DETERMINANTS OF HOUSEHOLD FOOD SECURITY IN THE SEMI-ARID AREAS OF ZIMBABWE: A CASE STUDY OF IRRIGATION AND NON-IRRIGATION FARMERS IN LUPANE AND HWANGE DISTRICTS.

BY

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DEDICATION

To my parents Mr. Elliot Sikwela and Mrs. Monicah Sikwela, brothers and sisters.

l love you all

DECLARATION

I the undersigned declare that the work contained in this study is my own work and has not previously in its entirely or in part been submitted at any University for a degree. Where use has been made of the work of others, it was duly acknowledged in the text.

Signature…………………………………Date……………………………

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Thank you, Almighty God.

WATER YOU ARE IMPORTANT

Water, you are important

Water you are wonderful

How wonderful and essential you are

No water, no food

No food, no survival

Water we need you all the time

In 1992 I still remember you

you were lifeless and ruthless

Animals and people perished

they starved to death because of drought

There was no water

Water you are very important."

Extract of a poem 'Water is important' by Zivanai Parato, Grade 6 student, Tsatse Primary School – Ward 21, Nyanga District, Zimbabwe – 2002

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ACRONYMS

AGRIBANK:	Agricultural Development Bank of Zimbabwe
AIDS:	Acquired Immune Deficiency Syndrome
AREX:	Agricultural research and extension
ARDA:	Agricultural Rural Development Authority
ADEQ:	Adult Equivalent
CSO:	Central Statistics Office
CIRAD:	Centre de Cooperation Internationale en Rescherche Agronomique pour le Development
FAO:	Food and Agricultural Organization
GMB:	Grain Marketing Board
GoZ:	Government of Zimbabwe
HIV:	Human Immune Virus
HTFCDP:	Horticulture and Traditional Food Crops Development Project
IFAD:	International Fund for Agricultural Development
IFPRI	International Food Security Policy Research Institute
IMT:	Irrigation management transfer
LDC:	Less developed countries
NGOs:	Non- governmental organizations
SADC:	Southern African Development Countries
SISP:	Small Holder Support Program
SSA:	Sub-Saharan Africa
TIP:	Traditional Irrigation Programme
UNDP:	United Nations Development Programme
WHO:	World Health Organization
WFP:	World Food Program
WUA:	Water users association
ZIMVAC:	Zimbabwe Vulnerability Assessment Committee

ABSTRACT

Lupane and Hwange districts fall under natural region IV and V and lie in the semi-arid regions of Zimbabwe with low and erratic mean annual rainfall not exceeding 600mm. Seventy percent of Zimbabwe's population lives in communal areas, whose livelihood is based on agriculture. The communities in these areas mainly practice mixed farming systems. However, crop production is constrained by water availability and suitable production techniques. As a result households in these areas are experiencing worsening levels of household food insecurity.

Two irrigation schemes were identified for this study and these are located in these two districts. Tshongokwe irrigation scheme is located in Lupane district and Lukosi irrigation scheme is located in Hwange district and these irrigation schemes are about 25 hectares in size. Lupane and Hwange districts are considered to be one of the most food insecure areas in the country because of the frequent droughts and unreliable rainfall in the region.

The major tool of enquiry in this study was the questionnaire which was used to collect data from the households that farm on irrigated land and those that farm on dryland farming. Household and farm characteristics were collected using structured questionnaires with the help of locally recruited and trained enumerators. Agricultural production, household consumption and marketing of agricultural produce were accessed using the questionnaire to establish problems experienced by farmers.

The main objective of this study was to investigate the determinants of household food security using a logistic regression model. The model was initially fitted with thirteen variables, selected from factors identified by previous researchers that affect food security in communal areas. Six variables were found to be significant at 1, 5 and 10 percent significance level and all had the expected signs except farm size. These factors include access to irrigation, farm size, cattle ownership, fertilizer application, household size and per capita aggregate production. The results obtained were further analyzed to

compute partial effects on continuous variables and change in probabilities on the discrete variables for the significant factors in the logistic regression model. Analysis of partial effects revealed that household size, farm size, cattle ownership and per capita aggregate production lead to a greater probability of household being food secure. Change in probability results showed that having access to irrigation and using fertilizer can increase the probability of household being food secure

The findings of this study highlight a positive and significant relationship between access to irrigation, fertilizer application, cattle ownership, per capita aggregate production to household food security. Household size and farm size have a negative and significant relationship on household food security. This study shows the effectiveness of irrigated farming over dryland farming in the semi-arid areas. The results show increased agricultural production, crop diversification and higher incomes from irrigation farming as compared to dry land farming. Irrigation farming has enabled many households to diversify their source of income and generate more income. Irrigation has enabled households with irrigation not only to feed themselves throughout the year but also to invest on non-agricultural goods and services from incomes received from crop sales.

Based on the results from the logistic regression model, it can be concluded that household size, farm size, per capita aggregate production, cattle ownership, fertilizer application and access to irrigation have a positive effect on household food security and the magnitude of changes in conditional probabilities have an impact on household food security.

CHAPTER 1

1. 1 Background information

Agriculture is the mainstay of the Zimbabwean economy. Agriculture is the livelihood for the majority of the population (about 70 percent) who live in the communal areas and accounts for between 15 and 20 percent of the gross domestic product (GDP) (FAO & WFP, 2006). Agriculture generates a large proportion of foreign exchange earnings, although the share of agricultural exports in country's total exports has declined from 39% in 2000 to 21% in 2006. The decline has been due to severe dry spells, shortage of vital inputs, land invasions and generally unfavourable rainfall during the 2005 to 2006 cropping season, compounding devastating effects of the unprecedented decade-long economic decline (FAO and GIEWS Global Watch, 2007).

Zimbabwe experienced several crop failures in 1987, 1992, 2000 (Zimbabwe Vulnerability Assessment Committee, 2002) and 2005 to 2006 (FAO and GIEWS Global Watch, 2007). The crop failures have been a result of early termination of the rains in most seasons or low rainfalls in the country. The reduction in yield and output at farm level has led to a 70 percent shortfall in agricultural production to meet annual food requirements for the population. In 2002, Zimbabwe experienced the largest deficit in its food production since 1980. This created severe food shortages in both urban and rural areas. The food shortages deteriorated into a famine and a humanitarian disaster. The cereal deficit in April 2002 to March 2003 marketing year was estimated at 1.65 million tonnes (Zimbabwe Vulnerability Assessment Committee, 2002). According to the Zimbabwe Emergency Food Security Assessment (2002), 486 000 tonnes of food aid was needed to meet food security requirements of 6 700 000 people (49% of the population) over the period September 2002 to March 2003. Of the 6 700 000 requiring food aid, 5 900 000 were in rural areas and 800 000 in urban areas. Seventy percent of the rural population was at risk of famine induced starvation (WFP, 2002). The scale of the food aid was unprecedented in the history of Zimbabwe.

Thus, there was need for rapid growth in food production to attain food security. The combined impacts of climatic and economic hardships induced severe food insecurity among both the rural and urban population, especially in areas where there were the greatest agricultural production shortfalls (Zimbabwe Vulnerability Assessment, 2002). The shortage of water brought about food insecurity in rural populations, including former commercial farm workers and their families and, as well as the urban poor. The principal causes of food insecurity and vulnerability in Zimbabwe were closely linked to the performance of the agricultural sector (FEWS, 2006). As a result of the poor performance of the agricultural sector, this has lead to an economic and social decline and severe food insecurity in communal areas of Zimbabwe.

Food insecurity has been caused by several factors among them being shortage of water to grow crops and keep livestock in most parts of Zimbabwe (Manzungu, 2003a). The unavailability of water resources and irrigation development have been found to be the major factors contributing to household food insecurity through reduced agricultural production in Zimbabwe. Water scarcity in communal areas has been seen as the most limiting factor to agricultural production (Manzungu, 2003a). The amount of rainfall for a particular region is determined by the climatic conditions and the soil types of the area. Agriculture is the main sector that contributes to the welfare of people and thus water is an important input to food production in Zimbabwe. Zimbabwe's land is divided into five natural regions based on temperature, rainfall and topography. Thus, Zimbabwe is classified into natural region I, II, III, IV and V as shown in Table 1.1 according to the area and the amount of rainfall received in each region.

Table 1.1 Characteristics of rainfall patterns in natural regions of Zimbabwe

Natural region	Area Km^2	Characteristics of region
I	7 000	More than 1 050 mm rainfall per year with some rain in all months
II	58 600	700 - 1 050 mm rainfall per year confined to summer.
III	72 900	500 – 700 mm rainfall per year. Infrequent heavy rainfall. Subject to seasonal droughts.
IV	147 800	450 – 600 mm rainfall per year. Subject to frequent seasonal droughts.
V	104 400	Normally less than 500 mm rainfall per year, very erratic and unreliable. Northern Low veld may have more rain but topography and soils are poorer.
Total	390 700	

Source: Adapted from Rukuni and Eicher (1994 pp.43)

Natural region I specializes in diversified farming and is suitable for forestry, fruit and intensive livestock production. Smallholder farmers occupy less than 20% of the area in this region. Natural II is suitable for flue-cured tobacco, maize, cotton, sugar beans and coffee. Sorghum, groundnuts, seed maize, barley and various horticultural crops are also grown in this region. Supplementary irrigation is done for winter wheat and barley. Animal husbandry like poultry, cattle for dairy and meat are also practiced in this region. Smallholder farmers occupy only 21% of the area in this productive region (Rukuni and Eicher, 1994, citing Vincent and Thomas, 1962).

In natural region III, smallholder farmers occupy about 39% of the area in this region and the region is good for crop production. Large-scale crop production covers only 15% of the arable land in this region and most of the land is used for extensive beef ranching. Maize dominates commercial farm production. Natural region III is subject to periodic seasonal droughts, prolonged mid-season dry spells and unreliable starts of the rainy season. Irrigation plays an important role in sustaining crop production.

Natural region IV and V are associated with frequent droughts and the type of soils and topography are poor. These regions are too dry for successful crop production without irrigation but communal farmers have no other choice but to grow crops in these areas even without access to irrigation. Millet and sorghum are the common crops but maize is also grown. Communal farmers occupy 50% of the area of natural region IV and 46% of the area of natural region V (Rukuni and Eicher, 1994, citing Vincent and Thomas, 1962).

Due to characteristics of natural region IV and V, the Government of Zimbabwe (GoZ) has been trying to adopt technologies that can reduce food insecurity through technologies such water harvesting tanks, water and soil moisture conservation technologies and irrigation farming (Manzungu, 2003). The area under irrigation in Zimbabwe is estimated at 120 000 hectares for both large scale and smallholder farms of which 82% is large scale, 7% is State farms, 2% is out-grower schemes and 9% is smallholder irrigation schemes (Agritex estimates, 1999). However, irrigation has played a very important role in the success of smallholder agriculture in Zimbabwe and other parts of Southern Africa.

In Zimbabwe, large scale irrigation projects emerged as a result of commercialization of agriculture while the smallholder irrigation projects were largely instituted by the government to provide food security in the drought prone areas. The other reason for the establishment of the irrigation projects was to settle people who had been displaced from the commercial farms around the 1940’s (Rukuni and Eicher, 1994, citing Vincent and Thomas, 1962).

1.2 The research problem

Smallholder farmers in the semi-arid areas of Zimbabwe have not been performing well in terms of their agricultural output because of erratic rainfall patterns in these areas. The majority of the farmers in these semi-arid regions have failed to achieve food security because of unreliable rainfall and other factors contributing to agricultural production in these areas. Smallholder farmers suffer from low incomes and living standards, poor nutrition, poor housing and health (FAO, 1997). This is aggravated by the fact that there is usually very little rainfall, especially in agro-ecological regions IV and V. Annual rainfall is 450-650 mm per year in region IV and less than 500 mm per year in region V, concentrated in a few isolated storms. Under these climatic conditions, rain fed agriculture fails four years out of five. Thus, those that rely on rainfall in these areas are still impoverished and they are faced with food insecurity. As a result of these erratic rains crop productivity on dryland has been low as compared to those farmers on the irrigation schemes. Dryland farmers are limited to these low productive crops such as millet, sorghum and maize (short season variety) because of inadequate rains in these regions (Manzungu, 2003b).

1.3 Research Questions

1. What are the determinants of food security in smallholder farming between irrigation and non-irrigation farmers at household level?
2. To what extent does irrigation contribute to household food security as compared to dry land farming in communal areas?
3. To determine which farmers realize higher farm incomes between irrigation farmers and dryland farmers?

1.4 Objectives of the study

The broad objective of this study is to assess the determinants of household food security among smallholder irrigation farmers and non-irrigation farmers in the semi-arid areas of Zimbabwe (Matabeleland North) and to analyze factors contributing to household food security in communal areas.

Specific objectives are to:

1. Investigate the determinants of household food security among irrigation farmers and non-irrigation farmers in the communal areas.
2. Assess the farm household crop productivity in Lupane and Hwange districts (Natural region IV and V).
3. Investigate the contribution of farming to household income.
4. Assess factors affecting farm household food security status.
5. Assess the relative contribution of irrigation to household food security, as compared to dryland farming.

1.5 Hypotheses

1. Food security increases with an increase in household income.
2. Food security increases with an increase in the area under cultivation.
3. Irrigation farming in communal areas enhances household food security.

1.6 Justification and Expected Contributions of the study

Zimbabwe is an agrarian economy with 70 percent of its people dependent on agriculture (Rukuni and Eicker, 1994). The Government of Zimbabwe has been trying to achieve food security at both household and national level through these communal and resettled farmers. Smallholder irrigation has been reported by many studies to have enhanced food security in the semi-arid areas of Zimbabwe (FAO, 1997).

This study focuses on irrigation and dryland farmers to establish who are food secure. Various factors contributing to household food security are discussed so that recommendations can be made for better strategies and measures to assist communal farmers address household food insecurity in the semi-arid areas of Zimbabwe. This study will help to identify gaps in communal areas and come up with reasons why communal farmers are food insecure.

Several studies such as one done by Dlamini (2003) have been carried out to assess household food insecurity in the semi-arid areas of Zimbabwe. Studies by Mano (2003) and Guveya (1995) have shown that there are many factors that enhance 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 communal areas of Zimbabwe (FAO, 1997). Thus, this study is going to concentrate on two selected irrigation schemes in Natural region IV and V of Zimbabwe to assess the impact of irrigation on food security when compared to dry land farming. 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 farmers can be able to achieve household food security (Makombe & Meinzen-Dick, 1993).

1.7 Organization of the Project

The project starts by looking at the contribution of agriculture to the economy, climatic conditions in all the Natural regions of Zimbabwe and problems faced by smallholder farmers in achieving food security. Definitions of food security, determinants of food security, successes and failures of irrigation schemes in the communal areas are discussed in Chapter 2. Chapter 3 covers the economic, physical and social aspects of the study areas. The methodology chapter looks at how other studies measured household food security and the logistic regression model is discussed in Chapter 4. Chapter 5 looks at the demographic characteristics of the study population, agricultural production and sources of incomes of the farmers. Empirical results of the logistic regression which help to explain which factors are significant in addressing household food security are discussed in Chapter 6 and then conclusions and recommendations are addressed in Chapter 7.

CHAPTER 2

REVIEW OF LITERATURE

2. 1 Introduction

This chapter provides a brief background of food security status in Africa and then looks at the definitions of household food security and hunger in the light of communal households. This chapter goes on to discuss literature on Zimbabwe's agriculture and irrigation. A brief discussion of research studies that have been carried out on food security and how food security has been measured is discussed in this chapter. It also looks at the how farmers in semi-arid areas have tried to address food insecurity and the constraints faced by irrigation farmers in communal areas. Determinants of household food security and other mitigation factors that can be adopted by farmers to achieve household food security are discussed in this chapter.

2.2 Literature review

The Government of Zimbabwe has given priority to improving national and household food security, as well as to improving the standard of living and the incomes in the rural areas (Mudimu *et al.*, 1989). A major challenge facing the government is to enable communal farmers to increase their production so that they can be food secure and also increase their participation in the market to generate incomes.

Since independence in 1980 the government has undertaken several initiatives to meet to these priorities (Rukuni and Eicher, 1994), including the following,

- Improving physical infrastructure, particularly road network in communal areas.
- Guaranteeing incentive prices for food and cash crops.
- Encouraging irrigation development in the semi arid areas.

Thus, over the years researchers have worked hard to answer changing questions about agricultural technology adoption in achieving food security (Sen, 1998). Initially, policy makers and researchers in Africa have sought simple descriptive statistics about the diffusion of new seed varieties and associate technologies such as fertilizer and irrigation (Sijm, 1997). Concerns arose later about the impact of technology adoption (irrigation, hybrid seeds, fertilizer and machinery) on commodity production, poverty and malnutrition, farm size and input use in agriculture, genetic diversity and a variety of social issues (IFPRI 2001). Numerous researchers have developed innovative methodologies for addressing such concerns, carried out surveys and collected enormous amounts of data to describe and document the adoption of new agricultural technologies but little has been done on adoption by these communal farmers (Sah, 2002).

In Zimbabwe, smallholder irrigation was introduced in the early 1930s by Emery Alvord (missionary) in the low altitude and low rainfall areas as a necessity to achieve food security (Rukuni and Eicher, 1994, citing Roder, 1965). Thus, the Government of Zimbabwe (GOZ) also committed itself to a program of poverty alleviation through "growth and equity" which was aimed at attaining self-sufficiency in food production (Von Braun, 1992). However, from the evaluations which have been made by some researchers like Jayne *et al* (1990), the result has been a food insecurity paradox. At the national level Zimbabwe has been food self-sufficient in years with average or above average rainfall, but food insecure at household level.

2.3 Definitions of food security

At the 1996 World Food Summit, 182 nations agreed to the definition of food security as "access by all people at all times to enough nutritionally adequate and safe food for an active and healthy life". According to the Food and Agricultural Organization (FAO, 1996) and the World Bank (2006a), extensive research has been focused on understanding household food security, food insecurity and hunger. This work was done by some experts working in the American Institute of Nutrition (AIN). The FAO, AIN and World Bank came up with the following definitions:

According to Monde (2003) and Food and Agriculture Organization (1996), food security refers to the availability of enough food in order for all people to live a 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 and ensure adequate safe and nutritious food to meet their nutritional, social and psychological requirements (FAO, 1996).

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 conditions resulting from financial resource constraint (FAO, 1996).

Hunger is the uneasy or painful 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 necessary, consequence of food insecurity (FAO, 1996).

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 and Msukwa, 1992). Rohrbach (1989) interprets 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). In contrast to the food self-sufficiency notion is food security. This has been widely accepted to mean the ability of individuals and households 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 and 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 assesses food security status at household level. It looks at the ability of the household to produce its own food to meet food requirements of households.

As a result of food availability and food access issue, the perception of food security has changed significantly. In the 1970's, the conventional wisdom was that food insecurity was caused by the decline or failure of aggregate food availability either at local level, regional, national level or global level (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 1970's. However, despite the favourable supply conditions and low food prices after the mid 1970's the incidence of food insecurity remained high in many developing countries (Sijm, 1997).

In the early 1980's, a paradigm shift occurred in the field of food security following Sen's (1998) claims that 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. Since then, accepted wisdom has defined food security as being a problem of access to food. At the same time, this analysis shifted from global and national level to the household level. Food security has been conceived as a function of entitlements, which includes a set of all alternative bundles of commodities that a person can obtain legally by using his or her endowments. People may suffer from food insecurity because of a lack of "entitlements" or access to food, implying that food insecurity should be analyzed in terms of the decline or failure of food entitlements of different socio-economic groups (FAO, 1996). 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 endowments, loss of employment, a fall in wages, or unfavourable shift in terms of trade of food exchange for assets.

