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FACULTY OF SOCIAL STUDIES
DEPARTMENT OF ECONOMICS**



**FACTORS AFFECTING FOOD AND NUTRITION SECURITY IN
GOROMONZI DISTRICT, MASHONALAND EAST PROVINCE OF
ZIMBABWE**

By

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**A dissertation submitted in partial fulfilment of the requirements for a Master of
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Final Draft

DEDICATION

To My Mother Serina Nyandoro

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For this research work to be what it is, I am grateful for the assistance I received from various people and organizations and above all am thankful to my Lord God the almighty for the strength and opportunities he gave me.

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ABSTRACT

This study seeks to establish factors affecting household food and nutrition security in Goromonzi District. It is motivated by the fact that household food insecurity in Goromonzi (11.7 %) is comparatively higher than that of areas such as Mutoko (10%) for an area that has ideal agro-ecological conditions for food production while close to the Metropolitan city of Harare where labour market exists. The research investigates the food security paradox that has been witnessed in the district. It seeks to establish factors that affect household food and nutritional in/security in Goromonzi District while further providing a comparison of factors affecting food access and food utilization as measured by HDDS and HFIAS respectively. OLS and Probit regressions analysis methods were used to accomplish the objectives of this study. OLS regression results show that there exist more socio-economic factors that affect food in/security in Goromonzi than demographic factors. The study establishes that income, granary capacity, experience in farming, extension services, age and household size are significant factors that affect dietary diversity in area under study. Probit results using HDDS was also consistent with OLS regression results. However, both OLS regression and Probit regression utilising HFIAS as the indicator shows that only incomes are the only significant factor explaining food access. Policies that support food supplements for the aged, birth control, provision for extension services, increasing household incomes as well as income transfer will enhance food and nutrition security

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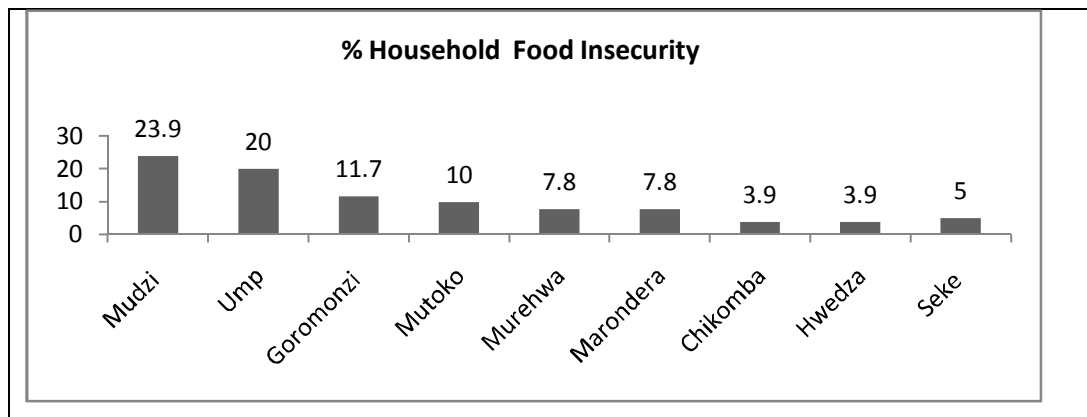
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Chapter One: Introduction

1.1 Introduction

The research examines the factors that determine the food and nutrition security status of smallholder farm households in Goromonzi District, Mashonaland East Province of Zimbabwe. The Zimbabwe Vulnerability Assessment Committee [ZimVac (2012)] estimates the food insecurity level among smallholder farmers in the district at 11.7 per cent. This figure is surprisingly high when compared with other districts in the province, given its more favorable agro-ecological, climatic, social and economic characteristics. Goromonzi is located in Natural Region II which has relatively better agro-ecological potential for food and cash crop production than Mutoko district, for example, which lies in the less favourable agro-ecological Natural Regions III and IV. ZimVac estimates the latter's food insecurity level at 10 per cent. Figure 1 below shows that out of the nine Mashonaland East districts, only two, Mudzi and Uzumba-Maramba-Pfungwe (UMP) record higher food insecurity levels than Goromonzi. This would be reasonably expected, given that the two districts lie in regions with less potential for food and cash crop production. For the reason that there seems to be little or no obvious positive correlation between Goromonzi's high food production potential and its food insecurity status becomes an issue worthy of further investigation.

Figure 1: Mashonaland East 2013 food insecurity by district



Data sourced from Zimvac 2012.

Key

UMP ó Uzumba Maramba Pfungwe

The concept of food security/insecurity is a complex and multi-dimensional phenomenon. Food security is said to exist, “*when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*” (World Food Summit, 1996). This is the widely accepted definition of food security within both academic and policy circles and also among food security practitioners within the donor community (USAID (2009), FAO-WFS (2009), World Bank (2003), Jacobs (2009), Coates (2007), Hoddinott & Yohannes (2002)). The concept of food security has three widely accepted dimensions which have been the focus of much research and policy analysis. These are: availability, accessibility and utilization (Oni (2010), Batatunde (2007), Bishir et al (2012)). The availability dimension refers to the physical presence of food at national, regional, household and individual levels from own production or through the market purchases, stocks, imports or food aid ((Batatunde *et al*,(2008); Devereux, (2009); (Jacobs, (2009)). Total Stocks of Food Calories Available is the commonly used indicator for food availability. However, this is an inadequate definition of food security as food availability may not necessarily be consumed. Food may be available but households, individuals and communities may lack the means to access it. Thus, the accessibility dimension becomes important. It refers to the possession of enough economic and physical resources that enables a household or an individual to have command over appropriate quantities of food for *an active and healthy life*” as accepted by the World Food Summit of 1996. The Household Food Insecurity Access Scale (HFIAS) is among the commonly used proxies of food access. Finally, the food utilization dimension refers to the food that is actually consumed, rather than what is available or accessed (Hoddinott & Yohannes (2002), Ruel (2002) Selvester (2008). It is therefore closely linked to the concepts of nutrition and the body’s biological capacity to make use of the various nutrients in food for a productive and healthy life (Swindale & Bilinsky; 2005), (FAO (2008)). Nutrition security can thus be explained to mean when one has a diet that is nutritionally adequate for the maintenance of growth, resisting and recovery from illnesses. The Household Dietary Diversity Score (HDDS) is one indicator of the utilization dimension that emphasizes on food nutrition for reasons to be explained later.

Each of these different measures, indicators and proxies of food security has their usefulness and weaknesses. For example, the notion stated above that Goromonzi district would be reasonably

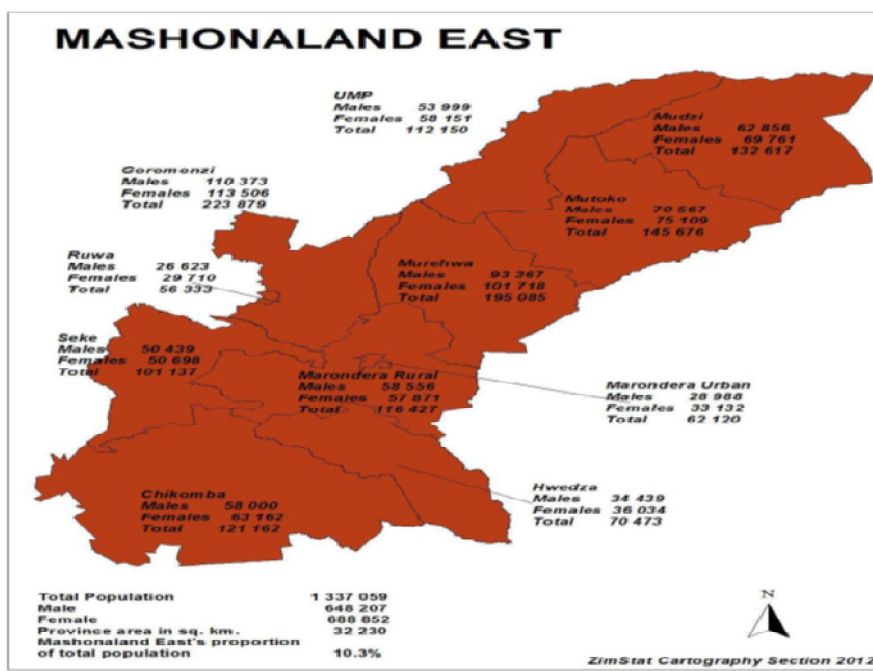
expected to have greater food security because of its relatively better agro-ecological potential for food and cash crop production than Mutoko district, infers the use either the availability and access dimension or both. The ZimVac (2012) food security assessment uses the Household Economic Access (HEA) as proxy of the access dimension to place Goromonzi district's food insecurity level at 11.7 per cent of households.

1.2 Background of the study

Location of the research area

Goromonzi district is situated just 32km south east of the metropolitan city of Harare. The district is the largest of the nine districts of the province. It has an estimated area of 2459km² (Chakona, (2011) & Marimira (2010)) and a population of 223879; of which 113506 are female and the remainder are male (Zimbabwe Population census (2012)). The average farm household size is four (4) constituting 56248 households in the district. The district is part of the urban areas of Zimbabwe with Harare to the west and Marondera to the east. The Figure below shows the sketch map of the Province where the district is situated.

Figure 2: Map of Mashonaland East Province

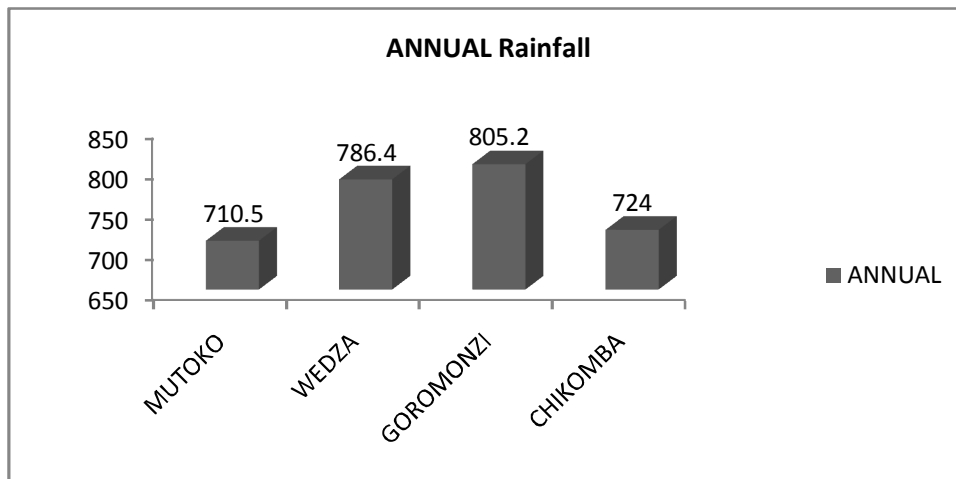


Source: Zimbabwe National Statistic Agency: Zimstat 2012 Preliminary Report

Weather and Climatic comparison for Districts in Mashonaland East Province

The district lies in Natural Region II characterized by moderately high rainfall and favorable climatic conditions; which makes it suitable for diversified cash and food crop farming. Since there is a hidden assumption that a rural household accepts farming as the only means of livelihood and there are limited efforts to attain livelihoods beyond the farming, Jowah (2009) argued that rural livelihoods are synonymous with agriculture. Basing on these conclusions, briefly outlining and understanding the agricultural potential of Goromonzi is important in addressing the problem of food insecurity in the district. It is thus necessary to have a brief outline of the four districts in province whose annual average rainfall was available with the Zimbabwe Metrological Department. Goromonzi had an annual rainfall of 805.2ml for the 2012 farming season compared to areas like Mutoko and Chikomba which had significantly less rainfall as shown in the figure below but with a lesser level of food insecurity.

Figure 3 Mashonaland East Annual Rainfall by district

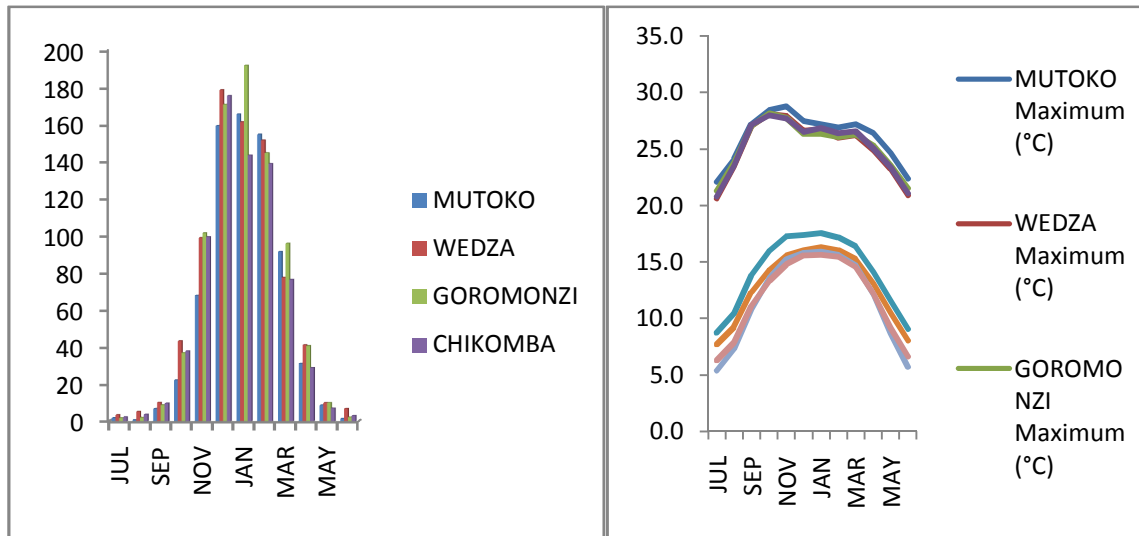


Data source: Zimbabwe Metrological Services Department.

Data on the monthly average rainfall and temperatures were also made available and are important as they prove the consistence of rains and temperatures across the agricultural season. The district seems to have a fairly higher and stable rainfall. Rainfall and temperatures are important as most of the farmers are communal and rely on them for food, staple and cash crop production. The more stable the rainfalls and temperatures, the more likelihood of a good yield and hence food availability and accessibility. A combination of high rainfall and good

temperature are good and most suitable for agriculture. The diagrams below depict the monthly averages for rainfall; minimum and maximum temperature arrived at over a 30yr period. It proves Goromonzi has a higher rainfall than the other district.

