by many studies to have enhanced food security in South Africa (FAO, 1997c). This study attempted to assess the degree of impact of this on household food security. An irrigation project is not only a system for producing crops but also, a place for a community of people and families to live healthy lives while working cooperatively and contributing to the food security of their nation. Irrigation is not simply a mechanical task of delivering water to crops. It is a human activity and a social undertaking. Consideration of irrigation development should note that, ultimately, the success of every project depends on the quality of the human effort invested in it.

There are quite a number of irrigation projects in the study area which are functioning well; we need to assess their socio-economic impact as well as productivity as compared to dryland farming and how has it affected the economic well being, health and food security of the populace. The study is aimed at improving the livelihood of the farmers in the district and increase stakeholders' participation to bring about development.

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1.4 Research Objective

The general objective of the study is to assess the socio-economic impact of smallholder irrigation projects on household food security using selected irrigation projects and dryland farms in Vhembe District of Limpopo Province, South Africa as case study.

1.4.1 Specific objectives of the study

- To assess the contribution of irrigation to household food security, in comparison to dryland farming;
- To assess factors affecting farm household food security status;
- To investigate the contribution of smallholder irrigation farming to household income;
- To investigate the availability and nutritional adequacy of household food in the study area.

1.5 Research Questions

The following are the research questions dealt with in this study:

- To what extent do smallholder irrigation projects contribute to household food security as compared to dryland farming?
- What are the factors affecting farm household food security status?
- To what extent does smallholder irrigation farming contribute to household income?

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- What is the level of availability and nutritional adequacy of household food in the study area?

1.6 Definition of Key Terms and Concepts

1.6.1 Household food security

Food security is a situation "when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food, and can meet their dietary needs and food preferences for an active and healthy life" (FAO, 2002). How to achieve this phenomenon at the household level poses a serious concern as either many households do not have access to food because it is not available or that the food eaten does not meet their dietary requirements or both.

1.6.2 Smallholder irrigation projects

These are multi-farmer irrigation projects larger than 5 ha in size that were either established in the former homelands or in resource-poor areas by black people or agencies assisting their development (Dension & Manona, 2007).

1.6.3 Rural livelihood

According to Chambers and Conway (1992) livelihoods consists of four parts, namely,

(i) rural people and their livelihood capabilities;

(ii) assets, including both the tangible (resources and stores) and intangible (claims and access), which provide the material and social means that are used to construct livelihoods;

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(iii) activities, i.e. what people do, and

(iv) a living, which refers to the outcomes of what rural people do.

When viewed from this livelihood perspective, smallholders' irrigation schemes are assets. They can be used to increase and diversify the livelihood activities, resulting in improved livelihood outcomes, either directly in the form of food or income for plot holders or indirectly by providing full or partial livelihoods to people who provide goods and services in support of irrigated agriculture on these schemes.

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CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

This chapter defines major terms. It propounds current status of food security and the impact of food insecurity in Africa in general. It goes on to discuss literature on South Africa's agriculture and irrigation systems. A brief discussion of research studies that have been carried out on food security and how food security has been measured previously are mentioned in this chapter. It also looked at how farmers in semi-arid areas have tried to address food security and the constraints faced by irrigation farmers in communal areas. The origin of smallholder irrigation projects and the impact made so far on household food security in South Africa with particular reference to the study area are discussed.

2.2 Defining Food Security

In the 1970s, the conventional wisdom was that food insecurity was caused by the decline or failure of aggregate food availability either at local, regional, national or global levels (Sijm, 1997). In other words, food insecurity was conceived primarily as a supply issue at an aggregate level because of the significant short falls in food supply and high food prices in the world market in the early 1970s. However, despite the favourable supply conditions and low food prices after the mid 1970s the incidence of food insecurity remained high in many developing countries (Sijm, 1997).

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Food security was defined in the 1974 World Food Summit as "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (United Nations, 1975). In 1983, Food and Agriculture Organisation of the United Nations (FAO) expanded its concept to include securing access by vulnerable people to available supplies, implying that attention should be balanced between the demand and supply side of the food security equation "ensuring that all people at all times have both physical and economic access to the basic food that they need" (FAO, 1983).

This new emphasis on consumption, the demand side and the issues of access to food by vulnerable people, is most closely identified with the seminal study by Amartya Sen. Eschewing the use of the concept of food security, he focuses on the notion of food entitlements of individuals and households (Sen, 1981). Sen's conceptualisations brought a paradigm shift into the field of food security. That is, food insecurity is more of a demand concern, affecting the poor's access to food than a supply concern, affecting availability of food at the national level. Briefly defined, entitlements are categories of lawful access to food. They include production (direct production or gathering of food), trade (including buying and selling food, selling labour and other goods in order to buy food) and transfers (from state to individual or household, between or among households, or between non-state agencies and households or individuals).

Sen's work revolutionised the long-held view that food insecurity was simply a supply problem, and that acute emergencies or famines were caused by a

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sudden drop in food availability. His core observation was that a collapse in entitlements can lead to famines or food security crises even in the absence of an overall food shortage: 'starvation is a matter of some people not having enough food to eat, and not a matter of there being not enough food to eat'. In other words, there can be food insecurity even without any fall in food availability due to a variety of other variables such as loss of endowment, loss of employment, a fall in wages, or unfavourable shift in terms of trade of food exchange for assets.

The highly influential World Bank report "Poverty and Hunger" (World Bank, 1986), focused on the temporal dynamics of food insecurity. It introduced the widely accepted distinction between chronic food insecurity associated with problems of continuing or structural poverty and low incomes, and transitory food insecurity, which involved periods of intensified pressure caused by natural disasters, economic collapse or conflict. The concept of food security is therefore, elaborated in terms of "access of all people at all times to enough food for an active, healthy life".

By the mid 1990s food security was recognised as a significant concern, spanning a spectrum from the individual to the global level. However, access now involved sufficient food, indicating continuing concern with protein-energy malnutrition. The definition was broadened to incorporate food safety and also nutritional balance, reflecting concerns about food composition and minor nutrient requirements for an active and healthy life. Food preferences, socially or culturally determined, became a consideration. The potentially high degree of context specificity implies that the concept had both lost its simplicity and was not

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itself a goal, but an intermediating set of actions that contribute to an active and healthy life.

The 1994 UNDP Human Development Report promoted the construct of human security, including a number of component aspects, of which food security was only one of many (UNDP, 1994). The list of threats to human security is long, but most can be considered under seven main headings: economic security, food security, health security, environmental security, personal security, community security, and political security. This conceptualisation is closely related to the human rights perspective on development that has, in turn, influenced discussions about food security.

The 1996 World Food Summit (WFS) adopted a still more complex definition, "Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). This definition is again refined in The State of Food Insecurity 2001, "Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). This study will adopt this particular definition to address the socio-economic impact of smallholder irrigation projects on household food security.

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The international community has accepted these increasingly broad statements of common goals and implied responsibilities. But the practical response has been to focus on narrower, simpler objectives around which to organise international and national public action. The declared primary objective in international development policy discourse is increasingly the reduction and elimination of poverty. The 1996 WFS guided this direction of policy by targeting the primary objective of international action on food security at halving the number of hungry or undernourished people by 2015.

Essentially, food security can be described as a phenomenon relating to individuals. It is the nutritional status of the individual household member that is the ultimate focus, and the risk of that adequate status not being achieved or becoming undermined. The latter risk describes the vulnerability of individuals in this context. As the definitions reviewed above show, vulnerability may occur both as a chronic and transitory phenomenon.

Food insecurity is "limited or uncertain availability of nutritionally adequate and safe foods, limited or uncertain ability to acquire acceptable food in socially acceptable ways". Food insecurity and hunger are also conditions resulting from financial resource constraint. Hunger is the uneasy or painfully sensation caused by lack of food or the recurrent and involuntary lack of access to food. Hunger may produce malnutrition over time. Hunger is a potential, although not necessarily, consequence of food insecurity (FAO, 1996).

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Given the number of closely related terms, it is worth noting how some of the definitions vary. 'Hunger', sometimes used synonymously with food insecurity in popular language, is technically defined as an 'uncomfortable or painful sensation caused by a lack of food. Hunger can be experienced temporarily by people who are not food insecure, as well as by those who are' (DFID, 2003). Malnutrition here refers to undernutrition – or a nutritional status significantly (at least two standard deviations) below expected levels.

In USAID terms, the pillars of food security include availability of food, production and trade; access, purchasing power or capacity to produce and utilisation, the household's ability to use the food they have, and the biological ability of the human body to digest food (Maxwell & Frankenberger, 1992). Food insecurity has been described as "a condition in which people lack basic food intake to provide them with the energy and nutrients for fully productive lives" (Cox et al, 2001). One report defines food insecurity in terms of the risks households face: 'households become food insecure when they are unable to mitigate negative impacts on food availability, access, and/or utilization' (Webb & Rogers 2003).

According to Monde (2003) and FAO (1996), food security refers to the availability of enough food in order for all people to live healthy, active and productive lives at all times, across all countries and regions, across all income groups, and across all members of individual households. Household food security is attained when household members are able to acquire adequate safe and nutritious food to meet their nutritional, social and psychological requirements.

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Household food security accounts for the consumption levels of all members of a household population. Farm household production and food security analysis at the household level requires understanding of the household's ability to either produce enough food or generate enough income to purchase food. Policies and measures, which have been implemented by most countries to ensure food security, include encouraging increased agricultural production to maintain food self-sufficiency (Kandoole & Msukwa, 1992). Rohrbach (1989) interpretes food self-sufficiency as the ability of a country to meet all its staple food requirements through domestic production. In relation to crop production, a household is regarded as self-sufficient if it produces enough for its needs (Masomera, 1998). Food security has been widely accepted to mean the ability of individuals located in specified geographical boundaries to meet staple food needs on a year round basis from their own enterprise production or through purchases from domestic markets (Amin, 1989).

Thus, there are two sides to the food security equation: food availability and food access (Rukuni & Bernsten, 1988). Many households simply lack the means to secure consistent access to food, which will allow them to lead active and healthy lives. This study assessed food security status at household levels. It looked at the ability of the household to produce its own food to meet its food requirements. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern.

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2.3 Global Food Security Situation

Recent estimates of the FAO, show that the number of undernourished people increased from 848 million to 923 million from 2003/05 to 2007, largely owing to the food price crisis (FAO, 2008a). The number of undernourished increased even further in 2008 as prices continued to rise and the financial crisis hit high levels due to the global economic melt down. Food price hikes have also raised micronutrient deficiencies, with negative consequences for nutrition and health, such as impaired cognitive development, lower resistance to disease, and increased risks for both mothers and children during childbirth.

In Bangladesh, for example, a 50 percent increase in the price of food is estimated to raise the prevalence of iron deficiency among women and children by 25 percent (Bouis, 2008). Because good nutrition is crucial both for children's physical and cognitive development and for their productivity and earnings as adults and the adverse consequences of this price shock could continue even after the shock ends. Food insecurity can be a key source of conflict and with increasing food and general living costs, people have turned to the streets in protest. Social and political unrest has occurred in 61 countries since the beginning of 2007, with some experiencing multiple occurrences and a high degree of violence (Von Braun, 2008). Although this unrest has occurred mostly in countries with low performance in governance, other countries have also been affected.

In view of Africa's limited public capacity to invest for development, spreading efforts and resources thinly over all possible areas of intervention has little

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prospect of succeeding (African Union, 2006). The agricultural sector significantly contributes to the Gross Domestic Product (GDP) in the form of export earnings and employment of most African countries. For the continent as a whole, the agricultural sector accounts for approximately 60% of the total employment capacity, 20% of total exports and 15% of GDP (African Union, 2005). However, a significant proportion of the rural population in sub-Saharan Africa is food insecure and malnourished (Figure 2.1). Therefore, food security is one of the main global concerns in many developing countries (FAO, 1996).

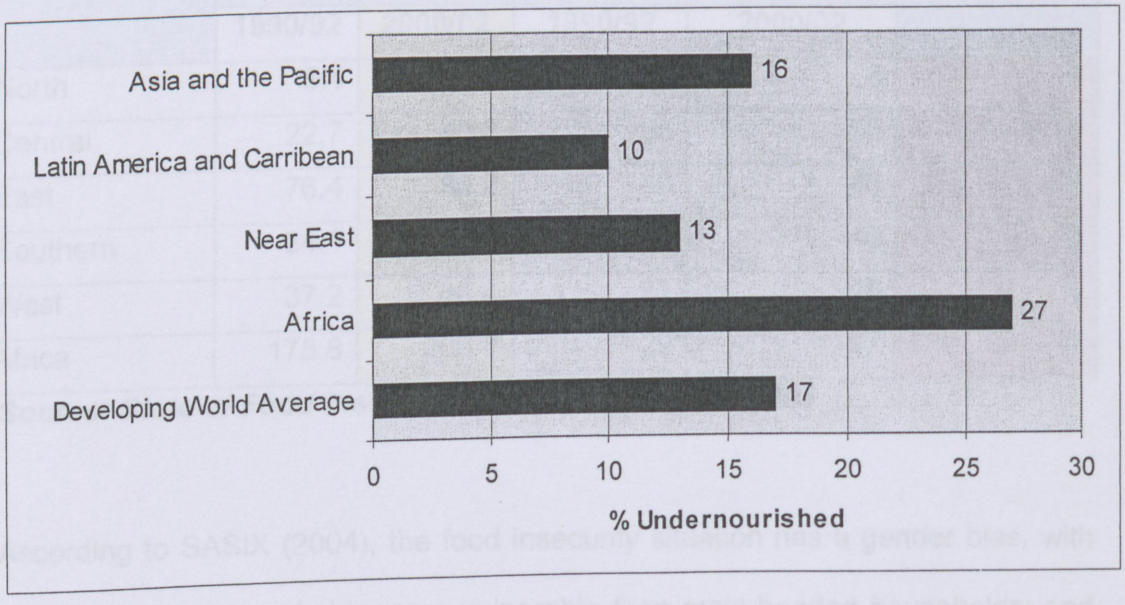


Figure 2.1: Proportion of the undernourished population in different parts of the world (FAO, 2004)

In Table 2.1 below, we can see that the percentage of the population that is under-nourished is estimated to be only 4% in North Africa, which has not changed substantially for 10 years. For the affected people this is a situation that is likely to be characterized by periodic hunger rather than life-threatening malnutrition. Experience from a number of underdeveloped countries indicates

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that this level of persistent food insecurity, although generally not life-threatening, is hard to eradicate totally even when government food assistance of one kind or another is provided.

Table 2.1: Performance of African Sub-Regions in Reducing Hunger (in millions and percentages)

African Sub-Regions	Number Persons Under-Nourished (millions)		Population Under-Nourished (%)		Change in 10 Years (%)
	1990/92	2000/02	1990/92	2000/02	
North	5.4	6.1	4	4	0
Central	22.7	45.2	36	55	+ 19
East	76.4	86.2	46	40	- 6
Southern	34.1	35.7	48	40	- 8
West	37.2	36.4	21	16	- 5
Africa	175.8	209.6	29	27	- 2

Source: State of Food insecurity in the World, FAO, 2004

According to SASIX (2004), the food insecurity situation has a gender bias, with female-headed households more vulnerable than male-headed households; and girls who are less than six years of age are more prone to stunted growth due to poor nutrition than boys. There is also a clear racial bias, with black South African households making up the vast majority of food insecure homes. There is also a glaring rural bias, with rural households being far more prone to food insecurity than urban homes. The issue of food insecurity is complex, systemic and multi-sectoral, involving access to viable land, sufficient water, environmentally-friendly technologies, access to credit and sustainable markets. It includes soil fertility, ecological health, income-generation opportunities and nutritional education.

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In 2007, a record number of countries (47) faced food crisis requiring emergency assistance, with 27 of these countries in Africa, 10 in Asia and the remaining 10 in other parts of the world. In the period 1993–2000, an average of 15 African countries faced food crisis annually; that number has climbed to about 25 countries since 2001 (FAO, 2008b). Having faced severe food insecurity in one season, many countries remain on the list for several years owing to the lingering effects of drought and/or conflict and low resilience. Others appear on the list more sporadically and need careful monitoring.

2.4 Historical Origins of Food Insecurity in South Africa

Poverty and food insecurity in South Africa are the result of several centuries of colonial and apartheid policies designed specifically to create general conditions that were unfavourable to the well being of black people, especially in the former homelands (Limpopo Department of Agriculture, 2002). In order to design effective policy interventions to redress the injustices of the past, it is important to unravel these injustices and understand these historical processes. Contemporary South Africa evolved at the turn of the 20th century from an agrarian setting through the rapid growth of commodity markets that sprung around major industrial mining, urban population and commercial agriculture centres. Initially, African farmers and entrepreneurs had successfully participated in the growing commodity markets under conditions of relative land abundance, low population size, low production, processing and distribution technologies, weak government interventions and relatively undistorted markets.

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Impelled by its social and economic imperatives, successive white governments throughout the greater part of the 20th century transformed agrarian 19th century society through a two-prolonged strategy that set in motion a process that would simultaneously cripple and debar African farming and entrepreneurial development. The strategy enabled and entitled white farmers and industrialists as leaders and chief beneficiaries of industrial development (Limpopo Department of Agriculture, 2002). The decline of African farming led to a gradual loss of agricultural and rural capital, wealth, farming and entrepreneurial skills and experience. The process of modern industrial development in South Africa, thus became the driving force that created the contemporary poverty and food insecurity among black people.

2.4.1 National Food Security

At the national level, South Africa is food secure. It produces its main staple foods, exports its surplus, and imports what it needs to meet its food requirements (Limpopo Department of Agriculture, 2002). National food security indicators reveal that in the past 20 years South Africa has been meeting the food needs of its growing population from domestic sources. It is only recently that agricultural produce was imported into the country to augment the ever increasing demand for food. The country became a net food importer last year for the first time since 1985 (Fresh Plaza, 2009). The country exported 29.9 billion rand ($2.9 billion) of agricultural goods and imported products valued at 30.3 billion rand. South Africa imported more food last year largely due to population growth. While the country's population rose 32 percent between 1991 and 2007, agricultural production only increased 10 percent during the same period. In 2008, this

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situation was exacerbated by food inflation and higher fuel costs, which increased the value of imports in relation to exports (Fresh Plaza, 2009). The country generated foreign exchange to fund the importation of food products that it cannot produce adequately or efficiently. The occasional maize exports have been largely confined to the neighbouring countries and within the SADC region, South Africa is the leading food exporter (Limpopo Department of Agriculture, 2002).

South Africa is a net agricultural exporter with an agri-food and seafood trade surplus of $2 billion (Berry, 2007). In 2005, the country exported $5.4 billion of agri-food and seafood. Agricultural products make up 8% of South Africa's total exports. South Africa is the world's top exporter of avocado, tangerine, and ostrich products. It is also ranked as the world's second largest exporter of grapefruit, third for plums and pears, and fourth for table grapes. Other major export commodities include wine, citrus, sugar, grapes, maize, fruit juice, wool, and deciduous fruit (Berry, 2007).

Projections indicate that should current production trends hold, domestic wheat production would be outstripped by domestic consumption by nearly 60% in 2010, and by over 100% in 2020 (Limpopo Department of Agriculture, 2002). Maize and beef is expected to increase by about 130% if production trends continue. The demand for poultry products has already outstripped domestic production by an estimated 22% in 2000, and is expected to increase to 92% in 2010 and to 192% in 2020 (Limpopo Department of Agriculture, 2002).