2.4 Food security situation in Zimbabwe

The majority of the communal farmers are located in the drier parts of the country (Natural region IV and V) which receive less than 600 mm of rainfall per annum (Table 1.1), with approximately one and half million households who make up about 6 million people or 65-70 percent of Zimbabwe's population (IFPRI, 2001). The welfare of the majority of these households is characterized by generally low crop productivity (in terms of per unit area cropped or per unit labour use) and high variability in food and cash crop output (USAID FEWS, 1994).

Low and variable food and cash crop output in this sub-sector is a result of a combination of separate but related factors that influence agricultural performance. These are agro-ecological, technological, and socio-economic factors. Crop productivity is generally low due to lack of appropriate crop varieties and production technologies. This is made worse by the fact that a significant proportion of the households are not well endowed with productive resources, that is land, animal draft power, and working capital for purchasing inputs such as fertilizers, improved seeds, draft power and transport services. For example, up to about 40 percent of household do not have adequate access to animal draft power (Zindi and Stack, 1992). Low crop output in the communal areas can be attributed to low productivity arising from low input use. The technologies that are currently available are expensive and to some extent inappropriate. They were developed for high input production systems obtainable in the large-scale commercial farming areas, mostly located in the agro-ecological regions II and III with high and stable rainfall. Due to the above conditions, households in the low rainfall areas have been vulnerable to transitory food and cash income insecurity as a result of the inter and intra-seasonal variability in food and cash crop production due to the rainfall. In these parts of the country, incidence of malnutrition and other health problems arising from malnutrition have been high (Mano, 2003).

In general, the rate of malnutrition across all communal areas is reported to be around 10-15 percent of all children between the ages of one year and five years (FAO, 1999). In the low rainfall communal areas, the rate rises to around 20-25 percent. It is as high as 30-40 percent in such communal areas such as Nyanga, Binga, and several areas in the Matabeleland Provinces (Rukuni and Jayne, 1990). In some of these districts, malnutrition is chronic. Research findings by the Food Security Research Project suggest that up to 40 percent of households in the communal areas may be faced by chronic food insecurity. This arises from the fact that a good number of households do not have adequate to produce enough food nor do they have adequate cash to purchase food available in the market (IFPRI, 2001).

2.5 Determinants of food security

Factors used to explain the differences in levels of productivity and food security between households include income, household land holdings, employment status, household productive asset endowments and household composition. A study carried out by Rukuni (1994) revealed that to ensure high productivity levels and sustainable food security among the poor, especially in low rainfall areas, on-farm productivity and income growth is essential.

2.5.1 Landholding

The most common asset in rural areas is landholding and this is a good indicator of poverty when income is unobserved (Ravallion, 1989). Households with small farms are prone to food insecurity. In addition, land quality has been found to provide a good amount of yield in communal farms. In most communal areas, farms are of relatively poor quality and require the use of chemical fertilizer (Rutsch, 2003).

2.5.2 Livestock

A study on livestock was conducted by Ndlovu (1989), who focused on the role of ruminants in promoting food security in farming systems in the SADC region. Ndlovu (1989) found that livestock are important to food security in the SADC region as sources of manure, draught power, cash income, food (milk and meat) and as long-term investments. Zindi and Stack (1991) did a survey on the contribution of livestock to household's food security in communal areas. The most important livestock types in communal areas are cattle, chickens and goats, each of which serves different functions under different household circumstances. Cattle are generally regarded as an investment and a production input while smallstock, especially goats, are viewed as a ready source of cash (Ndlovu, 1989). Thus, FAO (1997) proposed a food based strategy to alleviate rural food insecurity that included smallstock (goats and sheep) and vegetable gardens as well as formal agriculture, especially the rearing of poultry to improve household food security. FAO (1997) showed that smallstock are easy to keep as they can survive in harsh conditions and are able to feed on low quality crops as compared to cattle.

2.5.3 Income sources

Farm households derive their income from many sources including crop and livestock sales, wages, salaried labour, remittances and small enterprises. These small enterprises include basket making, brick making, curios and selling of fish. The contribution of each source to total income and its reliability varies greatly between households. Factors contributing to this variation include agro-ecological conditions, wealth and income levels (Jayne *et al*, 1994).

Off-farm labour is an important source of income for most smallholder farmers. Off-farm income is positively associated with higher and less variable total income (Jayne *et al*, 1994). Some studies have also shown that off-farm income has a positive effect on the adoption of expensive traction technology and good quality inputs, which results in high productivity levels (Zindi and Stack, 1991). Thus, it is clear that income diversification can have a positive effect on food access by increasing total incomes and under proper circumstances increasing investment in agriculture (Jayne *et al*, 1994).

Chopak (1989) carried out a study on family income sources and food security. The study focused on analyzing the food security status of households in natural regions IV and V of Zimbabwe and identifying alternative strategies for improving household food security in these areas. The three most important income sources during the hunger season were labour payments from off-farm employment, remittances (from family members employed), government transfer payments and pension funds.

2.5.4 Gender of household head

Men and women engage in different activities to obtain income. This is important in determining the impact of gender of household head on crop productivity and food security. Studies have shown that women focus on the production of food crops, and that women's income from cash cropping and other sources is more likely to be spent on food than the men's income (Mattias *et al*, 1995). It has been argued that households with female heads are more likely to be food insecure than those with male heads

In a study conducted in Kwazulu-Natal to assess the impact of land reform programme in South Africa, it was realized that it failed to integrate food security concerns and the needs of rural women. The study suggested that there are important differences within and between households headed by women and communities with respect to security levels and strategies to attain food security. It was noted that there is great concern in Southern Africa on issues of poor governance, economic mismanagement and scant regard for adequate food and satisfactory quality life as basic human needs have contributed significantly to the acute and chronic insecurity in most parts of the region (Boyd and Turner, 2000).

2.5.5 Household productive asset endowments

Access to food by communal farmers has been conceived as a function of entitlements, which includes a set of all alternative bundles of commodities that a person can obtain legally by using his or her endowments (Feleke *et al*, 2005). People may suffer if there is inadequate food because of lack of "entitlements" or access to food, implying that food insecurity should be analyzed in terms of the decline or failure of food entitlements of different socio-economic groups (Anderson, 1988). 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 endowments, loss of employment, a fall in wages, or unfavourable shift in terms of trade of food exchange for assets.

Ownership of other productive assets such as farm equipment (ploughs, cultivators, labour and draft power) may be reasonable *proxies* for food security status of households. Dione (1989) in Mattias *et al* (1989) showed that there is a positive relationship between agricultural equipment ownership and per capita grain production. However, Sunderberg (1989) in Mattias *et al* (1989) used the same variables and found that there was no strong positive correlation between agricultural equipment ownership and the nutritional status of individual household members.

2.5.6 Issues that impact on household food security

May *et al* (1999) observed that households have various ways of achieving food security. In this regard, pensions and access to salaried labour has gained prominence. The FAO (1997) proposed a food based strategy to alleviate rural food insecurity that included conservation strategies, food assistance, production from agriculture and buying power of communal farmers. The FAO (1997) came across these indicators when there were assessing food insecurity in some southern African countries that were food insecure such as Namibia, Zambia, Lesotho, Mozambique and Zimbabwe. Abalu (1999) and May (2000) argued that agriculture is one of the main sources contributing to livelihood strategies and underpinning food security in the rural areas of southern African countries. Figure 2.1 show some of the ways that food security can be enhanced in communal areas, these include conservation strategies, food assistance, production, purchasing power and feeding livestock from crops residues. This also follows Kirsten *et al* (1998) suggestion that increased agricultural production has a positive contribution to household food security and nutrition. Figure 2.1 illustrates the multiple and often interrelated dimensions of food security.

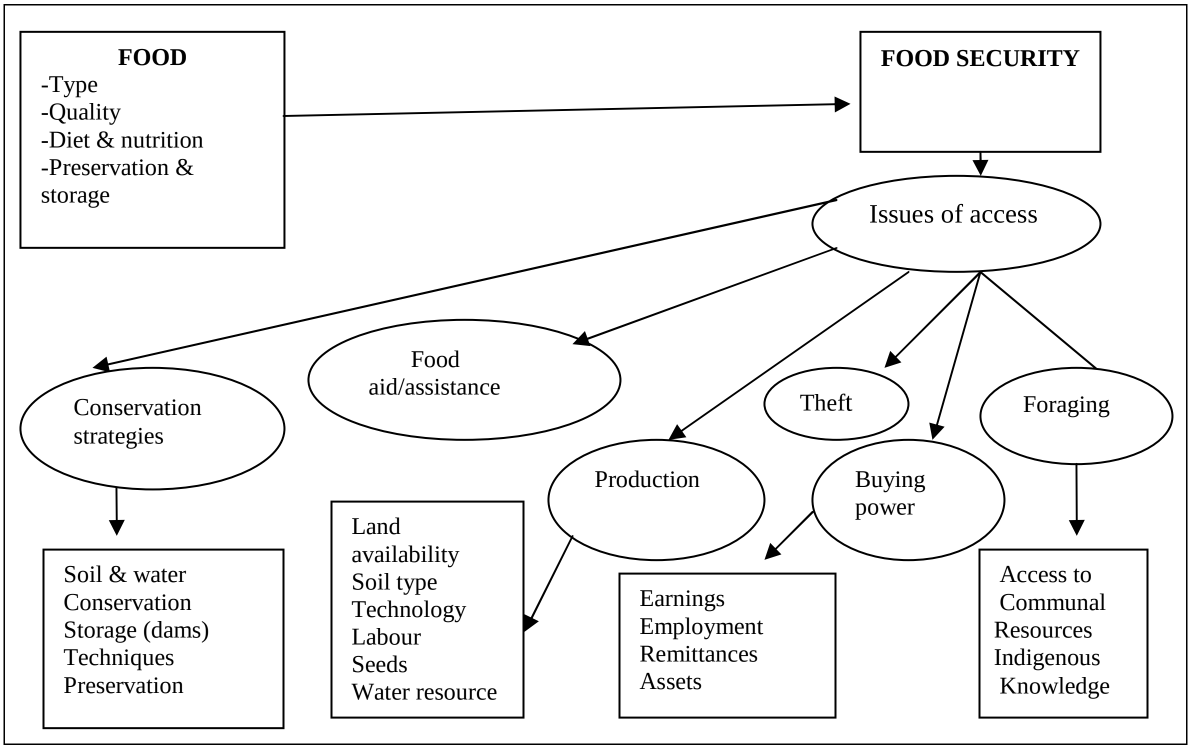

Figure 2.1: Issues that have an impact on household food security.

Source: Adapted from Agenda-Empowering women for gender equity (2002 pp18)

In terms of food security *per se*, the type, quality, diet and nutrition as well as the preservation and storage methods are important (Abalu, 1999). It is also important to integrate economic and political dimensions of food security which impact on the aspects delineated in the above figure. For example, issues of governance and decision making at both the community and household levels have an impact on food security (Kirsten *et al.*, 1998). Thus, power relations are the key to obtaining an adequate conceptual understanding of the opportunities and obstacles to the goals of food security and improved agricultural production. From the aspects highlighted in Figure 2.1 food security can be attained or enhanced if the governance and political structures are put in place to cater for the rural poor farmers.

2.6 Measurement of food security

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 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 information of condition, experience and behaviour pattern that consistently characterizes the phenomenon of food insecurity and hunger in households.

Two objective methods of food security measurement have been widely used in most food security studies. One is to estimate gross household production and purchases over time, estimate 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 to argue that there has been a paradigm shift in food security measurement from one based on objective indicators to one based on subjective perception (Maxwell, 1996). One such subjective approach has been to analyze the use of and reliance upon strategies developed by households and sequential response for dealing with insufficiency of food at household level as direct indicators.

Hoddinott (1997) outlines four ways of measuring food security outcomes, namely individual intake, household caloric acquisition, dietary diversity and indices of household coping strategies. Each method of measuring food security outcomes entails different methods of collecting and analyzing 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 depends to a large extent on the availability and degree of analysis of food security. However, it should be noted that poor rural farming households produce to subsist and only that part of the produce which cannot be consumed (surplus) is marketed.

In Free State Province (South Africa) a study was carried to assess the contribution of rainwater harvesting and conservation practices to household food security (Klasen, 2000). 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 following Aliber (2003):

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

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) and 0.9 is the scale parameter.

After the determination of adult equivalent, the total household income 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:

$$ADEQI= HHt/ADEQ$$

Where HHt 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.

$$\%ADEQI \text{ spent on food} = ((FEm/ ADEQ)/ADEQI)* 100$$

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. As households become more "well off", they tend to spend less money as a proportion of the total household income (Woolard, Klasen and Leibbrandt, 2001). Generally poor households (low income earners) spend a considerable proportion of their incomes on food. The expected results were an increase in production using water harvesting technology that would result in a reduction in the proportion of income used to acquire food (Aliber, 2003). The increased income would be generated from the sale of the produce enabling farmers to meet household food requirements.

2.6.1 Logistic regression model

A logistic regression was used by Kidane *et al* (2005) and Feleke *et al* (2005) to assess the causes of household food insecurity. These studies were done in Ethiopia and looked at the following 'Causes of household food insecurity in Koredegada Peasant Association, Oromiya zone,' and 'Determinants of food security in Southern Ethiopia'. Both these studies involved assessing various indicators that could affect the dependent parameter food security. A logistic regression (binary or dichotomous) was used to investigate which independent variables affected food security. Among these variables included were continuous and categorical variables.

The variables included in both studies were age of household head, gender of household head, wealth, farm size, cattle ownership, fertilizer application, education level of household heads, physical access to markets, household size, off-farm employment, on-farm income and per capita aggregate production (Feleke *et al*, 2005 and Kidane *et al*, 2005). These variables were chosen because the researchers felt that these could influence food security either positively or negatively. Among the variables included in both models, those identified as statistically significant determinants of household food security were technological adoption, farm size, land quality, household size, per capita aggregate production and access to market.

2.7 Development of the agricultural sector in promoting food security

Development of the agricultural sector in Zimbabwe is therefore seen as central to combating hunger, reducing poverty, and generating economic growth (through the reduction of food imports and the boosting of exports) (Moyo, 2003). However, progress in the sector can only be achieved if the main constraints (listed below) are successfully addressed:

- Variability in climate
- Limited access to technology
- Low levels of rural infrastructure
- Poor institutional structures

Other areas that need to be addressed are the poor political and economic governance, the need to introduce supportive policy and legislation, the need to develop rural entrepreneurship capacity, invest in HIV/AIDS, mobilize savings for investment and improve the performance of crops (Mano, 2003). Although there are various ways in which the above-mentioned issues can be tackled, one key strategy that could contribute to the alleviation of poverty and improvement in food insecurity in communal areas is assisting poor farmers to increase the productivity on their farms (Mutangadura and Norton, 1999). Low farm productivity can be addressed through integrated approaches such as increasing the use of organic and mineral fertilizers, using improved seed varieties, applying irrigation techniques and increasing the level of mechanization.

2.7.1 Increased agricultural production

Agricultural production in most smallholder schemes has been found to be attractive because of the low capital investment required and the demonstrated capacity of the beneficiaries to manage, operate and maintain the irrigation schemes. Studies carried out by FAO (2001) in Zimbabwe's ten provinces showed that improved crop production technologies can lead to better opportunities for farmers. Crop yields under irrigated agriculture exceeded those under rain-fed agriculture by almost two to three times, making these farmers more food secure than their counterparts on dryland farming. Irrigated vegetable production in the dry season in Mutema, Chitora, Murara, Mzinyathini irrigation schemes particularly those close to urban centres was gaining importance in the farming community (FAO, 2001). Irrigation has promoted crop diversification and better nutrition in these communal areas. The availability of water on the irrigation schemes has actually allowed farmers to grow a variety of crops such as wheat in the winter season and vegetables throughout the year (Meinzen-Dick *et al.*, 1993). As a result they can grow both food and cash crops that can increase their incomes.

2.7.2 Improved incomes

Irrigation has alleviated famine in most rural areas of Zimbabwe. Meinzen-Dick *et al* (1993) reported that the greatest food deficits in Zimbabwe occur in dry land areas of Natural Region IV and V. In their study they noted that fewer people ran out of food during the year than people on dryland areas. Rukuni (1984) showed that, in general, yields achieved on smallholder schemes are higher than rain fed dry land yields in communal areas. Meinzen-Dick *et al* (1993) showed that gross margins for irrigating farmers were significantly greater than dry land farmers. They further pointed out that the effect of irrigation on increasing crop production and incomes is even more marked in the dry winter season, when dryland production is impossible because of lack of rain.

2.7.3 Employment

Irrigation has also been said to generate income and reduce rural to urban migration by offering the rural population an alternative source of employment and income (Griffith, 1982). Most studies revealed that sustainable irrigations schemes were able to keep farmers in employment and also people open vegetable markets from these irrigation schemes (Moyo, 2003). Apart from creating employment for local farmers, irrigation engineers, extension officers and health officers also get employed on these irrigation schemes (Mutangadura and Jackson, 2001). The majority of the white farm workers who lost their jobs from the commercial farms were absorbed by the fast track land reform and some small scale irrigation schemes. FAO (1997) established that irrigation schemes have a multiplier effect as people from urban centres would open vegetable markets and employ staff to run the vegetable markets. The multiplier for smallholder farmers was 1.92 using 1991 prices (CSO, 1997). This is specific to the Mutema and Chitora irrigation schemes in the Eastern Highlands (Manicaland Province) and lowveld (Masvingo Province) respectively (Moyo, 2003). These irrigation schemes sold their produce to local and distant markets in Harare such as Mbare Vegetable Market (FAO, 1997).

2.7.4 Nutrition

The International Food Policy Research Institute (IFPRI) (2001) carried out research on malnutrition in both developed and developing countries, which revealed that there were 170 million children suffering from malnutrition across most rural household serious enough to jeopardize their chances of becoming healthy adults and 16 million children died everyday from malnutrition worldwide. The largest portion died in sub-Saharan Africa of debilitating disorders brought on by a painful lack of good quality food (IFPRI, 2001). However, IFPRI (2001) showed that if progress continued at the present rate (slow), the number of people suffering from malnutrition (staggering at 800 million worldwide) would be halved by the year 2030 if proper institutional, economic and political issues are addressed quickly (Anderson *et al*, 1993). The research publicized that malnutrition could only be reduced by increasing incomes and food production, especially in rural households of most sub-Saharan Africa. The IFPRI (2001) and policy makers suggested that malnutrition could be reduced through infrastructural development and irrigation development in rural areas.

A study carried out in Zimbabwe showed known that in general, the rate of malnutrition across all communal lands located near irrigation schemes are reported to be low (Msukwa, 1989). A good number of households rely on agricultural produce from the irrigation schemes to meet some of their nutritional requirements and live a healthy life (FAO, 1995).

2.8 Irrigation development and food security

The development of smallholder schemes were followed by a number of socio-economic studies in order to help policy makers in formulating sound policies for future development in the communal areas (Bembridge, 2000). Irrigation development is a determinant of household food security in that it has both advantages and disadvantages to communal households. Thus, it is important to look at the development of irrigation in relation to food security in communal areas as it has a direct effect on agricultural production in communal areas.

Irrigation development is an important part of policy development for sustainable economic growth of any country especially third world countries. The initiative for development of irrigation mostly has been taken up by governments and to some extent development agencies since farmers are unwilling or unable to undertake irrigation development due to the large amounts of money required for the initial development. The rate of expansion and improvement of irrigation is constrained not only by the country's land and water resources limitations, but by its ability to plan, construct and manage irrigation systems (Alibaruho *et al*, 1979).