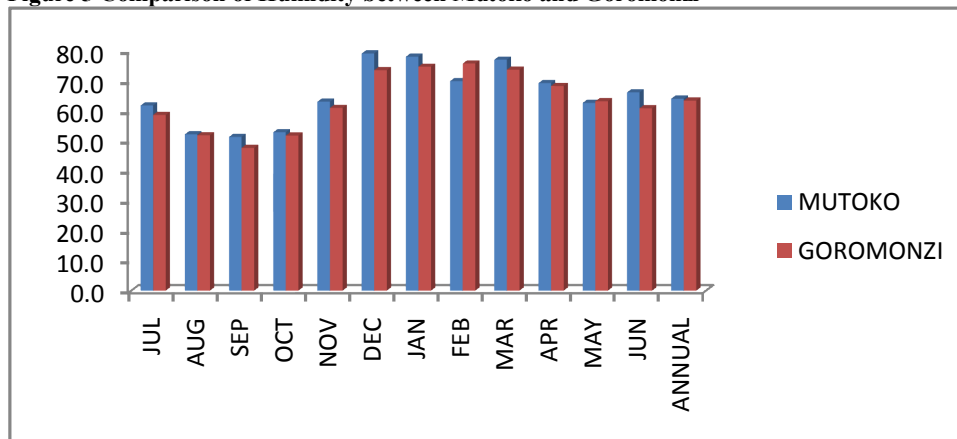
Figure 4 Monthly rainfall and temperature averages



Data source: Zimbabwe Metrological Services Department.

Storage is a factor that contributes to the distribution of the number of food insecure households over time. According to the ZimVac (2012) report, food insecurity is usually lowest just after the harvest and vice versa. Those with proper storage conditions can store food for a fairly longer period of time and hence reduce the risk of food insecurity even just before the harvest. Area Humidity affects the state and the amount of food that can be stored and hence available to a household at a later date. Goromonzi is relatively less humid compared to Mutoko making it easier for the storage of food and grain. The graph below depicts the comparison of humidity between Mutoko and Goromonzi.

Figure 5 Comparison of Humidity between Mutoko and Goromonzi



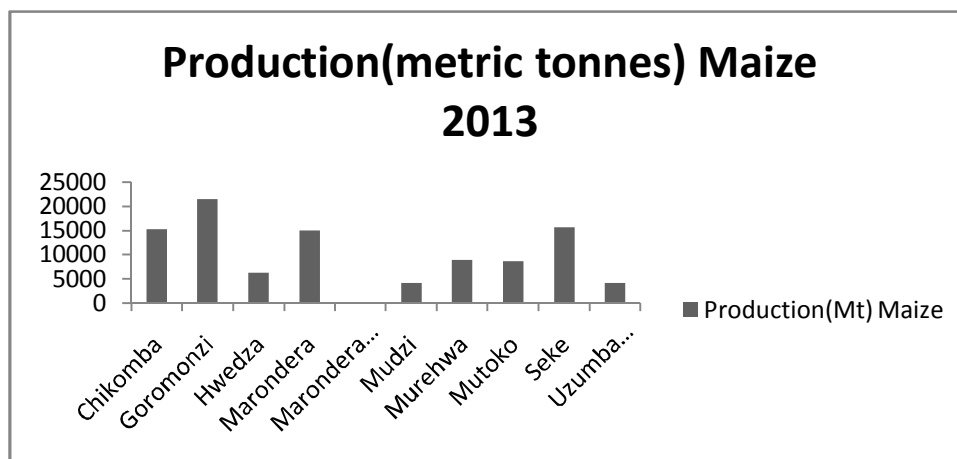
Data source: Zimbabwe Metrological Services Department.

Agricultural output comparison for Districts in Mashonaland East Province.

Food crop production

For the 2012/13 agricultural year, Goromonzi district had the highest maize production for the whole province as shown in the graph below. Maize is the major cereal that is consumed in Zimbabwe and having a greater output is supposed to translate in a better food security measured by the availability standard. With this relatively high maize production, Goromonzi is facing a relatively worst case scenario in terms of food security.

Figure 6 Maize Production For 2013



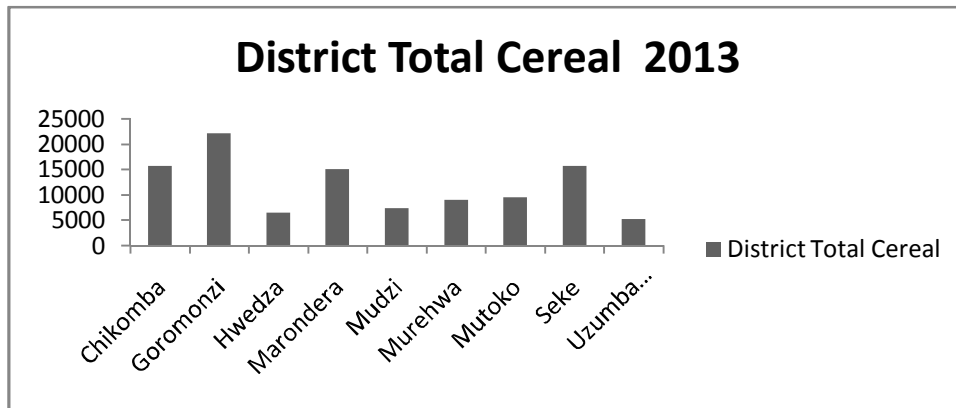
Data source: Zimbabwe Agritex Office

Key

Uzumbaí ó Uzumba Maramba Pfungwe

There are some other cereals produced and consumed in the province. The Figure below shows that still Goromonzi remains with the highest on all cereal production. It becomes a real problem if the district with so much potential and actual production faces a food insecurity that is relatively higher than the others. This proves the practical existence of the food security paradox in the area of Goromonzi.

Figure 7 Cereal Production 2013



Data source: Zimbabwe Agritex Office

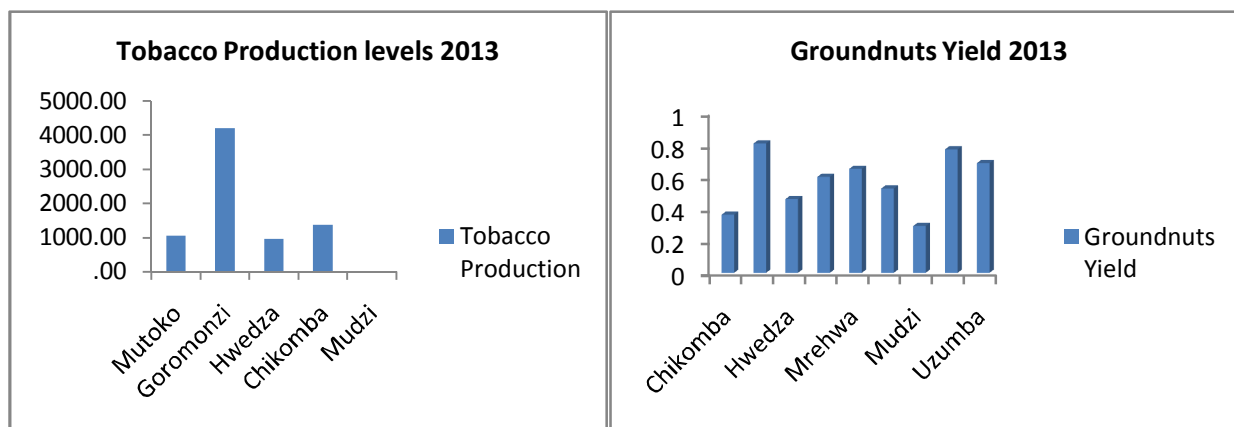
Key

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Cash crop comparison by district in Mashonaland east Province

According to Chakona, (2011) groundnuts and Tobacco are the major cash crops grown in Goromonzi. They are the major sources of incomes for households although other incomes come from leasing of land and property whose extent is not properly researched. Incomes generated from the sale of cash crops are supposed to increase food security as measured by accessibility, which looks at having enough financial resources to claim food. The graphs below show the productions of both groundnuts and tobacco as sources of income in selected districts of Mashonaland East.

Figure 8 Tobacco and Groundnut Production 2013



Data source: Zimbabwe Agritex Office

From the above two graphs, it is clearer that Goromonzi has a sound production in of both tobacco and groundnuts, it is however confusing that such a productive district has a relative high food insecurity.

Goromonzi is a district faced with a whole host of favorable characteristic; it is however a serious cause of concern if the level of food insecurity is and remains high. This has prompted this research, in order to fill in the information gap on the factors that are affecting the level of food insecurity.

1.3 Problem statement

Goromonzi district's situation in natural region II with ideal agro-ecological conditions for staple, food and cash crop production implying better agricultural potential yet it has a higher level of food insecurity compared to the other districts in Mashonaland East Province in particular Mutoko district which lies in natural region III and IV with less favorable agro-ecological conditions (ZimVac, 2012). This higher potential is confirmed by the higher actual maize, cereal and cash crop production cited above. As maize is the major cereal consumed in Zimbabwe, this higher food availability generates an expectation that it would translate to greater food security. Similarly, the observed higher cash crop production would be expected to raise household cash incomes from the sale of these crops. This in turn would increase household access to food from the market such that food security is enhanced.

In addition, its proximity to Harare confers certain advantages often associated with peri-urban locations, such as better road infrastructure, information and communication networks and access to inputs and produce markets. Proximity to Harare reduces transportation, information and variable transactions costs for input purchases and output sales as compared to districts like Mutoko, Chikomba, Hwedza and others. In addition, urban-rural remittances among other incomes are easily accessed in Goromonzi as it is closest to the financial institutions in the capital. The process of urban expansion of Harare and its satellite towns into Goromonzi district has witnessed rural households' participation in non-farm employment, the selling and leasing of rural land for residential purposes. The effect is to increase some rural households' incomes from rentals, non-farm wages and urban-rural remittances. These advantages would be expected to increase household food entitlements and food security.

However, despite the above cited geographic, agro-ecological, climatic characteristics, social and economic advantages, Goromonzi district is found to face relatively higher levels of food insecurity than the other six districts without these advantages. It is therefore surprising that a district with all these favorable attributes faces what appears to be a food security paradox. This apparent paradox provides the motivation for this study. Such a district with favorable socio-economic, agro-ecological and climatic indicators facing comparatively higher food insecurity is an issue that begs further investigation.

In general, the subject of food security has been investigated food availability and access dimensions (Munamati (2011), Tawodzera (2012), Mitiku *et al* (2012), Amanza (2006)), with only a few having looked at the utilization and nutritional contribution of food (Selvester (2008)). The problem of food security as a utilization phenomenon is not properly researched and this research tries to look into the determinants of the nutrition security of the food that is either available or accessed at the household level.

1.4 Research Objectives

1. To establish the factors that affect household food and nutrition in/security in Goromonzi as measured by the Household Dietary Diversity Score (HDDS).

2. To compare and contrast the factors that affect food utilization and access in Goromonzi as measured by Household Dietary Diversity Score (HDDS) and Household Food Insecurity Access Score (HFIAS) respectively.

1.5 Research Questions

1. What are the factors that affect food and nutrition in/security in Goromonzi district as measured by the Household Dietary Diversity Score?
2. Are the factors that affect food utilization in Goromonzi consistent with the factors that affect food access as measured by Household Dietary Diversity Score and the Household Food Insecurity Access Score respectively?

1.6 Hypothesis

H0: Assets, liquidity, human capital and demographic factors affect HDDS as a measure of food and nutrition security and as well they affect food Access measured by HFIAS.

1.7 Justification and Significance of the Study

This research seeks to bridge the literature gap on food and nutrition in/security in Goromonzi, an area where the problem is least expected. Although studies have been conducted elsewhere, few have focused on the paradox of food insecurity amid favorable indicators of good potential for the district achieving food security. The significance of this study lies in the use of the Household Dietary Diversity Score as an indicator of food and nutritional security. Most research studies have used availability indicators of food in/security (Munamati, 2011), Tawodzera, (2012), Pankomera *et al* (2009), Mitiku *et al* (2010) and Amanza, (2006). However, food availability does not translate into consumption as the food may be available but lacks utilization. The ZimVac (2012) used the access dimension to determine the food in/security status is an availability indicator and as well the dimension has been used by other researchers (Tweeten (1999) and Selvester (2008)). Accessibility only captures households' capacity to put claim on food but fails to reflect its consumption and utilization of the food. These two measures ignore the nutritional dimension or aspect of food and food security, FAO (2008). Utilization measures consider food that is actually consumed and the body's biological capacity to make use of the various nutrients in food (Swindale & Bilinsky 2005). As Swindale and Bilinsky (2005) argue, household dietary diversity is a key aspect contributing to household food and nutrition security. It is associated with

improved outcomes such as birth weight, child anthropometry and hemoglobin concentration. It focuses on and captures the nutritional aspect of food security. Bhargaveet *al* (2001) and Daniels *et al* (2007) also noted the importance of a balanced diet for achievement of a healthy and productive life. Thus, indicators of utilization such as the HDDS are superior as they track the food that is consumed and not just what is available or accessed by the household. Identifying the factors that affect household dietary diversity and food security would help policy makers in coming up with appropriate interventions and to respond to problems associated with food insecurity.

1.8 Outline of the dissertation

This dissertation is divided into five chapters. This first Chapter covers the introduction to the study. It outlines the background to the research area, the research problem, objectives and research questions and its justification. Chapter 2 presents the literature review to help identify the factors that affect food security and attempts to explain Goromonzi's food security paradox. A conceptual framework that forms the basis of the subsequent empirical models is also outlined therein. Chapter 3 provides a more detailed presentation of the empirical methodology and methods used to investigate the research questions. The empirical models to be estimated are specified and the definition of the explanatory variables given. The data used to estimate the models is given further attention. Chapter 4 is the presentation, interpretation and discussion of the results while Chapter 5 concludes with policy implications of the research findings, limitations and suggestions for further research.

Chapter Two: Literature Review

2.1 Introduction

This chapter defines food and nutrition in/security, highlighting its dimensions in detail with particular relevance to Goromonzi. It also provides a brief outline of the measures of food security used in Zimbabwe by different stakeholders. The chapter provides a conceptual framework on food utilization and access. It further develops the model and the broad categories of variable that helps to investigate utilization of food that will be used as supported by the methodology. The chapter also identifies and justifies the specific variables to be included in the models that will be estimated.

2.2 Definition of food security

Food can be defined as, *öany substance that people eat and drink to maintain life and growthö* (Gross *et al.* 2000). This definition takes water and liquids that people drink to be important elements prior to exploring food security and is integrated in the FAO (2003) definition of food security as stated in the previous chapter. This definition looks at all levels of food security, individuals, households, community, national and regional. Household food security as the main focus of this dissertation can be considered as the application of food in/security concept at the family level, with individuals within households as the focus of concern. The World Bank (1986) defined food insecurity as, *öthe lack of capability to produce food and to provide access to all people at all times to enough food for an active and healthy lifeö*. It was further defined by Gebre (2012) and Carter *et al.* (2010), as *ölimited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable waysö*. These definitions are the ones used for this research as they consider what is available or potentially accessible with nutrition as a major component.