The erratic fluctuations in the value of the Rand have also underlined the close relationship between macroeconomic or economy-wide factors and food security in South Africa. The tariff policy is also significant, and needs to be constantly

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examined in the light of its effects on national food security policies. Lowered tariffs on poultry products from the USA in the late 1990s caused a severe crisis in the South African poultry industry. South African consumers, on the other hand, enjoyed more affordable poultry products. In order to appease both producer and consumer interests, the Government intervened to raise tariffs on US poultry to a level, acceptable to both sides (Limpopo Department of Agriculture, 2002). Food security can be said to have two components;

- Ability to be self sufficient in food production through own household production
- Accessibility to markets and ability to purchase food items

2.4.2 Integrated Food Security and Nutrition Program

The target goal of the Integrated Food Security Strategy (IFSS) is to reduce the number of food-insecure households by half by 2015. One of the strategic objectives to reach this target is "to increase domestic food production by providing support services to farmers". The Department of Agriculture (DoA) has the responsibility to provide every citizen access to available food on a sustainable basis. To this effect the DoA is to support the 244,000 food parcel beneficiaries to make use of the "Starter Packs for Food Production" for their own benefit (Department of Agriculture, 2006).

The food bank programme under South Africa Social Security Agency (SASSA) has been able to feed 1,900 people monthly in KwaZulu-Natal since 2006 from donated food parcels (SASSA, 2008). It also has to support individual and community gardens to support school nutrition and health care projects. Though it

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does not include support programmes for vulnerable people over the full spectrum of agriculture to enhance environmental sustainability and nutrition security (Department of Agriculture, 2007a).

2.5 The Impact of Food Insecurity

People living in poverty often cannot produce or buy enough food to satisfy their needs and so are more susceptible to disease. Sick people are less able to work or produce food. The UN Standing Committee on Nutrition concluded that nutrition is an essential foundation for poverty alleviation and also for meeting Millennium Development Goals (MDGs) related to improved education, gender equality, child mortality, maternal health and diseases (POST, 2006). Food security is also seen as a prerequisite for economic development. Losses in labour productivity due to hunger can cause 6-10% reduction in per capita GDP while under-nourishment and pre-birth of young children is associated with poor cognitive development, resulting in lower productivity and lifetime earnings potential (POST, 2006).

Over a billion people live on $1 a day or less (UN Task Force on Hunger, 2005). Families in such extreme poverty have to go without food that they need every day of their lives. A billion malnourished people, mostly women and children, are losing their health and lives, their potential for prosperity and their hope for a better future. More than 800 million people know what it is like to go to bed hungry; most of them women and children. Hunger and poverty claim 25,000 lives every day. 2 million babies a year are so weak from hunger that they die when they get a bad case of diarrhoea. Poor families spend over 70% of their

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income on food (an average American family spends just over 10%). 226 million children are stunted physically and mentally from malnutrition, wrecking their chances for a good education and productive future (UN Task Force on Hunger, 2005).

Moreover, the cost of food insecurity is high, since it affects all levels of social and economic life. At the household level, food insecurity leads to disproportionately high health and medical costs, high funeral expenses and low labour productivity. Within the household, food insecurity often affects the more vulnerable members of the family, namely children and women. The cost associated with food insecurity at the intra-household level result in slow educational development (often of female children), stunted growth, etc. At the national level, food insecurity can lead to indirect social costs as diverse as high policing, criminal and justice expenses, low investor confidence, and the resulting loss of capital investments.

Threats to food security arise from a combination of factors which individually and collectively place food systems under stress. These include climatological, ecological, socio-economic and political factors. These factors interact with such factors as market and access to credit, the availability and sustainability of technology, the terms of trade, pricing policies and other idiosyncratic factors to threaten food supply. The socio-economic conditions play a very important role in food security or insecurity. National food self-sufficiency should not be used as a proxy for household food security or as an index of national welfare. While South Africa produces sufficient food, this in no way ensures food security at individual household level. This is because ensuring access to food at the household level

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depends not only on secure food supplies, but also on stable demand or purchasing power. If families are unable to grow or purchase enough food, and social welfare nets are absent or ineffective, there may be hunger. This is the case in the South African society.

2.5.1 Impact of HIV/AIDS on household food security

While it is common to see broad references to "the impact of HIV/AIDS", in reality there are three main ways in which food security of a household can be affected by AIDS, and these have different sets of impact that have to be examined separately: that is chronic illness; death; support of orphans (O'Donnell, 2004). Each of these categories, existing wealth or socio-economic status and the demographic composition of the household have substantial bearing on the extent of the impact of AIDS on the livelihoods.

De Waal and Tumushabe (2003), also highlight the centrality of the labour system in mitigating the extent of the impact. Where there are labour bottlenecks (e.g. areas with one rainfall season, with peaks of activity), or where there is not enough land or capital to absorb the available labour, or where there are inflexible gender roles (e.g. where a widow is prevented from doing a "man's work"), the impact of the illness or death of a productive adult will be greatest. While in the overwhelming majority of cases the impact of AIDS will be negative. For many other households the severity of that impact may not be so great as to be unmanageable. But there may be circumstances where there is no impact or even a positive impact.

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2.6 Effect of Global Warming and Climate Change on Food Security

The global climate system is driven by energy from the sun. Several gases in the atmosphere act to trap the energy from the sun, thus warming the earth. These gases are called greenhouse gases and the process is the greenhouse effect. Without this there would be no life on earth. Human activities over the last 200 years, particularly the burning of fossil fuels (oil, coal, natural gas) and the clearing of forests, have increased the concentration of greenhouse gases in the atmosphere. This is likely to lead to more solar radiation being trapped, which in turn will lead to the earth's surface warming up – called the enhanced greenhouse effect (Department of Agriculture, 2007b). However, the enhanced greenhouse effect can be slowed down by the following two guidelines: increase sinks, that is, planting of trees which extract carbon dioxide for photosynthesis and by decreasing greenhouse gases emission process such as coal burning, bush burning, industrial gas emission (SANBI, 2005).

Climate change, especially indicated by prolonged drought, is one of the most serious climatic hazards affecting the agricultural sector of the continent. As most of the agricultural activities in African countries hinge on rain, any adverse changes in the climate are likely to have a devastating effect on the sector in the region and the livelihood of the majority of the population. South Africa is particularly vulnerable to climate change as farming depends entirely on the quality of the rain season. Increased droughts in combination with higher temperatures have a serious impact on the availability of food. The impact of droughts extends beyond food shortages to negatively affecting national

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economies and reducing country's abilities to export crops and generate foreign currency.

There are five main climate change related drivers that may affect the agriculture sector, particularly food security. These are temperature, precipitation, sea level rise, atmospheric carbon dioxide content and incidence of "extreme events" (floods, hailstorms and hurricanes). Food security is affected in the following ways: reduction in crop yields and agriculture productivity, increased incidence of pest attacks, limit the availability of water, exacerbation of drought periods, reduction in soil fertility, low livestock productivity and high production cost, and the non-availability of human resource due to diseases.

It is well known that agriculture represents the main livelihood strategy for most households in Southern Africa, and most of it is subsistence agriculture. Rockström *et al* (2004) note that rain-fed agriculture is carried out on 97% of agricultural lands in sub-Saharan Africa. In addition the consensus seems to be that erratic rainfall due to global warming and climate change is likely to increase (Mason & Joubert, 1997; IPCC, 2007) and that agricultural production in Africa is expected to be severely compromised. According to the same source, rain-fed agriculture may decline by up to 50%. Thus, for many, droughts and floods may not only impact on access to food due to higher prices, but also due to declining own production. The cumulative effects of such recurrent shocks could be devastating. Thus, it seems that climate change is likely to erode livelihoods for various Southern African countries in the future.

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2.7 Household Nutritional Impact

In general, in analysing the possible nutritional impacts on household and individual behaviour in response to high food prices, coping strategies can be classified as being either food-based or non-food based. The first in the food-based coping strategies is the sudden loss in purchasing power which may result in changes in the quantity, quality and/or diversity of food items consumed. For example, an increase in the price of imported rice in West Africa might force households to switch to cheaper domestic rice or other starchy staples, such as locally produced sorghum or millet. Low income households with little or no choice to reduce the diversity of their diets will respond by simply having less meal per day and reducing non-food expenditure.

Non-food based coping strategies may include a reduction in expenditure on health care and education and seeking other sources of income to offset the loss in purchasing power. The most important is the extent to which households and individuals are affected depends considerably on their consumption behaviour and income status before the price shock set in. As nutritional problems among children and adults are likely to worsen substantially if high food prices persist, immediate action should be taken to mitigate negative effects. For appropriate policy and programme responses to be implemented, a clear understanding of the individual country specific is essential, as the nutritional impact of coping mechanisms will vary considerably in different settings and among different population groups.

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Food based interventions should aim to maintain or improve dietary diversity in order to prevent increases in micronutrient deficiencies. Policy and programme responses should include direct interventions such as micronutrient supplementation or distribution of fortified foods for highly vulnerable groups, such as children and pregnant or lactating women. These stopgap measures should be complemented by longer-term measures to ensure that low-income households have access to affordable diversified diets. Such examples include supporting small-scale food industries to produce weaning foods of good nutritional quality; supporting and promoting breastfeeding; providing adequate nutrition education messages; and conducting growth monitoring.

Evidence that emerged from Bangladesh in the 1990s suggests that macroeconomic food policies that keep the price of staple foods low can, in combination with other food and nutritional interventions, help reduce the percentage of underweight children (Torlesse et al. 2003). Considering the importance of women's status for child nutrition, effective measures should aim at eradicating gender discrimination and reducing power inequalities between women and men.

2.8 Causes of High Prices of Staple Food

Soaring food prices have triggered worldwide concern about threats to global food security, shaking the complacency created by many years of low commodity prices. In early June 2008, representatives from 180 countries plus the European Union, including many Heads of State and Government, met in Rome to express their conviction "that the international community needs to take urgent and

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coordinated action to combat the negative impact of soaring food prices on the world's most vulnerable countries and populations". In addition, at the G8 Summit in Japan in July 2008, the leaders of the world's most industrialized nations voiced their deep concern "that the steep rise in global food prices, coupled with availability problems in a number of developing countries, is threatening global food security". This was traced back to what could be described as production shortfalls. Extreme weather events in 2005–07, including drought and floods, affected major cereal-producing countries. World cereal production fell by 3.6 percent in 2005 and 6.9 percent in 2006 before recovering in 2007 (FAO, 2008b). Two successive years of lower crop yields in a context of already low stock levels resulted in a deficit supply situation in world markets. Growing concern over the potential effect of climate change on future availabilities of food supplies aggravated these fears.

Another problem among others could be increasing petroleum prices. Until mid-2008, the increase in energy prices had been very rapid and steep, with one major commodity price index (the Reuters-CRB Energy Index) more than tripling from 2003 (FAO, 2008b). Petroleum and food prices are highly correlated. The rapid rise in petroleum prices exerted upward pressure on food prices as fertilizer prices nearly tripled and transport costs doubled in 2006–08 (FAO, 2008c). High fertilizer prices have direct adverse effects on the cost of production and fertilizer use by producers, especially small-scale farmers.

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2.9 Food Security Measurement

The full range of food insecurity and hunger cannot be captured by any single indicator. Instead, a household's level of food insecurity or hunger must be determined by obtaining information on a variety of specific conditions, experiences and behaviours that serve as indicators of the varying degrees of the severity of the condition. Household surveys are usually used to get this information. Research over the past two decades has identified a particular set of these kinds of condition, experience and behaviour patterns that consistently characterize the phenomenon of food insecurity and hunger.

Two objective methods of food security measurement have been widely used in most food security studies. One is to establish gross household production and purchases over time, establish the growth or depletion of food stocks held over that period of time and presume that the food that has come into the household possession and disappeared has been consumed (Maxwell, 1996). The other is to undertake a twenty-four hour recall of food consumption for individual members of the household and analyze each type of food mentioned for caloric content. However, neither method provides a full assessment of the food security because they fail to take into account the vulnerability and sustainability elements of food security and hence neither method has been accepted as a "gold standard" for an analysis of household food security (Maxwell, 1996). Maxwell (1996) goes on that there has been a paradigm shift in food security measurement from one based on objective indicators to one based on subjective perception. One such subjective approach has been to analyse the use of and

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reliance upon strategies developed by the households and sequential response to dealing with insufficiency of food at household level as direct indicators.

Each method of measuring food security outcomes entails different methods of collecting and analysing the data. Food secure households at the minimum are able to produce enough food at all times such that all members can lead a productive and healthy life. The food can either be produced or the household's agricultural production can generate enough income to purchase all the required food items. This means that food security can be measured in terms of both household actual food quantities produced from the family farm or the income generated from the production. The choice of method to use depends to a large extent on the availability and degree of analysis of food security. However, it should be noted that most poor rural farming households mostly produce to subsist and only that part of the produce which cannot be consumed (surplus) is marketed.

2.9.1 Adult Equivalents Method

In Free State Province, a study was carried out to assess the contribution of rainwater harvesting and conservation practices to household food security (Aliber, 2003). Crop production from water harvesting technology was measured by its contribution to household food or income requirements. Household food security was achieved by determining the family size which was then converted to adult equivalents. Household Adult Equivalent (ADEQ) in the study was calculated based on household demographics as follows:

$$ADEQ = (A+0.5C)^{0.9}$$

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Where,

ADEQ is the Adult Equivalent,

A is the number of adults in a household,

C is the number of children in the family (where every household member below 15 years is a child).

After determining the adult equivalent, the total household income (HHIt) was divided by the adult equivalent to determine the adult equivalent income (ADEQI), which is a proxy for the income available for each adult member of the household. The ADEQI was calculated as follows:

ADEQI = HHIt/ADEQ

Where,

HHIt is the total income that the household received over a month, the ADEQI was used to determine the proportion (%) of ADEQI spent on food for each household.

%ADEQI spent on food = ((FEm/ADEQ)/ADEQI) * 100

Where, FEm is the total household income spent on food by the household per month. %ADEQI is used as an indicator of the welfare or food security status of a household. Generally, poor households (low income earners) spend a considerable proportion of their incomes on food. The study in the Free State Province expected an increase in proportion using water harvesting technology that would result in a reduction in the proportion of income used to acquire food. The increased income would be generated from the sale of the produce and enabling farmers to meet household food requirements. Unfortunately, other non

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income factors influencing household food security are not captured in this method.

2.9.2 Measuring household vulnerability

Given the difficulties in acquiring valid and reliable figures for income, expenditure and production, and the high cost of collecting data with 24-hour recall, a Coping Strategies Index (CSI) was developed to capture short term food sufficiency elements of food insecurity at household level (Maxwell, 1996). The CSI is a relatively simple and quick-to-use indicator of household food security that is easy to understand and correlates well with more complex measures of food security (Mzibule, 2004; Maxwell et al, 2003). The index measures the frequency and severity of household coping strategies, indicating behavioural responses (the things that people do when they cannot access enough food) which people adopt to manage household food shortage during emergencies (Owubah et al, 2005; Food Aid Management, 2004). Comparative studies have shown coping strategy indices to be good proxies for food intake (or energy adequacy), food budget shares, food frequency, income status, and the presence or absence of a malnourished child in the household (Food Aid Management, 2004; Maxwell et al, 1999).

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Table 2.2: Frequency of consumption-smoothing strategies used at Embo

Freq of coping strategy	Household using the strategy (%)							
	Substituting inexpensive foods	Purchase food on credit	Borrowing food	Reducing quantity of food eating	Leave food for child	Reducing the number of meals eaten in a day	Borrowing from neighbours or friends	Skip meals in a day
Every day	24.9	12.2	19.3	21.3	10.2	8.6	19	2.6
3-6 day/ week	19.8	14.2	25.4	8.1	3.6	9.6	25	1
1-2 days/week	10.7	4.1	7.6	3	.5	2	7.5	0
Not more than once/week	6.1	3.0	.50	.5	0	0	.5	0
Never happen	38.6	66.5	47.2	67	85.8	79.7	46.5	96.4
Proportion used as a strategy	61.4	33.5	52.8	33	14.2	20.3	53.5	3.6

Source: Mjonono, Ngidi & Hendricks, 2009

The following are the typical coping strategies to mitigate food shortages when households were asked to quantify how frequently, during the previous seven days, the household had resorted to using each strategy because they did not have enough food or enough money to buy food (Table 2.2):

- Substituting expensive foods
- Purchase food on credit
- Relying on help from friends or relatives
- Reducing quantity of food intake
- Leave food for children
- Reducing the amounts of food eaten in a day
- Borrowing from neighbours or friends
- Skip meals in a day

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In Table 2.3, the mid-point of each time range was used as the frequency measure in the calculation of the CSI for each household (Maxwell et al, 2003).

Table 2.3: Frequency description of CSI

Description	Frequency of use per week				
	Never	Hardly at all	Once in a while	Pretty often	Every day
Number of days	0	<1 day	1-2 days	<6 days	7 days
Mid-points	0	.5	1.5	4.5	7

Source: Mjonono, Ngidi & Hendricks, 2009

For each coping strategy the frequency indicated by the household was multiplied by relevant severity of that strategy. The sum of this product for all coping strategies yielded the household's CSI score. Maxwell et al (2003) argue that households with a score of zero could be food secured, as they do not employ food insecurity coping strategies. As the score increases, so do households rely more on consumption-smoothing strategies. Households with low CSI scores are more food secured and apply consumption-smoothing strategies less frequently than households with high CSI scores. Table 2.4 shows that the CSI was positively and significantly correlated with the use of all but one of the consumption-smoothing strategies.

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Table 2.4: Correlation between the CSI and use of consumption-smoothing strategies at Embo (Mjonono, Ngidi & Hendricks, 2009)

Coping strategy	Spearman correlation
Substituting inexpensive foods	0.380**
Reducing quantity of food eating	0.589**
Reducing the number of meals eaten in a day	0.471**
Borrowing from neighbours or friends	0.671**
Purchase food on credit	0.327**
Send household member elsewhere to eat	0.116
Consume seed held for next season	0.303**
Leave food for child	0.451**
Beg/Borrowing food	0.345**
Skip meals in a day	0.228**
Gather wild food, hunt or harvest immature crops	0.167*

*Note *, ** = significant at p<0.05 and p<0.01 level (two-tailed) respectively*

The range of CSI scores was wide. Households that did not employ coping strategies have a CSI of zero. Correlation showed that there was a statistically significant negative relationship between the CSI score and per capita consumption from own production which showed that reliance on coping strategies was reduced by producing food for consumption and the sale of these crops, in turn, reducing food security.

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2.9.3 Consultative Group to Assist the Poorest Poverty Assessment Tool (CGAP)

A promising new methodology for a simple low-cost tool for identifying the poor or the food insecure is offered by the Consultative Group to Assist the Poorest (CGAP) Assessment Tool (Falkingham & Namazie, 2002), which has recently been developed by the CGAP of the World Bank in collaboration with the International Food Policy Research Institute (IFPRI). Its development is detailed in Zeller et al. (2001).

The first step in the development of the CGAP tool was to identify a large number of indicators that 'powerfully reflect poverty and for which credible information can be quickly and inexpensively obtained' (Zeller et al., 2001). The initial compilation of indicators was based on a detailed review of results of large, in-depth surveys on household economics as well as of indicators and methods used by micro finance institutions (MFIs), famine early warning systems and national monitoring systems for food security, nutrition and vulnerability (see, for example, Wratten (1995)). This yielded a total of over 300 indicators. The indicators were then divided into two groups.

