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# Indicators of household-level vulnerability to climate change in three topographically diverse rural villages

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**Declaration**

I, Kayalethu Sotsha, hereby declare that all the contents of this document that will be submitted in fulfilment of the requirements for the Degree of Master of Science in Agricultural Economics at the University of Fort Hare's Faculty of Science and Agriculture is my original work except where due acknowledgement has been made in the text, and has not been previously written or submitted for Degree purposes at any other University.

**Signature:** 

**Date:** 30 December 2013

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**Abstract**

Climate change has become a major concern globally and it clearly exerts a profound influence on the lives of poor rural populations who depend on agriculture for livelihoods. Generally, agriculture is more at risk from weather, pests and diseases than is industry or trade. Furthermore, many farming units are at low levels of development with little technological input in their production systems. This makes them vulnerable to any exposure to climate and environmental variation, given that there is little capacity for the system to adjust to change. Most at risk are the rural poor with low levels of development and limited ability to adapt to and overcome the effects of climate change.

Using data from a sample survey of 120 households this study attempts to assess and compare indicators of vulnerability to climate change. The comparison was made at household level between three typical villages, an inland, a river catchment and a coastal village. This idea of comparison arises from the general understanding that different variables affect different regions differently so that the impact of and vulnerability to climate change differs across regions, areas and populations. The data was obtained using a questionnaire that was administered through face-to-face interviews. Given that sensitivity and adaptive capacity of farming systems to climate change is shaped by both socioeconomic and institutional factors, a multiple regression model was used to test the relationship between indicators of vulnerability and household socioeconomic and institutional characteristics.

Indicators were selected based on significant statistical relationships. This means that the statistical procedure for selecting indicators involved relating a large number of variables to vulnerability in order to identify statistically significant factors. The results showed reliability of income and reliability of water resources to be good indicators of vulnerability. Many statistically significant variables as well as respective $R^2$ of 0.988 and 0.825 confirm the foregoing. Another indicator was the Simpson index that measures diversification of agricultural production. The results show that vulnerability to climate change was highest for the households near the river and lowest for the inland village. Moreover, the results confirmed that most blacks that are practicing agriculture receive little if any support largely because available resources are highly skewed towards certain farmers rather than others.

*Keywords:* Vulnerability indicators, climate change, rural livelihoods, adaptive capacity, Simpson index.

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**List of acronyms**

ABET – Adult Basic Education and Training

AIDS – Acquired Immune Deficiency Syndrome

ARDC – Agricultural and Rural Development Corporation

DBSA – Development Bank of South Africa

DEAT – Department of Environmental Affairs and Tourism

DEDEA – Department of Economic Development and Environmental Affairs

ECDC – Eastern Cape Development Corporation

FAO – Food and Agriculture Organization

FANRPAN – Food, Agriculture and Natural Resources Policy Analysis Network

HIV – Human Immunodeficiency Virus

IISD – International Institute for Sustainable Development

IHLM – Ingquza Hill Local Municipality

IFAD – International Fund for Agricultural Development

IFPRI – International Food Policy Research Institute

IPCC – Intergovernmental Panel on Climate Change

MDG – Millennium Development Goal

NEPAD – New Partnership for Africa's Development

NGO – Non-governmental organization

RDP – Reconstruction and Development Programme

RVAC – Risk and Vulnerability Atlas Centre

USAID – United States Agency for International Development

WHO – World Health Organization

## Chapter 1: Introduction

Climate change has become a major global concern due to its threatening effects on agriculture and on the livelihoods of the world's population. The effects of climate change are particularly serious for rural communities with low capacity to adapt (FAO, 2008b). This study is concerned with assessing indicators of the vulnerability of rural households to climate change. Of course, these rural households face several other constraints and challenges briefly reviewed below to provide background to the study.

It is widely accepted that climate change has three interrelated interfaces with agriculture, namely the impact of climate change on agricultural production; the impact of agricultural production on global warming; and the impact of mitigation policies, programmes and projects on agriculture. This study will deal with the first of these, e.g. the impact of climate change on agricultural production and its effects on rural households practicing agriculture. This approach is based on several recent studies of climate change and vulnerability, including those by Gbetibouo & Ringler, 2009; Gbetibouo *et al*., 2010, Deressa *et al*., 2008; Ringler, 2008; Brooks *et al.*, 2004; Cutter *et al*., 2009; Olmos, 2001; Kiker, 1999; FAO, 2008b; Morton, 2007; Desanker, 2003; Ludi, 2009; Palitza, 2009. These studies indicate that a large proportion of the world's population are presently vulnerable to disruptions of their livelihoods through their insecure socioeconomic situations, exacerbated through extreme climate events. Moreover, the impacts of climate change become significant when they affect human society and wellbeing; thus social vulnerability is an important concept in examining future planned adaptation to climate change.

In addition, Gbetibouo *et al*. (2010) concluded that in spite of the necessity of national climate change adaptation; policymakers should develop region-specific policies. Dealing specifically with the impact of climate change on agricultural production is ideal because the majority of the vulnerable population employ agricultural production as one of their livelihood strategies (Aliber *et al*., 2009). This approach will also set the basis for appropriate adaptation strategies through analysing the vulnerability of the farming rural households to climate change. It will also allow policymakers to trace the vulnerability of these households back to its underlying determinants.

## 1.1 Background to the study

This section begins with a broad indication of the importance attached to agricultural production as one of the major sources of rural livelihood, which is then narrowed down to rural households of South Africa. According to Aliber *et al*. (2009), 75% of the world's poor live in rural areas and most of them depend on agriculture. Within the context of South Africa, the population is about 40% rural and the poor in rural areas account for around 70% of all poor in the country (Aliber, *et al*., 2009). Mbuli (2008) indicated a similar argument.

In its nature, rural household agriculture consists mainly of the production of staple foods for household consumption. Relatively few products find their way into local or other markets (Musemwa *et al*., 2007). Mbuli (2008) describes rural agricultural production as being characterized by low labour productivity and inadequate technology. As a result, it makes a very small contribution to household income. This, in turn, results in a greater reliance on state pensions and social welfare grants, and migrant labour remittances for household survival (Jari, 2009).

The type of agricultural production referred to as subsistence agriculture is most common among rural households. Machethe *et al*. (2004) argued that there are many definitions of subsistence farming since it may mean different things in different countries. Consequently, there are various terms used to describe this type of farming, such as small-scale, resource-poor, peasant, food-deficit, household food security, land reform beneficiaries, and emerging famers. The fact that farmers might not be a homogeneous group and the farming systems might not be same is not disputed. However, by observation and by general knowledge from the rural households' literature in South Africa rural households, particularly in the former homelands where this study was conducted, in most cases are a homogeneous group with the same farming systems. Hence, within the context of this study, subsistence production is the type of farming designed to provide all or most of the foods required by the households, usually without any significant surplus for sale (Ntombela, 2003). This definition is chosen because all the various terms mentioned by Machethe *et al*. (2004) entail the perception that subsistence production is mainly meant for home consumption, any surplus being coincidental.

It is generally understood that rural households employ a wide range of livelihood strategies but researchers tend to concentrate on crop production and ignore livestock production, or they tend to separate the two. In this study, rural household agricultural production refers to

both crop and livestock production. According to Lahiff & Cousins (2005), many rural households do not own livestock; nevertheless, livestock plays a very important role in local livelihoods including those of non-owning households. This is because livestock provides a range of goods and services including milk, manure, draught power, meat, dung as fuel, savings and ceremonial and customary uses. Many of these services provided by livestock are enjoyed by the community at large and/or even by relatives and friends from other communities.

It is important also to highlight that in South Africa poverty is more persistent in rural areas, particularly in the former homelands, with 78% of the poor likely to be chronically poor (Machethe, 2004; Christen & Pearce, 2005). Moreover, although South Africa is self-sufficient in the production of most major crops, inaccessibility to nutritious food remains prevalent in large parts of rural South Africa with more than 16 million people suffering from malnutrition and facing starvation (Meyer *et al*., 2009). The suffering largely depends on availability of, access to, and the control of resources in a society (FAO, 2003).

In this regard, South Africa's inability to meet basic needs, resulting particularly in poverty and hunger, is a legacy of apartheid (Koch, 2011). The apartheid system shaped poverty and hunger through its deliberate dispossession of assets such as land and livestock from the black majority, denying them opportunities to develop access to markets, infrastructure and human capital (Koch, 2011). During the apartheid system, black agriculture was heavily discriminated against in terms of land rights (Adey, 2007), pricing, marketing, extension and infrastructure (Manona, 2005). Manona further indicated that black people were given access to only 13 present of the land and that the Land Act policies led to disadvantageous programmes for the black population. Such programmes include Betterment Planning. The impact of Betterment Planning included reduction in the size of arable plots in rural areas, control of livestock numbers and movement, as well as forced social organization, within settlements. The consequence of Betterment Planning was increasing underutilization of arable fields in both Ciskei and Transkei (Vink, 2012).

Land holdings in the former homelands are generally very small and are mainly used for subsistence purposes (Aliber & Hart, 2009). A similar pattern obtains for ownership of livestock (May, 2000). Aliber & Hart (2009) further indicate that for the former homelands situated in the eastern part of the country, the steep terrain limits the amount of arable land available; this is aggravated by increased soil erosion in such terrain. Aliber & Hart (2009)

further found that current stocking practices exceed the carrying capacity of the land in most of the former homeland areas so that overgrazing has severely affected the quality of arable land, causing some of it to be no longer suitable for crop production.