As argued by Maxwell and Smith (1999), food security is a necessary condition that is not sufficient for nutrition security at individual or household level. Frankenberger *et al.* (1997) as cited in Pangaribowo *et al.* (2013) defined food nutrition security as, a situation when an individual, household or community has *öa nutritionally adequate diet and the food consumed is biologically utilized such that adequate performance is maintained in growth, resisting or recovering from disease, pregnancy, lactation and physical work.ö* Selvester *et al.*, (2008) and

Arimond & Ruel, (2004) are among the few authors who covered the utilization and nutritional dimension which will be the main focus of this research. It is thus necessary to emphasize on the nutrition security in the area of Goromonzi, as nutrition and food utilization have a positive relation with health outcomes such as the Body Mass Index, Height for Age and Birth Weight, (Gulliford(2003) and Saaka & Osman (2013)). Nutrition remains fundamental and important for individuals to recognize both their physical and intellectual potential. Under-nutrition reduces the income earning capacity and educational performance while raising the prevalence to mortality, morbidity and disability. This thereby increases the rise in poverty and illnesses, Ecker and Breisinger (2012). Having outlined the costs of nutrition insecurity it is important to investigate the food and nutrition security paradox in Goromonzi. Analyzing nutrition security in this district would provide a wider and broader understanding of the food utilization patterns of the district rather than the simply resource ownership which may not in turn be translated into consumption or energy.

2.3 Dimensions of food and nutrition security

As highlighted in the previous chapter, availability, accessibility, utilization and stability are widely acceptable by the academic and humanitarian organizations as the dimensions of food security. American Institute for Cooperation on Agriculture adds the aspect of social acceptability as another concept of food security. These dimensions are accepted by the Government of Zimbabwe through the Zimbabwe Vulnerability Assessment Committee (2011, 2012, and 2013). The concepts do not all integrate biological utilization of food as defined by Swindle and Bilinsky (2005) as, *“the individual’s biological capacity to make use of food for a productive life.”* The dimensions of food and nutritional security can be divided into who (individuals, household community, national and regional), the what (lack of calorie, lack of quality nutrition and cultural acceptance) and the when (over time periods or during a crises). On the other hand food is sourced mainly from, own production, market purchase, borrowing, aid and others, WFO (2011).

Food availability considers the production, distribution, imports, stocks and exchange of food, mainly looking at the food that is available in stocks at all levels ranging from the household, community, national and regional as argued by Tweeten (1999). It explains food security as being a supply side phenomenon, influenced by stock level and balance after trade. This is the

concept that was used by authors such as Bashir *et al*, (2012), Batatundde (2007) and Oni (2010) among others in their analysis of food security. Availability may be more suitable to areas such as Goromonzi which are predominantly agro-based as the greater of the food is both produced and stored at household level. Most of the households in the district have granaries at their homesteads for the storage of farm produce. This can be measured by the minimum daily per capita calorie requirement Bashir *et al*, (2012) and Batatunde (2007) among others.

This measure has over time led to the food security paradox as highlighted by Sen (1981) since it does not look at the other dimensions of food security, mainly access and utilization. Availability measure emphasizes on the food that is available and not what has been consumed and does not allow geographic targeting and tracking of food security overtime. This is so as the stocks of food change often over time. Average food available to each person in a population is not a good indicator as there is no guarantee the food will be consumed (utilization). As further argued by Smith *et al*, (2006), stunting, compromised immune, child malnutrition and goiter in adults among other problems may worsen as the national, regional, district or household food availability improves. This has been the case in Goromonzi where a food security paradox has been outlined in the background of this study. Average food availability per household or individuals give no insight into the temporary or short term food security or hunger statuses.

In theory, the food security paradox was noted by Amartya Sen (1981) in his Entitlement theory where he explained the existence of food insecurity and famine where food is available. Sen (1981) as will be critically reviewed and analyzed latter in this chapter, argued that food insecurity is caused by the lack of entitlements that makes one have the resources capacity to claim enough food. His observations were that prices were excessive and households lacked the buying power to claim food items. This brings the aspect of access into the picture as it considers the resources that the household own which can be used to claim (buying power) food for individuals and or households. Tweeten (1999) further argued that the elderly, the young and hired agricultural workers often are poor and lack access to food and favored an improvement in the incomes of societies.

The access dimension considers the expenditure side of food security, explaining it with regards to the monetary value, prices and markets of food. Access measures what can be rightfully owned from the household or individual resources and not what has been consumed. This can be

measured by the Household Food Insecurity Access Scale (HFIAS), as in Goromonzi there are rather significant proportions of households that get food through the markets, necessitated by the geographic and economic characteristics of the district as discussed in Chapter One. The market is active even though the area is mainly rural but due to its nearness to Harare, there has been an influx of renting dwellers from the capital city. On the contrary the food that may be accessible may not necessarily be utilized (or consumed) due to factors such as inadequate nutrition education and food preparations, bad eating habits, eating disorder and unclean water or sanitation. Thus food may be readily available and simply accessible but while there is a high prevalence of malnutrition and limited utilization (WFP, 2009). The limited and lack of food utilization and the unbalanced diets which may be reflected by Household Dietary Diversity Score (HDDS) have a direct impact on several health related outcomes mainly on infants, and the elderly as examples given and highlighted above. The impacts are more severe when the nutritional and food insecurity repeats over time. This brings about the stability concept of food security which looks at the availability, access or utilization of food over time. These may be pronounced in Goromonzi as there is evidence of a diverse demographic distribution in the households.

Food security should not just be considered as the availability, access and stability of food but also the nutritional and biodiversity dimension ought to be respected. FAO guidelines defined biodiversity as, *“the diversity of plants, animals and other organisms used as food, covering the genetic resources provided by the ecosystem.”* Nutrition and the actual consumption should be taken into account as the food might be plenty in stock but as highlighted by Tweeten (1999) and Selvester (2008) may intern not be accessed, stable and or utilized. These arguments were also further put forward by Hoddinott & Yohannes (2002), when they tried to establish the factors that affect nutrition and dietary diversity. Among others, Drescher and Goddard (2011), Drescher *et al.* (2009), Lee and brown (1989) as cited and consistent with Doan (2013), did researches on food utilization for different recall periods, areas, levels and using different estimation procedures. In light of all these, studying food utilization and nutrition security in Goromonzi should be important as the area can be taken as a representation of the other districts in Mashonaland East province and other areas around urban cities.

2.4 Measures and Proxies used for Food Security in Zimbabwe.

Considering a household, individual or community as food secure or insecure differs among individuals, analysts and organizations. The USAID as quoted in Ignowski (2012) considers any household that has need for food aid for at least one quarter of the year starting in January as being food insecure in Zimbabwe. This is the nature of the definition for those in the humanitarian operation but falls short of recognizing food security as a short term problem to the society. This research considers food security in Goromonzi at a given point in time regarding mainly utilization and access as measured by Household Dietary Diversity Score and Household Food Insecurity Access Scale respectively. This is so since in some areas a household can be food insecure only on a very short period of time such as the past twenty-four hours and or the past 7 days. It also may be such that there are several infants, children, minors and the elderly that may not endure the long periods that qualifies them to be food insecure as per the USAID above standard. Why should the three months be used yet it's a relatively long period of time. The idea of using the January to March only puts a strong underlying assumption that communities rely entirely on agriculture and sidelining households that survive on non agriculture activities. Over and above families may be tempted to accept aid even if they are secure only for the sake of receiving a free benefit. Considering only whether a household has received aid does not give any insight into the diversity and the nutritional contribution of the Aid and the diet of the household. Totally the definition and distinction have nothing to do with nutrition; a household may be getting Aid all the time but having a highly nutritious diet than those that are not accessing the Aid. This definition cannot be used for the area under study (Goromonzi) as it does not have very active food Aid and donor organizations, thus making a definition tailor made for such stakeholders give misleading conclusions. Mudavanhu and Mandizvidza (2013) noted otherwise that the donor participation in Goromonzi is only active in the provision of inputs that may be used in food production and not directly the food itself.

The ZimVac (2011, 2012, and 2013) on the other hand considers a household that has no access to or has the capacity of attaining the minimum of 2100 kilocalories per head per day as being food insecure, ZimVac (2012). Bashir *et al* 2012, used a cut off of 2450kcal/capita/day as recommended by the Government of Pakistan as a threshold for food security while on the other hand Batatunde (2007), used 2260kcal per capita daily for Nigeria. There is no consistence in the

levels that are used as cut offs for different nations, communities and even households. As well the differences in minimum calorie requirements are too wide, such that it becomes difficult to come up with a relevant cut-off for an area such as Goromonzi which represents households of varying demographic and socio-economic statuses. This on the other hand is the definition for analyzing the extent of vulnerability to food in/security but it fails to look at the nutritional components of the available and accessed food.

The access and entitlements approach used by the Zimbabwe Vulnerability Assessment Committee fail to acknowledge the existence of violent and non legal transfers and sources of food. Food may be available through a host of unorthodox means such as scavenging and theft. This can be the case in Goromonzi as there are several options that may be followed by the households to get food such as the gathering and or selling of wild fruits and vegetables such as mazhanje, matamba, hacha, black jack, wild okra and mushrooms. These may not be conventional food stuffs but stem from cultural and oral traditional as food that are rich in nutrients. These options provide diversity in the diet and as well a range of nutritional components and medicaments that may not be captured using several other measures. Access may also not be from conventional means as Marimira (2010) noted the sale of fire wood as a source of livelihood in the district of Goromonzi. In his purest theoretical form Sen, takes away the role of diseases as it argues that death is solely caused by hunger and fails to take account the intra household food security. This research mainly measures food in/security using the HDDS as will be discussed latter in this chapter, which is rather flexible and can be broken down into the Individual Dietary Diversity Score used to analyze food and nutrition security at an individual level or intra-household level. FAO calorie cut-off point criticized for underestimating nutrition insecurity (Svedberg (2002)) and treating all food as the same. It does not highlight the composition or diversity of the available calories and also suppresses the role of culture and preferences (Maxwell and Smith (1999)).

The ZimVac (2012) used the Household Economy approach (HEA) in establishing the estimates of the levels of food insecurity for all the districts of Zimbabwe. It used the access to a minimum of 2100kcal per individual daily as the yardstick of food security. HEA sums up the ways a household acquires incomes, savings and asset holdings that helps in meeting its food and non food needs (Holzmann *et al* (2008)). In computing the food prices, ZimVac considered the

cheapest prices accessible to the household; this means that there is no standard and uniform determination of the food security statuses. Distortions in prices, markets and the food markets are also difficult to totally control or factor in. Thus the idea of looking at capacity falls short of explaining what exactly has been consumed. Considering these variables over a period of a whole year is rather oversimplifying and does not reflect on the actual situation as the time is too long allowing for variations. The HEA is on the other hand not a sufficient indicator and tells us nothing about the household economic productivity, (Masset (2011), Mason (2005) and Svedberg (2000)). It should also be noted that, ZimVac in establishing security levels at household levels, has made five unrealistic assumptions among them, stability of prices over the year and that food will always be available on the market as long as one has the means to acquire. The ZimVac (2012), report noted the stocks, own production, cash crop production, livestock and others such as gifts, remittances, casual labour, pensions and formal employment as the sources of food access for the households.

The Food Consumption Score (FCSs) and the Food Consumption Groups (FCGs) are the other measures commonly used by the WFP (2008) for assessing and monitoring of food security. They are scores based on the dietary diversity, food frequency and the nutritional importance of different food groups. There are country differences in the context of the cut-offs (WFP (2008), Wiesmann (2009)). The information is collected on a country specific and is based on a 7 day recall. The weighted scores are grouped such that a score of less than 21 qualifies one as being a poor diet or food insecure. A score of between 21.5 and 35 as being on the border line while the one greater than 35 is considered secure. The WFP also argues that even though these thresholds are standardized, they can be adjusted on a case basis. Sudan uses different cut-offs for South and North whereas Haiti used 26 and 40 as cut-offs on a 5 day week (WFP (2008), Wiesmann (2009)).

These measures are superior over simple diversity as they take into account both the quality (nutrition and diversity) and the amounts (weights and frequency). The major weakness of the measure is that of its recall period. It is rather too long and would give wrong responses, conclusion and recommendation. A recall period of 7 days gives distorted results as one cannot recall the meals in a precise and accurate manner and most of the responses would be giving incorrect information. The choice of the food components also appears not to be standard,

prompting lack of consistency when the score is used. The idea of bundling up diversity, nutrition, frequency and time compresses so many important elements of food security thereby reducing the results and conclusion to mere generality. It is important to consider nutrition as a component to provide a detailed analysis and an informed conclusion. Analysis of utilization measured by the HDDS as a single component of the FCS helps in giving a well defined and informed conclusion on its distribution in the district of Goromonzi.

Household Food Insecurity Access Scale (HFIAS) is a score that seeks to establish whether a household has experienced food access problems in the last thirty days. Selvester, (2008), Coates (2007), Swindale and Paula Bilinsky(2006), defined it as, *“a continuous measure of the degree of food insecurity (access) in the household in the past four week”* as reported by the household. It takes into account the occurrence and severity, answering nine standardized questions whose responses are coded and weighted. These questions cover among other the severity and occurrence of less preferred meals, skipping meals and the lack of resources to have the preferred meals. HFIAS is built on the assumption that experiences of food insecurity induce behaviors and actions that can be coded and a scale established (HFIAS), (Coates (2007) and Selvester, (2008)). This measure can be used to assess seasonal food access insecurity the HDDS being used to investigate the problem of food utilization insecurity in the short. The HFIAS as a measure of food access, increases with increases in food insecurity, thus a high score reflects experiences and occurrences of high food insecurity. On the contrary, HDDS increases with improvements in food security, implying a high HDDS as a reflection of food security. As argued by Nathalie (2012) the two indicators of food security are negatively related. For the same household, a high HDDS should be associated with low HFIAS and vice versa. As the diet of household diversifies, the household reduces on the behavior that is coded to form the HFIAS and vice versa. The major advantage of the HFIAS is that it is easy to administer, flexible to interpret and measure directly the household's experience of food insecurity. It is the only measure that looks at the household experiences of food insecurity rather than distance proxies such as anthropometry measures and food stocks (availability).

There are however, weaknesses associated with this measure especially where there is an active distribution of food handouts. Responses may overstate food insecurity in anticipation of food handouts (Webb et al (2006) and Swindle & Bilinsky (2007)). Goromonzi, the area under study

has limited humanitarian agencies that distribute food aid to the rural household and thus this weakness may be of little significance. This measure can be used jointly with the Household Dietary Diversity Score in analysing the factors that affect food security. As HFIAS is a flexible and simple measure, Selvester (2008) used a cut-off point of 17 or more for HFIAS, as a distinction between those that are considered food insecure and otherwise they were secure.