The first group reflects the means to achieve welfare (i.e. the income potential of the household) and includes indicators of the household's human capital (family size, education, and occupation), physical capital (type and value of assets owned) and social capital. The second group includes indicators related to achievements in consumption in order to fulfil present and future basic needs (access to health services, food, electricity, energy, water, shelter and clothing,

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human security and environmental quality). From this it is clear that the CGAP tool is capturing a wider concept of poverty than simple material or economic poverty and is more akin to a measure of capability poverty and food insecurity.

2.10 Linking Water to Household Food Security

Food security is the outcome of many interrelated factors, one of which is water, an essential resource for food production. Access to water in rural areas, and the price of water, affects household food security for the following reasons (Hubbard, 1995):

- Rural water costs tend to be high and unstable, whether in monetary terms or in the time and effort required by households to fetch water, thus influencing their real incomes. For example, Khosa (2003) reports that households in Sekuruwe and Molekane (Limpopo Province) paid R0.50 for 20 litre potable water obtained from private boreholes and travelled long distances to collect water from rivers or springs for purposes other than drinking and cooking. Rural clean water sources are often vulnerable to droughts and floods, leading to increased costs of obtaining clean water at times when food prices typically are also likely to be high.
- Water-related local diarrhoeal diseases reduce food absorption. Nearly 50% of South African children do not have access to clean safe water and large numbers of children are hospitalised annually for complications as a result of diarrhoeal disease (King et al., 2006). In South Africa diarrhoeal diseases are the third leading cause of

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death for South African children younger than five years (Bradshaw and Nannan, 2006).

- Access to water for livestock and particularly for the irrigation of crops, including food crops, is one of the ways poverty and food insecurity can be reduced in rural areas. This has resulted in water being called the dividing line between poverty and prosperity, as it is a cross-cutting tool for the achievement of the Millennium Development Goals (MDGs).

The ability to produce more food for a growing world population has improved significantly in recent decades as a result of expansion of irrigated cropland. Increasing the proportion of irrigated agricultural land has provided a solid base for boosting productivity and reducing the volatility of agricultural yields. With demand for water rising and climate change imposing further restrictions, efficiency in the management of available water resources becomes a necessary condition for productive increases in agriculture and for food security.

In about 25 percent of the world's irrigated agricultural systems, the rate of water withdrawal exceeds that of renewal (FAO, 2008b). Even more disturbing are reports that water is becoming scarce in several regions. Open access or loose property rights on water resources and irrigation systems lead to the overexploitation of aquifers and unsustainable irrigation practices that exhaust, contaminate or at the very least increase irrigation costs.

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Land degradation is also an outcome of inefficient use of water resources and inadequate irrigation management practices, resulting in productivity reductions and increasing losses of cropland. Small-scale farmers are more affected by these practices as they lack the capacity to secure rights to water as well as the resources to invest in more expensive but more effective pumping tools. In Africa, less than 5 percent of cropland is irrigated (FAO, 2008b). Large benefits could accrue to small farmers by the expansion of irrigated land to increase and stabilize the level of production, while also minimizing the impact of rainfall uncertainty in agriculture. Irrigation investment projects have high rates of return estimated as exceeding 15 percent and even reaching 30 percent in sub-Saharan Africa (World Bank, 2007).

Food production is the most water-intensive activity in society and water is the number one food-limiting factor in many parts of Asia and sub-Saharan Africa. Agriculture accounts for 70% of the worldwide human fresh water use (Gerbens-Leenes & Nonhebel, 2004) and this figure can be as high as 90% in developing countries (SIWI-IWMI, 2004). Whilst about 50 litre water/person per day is the recommended minimum for household use, 70 times as much (3,500 ℓ/d) is needed to meet the consumptive water use for producing a projected human diet consisting of 3,000 kcal (12,600 kJ) per day for one person (SIWI IFPRI IUCN IWMI, 2005). Large volumes of water are transformed into vapour during production in the form of plant transpiration and evaporation from fields, canals, reservoirs and high water tables (SIWI-IWMI, 2004).

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Water, however, is the main limiting resource in South African crop production, and this limits the potential to increase food production in the dry rural regions where the prevalence of under-nutrition is high (Laker, 2004). At the global level, Rosegrant et al (2002) predicted that, if current water policies continue, farmers will find it difficult to meet the world's food demands and projected that the global yield growth rate for all cereals will decline from 1.5% achieved between 1982 and 1995 to 1.0% per year during the period 1995 to 2025.

Methods of increasing production without using more water include promoting crops that are well adapted to harsh climatic and growth conditions, breeding drought-tolerant crops, changing agronomic and field practices, applying low cost supplementary irrigation technologies for rain-fed areas, reutilising water, introducing innovative water pricing systems and incentives, water harvesting, using labour- and/or water efficient irrigation technologies, etc. (Welch & Graham, 2002; Khosa, 2003; Kundhlande et al., 2004; SIWI-IWMI, 2004; SIWI IFPRI IUCN IMWI, 2005; Spreeth et al., 2004; IFAD, 1992a,b; Daka, 2001; Laker, 2004; 2006).

For agricultural interventions to improve food security and nutrition, the intervention must have a well-designed agricultural component as well as a well-designed nutritional component, and these two components should be mutually reinforcing (Bonnard, 1999). Water is one of the essential resources to ensure food production. Feeding more people with the same amount of water is an important consideration for the promotion of food security and alleviation of malnutrition.

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2.10.1 Livelihood option among plot holders on smallholder irrigation schemes

According to Van Averbeke & Mohamed, 2007, providing for the formal education of the children emerged as the key livelihood objective of plot holders at Dzindi. Formal education was aimed at giving their children a good opportunity to find employment, not to become skilful irrigation farmers. For the transfer of agricultural knowledge, plot holders engaged their children in day-to-day farming activities on the plots. Generally, plot holders did not mind their children becoming farmers, but they preferred them that they get educated to enable them find professional employment later. Important here was that among the different livelihood types identified at Dzindi, skilled wage earner homesteads, a sub-category of the wage-earner homesteads, had by far the highest incomes.

2.11 Improving Smallholder Irrigation

Improving contemporary smallholder irrigation schemes will entail rehabilitating the irrigation infrastructure, providing effective extension services and facilitating access to information are public interventions that will undoubtedly be of benefit to smallholders. And in addition, it is of note that when seeking to improve smallholder irrigation schemes it is important that diversity among schemes is acknowledged. Each scheme represents a particular set of circumstances. Differences among schemes may occur in many domains, including spatial (remote or close to urban markets), ecological, technological, adequacy of land and water, agricultural traditions, historical evolvement, institutional arrangements and social organisation, to name but a few. The opportunities for improvement of

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smallholder irrigation schemes need to be considered within the context of diversity among schemes.

2.11.1 Revisiting the land preparation question

Mechanisation is an important concern on smallholder irrigation schemes, particularly to farmers primarily engaged in farming for own consumption, because they invest cash, mostly obtained from sources other than farming, to produce food. In the past, smallholder irrigators had access to public tractor services, which may not have been particularly efficient, but they were cheap (Lahiff, 2000). When this service was withdrawn, mechanised land preparation services were only available from private providers. For various reasons, including the rise in the cost of fuel, the relative contribution of mechanised land preparation to total variable costs of production (excluding labour) on smallholder schemes has increased substantially.

In 1995 at Tshiombo, land preparation contributed 20% to the total variable cost of maize production when the public land preparation service was used, and 27% when this service was obtained from a private supplier (Lahiff, 2000). In 2003 at Dzindi, the contribution of land preparation to the total variable cost of maize production was 34% (Van Averbeke, 2006). The rising cost of mechanised land preparation was identified as the main cause for the emergence of land exchange markets on smallholder schemes in VDM. On these schemes, plot holders, mostly poor food farmers, made available part of their land to others in exchange for land preparation (Van Averbeke, 2006).

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At Dzindi, where land exchanges have persisted until recently, especially with outsider, market-oriented farmers, particularly those who owned tractors, have recently obtained access to additional land in exchange for land preparation services. Whereas growth in land exchanges among plot holders supports the diversity in livelihood and farming, there is still a need to investigate alternatives to mechanised land preparation. Laker (2004) presented evidence from Dzindi that

- land preparation using animal draught was cheaper than when a tractor was used;
- compared to mechanised draught, the use of animal draught reduces the hazard of soil compaction; and
- as with mechanised land preparation, land preparation services using animal draught can be commercialised.

2.11.2 The Human aspect of irrigation projects

As in other human activities, the first requirement for success is that the workers engaged in the activity should be strongly motivated and committed to the task. The second requirement is that they are properly informed, not merely trained in the performance of routine operations but enabled to understand the fundamental principles of proper irrigation management. An investment in research and in training personnel is even more vital in this respect than an investment in pipes or pumps. The third requirement, of course, is that the irrigation workers be given access to (preferably, an opportunity to acquire) the material inputs necessary for the best performance of their work (FAO, 1997a).

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One of the worst mistakes that can be made by irrigation developers or managers is to assume an authoritarian role, expecting the workers to obey the instructions handed them from above without question. Depriving human beings of personal stake in their own work, and of the challenge and incentive to apply their own creative ingenuity, is a waste of a resource even more precious than soil and water. People who are given a sense of participation, and allowed to reap rewards commensurate with their initiative and contribution, care much more for their work and give much more of themselves to its success. The incentives offered may be social, administrative, economic, or, best of all, a combination of all three. The greatest incentive is to allow, indeed encouraging people and families to work for themselves, in harmony with their neighbours, on their own plots of land and with access to assured supplies of water and other essential means of production.

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To accomplish this aim, policy-makers and administrative agencies need to resolve a complex set of problems involving land reform and tenure, water rights, and the coordination of resource allocation and utilization among various competing sectors, all of which, however, range far beyond the limited scope of this discussion (FAO, 1997b). In addition to providing workers with incentives, an irrigation scheme may also contribute to human welfare in a larger sense. Many, perhaps most, irrigation systems in the developing world are used for non-agricultural purposes as well as for raising crops: for domestic water needs, waste disposal, power generation, transportation, fishing and recreation. Some of these needs may interfere or conflict with the basic functioning of the irrigation project, particularly if they are not recognized at the outset and included in the initial planning stages.

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One of the most serious problems in irrigation projects is the potential health hazard resulting from the use of open water channels for drinking, bathing, washing of clothes and the disposal of human and animal waste. It has been said that "wherever water goes, disease follows" (FAO, 1997a). Unfortunately, water storage and conveyance structures present favourable breeding grounds for disease vectors (such as mosquitoes and snails) and for pathogens of some of the most debilitating illnesses rampant in the developing world. Among these are schistosomiasis (bilharzias), onchocerciasis (river blindness), malaria, cholera, dysentery and other intestinal diseases (FAO, 1997a). Public health specialists should therefore participate in the design and operation of all irrigation schemes, as well as in the rehabilitation or modernization of existing schemes. Among factors that may contribute to the control of water-borne diseases are the following:

- concrete lining and shaping of the conveyance and drainage channels to prevent stagnation along the banks (as well as, incidentally, to reduce seepage losses);
- control of riparian vegetation within the channels, to prevent clogging, stagnation and harbouring of diseases;
- protection of the channels from wading animals that may breach the banks and pollute the water;
- control of waste disposal by humans, who must be provided with environmentally safe sanitary facilities;
- treatment of the water used directly for human needs (filtration and, where necessary, use of chemicals to control parasites).

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All these measures can be carried out most effectively in systems that convey water in closed conduits and that restrict access to storage reservoirs. Such conveyance can also facilitate the adoption of the HELPFUL (high-frequency, efficient, low-volume, partial-area, farm-unit, low-cost) irrigation methods (FAO, 1997a). It can thus be seen that the proper development and management of irrigation is a complex and comprehensive undertaking, requiring attention that is much more than hydraulics and agronomy. Thus the design and operation of each irrigation project is necessarily site specific not only because of variable physical and agronomic conditions but also special combination of human and economic factors exist in each case and must be recognized in any attempt to promote or improve the practice of irrigation.

2.12 Summary of the Reviewed Literature

Approximately one third of South African households are involved in small-scale farming but agriculture does not contribute more than 4 per cent to their total incomes even though farming requires very high time commitments from family members (Schmidt, 2005, Hendricks & Maunder, 2006). The level of farming depends on access to land, water, seeds and agricultural implements which directly influence food security. Various methods of measurement of food security were discussed in the review. It has been found that a more appropriate measurement is the one that predicts factors that influence household food security and which are expected to give significant signs after data analysis. Smallholder irrigation is one of the key indicators in addressing household food security as it brings a number of benefits to farmers.

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In South Africa, the history of smallholder irrigation schemes has been linked to particular political developments in the country. Contemporary assessments have been critical of the performance of these schemes. An analysis of livelihoods and farming on selected smallholder schemes revealed that livelihood and farming on plots were diverse and highly dynamic, which is an indication that these patterns were natural and persistent, and should, therefore, not be resisted politically. Instead, these patterns should be viewed as opportunities to increase the socio-economic impact of smallholder schemes. This could be achieved by enhancing the flexibility of prevailing institutional arrangements to enable expansion and contraction of individual irrigation enterprises in response to changes in the structure of the livelihood of individual plot holder homesteads.

The overall economic performance of smallholder irrigation schemes were identified as institutional developments to improve access to land and water, the (re)introduction of animal draught in land preparation, collaboration among smallholders in relation to markets, and the incorporation and integration of animal production into irrigated farming systems. Western technology should be adapted or redesigned to be flexible so as to suit the prevailing conditions and requirements. Government, private agencies and the farming communities should be geared towards achieving a sustainable smallholder irrigation scheme that will enhance food security.

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CHAPTER 3

DESCRIPTION OF THE STUDY AREA

3.1 Introduction

This chapter gives descriptions of the geographical and climatic conditions, population, and economic, social and physical nature of the study area. The chapter attempts to expound reasons for the need for irrigation investments in the study area. The chapter also looked at other activities that people could adopt for their survival to improve food security.

3.2 Description of the Study Area

This study was carried out on smallholder irrigation projects and dryland farms in selected villages within the Vhembe District Municipality (VDM) of Limpopo Province. Vhembe District is one of the most underdeveloped provinces in South Africa. It contributes only 3% to the GDP of the country (Stats SA, 2000). It is an agricultural district and yet is ridden with food insecurity.

The district was established in terms of the Municipal Structures Act 117 of 1998 as a demarcated sphere of governance. It covers an area of approximately 21,000 square kilometres. The Vhembe District is the most northern region in Limpopo, with borders of Zimbabwe to the north, Botswana to the northwest and the Kruger National Park (KNP) to the east (Blunt, 2009). Figure 3.1 below shows Vhembe District Municipality (VDM) which is composed of four local municipalities, namely; Makhado, Musina, Thulamela and Mutale. The region's

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administrative capital, Thohoyandou is situated within the Thulamela Local Municipality. Other important towns are Louis Trichardt, Musina, Levubu and Vivo. Despite the district's newly acquired mineral wealth and fairly large agricultural and tourism sector, the majority of the district's 1.2 million population live below the poverty line in mostly rural communities. The poverty rate in Vhembe is estimated to be 64.7% (Blunt, 2009).

Nourished by the Limpopo River, agriculture is the major economic activity and employer in the district, both in terms of commercial and subsistence farming. Vhembe's vast bushveld area supports commercial and game farming, contributing to both the agriculture and tourism industries. Subtropical crops such as bananas, mangoes, avocados, pawpaws and pineapples are farmed in suitable areas in the district, while tea and coffee plantations are prevalent in the northwestern parts of the VDM.

The area around Levubu produces macadamia nuts, with macadamia oil becoming a sought after commodity worldwide for both the food and cosmetics industries. The district also features the only inland salt production enterprise in South Africa which is found at the foot of the Soutpansberg Mountain (Blunt, 2009). Mining activities in Musina, include copper-mining, iron ore, magnetite, graphite, asbestos and platinium which are still mined on a relatively small scale.

The former Venda, which was a homeland of apartheid South Africa were part of VDM which was allocated to black families, and the land was often marginal. The VDM is the home to the ancient Kingdom of Mapungubwe, the Land of Legends

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which has been declared as a World Heritage Site and the region is blessed with a wide range of other tourist attractions like the Verdun, Machemma and Dzata, the site of ancient salt production. The district is also an important entry point to Pafuri and Punda Maria Gate in the northern part of the KNP.

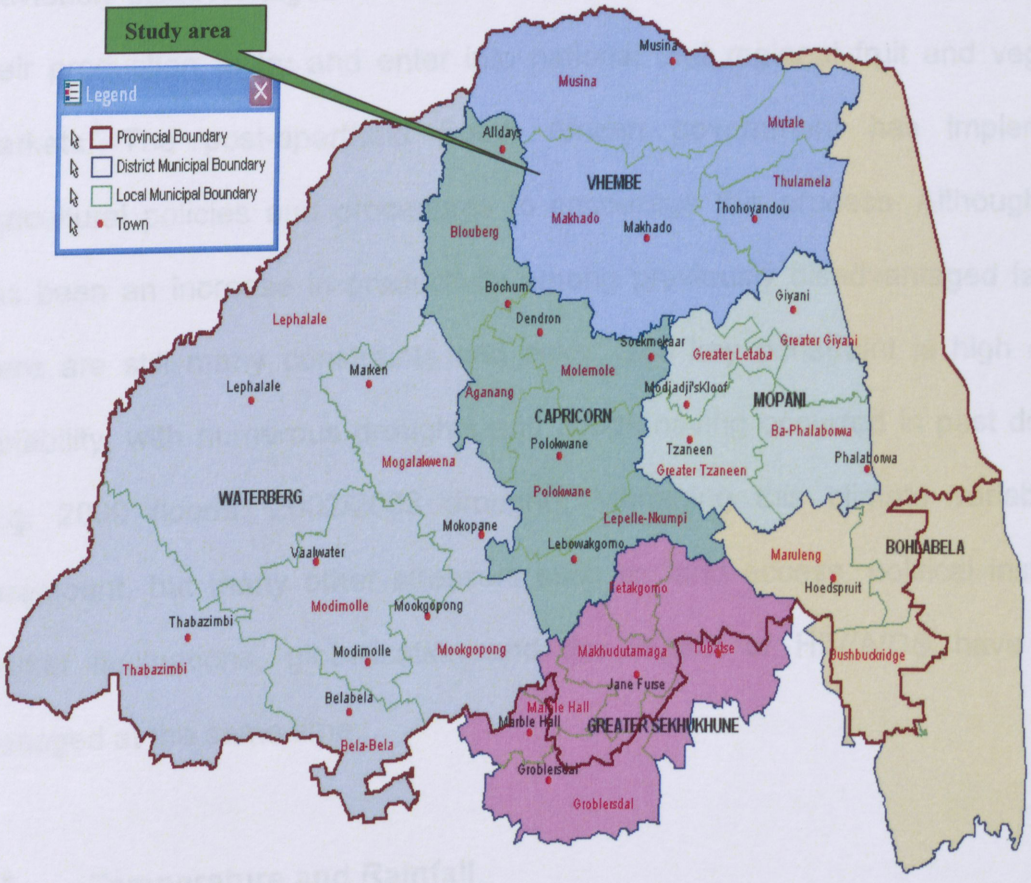


Figure 3.1: Geographical location of the study area

3.3 Location of the Study Area

It also borders Mopani District in the south-east and Capricorn District in the south-west. The protracted war in Mozambique, the political instability and the recent outbreak of the cholera epidemic in Zimbabwe have forced people to cross

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the border into South Africa and most of them have settled in the Vhembe District. The rising population from politically unstable neighbouring countries' demands have increased food insecurity in the area.