In the apartheid era, there were no endeavours undertaken by government to develop subsistence-farming areas as they were largely seen to be labour reservoirs (Makhanya *et al*., Undated). Even decades after the end of apartheid, very little real improvement in rural people's livelihoods has taken place. The fact is that rural people still constitute over 70% of the poorest people in South Africa (Manona, 2005). Income inequality is still a challenge in South Africa (Altman *et al*., 2009). Over the past decade, for instance, the South African government has been boosting budgets to provide direct support to black and disadvantaged farmers in the form of grants for infrastructure, production inputs and recently through extension services, to improve the welfare of these farmers (Hall & Aliber, 2010). Yet, the evidence shows that most blacks who practice agricultural production receive little if any support because the available resources are distributed to favour certain farmers over others (Hall & Aliber, 2010).

Many households in the rural areas of South Africa are victims of poor service delivery by the state. Moreover, these households must make do with low purchasing power, inadequate infrastructure, limited access to support services, including effective extension, poor access to credit and veterinary services, lack of market access and market information, lack of ownership of productive inputs and low management capacity as well as limited or even no access to clean water (IISD, 2011). Other challenges include limited access to factors of production, developed infrastructure, information, and lack of job opportunities (Ortmann & King, 2006). These challenges, combined with the nature of subsistence production, render rural household agricultural production very vulnerable to the effects of climate change.

Climate change is often referred to as global warming; however, it is not just about a moderate temperature increase. It is more about serious disruptions of the entire world's weather and climate patterns including impacts on rainfall, extreme weather events and sea level rise (DEAT, 2004). It has been occurring for at least a century but the global average temperature is projected to increase by a record high of 1.4 – 5.8°C in the next century (Madu, 2012).

Causes of climate change include natural processes such as variations in the sun's activity as well as human activities such as air pollution (mainly from the burning of fossil fuels to meet

increasing energy demand (FAO, 2008a) and deforestation (Bathembu, 2011), which often results from the spread of intensive agriculture to meet increasing food demand (FAO, 2008a). Climate change is now a global threat and a major concern (Ringler, 2008). It is attracting increasing attention from the media, academics, politicians and even businesses as evidence mounts about its scale and seriousness and speed at which it is affecting the world (Madu, 2012). It threatens agriculture and affects the livelihoods of the world's population (Ringler, 2008) and its effect is determined by the ability to adapt or to cope with stress, with the most vulnerable sectors including water resources, agriculture, health, coastal zones and forestry (Madu, 2012). Its effects are likely to be particularly significant in specific rural locations where crops fail and yields decline (FAO, 2008b). Agriculture is widely considered more at risk than industry or trade, since weather, pests and diseases affect yields, in extreme cases quite substantially (Christen & Pearce, 2005).

Many farming units are at low levels of development with little technological input in their production systems. This makes them vulnerable to any exposure to climate and environmental variation, given that there is little capacity for the system to adjust to change (Newton *et al*., 2010). Most at risk are the rural poor with low levels of development and little capacity to adapt and overcome the effects of climate change (Mutangadura *et al*., 1999). After all, rural livelihoods depend on water availability, and the poorest rely heavily on rain fed production systems that are particularly susceptible to droughts and floods. As already mentioned, households of poor rural populations, in most cases, depend on agriculture for livelihoods.

Climate change has also become a major threat to sustainable food security. Temperatures are rising, precipitation patterns are changing, and extreme weather events are occurring more frequently (IFPRI, 2011). These changes already have an impact on nature's ability to provide the goods and services on which people depend (Wongbusarakum & Loper, 2001). As a result, production of food for a growing population is becoming more challenging. This increases the need for everyone in the agricultural sector to adapt quickly to limit the costs that will be incurred in future (IFPRI, 2011).

This subsection has provided some background to the study in describing the nature of rural household agricultural production. It also gave a brief background on what climate change is and why it is such a concern, especially for agriculture. The main aim of this study is to assess and compare indicators of vulnerability to climate change at household level between

three typical villages, an inland, a river catchment and a coastal village. The IPCC (2007) notes a general perception that the economy of rural households is based mainly on the control of natural resources, in particular water and land, and on their own products and services. In addition, Wongbusarakum & Loper (2011) stressed that resource-dependent communities are particularly vulnerable to climate change. However, Machethe (2004) indicated that many rural households of South Africa are poor and less developed and thus their productivity is low. As a result, off-farm sources of income tend to be the most significant and substantial sources of income available to rural households, as indicated by many studies, including that of Andrew *et al*. (2003).

The point is that the resilience of ecosystems and human systems are interdependent, meaning that building resilience in one will increase it in the other (Wongbusarakum & Loper, 2011). Hence, the interrelationship of people to impacted environments and their capacity to cope with and adjust to the new situation plays a fundamental role in the level of vulnerability to climate events and impacts. The assessment and comparison of vulnerability indicators can provide an understanding of vulnerability to climate change. The next chapter argues so more fully. The next subsection will introduce the research problem.

### 1.2 Problem statement

The three villages chosen for this study are poor and therefore vulnerable to the effects of climate change. However, it is not enough to know that these households are poor and vulnerable to climate change. It is already known that agriculture must adapt to minimize or mitigate the effects of climate change. Subsistence agriculture must be helped to build and, where appropriate, improve existing local practices, as they address various existing threats to this type of production (Aliber & Hart, 2009). The purpose of this study is to provide a basic understanding of indicators of household-level vulnerability to climate change that may inform future planning for rural household adaptive capacity. This follows the argument that policies about protecting rural households need to address the specific issues that make specific areas or socio-economic-agricultural systems more vulnerable than others do. That accounts for the need for research to determine specific predictors of vulnerability.

Moreover, it must be known how particular localities are affected by climate change. This is based on Wongbusarakum & Loper's (2011) argument that armed with good knowledge about the nature of the linkages and the implications of different management options, natural resource managers and policy makers have the best chance of identifying strategies that

improve households' resilience without worsening the vulnerability of the already vulnerable households. For example, Altman *et al*. (2009) argued that rural household agricultural production might be an option to contribute to incomes and/or savings as well as to encourage food diversification. However, for this to be achieved it has to be taken into consideration that while rural household production of food is wide-spread, opportunities and threats need to be better understood. This will enable the development of appropriate interventions to support household-level production.

According to Adger *et al*. (2004), there is a long and extensive list of indicators of vulnerability but the indicators differ between areas and levels. Within the context of this study, three indicators of vulnerability to climate change were assessed; these are stability of income, reliability of water resources, and diversification of agricultural production. This choice of indicators of vulnerability was based on two arguments. One general argument is that poor rural livelihoods are linked to water availability and use with the poorest relying heavily on rain fed production systems that are particularly susceptible to the effects of climate change. Also, and more specifically, Tompkins & Adger (2004) argue that adaptation policies must ultimately aim to move human, economic and ecological systems along a path from climate vulnerability towards climate resilience.

### 1.3 Objectives of the study

The main objective of this study is to provide indicators of vulnerability to climate change, specifically for rural households involved in agricultural production under rain-fed conditions. Knowing and understanding the adaptive capacity of resource-dependent rural households is expected to provide a platform for rural development to help rural households plan to forestall and overcome the effects of climate change, thereby uplifting the living standards of these households.

Specific objectives are:

- To assess the main indicators of vulnerability related to climate change in agricultural production by rural households
- To examine the underlying socioeconomic and institutional characteristics that are associated with households' vulnerability to climate change;
- To determine the role of agricultural production in the livelihoods of the rural households. As indicated by Andrew *et al*. (2003), rural households rely on crops,

livestock and a wide variety of natural resources for food security and income and other basic needs such as water and medicine. This will help to determine how and the extent to which rural households are vulnerable to the effects of climate change.

### 1.4 The research questions and procedure

This section presents the research questions, the hypothesis and the procedure used to answer the research questions. In view of the objectives of the study, three research questions were formulated as presented and discussed below:

i) What factors determine how rural households respond to and cope with climate change, thus allowing for a greater role of agricultural production? It was hypothesized that the capacity of rural households to adapt to climate change is influenced by different socioeconomic and institutional characteristics. To answer this question, it is necessary to understand socioeconomic and institutional characteristics (e.g. ownership of assets, access to credit facilities, level of education, access to water resources, land ownership, etc.). The information was obtained through primary data from a household survey analysed using descriptive statistics. Moreover, three indicators of vulnerability, stability of income, reliability of water resources and diversification of agricultural production were selected and regressed against explanatory variables that represent socioeconomic characteristics influencing household adaptive capacity. Regression analysis served to measure the relationship between vulnerability indicators and explanatory variables influencing rural households' resilience to climate change.

ii) What constitutes the basis for rural livelihoods? Andrew *et al*. (2003) argued that land-based livelihoods are critical to the survival and health of most rural households, particularly the very poor. It was hypothesized that rural households depend on agricultural production as one of their livelihood strategies. To answer this question, it was necessary to understand their livelihood strategies (e.g. remittances, social grants, agricultural production, etc.). This information was also obtained as primary data from a household survey analysed using descriptive statistics.

iii) How and to what extent does climate change affect agricultural production? It was hypothesized that rural household agricultural production is vulnerable to climate change. To answer this question, it was necessary to understand rural household food production (e.g.

agricultural production). The information too was obtained as primary data from a household survey analysed using descriptive statistics.