Much of the available literature (Devereux (2000), Mitiku (2012) and Oni (2010)) considered only access and availability and forgone utilization as a dimension of food security setting aside the crucial element of nutritional security (Swindle and Bilinsky (2005)). Having considered the two differently used measures of food in/security in Zimbabwe and with particular reference to the area of Goromonzi under study, it is thus important to consider a measure that considers the nutritional component of food security. One distinctive proxy measure of food utilization and nutrition security approved by the WFP is the Dietary Diversity Score which can be assessed at all levels of the society. HDDS measures the diversity of a household's diet and was defined by Hoddinott and Yohannes (2002), Ruel (2002) & Selvester (2008), Kennedy *et al* (2010), as *the total number of different food groups eaten in the previous 24 hours* by a household and they further argued that a household can only consume a diversified diet when it has the means to do so. It should then follow that a household can only consume a variety of food groups if either the food is there (availability) or there is the means to acquire or access it (accessibility). This measure they argue is superior as it reflects on both access and availability over and above utilization as dimensions of food security. Inherently, the HDDS reflects on the other concepts of food in/security as well in that a household can only consume the food that is available and that has been accessed.

On the contrary, the reverse is not true as availability and access measures cannot reflect on utilization and nutritional depth of a household diet. Hamond and Dube (2012) argued that the absence of nutrition has several implications at individual, household and societal level ranging from malnutrition, obesity, disease and poverty. Among other advantages, HDDS as a utilization measure is preferable over the others discussed above, since questions on HDDS are simple to administer and it has direct relationship with improved health outcomes as stated previously (Gross *et al*(2000)). Kennedy *et al* (2010) argues that HDDS has a direct correlation with access

measures and with the probability of access to adequate nutrients. As argued by Doan (2013) dietary diversity reflects on the lifestyle and economic statuses of the respondents requiring higher incomes in most cases. Other advantages include a reflection on the diversity of micro and macro nutrients. HDDS can be used to assess food and nutrition security at different levels ranging from individuals; it can also be a tool to assess intra household distribution rather than bundling the whole household on the available calorie as if they all consume the same quantities and types of the food. HDDS can be used to assess changes in the level of food in/security over different time periods, (Selvester (2008)) on the pretext that a reduction in the diversity of the household or individual reflects worsening of the food security status.

Dietary diversity and food utilization analysis can also be conducted among individuals that are not members of the same household and over a diversified population since it can be analyzed at individual level. Societies such as children and old peoples' homes, schools, prisons, hospitals and church gatherings pull together individuals that are from diverse backgrounds and households. These societies might not even appreciate what the units of measurements are when responding to the researchers on food security. They may also not own the resources and or entitlement while they continue having meals and remain being affected by the lack of micro and macro nutrients in their diets. Using any other measure or proxy would yield limited benefits as most of these societal members do not have any available food or the means to access the food. It is thus the advantage of HDDS since it tracks what has been consumed and it is the only that may be attributable to utilization where food is secured even from resources that are not owned.

Swindle and Bilinsky (2005) argued that the HDDS and IDDS (Individual Dietary Diversity Score) conclusions can be drawn on two basic lines. The first being that where information on the incomes is available, comparison can be made to that of the highest earners on the conclusion that increases in these is used to diversify a household diet. The other conclusion can be drawn from the comparison to everyone with the 33% of the highest household diversity. Contrary to this principle, Selvester (2008), used a less than 4 cut-off to distinguish the secure and non secure household which may be low for an area such as Goromonzi that is relatively advanced than the pure rural households whereas Razes and Dop (2010), established a mean of 6 for the food insecure and a mean of 7.2 for the food secure. It is thus a flexible measure where a cut-off can

be set as a case and or researcher specific. Dodson *et al* (2012), established a median of 5 and shown that poorer households had less nutritious diets. This research used HDDS for Goromonzi and raises the cut-off point to 5 as the more a household is exposed to the urban areas; the more likely they are exposed to a variety of food items, thereby improving on the diversity of the household diets.

2.5 Conceptual framework

In his 1798 essay Malthus argued that food insecurity, hunger, famine and starvation are caused by the decline in food output per head. He proposed that it is usually the increases in population that is often more than the increases in the food production which impacts on food in/security in any nation or community. His consideration were that food production should improve or increase at a rate more than the increases in the population such that food output per head does not decline. Malthus was of the opinion that these problems arise since population grows at a geometric rate whereas food availability may grow at an arithmetic rate. It can in present day be noted that Malthus based his theory on the availability concept or dimension of food security against community or household members as discussed before. This concept has been widely used across the world and even recommended by the FAO with a minimum of a daily calorie of 2100. Bishir *et al* (2012) and Batatunde (2007) are some of the authors who have used the food available per head as a measure in analyzing food security. Communities and nations are faced with the problem of food insecurity, hunger and even famine even though the food production, stocks and availability have not significantly been affected. This situation is the one described in the previous chapter as the food security paradox.

Given population levels in the district of Goromonzi (Zimbabwe Census, 2012), this may not be significantly high even though the theory hints towards investigating the household membership. It is thus necessary to explore the impact of the household size as a characteristic together with age and marital statuses of the household head on the level of food security and food utilization as further justified latter. It should be noted that food production has improved over the years. On the backdrop of these arguments food insecurity has been persistent over time. Goromonzi remains one of the most productive of the districts in Mashonaland East province faced with the higher number of households that are considered to be facing food security problems.

Malthusian theory on famine, hunger and food insecurity has been extensively criticized over time by economic theorists such as Becker (1993) and Sen (1981, 1986). Becker proposed advancement in knowledge, skills and investing in the human capital. This increases the rate of return on the investment in the human capital through education, training and household or community development. These returns can come in the form of increased quality and quantity of food production, storage and access. It can even include the aspect of utilization as there will be an investment in information on food preparation and feeding practices over time. This suggests that as population increases over time as suggested by Malthus, resources may increase thereby improving on the food output available, accessed and utilized.

It also implies that it is not just population growth that should be taken into account but the training and strengthening of the family as an institution that promote education quality of life and food security. The education is not only sourced formally but may also come from experience, exposure and over time. This research suggests from the Human capital and the Rotten kid theory, both proposed by Becker (1993), education as an important element in the household. It is thus important to investigate the factors that affect the productive capacity and quality of the household. These can include factors such as the education of the household head, their experiences in farming and their time they spend with the extension service officers as the rural knowledge source. These are the factors that this research takes from the human capital theory and investigate with particular reference to Goromonzi. Since according to Becker the household makes decisions as a single unit and there exist social harmony, it is necessary to analyze food security on the basis of the household head characteristics. This also is supported by the fact that the educated head would thrive to promote the passing of knowledge, information and life experiences to other members of the household

Amartya Sen (1981,1986) having scrutinized the famine in Asia and Africa after observing that there was no significant decline in food output for Bengal, Ethiopia and Bangladesh for the years 1943, 1973 and 1974 respectively. These nations among others faced food shortages and experienced famine even though food output per head and the availability did not substantially drop. This prompted Amartya Sen to come up with an alternative theory that try and explain the food security paradox. He differed significantly from Malthusian approach to the subject of food security, hunger, famine and the policy implications. Sen noted that worldwide food per head has

steadily increased over the years even though hunger and food security has been on the rise. This has manifested in Goromonzi where a food security paradox is evident.

According to Sen, famine, hunger and food insecurity are caused by the failure of entitlements on the part of the substantial elements of the community. Sen (1986) defined entitlements as a reflection on the alternative goods and services that one gets through channels open to him. Where there is private ownership, the entitlement set are derived from the initial resources that are owned by the individual or household. These were referred to as endowments by Sen and can be represented in this research by the land, livestock, granaries and incomes. A household may starve or at least be food insecure if its entitlements have limited food bundle or endowments that can be converted into food. The model is outlined in detail with particular reference to Goromonzi below.

The entitlement approach takes the entitlement set, the endowment set and the entitlement mapping as the three basic conceptual categories. Sen (1981 & 1986) defined the endowment set as the *“fusion of resources, tangible or otherwise that are legally owned by an individual or household in a way that do not defy accepted practices and that’s considered normal”*. Over and above the above examples of tangible resources, the intangibles include education, experience, privileges, age based strength and knowledge. Sen’s entitlement set pulls together the possible combination of commodities that a household can obtain from the endowment set. This may be through exchange, transfer and or production. According to Sen, there are basically four types of entitlements which are the trade, production, inheritance and own labor based. The trade based entitlement come from what one owns from a mutual exchange, the production emanates from the arranging resources in production and inheritance are obtained as a willful gift. The interaction of the endowment set and the entitlement set was defined in the theory as the entitlement mapping. This is the rate of conversion of the endowment set into the commodities defined and included in the entitlement set.

According to the theory food insecurity sets in where the entitlement set has limited food elements in the absence of non entitlements such as charity. They divided the food security into the one caused by changes in endowments and the other one by entitlement mapping. Sen places himself against the idea of defining food insecurity and famine as an availability issue, but look at the characteristics of the household and the individuals as spelling out the causes. He also

acknowledges the failure of markets which are a food access component. It is the factor that the entitlement theory suggests that are subject of investigation for this research.

The theory best fits the area of Goromonzi under study as it has several characteristics that may either promote or suppress food insecurity. The area supports the phenomenon of the food security paradox that has given birth to the theory. These are the relatively high levels of food insecurity that is coupled with food availability. The resource endowments of the households in the district are wide and general but may be analyzed such that the characteristics may be investigated on their impact on the food and nutrition utilization.

In light of the above theories, the demographic and socio-economic factors are divided into the assets or endowments, human capital, incomes and the demographic. Of the factors that this research seeks analyzes, the demographic ones are the age, age squared, size of the household marital status, occupation and sex of the head the household head. The human capital which tries to estimate the productivity of the household is the education, experience and access to the agriculture extension services. Liquidity will be used as the total income whereas the assets that are important to the rural farm household used are the land size, livestock ownership and the granary capacity. Having gathered these factors from theory it is thus necessary to justify them as in further below.

2.6 Empirical literature review on food in/security

FAO recommended a cut off of daily 2100kcl per individual prompting the analysis of the subject of food security using Probit and binary models. Literature on food security has extensively used this availability concepts, measuring Calorie food availability and using cut offs that were not standardized and inconsistent with each other such as 2228kcl (Pankomera(2009), 2100kcl (Bogale&Shimelis 2009), 2450kcl (Bashir *et al* 2012), 2250kcl (Amaza2006) and others where Mitiku (2012) and Sidhu (2008). Much emphasis has been put on the availability dimension with all its weaknesses against utilization, access and stability as highlighted previously. On the other hand, Arene and Anyaeli (2010) and Selvesteret *al*, (2008) used the HFIAS to analyze food in/security as measured by the access concept. They used logit models defining the cut offs for being food secure and otherwise food insecure. In Goromonzi the use of Binary Logit or Probit on this measure may be useful as it tracks and codes the behavior of households in response to the lack of enough or sufficient food. There has to be a threshold on

the actions that a household can take and these may be placed at a level that is relatively higher than for purely rural and for purely urban. The threshold arises since by definition HFIAS codifies the occurrence and severity of food insecurity. There has to be a limit on what a household has to do as induced by food insecurity. It control for the avoidance of scavenging and violent means of sourcing food. This is so as the district of Goromonzi has access to both amenities and institutions for the urban and rural. Food security analysis should not just be based on variables (Calorie and HIFIAS) that are for a relatively longer period of time and that may be subject to change and to be different at a later date. They may not be the best for analysis of food security at a point in time. Most measures of food security are continuous variables that may be simple to analyze with the Ordinary least Squares methods

Selvester *et al*, (2008) went further to look at the utilization of the food by households in Mozambique by measuring food in/security using HDDS. They used Logit defining a cutoff of 3.9 for the households. With HDDS it is important to have an improvement of the score itself. An addition of one food group consumed by an individual or household is in itself a favorable outcome as it improves on the nutrition and health benefits as already discussed. It has a general inherent reflection on the lifestyle, incomes and economic statuses (Doan (2013)). It is thus necessary to apply OLS as it gives a linear relationship between the dietary diversity at household level with the factors (social, economic and demographic) that contribute to the HDDS. Using several indicators of diversity that include the Berry Index, Count Index and Entropy Index, Drescher & Goddard (2011), Hoddinott & Yohannes (2002) and Lee (1987) analyzed dietary diversity respectively as cited in Doan (2013). The Berry index and the Entropy are indexes of products consumed in a food basket and are difficult to administer as it considers the actual food whose list may be endless. Using HDDS is better as it groups food items with similar base nutrients together. All these researches among others used the ordinary least square methods of estimation. They concluded that incomes are a major factor that affects the diversity of a diet regardless of the measure. The researches cover areas that are diverse in themselves ranging from the developed to developing nations and from rural to urban areas. Their method of estimation remained OLS. Although HDDS can be made dichotomous, in itself, it meets the requirement of the OLS estimation as it is a continuous variable and may follow:

$$HDDS = \phi + X\beta + \varepsilon, \quad \text{where } \varepsilon \approx N(0, \delta^2)$$

$$V(HDDS) = V(\phi + \sum X\beta) + V(\varepsilon)$$

This implies the variance of the HDDS being the same as the sum of the explained variance and the residual variance.

2.7 Theoretical and Empirical Justification of Variable

2.7.1 Demographic factors

Age of the household head: Age and Age squared

This is the number of years of a household head, a continuous variable that captures the effect of gained life skills on food and nutrition security. Age can be interpreted as the level of assuming responsibility as the household head is the centre for decision making, affecting household access and food diversity. Age may interact with other variables such as gender and income in determining food security. The age of a household determined whether or not one is able to provide labour either for home production or in the labour market. In addition, age plays an essential role in the decision making process as skills gained over life years are factored in when one makes a decision such as participation in cash crop farming or cereal production. It helps distinguish between the levels of food security for households as the age varies, common distinction are often that of child, elderly middle aged and working class headed families. Household head age is one of the most researched determinants of food security in literature (Pankomera et al., 2009 and Bogale and Shimelis (2009)). Musaraet al (2011) argued that age is negatively related to farmer's probability of participation in contract farming. In 2003, Donovan et al noted that individuals between the ages of 15-60 years will be at their prime age when they being most productive and contributing more labour and income. We however consider the positive contribution of higher age to have a limit. Thus there should be a limit after which age will negatively contribute to food security as the production capacity of household head will be declining, both in the labour market and own production. In this study we therefore expect household's Agesq to have a positive relationship with Dietary Diversity and to have a negative related to food security as highlighted in the descriptive statistics in chapter Four. We anticipate that as age increases the level of food utilization and access has to improve up to a certain point beyond which it declines. This therefore implies that there is an anticipated negative relationship between food utilization and age of the household head squared. The study expects an inverted U

shaped or a concave relationship between a household head's age and food security and a convex relation with food and nutrition insecurity as measured by HDDS. It should be such that the child and elderly headed families be relatively food insecure consuming a less diversified diet (DDS) and adjusting their consumption behavior more often (HFIAS) compared to the middle age headed families. This is the general expectation for the three models that will be estimated.