3.4 The Climatic Condition of the Study Area

The climate is characterized by lowveld (arid and semi-arid). Many of the previously disadvantaged farmers in the area have begun increasing the size of their production to try and enter into national and regional fruit and vegetable markets. The post-apartheid South African government has implemented agricultural policies and procedures to encourage this process. Although there has been an increase in productivity among previously disadvantaged farmers, there are still many constraints and risks. One key constraint is high climate variability, with numerous droughts and floods having occurred in past decades (e.g. 2000 floods, 2002/2003 drought). Managing this climate variability is paramount, but many other stressors such as land access, political instability, market fluctuations, globalization and the impact of HIV/AIDS have to be managed at the same time.

3.5 Temperature and Rainfall

Vhembe District is characterised by an annual rainfall of ±500mm per annum and temperature range from a minimum of 10°C during winter to a maximum of 40°C during summer. The rural economy is heavily reliant on agriculture and 85% of the population in this region is involved in farming (Ramaru *et al.*, 2000).

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3.6 Size of the Irrigation Schemes in Vhembe District

The VDM has a total of 3,236 small-scale irrigators (Limpopo Department of Agriculture, 2007), on about 48 schemes. Thulamela has the highest number of irrigators 1,864 representing 57.6%; while Makhado has the second largest number 1,128 representing 34.85%; Mutale is next with 194 representing 6.0%; while the least number is from Musina with only 50 irrigators representing 1.55%.

3.7 Population and Population Density

The land area covers 21,407 km^2 and has an estimated population of 1,192,251, that is over 1.1 million living in 274,480 households. The population is comprised of mostly Venda and Shangaan tribes, with a sprinkling of white Africaners who are the major owners of large commercial farms.

3.8 Geology of the Study Area

The smallholder farms are located mostly in the former homeland areas and they cover approximately 30% of the provincial land surface. It is recognized that resource degradation in the former homelands was mainly caused by poor living conditions and overpopulation (White Paper on Agriculture, 1995). Farming under smallholder system is characterized by low level production and small farms of approximately 1.5 ha with production being primarily for subsistence with little marketable surplus. The increasing pressure on the land resource due to increasing human population has also resulted in intensive continuous cultivation and a rapid depletion of plant nutrients. In addition, these drier areas often have highly degradable soils that are susceptible to soil erosion and eventual decline in soil fertility, especially under arable cultivation where soil conservation measures

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are absent. One of the major constraints to crop production faced by the smallholder farmers in this region is inadequate supply of nutrients due to declining soil fertility (Ramaru *et al*, 2000).

3.9 Land Suitability for Irrigated Cultivation

The high climate variability, with numerous droughts and floods that have occurred in past decades (e.g. 2000 floods, 2002/2003 drought) are some of what characterise the study area and irrigated cultivation could increase productivity and yield. The VDM has many large fruit and vegetable farms located around the Soutpansberg mountains which spread the length and breadth of VDM. A number of irrigation regions in Dzanani, Tshiombo, Vuwani, etc could be identified for the production of vegetables, tobacco, cotton and citrus.

3.10 Land Suitability for Grazing

The district also has thriving livestock farming which has potential for red and white meat cluster. Farming opportunities for red and white meat can be established and should be promoted in all the Local Municipalities in the VDM.

3.11 Local Economic Activities

Economic development can be defined as being an effort or undertaking that aids in the growth of an economy, be it local, provincial or national. Local economic activities will go a long way in poverty reduction and hence improving food security among the people. When identifying and determining development potential within an economy, a set of criteria is required against which development potential can be gauged. The set of criteria serves as an evaluation

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tool to identify areas with potential for development and opportunities within each of the local economic sectors. These include:

- Availability of raw materials and resources – regarded as the primary production factor.
- Availability of labour – the labour force is vital to the production process due to the fact that they drive production.
- Economic linkages – there are the various interactive relationships that exist in the different economic sectors within a region's economy.
- Market trends – this criterion is consumer related and the most difficult of all to map and determine.
- Value chain/Gap analysis – a gap is defined as being a disparity between what is provided and what is needed (or required).
- Agglomeration advantages – agglomeration advantages can be illustrated by developing a mining logistical hub or cluster.
- Logistics/Nodal point function – to determine if the area has potential for delivering a logistics or nodal point function, one need to answer the following question: can the area serve as a distribution point for specific products or services?
- Regional service delivery function – this criterion refers to the ability and capability to provide for both the local and regional requirements.
- Technology change – this is the most dynamic of the entire set of criteria. Technology changes refer to the changes in the ways we produce goods and services.
- Enabling policy environment – potential for development can also be identified when considering the policy environment.

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The potential development areas and projects identified within the various economic sectors are aligned with these criteria.

3.11.1 Agriculture

Agricultural growth is widely seen as the means to address the global food crisis and simultaneously alleviate poverty, hunger and malnutrition – particularly in Africa (NEPAD, 2009). The agriculture sector incorporates establishments and activities that are primarily engaged in farming, but also establishments focusing on commercial hunting and game propagation and forestry, logging and fishing. The agricultural sector contributes significantly to employment in the VDM, even though this sector's full potential has not yet been realised in the economy. Not only can it have significant multiplier effects throughout the entire regional economy, but it can also stimulate many other economic activities through its linkages to other sectors. The main agricultural products produced within the district are: Potatoes, Tomatoes, Eggs, Broilers/beef, Pork, Citrus, and Maize. The land availability, suitability and capability in each of the local municipalities should be unravelled. The development potential in the agricultural sector of VDM is contained in the expansion of the production of existing products in the region.

More potential for development lies in products such as vegetables or livestock, which generally fair well in other areas of Limpopo. Further development potential in the agricultural sector is also seated in agro-processing, linked to the manufacturing sector. There are other value chain developments and cluster formations in the establishment of abattoirs, processing plants, packaging,

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distributions, etc, e.g. grain products, red meat and cattle breeding, horticulture, oilseeds, agro-based pharmaceuticals, etc.

The development of upstream beneficiation such as supplying pesticides, feedlots machine parts, etc, could be coupled with financial and technical support to emerging farmers and SMMEs in order to improve access to the commercial market.

3.12 Conclusion

Agricultural sector contributes significantly to employment in the VDM, even though this sector's full potential is not yet realised. Not only can it have significant multiplier effects throughout the entire regional economy, but it can also stimulate many other economic activities through its linkages to other sectors.

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CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

This chapter covers the research methodologies used for the study. That is, the research design, population sampling procedure, data collection and data analysis methods that were used in the study are explained. Ethical considerations and the limitations that underpin the study are also explained.

4.2 Data Types and Sources

Both primary and secondary data collection methods were used in the study. The preliminary study consultation with the supervisors started in December 2008. The secondary data was collected from various government official reports which included Department of Agriculture, the Agricultural Service Centres in Thohoyandou, Makhado, Musina and Mutale; Statistics South Africa 2000-2008 census reports and mid-year estimates; private and public institutions including local farmers' organisation in the district; policy documents; journals, research papers on internet and related books in the University of Venda library and elsewhere. Primary data was collected using a pre-tested questionnaire administered among selected farmers in the study area.

4.3 Sampling Procedures

A probability sampling method involving simple random sampling technique was used to select the respondents. Vhembe district has a total of 3,236 small-scale

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irrigators (Table 4.1). A desired sample of 150 irrigators was randomly selected using simple random sampling techniques while 50 non-irrigators of dryland farmers were selected adjacent to the selected irrigators (Table 4.2).

Table 4.1: Database of Irrigation Projects in Vhembe District

Scheme	Municipality	Hectares	Irrigator	Sample size	
				Irrigator	Non-irrigator
Beaconsfield	Makhado	35	25	1	1
Cordon a+b	Makhado	73	60	2	1
Diephkloof/Mavhunga	Makhado	40	39	1	1
Luvhada	Makhado	28	79	4	1
Mamuhohi	Makhado	78	60	2	1
Mandiwana	Makhado	67	55	1	1
Mphaila	Makhado	71	76	3	1
Mphephu	Makhado	114	89	5	1
Phadzima/Mpesema	Makhado	82	65	1	1
Rabali	Makhado	87	73	3	1
Ralipaswa	Makhado	15	13	1	1
Vhutuwangadzebu	Makhado	18	60	2	1
Garside	Makhado	52	40	1	1
Joubertstroom	Makhado	70	60	2	1
Khumbe/Rebanda	Makhado	145	145	8	2
Manunswa	Makhado	255	1	0	0
Hamutsha	Makhado	7	31	1	1
Nesengani	Makhado	71	34	1	1
Tshimbupfe	Makhado	12	24	1	1
Mashamba 1	Makhado	27	6	1	1
Capesthome	Makhado	99	77	4	1
Gogobole	Makhado	16	16	1	1
Tshwinga	Musina	50	50	3	1
Folovodwe	Mutale	55	45	2	1
Klein Tshipise	Mutale	9	18	1	1
Mauluma	Mutale	50	40	2	1
Sanari	Mutale	39	6	0	0
Rambuda	Mutale	102	85	4	1
Dopeni	Thulamela	170	150	9	2
Makuleke	Thulamela	239	243	18	3
Matsika	Thulamela	102	47	2	1
Mangondi	Thulamela	17	59	3	1
Morgan	Thulamela	75	24	1	1
Tshaulu	Thulamela	150	69	5	1
Tshikonelo	Thulamela	27	3	0	0
Tshiombo	Thulamela	1100	930	25	4

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Britz	Thulamela	70	7	0	1
Makonde	Thulamela	200	11	0	1
Lanbani	Thulamela	44	50	6	1
Malavuwe	Thulamela	26	24	1	1
Mhinga/Xikundu	Thulamela	229	28	1	1
Muledane	Thulamela	48	5	0	0
Mutele	Thulamela	33	7	0	0
Phaswana	Thulamela	235	15	1	1
Dzindi	Thulamela	137	105	9	2
Murara	Thulamela	37	7	0	1
Palmaryville	Thulamela	93	80	7	1
Total		**4799**	**3236**	**150**	**50**

Source: Limpopo Department of Agriculture (2007)

Table 4.2: Sampling distribution for the survey

Municipality	No. of irrigator	Sample size	
		Irrigator	Non-irrigator
Makhado	1128	50	17
Musina	50	3	1
Mutale	194	9	3
Thulamela	1864	88	29
Total	**3236**	**150**	**50**

4.4 Data Collection

4.4.1 Questionnaire design

The data collection tool was the questionnaire which was designed and used to obtain the required data needs of the study. The questionnaire elicited household characteristics such as demographic information (name, sex, age, level of education, etc), farm specific characteristics (number and class of livestock, crops grown, hectarage and output), food and non-food expenditures, remittances, employment and income, agricultural activities and finally the nature and risks of farming. The questions were designed in such a way as to avoid ambiguity, sensitivity and provocativeness. The questionnaire included a few open-ended

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and numerous close-ended questions. Data was collected from September to October 2009. Face-to-face interview method between the researcher together with the enumerators and the respondents was used to administer the questionnaires. The questionnaire consisted seven parts namely:

- demographic data (household information);
- irrigation information;
- questions on household food security including list of food recalls;
- aggregate production of crops and livestock;
- household income and expenditure;
- marketing of commodities and;
- asset ownership including wealth status of respondents.

4.4.2 Pilot test

The designed questionnaire was pre-tested (pilot test) in order to determine the following:

- Time spent when completing the questionnaire;
- Validity and reliability of the questionnaire;
- Ethical standards such as sensitivity questions;
- Respondents' understanding of the questions.

4.4.3 Field survey

The interviews were conducted in the three main languages of the area, that is, Tshivenda, Tstonga and Sepedi. This was handled by 3 field enumerators who were employed and trained for this study.

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4.5 Ethical Considerations

Like every other study, this study also has some ethical dilemmas, particularly the invasion into people's private lives. The areas of discussion covered bordered on what one might consider to be private matters within and between households. This was especially pertinent when it comes to issues of intra-household relations, income and expenditure by the household members. They are the kind of issues people rarely discuss with other people and, less still with a stranger who comes in to do research. As such when questions bordering on such areas were posed, most if not all respondents became uncomfortable and hesitated to answer. The skill of probing then became very useful here. General questions were asked so as to avoid breaking the rapport created with the respondents. During data collection, respondents were assured of the confidentiality of the information and the names and addresses of respondents were not divulged for any purpose other than for the study. A letter authorising the research work (Appendix 2) was also submitted to the Department of Agriculture Service Centre offices in the study area. By this approach the respondents remained anonymous and their answers were kept in strict confidence.

4.6 Limitations and Delimitations

Since most of the farmer-respondents did not keep records, majority of their responses were based on memory recall, thus the information might not be absolutely accurate. This can be a limitation to the reliability of the data used for the study. However, this limitation was overcome by researcher's personal visit to the households to double check data collected by the enumerators.

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4.7 Data Analysis

A combination of quantitative and qualitative design methods was used. However, the study was based more on quantitative (survey), complemented with food recalls using qualitative data collection method. In the quantitative approach, the investigator primarily uses post-positivist claims for developing knowledge (that is cause and effect thinking, reduction to specific variables, hypotheses and questions, use of measurement and observations, and the testing of theories) and collects data using pre-determined instruments that yield statistical data. Neuman (1994) defines the survey design as a method, which provides a qualitative or numeric description of some fraction of the population or the sample, through the data collection process of asking questions. This data collection process enables a researcher to generalise the findings from a sample of respondents to a population. However, this study was based more on quantitative data. A logistic regression model was used to analyse the impact of smallholder irrigation on household food security. This model was complemented by eleven factors which influence food security, (the dependent variable).

4.7.1 Logistic regression model

The logistic regression was used by Feleke et al (2005) to assess the causes of household food insecurity. That particular study involved assessing various indicators that could affect the dependent parameter, food security and to investigate which independent variables affected food security. Among the variables were continuous and categorical variables, which include age of the household head, sex of the household head, wealth, farm size, cattle ownership,

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fertilizer application, educational level of the household head, physical access to markets, household size, off-farm employment, on-farm income and per capita aggregate production (Feleke et al, 2005). These variables were chosen because the researchers felt that these could influence food security either positively or negatively.

Households derive utility from the consumption of foods through the satisfaction found in a set of taste characteristics as well as the health effects of the nutrients consumed. In this study, the researcher is interested in the probability response variable that takes on the value of interest (usually coded as "1" and the other being "0") depending on the explanatory variables. The following model was used in this study to determine factors affecting household food security:

$$\phi_i = \mathrm{E}\left(\gamma_i = \frac{1}{\chi_i}\right) = \frac{1}{1+\ell^{-\left(\beta_i + \sum_i^k \beta_j \chi_i\right)}} \qquad (1)$$

ϕ_i stands for the probability of household ($_i$) being food secured and γ_i is the observed food security status of the household $_i$, χ_{ij} are the factors determining the food security status for household $_i$ and β_j stands for parameters to be estimated.

Denoting $\beta + \sum_{j=1}^{k=n} \beta_{ij}$ as Z, equation (1) can be written to give the probability of food security of household $_i$ as:

$$\phi_i = \mathrm{E}\left(\gamma_i = \frac{1}{\chi_i}\right) = \frac{1}{1+\ell^{-z_i}} \qquad (2)$$

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From equation 2, the probability of a household being food insecure is given by $(1-\phi_i)$ which gives equation 3, which can be written as

$$(1-\phi_i)=\frac{1}{1+\ell^{z_i}} \qquad (3)$$

Therefore, the odds ratio, i.e., $\phi_i/(1-\phi_i)$ is given by equation 4 as

$$\left(\frac{\phi_i}{1-\phi_i}\right)=\frac{1+\ell^{z_i}}{1+\ell^{-z_i}}=\ell^{z_i} \qquad (4)$$

The natural logarithm of equation 4 gives rise to equation 5.

$$\text{Ln}\left(\frac{\phi_i}{1-\phi_i}\right)=\beta+\sum_{j=1}^{k=n}\beta_{ij}+\varepsilon_i \qquad (5)$$

Rearranging equation 5, with the dependent variable (food security) in log odds, the logistic regression can be manipulated to calculate conditional probabilities as

$$\phi_i=\frac{\ell^{\left(\overline{\beta_0}+\sum_{i=1}^{k=n}\overline{\beta_j}\chi_{ij}\right)}}{1+\ell^{\left(\overline{\beta_0}+\sum_{i=1}^{k=n}\overline{\beta_j}\chi_{ij}\right)}} \qquad (6)$$

Once the conditional probabilities have been calculated for each sample household, the "partial" effects of the continuous individual variables on household food security can be calculated by the expression.

$$\partial\phi_i/\partial\chi_{ij}=\phi_i(1-\phi_i)\beta_j \qquad (7)$$

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The "partial" effects of the discrete variables are calculated by taking the difference of the probabilities estimated when value of the variable is set to 1 and $0(\chi_i = 0, \chi_i = 1)$, respectively.

In this study, the selected independent variables are sex of the household head, the age of household head, the household size, the education level of household head, the technology adoption level (water frequency), farm size, per capital aggregate income, land quality, aggregate production, marital status, physical access to markets and physical access to irrigation. These factors could have positive or negative impact on household food security. The model was specified as follows:

Y = f(x1, x2, x3, x4, x5, x6, x7, x8, x9, x10, x11)

Where,

Y = Dependent variable (food security)

x1 = Household size

x2 = Water frequency

x3 = Household farm size

x4 = Irrigation technology

x5 = Access to market

x6 = Per capital aggregate income

x7 = Age of the household head

x8 = Sex of the household head

x9 = Educational level of the household head

x10 = Marital status

x11 = Land quality

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The above model was estimated using cross sectional data collected from the respondents. The data analysis was carried out on 147 irrigators and 43 dryland farmers, making a total of 190 respondents excluding 10 questionnaires not captured due to errors in entries. The logistic regression was carried out on two separate groups and on a combination of the two groups. The variables were grouped into farm specific (irrigation technology, water frequency, land size, per capital aggregate income, land quality, access to market) and demographic variables (sex, age, marital status, education level, household size). The food security was measured based on whether or not the household produced enough food from their farm in the last one year. Household size was the sum total of the number of household members living with the household head. Water frequency represented how regular the water from irrigation got into the farm. This was measured by the number of times water was pumped and for how long. The household farm size was measured in terms of number of hectares of land owned by the farmers. Irrigation technology indicated whether or not a farmer used irrigation technology on his/her farm. Access to market indicated whether the farm have access to market or not. Per capital aggregate income was measured by adding the total income from farm produce including crops and livestock. The age of the household head was grouped into four to know those who were 66 year and above, 51-65, 18-50 and those who were less than 18 years. One of the groups was made a dummy to be able to analyse variables in the equation. Educational level of the household head was also grouped into four with those who have no formal education, up to grade 7, grade 7-12 and those with post secondary education. One of the groups was used as dummy variable.

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The logistic regression was chosen for this study because of the nature of the response variable which was dichotomous (Der & Everitt, 2002). The logistic regression can be used to predict a dependent variable on the basis of continuous and/or categorical independents and to determine the percentage of variance in the dependent variable explained by the independent variables, to rank the relative importance of independents, to assess interaction effects and to understand the impact of covariate control variables (Hesketh & Everitt, 2000).

A statistical analysis was performed with Statistical Package for Social Scientists (SPSS) for Windows (Version 14.0). The variance, frequencies, crosstabulation and chi-square analyses were used to explore relationships between household food security status and household demographics. Logistic regression was conducted to determine whether variables could be identified that would explain the process of attaining or not attaining household food security over the course of one year. After the first screening of bivariate statistics, variables in the model building process were included such as highest year of education completed, sex of household head, household income, marital status, number of years in farming, age of household head, etc. The fit of the model was assessed by using both graphing techniques (ROC curve), variables in the equation, and classification-table methods.