### 1.5 Limitations and delimitations of the study

The study was limited to providing vulnerability indicators to climate change and analysing the vulnerability of the rural households involved in agricultural production in three typical villages. Given the background to the study, where the nature of rural household agricultural production was discussed, the study was able to determine the vulnerability of rural households in the villages investigated and provided the indicators. Primary data was used as a source of information about the chosen indicators of vulnerability and their indicator variables.

### 1.6 Ethical aspects relevant to the study

As argued by Broom (2006) obtaining approval before the research begins, and maintaining high ethical standards throughout a research project, are central to good research conduct. This applies to social research no less than to clinical trials. Given the nature of this study, the relevant ethical issues include informed consent, confidentiality and privacy as well as fatigue during the fieldwork. Many studies indicate that obtaining informed consent is crucial for any research project. This does not just involve a signature on a form. Rather, the process of gaining consent involves numerous elements including (a) a lay-accessible description of the project; (b) an opportunity for participants to ask questions; (c) the opportunity to discuss involvement with friends and family; and (d) a description of the participants' rights at each point in the project. Participants should be given a description of the project to keep (including funding source, aims and objectives, and the nature of their involvement) and contact details of the principal researcher. The participants should have someone to contact if they have questions about the project. It is also important to ensure the privacy and confidentiality of the participants. The researcher acted according to these ethical guidelines.

#### How ethical aspects were addressed

a) Informed consent

The researcher paid a visit to the study villages before the actual data collection to do (a) to (d) as explained in the paragraph above. This visit served as opportunity to meet with the headmen of the villages to be studied. All the villages in the Ingquza Hill Local Municipality

are led or ruled by tribal chiefs or headmen who do not allow strangers to go door to door asking questions. People only participate when the chief or headman in one of their regular meetings informs them of the intended research.

(b) Confidentiality and privacy

To ensure confidentiality and privacy, anonymity was ensured by not recording the names of respondents in the questionnaires, and by not asking sensitive questions. For example, while HIV/AIDS prevalence plays a very crucial role in determining how rural households cope with climate change effects, the researcher decided not to include HIV/AIDS as a variable since the participants do not like to disclose such information. Lastly, information deemed confidential by the researcher was not directly asked for. For example, the income earned by the household head was categorized rather than precisely specified, e.g. R1500 – R2000. This, to some extent, precluded respondents from giving false information about their incomes.

(c) Fatigue

To avoid fatigue the questionnaire was kept short. The questions could be answered within 10 minutes. Respondents were free to withdraw their participation at any time.

### 1.7 Outline of the study

This dissertation is organised in eight chapters. The **first chapter** gives a general background on rural household agricultural production. It raises the issue of climate change as a current global concern. The **second chapter** reviews the literature about manifestations of climate change in South Africa. The **third chapter** provides a conceptual framework for analysing vulnerability to climate change. The **fourth chapter** presents a review of the literature concerning individual factors that influence households' resilience to climate change. The **fifth chapter** presents the methodology, while the **sixth chapter** presents the descriptive findings. The **seventh chapter** is the presentation of empirical results and the **eighth chapter** presents the conclusions and recommendations.

## Chapter 2: Manifestations of climate change in South Africa and its impact on rural household agricultural production and livelihoods

### 2.0 Introduction

It is widely accepted that agriculture in the African continent as a whole is already under stress as a result of population increase, which increases competition over use of scarce resources, degradation of resources and insufficient public spending on rural infrastructure and services (Ludi, 2009). While the continent is already suffering from such stress, the impact of climate change is likely to exacerbate these stresses (FAO, 2008b). This is certainly true for Southern African agriculture (FAO *et al*., 2011). This chapter focuses on how climate change manifests itself in different regions of South Africa.

The term livelihood is appropriate because the impact of climate change will always have some implications for rural household food security, nutrition and health. As argued by Brown & Hansen (2008), climate change has become a major concern globally and it exerts a profound influence on the lives of poor rural populations who depend on agriculture for livelihoods and subsistence. By definition, a livelihood comprises of the capabilities, assets (including both material and social resources) and activities required as a means of living. For a livelihood to be sustainable, it must cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Dorward *et al*., 2001; Monde, 2003).

Surveys indicate that developing countries bear the burden of the adverse consequences from climate change largely because of high poverty levels and low capacity to adapt to climate change (Ringler, 2008). Moreover, the rural population in these countries are the most affected due to agriculture's vulnerability to climate change since rural populations engage in agriculture as a primary source of direct and indirect employment and income (Ringler, 2008).

There has been a warming trend with the number of warmer days on the rise as compared to cooler days that are becoming fewer (Benhin, 2006). A continuation of this warming trend, with changes in precipitation patterns, a rise in sea level and increased frequency of extreme events is expected over the next century (Desanker, 2003). Below *et al*. (2010) indicated, in general, that changes in temperature, rainfall and variability and extension of drought periods in some regions would have severe implications for agriculture. Ziervogel *et al*. (2010)

indicated that the greater part of the interior and western part of South Africa is arid or semi-arid. Furthermore, rainfall is not evenly distributed and it displays strong seasonality that makes the natural availability of water across the country variable. In addition, climate change scenarios suggest that changes in seasonality and intensity of rainfall will affect the runoff and groundwater recharge and the storage of water in the soil, dams and reservoirs (Ziervogel *et al*., 2010). Ziervogel further argued that increased temperatures would increase evaporation and result in an increased transpiration rate from plants. According to Bradley *et al*. (2012), about 10% of crops in South Africa are irrigated and are susceptible to climate change owing to water scarcity throughout the country.

### 2.1 Extreme events (Droughts and floods)

There is limited specific information about the extent and frequency of the occurrence of droughts and floods in the different regions of South Africa. Nevertheless, it is predicted that South Africa is set to experience an increasing incidence of both droughts and floods with prolonged dry spells followed by intense storms (Gbetibouo & Ringler, 2009; DEAT, 2004). Projections of the potential changes over the next 50 years show a warming of between 1°C and 3°C; a reduction of approximately 5 to 10% in current rainfall; increased daily maximum temperatures in summer and autumn in the western half of the country (Madzwamuse, 2010). The western half of the country is likely to experience a 10% decrease in water runoff per quaternary catchment by the year 2015, whereas the eastern part of the country should experience this reduction by the year 2060 (DEAT, 2004).

### 2.2 Changing precipitation patterns

Climate change in South Africa is expected to have a severe impact on agriculture given expectations of an increase in the frequency of droughts and greater spatial variability in rainfall. These conditions are set to have negative effects for farming on already marginal lands (Hassan, 2006). The climate now varies from desert and semi-arid in the west to sub humid along the eastern coastal area and rainfall is unevenly distributed across the country (Gbetibouo *et al*., 2010). The east of the country is projected to become wetter, but the distribution of the rainfall season (summer) will also change, with the rainfall season beginning later and the annual average falling over fewer days with an increase in extreme events (which has implications for the growing season). The west of the country - the winter rainfall region – will become drier (United Nations, 2009). Winter rains will decrease by as

much as 40% in the extreme west, while in the eastern parts early summer rainfall (October to December) is expected to decrease and late summer rainfall (January to March) is expected to increase (Below *et al*., 2010). For the Eastern Cape it is projected that precipitation which is generally stable or slightly higher than at present will be experienced. It will be of higher intensity and increased precipitation is more likely in the east of the province (DEDEA, 2011).

### 2.3 Changing temperature patterns

Some studies point out that the mean global temperatures have been increasing since 1850, mainly owing to the accumulation of greenhouse gases in the atmosphere (FAO, 2008b). Noted is the continuous growth of greenhouse gas emissions that raise the earth's temperatures (IFPRI, 2009). In comparison, South African temperatures have been increasing by a yearly average of 0.13°C per decade between 1960 and 1993 (Benhin, 2006). Benhin (2008) indicates the varying increase across the seasons: Autumn 0.21°C (March-May). Winter 0.13°C (June-August), Spring 0.08°C (September-November) and summer 0.12°C (December-February). Benhin (2008) also demonstrated an increase in the number of warmer days and a decrease in the number of cooler days between 1960 and 1993

Temperatures are projected to increase for the entire country, with the highest increases up to 4°C, in the north-central parts of the country. On average, the highest projected mean annual temperature increases range between 2.5° and 3°C, with lower increases projected for the coastal regions (Turpie *et al*., 2002). The western and central parts of the country will experience an increase in temperature in a range of 1-3°C (DEAT, 2004). The higher temperatures will result in increases in evapotranspiration rates and increased intensity of droughts (DEDEA, 2011).

### 2.4 Rising sea levels

Increasing temperatures cause sea-level rise, primarily due to thermal expansion of water and secondarily due to melting ice. It was projected that the sea level would rise by between 9 cm and 88 cm between 1990 and 2001. For South Africa too, these global projections apply and are in fact conservative estimates according to other sources. Extreme events such as storm surges would add to the impact of these average increases, but are not included here due to their unpredictability. In South Africa, a sea-level rise of 10 to 15 cm over the last century has already been noted (Turpie *et al*., 2002).

## 2.5 Implications for rural household agricultural production and livelihoods

Climate change represents one of the greatest environmental, social and economic threats facing the planet today. How climate change manifests itself in South Africa will have a significant adverse impact on rural household agricultural production that in turn will have important implications for the wellbeing of especially the poorer subsistence producers. According to Gbetibouo & Ringler (2009), agriculture plays a prominent role in the stability of rural communities and the poor in the country are disproportionately found in rural areas while most rural households depend on agriculture for food (Machethe, 2004). Rural households in the former homelands are subsistence producers and therefore several types of crops are grown, harvested and directly consumed throughout the growing season (May, 2000).