Household size

This is a continuous variable measured by the number of household members. The more members a household has the more labour maybe available for own production and probably for off-farm income. However, more household members exerts more inward pressure as more food will be required on the table for own production. The net advantage of more household members depends on their individual characteristics which are difficult to capture in this study. The overall position depends on the age distribution of the whole household, including the number of household members that provide agricultural labour, those participating in the market and minors. Pankomera *et al*, in 2009 found that household size was negatively related with food security. In contrast, Amazaet *al* (2006) reported that household size has a negative impact on food insecurity. Since Goromonzi is primarily an agriculture dependant community this research generally expects a positive relationship between food security and household size on the pretext that the more household members, the more labour available for production. Breaking the impact into the two measures used, Food security as measured by HDDS may be limitedly affected by household size as it tracks the diversity of what they are consuming. On the other hand HFIAS tracks the food insecurity experiences, thus it may be affected by the household size. A bigger household has exposure to experiences such as the limiting of meals and skipping of meals more often than a smaller one. Hence the size of the household is expected to have some impact on the HFIAS more than it can have on the HDDS. With HDDS, it may be such that a household head concentrates only on having meals rather than on the nutritional components and the diversity of the food hence the limited expected impact on food insecurity.

Household Head sex

Household sex will be a dummy variable capturing whether or not food security status differs between male and female headed household. Gender plays a special role in the aspects of food security. Males may be considered strong in the aspect of providing crucial farm decision

making and labour than females. In addition there is a tendency to specialize within the household, where the females perform tasks related to food preparation while males are important in the production of food in the farm and in the participation in the market employment. Females have limited access to productive resources such as land (Chakona (2011)) which in cultural and rural male chauvinist communities identified with and considered to be primarily owned by males. Generally, households with more males are likely to be more food secure than those with less. Females are however considered important in that they are more caring for the family compared to males and also that food preparation is done with more consideration to diet. Males at times prepare food for the sake of feeding concentrating mainly on quantities and failing to take into account diet and also with less attention to quality. Amazaet al (2006) found a statistically significant difference food security status between males and females. Kennedy (1992) stated that gender interact with income to impact on food security and as well may affect the nutritional security of the households in the district of Goromonzi. It is the expectation of the study that there shall be a higher level of food and nutrition security for male headed families and vice versa. There is however a pronounced and a generally agreed preconceived notion in rural Zimbabwe that the decision on food and diet is made by the female household members, even if they are not the head of the family. It is such that even if the household is headed by a male, the decisions are made by the senior female who may happen to be the spouse, daughter, aunt and or sister among others. This would reduce the relevance of the household head sex as a determinant of food and nutritional diversity. Nonetheless this measure need to be investigated and insights be drawn to establish its impact on food access and utilization.

Household head marital status

The marital status of the household head affects the level of utilization and access to food. There has to be a difference between a single and unmarried household head food security status. It is the prior expectation of the research that the couple headed family has a limited HFIAS and a high HDDS indicating substantial food access and utilization. This is an important variable as Carter et al (2010) found out that food insecurity was associated with unmarried headed households.

2.7.2 Human Capital Factors

Experience in farming, exp

This variable is continuous variable measuring the years that the household has been farming. Households with more years in farming are likely to produce more output stemming from utilization of past experiences both in production and consumption. Appropriate farming experience is applied in decision making, responding to policy, threats and challenges posed by various stakeholders and nature during any farming season. Well established farmers are also able to get financial assistance from financial institutions as well as support from agricultural institutions compared to new and inexperienced farmers. The farmers are also well positioned in the market than their counterparts. Thus farmers with more years in farming are more likely to be more productive than new farmers. This view was tested supported by Barkai *et al* (1973). He stated that productivity increases as efficiency increases with more years in production. We therefore expect a positive relationship between farming years and food nutrition security.

Access to the agricultural extension worker

Farmers who regularly receive extension services are expected to improve productivity through adoption of innovation and improved technology (Enesu, 2005). Improved productivity will enhance the food basket of the household, thus addressing the access and utilization dimensions of food and nutrition security. The variable can either be measured by the distance from the nearest service provider or the number of visits by extension service providers. The study measures access to extension services by the number of visits by extension service providers to the household. Further the study predicts a positive relationship between food access security and the visits by the extension services provider. It should be such that more visits should be associated with low levels of HFIAS. With a positive access contribution to food security, there should come an improvement of the Household Dietary Diversity Score. Therefore there has also to be a higher level of visits by the extension officer corresponding to high levels of food utilization and food and nutrition security (HDDS).

Education

Education measures the level of schooling that a household head has attained. It is an important aspect of life with those educated likely to be better than the uneducated ones as education opens

up for labour income, information, networks and prompts options in addressing food utilization and access. Education is crucial in as far as life skills and decision making are concerned. It further plays a significant role in areas where technological development and adaptation to changes are important. This factor is important for Goromonzi as it is adjacent to the metropolitan city where information is easily disseminated and new ways of doing things are accessed. This is accelerated by the level of education as people learn about the new foods on the market and also new ways of preparing them. In 2006, Amaza *et al* noted that education of a household as a statistically significant determinant of food security with a negative relationship. Iram and Butt (2004) argued that mother's education is one of the most important determinant of food security with a positively impact in Pakistan. Other studies such as Oni *et al* (2010) found out that respondents' food security status was indifferent with education. This study however considers education to be an important contributor to food security, thus we expect a positive relationship between household head education and food security.

2.7.3 Assets

Land size, ls

Land is the principal factor of production, where food is both generated and consumed. The more land a household holds the more chances they have in the ability to produce. Those with less land are also limited in production and cannot hold draft animals as they need a fairly large piece of land. They may not do animal husbandry and poultry rearing. This promotes the availability of milk and milk products and protein thereby raising the access and utilization these food stuffs. An improvement brought about by the access of these improves both the access (HFIAS) and utilization (HDDS). However output from a piece of land both in crop and animal farming may depend on the productivity of the farmer. Output per unit of land may differ, meaning that it may be possible for farmers with the different pieces of land to produce the same level of output and also for farmers with the identical pieces of land to produce different yields. Begale and Shimelis (2009) noted that farm size has a positive impact on calorie intake, a point supported by Amaza *et al* (2006) who argued that there was a negative relationship between food insecurity and farm size. The study will expect a positive relationship between food utilization security and farm size.

Livestock ownership, lo

This variable refers to livestock as part of the major assets owned by a household. Assets are an important component for a household food production as well as getting food entitlement. Bogale and Shemelis (2009) stressed that there exist a positive relationship between assets owned and food security. Amaza *et al* (2006) provided the foundation as he argued that the value of assets owned had a negative relationship with food insecurity. Livestock can reflect on the capacity to generate, access and utilize food at household level. Livestock are an important asset for households and are the prime assets for farming predominantly used for draught power in most rural areas of Zimbabwe Goromonzi included. They can be directly consumed for meat, while they provide milk for the household. This in its own advances the access and the utilization of food, thereby improving food security at household level. Livestock provides the household with organic manure that is an input in the production by the family. Furthermore, cattle can be a crucial exchange item for food stuffs during times of famine and hunger. Livestock can be sold to generate substantially significant amounts of incomes that can improve the food access and as well the utilization by the household. Mitiku *et al* in 2010 put forward the fact that livestock ownership is an important aspect for food security. The view that livestock ownership has a positive significant impact on food security was also concluded by Pankomera *et al* (2009) and Zeller and Sharma (2000). This study will expect a positive relationship between food security and livestock ownership.

Capacity of the granary

This is storage dimension of farm production. Households may lose output and fail to consume food or fail to have enough because of poor storage facilities and capacity. Aspects of storage include standard granary containing adequate moisture components, control of insects and management of the taking into and out of the granary. It also takes into account the temporary storage infrastructure such as the *dara* used in rural Zimbabwe and long term granaries that may be built separately with compartments for a variety of cereals. The measuring of the granary for analysis is discussed in the next chapter. We expect a positive relationship between granary capacity HFIAS and utilization HDDS. It should be such that those without proper storage in terms of quality and space should experience exposure to food access insecurity induced behavior while the ones with will consume from their granary.

2.7.4 Liquidity

Liquidity covers the incomes earned from labour market, farm activities, and remittances. The farm incomes include both the sale of crops, livestock and livestock products. The variable sums up incomes from all sources. Income provides entitlement to food from the market and enables a household to diversify its diet. The more a household earn, the more secure he is likely to be. More income will further mean more command to inputs required for own production such as agricultural inputs and farm assets. Income provides a channel for commanding and accessing adequate food. In 2009, Mitiku *et al* concluded that incomes are positively related to food security. Supporting this idea, (Marco M De and Thornburn S, The relationship between income and food insecurity among Oregon residents: Does social support matter?, 2009) stated that income has a strong positive impact on food security such that social support cannot offset the negative impact of low incomes. In 2001, Barret stated that non farm income promotes farm productivity by intensifying animal traction adoption. However, Migot-Adholla *et al* (1991) had argued that households with nonfarm income experience higher levels of production. This study will nonetheless expect a positive relationship between income and food security.

2.8 Conclusion

Having explored the definitions of food and nutrition security and provided a detailed theoretical analysis of the subject, in conclusion, it can be noted that Goromonzi has potential and the prevalence of food insecurity should not be expected to be high. This area has several favorable characteristics as compared to most of the other districts in the Mashonaland East Province. It is thus necessary to analyze the relationship between the food and nutrition in/security and socio-economic and demographic characteristics of the district of Goromonzi. The following chapter tries to outline how the research was investigated on the determinants of food and nutrition security in the district of Goromonzi. It explains the measurements of the variable justified above and the methodologies that will be employed in the furtherance of the research objectives.

Chapter Three: Methodology

3.1 Introduction

This chapter lays down the methodology and procedures adopted to establish factors accounting for food in/security in Goromonzi district. Measures of food in/security to be used, HDDS and HFIAS will be defined while the econometric model to be estimated will be specified. The actual measurements of the variables discussed in the previous chapter will also be highlighted special consideration of the available data, area under study, research problem, research questions, theory on food and nutrition in/security and related empirical literature. Data source and their relevance will also be discussed in the chapter. The chapter therefore focuses on outlining the way the research objectives will be made operational.

3.2 Theoretical Model

There are basically three models to be estimated. The first one is a basic OLS which tries to explain the HDDS as a proxy measure of food security. The second will seek to divide the utilization measure HDDS into two, the food secure and the food insecure, then use the Probit model to investigate the determinants of the food in/security. Further to this, a food access score, the HFIAS will also be divided into two and Probit models will be used to establish the statistically significant factors. These three models tries to establish the factors that are highlighted in the research objectives and answering the research questions raised in chapter one. Theories outlined in chapter two summarize food in/security as mainly affected by Assets, Liquidity, Demographic and Human Capital factors. Thus, the generalized theoretical model of food in/security can be stated as follows:

$$FI = f(l, a, hc, d)$$

where

FI is an indicator that measures or the distinction between whether or not the i^{th} household is food access and or utilization secure. l is the incomes that proxy the liquidity of the household, a is a set of assets owned by the household, hc is the set of human capital factors, while d is a set of demographic factors affecting food nutrition and access security at household level. This model considers factors that are set to affect home food production and those that determine

access to market food. This is but the generalized form of the equations whose actual factors are drawn from a wide range as discussed in Chapter Two and are specified in the models that are listed in sections below. The models that will be estimated are the simple Ordinary Least Squares, a binary estimation for HDDS and a binary estimation for HFIAS. The exogenous variables remain the same so as to allow for comparison between the measures and the factors that affect them as suggested by the second research question.

3.3 Model specification

For the three models that are to be estimated, the functional form will be given as below with the exogenous variables highlighted further below.

$$FSI_i = f_i(\text{age}, \text{agesq}, \text{edu}, \text{hsize}, \text{hsex}, \text{hmstatus}, \text{exp}, \text{ls}, \text{lo}, \text{income}, \text{grcp}, \text{ext})$$

Where;

FSI is the food security indicator for the i^{th} household and the dependant variable in the models. These dependant variables can either be the HDDS, binary for HDDS and binary for HFIAS.

age is the age of the i^{th} household head

agesq is the squared age of the i^{th} household head

edu is the level of education of the i^{th} household head

hsize is size of the household of the i^{th} household

hsex is the sex of the i^{th} household head

hmstatus is the marital status of a i^{th} household head

exp is farming experience for the i^{th} household.

ls is total land size owned by the i^{th} household.

lo is livestock ownership by i^{th} household.

income is the total income received by the i^{th} household as a whole.

$grcp$ is the capacity of the granary for the i^{th} household

ext is the access to the agricultural extension worker by the i^{th} household

The first OLS specific model for food utilization and dietary diversity is given as below:

$$HDDS_i = \alpha_0 + \alpha_1 age_i + \alpha_2 agesq_i + \alpha_3 edu_i + \alpha_4 hsize_i + \alpha_5 hhsex_i + \alpha_6 hmstatus_i + \alpha_7 exp_i + \alpha_8 ls_i + \alpha_9 lo_i + \alpha_{10} income_i + \alpha_{11} grcp_i + \alpha_{12} ext_i + \varepsilon_i$$

Where HDDS is the Household Dietary Diversity Score

The second specific model is the Probit regression model which seeks to establish the factors that are as given above measuring food in/security with HDDS. This can be as given below where FS_{HDDS_i} is the food security or insecurity of Household i using HDDS and it takes the value of 1 for food secure and 0 for otherwise

$$FS_{HDDS_i} = \beta_{0i} + \beta_{1i} X_i + \mu_i$$

The X represents the factors as highlighted in the first estimation

The third specific model is a Probit regression and mirrors the second model above but using the HFIAS to determine the household status on food in/security. It analyzes exactly the same factors as the previous models. The model can be specified as where FS_{HFIAS_i} is the food security for a household i and takes the value of 1 for food secure and 0 otherwise

$$FS_{HFIAS_i} = \lambda_{0i} + \lambda_{1i} X_i + \omega_i$$

3.3.1 Definition, justification and quantification of the variables

This research extends the scope of food security research from the commonly used (Arene and Anyaeli (2010), Oni *et al* (2010), Iram and Butt (2004)) by looking at the extent of impact of the factors discussed derived in the previous chapter on the utilization of the available food as an indicator of food and nutrition in/security while comparing it with the access. Measures of food in/security are different from those that were used by Devereux 2000, Mitiku *et al* (2012), Oni *et*

al (2010) Pankomera *et al* (2009), Bogale & Shimelis (2009) and Bashir et al (2012) among others. This research has its main thrust in the establishment of factors that influences the diversity of a household diet as a proxy measure for food and nutrition security.