4.8 Conclusion

A logistic regression model was used to analyse the impact of smallholder irrigation projects on household food security. A comparison of the variables in the model was made between irrigation and dryland farming to establish whether

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they produce enough food or not in order to ascertain the variables impact on the household food security of Vhembe District Municipality farmers. These variables showed significant signs after analysis. The result of this analysis is presented in the next chapter.

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CHAPTER 5

EMPIRICAL RESULTS AND DISCUSSION

5.1 Introduction

This chapter discusses the empirical results of the study. The study identified farmers' involvement in smallholder irrigation projects, the impact of these projects on household food security, household income and productivity. Household demographic characteristics, farm characteristics and income sources for irrigation and dryland farming are presented in this chapter. A comparison of income sources and agricultural production between irrigated and dryland farming is also discussed to determine which households were food secure and which ones were food insecure.

5.2 Demographic Characteristics of Study Households

This study was conducted in selected villages of Vhembe District in Limpopo Province. Some questionnaires (10) were not captured for errors in data entries. The study sample consisted of 190 households with 77.4% irrigators and 22.6% non irrigators. The household size represented the total number of family members that were permanently available on the farm. The highest percentage (52%) had 1-5 household members; while only 5.8% had more than 10 household members.

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5.2.1 Sex of household head

Table 5.1 below shows a total of 143 were irrigating farmers while 47 were dryland farmers. The gender breakdown revealed that about 52% of the irrigators were male while 48% were females and 49% of the dryland farmers were male while 51% were females.

Table 5.1: Household demographics in the study area

Characteristics	Irrigators		Dryland	
	Number	Percentage (%)	Number	Percentage (%)
Sex				
Male	65	52.4	32	48.5
Female	59	47.6	34	51.5
Household age				
Less than 18	1	0.8	0	0.0
18-50	39	31.5	13	19.7
51-65	38	30.6	32	48.5
66 plus	46	37.1	21	31.8
Household size				
1-5	73	58.9	26	39.4
6-10	45	36.3	35	53.0
More than 10	6	4.8	5	7.6
Marital status				
Single	9	7.3	3	4.5
Married	92	74.2	53	80.3
Divorced	6	4.8	1	1.5
Widowed	11	8.9	7	10.6
Living together	6	4.8	2	3.0
Education level				
No formal education	24	19.4	18	27.3
Up to grade 7	42	33.9	35	53.0
Grade 8-12	44	35.5	10	15.2
Post secondary	14	11.3	3	4.5
Irrigation	147	77.4	43	22.6
Tenure status				
PTO	79	63.7	42	63.6
Title Deed	10	8.1	6	9.1
Rented	9	7.3	5	7.6
Others	26	21.0	13	19.7
Farming year				
Less than 1 yr	2	1.6	1	1.5
1-5 yrs	11	8.9	3	4.5
Over 5 yrs	111	89.5	62	93.9

Source: Computed from field survey, 2009

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5.2.2 Age of household head

The results of this study showed that the highest percentage (37.1%) of people using irrigation technology were above 66 years of age while the highest percentage of people in dryland farming (48.5%) were of aged between 51 and 65 years (Table 5.1).

5.2.3 Household size

Household size always has an influence on the food security status of households. 52.1% of the households had between 1-5 household members; while only 5.8% of household had more than 10 household members. Comparing the family sizes in the irrigation and dryland farming, the family size was 58.9% and 39.4% respectively for family size of between 1 and 5 while it was 4.8% and 7.6% respectively for family size of more than 10 (Table 5.1). Increasing family size tends to provide households with the required labour for agricultural production, while on the other hand; large families had a lot of pressure on food consumption as compared with the large labour it contributes to agricultural production (Paddy, 2003).

5.2.4 Marital status

Marital status was considered in this study because it was important in accessing the time devoted to household activities and agricultural production in communal areas. Married people were able to share household activities such as agricultural production, herding of livestock, harvesting of fruits, fetching firewood and water. While households with single, divorced and widowed heads had to perform all the

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household activities as they did not have adult support except from children who were old enough to do some household chores. In both dryland and irrigation farming households, most of the households were constituted of married couples (80.3% and 74.2%) respectively (Table 5.1). The rest of the categories (single, divorced, widowed and living together) were all of smaller percentages.

5.2.5 Education level of the household head

The number of years spent in formal education is one of the important determinants of increased agricultural production and adoption of new technologies (Ersado, 2001). Education catalyses the process of information flow and leads the farmers to explore as widely as possible the different pathways of getting information about agriculture and technology. Bester, et al (1999) also notes that illiteracy is one of the factors that limit economic, social, physical, technical and educational development in less developed countries. Educational considerations generally influence the adoption of new behaviour. In the dryland farming, 53.0% of farmers attained up to grade 7 level whereas in the irrigation farming, (35.5%) attained between grade 8 and 12 levels of education (Table 5.1). In general, most of the farmers in both dryland and irrigation farming have gone through some formal education.

5.3 Farm Characteristics of Households

The size of the land in agriculture influences household food security in that the larger the farm the higher the production (Najafi, 2003). The farm size is the total farm land owned by the household measured in hectares (ha). Family labour refers to household members who assisted in all farming activities during the

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farming season. This was captured using the data of the family members who were engaged in the project only. The dryland farmers had the highest percentage (53.0%) of farm size that is more than 5 ha, while the irrigators had only 36.3% of farm size of more than 5 ha (Table 5.1). Farm size for irrigation projects was significantly small when compared with dryland farms. Farm labour for irrigation farmers was higher per hectare of cultivated land when compared to dryland farmers. The reason could be that irrigation farming requires a lot of labour or family sizes for irrigation farmers are generally larger as compared to dryland farmers.

5.3.1 Asset ownership

The majority of households had access to agricultural implements. The wheelbarrow, spade and plough were the most common implements and in most cases these were found to be the only agricultural implements in excess to household sizes. These assets were investments by the farmers so that they could cultivate more land to meet their food requirements. Most of the farmers had luxury goods like Television, radio, fridge, etc and so they did not invest much in livestock. Those who had livestock, especially cattle or donkeys were not selling them but were kept as security. Cattle or donkeys are only sold if the household is in dire need of cash, especially in times of poor harvest. It can be inferred that an increase in livestock ownership is concomitant to an increase in household income and household food security. Households with livestock are in a better position to purchase supplement grain if the need arises compared to household without livestock.

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5.3.2 Crops grown by households

The crops grown on irrigation farms include Tomatoes, cabbage, onion, maize, potatoes, mangos, oranges, etc. But the majority of the dryland farmers only plant maize. This study revealed that maize was the predominant crop grown by both the irrigation and dryland farmers and accounts for most of the area under utilization because it is a staple food for almost everyone in the district. Farmers on irrigation projects grow tomatoes, spinach, cabbage, onions, etc which were crops that generate income for households. These crops are rarely grown by the dryland farmers. Farmers on the irrigation projects grow these crops because they mature quickly and can be harvested several times a year bringing in a steady income for the households.

5.4 Income Sources of Households

An analysis of income sources adds further insight into the income generation processes. Household income was calculated from the summation of all sources of income i.e. income coming from crop sales, livestock sales and non-agricultural labour. Table 5.2 classifies the income according to the various income groups so that a comparison can be made between irrigation and dryland farmers. The average total household income for irrigation was estimated as R23,925.00 per annum while that of dryland household was estimated as R4,729.00. The breakdown of the income is discussed below.

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Table 5.2: Distribution of total household income category of farmers (R000,000 for the 2008-2009)[1]

	Irrigation				Dryland			
Income sources	N	Amount (R)	Average amount	%	N	Amount (R)	Average amount	%
Maize	81	2,044,087	25,235	64.02	10	52,030	5,203	50
Vegetables*	48	1,135,651	23,659	35.9	7	48,110	6,872	46.3
Livestock**	4	2,300	575	0.08	5	3,900	780	3.7
Total	133	3,182,038	23,925	100	22	104,040	4,729	100

* Vegetable – include tomatoes, onions, spinach, cabbage, etc

** Livestock – include cattle, goats, sheep, chickens, donkeys, etc

The dominant crop in the region in terms of production was maize. Wheat is winter crop that is only grown on irrigation schemes because of availability of water. Table 5.2 above shows that 64% of the irrigation farmers received their income from maize and the figure was 50% in dryland. This table shows that irrigation farmers realize a higher income from maize sales than dryland farmers even though the dryland percent was considerably high because of the land size. The high figure for irrigation farmers was also a result of double cropping of maize on the irrigation schemes and that the maize could be sold as green mealies. Thus, they unlikely to have maize shortages during the course of the year when compared to dryland farmers who grow their maize crops in summer season only. This makes it difficult for them because they can ran out of staple food.

[1] Figures at the exchange rate of Rand (R) to $0.13 US Dollar

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Most of the produce was marketed at the farm gate (farmers sold their products directly to the customers). Farmers on both irrigation projects faced transport problems to sell to more distant markets and profitable markets. Average total incomes from vegetables were higher for irrigation farmers (R23,659.00) as compared to dryland farmers (R6,872.00) as shown in Table 5.2. Vegetable crops had a high income because they were grown twice of more times per year and they mature quickly because of intensive cultivation practiced on the irrigation projects. The vegetable average total income for dryland farmers was low because very few farmers grow vegetables. Those that grow vegetables either have boreholes or are located along perennial rivers that constantly supply them with water to irrigate their vegetables. Vegetables produced by dryland farmers were primarily for household consumption, unless the rains are adequate. From the figures above it can be inferred that irrigators have more disposable income than non-irrigators because vegetables contribute higher average total income realize by the farmers as they are popular source of income for daily household use.

A study by Kassa et al (2002) found that households who own livestock have a better chance of being food secured. In the calculation of income from livestock, sales during the course of the year were recorded. Insight from analysis shows that most of the income from livestock sales was from dryland farmers (3.7%). Cattle were sold to purchase food, pay school fees and other household expenses. The high incomes were from dryland farmers as these had no other means of raising money to buy or pay for household expenses. Table 5.2 shows

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that few farmers from the irrigation projects sold their livestock. The livestock income was less than 1% in the area.

5.4.1 Income from crop sales

The dominant crop in the region in terms of production was maize. The study shows (Table 5.2), that irrigation farmers realized a higher income (64%) from maize sales than dryland farmers (50%).

Most of the vegetable produce was marketed at the farm gate (farmers sold their produce directly to the customers). Farmers on both irrigation projects and dryland farming faced transport problems to sell to more distant markets and profitable markets. Incomes from vegetables were higher for irrigation farmers as compared to dryland farmers. Vegetable crops had a high income because they are grown twice or more times per year and they mature quickly because of intensive cultivation practiced on the irrigation projects. The vegetable income percentages (46.3) for dryland farmers were low because very few farmers grow vegetables around their homesteads. Vegetables produced by dryland farmers are primarily for household consumption.

A very high income was generated from tree crops (mangos, oranges, litchis, etc) from few farmers that produce them. Many of the tree crops were produced by irrigation farmers and they realized as high as R200,000 or more annually from their produce. This study revealed that irrigation farmers have more disposable income than dryland farmers because their produce contributes a higher percent of total income realized.

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5.4.2 Livestock income

A study by Kassa et al (2002) found that households who own livestock have a better chance of being food secured. When there is crop failure due to frequent dry spells, livestock can reduce food shocks in time of crop failure or unforeseen events. Sale of livestock can enhance food security in rural areas and the level of ones resources is very important to combat food shortages. Insight from the analysis shows that most of the income from livestock sales was from dryland farming. Cattle were sold to purchase food, pay school fees and other household expenses.

5.4.3 Off-farm income

There were people who were engaged in piece jobs as a source of income. Farmers received income for working in other people's fields or homesteads and most of the people employed as casual labourers were from dryland farming. Plot holders on the irrigation projects temporarily employ people to weed or harvest crops. In other instances, old aged irrigation plot holders employ people to assist them with irrigation activities and these are paid through produce from the irrigation project or income from crop sales. Other farmers may practice the exchange of labour by working on each other's fields during periods of weeding.

Very few people were employed as skilled labourers in these areas and it was not surprising to find that most of the smallholder farmers were poor. This is because the total household income is not the net household income as from this income;

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farmers derive their subsistence money, money for agricultural inputs, school fees and to pay for casual labour.

5.5 Marketing of Agricultural Produce

Key constraints that block the expansion of rural agricultural production have been a focus of attention, as poor and unreliable agricultural production becomes a constraint for effective and efficient agricultural marketing system (Zenda, 2002). While poor marketing systems become a cause for poor agricultural production, efficient and effective marketing systems are taken as the stimulus of high production (Zenda, 2002). It has been pointed out that producers have cited finance as the main problem that they face and agricultural inputs as the second problem. A number of problems were experienced along this line in the study area which is discussed below.

5.5.1 Marketing system

Both irrigation and dryland farming did not have an organized marketing system for their produce as there was no readily available transport to get their produce to distant and more profitable markets. Most of their produce went bad soon after harvesting because they did not have storage facilities to keep the produce fresh. About 63% of irrigation farmers sold their produce to hawkers as against 47% among the dryland farmers (Table 5.3). Only 6% of irrigation and 2% of dryland farmers sold their produce to the marketing board. That is, most of the farmers sold their produce to local people or hawkers (Table 5.4). Most of the dryland farmers 44% did not sell their produce while only 16% of irrigation farmers did not sell. The reason for selling to hawkers was to reduced transport cost incurred by

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farmers. Hawkers came with their private transport to purchase produce from the irrigation schemes and took these to urban areas where they sell the crops at a higher price.

Table 5.3: Marketing problems

	Irrigation		Dryland	
	Frequency	%	Frequency	%
Storage facilities	25	62.5	6	85.7
Transport	37	77.1	4	66.7
Sourcing inputs	16	55.2	5	83.3
No market around	28	63.6	6	85.7
Market information	14	42.4	3	60.0
Other marketing problems	10	90.9	6	85.7

5.5.2 Marketing problems faced by farmers

The majority of the farmers stated that they had serious marketing problems (Table 5.4). Among the irrigation farmers, 59% were not satisfied with the market situation while 49% of the dryland farmers also said the market situation was bad. About 86% in the dryland farming experienced losses through the spoilage of their crops like vegetables which easily perished due to the unavailability of suitable storage facilities and a good market. Among the irrigation farmers, 62.3% experienced similar problems. Irrigation farmers (77%) had difficulty in getting transport to market their produce and these stated that they felt that they were being exploited by hawkers and customers with own private transport while 67% experienced similar transport problems in the dryland farms. The percentage of

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the dryland farmers was lower due to the fact that most of the dryland farmers were subsistence farmers.

Furthermore, farmers said they had serious problems sourcing inputs such as hybrid seeds, fertilizers and some had problems with accessing market information especially prices of their produce. Farmers said they failed to secure proper markets around their irrigation projects. Table 5.3 shows that the dryland farmers had a lower percentage (67%) in transport problems as compared to 77% from the irrigation farmers due to the fact that they produce little which does not require market selling or they produce for household consumption.

Table 5.4: Market channels used by farmers

	Irrigation		Dryland	
	Frequency	%	Frequency	%
Hawkers	90	62.5	20	46.5
Marketing Board	8	5.6	1	2.3
Shop/schools	23	16.0	3	7.0
Did not sell	23	16.0	19	44.2

Some of the irrigation farmers said they sold their produce to buyers (hawkers) and the hawkers determine the prices they want to buy and on credit to avoid losses from spoilage (Table 5.4). The farmers sold some of their produce to schools and local shops and these came with their transport to purchase tomatoes and green vegetables from the irrigation projects. Table 5.4 shows that 16% of the irrigation farmers and 7% dryland farmers sold their produce to local

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shops and schools respectively. In the irrigation farming, 16% mentioned that they did not sell their produce at all while 44.2% in the dryland did not sell any of their produce. The high percent was due to the fact that most of the dryland farmers practiced subsistence farming only.

5.6 Food Production Promotes Food Security

Although the vast majority of the respondents were farmers, a substantial number of these smallholders were food insecure. Slightly more than half of the households had to borrow money or food or accepted help from friends and relatives to cope with consumption shocks. Slightly less than half (49.7%) sold productive assets or reduced consumption to cope with income shocks. The majority of the farmers on irrigation projects were less dependent on consumption-smoothing strategies than non-irrigating farmers. The evidence shows that vulnerability to consumption shocks reduces as per capita crop income increases (Wolfe & Frangillo, 2001).

5.7 Food Consumption in the Study Area

Household food security depends on a nutritionally adequate and safe food supply, at the household level and for each individual; a fair degree of stability in the food availability to the household both during the year and from year to year; and access of each family member to sufficient food to meet nutritional requirements (Latham, 1997). It is also important that the available food be both safe and of good quality. Social factors and cultural practices in most countries have a very great influence on what people eat, on how they prepare food, on their feeding practices and on the foods they prefer.

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5.7.1 Analysis of the Food Frequency Tables

Modern man and especially modern, western man, is faced with a bewildering number of foods to choose from. Compared to our ancestors and rural people in Africa, people living in South African cities have so many different foods to choose from, that it is quite understandable that they get confused. However, the basic food groups as shown in the food pyramid (Figure 5.1) have remained the same, only the variety in each group has expanded dramatically.

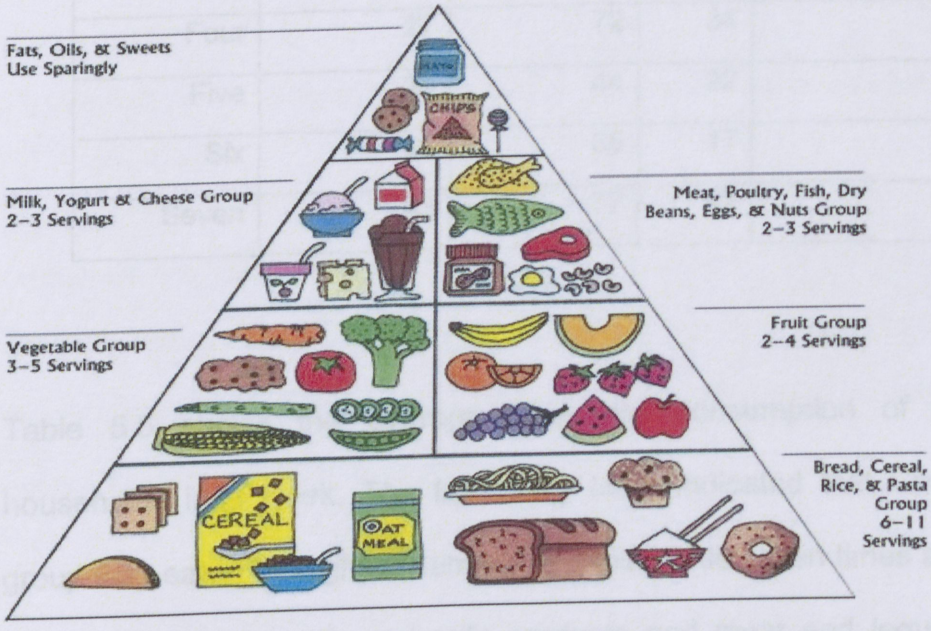


Figure 5.1: Food Pyramid provided for the public domain by the USDA Centre for Nutrition Policy and Promotion (CNPP) 2005

Foods can be classified into a number of broad categories: Carbohydrates or grains and cereal group. The body needs 6-11 servings of these every day. In Fruit group, each person requires 2 to 4 servings every day. Vegetable group, each person needs 3 to 5 servings of these every day, Milk and dairy group, an

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individual requires 2 to 3 servings a day. Meat, fish and egg group, each person needs 2 to 3 servings every day. Fat and oil maybe found in all other food groups and are used sparingly (Figure 5.1).