Climate change has turned out to be a major threat to sustainable development and the attainment of the Millennium Development Goals (MDGs) in South Africa. Combined with other factors, climate change threatens to affect food and water resources and the livelihood of rural households of South Africa (Ludi, 2009). Increasingly variable rainfall, increase in acidity, especially in the east and an increase in extreme events (both droughts and floods) are expected result in reduced yields of several staple food crops. Moreover, the rate of evapotranspiration is to increase and surface and underground water to be more limited (Benhin, 2006). Obviously, agriculture-based livelihood systems already vulnerable to food insecurity stand to experience increased crop failure, along with new patterns of pests and diseases, and loss of livestock (FAO, 2008b).

Clearly, any significant change in climate affects local agriculture and affects local crop and animal productivity. As noted by IFPRI (2009), generally, higher temperatures will reduce the yields of desirable crops and encourage weed and pest increases. In addition, changes in precipitation patterns will increase the likelihood of short-run crop failures and long-run production declines (IFPRI, 2009).

### 2.5.1 Limited availability of water

Surveys indicate that South Africa already is a water deficit country and due to its impact on temperatures and rainfall patterns, climate change is expected to worsen the scarcity of water in the country (Benhin, 2008). The impact of climate change including an increase in extreme events is likely to place additional pressure on water availability, accessibility, supply and

demand (Ludi, 2009). In addition, the level of food security is determined by people's opportunities to produce agriculturally and these are very dependent on access to water (Ludi, 2009). In South Africa, agricultural production is limited mostly by insufficient water (Benhin, 2006). Water is often an indispensable production input for products that are essential for direct household consumption and/or income generation (Ludi, 2009).

Given that rainfall is unevenly distributed across the country and the fact that most rural household agricultural production relies on rain makes it vulnerable to changes in climate variability, seasonal shifts and changing precipitation patterns. As noted by Blignaut *et al*. (2009), the use of water has increased greatly in the country.

### 2.5.2 Increased incidence of pests and diseases attacks

It is predicted that the incidence of diseases in South Africa will increase because of climate change (Palitza, 2009). Climate change raises temperatures and this is likely to spread malaria more widely (Palitza, 2009). Moreover, there appears to be a connection between rainfall and certain pathogens. Changes in rainfall will affect the presence and absence of vector and water-borne pathogens as Desanker (2003) has argued. It is expected that small changes in temperature and precipitation will boost the population of disease-carrying mosquitoes and result in increased malaria epidemics. Furthermore, increased flooding could facilitate breeding of malaria carriers in normally arid areas (Desanker, 2003). This could have a negative impact on agriculture in the form of a reduction in available farm labour. In addition, crop diseases and insect pests are likely to increase in hotter or more humid conditions (Biello, 2009).

### 2.5.3 High production costs

Generally, it is no longer possible to prevent the progression of climate change for the next two to three decades. However, it is still possible to protect our communities and economies by investing in the necessary infrastructure and technology to mitigate the effects of climate change (Stern, 2006), but not without an increase in production costs (Gardiner, 2008). Hence, managers and policy makers need to respond by building adaptive capacity, thereby increasing the ability of individuals, groups, or organization to adapt and implementing the adaptation decisions.

### 2.5.4 Low agricultural productivity

The supply of agricultural products differs from season to season as a result of both weather and diseases (Mohr *et al*., 2008). Droughts are among the major threats due to their adverse impact on agriculture; they are regarded as the world's most costly disasters (Brown & Hansen, 2008). Droughts have the potential to destroy the economic livelihood and food source of those depending on agriculture for own food requirements (Brown & Hansen, 2008). This is clear from the serious droughts and their effect on output in several key grain producing countries (Ramalingam *et al*., 2008). Australia, one of the of the world's largest producers of wheat saw its wheat production severely limited due to a multiyear severe drought around 2005 (IFPRI, 2008). On the other hand, floods destroy infrastructure, disrupt transportation and economic flows of goods and services (Brown & Hansen, 2008). Moreover, floods can lead to contamination of water supplies and to outbreaks of waterborne diseases such as cholera (Brown & Hansen, 2008). These too, may greatly influence agricultural productivity.

Agricultural production is likely to be compromised by climate change, especially in smallholder systems that have little adaptive capacity (Brown & Hansen, 2008). Yields from rain fed agriculture could be reduced by up to 50% by 2020, thus severely compromising access to food (Muller *et al*., 2010). A continuous increase in temperatures is likely to increase drought, increase crop failures, cause runaway fires, destroy pastures due to water shortages (Biello, 2009) and increase evaporative loss of surface water resources (Brown & Hansen, 2008). Therefore, it is expected that crop and livestock production will decrease and the food crisis will worsen because food supply will be reduced and the prices of staple foods such as maize will rise (Biello, 2009). More extreme weather, also in the U.S., the world's largest agricultural exporter, is likely to disrupt harvests, and to limit the production of grains, livestock and cooking oils and to boost prices (Javier, 2011). Extreme weather due to climate change will inevitably have a negative impact on food production/agricultural productivity.

## 2.6 Implications for food security in rural households

This study uses the widely accepted and widely used definition of food security used by the World Food Summit of 1996. According to the World Food Summit, food security is defined as a situation where all people at all times have access to sufficient, safe, nutritious food to

maintain a healthy and active life (Du Toit *et al*., 2011; WHO, 2010, FAO, 2008a; Ludi, 2009; McDonnell & Ismail, Undated, Topouzis, 1999).

Access to adequate food is the most basic of human needs and rights (Topouzis, 1999). Du Toit *et al*. (2011) pointed out that since South Africa became a democratic country (1994), food security has been talked about a lot as a prime Millennium Development Goal (MDG). Du Toit *et al*. (2011) further note that the Department of Agriculture, Forestry and Fisheries was mandated to develop agricultural policies and support programmes to ensure that South African citizens are given agricultural opportunities that will enable them to meet their basic food needs. Moreover, to meet the goal of reducing by half the number of people who go hungry over the period 1990 and 2015 and to halve unemployment by 2014, food security was reprioritised in the 2010/2011 financial year by the South African government.

Drought stress, low adoption level of improved crop production technologies, poor soils and lack of resources have negative effects on arable crop production and result in considerable yield reductions (Legwaila *et al*., 2011). There is no doubt that climate change too is a serious threat to household agricultural production due to its negative impacts on both animal and crop productivity. Most certainly, there are implications for food security as well as nutrition in rural households. It is noteworthy that food security is a broad term defined in different ways by a number of organisations around the world (Monde, 2003).

At a household level, food security can be defined as the success of local livelihoods in guaranteeing access to sufficient nutritious food (Ziervogel *et al*., 2006). Topouzis (1999) defines it more precisely as the capacity of a household to procure a stable and sustainable basket of adequate food. A household is food secure when the members of the family do not live in hunger and fear of starvation (Du Toit *et al*., 2011) and so households must have sufficient income to purchase the food they are unable to grow for themselves (Topouzis, 1999).

Food security has three dimensions as stated by Du Toit *et al*. (2011); Altman *et al*. (2009): 23; Monde (2003); Koch (2011); Ludi (2009); Topouzis (1999); these are i) Food availability, which implies that a country must have sufficient quantities of food available on a consistent basis at both national and household level. ii) Food access implies the ability of a nation and its households to acquire sufficient food on a consistent basis. iii) Food use refers to the appropriate use of food based on knowledge of nutrition and care, as well as adequate water and sanitation.

Given that many of the farming units operate with very little technological input to their production systems, rural households tend to be vulnerable to climate and environmental variability, and often unable to adjust to changing conditions (Monde, 2003). Through its impact on human health, livelihood assets, food production as well as changing purchasing power and market flows, climate change affects all dimensions of food security (FAO, 2008b). Climate change significantly lowers agricultural productivity. The impact of climate change on all dimensions of food security affects poor rural households' nutrition and health (Kirsten *et al*., 1998).

### 2.7 Implications for nutrition in rural households

Households in the former homelands are highly susceptible to malnutrition and the reprioritisation of food insecurity reduction in South Africa could serve to alleviate nutritional deficiencies in households (Kirsten *et al*., 1998). Hunger and under-nutrition are primarily caused by inadequate intake of food (Altman *et al*., 2009). The reality is that not much has been done to improve food security since 1995 and the eradication of child malnutrition is proceeding too slowly to meet the Millennium Development Goals (MDGs) target of halving hunger by 2015 (Cohen *et al.*, Undated). Malnutrition has severe outcomes including weak educational performance, increased risk of morbidity and impaired immune function for children (Altman *et al*., 2009). One-fifth of all children in South Africa are stunted due to malnutrition and the reason is inadequate food in the household and lack of a balanced diet (Adey, 2007). Even though South Africa is self-sufficient in the production of most major crops, inaccessibility to nutritious food remains prevalent in large parts of rural South Africa with more than 16 million people suffering from malnutrition and starvation (Meyer *et al*., 2009; Rose & Charlton, 2001). The most affected are rural households where poverty has been persistent (Binswanger & Lutz, 2000; Altman *et al*., 2009; Asenso-Okyere *et al*., 2008).