Dependant variables

Household Dietary Diversity Score (HDDS)

This is the dependant variable in the first model measuring the diversity of a household diet as reported by the household respondent. This is a continuous measure of food consumption considering the number of different types of food groups that are consumed by a household in a 24hr recall. The more the food group types that the household consume, the more food and nutrition secure a household is and vice versa. It is built on the assumption that the food is consumed at household level and there are limited cases where there are differences in the intra-household consumption patterns. For this research, the food groups are divided into ten and this gives the measure a maximum possible range of from 0 to 10 in the area under study. These groups include fruits, cereals, roots and tubers, milk and milk products and meat, poultry and offal. The most food secure household consumes all the ten food groups whereas on the other hand the one who does not consume anything is the most insecure. This variable is numeric and continuous and it allows for the use of the simple OLS. Kennedy *et al* 2010 and Swindale & Bilinsky (2006) noted that, it is necessary to improve the diversity of a diet at household or individual level and thus, this research seeks to investigate the factors that can induce an increase in the food groups that are consumed at household level. This variable is regressed on the assets, liquidity, human capital and demographic factors that are associated with the household.

Food security indicators for HDDS (FS_{HDDS})

This indicator is analysed using the Binary Probit model assuming 1 for food secure and 0 for the food insecure household. This is the dependant variable in the second model to be estimated and uses the HDDS cut off to establish and divide the households into two, the food and nutrition secure or non-secure. Selvester *et al*,(2008) used a cut-off of less than 4 for Mozambique whereas for Tanzania a cut off of 5 was used by Cordeiro 2012, as a distinction of whether a household is food secure or otherwise. The household that had a score of equal to or greater than

4 for Mozambique was considered to be food secure whereas the less than was considered to be food insecure and the score of 5 for Tanzania. Selvester et al, 2008 did his research 5 years ago, and now in 2013 it is necessary to raise the score for one to qualify as being food insecure as time should allow for improvements in community welfare were information is easily available. Cordeiro, raised the score in his 2012 research, it is necessary to raise the score by one from the level used for Tanzania and such that at least the research uses the mean and median score as the cut-off for a household to qualify as being food and nutrition insecure. It is also necessary to raise the score as for the past 5 years in Zimbabwe incomes and the food availability have generally improved in the multi-currency system that is prevailing at the time of this research. Generally analyzing the data for Goromonzi district can show that the mean and the median are 6 and the mode is 8. This confirms the district has better economic, lifestyle and nutritional exposure than in Mozambique and Tanzania. These are the same households that are same households that were estimated to endure a relatively high food insecurity level. Thus it should be necessary to set a maximum of five as the cut-off for food insecurity such that any household that has a HDDS of five and less is considered food insecure otherwise they are food secure.

Food security indicators for HFIAS (FS_{HFIAS})

This is a dependent variable in the third model to be estimated and distinguishes between food secure or insecure households on a scale ranging 0 to 27 using the access concept of food security. Selvester *et al* (2008) used a score of 17 as a cut-off for establishing if one is food secure or otherwise they are food secure. The score seeks to strike a balance between the occurrence and severity of food insecurity by asking nine questions on food insecurity. There are 9 questions whose responses are coded from 0 to 3. It is such that 0 has no occurrence of the insecurity experience and 1 is for the least affected by the exposure where on the other hand 3 is the most affected. The responses to the 9 questions are summed up to get the HFIAS. Building on this, the research makes a cut-off of 13, implying that, any household that has a score of at least 13 and above is considered to be food insecure otherwise they are food secure. Out of a total score of 27 it is thus necessary to adjust for time on the score used but rather change the cut-off that was used by Selvester et al, (2008). It is necessary to drop the HFIAS score to at least 13 as to qualify for being food insecure on the access scale.

Independent variables

Age and Age squared

Age is continuous taking the life years of the household head. For ease of administration and limited by the data availability, it is only the age of the head of the household that is used. The age is as reported by the respondent and as provided CIAT. The age distribution in Goromonzi as per the available data has a range of 66 years and an average of 49. The age of the other household members are not used for this research as the main inclusion of the variable was motivated by power of influence in decision making. To arrive at the age square, the age of the household head is multiplied by itself.

Size of the household

The size of the household takes the number of members of the household. It sums up all the people that are members of the same household, taking the children, parents, household head and even the family extension. It takes those considered to be members of the household. The families in Goromonzi were covered by the Zimbabwe Census (2012) and an average of 4 was arrived at as highlighted in the background to this research.

Household head Sex, Education and Marital status

These variables are included in the model as dummies. The education is a dummy variable that seeks to capture the ability to interpret simple and basic information. For this research the dummy seeks to look at whether or not the household head has basic literacy. This would help in basic communication and even information gathering, interpretation reporting and even in negotiation. At least a Secondary level is considered as the basic cut off point for this research and takes the value of one against the below secondary level standard which takes a value of zero.

The marital status on the other hand is a dummy variable that takes the value of one for a married household head and zero for otherwise. The otherwise case takes the widowed, single, divorced, never married and the widowers. These will be compared with the household headed by the married. The sex of the household head takes the value of one for male and zero for female headed households

Farming Experience and access to extension services by the household

The experience of the household in farming is measure as a continuous variable in all the models estimated. It tracks the number of years the household as a whole has been farming, regardless of the household head age or size. These are the measured in the number of years as reported and provided by the CIAT. The experiences are reinforced by the pillars of information in rural areas. These are the extension service providers. Access to the extension service is measured for this research by the number of visits received at the homestead by the extension officer in a given year. These two variables are continuous.

Land size and livestock ownership

The land size measure in hectors the land owned and controlled by the household as a whole. It tries to cater for the ability of the household to rear livestock and diversified farming. The number of the hectors is as provided by the data source. It does not consider the quality of the land, whether it is for animal husbandry or crop production. The land supports the raising of livestock which for this research is measure by the number of cattle owned by the household as a whole. The household may own other domestic animal but, these were not included in this research as it is difficult to sum them up. The research only considered the cattle owned as justified in the second chapter.

Incomes

These are the total incomes that accrue to the household as a whole as measured in United States Dollars. Incomes are arrived at by summing up the remittances, employment, agriculture and any other income of the household. This is an important and as well as a continuous variable that is used in the models of estimation. The data on the various sources of the farm household incomes was provided with the data. The researcher had to sum them up to come up with the total that was used a proxy to the liquidity of the household.

Granary capacity

This measures the storage ability and capacity of the household. It is a continuous variable that tracks the available space to the household that is set aside for the store of the final food stuffs and inputs. The area is measured in terms of the number of square meters set aside for storage. It does not limit to only a formal stand alone granary building but looks at the space created or that

can easily be converted for storage as and when the need arises but not for temporary drying of crops. This inclusion helps in capturing the households that do not have separate buildings set aside as granaries but make use of their infrastructure for storage as the need arises. It was because of the limitation of the data that the quality of the data could not be included in the model. Storage capacity may reflect on the productive and income generating capacity of the household. Thus the number of square metres allocated or easily transformed into grain storage facilities is used.

3.4 Data Sources

The data used was obtained from a question survey of Goromonzi District conducted by the International Centre for Tropical Agriculture (CIAT). They collected both quantitative and qualitative data on food security status, households' socioeconomic and demographic characteristics from across the 25 wards in the district. These two measures of food utilization (HDDS) and access (HFIAS) respectively were calculated and provided with the data. Thus, the data set contains sufficient information to investigate the various food and nutrition security indicators to be used in the execution of this study. Secondary data on rainfall, temperature and humidity was sourced from the Meteorological Services of Zimbabwe while that on food production across the Mashonaland East Province was collected from the Agricultural extension services. These secondary data were instrumental in informing the formulation of the research problem that is the subject of this dissertation.

3.5 Conclusion

This chapter primarily focused on outlining methods employed in the study to establish factors affecting food and nutritional security. The model to be estimated was specified and measurements of all variables considered in the study were defined and justified. It discussed the nature of the data that will be used in addressing the questions that the researcher is posing and also its sources. The next chapter will provide descriptive statistics of the data used in the study, estimate the OLS and the Probit regression models and interpret the results. It runs the diagnostic tests that have been highlighted in this chapter.

Chapter Four: Estimation, Presentation and Interpretation of results

4.1 Introduction

This chapter estimates the models that are specified in chapter three after having and the results of the diagnostic test carried out. It estimates the results of the Household Dietary Diversity Score and the Household Food Insecurity Access Scale as explained by Assets, Liquidity, Demographic and human capital factors. These are regressed on the explanatory variables as outlined in the previous chapter. The significance of these variables is discussed in detail and in stages as well as the implications of the results on the food and nutrition security. Firstly the results of the Ordinary Least Squares Estimation are discussed, then the Probit for factors that affect food utilization and lastly the Probit for food access. The chapter outlines the descriptive analysis of the data used for the research by way of cross tabulations.

4.2 Descriptive analysis of Goromonzi

For the tables in this subsection, the data is presented such that frequencies are given by the absolute number of households that are consistent with a given level of HDDS and HFIAS. The figures in brackets right below the absolute frequency are the percentages of households that have the same given characteristic. The variables that are analyzed below are the age, experience, incomes and marital status of the household head.

HDDS

The distribution of the household dietary diversity for the district of Goromonzi can be divided into four groups and represented in the table below. It can be noted that more than 50% of the households under survey in the district of Goromonzi have a diversity of diet less than 6. It can further be observed from table 1 below that a very small proportion (3%) is highly secure as compared to the ones that are highly food insecure (19%). Most of the households are concentrated in the group of the diversity that is less than the mean and the mode of 6 and 8 respectively. A proportion of 19% consumes less than 4 food groups a day. This figure is relatively more than the one that is reported by the ZimVac (2012 & 2013) as being food insecure in the same district. This highlights the need to investigate the household characteristics.

Table 1: HDDS Frequency distribution

HDDS Level	Ö4	5-6	7-8	9-10	Totals
Frequencies	32	57	74	6	169
percentages	(19%)	(34%)	(44%)	(3%)	(100%)

HFIAS

Food security improves as the HFIAS score declines and vice versa. It can be observed from the data in table 2 below that as high as 69% of the households in Goromonzi are food secure. They have not severely experienced food insecurity, although 31% of the households are food insecure. These are a higher proportion for an area such as Goromonzi that is supposed to have better access to food with all its characteristics as discussed in the previous chapters. It is such that the proportion that are not accessing food (high HFIAS) is almost the same as the one that is not utilizing the same food (low HDDS) thus these need to be further statistically investigated.

Table 2: HFIAS Frequency Distribution

HIFIAS Level	Ö13	>13	Total
Frequencies	116	53	169
percentages	(69%)	(31%)	(100%)

Experience and HDDS

If the farming experience of the household is grouped into the less experience and the relatively experienced household, a trend can be observed. For the households that have the limited experience in farming with a maximum of 15years, it can be noted from table 3 that more than 70% lay in the lower groups of the food utilization clusters. Only less than 30% of the less experienced households have higher HDDS.

Table 3: Farming Experience and HDDS

HDDS level		2-4	5-6	7-8	9-10	Total
Lowly experienced	Ö15	30 (28.57%)	49 (46.67%)	25 (23.81%)	1 (0.95%)	105
Highly experienced	>15	2 (3.13%)	8 (12.5%)	49 (76.56%)	5 (7.82%)	64
Total		32	57	74	6	169

On the contrary the highly experienced households have more than 80% enjoying high Dietary Diversity with only the remainder as having lower experiences in lack of food utilization. It can be noted that experience has an effect on the food utilization as measured by HDDS in the district of Goromonzi. This supports the priori conclusion that has been arrived at in the previous chapters.

Income and HDDS

Incomes prompt and promote food access and utilization as well has been the case in the district of Goromonzi. The incomes for the district have been grouped into three struts to allow for easy comparison as the basic (less than USD1000), enough (between USD1001 and USD4000) and plenty (more than USD4000) incomes. The main aim is to establish if those with plenty incomes can use them for the utilization of food as indicated in the diversity of the food that is consumed by the household. It can be noted that those with limited incomes are much concentrated in the lower levels of HDDS and hence the lower levels of food utilization. As the incomes increases proportions of households with lower HDDS reduces as well those with improving scores improves. From the table 4 below a proportion of 1.82% has plenty incomes but does not highly utilize food. This proportion is rather negligible and insignificant. The group also has all the households that enjoy the highest HDDS level of 9-10.

Table 4: Incomes and HDDS

Income levels	Frequencies of household with HDDS at a given income bracket				Total
	2-4	5-6	7-8	9-10	
Ö1000	27 (33.33%)	45 (55.56%)	9 (11.11%)	0 (0)	81
1001-4000	4 (12.12%)	11 (33.33%)	18 (54.55%)	0 (0)	33
×4000	1 (1.82%)	1 (1.82%)	47 (85.45%)	6 (10.91%)	55
Total	32	57	74	6	169

Age and HDDS

With age divided into three clusters taking less than 35, from 36 to 55 and above 55, the utilization of food can also be analyzed in respect of this demographic characteristic. From the table below it can be noted that the middle class of age has a greater proportion of the households in the food secure levels of utilization. This is not the case on the young and aged headed households as they have more than 50% below the HDDS of 6.

Table 5: Age and HDDS

Age	Frequencies of household with HDDS at a given age bracket				Total
	2-4	5-6	7-8	9-10	
Ö35	1 (3.45)	14 (48.28)	10 (34.48)	4 (13.79)	29
36-55	9 (9.68)	25 (26.88)	57 (61.29)	2 (2.15)	93
×55	22 (46.81)	18 (38.3)	7 (14.89)	0 (0)	47
Total	32	57	74	6	169

From this conclusion it can be established that for low age have low HDDS but improves as age increases. These increases are up to a certain point where the utilization begins to decline. This prompted the necessity to include age square in the model estimation as argued in the previous chapter since the data suggests a quadratic relationship between age and food utilization.

Marital status and HDDS

The marital status of the households has been divided into two for this research taking the married and comparing it with all the other possible non married responses from the responses as discussed in the previous chapter. The aim of this analysis is to distinguish food utilization between households whose heads are married and those that are single. From the data on Goromonzi it can show that the highly food insecure are the non married headed household although the differences are not that pronounced. It can be noted that a diversity of less than 4 is relatively more pronounced in the non married headed households in Goromonzi.