Irrigation development has contributed immensely to improved food security (Burton *et al*, 2005). The proportion of global food supplies due to improved irrigation is significant. On the other hand, irrigation enthusiasts should not exaggerate the contribution of irrigation to food security and neglect other important influences on global food growth such as substantial increases in use of fertilizer and crop protection chemicals, and the development of improved, high-yielding varieties supported by agricultural extension services (Carruthers *et al*, 1996). Approximately 40% of the world's food production comes from 260 million hectares of irrigated lands (FAO, 1995).

The marginalized rural poor are the major focus of irrigation development programmes (Aderndorff *et al.*, 2000). There is a perception that irrigation is promotes food security in rural areas (Crosby *et al.*, 2000). This has seen an increase in the development of smallholder irrigation schemes in bid to ensure food security in these areas. Despite the huge investments in irrigation development, the performance of most smallholder irrigation schemes has been poor and the goal of achieving food security has not been realized due to mismanagement of the irrigation schemes by the irrigation committees (Bembridge, 2000). In some irrigation schemes, there a tendency to produce more cash crops than food crops such that food security is not attained.

2.9 Constraints facing irrigation development

Apart from being associated with household food security, irrigation schemes in the semi-arid areas have some problems associated with their development and management. The problems faced by smallholder irrigation schemes in communal area can be categorized as follows:

2.9.1 Environmental factors

On some irrigation schemes, it has been noted that poor water quality especially as related to sediment concentration has affected the amount of water that can be used for irrigation purposes. This means that farmers experience low crop production and farmers cannot grow crops throughout the whole year (FAO, 1997). Land degradation is also one of the important environmental factors which result from poor operation and management activities leading to siltation of some of these irrigation schemes. This is partly related to inefficient water management resulting in water wastage and water logging as well as land-use regulation (Rukuni, 1993).

2.9.2 Capacity of the farmers

The level of literacy in most circumstances has been a major constraint to communal irrigation schemes. Farmers lack know-how in and access to, the opportunities of irrigation technology (Pazvakawambwa and Van Der Zaag, 2000). The weak economic base of most farmers in communal areas and the relatively high development costs involved in developing irrigation schemes has resulted in some irrigation schemes performing poorly because of not being maintained properly (Makombe & Meinzen-Dick, 1993).

2.9.3 Government policy, institutional and legal support

There has been limited or no priority given to irrigation development during national, local planning and budgeting in sub-Saharan countries. This has led to some irrigation projects failing to sustain themselves. In communal areas of Zimbabwe there are poor management structures in place to support farmers and promote irrigation development (Hillel, 1989). For example, the infrastructure (roads, marketing facilities and storage facilities) in Zimbabwe’s rural areas to facilitate agricultural development is underdeveloped. The land tenure system does not encourage farmers to invest in permanent improvements on their plots and make improvements which can be used to obtain credits for further development has also contributed to the failures of these irrigation schemes. Also, the issue of unclear water rights and their enforcement has had an impact on both crop production and sustainability (Makombe & Meinzen-Dick, 1993).

2.9.4 Economic and financial constraints

The availability of financial resources for the development of smallholder irrigation is a constraint in almost all the countries. Development costs for small-scale irrigable schemes are high in sub-Saharan countries. The Department of Rural Development and Agricultural Research and Extension (AREX) estimates that the present costs are extremely high per hectare for irrigation engineering works alone (FAO, 1997).

A study carried out in sub-Saharan Africa showed that rehabilitation of irrigation schemes is expensive (FAO, 1997 and Tafesse, 2003). Government schemes were found not to be functioning as efficiently as before, given the government's failure to fund operation and management costs. The cost of borrowing money from credit institutions is high and this makes it difficult for farmers to borrow and pay back the loans (FAO, 2001). Local NGOs and agri-business institutions, which promote certain export crops, for example, in Zambia, are now financing smallholder irrigation schemes. Recently, the Support to Farmers' Association Project (SFAP) through external financing has created a credit line for small-scale farmers. In Kenya, lack of financial resources has led to a decline in share in the volume of exports (Tafesse, 2003).

In Ethiopia, smallholder community irrigation projects are financed either by the government or by NGOs, although beneficiaries contribute about 10% of the investment cost in the form of labour or by providing local materials such as sand, stone and wood (Rogers, 1998). The beneficiaries also cover minor operation and management costs. However, major maintenance works (e.g. pumps, and head works) are carried out with government assistance. There are various programmes supporting smallholder irrigation development in African countries, which are funded by different financing agencies such as the World Bank, African Development Bank, International Fund for Agricultural Development (IFAD) and donor countries, like Denmark, Japan and Netherlands, through their respective development agencies, are collaborating with governments in Africa in implementing studies and construction activities geared towards developing irrigation in these countries (Tafesse, 2003).

The FAO (1995) explained these high costs of irrigation schemes as resulting from fairly remote water sources requiring long supply canals. Smallholder irrigation schemes in the semi-arid areas consist of soils of high infiltration rate and thus construction of these canals especially if they are lined add significantly to overall development costs. Communal lands are also said to be far from major supply centres of irrigation building materials. Thus, it is costly to haul construction material.

2.9.5 Marketing

Almost all smallholder irrigation schemes have marketing of produce as one of the most difficult challenges. In Zimbabwe, most of the produce from irrigation schemes is sold to locals as irrigation farmers are constrained by transport to carry their produce to profitable markets, lack of information and marketing linkages and lack of collection centres in communal areas (Meinzen-Dick, Makombe and Sullins, 1993). Meinzen-Dick, Makombe and Sullins, (1993) revealed that Chitora irrigation farmers had problems with transporting their produce to profitable markets. The transporters were shunning their irrigation scheme because of the poor road service in the communal areas. The transporters were charging exorbitant fees to get the farmers produce to the market because of the difficulty in using the communal roads (Mupawose, 1984). However, in Kenya, the Horticulture and Traditional Food Crops Development Project (HTFCDP) has been able to offer better marketing opportunities for farmers. It has assisted farmers in exporting some of their produce to international markets such as United Kingdom, France, Netherlands, Germany, Saudi Arabia and South Africa (Bembridge, 2000).

In countries like Zambia, Malawi and Zimbabwe, local markets are not well organized and the crops produced by smallholders are sold at low prices (Meinzen-Dick, Makombe, and Sullins, 1993). In Zimbabwe, vegetables are produced for local markets in urban centres. Efforts have been made to link farmers to the local chain stores, but this has met with little success because smallholder farmers produce lacks consistency in both quality and quantity. Rural processing is also not well developed and so market linkages remain the biggest challenge among small-scale irrigators (Tafesse, 2003).

Marketing has continued to be a big challenge for smallholder irrigators. Most of the farmers produce vegetables like tomatoes, onions, carrots and cabbages, however, because of the perishable nature of the crops and price fluctuations farmers are often forced to sell at low prices. Further, the absence of organized markets has allowed middlemen or tradesmen to take advantage of the situation (FAO, 1995).

2.10 Sustainability of irrigation projects

Despite the myriad of problems facing smallholder irrigation schemes or cooperative societies, they can become more efficient and sustainable by:

- Upgrading smallholder irrigation techniques
- Putting in place a management structure responsive to water users
- Access to (innovative) credit schemes
- Good support services (credit, marketing, transport, storage)

Government's role in supporting irrigation development is therefore important in terms of the policies and regulations formulated and implemented (Msukwa and Kandoole, 1992). The planning undertaken at the macro and micro level, training and provision of services to support development of the agriculture sector requires support from both government and NGOs so that irrigation schemes can be completely be transferred to communal farmers (Bembridge, 2000).

Thus, professionals, academics, research institutions and governments in many countries are in the process of considering or adopting such irrigation management transfer (IMT) reforms because they allow farmers to have a sense of belonging and farmers are able to invest in the irrigation schemes (Bembridge, 2000). Also farmers need tenure rights to the irrigation schemes to be able to run the schemes properly. In Zimbabwe, the government has partially transferred some irrigation schemes to smallholder farmers and it provides some inputs on credit. Some governments are still unsure about whether to adopt reforms and how to design and implement them (Rukuni, 1994). The reason for this is that irrigation development has been increasingly exposed to new challenges and the changing driving forces. For example, competing demands for water, emerging environmental issues, persistent and even pervasive food insecurity and poverty in communal areas.

2.11 Insights from the literature review

In conclusion a lot has been done in sub Saharan Africa to address the issue of food security in communal areas. There are determinants that should be addressed for households to achieve household food security in communal areas. Irrigation is one of the key indicators in addressing household food security as it brings a number of benefits to the farmers. The Government of Zimbabwe has been reluctant to improve this situation which could actually serve as an important tool to economic growth and development in the communal areas. This has resulted in non-governmental organizations (NGOs) and other parastatals assisting communal farmers in addressing the food security problem through irrigation development. The problem these farmers are facing is that of finance and accessibility of inputs to maintain and repair these irrigation schemes and to purchase inputs such as seed and fertilizers. The level of infrastructure in the communal areas makes it difficult for irrigation development because of the transport costs that are incurred in communal areas.

CHAPTER 3

DESCRIPTION OF THE STUDY AREA

3.1 Introduction

The chapter looks at the geographical area, population, economic, social and physical nature of the study areas. This chapter also covers the climate of the study areas and tries to establish reasons for the need for irrigation development and other activities that people can adopt for their survival in these areas. Non-agricultural activities that can be carried out apart from agricultural production are discussed in this chapter.

3.2 Location of study areas

Food insecurity is greatest in poorest agro-climatic regions, defined by rainfall and soil characteristics. The study sites were selected in Natural Region IV and V as shown in Figure 3.1, in areas with relatively less rainfall. Lupane and Hwange District are two of the seven Districts situated in Matabeleland North Province. The Districts are characterized by poor rainfall (Table1.1) and high temperatures during the summer season, making the vast track of land unsuitable for both food and cash cropping.

Tshongokwe and Lukosi irrigation schemes were selected for this study and are found in Lupane and Hwange districts respectively. Tshongokwe irrigation scheme is in Natural region IV and Lukosi irrigation scheme fall under Natural Region V according to the Natural Regions and Farming Areas Map of Zimbabwe (Surveyor General, 1984).

Tshongokwe irrigation scheme, which is situated approximately 41 km north-west of Lupane growth point. The area itself is a broad plateau with narrow pans cutting through it. The topography is relatively flat and with little surface drainage due to the perviousness of the sands (Scholes, 1997).

In Hwange, Lukosi irrigation scheme is under Lukosi village. The irrigation scheme is about 18 km north-west of Hwange town. The topography in Hwange is mountainous and with relatively few areas with undulating ground. The soils in Hwange are mostly Kalahari soils, few loamy and clay soils (Scholes, 1997). Hwange and Lupane have are very similar climate though they are in different climatic regions.

The map of Zimbabwe showing the five natural regions.

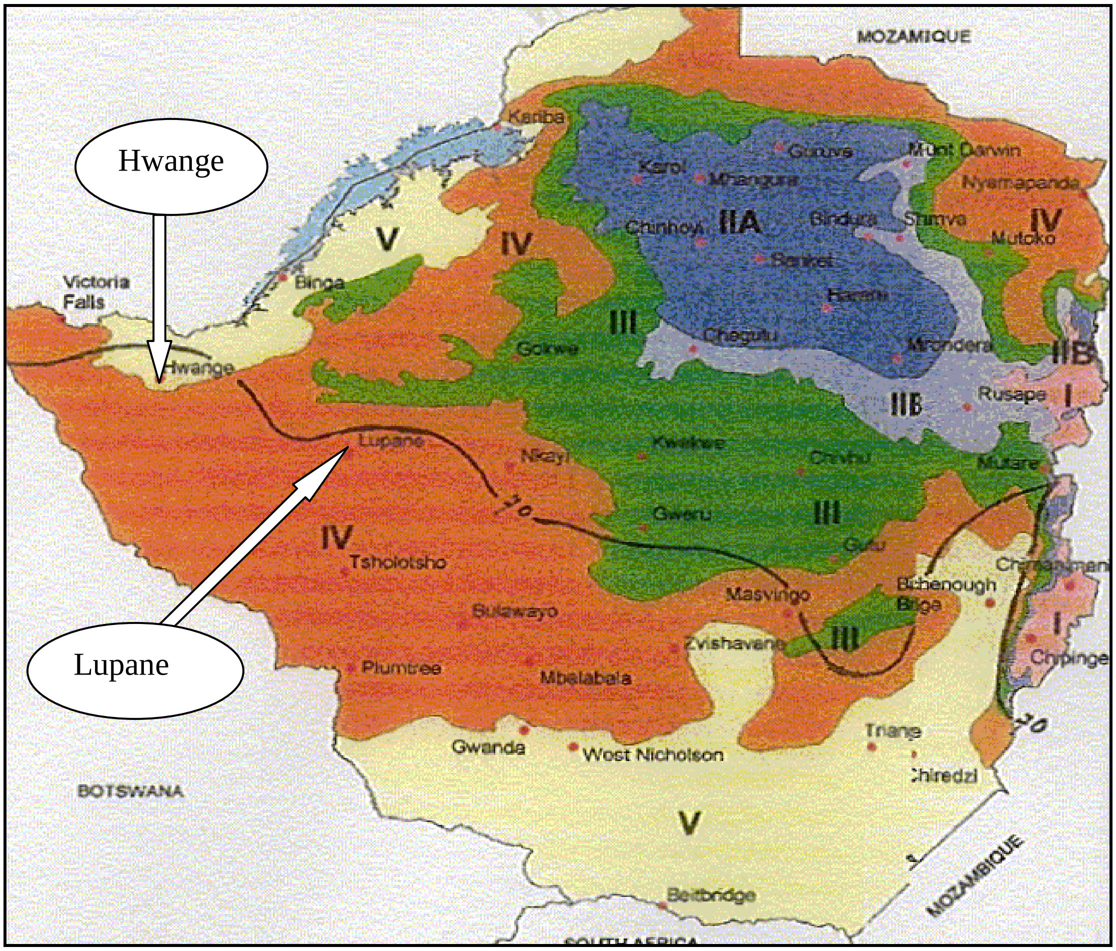

Figure 3.1: Map of Zimbabwe showing natural regions and surveyed areas

Adapted from Rukuni and Eicher (1994)

3.3 Rainfall

On average, the rainy season starts in earnest during the first weeks of November, reaches its peak in late January and ends in the last days of March to early April. The period from late May to early October is completely dry for both areas. Mean annual rainfall is 600 mm (Sibanda *et al.*, 1994). One year out of five years has good rains to support crops to maturity and in other years, one year out of two has at least 700 mm and four out of five has at least 460mm of rain which is not adequate for crops. With this analysis it can be concluded that these areas have erratic rainfall patterns (Sibanda *et al.*, 1994).

3.4 Size of the irrigation schemes and water sources

In Lupane, Tshongokwe irrigation scheme receives its water from the Shangani River. The water is trapped in a dam and is directed to the irrigation scheme using gravity. The dam is about 1.5 km away from the irrigation scheme. The farmers use water canals and pipes to direct the water into the field plots. Tshongokwe irrigation scheme is about 24 hectares and the irrigation scheme consists of 60 plot holders.

Lukosi irrigation scheme in Hwange gets its water from the Lukosi dam. The dam receives water from a tributary coming from the Lukosi River. The water is directed into a dam, which is then directed to the irrigation scheme using gravity like in the case of Tshongokwe irrigation scheme. The dam is located about 3 km away from the irrigation scheme. Lukosi irrigation scheme is about 25 hectares and has 73 plot holders.

3.5 Land suitability for irrigated cultivation

Tshongokwe irrigation scheme covering 24 hectares is already operational in Lupane District. There is still more land in this area that could be irrigated if water was available. The edges of this area have limitations like slope shallow soils (Thompson & Purvis, 1978). The villages with potential for irrigation in the same district are Ngombane, Tshongokwe and small portions of Bhuyu and Mutshekwa.

In Hwange, Lukosi irrigation is about 25 hectares and has sandy loamy soils with clay content ranging from 3% to 7% which are not so good for crop production (Anderson *et* al., 1993). The use of inorganic fertilizer has enabled farmers to grow their crops throughout the whole year. The irrigation scheme has 73 farmers who operate on the irrigation scheme full time. The surrounding villages are not suitable for intensive crop production because of the sandy soils and the erratic rainfall in the area.

These irrigation schemes are supplied by water from dams which were constructed by the government and non-governmental organizations. Both these irrigation schemes use gravity to direct water to the irrigation plots which makes it less expensive for the farmers. Other water sources for the people in these areas include boreholes and wells found in the districts (Agritex, undated).

3.6 Economic activities

Matabeleland North Province has been an important timber belt since the 1890s, supporting local people with employment. However, most sawmills have closed down as timber species dropped to uneconomic levels increasing the rate of unemployment. However, with the decrease in timber harvesting, tourism has been a major economic activity in the Province.

Tourism has taken over from timber lumbering in Matabeleland North Province as a result of good grazing, increased employment opportunities and has brought a lot of foreign currency to the country. Apart from offering a large variety of scenery and wildlife viewing, tourism has created job opportunities for the local people in the communal areas (Chenje, Sola, & Paleczny, 1998). Other economic activities that are available are fishing and hunting in the Province.

3.7 Conclusion

Lupane and Hwange districts are characterized by low rainfalls, high temperatures, poor soils and poor topography. Farmers who grow crops on dryland have problems of good soils and water and this affects their crop outputs when compared to irrigation farmers who benefit from the availability of water. Generally the two districts face high rainfalls and high temperature in the summer season and low temperatures and low or no rains in the winter season. Otherwise, the area is good for livestock production and wildlife.

CHAPTER 4

METHODOLOGY

4.1 Introduction

Food Agricultural Organization (FAO) and World Food Programme (WFP) (2006) have conducted studies in and around Africa on issues regarding the measurement of food security. Food security has been a major concern especially in Africa where close to thirty million people are food insecure in Africa because of frequent droughts, armed conflict, corruption and the mismanagement of food supplies, environmental degradation and trade policies affecting most African countries (Benson, 2004).

In Ethiopia, a household food security model was used to look at the importance of the supply side against demand side variables in determining household food security in Southern Ethiopia (Feleke *et al.*, 2005). From the results, it was established that the supply side variables are more powerful determinants of household food security than the demand side variables. The reason was that if supply is high it means people have access to food and the demand variables were not so significant. In the study, maize was used to measure food security as it is a staple food. The study involved measuring harvesting patterns of maize as determinants of food vulnerability or sustainability. Those people who harvested their maize crop before it reached maturity were said to more vulnerable than those who harvested the crop when it was mature. The reason behind this was because those that harvested early had no other alternatives forms of income to purchase food while those who harvested after the crop had matured had other sources of income to purchase food.

In the United States of America, a qualitative questionnaire was designed to assess food insecurity and hunger in households. The questionnaire consisted of 18 standard questions used to assess food insecurity in both developed and developing countries. This questionnaire had merits in that the information derived from it could be used by policy-makers (Andrews, Bickel and Carlson, 1998). A major advantage was that it incorporated some qualitative elements that could be used to perceive food insecurity and hunger in most households. Andrews, Bickel and Carlson (1998) found out that this questionnaire is a more direct measure of food insecurity than any other proxy measures.

4.2 Methodologies used in related studies

4.2.1 Multivariate regression

Multivariate regression was used to assess household food security in Madagascar which is a developing country (Migotto *et al*., 2005). Multivariate analysis was chosen because it could explore the relationship across various indicators to determine which socio-economic characteristics are associated with perceptions of subjective food adequacy. The aim of the research was to compare information on self-perceived food consumption adequacy from the subjective modules of household surveys with standard quantitative indicators, namely calorie consumption, dietary diversity and anthropometry.

In the first model probit analysis was used because it was able to measure the consumption adequacy question (CAQ), where a positive coefficient of a given explanatory variable of the CAQ showed an association with a higher probability of food adequacy.