Climate change is a major challenge to food security. Given the negative impact of climate change on agricultural production, it is obvious that there will be reduced access to food for vulnerable rural households and this will adversely affect food security and worsen malnutrition (Muller *et al*., 2010). Only a minority of rural households would be able to afford a food basket that is diverse and high in essential macro and micronutrients (Altman *et al*., 2009). With the prospect of a further rise in food prices due to short supply and the situation looks even gloomier (Biello, 2009).

## 2.8 Implications for health in rural households

A combination of insufficient clean water, inadequate sanitation and malnutrition causes health problems (Mtshali, 1999). Food insecurity is associated with poor-quality diets, lower macro, and micronutrients intake leading to numerous health problems due to a compromised immune system (Altman *et al*., 2009). Lack of ability to adapt to climate change and self-reliance will affect children - the bulk of the population – most severely (Biello, 2009).

Given the anticipated reduction in agricultural productivity and land holding due to climate change, reliance on purchasing food may increase, especially in times of droughts (Mtshali, 1999). However, reduced own food production may exacerbate poverty and, with unemployment more rural households may well experience hunger (Cohen *et al*., Undated). Moreover, since a household's nutritional status is influenced by access to the appropriate quantity and quality of food, clean water and food preparation equipment, access to wood or other fuel, lack of these will have an adverse impact on people's health (Mtshali, 1999). Rural Health Advocacy Project (2011) pointed out that lack of access to fresh water and increased weather extremes will increase health risks in many areas of the country. Diarrhoea and other diseases from contaminated water are already big killers in the rural areas of South Africa and this problem is expected to increase the child mortality rate especially in areas experiencing a shortage of nurses, doctors and other health workers and a lack of health resources that are inequitably distributed between rural and urban areas (RHAP, 2011).

## 2.9 Concluding remarks

This chapter has focused on how climate change manifests itself, particularly in South Africa. A comparison was made between South Africa and global climate change. The implications of climate change for food security, nutrition and health in rural households was reviewed. The relationship between climate change and rural household agricultural production appears to be negative because the way climate change manifests itself causes the rural poor to be vulnerable. Therefore, adaptation strategies as well as resilience and the ability to cope with the effects of climate change is required. In order for rural households to adapt, there is a need to know the indicators that make them vulnerable. Hence, the next chapter looks at a conceptual framework for analysing vulnerability.

## Chapter 3: A conceptual framework for analysing rural households' vulnerability to climate change

### 3.0 Introduction

This chapter begins by presenting a framework from which the factors that cause vulnerability to climate change are drawn. In trying to combine the factors that cause household-level vulnerability to climate change, a conceptual framework emerged. A conceptual framework, as defined by Rousenvell *et al.* (2010) is a visual or written product; one that explains, either graphically or in narrative form, the main things to be studied - the key factors, concepts, or variables - and the presumed relationships among them.

This study was conducted in three typical villages, a village near the river, an inland village and a coastal village. The study aimed to assess the indicators of vulnerability to climate change, specifically for rural households involved in agricultural production. Vulnerability levels of the respective villages were compared based on the notion that different variables affect different regions differently. The impact of and vulnerability to climate change differs across regions or areas or populations. Gbetibouo & Ringler (2009) argued that vulnerability to climate change and variability are intrinsically linked with social and economic development. The villages studied are in the former Transkei, where many households engage in subsistence production. It is widely accepted that the most vulnerable regions are those with a larger number of farmers practising subsistence farming known to be highly dependent on rain fed agriculture (Morton, 2007) affected by land degradation and a dense population relying on agriculture for livelihoods (Gbetibouo & Ringler, 2009).

The assessment was based on socioeconomic and institutional characteristics that tend to determine the capacity of rural households to adapt to the effects of climate stress (Gbetibouo *et al*., 2010). After all, the degree to which climatic events affect an agricultural system depends on a wide variety of factors including, among others, types of crops and livestock produced, scale of operation, degree of orientation towards commercial or subsistence purposes, and specific demographic and social variables such as education, age, etc. (Gbetibouo & Ringler, 2009). Furthermore, vulnerability is also influenced by institutional factors that govern land tenure, the availability of markets, financial capital, support programmes and the degree of technology development, and distribution (Gbetibouo & Ringler, 2009). This section also explains how the socioeconomic and institutional characteristics are expected to determine the adaptive capacity.

Other research to date suggests that the vulnerability of agricultural populations to climate change cannot be understood through the quantification of biophysical impacts alone. Studies that explore the social aspects of vulnerability to climate change by in-depth examination of the underlying socio-economic and institutional factors are also required (Gbetibouo *et al*., 2010).

A number of studies have adopted the IPCC's (2001) definition of vulnerability, which is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (Olmos, 2001; Levina & Tirpak, 2006; Gbetibouo *et al*., 2010; Deressa *et al.*, 2008; Brooks, Adger & Kelly, 2004; Stringer *et al*., 2009; Madu, 2012). The present study too adopts the IPCC's definition of vulnerability, where exposure, sensitivity and adaptation set the pattern. Other definitions used in other studies convey vulnerability as having two elements. Shewmake (2008) for example, suggested that vulnerability is composed of: 1) an exposure to risk and 2) a low capacity to cope with adverse outcomes. Kiker (1999) and Gbetibouo & Ringler (2009) suggest that vulnerability depends on a system's sensitivity and its ability to adapt to new climatic conditions.

The IPCC definition is adopted because it correctly sees vulnerability to be a function of three components: i) exposure, ii) sensitivity, and iii) adaptability (Olmos, 2001; Levina & Tirpak, 2006; Gbetibouo *et al*., 2010; Deressa *et al*., 2008; Stringer *et al*., 2009; Madu, 2012). Actually, a production system is first *exposed* to injury, damage or harm. Secondly, it has to *respond* and, finally, it must *adapt*.

This study seeks to provide the indicators of vulnerability to climate change for rural households involved in rain-fed agricultural production. The vulnerability model which is given as Vulnerability = f (exposure, sensitivity and adaptive capacity) was used to obtain a list of vulnerability indicators to climate change. This model has been employed in a few studies that include Gbetibouo & Ringler (2009); Deressa *et al*. (2008); and Gbetibouo *et al*. (2010). Each of the three components of vulnerability has one or more indicator variables; for example, exposure may be measured by extreme events (droughts and floods); sensitivity may be measured by irrigation rate; and adaptive capacity may be measured by infrastructural development.

### 3.1 Selection of indicator variables

**Exposure** is defined as the nature and degree to which a system is exposed to significant climatic variations (Gbetibouo *et al*., 2010). Therefore, exposure can be measured by predicted change in temperature and rainfall; these will include extreme events (droughts and floods), changing patterns of precipitation, changing temperature patterns, and rising sea levels. The climate changes to which households in the study are expected to be exposed will be gleaned from the available literature. It is hypothesized that the more favourable the variables, the less will be the vulnerability of the community to climate change and vice versa.

**Sensitivity** is defined as the responsiveness of a system to climatic influences and is shaped by both socioeconomic and environmental conditions (Gbetibouo *et al*., 2010). The agricultural sector is rather sensitive to climatic conditions. Deressa *et al*. (2008) have argued that in places with a greater frequency of droughts and floods, the agricultural sector responds negatively, meaning that yields are reduced. Based on the factors to which rural communities are exposed and the definition of sensitivity, sensitivity can be measured by such variables as the extent of irrigation, land quality, and the extent of crop diversification. The hypotheses here are that: (i) Assuming that there is no shortage of water, the larger the irrigated land the less will be the vulnerability. The idea behind the hypothesis is to find out if, even though water is one of the limiting factors, rural households are able to use the water resources available to their advantage in terms of irrigation. (ii) The poorer the land quality the higher will be the vulnerability, and (iii) the more enterprises and sources of income are diversified the less will be the vulnerability. The source of this type of data is the rural household survey.

**Adaptive capacity** is the ability of a system to adjust to climate change (including climate variability and extremes), to minimize potential damage, to take advantage of opportunities, and/or to cope with consequences (Levina & Tirpak, 2006; Brooks *et al*., 2004). In this context, capacity may include physical, institutional, social or economic means as well as skilled labour (Levina & Tirpak, 2006). This component of vulnerability can be measured by wealth, technology, availability of infrastructure, potential for irrigation, literacy rate, HIV prevalence, farm organizations (collective action), farm income, size of the farm holding, farm assets, and access to credit. The hypotheses are given below:

- **Wealth** –The wealthier the household the less will be the vulnerability. Deressa *et al*. (2008) argue that wealth enables households and communities to absorb and recover

from losses more quickly through own reserves, insurance, social safety nets and entitlement programmes. In this study, the number of livestock owned and ownership of assets will be used as indicators of wealth. Primary data were obtained from the rural household survey.