Table 6; Frequencies of Marital Statuses and HDDS

Marital status	Frequencies of household with HDDS for a given marital status				Total
	2-4	5-6	7-8	9-10	
Married	5 (12.5%)	18 (45%)	15 (37.5%)	2 (5%)	40
Otherwise	27 (20.93%)	39 (30.23%)	59 (45.74%)	4 (3.10%)	129
Total	32	57	74	6	169

(Percentage in brackets)

4.2.1 Results of the tests carried out

Upon completion of the three regressions as explained in the previous chapter, different factors proved to be relevant in explaining the concept of food and nutrition security as measured by the access (HFIAS) and the utilization (HDDS). Some of the variables were significant for both the HDDS and HFIAS. These variables can be explained as affecting both consumption patterns of the household and the experiences or behavior of the household in response to food and or nutrition in/security. However there were some factors that are important that still could not be

justified to have explained food access and utilization. These remained statistically insignificant at 10% level of significance testing.

Table 7: Results of the Models estimated

Variable	Statistically significant variable for HDDS		Statistically significant variable for HFIAS
	OLS	Probit	Probit
Income	0.0000976 (0.000)	0.001 (0.001)	-0.0002 (0.005)
Exp	0.0256124 (0.002)	-0.064 (0.048)	
grcp7	0.1692199 (0.000)	0.631 (0.000)	
Hhsize	-0.0364006 (0.003)	-0.386 (0.007)	
Ext	0.0567508 (0.000)	0.588 (0.000)	
Age	-0.0278437 (0.000)		
R ²	0.7452		
Adj-R ²	0.7255		
F-test	38.01 (0.0000)		
LR Chi2		175.12 (0.0000)	
Pseudo-R ²		0.8212	

Results of the variables that were significant in the first model run across all the three models.

The factors under investigation were grouped into four in the previous chapter. By making a general analysis of the groups it can be noted that the demographic factors do represent a limited number of factors that affect food security as measured by both the access (HFIAS) and the

utilization (HDDS) assessment. It is the other three groups of factors that command the greater proportion of factors that significantly influence food utilization on the data that was used on the research area. On the other hand, with the data that was used in the research, only incomes, statistically affected food access as measured by HFIAS scale. Under Probit for food utilisation it was factor such as age, size of the household, incomes, and access to extension services that proved to be statistically significant in affecting food utilisation on the data for Goromonzi district. These were also significant for the OLS estimation of the HDDS as a measure of food utilisation and a proxy for food security. Below is the statistical analysis of the variables in respect of the three estimations. The variables are discussed in detail for each and every method of estimation. First is the analysis of the results for the Ordinary Least Squares and then the Probit for utilisation and then the Probit for food access.

4.2.2 Dropping of the insignificant variables

It was difficult to continue with the Probit for access as measured by HFIAS as a greater number of the variables were insignificant. Of the unrestricted model or the general model estimated, only income was found to be statistically significant in affecting food security as measured by the HFIAS and as has been shown in the table below. In the unrestricted model of HDDS, household head education and marital status, age squared, land size, livestock ownership, household head occupation and sex were found to be statistically insignificant at all levels. These variables were dropped and the regressions were carried out with only those variables relevant in the first OLS model. These variables are the age of household head, size of household, experience, granary capacity, access to extension service and income. They were tested across the three models to check answer the second research question on the consistence of factors affecting Access and utilization as explained in the first and second chapters of this dissertation.

4.2.3 Heteroskedasticity tests

The research utilised the Breusch-Pagan test for hetero-skedasticity. It was tested with the null hypothesis that there is no heteroskedasticity (existence of constant variance). A Chi² statistic of 0.77 and a P-value of 0.3804 meaning that the study fails to reject the null hypothesis of constant variance at all conventional significance levels or at 1%. The result therefore rules out the possibility of heteroskedasticity in the model.

4.2.4 Multi collineality

The correlation of the variables was checked from the correlation matrix. It shows the level of movement in tandem of the variables that are included in the model. The level that calls for suspicion in the variables should at least be equal to 80% otherwise it can be accepted. From the variables that are used in the models of estimation variables such as age, age squared, education, experience and faming experience may be correlated. From mathematics, age is naturally related to its own square, such that there is a higher level of correlation between the two. It can be noted from the correlation matrix that there was a level of relationship between these two though it was less than 0.4. There was no need to drop one of the two as they are both important from literature hence they were used together. The age squared would help capture the impact of the diminishing returns of age to the food utilisation and nutrition security in the district. It was the estimation of the researcher that food utilisation and access improves as age increases but reaches a maximum and then begins to decline. The researcher continued to use the age and age squared since the correlation matrix shown that there was a limited relationship between the two.

Education and the age of the household head are related as one gets education years from the life age that he or she has lived. To solve this problem of several variables that are correlated, the researcher had to transform the data into dummies that distinguish the educated to basic secondary level who participate in agriculture and others. This moves the data from a continuous that may be directly related to the age. It eliminates the relationship between the age and the years spent in school taking away the correlation between the variables. The experience of the household in farming may again be related to the age. The researcher had to use the experience of the household as a whole and not of the household head. It can be noted from the data that some household head had the age that would be less that the faming experience of the whole family. It should also be noted that in most rural male chauvinist societies, the head of the household can be a son who benefits from the experiences of the senior members of the household. The research uses farming experiences of the household as whole and does away with the household head farming years as one may be involved in market employment when the other household members engage in farming activities. Family experience has nothing to do with the age of the household head. Incomes were almost 60% related to the granary capacity, these do not have any practical, theoretical or empirical relationship and hence should not cause any worry.

4.2.5 Misspecification test

The RESET test for model misspecification was carried out and results are given in the appendix. The study reports F (3, 153) value of 21.75 and a P-value of 0.0000 meaning that we reject the null hypothesis that the model has no omitted variables. This signifies the possibility of missing variables in the model, the data that this research is based on does not include any variable that may be argued from theory or previous research as affecting food and nutrition security. Further to this, it is not the main aim of the research to investigate the factors that are not included in the model but to investigate the factors that affect food and nutrition security. The variables that were investigated are the ones that have been investigated in literature and supported in theory. The researcher continued to analyze food and nutrition security with the variables that were available since the adjusted R^2 was relatively high. An adjusted R^2 of 0.7452 is significantly high. It shows that 74.52% of the variation in the dependant variable is explained within the model. This measure would support the continuation of the estimation.

4.2.6 OLS regression results using HDDS

Age and age Squared

Age was found to be statistically significant at 1 % level of significance and has a negative impact on HDDS while its square was found to be of no effect. The reported coefficient of age, negative 0.027 meaning that an increase of 10 years by the household head is likely to reduce the HDDS score by 0,27. The effect of age defies the prior expectations of this study of a quadratic relationship as it implies that as a household head grows older, the household's ability to access a range of foods will be reduced. This negative effect may further imply that in Goromonzi district the older the household head becomes the more dietary rigid the household become. However, this do not prolong as there exist a limit when household head's age has no impact implying that some factors may be more important than age. The time frame when age is an important variable explaining dietary diversity may be that when the head is in direct control of sources of food for consumption either from own production or the market. When the head has no direct contribution upon resources in consumption, is when the dietary diversity begins to fall and the problems associated with malnutrition become evident.

Household size

This variable was found to be statistically significant at 1% level of significance and has a negative impact on food security as measured by HDDS. The reported coefficient of negative

0.035 means that a unit increase in the size of the household is likely to marginally reduce the HDDS score by 0.035 units, holding other things constant. These results defy the prior expectation of the study that a positive relationship exists between food security and household size based on more productive labor for the household. This may have been the result of the composition and distribution of the household. There may exist more of children and school or working members who may not participate in agriculture. These would put pressure, increasing food requirements without contributing to food production and purchase. Additionally, we show that in Goromonzi the negative effects of household size outweigh the positive ones to generally deteriorate food security for household members. The findings support findings by Pankomora *et al* (2009) while they differ with conclusions given by Amaza *et al* (2006).

Granary capacity

Granary capacity was found to be statistically significant at 1 % level positively impact on food security. Its coefficient of positive 0.173 means that an increase in the granary capacity available utilization by 1 ton is likely to increase HDDS by 0.173 scores. The results support the expected relationship between granary capacity and food security. While other qualitative factors of food storage are difficult to measure, the impact of storage on food security cannot be overlooked. It can be explored from the results that an increase in granary capacity by 10 tons is likely to increase HDDS score by 1.73. Further it can be inferred that households with larger storage capacity are likely to avoid losses during storage while they are able to store different agricultural produce for future consumption. Thus while production itself is important, food insecurity in Goromonzi can be explained by failure to ensure proper and sufficient storage of agricultural produce. Farmers without enough storage may sell their produce thereby limiting their utilization of food and as well their dietary diversity at a latter date.

Experience in farming

A household's experience in farming was also found to be statistically significant at 1% level of significance and had a positive impact as expected. Its coefficient of 0.027 implies that an additional year in farming is likely to increase the HDDS by 0.027 scores. Thus 10 additional years in production can result in additional scores of 0.27. These results show that despite having factors such as rainfall playing a significant role in ensuring food and nutrition security, experience in farming is an important factor that indicates how a household can manage

production over time. Thus factors such as land reform and price distortions that may cause crop migration are detrimental to food security. The implication of this result is that in an effort to ensure food and nutrition security, comprehensive policies should ensure continued production of crops to ensure that farmers will utilize skills and knowledge accumulated over the years. Overall result supports the argument by Barkai et al. (1973) as stated earlier. Farming years and food security are positively related.

Liquidity (Incomes)

Income was found to be an important variable explaining food nutrition security. Its coefficient of 0.001 is statistically significant at 1% significance level and has a positive impact on household food security as measured by HDDS. The results imply that an increase in income from agricultural income of US\$1000 will improve HDDS by 1 scores. These incomes are generated from sale of agricultural crops and livestock, remittances and any other nonfarm activity that may include but not limited to employment incomes. As indicated earlier in the study, Goromonzi district as close as it is to the Metropolitan City of Harare is likely to benefit from the market of agricultural produce. It also means that well functioning markets of agricultural products will have a role to play in ensuring food security.

Access to extension services

Access to extension services was found to be an important factor that explains food in/security in the district under study. The reported coefficient of 0.058 was found to be statistically significant at 1 % level of significance. It means that an additional unit of farm visit by extension service providers is likely to enhance food and nutrition security as measured using HDDS by 0.058 scores. This positive influence can be via the influence of extension services on farm production. Extension services are crucial in imparting crop and livestock technical skills that will improve production enhancing food security either through own production or commanded using income from sale of crops.

4.2.7 Probit Results of HDDS

Household Size

Household size was found to be an important factor that explains food security in Goromonzi District. A coefficient of negative 0.386 was found to be statistically significant at 1 % and had a

negative impact on food security. The result is consistent with those reported earlier from OLS regression. The reported marginal effects mean that an increase in household size will reduce the chances of a household being food and nutrition secure. Since the marginal effects are too small, it can still be noted in the direction of impact of the size of the household that a household that has more members has a greater probability of being food insecure and vice versa. The result may also be interpreted as concluding statistically that the more a household size is, the lower the diversity or the variety of the meals that the household consumes. Policy may be directed in a way that limits the extended nature of the local household.

Experience in farming

This variable was found to be an important factor distinguishing households that are food secure and those that are insecure. The reported coefficient of negative 0.064 was found to be statistically significant at 5 % level of significance. Computed marginal effects shows that a unit increase in years of farming reduces a household's chances of being food secure. These results tend to be contrary to those provided earlier from theory, from expectation and as well OLS regression. The experience in farming on its own has a negative impact on the probability of one household being food and nutrition secure.

Granary capacity

The Probit model provides granary capacity as an important factor that explains food security. The results report a coefficient of 0.631 that is significant at 1 % level of significance and implies that granary capacity is positively related with food and nutrition security. Computed marginal effects put forward that a unit increase in granary capacity is likely to increase the probability of one being food and nutrition secure. The result is in tandem with those reported earlier from the OLS model of food and nutrition in/security. The result has been consistent with the prior expectation and previous researches as argued in Chapter two.

Liquidity (incomes)

Consistent with the earlier regression results from the OLS regression and with the theory, this study finds incomes to be an important factor that explains food security. The reported coefficient of 0.001 is statistically significant at 1% level of significance and shows positive

relationship between income and food utilization. Marginal effects from the model suggest that an increase in the incomes of the household increases the probability of a household being food and nutrition secure.

Access to extension services

Access to extension services is an important variable that explains differences in food secure and non-secure households. The model reports a positive coefficient of 0.588 that is statistically significant at 1% level of significance. Computed marginal effects imply an additional visit by extension service providers is likely to increase probability of a household being food and nutrition secure. This result is also consistent with those provided earlier from the OLS regression model and also with the prior expectation of this research.

4.2.8 Probit regression of HFIAS

Liquidity (Income)

This is the only variable that was found to be statistically significant in influencing household food security as measured by HFIAS. The reported coefficient of negative 0.0002 is statistically significant at 1 % and implying a positive relationship between access to food and incomes. As the incomes increase for any given household, the access to food improves. This is also accompanied by the reduction in the chances of one being food insecure as measured by HFIAS. Since as HFIAS falls the more food secure a household is it is highly commendable for a negative relationship. The marginal effects as shown in the appendix show that an increase in the incomes of the household reduces the coded behavior of food insecurity thereby improving on the food access security of the household. An increase in the household incomes reduces the probability of it being food insecure thus improving on the access security of the household. This implies that policy makers should emphasize on the improvement of the incomes as this has proved to be a consistent variable in the determination of the level of food access and nutrition security at household level. These improvements may come in the form of remittances, agriculture and even employment incomes.

4.3 Conclusion

Having outlined the tests that have been carried out in the furtherance of the research objectives and in trying to solve for the research questions, these have been detailed above. Food and nutrition security in the district of Goromonzi has been investigated and the factors that are attributable to these established. The second and third estimation was limited by the magnitude of the marginal effects most of which were too insignificant to comment. These though too small were consistent with the ones established by the other researches among, (Pankomeraa P N. H., 2009). The conclusions were nonetheless derived from the direction of the signs of the coefficients. These factors help to establish policies on implications of food and nutrition security in the district while and providing a stand point for establishment of recommendations by policy makers. This being done, the next chapter looks also at the areas of further study.

Chapter Five: Conclusions and Policy Implications

5.1 Introduction

The chapter summarizes the whole paper, relating the problem of food and nutrition, the objectives to the methodology and the research findings. It will further give the policy implications of the research findings with reference to the peri-urban and food paradox in the research area and in Zimbabwe. The last section will discuss the areas that need further researches and as well the limitations of this study.