The second model used was identical to the first except for the use of per capita food expenditures in lieu of per capita calorie consumption to see whether subjective answers are more responsive to food expenditure than to calories. The CAQ was simply regressed to capture the following variables in the model, The full model can be expressed as:

$$CAQ = \alpha + \beta_1 C + \beta_2 D + \beta_3 A + \beta_4 NF + \beta_5 Z + \beta_6 M + \beta_7 O + \beta_8 R + \beta_9 E + \beta_{10} G + \beta_{11} RD + \beta_{12} S + \varepsilon$$

where:

- C refers to the log of per capita calories per day or to the log of per capita food expenditure (two separate, identical models),
- D refers to a dietary diversity index,
- Following Morris *et al* (2000), A refers to a household asset index, including both agricultural and non-agricultural assets,
- NF refers to the share of non-food items in total consumption,
- Z refers to a vector of household characteristics including household size, dependency ratio, gender, age of the household head, pension status, gender of the respondent and age composition of the household,
- M refers to migration variables,
- O refers to occupation of the household head (skilled versus unskilled) and to whether the household head is employed,
- R refers to the religion of the head of the household,
- E refers to education,
- G refers to a series of geographical location variables,
- RD refers to relative deprivation, that is, a household's wealth position relative to other households in a given geographical area, which is calculated following Stark and Taylor (1989),
- S refers to other subjective variables,

The results from this study in Madagascar showed that dietary diversity, household level and wealth characteristics, as households become wealthier, instead of maximizing calories, they improve the quality of consumption (substituting better types of the same foods or expanding the diversity of foods eaten) and the type of consumption, such as eating out more often. This confirms the earlier works of Pradhan and Ravallion (2000) in that as households get better incomes they are able to substitute the diet more often than households with low incomes. The multivariate regressions showed that perceptions of food adequacy are highly correlated with perception of relative and absolute wealth.

4.2.2 Gross Food Security Index and Net Food Security Index

A study by Dlamini (2003) looked at the empirical measures of household food insecurity such as nutrition indicators, income, per capita grain availability, and low productivity assets may serve as reliable proxies for food insecurity. Households, which may suffer from food insecurity, are those with low per capita income, low productivity levels and inadequate resources combined with big families. Dlamini (2003) used Guveya's (1995) formula to calculate food security index:

GFSI = TOTAL GRAIN/ REQUIREMENT

Where GFSI is Gross Food Security Index.

NSFI = SURPLUS/ REQUIREMENT

Where surplus = production levels-consumption-sales/year

Surplus is defined as output necessary to maintain a population of producers and their dependents at the prevailing standard of life. The surplus product is whatever is produced in excess of those necessities.

NSFI = Net food Security Index

The Gross Food Security Index (GFSI)

If the index is equal to one (100 percent) it implies that production equals requirements i.e. the household is self-sufficient but does not have excess to sale.

If the index is greater than one it means the household is self-sufficient and food secure.

If the index is less than one it means the household is not food self-sufficient.

The Net Food Security Index (NSFI)

If the index is at least 100 percent it shows that households retain enough grain to meet their requirements till the next harvest season and,

If less than 100 percent it shows that the household does not retain enough grain after sales to last till the next harvest (Guveya, 1995).

In conclusion, the United States of America (US) food security module consisting of 18 standard questions is the product of several years of methodological advances and of field testing. It measures the sufficiency of household food through food-related behaviours as directly experienced by people. One of its main drawbacks is that, while internal validity and consistency have been extensively tested (at the population level, not at the level of an individual household), its external validity has not (Bickel *et al*., 2000). The inclusion of a contextually sensitive module similar to that of the United States of America (US) into household surveys in developing countries, reflecting also future vulnerability, provides an excellent opportunity to validate externally 'subjective' indicators, both at the population level and at the level of the individual household.

4.3 Questionnaire design

Both primary and secondary data were used in this study. Primary data was collected using a pre-tested questionnaire which included household characteristics such as demographic questions (name, sex, age, education etc), farm specific characteristics (number and class of livestock, crops grown and the hectarage), food and non-food expenditures, remittances, employment and income, agricultural activities and finally the nature and risks of farming. The manner in which the questions were designed was that they were carefully phrased to avoid ambiguity, sensitive and provocative questions. Interviews were conducted in Ndebele and Nambya, which is the local language used in the study area.

Secondary data was collected from the local Agricultural Research and Extension offices (AREX), District Council Offices, local bank (Agribank) and local farmers' organization in the districts.

4.3.1 Sampling of Respondents

Stratified sampling was used to group irrigation and dry land farmers in the villages. The farmers were divided into those belonging to the irrigation schemes and those farming under dryland farming (a distant village from the irrigation scheme). These farmers were put into relatively homogeneous subgroups before simple random sampling was used to pick respondents for interviewing (Matata *et al.*, 2001).

An irrigation register with a list of farmers on the irrigation schemes was used. All the farmers were then allocated serial numbers for easy identification, random sampling using a random table was used to choose the farmers from the finalized list. This approach was employed to ensure that as many different farmers were included in the study. Interviews were conducted on adults that are on the irrigation schemes.

4.3.2 Sampling Size

A total of 200 questionnaires were administered to farmers on the irrigation and on dry land farming. Questionnaires were administered in two areas with irrigation schemes under the semi-arid areas of Zimbabwe as shown in Table 4.1. This was done to reduce discrepancies in the data collected. A total number of 50 questionnaires were administered to each group.

Table 4.1 Interviewed farmers in Lupane and Hwange Districts

LUPANE DISTRICT	HWANGE DISTRICT
Tshongokwe irrigation scheme	**Lukosi irrigation scheme**
50 farmers	50 farmers
Jotsholo village-dryland	**Change village-dryland**
50 farmers	50 farmers

4.3.3 Interviewing procedure

Interviews were carried out by the researcher and his assistants who were taken from the local villages. Local teachers were the most preferred since the questionnaire required some numerical data and were able to speak the local languages in the area. Extension officers were excluded as enumerators because the respondents (farmers being interviewed) were going to give biased answers to some of the questions since they get advice to do with agricultural activities from extension officers, thus distorting the whole purpose of the study.

The purpose of the study was explained to the assistants and the data needs made clear. Knowing what is required for the study ideas were shared on how to approach the respondents in the various villages of Lupane and Hwange. The study objectives and questionnaire were first discussed and explained to the sampled farmers. When the farmer was found to be willing to answer questions interviews progressed. All this was done, so that enumerators can establish good rapport and encourage respondents to cooperate and hopefully give honest and unbiased answers.

4.4 Method of data analysis

4.4.1 Logistic Regression

The main objective of the study is to examine the determinants of households' food security using a logistic regression model. This model was fitted with thirteen variables that help explain food security, of which they were expected to give significant signs after data analysis. The logistic regression was chosen for this study because of the nature of the response variable which is dichotomous (Der and Everitt, 2002).

4.4.2 Analytical techniques and variables measurement

To identify the determinants of the food security status of farming households, two stages of analysis were performed. The first was to construct a food security index (ϕ_i) and determine the food security status of each household based on the food security line using the recommended daily calorie required by an individual (FAO, 1996). Cereal[1] availability from own production was calculated and used to determine calorie availability for each household. However, since in Zimbabwe foods other than cereals contribute about 20% of energy in the diet, it was taken that cereals supply 80% of energy in diets of the people (FAO, 1996). Since maize, millet and sorghum are the main cereals in Zimbabwe's communal areas, food security was determined based on maize, millet and sorghum equivalent energy content. The average daily calorie requirement for a moderately active adult equivalent (ADEQ) is 2850 kcal/day. According to WHO (2005), a safe minimum daily intake should not fall below 80% of the above calorie requirement, which means that the minimum intake should be 2,200 kcal/ADEQ/day. Based on the above information, the minimum daily maize requirement per adult equivalent per day is 568 grams of maize, which is equivalent to 207.3 kg of maize (or any grain expressed in maize equivalents) per year.

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[1] Maize, sorghum and millet were chosen as an indicator that can capture the vulnerability and unsustainability elements of food insecurity. These cereals were chosen because they are part of Zimbabwe staple cops in communal areas.

To measure food security at household level, all household members were converted into *adults equivalents* using the formula:

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

where:

ADEQ = adult equivalent units, A = number of adults, C = number of children in a household (below the age of 15 years).

Secondly, the logistic regression model was used to estimate the food security status of households as a function of a set of independent determinants. A household whose daily per capita calorie intake was 2,200 kcal (568 grams) or more was regarded as food secure and those below 2,200 kcal (less than 568 grams) were regarded as food insecure households. To calculate the calorie intake required for household to meet the food security requirement, quantities of grain consumed were converted to grams and the calorie content was estimated by using the nutrient composition table of commonly eaten food in Zimbabwe (Appendix 2). Per capita calorie intake was calculated by dividing the estimated total household calorie intake by the family size after adjusting for adult equivalents using the consumption factors for age-sex categories (Appendix 3). To get the households' annual per capita intake, households' per capita calorie intake was divided by the number of family members multiplied by 365 days.

4.4.3 The food security model

The food security model is adapted from production and consumption behaviours of rural households by Strauss (1983), Barnum and Squire (1979) and Yotopoulos (1983) (cited in Shiferaw *et al*, 2003) and Kidane *et al* (2005) the extent of household food security found in this study is modelled within the framework of consumer demand and production theories.

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. The model below was used to determine which factors affect food security.

In this model, the researcher is interested on the probability of that response variable takes on the value of interest (usually coded as “1” and the other being “0”) depends on the explanatory variables. The following model was used in this study to determine factors affecting household food security (Hesketh and Everitt, 2000):

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

ϕ_i stands for the probability of household (i) being food secure 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:

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

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

$$(1-\phi_i) = \frac{1}{1+\ell^{\mathrm{Z}_i}} \quad (3)$$

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

$$\left(\frac{\phi_i}{1-\phi_i}\right) = \frac{1+\ell^{\mathrm{Z}_i}}{1+\ell^{-\mathrm{Z}_i}} = \ell^{\mathrm{Z}_i} \quad (4)$$

The natural logarithm of equation 4 gives rise to equation 5

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

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

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

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

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

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 $0 \left(\chi_i = 0, \chi_i = 1\right)$, respectively.

4.5 Explanation of independent variables

Thirteen explanatory variables measured as continuous and discrete variables were identified to be major determinants of food security in this study. These variables were included in this model as they have been used in other studies to determine household food security. Feleke *et al* (2005) and Kidane *et al* (2005) adopted the same logistic regression model in their studies. These variables include gender of household head, age of household head, household size, education level of household head, technology adoption, farm size, land quality, per capita aggregate production, cattle ownership, wealth, off-farm work, physical access to markets and physical access to irrigation. These factors are a *priori* and are expected to have a positive or negative impact on food security.

4.5.1 Gender of Household Head

Agricultural production in communal areas is usually centred on women as men often migrate to urban areas to seek employment. Women are left in charge of the fields and livestock. Women play a critical role in agricultural production, and especially in subsistence agriculture, as well as in livestock keeping and food processing (FAO, 1995). Other activities involve gathering of wild fruits and herbs. They also fetch water and fire wood to use in households to prepare food. While men are working in urban areas, they buy agricultural inputs and send money back home. Women concentrate on the production of food crops to attain household food security and men's income can be used on other activities that do not contribute to household food security (Mattias *et al*., 1994).

4.5.2 Age of Household head

Hofferth (2003) argues that the higher the age of the household head, the more stable the economy of the farm household, because older people have also relatively richer experiences of the social and physical environments as well as greater experience of farming activities. Moreover, older household heads are expected to have better access to land than younger heads, because younger men either have to wait for a land distribution, or have to share land with their families. A similar study by Obamiro *et al* (2003) arrived at a similar conclusion regarding the relationship between age of a household head and household food security. Age of household head is a continuous variable and is measured in years.

4.5.3 Household size

Household size is measured by the number of family members in the household. Since food requirements increase with the number of persons in the household and also because land and finance to purchase agricultural inputs are very limited, increasing family size, according to Brown (2004), tends to exert more pressure on consumption than the labour it contributes to production. Thus, a negative correlation between household size and food security is expected (Paddy, 2003) as food requirements increase in relation to the number of persons in a household. Household size is a continuous variable. It is measured in this study by the number of adult equivalent units in a household.

4.5.4 Education level of household head

Educational status of household head could lead to awareness of the possible advantages of modernizing agriculture by means of technological inputs, enable them to read instructions on fertilizer packs and diversification of household income which, in turn, would enhance household food supply (Najafi, 2003). Educational attainment of a household head is considered to be a qualitative variable. Households led by educated (attended formal education e.g. primary, secondary etc) heads take a value of 1 while those who are led by uneducated (did not attend any schooling) heads take a value of 0.

4.5.5 Technology adoption

Technology adoption refers to the use of high yielding varieties of seed, use of tractors and fertilizer use with improved agronomic practices Obamiro *et al* (2003). Households that reported to have used some package of technology are considered adopters and those that have not used this package are considered non-adopters. Adoption is expected to increase food security through its effect of increasing food availability and income.

4.5.6 Farm size

Farm size is the total farmland owned by the household measured in hectares. The larger the farmland, the higher the production level. It is expected that households with large farms are food secure than those with small farms (Najafi, 2003). The expected effect on food security is positive because the more land used for farming the higher the output. Farm size is a continuous variable.

4.5.7 Land Quality

The quality of land also determines the amount of output a farmer gets. Land in the communal areas is of relatively lower quality in the sense that they do not provide a good yield without the use of chemical fertilizer. Under optimal management, better land quality boosts crop production (Sah, 2002). Stephen (2000) found that a decline in soil fertility negatively affects food security. Hence, in relative terms, farms in the area have been classified into poor quality and good quality based on the requirements for fertilizer. According to Brown (2004), any farm input that augments agricultural productivity is expected to boost the overall production. This contributes towards attaining household food security. Fertilizer use was measured on the basis of whether or not a household uses fertilizer, i.e. a dummy variable was used. A household that applies fertilizer has a value of one and that did not has a value of zero. It is expected that fertilizer users are more food secure than non-users of fertilizers in the communal areas. The expected effect on household food security is positive for fertilizers users.

4.5.8 Per capita aggregate production

Per capita aggregate production[2] consists of the crop output which includes all cereal harvested (maize, sorghum, wheat and millet) by the farmers for each study area. It is assumed that per capita aggregate production influences household food security through the price effect. That is, an increase in per capita aggregate production causes price to fall hence those households whose income is dependant on food crops face a fall in farm income. The higher the market supply the lower the price and hence the higher the loss of production revenue in the case of inelastic demand (Foster, 1992).

[2] Per capita aggregate production was computed by converting the different cereals into maize equivalents.

4.5.9 Cattle Ownership

Cattle[3] ownership, a continuous variable, is another determinant of the food security status of households. Cattle serve as a source of traction in many developing countries, thereby significantly affecting households' crop production. Animal traction power enables households to cultivate greater areas of land and to execute agricultural operations timely (Govereh and Jayne, 1999). Therefore, a positive relationship between cattle ownership and food security is expected in this study.

4.5.10 Wealth Status

The wealth status of the household is measured by the number of livestock owned, since livestock is the most important indicator of wealth in rural areas. A household level of farm resources e.g. livestock can be expected to affect its ability to withstand abrupt changes in production, prices, income or unforeseen events that create the need for additional expectations. Livestock provides not only food for the households but also a number of other products which could be sold or consumed by the household members to provide nutrition, income, traction and fuel. Products from livestock include draught power, meat, milk, eggs, manure which is used as fertilizer or fuel, fibre and hides. When crop failure occurs because of rainfall shortage, the level of one's resources (livestock) is very important to combat food shortages (Kang'ara *et al*, 2001). The expected effect on food security is positive.

4.5.11 Off-farm work

FAO (1999) reported that employment in off-farm and non-farm activities are essential for diversification of the sources of farm households' livelihoods. It enables households to modernize their production by giving them an opportunity to apply the necessary inputs, and reduces the risk of food shortage during periods of unexpected crop failures through

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[3] Cattle ownership refers to the number of cattle owned by a household. In Zimbabwe, both ox and cows are used for ploughing purposes. Cows are used for both reproductive and traction purposes because of the limited number of cattle kept by communal farmers.

food purchases (Devereux, 1993; Maxwell & Frankenburger, 1992). It is measured based upon whether or not the household has off-farm work. A household member who is engaged in off-farm work and non-farm activities took the value of one and households who did not engage in those activities took the value of zero, i.e. a dummy variable was used. A household without a member with off-farm work is expected to have a negative food security and a household with a household member with off-farm work is expected to have a positive effect on food security.

4.5.12 Physical access to markets

Access to market is measured by the amount of time (hours) required to reach the nearest local market. The longer it takes to get to the market, the less frequent the farmer visits the market and hence the less likely he/she to get market information. In this study, the distance to the nearest market was used since Zimbabwe was experiencing fuel shortages during the time the data was being collected. Using time would distort results as farmers were spending a lot of time searching for fuel. When there is less adequate information about prices, farmers may sell their produce at times when prices are low and buy when prices are high. Expected effect on food security is positive.

4.5.13 Physical access to irrigation

Access to irrigation is expected to have a positive relationship with household food security (Burton *et al.,* 2005). Farmers with plots on the irrigation schemes are able to grow crops through out the year and meet household food requirements than those on dryland farming. A dummy variable is used. Those farmers on the irrigation schemes take the value of one and those not on the irrigation schemes take the value of zero. Thus, the expected effect on food security is positive for irrigation farmers.

4.6 Conclusion

The logistic regression model was chosen as a method of analysis because it can estimate the probability of a certain event occurring and it accommodates a lot of variables (discrete and continuous) which can be ranked in a hierarchy to show which variables strongly affect the response variable. It also shows the association between the independent variables. The logistic regression model was chosen also because of the advantages it has over the adult equivalent income, multivariate regression and food security indices.

CHAPTER 5

CHARACTERISTICS OF THE STUDY POPULATION

5.1 Introduction

This chapter is a presentation of research results in the context of the agricultural production between irrigation farmers and dryland farmers. The aim of this chapter is to highlight the various factors affecting farm household crop productivity and food security. Household demographic characteristics, farm characteristics and income sources for irrigation and dryland farmers are presented in this chapter. A comparison of income sources and agricultural production between irrigation and dryland farmers is discussed in this chapter to determine which households are food secure than the other.

5.2 Demographic characteristics of study households

The study sample[4] consisted of 199 households. Of these, 40.6% were female headed and 59.4% were male headed. Household size represents the total number of family members permanently available on the farm. The average household size for Lupane was 5.4 and for Hwange it was 4.2. When compared to national statistics the average of the two districts is almost equal to that of the province.

5.2.1 Gender of household head

Table 5.1 below shows the household demographics of Lupane and Hwange households that were interviewed for this study. In Lupane, out of the 100 households were interviewed 38% were female headed and 62% were male headed. In Hwange, of a total of 99 households interviewed, 45% were female headed and 55% were male headed. On average both areas have men dominating as household heads.

[4] One of the 200 questionnaires was discarded because it had a lot of missing information and could not be used in this study.

Table 5.1 Household demographics

District	Lupane (N=100)		Hwange (N=99)	
Household characteristics	**Number**	**Percentage (%)**	**Number**	**Percentage (%)**
Female	38	38	45	45
Male	62	62	54	55
Average age	54.9	-	52.5	-
Average household size	5.4	-	4.2	-
Average adult equivalents	4.7	-	4.1	-
Marital status				
Single	2	5	14	2
Married	68	68	65	66
Divorced	5	2	2	14
Widowed	25	25	18	18
Education level				
No education	10	10	22	22
Primary	59	59	53	54
Secondary	31	31	24	24
Employment status of household head				
Yes	12	12	21	21
No	88	88	78	79

5.2.2 Age of household head

Age is one of the most important factors pertaining to the individual's personality make up, since the needs and the way in which an individual thinks are closely related to the number of years a person lived. According to Romuld and Sandham (1996), young people are more adaptable and willing than older people to try out new innovations since old people believe in their old cultural way of doing things. However, 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 than younger people. The results of this study show that the average age of household heads for Lupane households is 54.9 and Hwange households are 52.5. This means that these household are headed by people who are economically active and are able to make household farm decisions as they have acquired more knowledge about farming, as observed by Bembridge (1987).