- **Technology** – Proximity to supplies of agricultural inputs is identified as an indicator of technology (Deressa *et al*., 2008). Adoption and choice of technologies is influenced by the asset situation of households. Where the poor lack the funds needed to obtain the required technology it is unlikely they will be able to acquire it (Hallman *et al*., 2003). Drought-tolerant or early maturing varieties of crops as technology packages usually require access to complementary inputs, such as fertilizers or pesticides (Deressa *et al*., 2008). With limited or no access to the required complementary inputs, it would serve no purpose to plant such varieties of crops. Hence, for the purposes of this study, data on the use of fertilizers, pesticides and tractors as indicators of technology is required. Relevant primary data will be obtained from the rural household survey.
- **Availability of infrastructure** – The quality of infrastructure is an important measure of the relative adaptive capacity of a region. The better the infrastructure the less will be the vulnerability. Indicators of infrastructure are classified as economic (e.g. roads, electrification, bridges and railways), social (e.g. health and education) and institutional (e.g. farmers cooperatives) (Meyer *et al*., 2009). The data will be obtained from the rural household survey.
- **Irrigation potential** – Households with access to irrigation infrastructure and affordable complementary inputs and access to water for irrigation are expected to have greater adaptive capacity. Meyer *et al*. (2009) identified limited water resources and high cost of irrigation schemes as major constraints to irrigation development in South Africa. Therefore, access to water resources and irrigation infrastructure as well as incentives for agricultural intensification arising from affordability of inputs, market access, quality of soils and favourable topography will all count as irrigation potential. The data will be obtained from the rural household survey.
- **Literacy rate** – Literacy rate is a proxy for the level of skills and education in a region (Deressa *et al*., 2008). Education is one of the key components of human capital and it is the knowledge or skill obtained or developed by a learning process (Zezza *et al*., 2007). Deressa *et al*. (2008) argue that countries with higher levels of

human knowledge have greater adaptive capacity than those in transition. Literacy levels reduce vulnerability by increasing people's capabilities and access to information, thereby enhancing their ability to cope with adversities (Gbetibouo & Ringler, 2009). Therefore, the hypothesis is that the higher the literacy level the less will be the vulnerability. Level of education will be used as an indicator of literacy rate; the data will be obtained from the rural household survey.

- **HIV/AIDS prevalence** – HIV/AIDS has an adverse impact on rural household agriculture and therefore on livelihoods (Mtangandura *et al*., 1999). Therefore, areas with higher rates of HIV/AIDS are more vulnerable. However, this variable is not going to be used as a measure of rural household vulnerability because most of the people do not feel comfortable about disclosing their status. This information can hardly be obtained from a household survey. Nevertheless, it is important to note that this is a variable affecting the adaptive capacity of the households.
- **Farm organizations, farm income, farm holding size, farm assets and access to credit** represent financial capital (Gbetibouo & Ringler, 2009). Regions with higher farm income, larger farms, greater farm value assets and more access to credit are wealthier and are therefore better able to prepare for and respond to adversity (Gbetibouo & Ringler, 2009). Primary data from the household survey will be used.

### 3.2 Quantifying the indicator variables

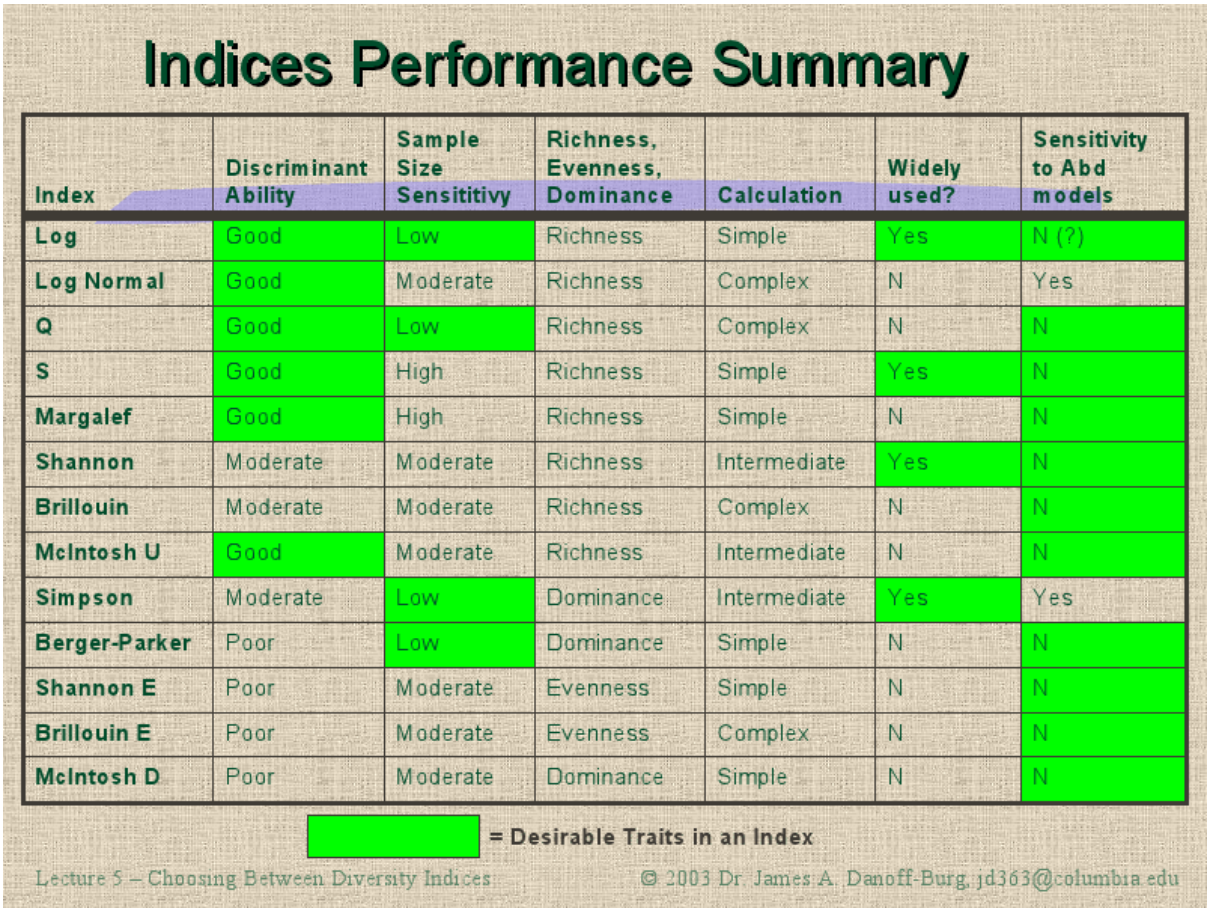
The vulnerability model, V = f (exposure, sensitivity, adaptive capacity) implies that the vulnerability of communities is determined by three components of which two (sensitivity and adaptive capacity) are shaped by both institutional and socioeconomic variables. Specific data on past and expected climate trends were not available for the study locations. This was due to the fact that climate change represents a long-term shift in the climate of a specific location, region or planet and the shift is measured by changes in features associated with average weather, such as temperature, precipitation and sea level (Schneider & Lane, 2005). Therefore, it was not possible to quantify the exposure component for the purpose of this study. However, the available information on the manifestation of climate change in South Africa showed clearly that rural households in the study area are and will continue to be exposed to adverse effects of climate change, especially households that engage in agricultural production as a livelihood strategy. That is enough to justify looking at how rural households respond and adapt to the effects of climate change given that the capacity of rural

households to adapt to the effects of climate change is shaped by socioeconomic and institutional characteristics.

Three indicators of vulnerability (stability of income, reliability of water and diversification of agricultural production) were selected and regressed against explanatory variables that influence the resilience of rural households' food production to climate change using a multiple regression model. Indicators were selected based on significant statistical relationships. Adger *et al*. (2004) identified two procedures for indicator selection, a deductive approach and a statistical approach. Both approaches were adopted and used in parallel. The deductive approach involves proposing relationships derived from a theory or conceptual framework and selecting indicators based on these relationships. In contrast, the statistical approach involves relating a large number of potential explanatory variables to vulnerability in order to identify statistically significant factors. The chosen vulnerability indicators (Y) are then regressed against institutional and socioeconomic characteristics (X) (education level, infrastructural development, ownership of assets, etc.) as these influence the way in which rural households respond to and cope with the effects of climate change using a multiple regression model. One of the indicators of vulnerability was diversification of agricultural production. It was measured using Simpson indices, explained below.

A Simpson index given as $SI = \Sigma\, n\,(n - 1) \div N\,(N - 1)$ was used to determine diversification of agricultural production. The index was chosen for its appropriateness to the study, for its discriminant ability and its statistical comparability. The calculated Index value ranges from 0 to 1, where 0 means infinite diversity and 1 means absolute specialisation. There are two more ways of calculating this index. One is given as Dominance = 1 – D where D is equivalent to the above equation and the other is Reciprocal = 1/D. The former is known as a Simpson's Index of Diversity and the latter is known as Simpson's Reciprocal Index. Simpson's reciprocal index is the inverse of the first two indices. There is a common understanding that a model has to be valid and reliable. Therefore, all three indices will be calculated and compared in order to determine the reliability and validity of the Simpson index within the context of this study. In comparing, a village that showed more diversity was deemed less vulnerable than one with lower diversity. The calculated indices were regressed against the socioeconomic and institutional factors that shape how rural households respond to and cope with the effects of climate change. The table below shows different models that can be used to measure diversity but not all of them are suitable and relevant for this study.

The table also shows the performance summary of the Simpson index as compared to other indices.