Table 5.5: Average consumption of food group by households per week

Frequency /week	Carbohydrate	Vegetables	Fruits	Milk and milk products	Meat and legumes
One	113	329	248	75	282
Two	46	138	86	40	159
Three	32	109	53	38	97
Four	27	72	34	11	64
Five	20	44	22	4	46
Six	52	65	17	10	59
Seven	163	77	22	14	66

Table 5.5 shows the average frequency consumption of food group by households in a week. The frequency table indicated that Carbohydrate food group was eaten by highest number of households seven times a week. The rest (vegetables, fruits, milk and milk products and meat and legumes) are eaten mostly once a week.

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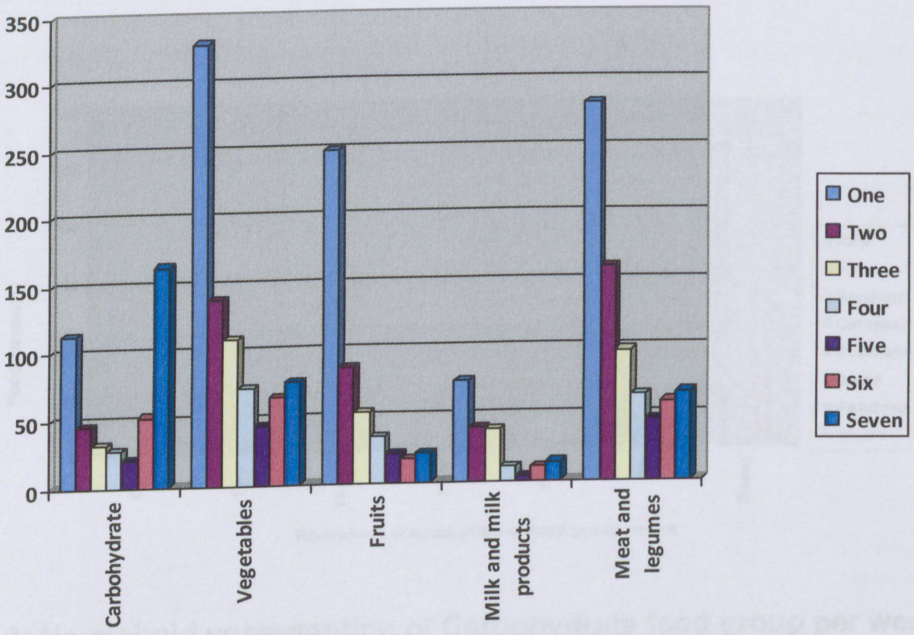


Figure 5.2: Average consumption of food group by households/week

Vegetables and fruits are planted by the farmers but they are not consumed more frequently like carbohydrate food group (Figure 5.2). This may be due to the social or cultural factors. Other reason may be due to the fact that most of the farmers are aiming at maximizing their profit from produce and could hardly take out produce for home consumption.

5.7.1.1 Carbohydrate

Starches are the main sort of Carbohydrate in cereals such as, rice, maize, bread, and wheat (King and Burgess, 2000). Carbohydrate is the major staple food of the farmers in the study area. This is the food the body uses for energy. The amount of energy that people need to get from their food in order to keep healthy and active varies. To find out the total daily energy needs you need to know the type of activity and the time that people spend on each.

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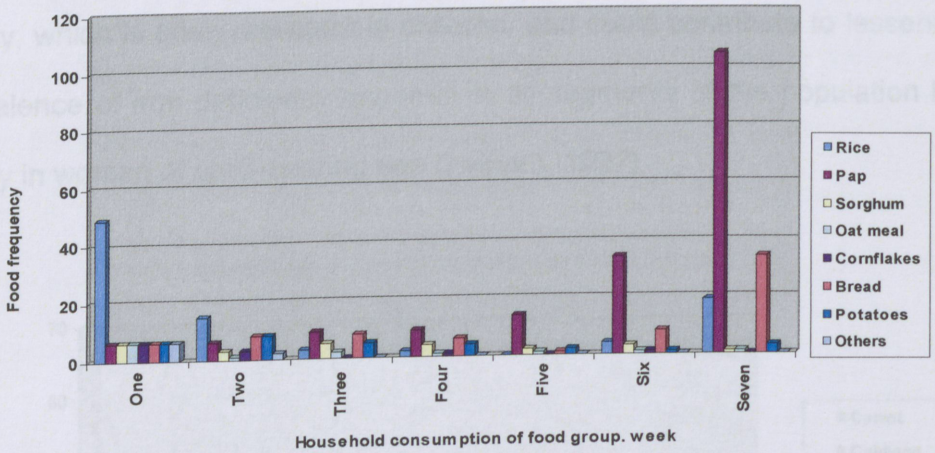


Figure 5.3: Household consumption of Carbohydrate food group per week

This study revealed that the type of carbohydrate food eaten the most is maize meal (pap) which is eaten seven times in a week by a large majority of the respondents (about 60%) out of 190 respondents, while very few eat other carbohydrate foods and only less than 1% eat oat meal a few times in a week (Figure 5.3). This could be because maize meal (pap) is the staple food eaten in the Vhembe District. Over-consumption, taking in many more calories than required, is often accompanied by a deficiency in vitamins and minerals. Enrichment of this food with other food groups like vegetables and fruits, with important minerals and vitamins is important as many of the farmers need to understand issues about balanced diet so as to stay healthy.

5.7.1.2 Vegetables

Vegetables are nearly all rich in carotene and vitamin C and contain significant amounts of calcium, iron and other minerals (Latham, 1997). Lots of leafy

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vegetables are a very good source. An increase in the consumption of green leaves and other vegetables could play a major part in reducing vitamin A deficiency, which is often prevalent in children, and could contribute to lessening the prevalence of iron deficiency anaemia in all segments of the population but especially in women of child-bearing age (Latham, 1997).

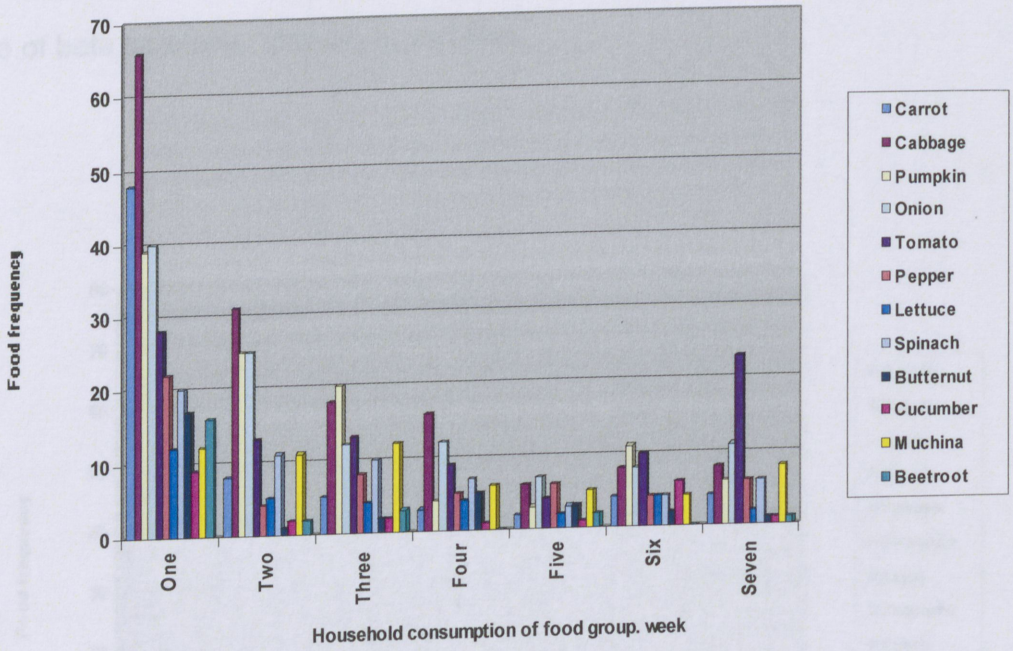


Figure 5.4: Household consumption of Vegetable food group per week

This study revealed that a high percentage of farmers eat vegetables at least two to four times per week (Figure 5.4). About 37% eat vegetables only once per week while a small percentage did not eat vegetables at all. This may be because vegetables like muchina, tomatoes, pepper, onions, etc cannot be eaten alone except along with other food items and once those supporting food are not eaten then vegetables are abandoned.

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5.7.1.3 Fruits

The main nutritive value of fruits is their content of vitamin C, which is often high. Fruits (except the avocado and a few others) contain very little fat or protein and usually no starch (Latham, 1997). Most experts agree that a person should eat at least three fruit servings a day. One fruit serving should be a citrus fruit such as oranges to ensure an adequate supply of vitamin C. Fruits are also a great source of beta carotene, Vitamin A, and fibre.

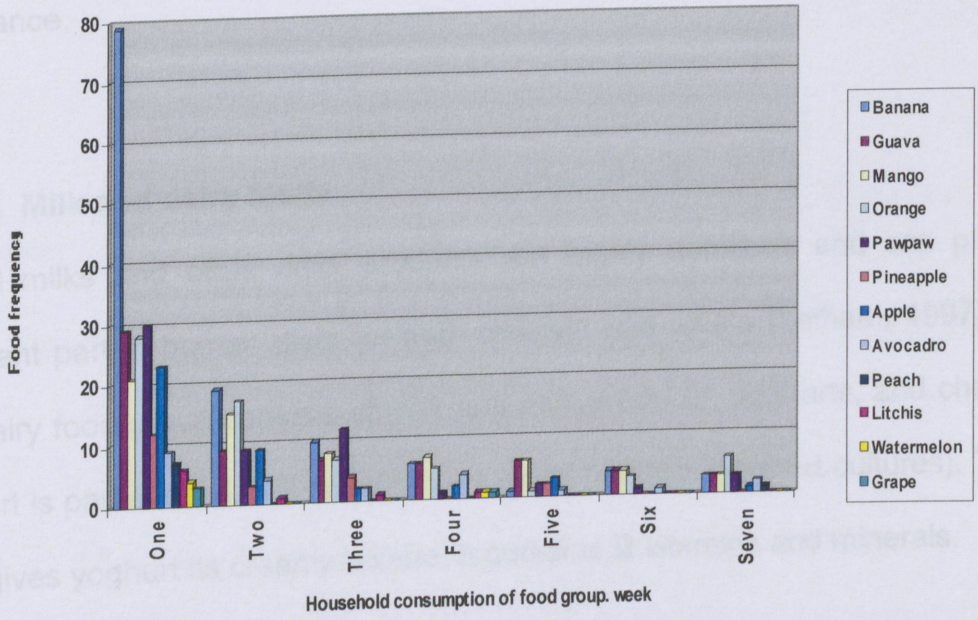


Figure 5.5: Household consumption of Fruit food group per week

Figure 5.5 shows that bananas were eaten by about 42% at least once per week even though it is always in season, while other fruits were eaten sparingly or not at all. A wide variety of fruits grows wild or cultivated in Vhembe. The variety

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available at any time in a given area depends on the climate, the local tastes for fruit, the species cultivated and the season (Latham, 1997). Fruits like watermelon are eaten by less than 1% of the farmers once a week. This may be because only few farmers plant the crop and they are strictly for commercial purpose. Fruit and vegetables contain so many protective nutrients, they should be eaten in large quantities and everyone should try and eat five or more serving a day (Figure 5.1). A typical example would be eaten an apple, an orange, half a cup of grated carrots, a green salad and drinking a glass of fruit juice to obtain those vital five serving a day. Many are not enlightened about the importance of eating more of this food group even though they sometimes have them in abundance.

5.7.1.4 Milk and dairy foods

Animal milks and other dairy products are highly nutritious and can play an important part in human diets for both children and adults (Latham, 1997). Milk and dairy food group consists of milk and milk products, yoghurts, and cheeses. Yoghurt is pasteurized milk cultured by special bacteria (yoghurt cultures). This is what gives yoghurt its creamy texture. It contains B vitamins and minerals.

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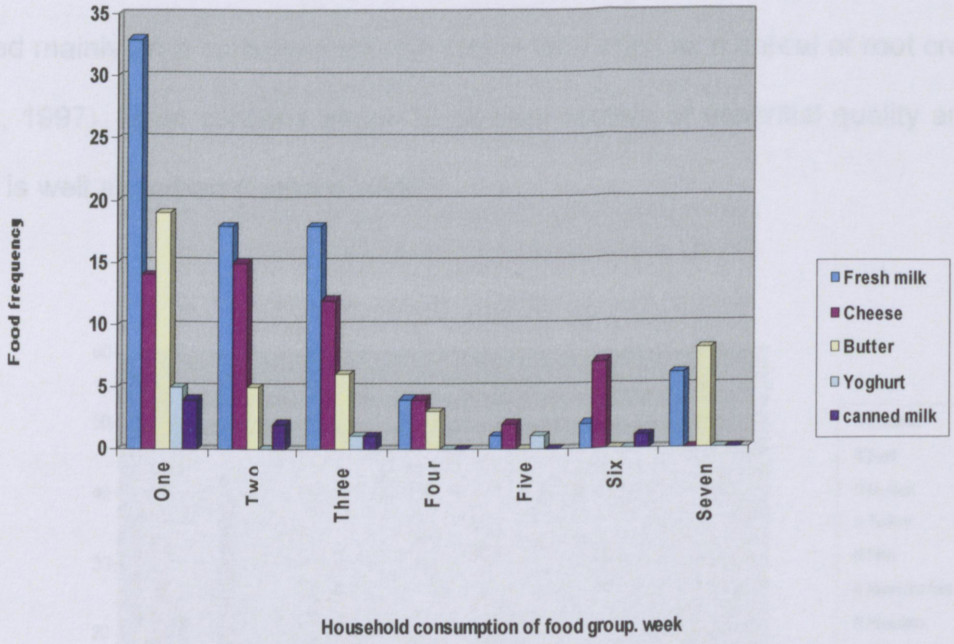


Figure 5.6: Household consumption of Milk and milk products food group per week

Figure 5.6 shows that only about 1% of the farmers drink fresh milk one to three times per week while only a little proportion drink fresh milk seven times per week. On average, the study showed that milk and milk products were not used by the majority of the farmers. This may be due to insufficient fund earned by these farmers. Although, a good source of vitamins and minerals but poverty may be one of the reasons why many households seldom use milk and milk products in their daily diet. Other reason may be the long distances of farm to the shop where these commodities are sold and also the milk products are expensive. Also many of these products need to be kept in a cool environment like fridge which may not be available in most of the homes of these farmers.

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5.7.1.5 Meat and legumes

Foods of animal origin are not essential for an adequate diet, but they are a useful complement to most diets, especially to those in developing countries that are based mainly on a carbohydrate-rich staple food such as a cereal or root crop (Latham, 1997). Meat contains about 19 percent protein of essential quality and iron that is well absorbed (Latham, 1997).

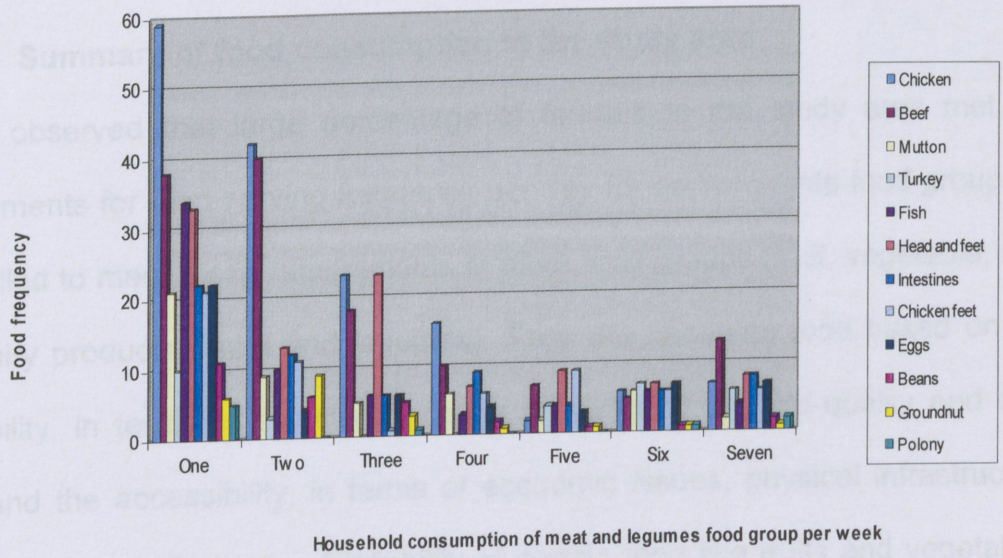


Figure 5.7: Household consumption of Meat and legumes food group per week

Figure 5.7 shows that only a few farmers are consuming meat and legumes at least once or twice a week. This is mainly due to financial capabilities of the farmers. Chicken, head and feet are the most commonly eating in this food group. Those with livestock are not eating from their animals as they prefer to sell them in order to have money for other commodities or to meet other responsibilities. Micronutrient and/or protein deficiency is present in a very large group of malnourished people (Malnutrition Matters, 2009). They either do not receive

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adequate amounts of vitamins and minerals (micronutrients), or the correct proportion of protein in their diets. This can have very debilitating effects on people and societies. The health symptoms may not be immediately visible to either the individuals themselves or to health workers, or they take years to manifest. The result is lost productivity, and a great increase in health care costs which negatively affect other government attempts to improve the quality of life - aside from the enormous social cost.

5.7.2 Summary of food consumption in the study area

It was observed that large percentage of farmers in the study area met the requirements for food serving frequency per day for carbohydrate food group but they failed to meet these requirements in other food groups (fruit, vegetable, milk and dairy products, meat and legumes). They are choosing food based on the availability, in terms of sufficient quantity and variety of good-quality and safe food; and the accessibility, in terms of economic issues, physical infrastructure and consumer preferences. Availability of certain food like fruits and vegetables depend on the seasons of the year. Other foods like milk and dairy products, meat and legumes depend on the farmers' purchasing powers.

5.8 Logistic Regression Results of the Study

The logistic regression result together with the probabilities result were used to identify the impact of smallholder irrigation on household food security in the study area. There were 190 cases used in the analysis. Given the base rates of the two decision options (147/190 = 77.4% using irrigation technology, 22.6% are on dryland farming), and no other information, the best strategy is to predict, for

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every case, that the subject will use irrigation technology. Using that strategy, it would be correct 77.4% of the time.

Table 5.6: Coefficient of the Logistic analysis for irrigation and dryland farming

Variable	Coefficient (B)	Std. error	Wald statistic	Significant level	Exp(B)
Constant	1.229	0.169	10.849	0.000	3.419

Under Variables in the Equation, the intercept-only model is ln(odds)=1.229. If we exponentiate both sides of this expression we find that our predicted odds [Exp(B)]=3.419. That is, the predicted odds of using irrigation technology is 3.419. Since 147 of the respondents were using irrigation technology and 43 were in the dryland farming, the observed odds are 147/43 = 3.419.

In table 5.7 below, the irrigation and dryland farmers were compared in terms of their household food security status. Selected parameters were presented to show the percentages of households that were food secure and those that were food insecure relative to the type of farming practiced. Using the logistic regression model, the researcher was able to determine which households was more food secured than the others. This was based on whether or not the household produce enough food to last one year. The analysis revealed that out of the 190 observed households in the study area, 141 households were food secured (86.3% and 53%) of irrigators and dryland farmers respectively while 49

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households representing (48.5% and 41.6%) of irrigators and dryland farmers respectively were food insecure.