5.2.3 Household size

The majority of households in Lupane and Hwange rural areas are small-scale or subsistence producers with limited participation in non-agricultural activities. Small-scale farming heavily depends on its family for labour.

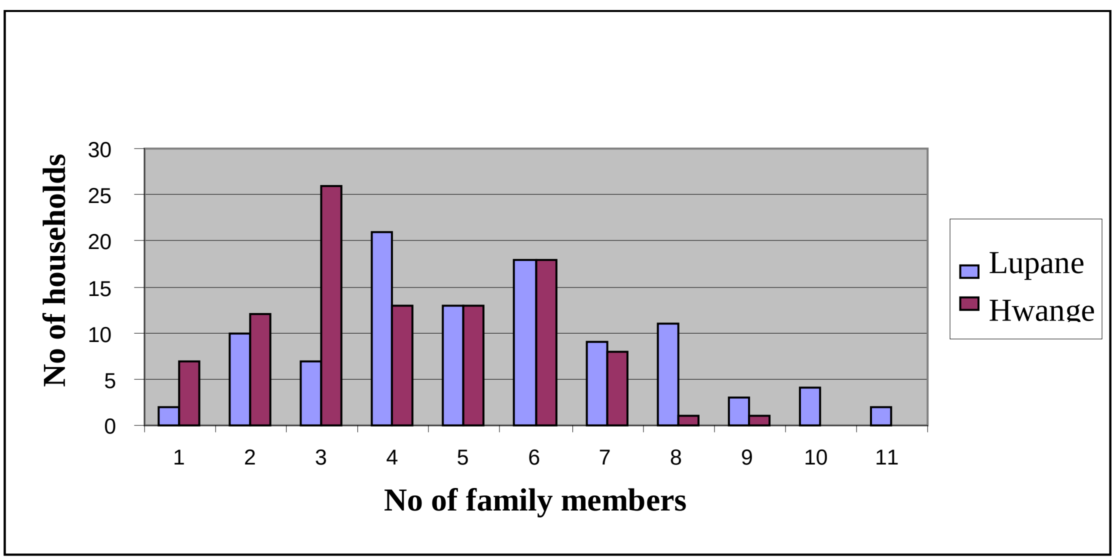

Figure 5.1: Household size

The mean household sizes for Lupane and Hwange areas are 5.4 and 4.2 respectively. Table 5.1 shows that the adult equivalents were found to be 4.7 and 4.1 for Lupane and Hwange respectively. The study revealed that household sizes were in the range of 1 and 11 for Lupane and 1 and 9 for Hwange people per household. It can be inferred that most of the households had enough labour to produce because the average household size was about 5 people per household. A larger family size also means that a variety of labour capacity is available in the form of young, middle aged and elderly members (Hayes *et al.*, 1997). Increasing family size tends to provide households with the required labour for agricultural production, while on the other hand larger families put pressure on consumption than the labour it contributes to agricultural production (Paddy, 2003).

5.2.4 Economically active population

In a rural subsistence economy or agriculture, the number of economically active population plays an important role in technology adoption. Studies by Ellis (2000), D'Hease and Kirsten (2003) indicated that a larger number of economically active population in a household generates a source of labour thus increasing the likelihood of adopting new technologies and this has a direct influence on household food security. Figure 5.2 illustrates the economically active groups in terms of household numbers in each homestead.

Households have been categorized according to the number of household members who are economically active and also participate in household activities which include agricultural production. The first category consists of households with 1 to 3 people, the second consists of 4 to 7 people and the final group consists of people who are more than 8 people who are economically active. Figure 5.2 illustrates that the majority of households have 1 to 3 and 4 to 7 people per household who are economically active and are able to assist in farm operations and other activities that can be of economic benefit to the households.

The reason for such low figures in the economically active people could be that people are migrating to urban areas and across the borders to seek employment while the rest of the family members remain behind to take care of the young and elderly people at home. Most of the family members could be migrating to South Africa, Botswana, Namibia and Mozambique to look for job opportunities. With the high unemployment rate in Zimbabwe, people are crossing borders so that they can be able to support relatives who will have remained behind.

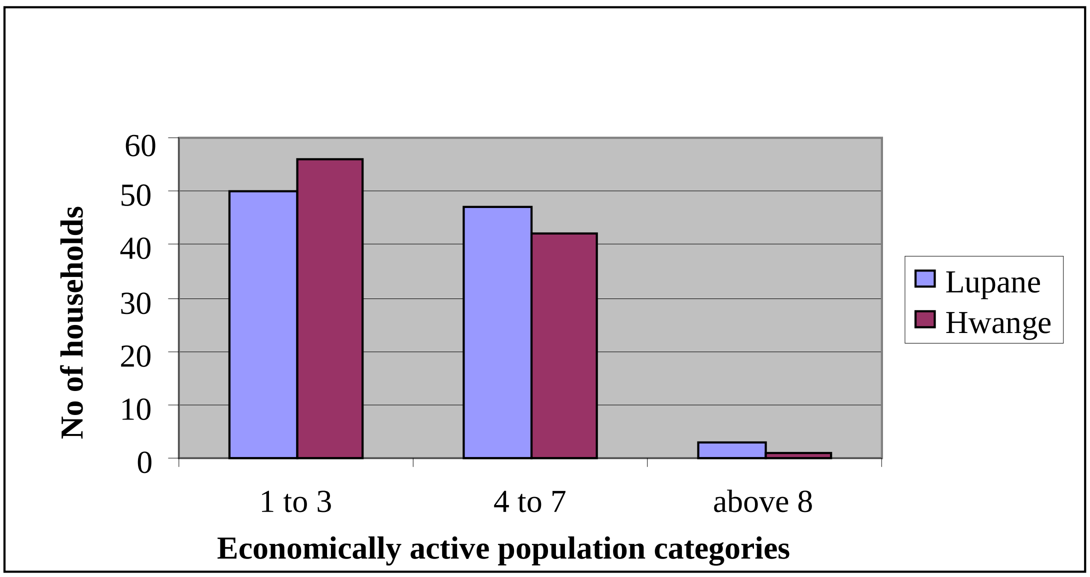

Figure 5.2: Economically active population

5.2.5 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. A study by Zenda (2002) revealed that married people are 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 have to do all the household activities as they do not have all the support unless from children who are old enough to do some household activities.

In both districts, most of the households constitute of married couples followed by widowed families, then divorced and single headed households. Sixty eighty percent of households in Lupane are married people, 25% are widowed, 5% are divorced household and 2% are single headed households. In Hwange, 65% of households heads are married, followed by 18% who are widowed, then 14% who are single and the 2% are widowed.

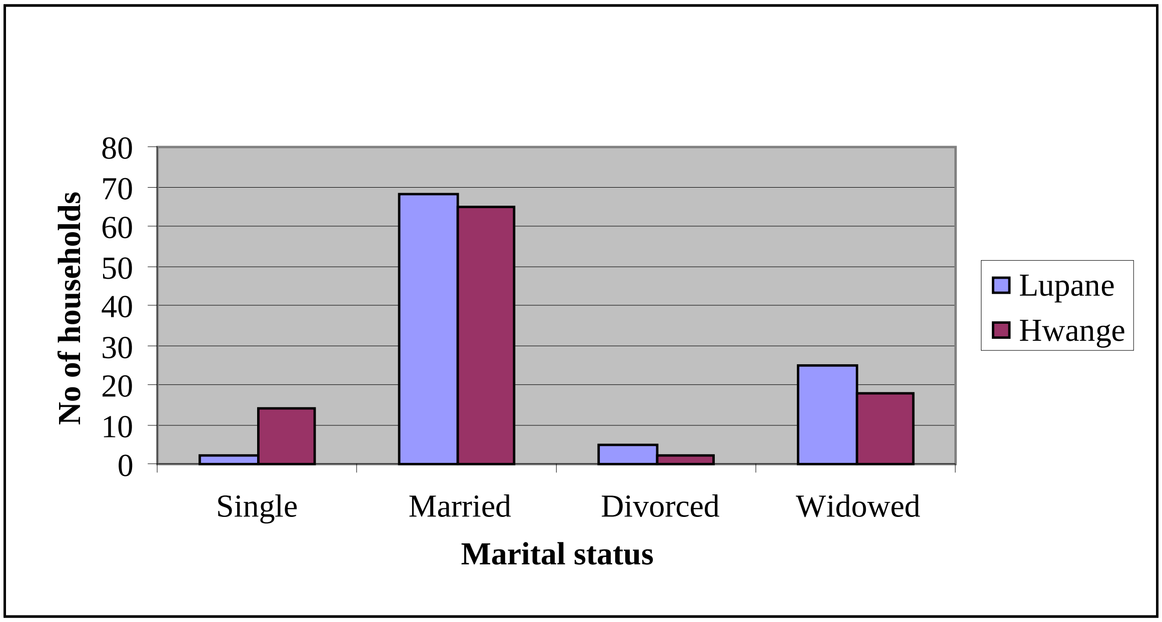

Figure 5.3: Marital status of households

5.2.6 Education Status of household head

The number of years spent in formal education is one of the important determinants of increased agricultural production. Education catalyses the process of information flow and leads the farmers to explore as wide as possible, the different pathways of getting information about agriculture and technology. Especially the use of modern technologies such as use of hybrid seeds, fertilizers and herbicides. The number of years spent in formal education is one of important determinants of adoption of new technologies (Ersado, 2001). Education catalyses the process of information flow and leads the farmer to explore as wide as possible, the different pathways of getting information about a technology. Bester *et al*, (1999) also noted 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 of farmers.

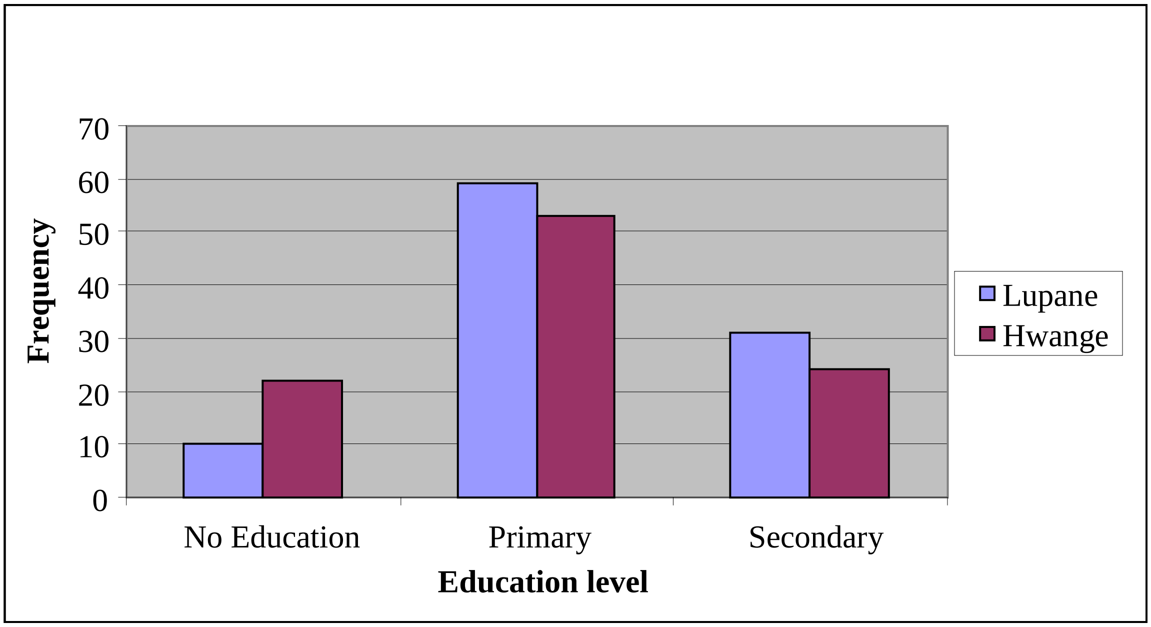

Figure 5.4: Education level of household head

Figure 5.4 shows that most of the households' heads attended school. The highest level of education attained by any of the farmers is primary and secondary education. None of the farmers interviewed attained tertiary education. The majority of household heads in Lupane and Hwange managed to attain primary education, followed by those that attained secondary education while the rest did not attain any formal education. It can be concluded that most farmers have had some formal education. This means they are able to understand information given to them especially that written in their own language.

5.2.7 Employment status of household head

Employment in off-farm and non-farm activities is important for diversification of sources of farm households' livelihoods (FAO, 1999). It enables households to modernize their production by giving them an opportunity to apply proper inputs and reduce the risk of food shortage during periods of drought. Diversification of income sources allows households to reduce the risk of chronic or transitory food insecurity (Devereux, 1993; Maxwell and Frankenburger, 1992).

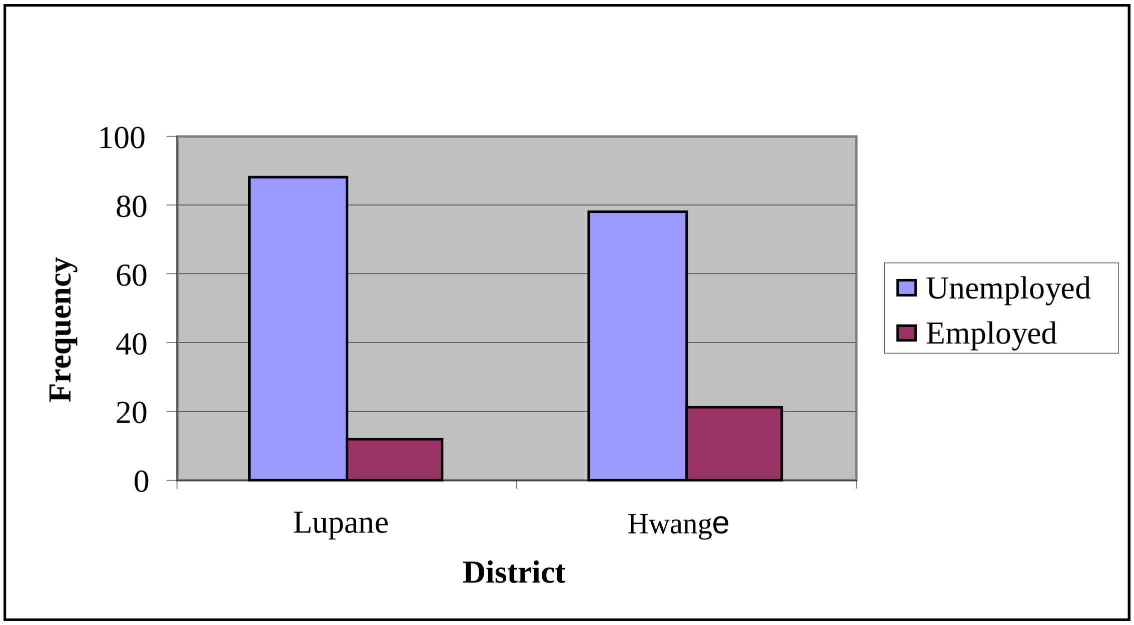

Figure 5.5: Employment status of household head

From figure 5.5 the study revealed that most of the household heads are not formally employed. Most of the household heads are dependent on agriculture for their survival means. In Lupane and Hwange, the percentages were 88 and 78 respectively of households' heads who are not formally employed and 12 and 22% are formally employed. Hwange has the highest number of people that are formally employed because the area is near a mining town. Off-farm employment allows farmers to invest in advanced agricultural technologies such as hybrid seeds, fertilizer and herbicides (Federizzi *et al.*, 2005). The majority of formally employed household heads are men working in urban centres and are more likely to purchase these inputs and buy food. Some family members are employed on farms, hotels, lodges or were either selling firewood, fish or crafts on the road sides linking major towns.

5.3 Farm characteristics of households

Farm size is the total farm land owned by the household measured in hectares. The size of the land in agriculture influences household food security in that larger the farm land the higher the production (Najafi, 2003). Table 5.2 shows that households under irrigation farming have an average farm size of 0.41 hectares while those farming on dryland have 4.57 hectares. Farm sizes for dryland farmers range from 0.1ha to 12ha while for irrigation farmers range from 0.1 to more than 0.5 hectares. Farm sizes for irrigation schemes are significantly small when compared to dryland farms.

Table 5.2 Farm characteristics of households

	Irrigation farming		Dryland farming	
Farm characteristics	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Land size	0.41	0.52	4.57	2.93
Family labour[5]	3.65	1.89	3.60	1.45
Cattle	6.10	5.01	4.51	5.34
Donkey	0.26	1.40	2.34	2.64

Table 5.2 shows that the average family labour for households is 3.65 for irrigation farmers and 3.60 for dryland farmers. The labour is from household members that participate in farm activities. Family labour for irrigation farmers is higher per hectare of cultivated land when compared to dryland farmers. The reason could be that irrigation

[5] Family labour refers to household members who assisted in all farming activities during the farming season.

farming requires a lot labour or family sizes for irrigation farmers are generally large as compared to dryland farmers.

Irrigation farmers own a lot of cattle as compared to dryland farmers. The mean number of cattle is 6.10 and 4.51 for irrigation and dryland farmers respectively. Cattle in communal areas are used for draught power and also as security. The level of one’s resources (cattle) is very essential to combat food shortages in periods of drought.

Some households use donkeys as means of draught power, but donkeys are regarded as inefficient and also do not contribute much to household income as compared to cattle. Table 5.2 shows that dryland farmers have more donkeys than irrigation farmers.

5.3.1 Asset ownership

According to the Figure 5.6 the majority of households have access to agricultural implements. The hoe and the axe is the most common implement and in most cases these were found to be the only agricultural implements in excess to household sizes meaning that these are cheaper than other implements used in communal areas. Farmers are still using the ox-drawn plough to till their land and the hoe is used to weed the crops. Few farmers in Lupane own cultivators. These assets are an investment by the farmers so that they can cultivate more land to meet their food requirements. Scotch carts are used to carry manure and produce to and from the fields respectively. They are also used to carry bags of maize to the grinding mills and seed from the Grain Marketing Board (GMB).