**Indices Performance Summary**

| Index | Discriminant Ability | Sample Size Sensitivy | Richness, Evenness, Dominance | Calculation | Widely used? | Sensitivity to Abd models |
|---|---|---|---|---|---|---|
| Log | Good | Low | Richness | Simple | Yes | N (?) |
| Log Normal | Good | Moderate | Richness | Complex | N | Yes |
| Q | Good | Low | Richness | Complex | N | N |
| S | Good | High | Richness | Simple | Yes | N |
| Margalef | Good | High | Richness | Simple | N | N |
| Shannon | Moderate | Moderate | Richness | Intermediate | Yes | N |
| Brillouin | Moderate | Moderate | Richness | Complex | N | N |
| McIntosh U | Good | Moderate | Richness | Intermediate | N | N |
| Simpson | Moderate | Low | Dominance | Intermediate | Yes | Yes |
| Berger-Parker | Poor | Low | Dominance | Simple | N | N |
| Shannon E | Poor | Moderate | Evenness | Simple | N | N |
| Brillouin E | Poor | Moderate | Evenness | Complex | N | N |
| McIntosh D | Poor | Moderate | Dominance | Simple | N | N |

= Desirable Traits in an Index

Lecture 5 – Choosing Between Diversity Indices © 2003 Dr. James A. Danoff-Burg, jd363@columbia.edu

**Figure 3.1: Performance summary of the Simpson index. Source: Danoff-Burg (2003)**

This approach to measuring vulnerability to climate change addresses the determinants of adaptive capacity in order to examine the potential responses of rural household agricultural production systems to climate change. Indicators are selected that relate to adaptive capacity and the information obtained from primary data was related to the conditions and structures of explanatory variables that promote or constrain adaptive capacity.

### 3.3 Concluding remarks

A conceptual framework has paved way for selecting indicators of vulnerability and for measuring vulnerability. The next chapter expands on this conceptual framework by identifying individual indicators that could build households' resilience to climate change. Based on the available literature, those indicators will show the capacity of the household's adapt to climate change.

## Chapter 4: Individual factors that influence how rural households respond to and cope with climate change

### 4.0 Introduction

Most poor rural households depend on agriculture for sustainable livelihoods (FAO, 2008a). However, their agricultural activity produces very low yields due to poor access to services, lack of knowledge and inputs and low levels of investment in infrastructure and irrigation (Calzadilla *et al*., 2009). As a result, they also tend to rely on a number of other livelihood strategies, including social grants and remittances from migrant members of the household (Altman *et al*., 2009).

Moreover, the combination of climate risk along with other factors traps rural populations in chronic poverty (Brown & Hansen, 2008). This chapter focuses on the factors that seem to be key challenges to poverty alleviation in the rural households of South Africa as they appear to be the ones that determine the adaptive capacity of these households to the effects of climate change. A number of challenges are important in the eradication of poverty, including poor infrastructure, lack of capital, credit and marketing, road networks and transport services for both input supplies and market access (Manona, 2005).

### 4.1 Access to water resources

One challenge in South Africa is poor service delivery. It affects rural households the most. Desanker (2003) highlighted that in many settlements the capacity of municipal authorities to provide civic works for sanitation and other health delivery services has been outpaced by population expansion. Recently Hemson *et al*. (2004) pointed out that clean water services had been extended to more than half of the rural population. However, most rural households in South Africa still do not have access to clean drinking water. Water is fetched from rivers and springs for cooking, drinking, washing and feeding chickens. The water pumps that some communities have hardly function. Other households still go to the river because they cannot afford to pay for the water. Water sources such as rivers that many households rely on may be unhealthy because rivers are also used by livestock and may be of poor quality for this reason.

### 4.2 Education level and skills

Education is a key component of human capital and provides a quality dimension to labour. It is also a key input in determining household ability to acquire sufficient income and escape poverty (Zezza *et al*., 2007). It is widely recognised to be conducive for empowerment, economic growth and general improvement in welfare (Gbetibouo & Ringler, 2009). Education represents knowledge and skills obtained through a learning process (Anonymous, 2006). Some knowledge can only be passed down to people through the education system. Young people in rural areas need role models to motivate them and they must be given the expertise and skills to understand and know farming activities better. Motivation is one of the tools that can be used to boost the self-confidence and to nurture positive attitudes in rural people especially the youth to engage them in producing their own food. Presently, as Hashe (2011) pointed out the youth shows a lack of interest in agriculture in the Eastern Cape. According to Bonti-Ankomah (2001), a sound educational background can reinforce natural talent; and can provide a theoretical foundation for informed decision-making. Many educated individuals think that to engage in own food production is for the uneducated and very poor. Ellis (1998) rightly argues that poverty is closely associated with low levels of education and lack of skills.

### 4.3 HIV/AIDS prevalence

HIV/AIDS had become an increasing global phenomenon (Mutangandura *et al*., 1999) and South Africa is ranked as among the nations with the highest number of HIV-infected persons in the world. It was reported to have the highest number in the year 2007, with about 5.5 million people living with HIV (Altman *et al*., 2009). Hunter (2007) pointed out that it was one of the goals of the Millennium Development Goals to combat HIV/AIDS and other diseases including malaria. However, it has been noted that since rural residents typically have less access to health care, testing and counselling, epidemics may be more difficult to combat.

HIV/AIDS has an adverse impact on rural household agriculture and therefore on the livelihoods (Mutangandura *et al*., 1999). This is aggravated by poor health infrastructure, restricted access to health facilities and inadequate surveillance mechanisms that make it hard to measure HIV infection rates in rural areas (Topouzis, 1999). HIV/AIDS increases vulnerability to food insecurity by acting as a long-term stressor that typically affects the

economically active household members (Altman *et al*., 2009). When people die of HIV/AIDS in rural households that rely on agricultural production as a method of own food production, the household's food security may be under threat (Hunter, 2007). The ability of the infected persons to seek employment or remain employed is reduced thus negatively affecting household income and the means to purchase food. In addition, HIV infection occurs amongst parents and working age adults more than children and can thus erode the ability of households to provide adequate food and nutrition for children (Altman *et al*., 2009). In addition, land preparation may suffer for lack of physical labour required (Hunter, 2007).

HIV/AIDS reduces the labour available for agricultural production (Manona, 2005). It does so in two ways: firstly, it affects the potential labour provided by infected individuals (Mutangadura *et al*., 1999) and secondly, it influences the availability of other household members who must now care for sick individuals (Hunter, 2007). As a result, the cultivated areas decrease due to labour shortages caused by illness and death (Mutangadura *et al*., 1999).

Moreover, because HIV/AIDS is often highest among prime-age adults, the important information on managing agricultural land is lost when adults die (Hunter, 2007). As a result of the HIV/AIDS impact, fields may be underutilised or left unattended, weeding and other cultivation measures may be neglected, agricultural information may be lost and some families may switch to less labour-intensive crops and/or from cash crops to subsistence crops (Topouzis, 1999). These socioeconomic effects are largely borne by individuals and communities with little, if any, support from policy makers (Mutangadura *et al*., 1999). However, the HIV/AIDS status of respondents will not be included as a variable in this study.

### 4.4 Infrastructural development

Meyer *et al*., (2009) classify infrastructure as either economic (e.g. roads, electrification, bridges and railways), social (e.g. health and education) or institutional (e.g. farmers cooperatives and agricultural institutions). Economic infrastructure produces services for facilitating economic production. The quality of infrastructure is an important measure of the relative adaptive capacity of a region. Regions with better infrastructure are more able to adapt to climate stresses. For example, a well-developed road infrastructure allows rural populations to access markets and sells livestock and other commodities in times of crisis. It also enhances the effectiveness of aid distribution programmes in response to disasters such

as droughts, floods and food crises. Improved infrastructure reduces costs and strengthens the links between labour and product markets (Gbetibouo *et al.*, 2010). South Africa's apartheid generated agricultural divide entails that the institutional infrastructure differs greatly in quality, availability and accessibility for commercial and subsistence farms (Gbetibouo & Ringler, 2009).

High transaction costs are one of the major constraints on the growth of household agriculture in African countries and are partly attributable to poor infrastructure. This is true of South Africa as well, particularly in the former homelands (Chaminuka *et al*., 2008). Even though the South African government endeavoured to improve the quality and quantity of infrastructure in rural areas through programmes such as the Community Based Public Works Programme, the Consolidated Municipal Infrastructure Programme, the Poverty Relief and Infrastructure Investment Fund and the Comprehensive Agricultural Support Programme, a large proportion of rural households continue to lack access to basic services because these programmes have had little impact on the lives of many rural people (Chaminuka *et al*., 2008). The shortfalls in the delivery of infrastructural services are attributable to, among others, biased and flawed priorities, poor management and resource scarcity (Makhura & Wasike, 2003). These are particularly severe in South Africa's rural areas where rural households continue to face poor access to infrastructure services, particularly social services (Makhura & Wasike, 2003). Types of infrastructure taken into account by this study include road, irrigation and storage facility infrastructure.

### 4.4.1 Road infrastructure

Rural infrastructure plays a vital role in accelerating agricultural production and produce marketing (Pote, 2008; Jari, 2009). In addition to market infrastructure, a good network of roads accelerates efficient delivery of farm inputs, reduces transport costs and enhances spatial agricultural production and distribution. In this way, the distribution of agricultural goods is expanded and additional opportunities for agricultural trade are opened up (Inoni & Omotor, 2009). The ability of rural households' agricultural production to connect with the wider economy is determined by the road network and markets (Kleih, 1999). Indeed, agricultural systems depend on the quality of road access for the delivery of farm inputs to local communities and for the transportation of produce from the local area to market centres (Kleih, 1999).

In formal, the extent of infrastructural development will determine the economic activity in a particular region. Access to road transportation for instance, influences households' demand for production and consumption goods and services. Where agricultural input and output markets are more accessible, rural households will tend to use these more and are likely to improve productivity (Chaminuka *et al*., 2008). Poor road conditions, high transport costs and distant markets have been identified as obstacles to emerging farmers in South Africa (Makhura & Mokoena, 2003). Factors that determine access to input and output markets include distance to the markets, the state of the roads, the cost of transportation and the frequency of visits to these markets and rural services centres.