Table 5.7: Descriptive results of the study

Variable		Food secure (%)		Food insecure (%)	
	Number	Irrigation	Dryland	Irrigation	Dryland
Sex					
Male	97	52.4	51.6	48.5	50.5
Female	93	47.6	48.4	51.5	49.5
Per capital aggregate income					
Yes	93	62.1	37.9	24.2	75.8
No	97	45.3	54.7	56.8	43.2
Irrigation					
Yes	147	75.0	97.9	81.8	56.8
No	43	25.0	2.1	18.2	43.2
Access to market					
Yes	82	50.0	50.0	30.0	69.7
No	108	61.1	38.9	52.6	47.4
Food security					
Yes	141	86.3	53.0	51.5	58.4
No	49	13.7	47.0	48.5	41.6

5.8.1 Age of the household head

The age of the household head, has a negative coefficient that was significant at 10% level (Table 5.8). This probably indicates that the older the household head, the lower the chances of the household being food secured. Hofferth (2003) argued that older people have better experiences in agricultural activities than younger people in that they know the social and physical environments better

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than younger people. This result shows that these households are headed by people who are economically active and are able to make household farm decisions as they have acquired more knowledge about farming.

5.8.2 Household size

This variable has a negative coefficient that is significant at 5% level, implying that as the household size gets larger, the probability of food security decreases. In other words, large size households are more likely to be food insecure than small size households. Small-scale farming heavily depends on its family for labour. Household size is significantly larger for households that are food insecure as compared to food secure households. Thus, there is a negative correlation between household size and food security. This follows Paddy (2003) that as household size increases it puts pressure on available food for the household to be food secured.

5.8.3 Education

This variable was found to be positive and significant at 5% level. It can be concluded that the farmers were able to understand information given to them that is written in their own language. This implies that households with an educated head are more likely to be food secured than uneducated head.

5.8.4 Land size

For this study, households that are food insecure have on average more than 1-5 ha of land on the irrigation projects while dryland farmers have as much as 10 ha of land. For dryland farmers, this contradicts Estudillo et al. (2006) findings, in

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that as farm sizes increase, households tend to be more food secured as they are able to get better yields from their fields in the absence of major technological advancement that can further increase yields. For irrigation farmers it could be that they lack management skills or do not have access to certain inputs required on the irrigation projects.

5.8.5 Per capita aggregate production

Per capita aggregate production was higher for irrigation farmers that have 62.1% of maize while dryland households have 37.9%. Food insecure households have per capita aggregate production of 56.8% for irrigation farmers and 43.2% for dryland farmers. From the above analysis in Table 5.7 above, per capita aggregate income was higher for farmers on irrigation projects than those on dryland. This could be due to high intensive crop production on irrigation projects and also that irrigation farmers have access to water and seeds and inputs that increase their productivity.

5.8.6 Market access by farmers

The shortest distance to the market was used in this study to determine how often the farmers went to the market to sell their produce. This study revealed that the shortest distance to the market was 5 km for irrigation farmers and about 1 km for dryland farmers. Those who did not market their crop either produce only enough for household consumption or sold at the farm gate. Feleke et al (2005) used amount of time taken to reach the nearest market to assess if households were food secured or not but, for this study distance was used because of lack of transportation in the rural areas.

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5.8.7 Parameter estimates of variables of food security

Eleven variables were all initially fitted in the binary logistic model. Six variables were found to have a significant impact in determining household food security (Table 5.8). These are irrigation technology, household size, farm size, per capita aggregate income, education, marital status. The data set was combined for both irrigation and dryland farmers to investigate which determinants had a significant impact on household food security (Table 5.7). The results showed an anomaly with land size. A positive sign for land size was expected but in this case it was negative. The data was then split into irrigation and dryland farmers to verify if land size still had a negative and significant sign between the two groups of farmers. The result was still negative even after splitting the irrigation and dryland farmers but the other variables showed some consistency.

Based on the results in Table 5.8, most of the variables had a positive impact on household food security while household size and farm size had a negative impact on household food security. The expected signs were irrigation (+), per capita aggregate production (+), farm size (+) and household size (-). From the analysis, irrigation and per capital aggregate income were found to have a positive relationship to the probability of households being food secured, meaning that the likelihood of food security increases when farmers have increased agricultural output and have access to a piece of land on the irrigation project.

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Table 5.8: Parameter estimates of the determinants of food security

Variable	Coefficient (B)	Std. error	Wald statistic	Significant level	Exp(B)
Constant	0.557	0.169	10.849	0.001***	1.745
Household size	-0.350	0.968	0.131	0.018**	0.705
Food security	1.736	0.625	7.714	0.005***	5.673
Water frequency	1.130	0.819	1.905	0.078*	3.404
Farm size	-0.889	1.039	0.731	0.393	2.432
Per capital aggregate income	1.822	0.564	10.437	0.001***	6.182
Irrigation	1.289	1.388	0.862	0.053**	3.276
Access to market	1.176	0.602	3.816	0.051**	3.243
Enough food	1.736	0.625	7.714	0.005***	5.673
Age	-0.659	0.609	1.172	0.079*	0.517
Sex	0.748	0.563	1.767	0.184	2.113
Education	3.296	1.306	6.372	0.012**	0.037
Marital status	-3.832	1.802	4.524	0.033**	0.022

Note: * statistically significant 10% level, ** statistically significant 5% level, *** statistically significant 1% level, Number of observations = 190

Restricted log likelihood value [Log(L_0)] = -1.378

Unrestricted log likelihood value [Log(L_0)] = -121.581[a]

Log likelihood value ($\chi^2_{(df=6)} - 2[Log(L_0) - \log(-(L_1))] = -1.378$

However, household size and farm size had a negative and significant effect on household food security meaning that the likelihood of a household being food secured decreases with an increase in household size and farm size.

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5.8.8 Household size

Household size has a negative sign meaning that an increase in the number of household members puts pressure on available food resources in the household. An increase in household size would mean more people to feed and with the low outputs produced in the fields, thus reducing the amount of food required by an individual to lead a healthy and active life. This implies that the probability of food security decreases with increase in family size. An increase in household size reduces the chances of a household being food secured. Household size as a determinant of food security agrees with Paddy (2003) in that as households become large, food insecurity is increased. Although it is expected that an increase in household size increases the labour requirements but the households with more people exert more pressure on food than the labour it contributes to agricultural production.

5.8.9 Farm size

An increase in the size of the land is expected to affect food security positively. According to Najafi (2003), food production can be increased extensively through the expansion of areas under cultivation. The results (Table 5.8) do not show a significant relationship between farm size and food security. Though farm size was not significant but has twice a likelihood of assisting to attain food security, meaning that the larger the size of the land, the more food secure the household. There could also be a possibility of other variables influencing each other (multicollinearity).

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5.8.10 Per capita aggregate income

A positive and 1% significance level relationship between per capita aggregate income and food security was observed from the results presented in Table 5.8. This indicates that the higher the household income, the higher the probability that the household would be food secured. This was expected because increased income, other things being equal, means increased access to food. A positive change in aggregate income calculated from own maize production results in an increase in the probability of household food security. The positive relationship was explained through the higher income generated by the irrigation farmers. The greater the produce from the farmers, the more income and alternative food they are likely to receive from crop sales. Per capita aggregate income was calculated by converting output for all cereals into maize equivalent units and for irrigation farmers it was calculated by converting vegetables into maize equivalent units.

5.9 Irrigation and Food Security

This study revealed that the proportion of food secured households was higher among farmers who were on the irrigation projects (86.3%) than those on dryland farming (53.0%). However, households that was on the irrigation farming and food insecure were (48.5%) while (41.6%) were households that were food insecure on dryland farming (Table 5.7).

Irrigation was found to be significant at 10% level meaning that irrigation plays an important role in enhancing food security in the study area. A dummy variable was set for non-irrigation farmers to assess if irrigation contributes to household food security or not. The results confirmed that irrigation is significant in ensuring

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that households achieve food security. Irrigation promotes crop production throughout the year and also crop diversification because of the availability of water. Thus, the development of irrigation has been advocated in these areas with insufficient rainfall for crop yields to meet minimum food requirements.

The perception of irrigation in enhancing food security in rural areas has also been acknowledged by Crosby et al (2000). This has seen an increase in the development of small-scale irrigation projects in a bid to ensure food security in these areas. Irrigation reduces the risk of crop failure and the increment can be substantial. However, realizing the potential requires not only good irrigation (water) but also a range of complementary agricultural support (for example, improved agricultural research and extension).

Despite the large investments, the performance of some small-scale irrigation projects has been poor and the goal of achieving food security has not been realized (Bembridge, 2000). Also with irrigation farming, there is a tendency to produce cash crops which are sold so that they can generate income for the households.

5.10 Insights from the Analysis

From the results obtained from this study, it has been found that irrigation farmers gain high income from the crops they grow and were relatively more food secured than dryland farmers. Most of their income came from vegetables that are grown on the irrigation projects. Vegetables and maize contribute the larger percentage of income as compared to other crops and off-farm incomes. Communal farmers

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receive less income from off-farm activities because a few people are employed and they receive fewer remittances from their urban relatives.

As was highlighted in Table 5.2, vegetables contribute about 35.6% of total income in irrigation farming as compared with 46.3% in dryland farming. Livestock income was very low as farmers sell their livestock only in time of pressing financial needs and animals were not usually kept for commercial purposes by farmers in the study area.

The analysis shows that irrigation farmers get higher income from on-farm activities as opposed to dryland farmers. On the other hand, dryland farmers realize higher off-farm incomes than irrigation farmers. This is due to the fact that irrigation farmers do not depend much from family members employed elsewhere like dryland farmers. Irrigation farmers get better incomes from crop sales.

Farmers also pointed out that they had marketing problems especially with perishable crops. Some of the problems included lack of storage facilities, unavailability of transport, exploitation by middlemen and failure to get inputs on time. These problems were affecting the profits they could realize if they had their own transport to get to profitable markets.

5.11 Conclusion

From the results one can conclude that irrigation projects play a significant role in enhancing food security of households in the study area. The income from irrigation farming is relatively greater as compared to dryland farming. The

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analysis also shows that vegetables contribute a higher income than other crops. The high income in vegetables is because they can be grown more than once per year and as they can be harvested several times making it possible to get a continuous flow of income.

Access to water for irrigation has shown that it can improve the farmers' situation with the availability of water; farmers can adopt intensive technologies and produce better yields than dryland farmers. Then it can be concluded that irrigation plays an important role in increasing household incomes.

The study revealed that marketing constraints are another problem that farmers face, these farmers are faced with reduced profits and most of their products get spoilt or rotten because they do not have storage facilities. This was especially critical for irrigation farmers who produce perishable products.

Based on the descriptive and empirical results of the logistic regression, it can be concluded that irrigation, household size, land size, inputs and per capital aggregate production play a major role in addressing household food security. The analysis shows that irrigation plays a significant role in enhancing food security through high yields as shown in Table 5.7 and also from logistic regression model where the size of the land proves that farmers on irrigation were more food secured than those (dryland farmers) who farm on large pieces of land. Irrigation has many advantages in that it increases farmer's yields, promotes diversified farming and increases household income and lack of water is a limiting factor to agricultural production in the semi-arid areas.

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CHAPTER 6

SUMMARY, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

This chapter presents a summary of major findings and some policy implications and recommendations for improvement in household food security in the study area. It also contextualize together with areas for future study.

6.2 Preamble

At the household level, food insecurity leads to disproportionately high levels of health and medical costs, high funeral costs, poor educational development and performance and low labour productivity and at the national level; the cost of food security is far-reaching and diverse. The inextricable relationship between poverty and food insecurity acts as a conveyor belt to the high costs of policing, criminal and justice expenses, as well as low investor confidence and the resulting loss of capital investment in the country.

6.3 Factors Influencing Household Food Security

The results presented in Chapter 5 show that access to irrigation by rural farmers has a positive significant effect on household food security. Farmers who are on irrigation projects are more likely to be food secured than dryland farmers. Access to irrigation does not only increase production but also increases incomes

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that can be used on non-farm goods and services. Although this study was based on the production of staple crops e.g. maize, food security encompasses nutritional quality which can be obtained from vegetable crops grown on the irrigation projects. Chances of irrigation farmers and their household members suffering from malnutrition are low in relation to dryland farmers. Calories from cereal crops were considered for this study because cereals constitute about 70% of total food requirements in terms of calories needed (2200kcal) to keep an individual healthy and active.

Household size was found to have a significant and negative relationship with household food security. An increase in household size means a higher demand for food and this puts pressure on available food resources. Household food security is closely related to per capita aggregate production. Households that have high per capita aggregate production were more food secured than households that have a low per capita aggregate production. It can be deduced that households with higher crop outputs from both irrigation and dryland farming have a higher per capita aggregate production.

Farm size was found to have a negative relationship to household food security. The results showed that farmers operating on small pieces of land were efficient and fully utilized their resources. Rural farmers are also considered to be resource poor or are constrained by resources (agricultural inputs). This means that the limited resources can only cover smaller pieces of land. Although it cannot be concluded that small farms are important in ensuring household food security, the other reason could be the presence of irrigation projects. The

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intensive nature of cultivation on irrigation projects contributes more to household food security and increased incomes than dryland farming.

6.4 Summary of the Findings

The findings from this study are summarised as follows:

- Vhembe District is characterised by a largely rural population. Agricultural production is characterised by a dual system combining subsistence farming with commercial oriented-agriculture.
- Only about 13% of arable land is under permanent cultivation; this leaves a potentially significant portion of arable land available for cultivation.
- Only about 2% of the total arable land is irrigated. Expanded irrigation use can increase productions, but in arid and semi-arid zones this must be done with caution. Water availability throughout the region is constrained by a number of ecological factors.
- Smallholder irrigation has a role to play in agricultural and economic development of Vhembe District. With water being the scarcest resource especially in the smallholder sector, the need for irrigation development in this sector is quite apparent
- Smallholder irrigation projects can be financially, socially and technically viable or non-viable. The most important factor that came out as affecting the viability of the irrigation projects is the mode of planning. Projects that are planned with full farmer participation appear to be more viable than those that are imposed on farmers.

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- Social aspects, such as land tenure and the social setting, should be considered in the planning of a scheme. If farmers are able to inherit the plots, some element of security is felt and thus farmers can invest.
- The choice of technology came out to be important. Systems that require less energy, like low pressure sprinkler and localized systems, should be looked at seriously. High electricity bills are a problem for some pumped schemes and generally the energy costs seem to be rising every now and again.
- It was expected that households with larger farm size are more likely to be food secured than those with smaller farm size because of increase labour but in this case, it has a rather negative effect on food security, which may be due to irrigation technology on farm.
- Age of the household head could also have either positive or negative effect on food security.
- Gross food production is growing in the region, but struggling to keep pace with population growth.
- Education is proven to be relevant in promoting development and fighting food insecurity.
- Large size households are more likely to be food insecured than small size households.
- The farmers in the study area grow fruits and vegetables but most of them are not eating these. Foods are chosen based on availability, accessibility, physical infrastructure and consumer preferences.
- Irrigation water management programme is a problem at some projects especially those who do not pay the stipulated fees. Some

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farmers over-irrigate their farms because there is no proper control. Also given that water is a scarce resource, allowing these farmers to continue wasting water is not acceptable.

6.5 Policy Implications

The investigation of the role and importance of smallholder farming with regard to socio-economic issues and food security are important because of the opportunities they provide for economic development through contribution to household level food security and income generation. A concerted effort, through a systemic, multi-sector approach to achieve food security is the foundation in the building of a strong, robust, secure nation.

In many places, the term 'food security' is still equated with 'food availability'. The result is that government strategies to address food security and various agricultural development strategies end up addressing only availability. These do not achieve the desired goal of reducing food security because government has not integrated into their policies other key determinants that impact directly on food security. There is the need for effective long-term agricultural policies that are situated within a wider development framework. For example,

- Productive commercially oriented smallholder farming systems that employ cheaper means of enhancing farm productivity could be promoted
- Irrigation development for drought mitigation strategies and sustainable food production could be encouraged
- Barriers to land ownership and secure tenure could be addressed, and

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- The capacity of farmers and rural institutions to continue to provide safety nets in times of food crisis could be better supported.

Food security depends on livelihood security that, in turn, depends on many factors, including social, economic and environmental determinants. Depending on the local, district and national situation, certain institutions support access, availability, and utilization of food. It is difficult to generalize about coping strategies in response to stress. Support for adaptation measures needs to be grounded in the local context.

The negative relationship in the analysis of farm size of the households in the study area could be due to irrigation farmers who operate on smaller plots and use hybrid seeds, fertilizers, pesticides and insecticides to grow their crops. Irrigation farmers get higher yields as opposed to dryland farmers. Irrigation projects are labour and capital intensive due to weeding and frequent use of fertilizers. Policy makers have to come up with policies that assist farmers to have access to agricultural inputs, irrigation plots, sufficient water, credit and agricultural information so that farmers are able to produce better yields.

6.6 Recommendations

Having thoroughly digested the findings from this study, it is recommended that the following medium-long term measures be introduced to assist the government and the stakeholders concerned with agricultural development both local, district and nationally:

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- Since the current food insecurity in South Africa is not a result of the failure of large-scale commercial farming, the emphasis must be on strengthening smallholder farming and community food gardening programmes as these will reduce household food insecurity even at the national level. There should be improved access to production resources through enabling policies that will ensure access to land and improved tenure support. To improve production, smallholder farmers need access to inputs and output markets which require them to have access to credit facilities and be able to market their produce.
- The results from the study have shown that access to irrigation by rural farmers has a greater impact in enhancing food security at the household level. With increased agricultural production from irrigation projects, food security can be achieved both at household and national levels provided the farmers get the necessary support from government, non-governmental organisations (NGOs), farmers' support groups and parastatals. The kind of support that the farmers will need include information from extension services, agricultural inputs and price policy interventions that protect farmers from frequent fluctuations in market prices. Stabilization of agricultural prices or producer prices can promote increased production in the short and long term. Such conditions can encourage farmers to produce more and sell surplus produce to profitable markets. An intervention like irrigation can bring employment to local people, increase household incomes, reduce rural to urban migration, reduce the level of

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malnutrition, increase per capita aggregate production and also promote crop diversification.

- In addition, own food production among farmers should be encouraged by the government and other stakeholders so as to break the dependency syndrome. Government and other stakeholders should provide support through the establishment of more irrigation projects and other income generating projects that can assist farmers to produce their own food and be food secured.
- Policy makers need to promote irrigation development so that farmers can still irrigate extra crops, produce fruits, vegetables and other produce.
- Farm size is one other important factor that contributes to household food security. An increase in farm size is likely to increase food security in rural areas without employing advanced technologies. In this study, farm size had a negative relationship to household food security. This suggests that farmers with small farms are more efficient than farmers who own large pieces of land. The reason could be the presence of irrigation projects which allows farmers to produce more on their irrigated land than dryland farms.
- An increase in per capita aggregate production means that the probabilities of households being food secured increases. With the current level of shortages there is a deficit of food crops, any surplus production by the farmers can be sold to profitable markets. Government, farmers' groups and input suppliers are therefore called to provide agricultural inputs to farming households at affordable prices

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to enable them to increase production. In addition, government should improve rural infrastructure to boost household income through the provision of better roads, water, electricity and telecommunications. This could increase the possibility of off-farm activities that could generate more income for the households.