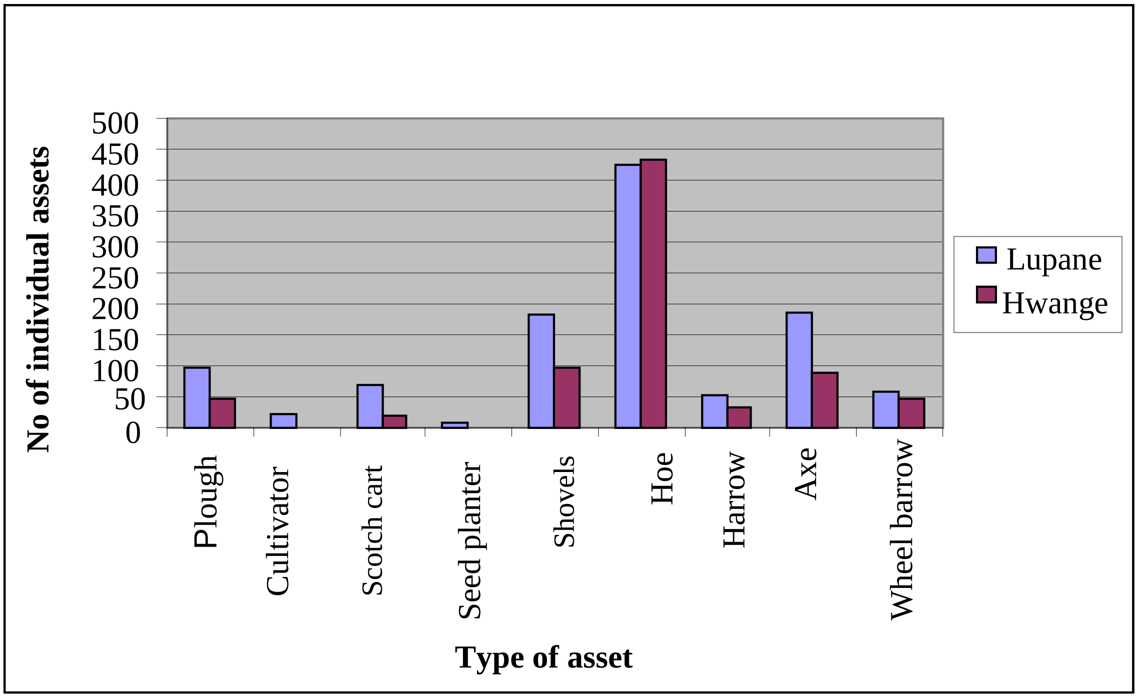

Figure 5.6: Asset ownership

5.3.2 Livestock ownership

The number of cattle kept by Lupane farmers is higher than those in Hwange district. Cattle in communal areas are kept for security reasons and are also used for carrying out farm activities in communal households. At times cattle are substituted by donkeys in providing draught power to communal farmers. Communal farmers prefer to keep cattle than donkeys because of the multi-purpose cattle have in communal areas (Mushunje, 2006)

Figure 5.7 shows that most households in the study sample have chickens and goats. This high number of chickens may be attributed to their easiness of up-keep and goats are small ruminants that can survive from eating low quality food. Thus, they can thrive in harsh conditions such as natural region IV and V. Guinea-fowl are wild birds that are tamed and used as white meat in communal households.

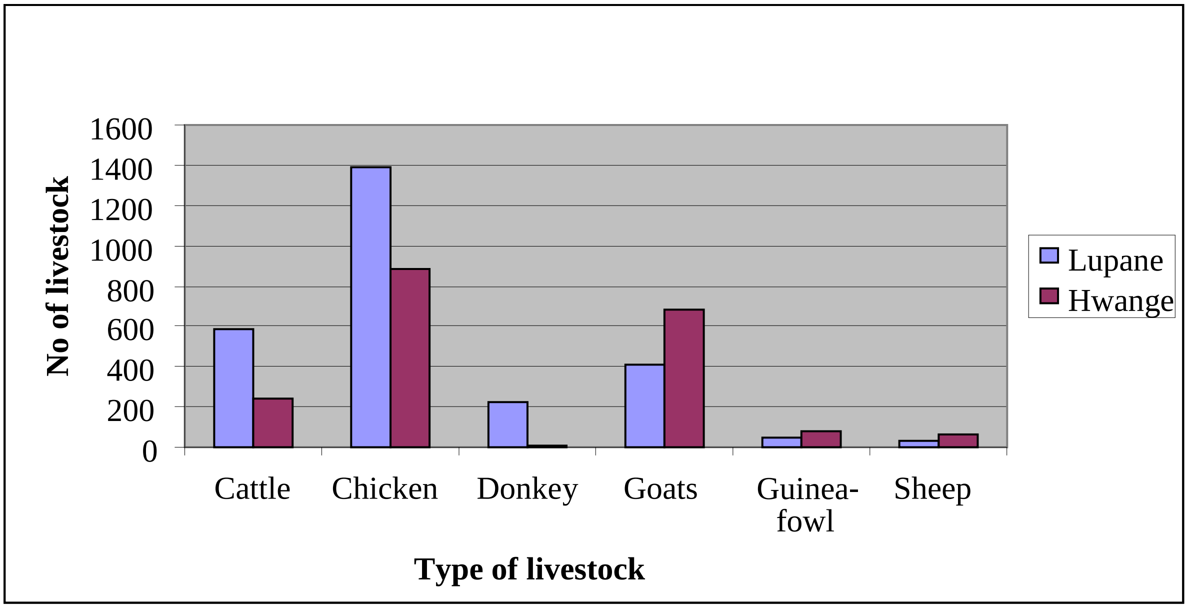

Figure 5.7: Livestock ownership

Small ruminants (sheep and goats) and cattle provide meat, milk, skins and manure. Cattle, goats, sheep and donkeys are regarded as a form of investment. Investments in these animals avoids loses due to increase in inflation rates found in unstable economies. Donkeys and cattle are used as production inputs (draught power). Sheep, goats, guinea-fowl and chicken can be sold quickly thus, they are used as a ready source of cash. In addition to being used as a ready source of cash guinea-fowl and chicken provide white meat to households. Cattle and 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 concomitantly increases household income and household food security. Households with livestock are in a better position to purchase supplement grain if the need arises compared to households without livestock.

5.3.3 Crops grown by households

Crops have been divided into those grown on irrigation and dryland farming. Those grown on dryland include sorghum, millet, maize, groundnuts and round nuts. Those that are grown on irrigation schemes include maize, wheat, tomatoes, onions, garlic, spinach, and rape. Table 5.3 shows that the majority of households in both areas grow maize. The percentage of farmers growing maize is high for both districts and the other cereals are very low. Maize is the most preferred because it is a staple food and is palatable.

Table 5.3 Percentage of households growing particular crops

	Lupane		Hwange	
Crops grown	**Dryland farming (N=50)**	**Irrigation farming (N=50)**	**Dryland farming (N=49)**	**Irrigation farming (N=50)**
Maize	99%	89.8%	98%	94.6%
Sorghum	46%	Not grown	58%	Not grown
Millet	23%	Not grown	36.4%	Not grown
Wheat	Not grown	89.3%	Not grown	Not grown
Groundnuts	46.9%	Not grown	23.6%	Not grown
Round nuts	40.2%	Not grown	48.7%	Not grown
Tomatoes	3.1%	92.5%	2.6%	96.4%
Onions	1.6%	63.9%	Not grown	73.5%
Garlic	Not grown	Not grown	Not grown	88.4%
Spinach, rape and cabbage[6]	5.6%	76.4%	2.3%	68.6%

Sorghum and millet is only grown by farmers practicing dryland farming because of the climatic conditions in the area. Forty-six percent of households in Lupane grew sorghum while 58% in Hwange grew millet on their farms in both areas. In Lupane, 23% of dryland farmers grew millet and in Hwange there were 36.4% that grew millet. Small grains (sorghum and millet) are able to survive under low rains in the area, thus dryland farmers have put part of their land to these crops. The study expected that many farmers

[6] Cabbage is grown by ARDA making it very competitive for the two irrigation schemes to grow the vegetable crop.

would grow these small grains in their fields since they can survive under such climatic conditions as compared to the maize crop.

This study also revealed that wheat is only grown at Lupane irrigation scheme during the winter season. The reason for this is Tshongokwe irrigation scheme is located near Agricultural Rural Development Authority (ARDA) which is a parastatal organization that gives advice to this irrigation scheme. Most of the farmers on the irrigation scheme grow wheat because it is a high income crop and they also get useful information from extension officers (AREX) and ARDA officers on how to grow the wheat crop. The income generated from wheat is basically used for household consumption and other needs that may arise, like school fees and medical expenses.

Table 5.3 shows that 92.5% of irrigation farmers in Lupane grow tomatoes and 63.9% grow onions while in Hwange 96.4% grow tomatoes and 73.5% grow onions on the irrigation schemes. Spinach and rape percentage is higher for irrigation farmers than dryland farmers. Most of these crops are sold locally, to hawkers and surrounding schools. Farmers on the irrigation schemes grow these crops because they mature quickly and can be harvested several times bringing in some income for the households. There are few dryland farmers who are into vegetable production. Those that are practicing it either have boreholes in their homesteads or are located along perennial rivers (Shangani River). The farmers growing vegetables constitute less than 5% for all crops grown under dryland farming. However, in Hwange garlic is the only high income crop that is grown and this crop brings in better income than the other crops to the farmers because it is highly demanded in supermarkets and hotels around Hwange. This crop was introduced to the farmers by a Non-Governmental Organizations (NGO) called Small Holder Support Program (SISP) and COSV an Italian non-governmental organization so that farmers could boost their household income. All other crops grown are used for household consumption. In times of bumper harvest, households sell surplus produce to increase income. Ground nuts and round nuts are the least crops grown by households in the study sample because the respondents had problems in accessing the seed which was also expensive to purchase.

5.3.4 Grain produced by farmers

Table 5.4 below shows the average yields produced by farmers from the two different groups. Yield in this study was calculated by dividing total household production (cereals) by the number of hectares that were planted with grain/cereal[7] crops.

Table 5.4 The mean maize productivity per hectare

	Lupane		Hwange	
Grain produced	**Dryland farmers (N=50)**	**Irrigation farmers (N=50)**	**Dryland farmers (N=49)**	**Irrigation farmers (N=50)**
Kilograms produced	75 680	64 130	38 975	33 950
No of hectares	257	24	202	25
Average Yield per hectare in (Kgs)	**294**	**2 672**	**193**	**1 358**

Irrigation schemes have higher yields compared to dry land farmers as shown in Table 5.4. High yields of maize are from the irrigation schemes because of the intensive cultivation done on the irrigation schemes. Dryland farmers have a low yields because they practice extensive agriculture which does not yield much. In Lupane, Tshongokwe irrigation scheme produced 2 672 kilograms of maize per hectare and Hwange, Lukosi irrigations produced about 1 358 kilograms per hectare. Dryland farmers in Lupane produced 294 kilograms on average per hectare while farmers in Hwange produce 193 kilograms of maize per hectare. When compared to Zimbabwe National Statistics (CSO, 2002) for the communal areas, these figures are low because yields in communal areas average around 702 kilograms per hectare. It is also important to note that this figure is for the whole country which includes yields from high potential areas (Natural region I, II and III) in communal areas of Zimbabwe. The reason Lupane dryland farmers

[7] Wheat, sorghum and millet were converted to maize equivalents to easily compare yields per hectare for dry land and irrigation farmers. See appendix 2.

have such high yields could be related to the size of their fields, as they are larger than those in Hwange as shown in Table 5.2 and also that their soils are of better quality as compared to Hwange district. A large proportion of the land owned by dryland farmers is allocated to maize but the maize yields are low. Those operating on the irrigation schemes benefit a lot from use of inorganic fertilizer and have enough water to support the crop until maturity.

5.4 Income sources for 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. Average total household income is an addition of off-farm income and on-farm income. On-farm income was divided into two categories i.e. income from sale of crops produced and income from sale of livestock. Off-farm income included income from salaries, remittances and pension funds. Table 5.5 below shows the different sources of income for the average households. Table 5.5 classifies the incomes according to the various income groups so that a comparison can be made between irrigation farmers and dryland farmers.

5.4.1 Income from grain crops

The dominant crops in the region in terms of production are maize, millet and sorghum. Wheat is winter crop that is only grown on irrigation schemes because of availability of water. Table 5.5 shows that 22% of the dryland farmers in Lupane received their income from cereals and in Hwange the figure was 17%. On the other hand, irrigation farmers in Lupane had an income of 24% while those in Hwange had 16.2% of their income coming from grain crops.

Table 5.5 Distribution of total household income by category of farmers (ZW$000 000 for the year 2006-2007)[8]

District	Lupane (N=100)				Hwange (N=99)			
Category	Dry land farming (N=50)		Irrigation farming (N=50)		Dry land Farming (N=49)		Irrigation farming (N=50)	
	Amount	(%)	Amount	(%)	Amount	(%)	Amount	(%)
Grain*	1.351	22	4.616	24	0.272	17	2.641	16.2
Vegetables	1.074	17	12.963	68	0.167	10	12.665	77.4
Livestock**	2.820	45	0.797	4.2	0.813	50	0.784	4.8
Total on- farm income	5.245	84	18.376	96.2	1.252	77	16.090	98.4
Remittances	0.325	5	0.385	2	0.175	11	0.065	0.4
Off-farm salaried labour	0.563	9	0.185	1	-	-	0.196	1.2
Casual labour	0.128	2	0.160	0.8	0.190	12	-	-
Total off-farm income	1.016	16	0.730	3.8	0.365	23	0.261	1.6
Total income	6.261	100	19.106	100	1.617	100	16.351	100
Average household income	0.126	-	0.382	-	0.033	-	0.327	-

Grain*- include maize, wheat, sorghum and millet.

Livestock**- include cattle, goats, chickens and guinea fowls.

Vegetable ***-include tomatoes, onions, spinach, rape etc.

[8] The 2006-2007 year had an inflation of about 1100%, the figures above are in Zimbabwean millions dollars.

Table 5.5 shows that irrigation farmers realize a higher income from grain sales than dryland farmers. The percentage income of grain crop was 24% and 16.2% for irrigation farmers for Lupane and Hwange respectively. The other reason for a higher percent for Lupane is the winter wheat which is grown on the irrigation scheme and that farmers get higher incomes from this crop as compared dryland farmers. The high figure for irrigation farmers is also a result of double cropping of maize on the irrigation schemes and that maize can be sold as green mealies. Irrigation farmers are unlikely to have maize shortages during the course of the year when compared to dryland farmers who grow their cereal crops in the summer season only. This makes it difficult for them because they can run out of the staple food.

5.4.2 Income from vegetables

Most of the vegetable produce was marketed at the farm gate (farmers sold their products directly to the customers). Farmers on both irrigation schemes 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 as shown in Table 5.5. In Lupane, irrigation farmers received 68% income from vegetables and in Hwange irrigation farmers it was 77.4%. Vegetable crops had a high income because of they are grown twice or more times per year and they mature quickly because of intensive cultivation practiced on the irrigation schemes. The vegetable income percentages for dryland farmers were low because very few farmers grow vegetables around their homesteads. Those that grow vegetables either have boreholes or are located along perennial rivers that constantly supply them with water to irrigate their vegetables. In Lupane, dryland farmers had 17% of their income coming from vegetables and in Hwange the income from vegetables was 10%.

Vegetables produced by dryland farmers are primarily for household consumption, unless the rains are adequate or the farmers have boreholes at their homesteads, that is when they sell surplus vegetables to locals around them. Table 5.5 shows that vegetables contribute a higher percentage of household income as compared to the other forms of incomes. The figures in Table 5.5 it can be inferred that irrigators have more disposable income than non-irrigators because vegetables contribute higher percent of total income realized by the farmers as they are popular source of income for daily household use.

5.4.3 Livestock income

In the calculation of income from livestock, sales during the course of the year were recorded. The high contribution of this source of income is a result of the drought that hit Lupane and Hwange during 2005-2006. Lupane and Hwange received about 46% and 50% of income from the sale of livestock. The 2005-2006 season was characterized by a long dry spell and farmers in region (Matabeleland North Province) were forced to sell some of their livestock to meet their food requirements.

Insight from analysis the shows that most of the income from livestock sales was from dryland farmers. Cattle were sold to purchase food, pay school fees and other household expenses. The high incomes were from dryland farmers in both areas as these had no other means of raising money to buy food or pay for household expenses. The other reason for high figure for livestock could be as a result of farmers who were accessing short-term loans from Agribank to buy and sell cattle. These farmers were making a living from buying and selling livestock to urban abattoirs. Table 5.5 shows that few farmers from the irrigation schemes sold their livestock. The livestock income was less than 5% for both areas.

5.4.4 Remittances

Remittances for dryland farmers in Hwange were the higher than that of Lupane. Hwange had 9% of income coming from remittances while Lupane had 6%. The reason for the high figure for Hwange is because Hwange is a mining area. Most of the family members are employed in the Hwange Colliery Mine. The mine workers have their communal areas located around Hwange and are able to send money to their families. After all members of households who are working in urban areas are expected to look after those who take care of family households in the communal areas. Although not expected to be large this is too low a percentage for both areas as the remittances are less than 10 percent. This result is surprisingly low and may indicate a level of poverty in urban areas such that people in urban areas contribute very little to the income of households in the communal areas (Mushunje, 2006).

Respondents in Lupane highlighted that most of their remittances come from relatives who are working in South Africa. The people living in South Africa (popularly known as injiva) send groceries and money so that households can meet their food needs. Other relatives are employed in Lupane town and have their communal areas around Lupane.

5.4.5 Off-farm income

Casual labour is another source of income in communal areas. Farmers receive income for working in other people fields or homesteads. Table 5.5 shows that most of people employed as casual labour are from dryland farming. Plot holders on the irrigation scheme would temporarily employ people to weed or harvest crops. In other instances, old aged irrigation plot holders would employ people to assist them with irrigation activities. These would be paid with produce from the irrigation scheme or income from crop sales. Other farmers would do “ilima” (exchange of labour) work in each other fields during periods of weeding.

Other family members are employed in game parks, lodges and rural shops. These jobs are usually temporary because of the nature of business. Lodges only operate during hunting seasons and these people are employed to put fire guards to reduce spread of veld fires and maybe cut fire wood to be used by tourists. Very few people are employed as skilled labour in these areas. It is not surprising to find that most of the smallholder farmers are poor. This is because the total household income is not the net household income (Mushunje, 2005). From this income farmers derive their subsistence money, money for agricultural inputs, school fees and to pay casual labour.

5.5 Marketing of agricultural produce from the irrigation

The key constraints that block the expansion of rural agricultural production has been an important 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 often been indicated that producers themselves most commonly cite finance as the main problem that they face and agricultural inputs as the second problem.

5.5.1 Marketing system

Both irrigation schemes did not have an organized marketing system for the produce. Transport availability was the major problem they faced in getting their produce to more distant and profitable markets. Most of their produce would go bad soon after harvesting because they did not have storage facilities to keep the produce fresh. About 45% of farmers sold their produce to hawkers as shown in Table 5.6. Most of the produce came from irrigation farmers and very few dryland farmers highlighted that they sell any of the crops. The reason for selling to hawkers is because of the reduced transport cost that they would incur if they were to sell on distant markets such as Hwange, Lupane and Victoria Falls. Hawkers came with their private transport to purchase vegetables from the irrigation schemes and would take these to urban areas where they would sell the crops at a higher price.

Table 5.6 Market channels used by farmers

Category	Percentage of respondents
Hawkers	45
Local people	27
GMB	16
Shops/schools	9
Did not sell	3

The respondents also stated that they sell to the Grain Marketing Board (GMB) (products like maize and wheat) because of the government regulation and also that the GMB was close by and farmers could transport the grain using their ox-drawn carts. The other reason for selling to GMB was because the farmers had received loans from Agribank under a contract to market the produce through the GMB.

Table 5.6 shows that 9% of the farmers stated that they sell to schools and shops around. Rural traders (shop owners) and schools would come with their transport to purchase tomatoes and green vegetables from the irrigation schemes. This was especially for Lupane irrigation farmers who are surrounded by boarding schools who came to purchase vegetables. Local villagers and teachers also came to purchase vegetables from the both irrigation schemes. Three percent of the farmers mentioned that they did not sell any of their produce.

5.5.2 Marketing problems faced by farmers

The majority of the farmers stated that they had marketing problems especially vegetables because these are highly perishable. Eighty-seven percent of the farmers had problems with vegetables such as tomatoes and leafy vegetables easily got perished due to the unavailability of suitable storage facilities and a good market.