5.2 Summary of the research and of the main findings

This research was motivated by the problem of relatively high food insecurity in Goromonzi, an area that has significant potential in geography, society and economics for food access, production and utilization. The main dimension that the research based on was of the utilization of the food that is available or food nutrition and that has been accessed measured by the HDDS and HFIAS respectively. The prime aim of the research was to investigate the determinants of the HFIAS and HDDS as proxies for food access and utilization respectively. The paper focused on investigating the socio-economic and demographic factors that may affect food and nutrition security in the area of Goromonzi that were divided into the Human capital, liquidity, Assets and the Demography.

Cross sectional survey Data from CIAT was used in coming up with the research findings. The data was analyzed using, the OLS, the Probit for food nutrition and utilization and the Probit for food access. The same variables were used for each of the models to try and establish if there exists a level of consistence in the factors that affect the access and utilization statistically. HDDS was the dependant variable in the first OLS model, which proved that there are more of socio-economic factors that affect food and nutrition security than the demographic factors. Only size of the household and the age of the household head were the demographic factors as compared to the granary, experience, incomes and visits by extension service worker as the other factors.

For the second model, the Probit for food utilization as measured by the HDDS, it can be noted that the size of the household is the only demographic factor that still affects food and nutrition security. The other ones are the socio-economic (assets, Liquidity and human capital) and these

are the experience, granary, incomes and extension services. These factors affect food utilization and nutrition security regardless of the method of estimation. The factors remain statistically significant even when estimated under OLS regression or Probit. These factors are also tested on their power to predict the access to food by a household.

When the same variables are used to estimate the level of food access as measured by the HFIAS it can be established that the only one has influence. It has been noted that only incomes are statistically significant in explaining the level of food access as measured by the HFIAS for the district of Goromonzi. Comparing food access, the general conclusion that can be drawn from the research about the determinants of food security in the district is that, incomes are the only factor that affects both food access and utilization in the area of Goromonzi.

5.3 Policy Implications

The findings of this research are a basis for analyzing policy implication in the district and beyond. This research had a greater emphasis on the diversity of the household diet as a measure of food security and the findings of the first estimation would help in giving possible policy directions. Child, family and nutrition policy can be affected by the results and the findings of this research. The household characteristics that significantly affect food and nutrition security stated above may be included in policies to attain improvements in the utilization and access to food at district level. These results are of interest to policy maker, implementers and other stakeholders such as government, NGOs, diplomatic bodies among others.

Since age of the household head has been noted to have a negative impact on nutrition security, it should be noted that it is necessary to provide diversified food supplements to the elderly headed families. This is so as there are a greater proportion of these families that are nutrition insecure food utilization decreases as age increase. These may be implemented by the Private Voluntary Organization or NGO or the public or central government. Over and above direct intervention of the stakeholders, input support may be used as a means of improving the access and utilization of food in the district. The size and the experience of the household are the other factors that have been proved to have statistical influence on food and nutrition security. It is necessary to use birth control and health policies that control fertility to limit the family size. Experience in farming should be encouraged as well by promoting agriculture and its returns to the household.

Policy makers may consider improving on the storage facilities as granary capacity is one of the major contributors to improved food diversity and nutrition security. Those who direct policy may also consider increasing the number and accessibility of the agricultural extension workers as to promote diversified farming and as well food diversity and utilization. Further it can be noted from the research findings, that policies that encourage the improvement in the income level of households should be implemented. It should be that policies meant to improve on all the household incomes including employment incomes, remittances and agricultural incomes may help in the improvement of the food and nutrition security in the district or province at large. Incomes go even beyond just the influence on the food utilization but also affect access to food. Policy Emphasis should thus be placed on provision of enough, stable and consistent incomes to the households such as promoting income transferring facilities for easy access in the rural areas.

5.4 Areas of Further Research and the limitations of the study

Since this research has primarily concentrated on the utilization of food and the nutritional security of households in peri-urban, the area need to be further investigated in purely rural or urban areas. The subject on nutrition security has not been properly researched in Zimbabwe as a whole. This is because in most cases a researcher is tempted to consider only the food availability foregoing the nutritional aspects of food as alluded to much earlier in this research. The factors that affect food and nutritional security go beyond demographic and socio-economic (human capital, assets and liquidity), the other of these include political, ecological, technological and geographical. This research was limited by the availability of data on all the other factors that may include technology, time and government policy. The research went on to analyze the factors whose information was available. Research should be expanded in line of the not yet researched sections of food security.

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Appendix

OLS Results

1) Unrestricted

```
. regress hdds hmstatus age hsize exp ls lo grcp7 ext agesq hedu hsex income
```

Source	SS	df	MS	Number of obs =	169
Model	361.517908	12	30.1264924	F(12, 156) =	38.01
Residual	123.641855	156	.792575994	Prob > F =	0.0000
				R-squared =	0.7452
				Adj R-squared =	0.7255
Total	485.159763	168	2.88785573	Root MSE =	.89027

hdds	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
hmstatus	.0308698	.2511655	0.12	0.902	-.4652543 .5269939
age	-.0278437	.0063695	-4.37	0.000	-.0404253 -.0152622
hsize	-.0364006	.0120821	-3.01	0.003	-.0602662 -.012535
exp	.0256124	.0080691	3.17	0.002	.0096737 .0415512
ls	.0155713	.0245611	0.63	0.527	-.032944 .0640865
lo	.0135998	.0263916	0.52	0.607	-.0385312 .0657308
grcp7	.1692199	.0365524	4.63	0.000	.0970185 .2414213
ext	.0567508	.0115591	4.91	0.000	.0339183 .0795832
agesq	.0000196	.0000549	0.36	0.722	-.0000889 .000128
hedu	.0661107	.1634483	0.40	0.686	-.2567468 .3889682
hsex	-.0104793	.2500951	-0.04	0.967	-.504489 .4835303
income	.0000976	.0000197	4.96	0.000	.0000587 .0001365
_cons	6.086984	.3924604	15.51	0.000	5.311762 6.862206

Restricted

```
. regress hdds age hsize exp grcp7 ext income
```

Source	SS	df	MS	Number of obs =	169
Model	360.698269	6	60.1163782	F(6, 162) =	78.25
Residual	124.461494	162	.768280828	Prob > F =	0.0000
				R-squared =	0.7435
				Adj R-squared =	0.7340
Total	485.159763	168	2.88785573	Root MSE =	.87652

hdds	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
age	-.0271358	.0055125	-4.92	0.000	-.0380215 -.0162501
hsize	-.0353957	.0115853	-3.06	0.003	-.0582733 -.0125181
exp	.0266584	.0076239	3.50	0.001	.0116034 .0417133
grcp7	.1726114	.0356733	4.84	0.000	.1021669 .243056
ext	.0575251	.0112171	5.13	0.000	.0353746 .0796756
income	.0000997	.000019	5.26	0.000	.0000622 .0001371
_cons	6.166926	.325135	18.97	0.000	5.524877 6.808975

Hetttest Results

```
. hetttest
```

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

H0: Constant variance

Variables: fitted values of hdds

chi2(1) = 0.46

Prob > chi2 = 0.4968

Multi collinearity matrix

```
. correlate
(obs=169)
```

	hdds	hmstatus	age	hsize	exp	ls	lo	grcp7	ext	agesq	hddsdu-y	hfiasd-y	hedu	hsex
hdds	1.0000													
hmstatus	0.0168	1.0000												
age	-0.5054	-0.0142	1.0000											
hsize	-0.1828	0.1324	0.1245	1.0000										
exp	0.5624	-0.0188	-0.2247	-0.0303	1.0000									
ls	0.0566	0.0306	0.0690	0.0641	0.0086	1.0000								
lo	0.3547	0.0753	-0.0939	-0.0009	0.3411	0.1392	1.0000							
grcp7	0.6998	0.0686	-0.3776	-0.0749	0.5337	0.0372	0.3140	1.0000						
ext	0.5544	-0.0200	-0.2208	-0.0266	0.3040	0.0869	0.2757	0.3214	1.0000					
agesq	0.0398	-0.1006	0.3606	-0.0313	0.2121	0.0822	0.1728	0.0655	0.0540	1.0000				
hddsdummy	0.8353	0.0292	-0.4852	-0.1323	0.4173	-0.0339	0.2874	0.6007	0.5160	0.0149	1.0000			
hfiasdummy	-0.3019	-0.1541	0.1347	0.0739	-0.2113	-0.1114	-0.1691	-0.2161	-0.1872	0.0189	-0.2321	1.0000		
hedu	0.0427	0.1032	-0.3101	0.0925	-0.0205	-0.0536	-0.0752	0.0597	-0.0746	-0.4964	0.0939	-0.0300	1.0000	
hsex	0.0533	0.7614	-0.0333	0.1641	0.0245	0.0766	0.1874	0.1136	-0.0047	-0.0526	0.0582	-0.1266	0.0844	1.0000
income	0.6983	0.0409	-0.2950	-0.0062	0.4450	0.0664	0.3675	0.6113	0.4641	0.1317	0.4425	-0.2778	-0.0603	0.0836
		income												
income		1.0000												

RESET test Results

```
. estat ovtest
```

```
Ramsey RESET test using powers of the fitted values of hdds
Ho: model has no omitted variables
F(3, 159) = 22.60
Prob > F = 0.0000
```

Probit HDDS Results without Marginal effects

```
. probit hddsdummy age hsize exp grcp7 ext income
```

```
Iteration 0: log likelihood = -106.62293
Iteration 1: log likelihood = -41.76234
Iteration 2: log likelihood = -27.735513
Iteration 3: log likelihood = -20.225348
Iteration 4: log likelihood = -19.07966
Iteration 5: log likelihood = -19.064434
Iteration 6: log likelihood = -19.064431
Iteration 7: log likelihood = -19.064431
```

```
Probit regression
Number of obs = 169
LR chi2(6) = 175.12
Prob > chi2 = 0.0000
Pseudo R2 = 0.8212
Log likelihood = -19.064431
```

hddsdummy	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
age	-.0295471	.018365	-1.61	0.108	-.065542 .0064477
hsize	-.3856159	.1426297	-2.70	0.007	-.665165 -.1060667
exp	-.0639436	.0323137	-1.98	0.048	-.1272773 -.00061
grcp7	.6307377	.1723567	3.66	0.000	.2929248 .9685506
ext	.587754	.1608268	3.65	0.000	.2725393 .9029687
income	.0007927	.0002403	3.30	0.001	.0003216 .0012637
_cons	1.110899	1.048675	1.06	0.289	-.9444664 3.166264

Note: 2 failures and 59 successes completely determined.

Probit HDDS Results with Marginal effects

```
. dprobit hddsdummy age hsize exp grcp7 ext income
```

```
Iteration 0: log likelihood = -106.62293
Iteration 1: log likelihood = -52.796867
Iteration 2: log likelihood = -37.404751
Iteration 3: log likelihood = -28.544016
Iteration 4: log likelihood = -22.78903
Iteration 5: log likelihood = -19.816599
Iteration 6: log likelihood = -19.107628
Iteration 7: log likelihood = -19.064602
Iteration 8: log likelihood = -19.064431
```

Probit regression, reporting marginal effects

```
Number of obs = 169
LR chi2(6) = 175.12
Prob > chi2 = 0.0000
Pseudo R2 = 0.8212
```

Log likelihood = -19.064431

hddsdu-y	dF/dx	Std. Err.	z	P> z	x-bar	[95% C.I.]
age	-2.78e-07	1.35e-06	-1.61	0.108	48.6095	-2.9e-06	2.4e-06	
hsize	-3.63e-06	.0000172	-2.70	0.007	5.69822	-.000037	.00003	
exp	-6.02e-07	2.82e-06	-1.98	0.048	14.5882	-6.1e-06	4.9e-06	
grcp7	5.94e-06	.0000284	3.66	0.000	2.70142	-.00005	.000062	
ext	5.53e-06	.0000262	3.65	0.000	6.15385	-.000046	.000057	
income	7.46e-09	3.48e-08	3.30	0.001	3470.21	-6.1e-08	7.6e-08	
obs. P	.6745562							
pred. P	.999998 (at x-bar)							

z and P>|z| correspond to the test of the underlying coefficient being 0

Probit HFIAS Results without Marginal effects

```
. probit hfiasdummy age hsize exp grcp7 ext income
```

```
Iteration 0: log likelihood = -95.849758
Iteration 1: log likelihood = -85.241093
Iteration 2: log likelihood = -83.955609
Iteration 3: log likelihood = -83.945257
Iteration 4: log likelihood = -83.945255
```

Probit regression

```
Number of obs = 169
LR chi2(6) = 23.81
Prob > chi2 = 0.0006
Pseudo R2 = 0.1242
```

Log likelihood = -83.945255

hfiasdummy	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
age	.0003873	.0086397	0.04	0.964	-.0165461 .0173208
hsize	.0147937	.0191343	0.77	0.439	-.0227089 .0522963
exp	-.0075958	.0144081	-0.53	0.598	-.0358351 .0206435
grcp7	-.0030691	.0608973	-0.05	0.960	-.1224255 .1162873
ext	-.00253	.0194206	-0.13	0.896	-.0405936 .0355336
income	-.0001571	.0000556	-2.83	0.005	-.000266 -.0000481
_cons	-.2710558	.521256	-0.52	0.603	-1.292699 .7505872

Probit HFIAS Results with Marginal effects

```
. dprobit hfiasdumy age hsize exp grcp7 ext income
```

```
Iteration 0: log likelihood = -95.849758
Iteration 1: log likelihood = -86.009486
Iteration 2: log likelihood = -84.069549
Iteration 3: log likelihood = -83.945921
Iteration 4: log likelihood = -83.945255
Iteration 5: log likelihood = -83.945255
```

```
Probit regression, reporting marginal effects
```

```
Number of obs = 169
LR chi2(6) = 23.81
Prob > chi2 = 0.0006
Pseudo R2 = 0.1242
```

```
Log likelihood = -83.945255
```

hfiasd-y	dF/dx	Std. Err.	z	P> z	x-bar	[95% C.I.]
age	.0001079	.0024068	0.04	0.964	48.6095	-.004609	.004825	
hsize	.0041204	.0053463	0.77	0.439	5.69822	-.006358	.014599	
exp	-.0021156	.0040214	-0.53	0.598	14.5882	-.009997	.005766	
grcp7	-.0008548	.0169634	-0.05	0.960	2.70142	-.034103	.032393	
ext	-.0007047	.0054153	-0.13	0.896	6.15385	-.011318	.009909	
income	-.0000438	.0000138	-2.83	0.005	3470.21	-.000071	-.000017	
obs. P	.2544379							
pred. P	.1982973	(at x-bar)						

z and P>|z| correspond to the test of the underlying coefficient being 0