- Education and extension training is essential for farmers so that they are able to adopt new technologies. Farmers need to be enlightened on programmes such as health education. This will assist them to know more about HIV/AIDS pandemic and how to protect themselves.
- Marketing, especially through contract farming, has proven to be a problem for smallholder farmers. Most of the contracts are verbal and farmers usually are cheated by unscrupulous dealers at the end. The terms are always in favour of the buyers and farmers lack bargaining power. Training in contract marketing is hereby recommended as a means of safeguarding the farmers against some unscrupulous people.
- A suitable local agricultural base is key to a community responsive food system. Farmers need increased access to markets that pay them a decent wage for their labour, and farmland needs planning protection from suburban development. By building stronger ties between farmers and consumers, consumers gain a greater knowledge and appreciation for their food source.
- It has been observed that when production goes beyond subsistence requirements, agricultural growth does drive food consumption demand and leads to beneficial dietary changes. Incentives to increase

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production and education on food group will help farmers make the right food choices and improve their quality of life. Nutrition should be part of the agricultural extension programme to cause a paradigm shift in the eating habit of the farmers.

- The stakeholders should invest in collaborative learning and knowledge development for sustainable food security, through the strengthening of the agriculture, rural development and food security networking and collaborative work with external partners.

6.7 Improving Food Security

Increased production of food for own consumption and for the market has helped to reduce the need for coping strategies. Most of the households in dryland farming were engaged in more erosive-coping strategies than did irrigation farming households. Adopting erosive-coping strategies undermines future resilience. Agricultural production for markets reduced consumption expenditure and helped households to accumulate cash savings or invest in assets. These assets buffered households from income shocks.

- The potential for local, demand-led economic growth means an increase in household income that generates proportionally greater expenditure on non-farm goods and services. Increased demand for locally produced goods and services could help to mobilise underused resources so creating additional income opportunities and local economic growth. However, increased production is limited by factors such as insecure land tenure, poor infrastructure and missing markets for credit and insurance. Farmers could reduce their subsidy

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dependence by marketing larger volumes. Such expansion would be facilitated by land improvements and land transactions, both of which are consumed by insecure land tenure. In addition, the studies recognise that growth requires farmers to invest in tangible and intangible assets such as storage facilities, transport and an empowerment label.

- Understanding the success potential of smallholder irrigation projects is critical because it aids in proper planning. The common understanding is that smallholder irrigation projects have a potential to provide multiple livelihood sources for the rural poor. Beyond serving the purpose of fulfilling subsistence needs, surplus production has a potential to improve household incomes. These improvements would feed right into the government's imperatives of poverty alleviation and economic growth.
- The implication of the results regarding market access is that in designing irrigation projects, market access should be included in the planning process and not as an added after thought late in planning. In other words, it should not come after assessments regarding physical suitability have been conducted but should be an integral part of the initial planning sessions. For existing irrigation projects, an assessment could be made and market access ruled out first when the project is encountering problems. Studies on how to develop critical links between policymakers, donors, researchers, and the private sector are necessary. These would contribute to improving the probability of

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realizing more successful smallholder irrigated agriculture in a sustainable manner.

- Almost all smallholder irrigation schemes have cited marketing of produce as one of the most difficult challenges. Makhura & Mokoena (2003) reviewed the particular challenges faced by South African smallholders with reference to market access. Smallholders can derive tangible benefits from collaboration in relation to produce markets when this enables them to access markets that are practically inaccessible to them as individuals. Three types of these kinds of markets can be identified. The first type consists of markets for bulk commodities to which comprehensive farmer support programmes are attached. In South Africa, the prime example of this type of bulk commodity market is sugar cane, and its history and functioning has been described in detail by Bates and Sokhela (2003). Production contracts are the second type of market where smallholder collaboration is advantageous. Here the main reason for collaboration is the achievement of threshold levels of production, which make the contract financially viable. The produce markets of (distant) urban centres, such as the metropolitan cluster of Gauteng, are the third type of markets that favour smallholder collaboration. These markets offer particular opportunities to smallholders in terms of supplying niche products, such as indigenous vegetables, which are not available on these markets at present, but for which a demand exists as a result of the urbanisation of black people. Remoteness of most smallholder irrigation schemes challenges cost effective access to these markets,

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but collaboration among farmers can generate the necessary economies of scale to link up with the fresh produce transaction chains used by neighbouring large-scale commercial farmers when accessing these urban markets.

- Specifically, government and farmers group should provide agricultural inputs to farming households at affordable prices facilitate the increase in farm size and food production since own food production was one of the significant determinants of food security in the study area. In addition efforts that could boost households' income generation should be promoted. For example, the provision of village infrastructures like motorable road, water, electricity, telephone etc could increase the possibility of off-farm activities that could generate more income for the households.
- Improved nutrition is clearly a positive externality for increased agricultural production in South Africa's rural areas. However, the scale of agricultural production strongly determines the magnitude of these nutritional benefits. To have a significant impact on the food security and nutritional status of rural populations, agricultural production must develop beyond the subsistence level. While production for home consumption increases the availability of vegetables and increases micronutrient intake, the income 'savings' derived from home production seems to have more positive influences on the nutritional status of rural productions. Income replacement leads to increased purchases of energy-dense foods as fats, oils and meat.

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6.8 Conclusion

This study encourages government to adopt policies that improve means for food access ability, irrigation development, access to affordable inputs and access to agricultural extension and information. It suggests that smallholder irrigation development is a strategic option for sustaining household food security. This study suggests that households that need to be targeted for food aid are those with large families; those having no access to irrigation; farmers with few farming assets and farmers without access to agricultural implements. Thus, it is important that government seriously looks into issues of constructing irrigation projects in the semi-arid areas and areas that receive enough rain because irrigation enhances food security, creates employment, improves nutrition, reduces rural to urban migration and this will eventually lead to a drop in market prices due to increased marketed surplus in years to come.

6.9 Areas for further study

The study showed that about half (48.5% and 41.6%) of the sample households in irrigation and dryland farming respectively were food insecure yet they still survived. This means that the respondents in this category are using coping strategies which could require an in-depth study. Other technologies like water harvesting, soil and water conservation strategies to address water shortage in rural area could also be looked into. Also there is a need to investigate the factors that prevent the farmers from eating food like fruits and vegetables even though these food crops are produced by the farmers.

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Appendix 1: Household Questionnaire

Research Title:
Assessment of the Impact of Smallholder Irrigation Projects on Food Security: A Case Study from Vhembe District, Limpopo Province

Strictly Confidential:
This information is confidential and the names and address of respondents will not be divulged for any purpose other than for the study

Purpose of Survey:
This survey is part of the M.Sc research. The research is aimed at making recommendations for the improvement of household food security and government intervention policy on irrigation investments in Vhembe District, Limpopo Province.

For Office Use

Enumerator's Name	
Questionnaire Number	
Municipality	
Name of the Project/Farm	
Name of Village	
Name of HH Head	
Date of Interview	

1.0 Household Information (*Tick ✓ in the appropriate box*)

1.1 Sex of the respondent

Male	1
Female	2

1.2 Age of the respondent

Less than 18 years	1
18 – 50 years	2
51 – 65 years	3

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66 years and above	4

1.3 Marital Status of the respondent (*Tick only one option*)

Single	1
Married	2
Divorced	3
Widowed	4
Living Together	5

1.4 Highest level of education attained by the respondent (*Tick only one option*)

No formal Education	1
Up to grade 7	2
Grades 8 – 12	3
Post secondary	4

1.5 How long has the plot/farm been established?

Less than 1 year	1
1 - 5 years	2
Over 5 years	3

1.6 Please indicate ownership of your plot/farm (Tenure Status)

PTO	1
Title Deed	2
Rented	3
Other (Specify)	4

1.7 If option 4 above is chosen, please explain

_____

_____

1.8 Please indicate the total number of other members involved on your plot/farm

	M	F
Adults 65 years and older		
Adults 18 – 64 years		
Children 6 – 18 years		
Children 5 years and under		
Total		

1.9 Number of Children in and out of School

	M	F
Children 6 – 18 years in school		
Children 6 – 18 years **not** in school		

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Children under 5 years in pre-school (crèche)		
Children under 5 years **not** in pre-school (crèche)		

1.10 Employment status of members who are 18 years and over

	M	F
i) Working for a wage or salary:		
Permanent Employment		
Seasonal Employment		
Temporary/piece jobs		
ii) Running own business		
iii) Engaged in this project only		
iv) Not working		
v) Still in school		

1.11 Number of people living in your household

1 – 5	1
6 -10	2
More than 10	3

2.0 Irrigation Information

2.1 Do you use irrigation technology on your farm?

Yes	1
No	2

2.2 If yes, what percentage of your land do you irrigate?

Less than 10%	1
Between 10 - 20%	2
Between 21 -50%	3
Between 51 – 75%	4
Between 76 – 100%	5

2.3 What type of irrigation technology do you use on your farm? (*Tick only one option*)

Furrow	1
Flood	2
Sprinkler	3
Micro	4
Other (Specify)	5

2.4 What is the source of your irrigation water? (*Tick only one option*)

Dam	1
River	2
Borehole	3
Municipal	4

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Other (Specify)	5

2.5 If option 5 above is chosen, please explain

_____

_____

2.6 How frequent do you get water?

Morning hours only (5h00-12h00)	1
Afternoon hours only 12h01-19h00)	2
Others (Specify)	3

2.7 If option 3 above is chosen, please explain

_____

_____

2.8 How reliable is your water supply?

Reliable	1
Not reliable	2

2.9 What problems do you encounter with your irrigation project? Identify and rank the major problems you are facing as a farmer. Use a scale of 1-3, where the least serious problems are scored 1 and the most serious 3.

Problem	Yes	No	Rank (*Circle the appropriate score*)
Lack of credit to start up			1 2 3
Lack of adequate seeds and fertilizers			1 2 3
Lack of support from government			1 2 3
Lack of markets for produce			1 2 3
Poor extension support			1 2 3
Theft			1 2 3
Others (Specify)			1 2 3

3.0 Household Food Security Information

3.1 Did you produce enough food last year to last a whole year?

Yes	1
No	2

3.2 Does your farm improve your household food consumption?

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Yes	1
No	2

3.3 Please explain how

_____

_____

3.4 Does your household have sufficient food to eat as of now?

Yes	1
No	2

3.5 Please explain

_____

_____

3.6 Which of these statements best describes the status of the food eaten in your household in the last 12 months *(Tick only one option)*?

We always have enough to eat and the kinds of food we want	1
We have enough to eat but not always the kinds of food we want	2
Sometimes we don't have enough to eat	3
Often we don't have enough to eat	4

3.7 Please explain

_____

_____

3.8 If enough food, but not the kinds you want in 3.6, what is the reason *(Tick only one option)*?

Not enough money for food	1
Too hard to get to the store	2
Kinds of food we want are not available	3
Good quality food is not available	4

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3.9 Please explain what you do when you have no food to feed the family

_____

_____

3.10 If sometimes or often not enough to eat in 3.6, what is the reason *(Tick only one option)*?

Not enough money for food	1
Too hard to get to the store	2
No working stove available	3
Not able to cook or eat because of health problems	4

3.11 Please explain what you do when you have no money to feed the family

_____

_____

3.12 Is your income sufficient to meet your food purchases?

Yes	1
No	2

3.13 Please explain

_____

_____

3.14 How much of your income do you spend on food?

Less than 25%	1
Between 26 – 50%	2
Between 51 – 75%	3
More than 75%	4

3.15 Choose one statement that describes your spending pattern from the following:

Spend money on food, even then cannot manage food properly	1
Spend mostly on food, send children to school but not for long	2
Spend money on food, children's education and private tutoring for long	3

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Spend money on food, luxury items and children's education for long	4

3.16 Please explain

_____

_____

3.17 In the last 3 years, what is the trend of your household food availability?

Increasing	1
Decreasing	2
Constant	3

3.18 What is the reason for the observed trend?

Loss of bread winner	1
Chronic illness of household member	2
Low income received by household members	3
High prices of food	4
Others (specify)	5

3.19 Please explain -

_____

_____

3.20 How do you adjust to the food shortages?

Substitute expensive food with cheap food	1
Reduce food intake	2
Others (Specify)	3

3.21 Please explain -

_____

_____

3.22 Did any special event occur in the last one week that affected your eating habits?

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Yes	1
No	2

3.23 Please explain -

_____

_____

3.24 How often did you eat the following foods in the last one week? *(If yes in 3.22, this question should refer to the week preceding the special event)*

Food List	Frequency/week							
i) Cereals								Other
Rice								
Pap (Maize)								
Sorghum pap								
Oat meal								
Cornflakes								
Bread								
Potatoes								
Others (Specify)								
Others (Specify)								
Others (Specify)								
ii) Vegetables								Other
Carrots								
Cabbage								
Pumpkin								
Onion								
Tomatoes								
Pepper								
Lettuce								
Spinach								
Butternut								
Cucumber								
Muchina								
Beetroot								
Others (Specify)								
Others (Specify)								
Others (Specify)								
iii) Fruits								Other
Banana								
Guava								
Mango								

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Orange								
Pawpaw								
Pineapple								
Apple								
Avocadro								
Peach								
Litchis								
Watermelon								
Grape								
Others (Specify)								
Others (Specify)								
Others (Specify)								
iv) Milk and milk products								Other
Fresh milk								
Cheese								
Butter								
Yoghurt/Amasi								
Canned milk								
Others (Specify)								
Others (Specify)								
Others (Specify)								
v) Meat and legumes								Other
Chicken								
Beef								
Mutton								
Turkey								
Fish								
Chicken head and feet								
Chicken intestines								
Chicken heart								
Eggs								
Beans								
Groundnuts								
Polony								
Others (Specify)								
Others (Specify)								
Others (Specify)								

4.0 Aggregate production Information

4.1 *(Mark crop with (x) if irrigation technology was used in crop production)*

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Type of Crop	Area Cultivated during production season (ha)	Total value of all inputs used for the crop during season (R)	Unit of measurement	Total harvest for the crop during season	Quantity of crop sold during season	Unit price (R)	Total Income from the crop (R)
Tomatoes							
Cabbage							
Spinach							
Onion							
Carrots							
Beetroot							
Beans							
Mangos							
Oranges							
Bananas							
Avocados							
Litchis							
Peaches							
Maize							
Wheat							
Potatoes							
Others (Specify)							

4.2 Livestock production

Type of Livestock	Area Cultivated during production season (ha)	Total value of all inputs used for the Livestock (R)	Unit of measurement	Total output for livestock during season	Quantity of livestock sold during season	Unit price (R)	Total Income from the livestock (R)
Cattle							
Goat							
Chicken							
Donkeys							
Sheep							
Others (Specify)							

5.0 Household Income and expenditure

5.1 Household Income

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Possible Household Income Sources INCOME SOURCE CODES		Does any household member(s) currently derive income from (…)? (Enter: 1 if Yes, 2 if No)	What would you say is the average Monthly income for your household in 2008? (Circle only one Monthly Income Code)	
Full time employment			No Income	01
Temporary employment			R1 - R400	02
Casual labour			R401 - R800	03
Self employment (business)			R801 – R1200	04
Crop production			R1201 – R1600	05
Livestock production			R1601 – R3200	06
Old age pension			R3201 – R6400	07
Welfare grants			R6400 - R12000	08
Child Supports			R12001 or more	09
Contributions from other family members			No Response	10
Other (Specify)			Do not know	11
Other (Specify)				
Other (Specify)				

5.2 Household Expenditure

HOUSEHOLD EXPENDITURE CODE		How much does the household spend on (…)? (Enter *Estimated Amount* for All items purchased Monthly for 2008)	How much does the household spend on (…)? (Enter *Estimated Amount* for All items purchased once Annually)
Food			
Transport (bus and taxis fares)			
Vehicle instalments			
Energy (Electricity, Parafin, firewood)			
Burial society and savings, stokvel			
Personal items (toiletries, washing powder, etc.)			
Telephone (cellular phone, talk time)			
Water (transport, purchase, pumping)			
Rental/Bond (housing/accommodation)			
Others (Specify)			
Others (Specify)			

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School fees, uniforms, books/equipment			
Clothes			
Others (Specify)			
Others (Specify)			

6.0 Marketing of commodities

6.1 Market channels (*Tick only one option*)

Local people/Hawkers	1
Marketing board	2
Shops/schools	3
Did not sell	4

6.2 How far is your farm to the market?

More than 100 km	1
Between 50 – 99 km	2
Between 5 – 49 km	3
Less than 5 km	4

6.3 Who sets the price of the commodity? (*Tick only one option*)

Yourself	1
Buyers	2
Producer's organisation	3

6.4 Pease explain

_____

_____

6.5 What was the time lapse between harvesting and selling?

Less than 1 week	1
Between 1 – 4 weeks	2
More than 1 month	3

6.5 What quantity of the product got spoilt?

More than half	1
Less than half	2
Very few	3

6.6 Are you happy with the market situation?

Yes	1
No	2

6.7 Identify and rank the major marketing problems you are facing as a farmer.

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Use a scale of 1-3, where the least serious problems are scored 1 and the most serious 3.

Problem	Yes	No	Rank (*Circle the appropriate score*)
Storage facilities			1 2 3
Transport			1 2 3
Sourcing input			1 2 3
No market around			1 2 3
Market information			1 2 3
Others (Specify)			1 2 3

7.0 Assets Ownership Information

7.1 What is the total area of your land (Ha)?

More than 5.0	1
Between 1.0 – 5.0	2
Less than 0.1	3

7.2 What is the quality of the land?

Good	1
Fair	2
Poor	3

7.3 Do you own the agricultural land?

Yes	1
No	2

7.4 If yes, how did you acquire it? (*Tick only one option*)

Bought	1
Inherited	2
Allocated	3

7.5 If no, how did you acquire it?

Is it on lease?	1
Borrowed?	2

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7.6 Household wealth status

Does any household member own any of the following items? (Circle Code of All owned Household durables)		Which durables were acquired in the last 5 years? (For each ticked item, Enter 1 if Item acquired in the last 5 years, ELSE Enter 2)	How Was The Item Acquired? (Enter 1 for Cash, 2 for Credit, 3 for Others)	How much would you say is the [...] worth? (Enter Amount for All items owned)	Are payments on the [...] still outstanding? (Enter 1 for Yes, 2 for No)
Sofa/Coach/Lounge suite	01				
TV	02				
Electric or gas stove (hob and oven)	03				
Vehicles	04				
Fridge	05				
Generator	06				
Radio	07				
Telephone	08				
Computer	09				
Cattle	10				
Pigs	11				
Donkeys	12				
Sheep	13				
Goats	14				
Chicken	15				
Wheel burrows	16				
Ploughs	17				
Spade	18				
Fork spade	19				
Hose pipe	20				
Others (Specify)	21				

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Appendix 2: Researcher's Introduction Letter

To: The Manger
Agricultural Service Centre,

_____

_____

From: Prof. S. A. Oni
Professor Emeritus,
Department of Agricultural Economics and Extension,
University of Venda

Date: 31st August, 2009

Dear Sir,

LETTER OF INTRODUCTION

This is to introduce Mr. Obadire OS and his team. Mr Obadire is a Masters Student in the Centre for Rural Development and Poverty Alleviation, School of Agriculture, Rural Development and Forestry. The team will be conducting research work in your area among the irrigators and dryland farmers. This field work will be between 4th and 31st September, 2009. I am his supervisor and the overall coordinator of this Research work.

I request that all necessary support be given to him and his team as they go about their field work in your area. Thanking you in advance for your cooperation in this matter.

Yours sincerely,

_____
Prof. Oni, SA

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