Table 5.7 Marketing problems

Category	Number of respondents (%)
Storage facilities	87
Transport	68
Sourcing inputs	38
No market around	93
Market information	46
No marketing problems	53

Sixty-eight percent of the farmers had difficulty in getting transport to market their produce and these stated that they felt that they were being exploited by hawkers and people with their own private transport as shown in Table 5.7. Farmers said they experienced problems of sourcing inputs such as hybrid seeds, fertilizers and some had problems with accessing market information especially prices of their produce. Ninety-three percent of the farmers said they failed to secure proper markets around their irrigation schemes. This was especially for Tshongokwe irrigation farmers because they were competing with the ARDA estate which was producing the same crops as them. Table 5.7 shows that 53% of the respondents said they did not experience marketing problems. The reason for not having marketing problems is because their produce was either small to be marketed or it was basically for household consumption. A small percentage of irrigation farmers said they sold their produce on credit to avoid losses to hawkers and also did not want to lose their crops from getting rotten.

Some farmers sell their produce to roadside markets on heavily travelled roads or major roads that connect cities. Farmers in Tshongokwe irrigation (Lupane) had to travel 12 km while farmers from Lukosi irrigation (Hwange) had to travel 3 km.

5.6 Insights from the analysis

From the results obtained, it can be shown that irrigation farmers realize high incomes from the crops they grow and are relatively more food secure than dry land farmers. Most of the income comes from vegetables that are grown. Vegetables and cereals contribute the largest percentage of income compared to other crops and off-farm incomes. Communal farmers receive less income from off-farm activities because few people are employed and they receive fewer remittances from their urban relatives.

As was highlighted in Table 5.6 vegetables contribute about 73% of total income, followed by cereals with 20% income as compared to 18% dryland farming. Livestock incomes are higher for dryland farmers as compared to irrigation farmers. The reason is that dryland farmers need alternative sources of income to reduce food shocks and have to rely on livestock.

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

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

5.7 Conclusion

From the results it can be implied that irrigation schemes play a significant role in enhancing food security of households in communal areas. The income from irrigation farmers is relatively greater as compared to dryland farmers. The analysis from this study 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 can be harvested several times making it possible to get a continuous flow of income.

Access to water for irrigation purposes has shown that it can put disadvantaged farmers to a better position. Considering the fact that 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.

This 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 for irrigation farmers who produce perishable products.

CHAPTER 6

EMPIRICAL RESULTS

6. 1 Introduction

The chapter explains the results of the logistic regression, probabilities and partial effects results of the logistic regression in trying to identify the main determinants of household food security in communal areas of Lupane and Hwange districts of Zimbabwe. This chapter also attempts to answer the hypotheses stated in chapter one of the study.

6.2 Descriptive characteristics of the study

Table 6.1 compares irrigation and dryland farmers in terms of their household food security status. Selected parameters are presented to show the percentages of households that are food secure and those that are food insecure relative to the type of farming practiced. Using the formula explained in Chapter 4, to determine which households are more food secure than the others. The analysis revealed that of the 199 observed households in Lupane and Hwange, 120 households are food secure (60.3%) and 79 (39.7%) are food insecure. The study shows that most households interviewed are headed by males (58%) as compared to female heads (42%). The proportion of food secure households is higher for male headed than female headed households.

6.2.1 Irrigation

Based on the analysis, 41.2% of food secure households are irrigation farmers while 19.1% are food insecure households on dryland farming. However, households that are on the irrigation schemes and food insecure are 9% while 30.7% are households that are food insecure and on dryland farming.

6.2.2 Household size

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 as shown in Table 6.1. Households that are big have more people to feed than small households and this agrees with Paddy (2003).

Table 6.1 Descriptive results of the study

		Food secure		Food insecure	
Variable	**N**	**Irrigation farming**	**Dryland farming**	**Irrigation farming**	**Dryland farming**
Gender of Household head					
Male	116	5.7%	18.1%	4.3%	31.9%
Female	83	34.9%	20.5%	15.7%	28.9%
Average Household size	199	4.03	4.18	4.64	5.25
Average farm size (Ha)	199	0.37	4.17	0.39	5.58
Average cattle ownership	199	6.78	6.25	3.59	3.19
Per capita aggregate production [9](kg)	199	227.3	192.7	116.5	87.3
Irrigation					
Yes	100	89%	-	11%	-
No	99	-	29.3%	-	70.7%
Fertilizer application					
Yes	129	75.9%	13.2%	1.6%	9.3%
No	70	-	40%	-	60 %
Access to off-farm work					
Yes	33	27.3%	48.5%	-	24.2%
No	166	33.7%	22.3%	1.2%	42.8%
Access to the nearest market (km)	199	6.5	14.3	-	-
Food security	199	41.2%	19.1%	9.0%	30.7%

[9] Per capita aggregate production consists of total maize output for dryland farmers and for irrigation farmers all other crops were converted to maize equivalents so that a comparison could be done between the irrigation and non-irrigation farmers.

6.2.3 Land size

The average farm size for food secure households is 0.37 ha for those on the irrigation schemes while that of food secure dryland farmers 4.17 ha. It is important to note that irrigation farmers have other pieces of land beside the plots on the irrigation scheme and also that not all of them plough the 0.37 ha of the irrigation plots. Some irrigation farmers are constrained by production factors such as labour, fertilizer and seeds. For this study, the dryland has been excluded from this analysis so that a better comparison can be made between irrigation and non-irrigation farming. Households that are food insecure have an average of 0.37 ha of land on the irrigation schemes while dry land farmers have 5.58 ha of land. For dryland farmers this contradicts with Estudillo *et al* (2006) findings, in that as farm sizes increase households tend to be more food secure as they are able to get better yields from their fields in the absence of major technological advancement that further increases yield. For irrigation farmers it could be that they lack management skills or do not have access to some inputs required on the irrigation schemes.

6.2.4 Cattle ownership

Table 6.1 confirms that the more cattle a farmer has the more food secure the household. The average number of cattle owned by irrigation farmers is 6.78 cattle while those on the dryland farming have 6.25 cattle. Food insecure households on irrigation schemes have 3.59 cattle while dryland insecure households have 3.19. The high figure for cattle among irrigation farmers could be a result of investment from the incomes they realize after crop sales. Farmers with more cattle are able to carry out their farm operations on time and also cattle can be used to withstand abrupt changes in production in periods of drought as these can be sold to purchase food and meet other household expenses such as school fees and medical expenses.

6.2.5 Per capita aggregate production

Per capita aggregate production is higher for irrigation farmers having 227.85 kg of maize crop while dryland households have 192.7 kg. Food insecure households have per capita aggregate production 116.5 kg for irrigation farmers and 87.3 kg for dryland farmers. From the above analysis in Table 6.1, per capita aggregate production is higher for farmers on irrigation schemes than those on dryland. This could be due to the high intensive crop production practiced on irrigation schemes and also that irrigation farmers have access to water and fertilizer that increase their productivity.

6.2.5 Fertilizer application

A total number of 129 farmers applied fertilizer on fields. Of these who applied fertilizer, 75.9% are irrigation farmers and 13.2% are dryland farmers who were found to be food secure. Households that applied fertilizer and were food insecure were 1.6% for the irrigation farmers and 9.3% for dryland farmers. Forty percent of dryland farmers who did not apply fertilizer were food secure and 60% were food insecure. Thus, the study reveals that most of the farmers who applied fertilizers in their fields were more food secure than those who did not apply fertilizer. This confirms studies carried out by Rutsch (2003) and Smith and Huang (2000).

6.2.6 Off-farm work

Most of the people in the study sample had no access to off-farm work. From 199 households sampled, 33 household heads had formal employment while the rest of the households did not. Seventy-six percent of those who had off-farm employment were food secure while 24% were food insecure households with household members formally employed.

6.2.7 Market access by farmers

The shortest distance to the market was used in this study to determine how often the farmers visited the market to sell their produce. The study revealed that the shortest distance to the market was 6.5 km for irrigation farmers and about 14.3 km for dryland farmers. Those who did not market their crop either produced only enough for household consumption or sold at the farm gate. For this study distance was used because of fuel shortages and unavailability of transport in communal areas in marketing crops.

6.3 Parameter estimates of determinants of food security

Six variables were found to have a significant impact in determining household food security (Table 6.2). These were irrigation, household size, farm size, per capita aggregate production, cattle ownership and fertilizer use. The data set was combined for both irrigation and dryland farmers to investigate which determinants had a significant impact on household food security. 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 in their signs. The results of the combined model (irrigation and dryland farmers) are shown in the Table 6.2.

Table 6.2 Parameter estimates of the determinants of food security

Variable	Coefficient	Std error	Wald statistic	Significance level
Constant	-3.908	2.198	2.759	0.0026
Household size	-0.8061	4.4818	3.8606	0.0494*
Farm size	-1.3399	0.4853	7.6208	0.0058**
Cattle ownership	0.1900	0.0883	4.6315	0.0314**
Irrigation	0.9127	0.5364	2.8953	0.0023***
Fertilizer application	0.0318	0.2344	0.0185	0.0283**
Per capita aggregate production	0.0185	0.00845	4.8113	<.0001***

Note: *statistically significant 10% level, **statistically significant 5% level,
***statistically significant 1% level, Number of observations =199
Restricted log likelihood value [Log (L_0)] = 67
Unrestricted log likelihood value [Log (L_0)] = -153
Log likelihood value ($\chi^2_{(df=6)}$) = -2[Log (L_0)-log (- (L_1))] = 92

Based on the results in Table 6.2, most of the variables had a positive and significant impact on household food security while household size and farm size had a negative and had significant impact on household food security. The expected signs were irrigation (+), fertilizer application (+), cattle ownership (+), per capita aggregate production (+), farm size (+) and household size (-). From the analysis, irrigation, fertilizer application, cattle ownership and per capita aggregate production were found to have a positive relationship to the probability of household being food secure, meaning that the likelihood of food security increases when farmers have cattle, use fertilizer, have increased agricultural output and have access to a piece of land on the irrigation scheme.

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 secure decreases with an increase in household size and land size. The results are discussed in detail in the following section.

6.3.1 Household size

Household size has a negative and significant effect on the probability of food security (10% significance level). An increase in household size would mean more people to feed and with the low outputs produced in the fields, thus food availability 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 secure. Household size as a determinant of food security agrees with Paddy (2003) in that as a household becomes larger food insecurity is increased. Although it is expected that an increases in household size increases the labour requirements, Frankenberger (2002) and Flores (2004) findings showed that households with more people exert more pressure on food than the labour it contributes to agricultural production.

6.3.2 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 result presented in Table 6.2 gives an inverse relationship between farm size and food security. The results show a negative and significant relationship between farm size and food security. Farm size was significant at 5% level meaning that the smaller the size of the land, the more food secure the households. Thus, this result is not supported by the hypotheses that food security increases with an increase in the area under cultivation. The negative sign could be due to other factors such as fertilizer application, labour, water availability and cattle ownership.

There could also be a possibility of other variables influencing each other (multicollinearity), thus giving a negative and significant sign.

Due to the frequent droughts in Hwange and Lupane, farmers tend to be reluctant to increase their farm sizes as their outputs are low and also that they are limited with resources such as labour, fertilizers and seeds they would prefer to plough smaller pieces of land than bigger pieces of land. The results shown in Table 6.2 contradict researchers like Eswaran and Kotwal (1986) who found that crop outputs could increase if farm sizes were relatively increased in small farms. While this may be the case, other researchers such as (Cornia, 1985; van Zyl *et al*., 1995) who are involved in this debate believe that there is an inverse relationship between land size and aggregate land productivity. Dorward (1999:153) also came up with the same findings in that "if smaller farms are more productive, a transfer of a hectare of land from a larger farm to a small farm would increase aggregate land productivity". Therefore in this study the hypothesis that says an increase in land size increases household food security is rejected.

6.3.3 Cattle ownership

Livestock ownership was found to have a significant and positive relationship with household food security (5% significance level). In communal areas, cattle can be used to execute farm operations on time such as ploughing and applying manure to fields. Farmers with more cattle can rent out cattle to their neighbours in peak periods of cultivation in communal areas to get some extra cash. Govereh and Jayne (1999) had similar findings that cattle are used as traction power which enables households to cultivate larger pieces of land and to execute agricultural operations timely. Cattle can also be sold in times of drought to mitigate household food insecurity. Thus, an increase in cattle ownership, calculated at average cattle owned by households increases the probability of household food security

6.3.4 Irrigation

Irrigation was found to be significant at 1% level meaning that irrigation plays a major role in enhancing food security in communal areas. 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 that households achieve food security. Irrigation promotes crop production throughout the whole year and also crop diversification because of the availability of water. However, realizing the potential requires not only a good irrigation (water) supply but also a range of complementary agricultural and institutional support (for example, improved agricultural research and extension). Despite the huge investments, the performance of some small-scale irrigation schemes has been poor and the goal of achieving food security has not been realized (Bembridge, 2000). Also with irrigation schemes, there a tendency to produce cash crops and these are sold so that they can generate income for the households.

6.3.5 Fertilizer application

The use of fertilizer by the farmers was found to have a positive and significant impact on household food security. Fertilizer use by farmers increases the probability of food security in communal areas. In other words, it can be inferred that fertilizer users are more likely to be food secure than non-users. Application of fertilizer by farmers means an improvement in the soil quality and hence better produce for the farmers. The study revealed that farmers who applied fertilizer were those mostly farming on the irrigation schemes because the soils easily get depleted of nutrients from leaching. Soils on the irrigation schemes require a constant supply of fertilizer to replenish some nutrients such as nitrogen, phosphorus and potassium which are required by crops. There were few dryland farmers who applied fertilizer in their fields, the reason for this is because they had this belief that fertilizer burns the crops while in actual fact crops got burnt from insufficient water.

6.3.6 Per capita aggregate production

A positive and significant (1% significance level) relationship between per capita aggregate production and food security was observed from the results presented in Table 6.2. A positive change in aggregate production calculated from own cereal production results in an increase in the probability of household food security. The positive relationship is explained through the high outputs produced 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 production was calculated by converting output for all cereals into maize equivalents units and for irrigation farmers it was calculated by converting vegetables into maize equivalent units.

6.4 Partial Effects on selected continuous variables of the logistic model

Partial effects were carried out on continuous variables to assess the marginal effect of a unit change in any of the variables that were found to be statistically significant on household food security in the logistic model. The partial effects were calculated from the logistic regression to show the effect of change in an individual variable on the probability of food security when all other exogenous variables are held constant. The results of "partial" effects are shown in Table 6.3.

Table 6.3 Partial effects for continuous variables

Variable	Partial effect
Farm size	-0.063
Household size	-0.041
Cattle ownership	0.037
Per capita aggregate production	0.001

Note: The "partial" effects of the continuous variables on household food security are calculated using equation (7) in chapter 4, $\frac{\partial \phi_i}{\partial \phi_{ij}} = \phi_i(1-\phi_i)\beta_j$.

6.4.1 Farm size

The partial effect of a unit increase in farm size is -0.063, meaning that the probability of a household being food secure increases when the farm size is reduced. In other words for a household to increase the probability of food security it needs to reduce its farm size to increase the probability of household food security by 6.3%. Since farmers have limited resources in communal areas, reducing the area planted could mean that all the available resources are channelled to a smaller piece of land and are used efficiently.

6.4.2 Household size

Household size has a negative and significant effect on the probability of food security. The partial effect is -0.041 meaning that as family size increases, food security status of the household decreases. Each additional member in the family reduces the probability of food security by 4% because the bigger the household size the higher the pressure on available resources.

6.4.3 Cattle ownership

Cattle ownership is another variable that was found to have a positive and significant relationship to food security. An increase in the number of cattle or livestock by 1livestock unit means that the probabilities of a household being food secure increases by 4%. The more cattle a farmer has the higher the probability of household food security.

6.4.4 Per capita aggregate production

Per capita aggregate production is positively and significantly related to the probability of household food security. A unit change in per capita aggregate production results in a 0.1% increase in probability of household food security which is a very small change.

6.5 Change in probabilities for discrete variables of the logistic regression

The change in probabilities of household food security due to the change in the significant discrete explanatory variables was calculated by taking the difference of the mean probabilities estimated for the respective discrete variables $\chi_i = 0$ and $\chi_i = 1$.

Table 6.4 Change in probabilities for irrigation and fertilizer use

Variable	Probabilities	Change in probabilities
Irrigation		
Non-plot holder	0.32	0.35
Plot holder	0.67	
Fertilizer application		
Non-users	0.29	0.19
Users	0.48	

6.5.1 Irrigation

A unit increase in use of irrigation defined as a shift from 0.32 for non-plot holders ($\chi_i = 0$) to 0.67 for plot holders ($\chi_i = 1$) increases the probability of food security by 35% as shown in Table 6.4. According to the results in Table 6.4, having access to irrigation or being a plot holder increases the probability of household food security by 35%. The effect of such a technology can be explained in two ways. One is that the adoption of irrigation improves the yields for farmers from improved agronomic practices and availability of water throughout the year. The second reason is the income effect, a farmer on the irrigation scheme is better off than a dryland farmer in that income generated from the irrigation scheme is higher than the income from dryland farming. The above result shows the significance of smallholder irrigation schemes in enhancing household food security.

6.5.2 Fertilizer application

Use of fertilizer by the farmers was found to have a significant impact on household food security as shown in Table 6.4. A shift from non-users of fertilizer to users of fertilizer from 0.29 ($\chi_i = 0$) to 0.48 ($\chi_i = 1$) increases the probability of household food security by 18%. The application of fertilizer improves the mineral content of the soil, thus crop yields are increased. A unit increase in fertilizer use by the farmers improves their household food security. Application of fertilizer restores the nutrients required by the crops. Dryland farmers who are risk averse can also be food secure from its use especially when the rains are adequate for crop production. Irrigation and fertilizer seem to have proved that a change can occur if farmers can adopt these technologies and move away from primitive farming methods which bring about low yields when compared to irrigation farming.

6.6 Insight from the analysis

Table 6.1 shows that 60.3% of the households are food secure and about 39.7% are food insecure. Food security of households is also dependent on other factors which include farm size, household size, per capita aggregate production, use of fertilizer and cattle ownership by farmers. An increase of the following variables: irrigation, fertilizer use, per capita aggregate production and cattle ownership and a decrease in land size and household size increases the probability of food security. Household size and land size are inversely related to household food security in the study area.

From results shown in Table 6.3 all the continuous variables showed that a small change in their probability has an impact on food security. For the discrete variables changes in probabilities were calculated to assess the effect of change on the probability of household food security. Irrigation and fertilizer use by the farmers were found to have a significant effect on household food security.

6.7 Conclusion

Based on the descriptive and empirical results of the logistic regression, magnitude of conditional probabilities and the "partial" effects of the continuous variables on food security, it can be concluded that irrigation, household size, land size, fertilizer use and per capita aggregate production play a major role in addressing household food security. The analysis shows that irrigation plays a significant role in enhancing from food security through high yields as shown in Table 6.1 and also from logistic regression model where the size of the land proves that farmers on irrigation are more food secure than those who farm on large pieces of land (dryland farmers).

Partial effects were carried out on continuous variable to investigate the change in magnitude on the probability of households being food secure. All the independent variables had significant results and all showed that any change in probabilities had a significant impact on household food security. All the variables had the expected signs except land size.

Change in probabilities also showed the significance of adoption of irrigation and fertilizer use by farmers in addressing food security. The probabilities taken from the logistic regression prove that a shift from dryland farming to irrigation would improve the output of farmers and also the use of fertilizer by farmers would increase their yields as compared to dryland farmers.

The other interesting aspect from the analysis was the size of the land which had an inverse relationship to food security. The analysis showed that farmers with smaller pieces of land are food secure as compared to those with larger pieces of land. This could mean that with the limited resources available farmers could cultivate smaller piece of land and channel all the resources to get better produce than cultivate a larger piece of land.

CHAPTER 7

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

7. 1 Summary and conclusions

This chapter provides the conclusions and recommendations drawn from the data analyzed on how agricultural production could be improved in enhancing communal farmers to meet household food security. The chapter looks at the aims of the study that were stated in the introductory chapter (Chapter 1), so that conclusions and recommendations can be drawn.

7.2 Aims of the study

The purpose of this study was to investigate the determinants of household food security among irrigator and non-irrigator farmers in the semi-arid areas of Zimbabwe. The objective of the study was to establish which determinants played a major role in addressing household food security in communal areas. Other factors were also put into account in trying to explain which factors are significant in enhancing household food security.

7.3 Socio-economic description of farm households

The average family size is relatively high for food insecure households as compared to the food secure households. Large households have more people to feed as compared to small households thus, reducing the calorie intake per household member increasing the food insecurity in those households.

Most of the farmers from this study received formal schooling (both primary and secondary) education which means that most of the farmers in the study population are literate. This aspect is very important because it determines the level the farmers can take up new technologies and information from extension officers and media to do with agricultural production. A small proportion of the farmers did not attend any formal education as show in Table 5.1. This study revealed that there are very few household heads that are formally employed and these constitute 16.6%. Formal employment assists farmers in purchasing agricultural inputs. Usually inputs from GMB take a longer time to get to the farmers, those with family members employed are able to get these inputs and are able meet crop planting dates. Formal employment also contributes to household food security in terms food purchases and other household requirements.

Communal farmers have small farm sizes ranging between 0.1 and 15 ha. Irrigation farmers have smaller plots ranging between 0.1 and 0.4 ha and dryland farms average between 3 and 5 hectares for those with adequate implements. The size of land normally determines if a household achieves food security or not. The study revealed that farmers with small pieces of land are more food secure than those with larger farms. Those with access to agricultural inputs are able to use intensive methods of production and thus realize better crop produce than those who practice extensive production methods.

The analysis revealed that irrigation farmers realize higher incomes as compared to the dryland farmers mainly from vegetables, followed by wheat and garlic. Vegetables bring a lot of income because they can be grown and harvested several times per year bringing in income more consistently as compared to cereals that are grown once per year. Wheat and garlic are high value crops that also brought better incomes for the farmers as compared to the other crops. Lupane irrigation farmers were mainly wheat production while Hwange irrigation farmers growing garlic on their plots. The reason for growing garlic is that it is highly demanded in hotels, restaurants, supermarkets and pharmaceutical industries because it is used to make drugs and prepare meals.

As far as household income is concerned irrigation farming proved to contribute a larger percentage of income to smallholder farmers in the semi-arid areas as compared to dryland farmers. The income from vegetables accounted for about 73% on average and cereals about 20% for irrigation farmers. While for dryland farmers income for vegetables accounted for 14% and cereals for 18%. Thus, any programme that intends to improve incomes for households in communal areas and reduce food insecurity or alleviate rural poverty it should seriously take irrigation farming into consideration.

7.4 Determinants of household food security

The results presented in Chapter 6 show that having access to irrigation by communal farmers has a positive and significant effect on household food security. Farmers who are on irrigation schemes are more likely to be food secure than dryland farmers. Thus, the hypothesis “Irrigation farming in communal areas enhances household food security” in the introductory chapter is accepted. Access to irrigation does not only increase crop production but also increases incomes that can be used on non-farm goods and services. An increase in income supports the first hypothesis stated in Chapter 1. Although this study was based on the production of staple crops (maize, millet and sorghum), food security encompasses nutritional quality which can also be found in vegetable crops grown on the irrigation schemes. The probability 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 (2200 kcal) 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 a higher output are able to feed their families as compared to those who have a lower output or lower per capita aggregate production. It can be inferred that households with higher crop outputs have also better incomes than those with low output. Thus, the hypotheses that food security increases with an increase in income is supported as excess crops are sold to bring income.

A positive and significant relationship between land size and food security was anticipated but based on the results of the logistic regression in Table 6.2, land size was found to have a negative and significant relationship to household food security. This result is surprising because other studies that have been conducted in Ethiopia (Kidane *et al.*, 2005) and Nigeria (Babatunde *et al.*, 2007) showed that land size is positively and significantly related to household food security from the expansion of areas under cultivation, especially under subsistence agriculture. Because of this negative sign, the second hypothesis is rejected because it does not support the stated hypothesis in Chapter 1. Hence, land size is a major factor in agricultural production in communal areas.

The possible explanation could be that farmers operating on small pieces of land are efficient and can fully utilize their resources. Communal farmers are also considered to be resource poor or are constrained by resources (agricultural inputs) in communal areas of Zimbabwe, which means that with the limited resources farmers can allocate these few resources to smaller pieces of land. Although it can not be concluded that small farms are important in ensuring household food security the other reason could be the presence of irrigation schemes and other support services from Government, NGO's and Private parastatals. The intensive nature of cultivation on irrigation schemes contributes more to household food security and increased incomes than dryland farming. The application of fertilizer improves the nutrient content of the soil and this increases crop yields. It can be inferred that the probability of food security increases with the application of fertilizer. Fertilizer is essential for both irrigation and dryland farmers because the soils in these areas are of poor quality and require a constant supply of fertilizer to be able to get better yields.

Cattle in communal areas play an important role in terms of draught power and also as wealth. Farmers keep their money in the form of cattle, cattle in communal areas are considered as an investment because money can be eroded quickly by inflation, as is the case in Zimbabwe. The other advantage of keeping cattle is because they can be sold when the need arises in situation such as funerals, school fees and other household needs.

7.5 Policy implications

Based on the results from the study, access to irrigation by communal farmers has shown that it can enhance food security at household level. With increased agricultural production from irrigation schemes, food security can be achieved both at household and national level provided the farmers get the necessary support from government, Non-governmental organizations (NGOs), farmer support groups and parastatals. The kind of support that the farmers will need includes information, 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 run. Such conditions can encourage farmers to produce more and sell surplus production to the GMB and other profitable markets. An intervention such as irrigation can bring about employment to surrounding people (locals), increase household incomes, reduce rural to urban migration, reduce the level of malnutrition, increase per capita aggregate production and also promote crop diversification (crops that cannot be grown under dry land conditions such as wheat and barley).

Government, private companies, parastatals and Non-Governmental Organizations (NGOs) should refocus their idea of giving food handouts in communal areas because these create a dependency syndrome and farmers become lazy to produce their own food. The above mentioned institutions can provide support through the establishment of more irrigation schemes or projects that can assist farmers to produce their own food and be food secure. These institutions can assist the farmers by introducing them to water harvesting tanks or water conservation methods or even try to get them into non-farm income generating projects so that they can be able to produce their own food and be food secure.

Policy makers need to promote irrigation development in the semi-arid areas and also in areas where it rains sufficiently, so that farmers can still irrigate an extra crop, produce fruits and vegetables or cultivate rice which uses a lot of water. Agricultural specialists say that future increases in developing countries' food production may come largely from irrigated areas.

Household that are big consume more food than small families, as such household grain requirement (consumption) increases. This is shown by a negative relationship between household size and food security results in the logistic regression model. It is recommended to government and other stakeholders in the health sector to intensify promotion of family planning programs.

The research findings showed that draught power or cattle ownership has positive impact on household food security. With this in mind, government and other relevant stakeholders are encouraged to formulate policies which give provision to the proliferation of the named *proxies* of food security.

Land size is one other important factor that contributes to household food security. An increase in land size is likely to increase food security in communal areas without employing any advanced technologies. In this study, farm size had a negative and significant relationship to household food security. This suggests that farmers with small farms are more efficient than farmers who own large pieces of land. With the limited resources that the farmers have, it could be rational to cultivate smaller pieces of land as in the case of the agricultural production theory (Stage II of the production curve) and get better produce.

The negative relationship for land size could also be due to irrigation farmers who operate on smaller plots and use intensive methods of farming or the quality of the land is good for crop production. Irrigation farmers get higher produce as compared to dryland farmers. Irrigation schemes are labour and capital intensive due to weeding and frequent use of fertilizers. People, policy makers and researchers such as in this Masters thesis farmers to have access to agricultural inputs, irrigation plots, credit and agricultural information so that farmers are able to produce better yields. This does not suggest an economic reason for land distribution but that irrigation schemes through dam construction are promoted by government, non-governmental organizations and parastatals to allow farmers to have access to water and be able to grow crops throughout the year.

An increase in per capita aggregate production means that the probability of households being food secure increases. With the current food shortages in Zimbabwe any surplus production by the farmers can be sold to the GMB, where it can be distributed to areas that are deficit of food crops. Government, farmer groups or organizations and input suppliers are therefore called to provide agricultural inputs to farming households in communal areas at affordable prices to enable them to increase production. In addition, government can improve rural infrastructure to boost households' income through the provision of better roads, household 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 programs such as health education and birth control measures. This will assist them to reduce their family sizes through family planning and thus increase their chance of being food secure. With the HIV and AIDS pandemic, education about how to protect themselves is very crucial as Zimbabwe is losing most of its productive people to AIDS and this also causes labour shortages as most of the people who die from this disease are the economically active people. When these people die they leave young children behind. It becomes very difficult for these children to make decisions in achieving household food security and accessing credit for agricultural inputs from banks and the GMB because of their ages since some are left while still young.

In conclusion, this study encourages government to adopt policies that improve food access to people, irrigation development, access to affordable inputs and access to agricultural extension and information. This study suggests that households that need to be targeted for food aid in Zimbabwe's communal areas are those with large families, have no access to irrigation, farmers with few cattle or no cattle and those without access to agricultural implements. Thus, it is important that government seriously looks into the issue of constructing irrigation schemes in the semi-arid areas and areas that receive enough rains despite the costs 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, since the overall price elasticity of demand for cereals is low in developing countries.

7.6 Areas of further study

The study shows that about 39.7% of the sample households were food insecure yet they still survived. This could mean that there could be other factors or determinants that contribute to household food security that might not have been taken by the logistic regression. This prompts the need to study other technologies such as water harvesting technologies, soil and water conservation strategies to address the food insecurity in communal areas.

Only a limited number of factors that significantly affect food security and crop productivity have been looked at in this study. There could be more factors that significantly affect household crop productivity and food security and therefore such salient factors such as technology availability, infrastructural development, tenure rights and many more should be taken into consideration. It is also recommended to undertake an in-depth analysis of mitigation measures of food insecurity which are within the reach of poor farm households in communal areas.

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APPENDIX 1

UNIVERSITY OF FORT HARE

FACULTY OF SCIENCE AND AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS & EXTENSION

DETERMINANTS OF HOUSEHOLD FOOD SECURITY IN THE SEMI-ARID AREAS OF ZIMBABWE: A CASE STUDY OF IRRIGATION AND NON-IRRIGATION FARMERS IN LUPANE AND HWANGE DISTRICTS.

Household Survey Questionnaire:

Respondent Name__________________________________Code____________

District____________________ Ward____________

Communal Area_______________ Village____________

Irrigation Scheme Name____________________

Name of Enumerator________________ Date of Interview_________________

A. HOUSEHOLD CHARACTERISTICS:

Respondent:

1. What is the sex of household head? [1]___Male [2]______ Female

2. What is the age of the household head? _________Years

3. What is the highest level of education of the household head? _________
   [1]______ Primary [2] _________ Secondary
   [3]______A' level [4] __________ College
   [5]Other Specify __________________________

5. Marital status of household head?

[1]____Married [2] ___Single [3] ___ Divorced [4] ___Widowed

6. Is the household head formally employed? Yes [1] No [2]

7. Fill in the table below:

a. Household Structure:

Name of household member	**Relation to Head**	**Sex**	**Age**	**Level of Education**	**Occupation**

7b) How many of the above assist with farm labor…………………………………….....?

B. HOUSEHOLD ASSET ENDOWMENTS:

1. **Livestock Type**

Livestock	**Cattle**	**Goats**	**Sheep**	**Chickens**	**Donkeys**	**Pigs**	**Other(specify)**
Numbers							

2. **Assets**

Type of assets& implements	**Numbers**	**Value of assets**
Brick House		
Tractor		
Car		
Plough		
Cultivator		
Scotch cart		
Seed planter		
Shovels		
Hoe		
Harrow		
Other……………..		
1)		
2)		
3)		
4)		

C. AGRICULTURE AND CROP PRODUCTION

1. What is the status of the respondent?
   [1]______ Plot holder [2] _________ Non plot holder

Indicate which crops/vegetables you grow in each season and the proportion of your plot you usually plant to each.

Crop/vegetables	**Area**	**Summer**	**Winter**
Maize			
Sorghum			
Millet			
Cotton			
Wheat			
Cabbage			
Onion			
Cow peas			
Spinach			
Carrot			
Garlic			
Tomatoes			
Pumpkin			
Beans			
Melons			
Other (specify)			

DRY LAND FARMERS

2. **Crops produced in the 2005/2006 dry land farming season**

Crop Type	**Quantity Produced**	**Quantity for household consumption**	**Quantity for Sale**	**Quantity given away**
Maize				
Sorghum				
Millet				
Cotton				
Wheat				

Other (specify)				

IRRIGATION FARMERS

3. Crops produced on the irrigation scheme 2005/2006 farming season

Crop Type	Quantity Produced	Quantity for household consumption	Quantity for Sale	Quantity given away
Maize				
Sorghum				
Millet				
Cotton				
Wheat				
Other (specify)				

D. FARM OPERATIONS

1. What type of draught power do you use?

…………………………………………………………………………………….

2. How much do you pay for hired [1] labour/ (ha) $……………

[2] Tractor/ (ha) $……………

[3] Draft power/ (ha) $……………

3. How much did you produce?………………………………………………..

4. a) For the farming season 2005/2006, did you produce enough grain to last until next harvest? [ ] yes [ ] no

b) If the answer to question a) is 'no', are you able to purchase supplement grain?

[ ] yes [ ] no

c) Do you have one or more gardens near you household? Yes [ ] No [ ]

d) How do you water the vegetables/crops in your back yard?

…………………………………………………………………………………………………

5) Which factors influence your choice of crops/vegetables in any growing season? Rank them in order of importance.

Activity	**Rank**
Good yield	
Easy to sell	
Water availability	
Climate	
Easy to manage	
Staple food	
Other, specify	

6) What sort of farming methods are you using in your fields?

[1] Tractor [2] Ox-drawn plough [3] Hoe

7) Did you apply fertilizer to your crops?

[1] Yes [2] No

8) For which crops did you apply fertilizer?

………………………………………………………………………………………..

9) How long does the water last you when you irrigate your crops?................months/year?

E. MARKETING

1. a) To whom do you sell the crops you grow?

Crop/vegetables	**Market**
Maize	
Sorghum	
Millet	
Cotton	
Wheat	
Vegetables	

Other (specify)	

[1] GMB [2] COTTCO [3] CARGIL [4] Locally to neighbors [5] Hawkers
[6] Schools [7] Local shops

b) Do you have any problems with getting produce sold?

[1] Yes [2] No

2. a) How far is the nearest market in ....(in km)

b) How far is the furthest market ....(in km)

3. a) During the past 12 months, what major crops did you sell?

……………………………………………………………………………………………

b) From which place did you source the inputs?

……………………………………………………………………………………………

c) From which shops/organizations did you source inputs?

……………………………………………………………………………………………

G. INCOME

CROPS

1. Which crops did you realize a lot of income after sales.

Crop/vegetables	**Income**

LIVESTOCK

2. How much did you realize from the sale of livestock for the year ending 2006:

Livestock	**Number**	**Income**
Cattle		
Goats		
Sheep		
Chickens		

Other (Specify)		

H. OCCUPATION

3 a) What is the occupation of the household head………………………………..

b) If 'yes' is what is your salary per month? $……………………………………

4. How many of your family members are formally employed..............................

5. How much income does your household derive from the following activities?

Source of income	**$/month**	**$/year**
Salary and wages		
Remittances		
Rental payments		
Casual labor *		
Other (specify)		

*NB-brick making, thatching, roofing, building houses, harvesting, weeding etc

I. RISK AND MANAGEMENT PRACTICES

1. What are your greatest problems you face in agricultural input and outputs, starting with the most pressing problem?

a) Agricultural inputs
i.____

ii.____

iii.____

b) Agricultural outputs
i.____

ii.____

iii.____

2. What are your main sources of market information?...
…………………………………………………………………………………………

3. a) Is obtaining market information a problem? [1]_____No [2] ____Yes

b) Why or why not?
____

c) What types of information are you unable to get which makes it more difficult for you to do agriculture?

____

4. a) Do you get some extension services from AREX offices?

[1]_____No [2] ____Yes
b) How often do you get this information?

____

c) What type of information do you get from extension officers?
i)____

ii)____

iii)____

5. What are the most time-consuming activities in farming? Rank 1 as most important and 5 least important.

Activity	**Rank**
Sourcing agricultural inputs	
Land preparation	
Planting	
Harvesting	
Weeding	
Marketing of crops Other: Specify	

6. Are there any ways that the activities could be improved or made more efficient?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

7. What would you say are the biggest risks your farming enterprise faces in buying and selling agricultural commodities?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

8. How do you deal with these risks?

……………………………………………………………………………………………

……………………………………………………………………………………………

9. What can the government do to reduce these risks?

……………………………………………………………………………………………

……………………………………………………………………………………………

10. For which agricultural commodities and inputs do you believe there is significant potential to expand sales within the next ten years?

……………………………………………………………………………………………

……………………………………………………………………………………………

11. In your own opinion, briefly state the fundamental factors affecting farm household crop productivity…………………………………………………….............................

……………………………………………………………………………………………

……………………………………………………………………………………………

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……………………………………………………………………………………………

Thank you

Thank you

APPENDIX 2

Calorie content of some commonly eaten food items in Zimbabwe

Food items	**Kcal/kg**	**Food items**	**Kcal/kg**
Staple foods		Mango	590
Cassava Tuber	1500	Pawpaw	300
Cassava flour	3870	Pineapple	320
Cassava chips	3000	Apple	570

Garri	3840	Coconut	580
Yam Tuber	1100	Guava	730
Yam flour	3810	Sugar cane	360
Yam chips	3000	**Meat and animal products**	
Sweet potato Tuber	1100	Cow meat	2370
Sweet potato chips	900	Goat meat	2370
Irish potato	1200	Sheep meat	2370
Cocoyam Tuber	3830	Pork	2370
Maize green	3100	Bush meat	2370
Maize grain	4120	Chicken	2380
Maize flour	4120	Turkey	2380
Sorghum grain	3500	Fish	2230
Sorghum Flour	3500	Snail	2245
Millet grain	3500	Shrimps	2230
Millet flour	3500	Crayfish	2200
Rice	1230	Crabs	2200
Wheat grain	3400	Eggs (pieces)	1400
Wheat flour	3300	**Dairy products**	
Cowpea (beans)	5920	Milk	4900
Ground nut	5950	Cheese	4000
Soybeans	4050	Yoghurt	4100
Soybean flour	2600	Ice cream	4100
Melon (shelled)	5670	**Beverages**	
Plantain	770	Cocoa	1200
Banana	960	Tea (leaves)	1200
Vegetables		Tea (liquid)	1200
Okra	4550	Coffee (powder)	1340
Tomato	880	Coffee (liquid)	1340
Pepper	3930	**Drinks**	
Onion	440	Soft drinks	620
Carrot	400	Orange juice	400
Egg plant	440	Apple juice	550
Cucumber	270	Pineapple juice	560
Cochorus/ewedu	500	Local beer	740
Spinach	220	Bottled beer	460
Bitter leaf	220	Wine	330
Water leaf	180	Condiments and spices	
Cabbage	230	Maggi	440
Pumpkin	220	Salt	180

Source: International Food Security Policy Research Institute (IFPRI), 2001.

APPENDIX 3

Adult equivalent scale for adjusting the household size

Age category	Male	Female
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78
12-14	0.96	0.84
14-16	1.06	0.86
16-18	1.14	0.86
18-30	1.04	0.80
30-60	1.00	0.82
>60	0.84	0.74

Source: Stefan and Pramila, (1998)