### 4.4.2 Storage infrastructure

Agricultural products are characterized by being bulky (they cannot be carried around easily), perishable (they cannot remain long on the way to the final consumer without suffering loss and deterioration in quality, except for some crops such as rice) and are seasonal in nature. That may necessitate storage and specialized transport facilities (Veres & Mortan, 2008). Buyers' attention and the producers' competitive edge depend on the ability to deliver a quality product to the market and, ultimately, to the consumer (Jari, 2009). Given that they are seasonal in nature, agricultural products must be harvested at a specific point in time, while they are consumed year-round. Therefore, proper post-harvest handling and storage contribute to quality maintenance for perishable agricultural produce, thereby ensuring a sustainable food supply (Jari, 2009).

### 4.4.3 Irrigation infrastructure

In South Africa, irrigation is by far the biggest single user of run-off water and it has substantial potential to make a significant socio-economic and social impact on rural society (SA Yearbook, 2010). Irrigation farming is currently one of the major consumers of electricity in agriculture with approximately 50% of the country's water being utilised to irrigate approximately 1.3 million hectares of land (Meyer *et al*., 2009). Major constraints to new irrigation developments in South Africa are limited water resources and high cost of irrigation schemes. This could be one of the impediments to development of irrigation infrastructure given that the key to improved irrigation lies more on efficiency of water use and cost effective technology (Meyer *et al*., 2009).

Generally, irrigation infrastructure increases returns to poor households' ability to achieve higher yields and revenues from crop production increases. Poor consumers also benefit from lower food prices because irrigation enables farmers to achieve economies of scale. However, rain fed agricultural production continues to dominate in the rural communities. Perret & Geyser (2007) provided some insight on the foregoing. In addition to scarcity of water in South Africa, Perret & Geyser indicated that multiple users increasingly demand more water for a number of purposes ranging from domestic, industrial, mining to power-generation. Agriculture as a whole extracts about 60% of the resource while it directly contributes only about 4% of GDP. In addition, smallholder farming uses only 4% of all irrigation water while it is hard to commercialize.

### 4.5 Adoption of new technologies

Adoption and choice of technologies is influenced by the asset situation of households. For example, where the poor lack the funds to purchase a desired technology, it is unlikely they will adopt it (Hallman *et al*., 2003). Assets that serve as key components in technology adoption include direct ownership of land and agricultural equipment. At the individual level, adoption of agricultural technologies can reduce vulnerability through increased income, strengthening of social relations and strengthening of self-confidence and problem solving capabilities (Hallman *et al*., 2003).

### 4.6 Access to information

In general, rural households have the lowest access to information and communication resources. Surveys of rural households suggest that the poor favour informal networks of trusted family, friends and local leaders over formal sources of information such as NGOs, newspapers and politicians. However, while the poor rely on informal networks, these networks do not adequately satisfy their information needs (Pigato, 2001).

Other factors, such as the impact of HIV/AIDS (Topouzis, 1999), low education level (FAO, 2004) and migration to urban areas in search of employment opportunities contribute to a lack of access to information. Lack of information, however, may cause low productive capacity in a number of ways. Low education is a characteristic that manifests itself as one of the factors leading to a rural household lack of access to credit needed to enhance productivity. Due to their low levels of education, credit providers believe that rural

households are not capable of managing written documents or keeping records, since they are not used to it (FAO, 2004).

### 4.7 Access to land and land quality

Land is obviously a resource critical to agriculture and it has a great influence on income distribution (Stockbridge, 2007). Access to land is often considered one of the determinants of people's involvement in agricultural production (Altman *et al*., 2009). In Latin America, where land ownership is highly polarised, one finds high levels of income inequality while in those parts of the developing world where land is relatively more equally distributed (as in many Asian countries, for example), income tends to be relatively more equally distributed (Stockbridge, 2007).

About 12% of South Africa's surface area is suitable for crop production. However, during the apartheid era blacks had access to only 13% of the country's surface area of land. The former homelands, much of them overcrowded and not suitable for agricultural production constituted this 13% (Lahiff & Cousins, 2005). Land holdings in the former homelands are generally very small (Aliber & Hart, 2009) and subject to the communal land tenure system. While there is high potential for veld grazing in these areas, overgrazing has severely affected the quality of arable land in many areas (Gbetibouo & Ringler, 2009).

### 4.8 Access to credit

Agricultural finance has been thought of as one of the important elements in rural development strategies used by development agencies and national governments. However, this financing has long been characterised by poor loan repayment rates and unstable subsidies (Christen & Pearce, 2005). FAO (2004) pointed out that in many countries there were directed credit programmes intended to encourage agricultural development. These programmes were meant to alleviate poverty, boost food production and develop small-scale farmers. They were unsuccessful because of a number of factors that made it difficult for small farmers to obtain access to credit from the programme's funds. They had no substantial positive impact on either rural development or on rural families. The FAO (2004) indicated that there was a complex combination of factors involved. These are discussed in 4.8.1 to 4.8.5 below.

### 4.8.1 The problem of moral hazard

As cited by Chang & Mishra (2012), Horowitz & Lichtenberg (1993) and Smith & Goodwin (1996) explain what moral hazard is and give agricultural examples. Moral hazard is an immoral behaviour that takes advantage of asymmetric information after a transaction. For example, Horowitz & Lichtenberg (1993) argue that a federally funded crop insurance program may increase usage of inputs because farmers may be inclined to undertake riskier production practices, while Smith & Goodwin (1996) argue that moral hazard through the crop insurance programme probably induces a reduction in input usage. It is also the case between lender and borrower where the borrower knows his/her own management capacity, and how the loan is to be used, which the lender does not know. The financial institutions resorted to incentives to ensure that borrowers would repay (FAO, 2004).

### 4.8.2 Traditional collateral is rarely available from small farmers

Most rural households possess little or no assets (FAO, 2004). Yet it is the ownership of and control over assets such as land and housing that provide direct and indirect benefits to individuals and households (Pote, 2008). These benefits come in the form of a secure place to live, the means of a livelihood, protection during emergencies, and collateral for credit that can be used for investment or consumption; hence, assets are important to reduce poverty and cushion risk and vulnerability from natural disasters, illness or financial crises (Doss *et al*., 2008). Even though many rural households may own land, a most accepted asset for use as collateral, it may well be of very limited value. Indeed, land titles may not be available or too costly to obtain (FAO, 2004).

### 4.8.3 In rural areas, clients are often widely dispersed and they often borrow small amounts

To be efficient lenders must be physically close to their clients (Christen & Pearce, 2005). Long distances have to be travelled by loan officers and credit providers further claim that lending in small amounts is more costly than lending in bigger amounts. This is because the cost of monitoring and following up on loans does not decrease with their size (FAO, 2004).

### 4.8.4 Rural households usually show low levels of education

They have not been taught and are not able to manage written documents and keeping records. In addition, rural clients are widely dispersed and they borrow in small amounts.

Successful agricultural lenders have to offer doorstep services and visit clients at their homes and land plots. Consequently, agricultural loan officers travel extensively. The lenders incur high transport, staff and other additional costs such as accident insurance (FAO, 2004; Hedden-Dunkhorst *et al*., 2001).

As a result, many rural households engage in informal financial dealings among themselves (Gbetibouo & Ringler, 2009). These are in the form of *Umgalelo* where they may be members of rotating savings and credit groups associated setting aside small amounts weekly or daily. The entire amount contributed by the group goes to one member and he/she uses it for his/her whatever expenditures. Rural households may also lend to each other and to family members and save under mattress (Christen & Pearce, 2005).

### 4.8.5 Adverse selection

Adverse selection can be defined as behaviour by a single or group of individuals wanting to benefit more than they pay. For example, Quillerou & Fraser (2010) give an example of existence of adverse selection in an Environmental Stewardship Scheme in England. It also exists in the case between lender and borrower where the borrower knows his/her own management capacity, and how the loan is to be used which the lender does not know. The financial institutions resorted to incentives to ensure that borrowers would repay (FAO, 2004).

## 4.9 Access to extension services

Inadequate support through extension services negatively affects market access. Extension services in South Africa have often not been timely or have been incomplete, thereby contributing to low productivity by rural households in the country. Farmers who have been empowered with farming techniques introduced by extension officers are likely to achieve higher production and higher productivity (Pote, 2008). The extension agents remain the main source of production and marketing information for most farmers. The extension officers themselves, however, are often not equipped to provide the required information due to inadequate training (Machethe *et al*., 2004).

Aliber *et al*. (2009) also noted a lack of formal skills, with less than 25% of extension staff having been exposed to technical training programmes in South Africa. In addition, more extension staff is still needed in the country (Aliber *et al*., 2009).

### 4.10 Access to veterinary services

Rural households are resource-poor farmers and therefore have limited access to veterinary care, whether by support services from state or private veterinarians and animal technicians. Lack of information about the prevention and treatment of livestock diseases, and preventative and therapeutic veterinary medicines, all of which result in reduced productivity and more livestock diseases and deaths (Dold & Cocks, 2001). In fact, a whole range of services are needed to enhance the capacity of poor households to exploit the full potential of livestock production. These include health and production services such as clinical care, preventive health-care and provision of pharmaceutical supplies, feed and fodder supply, artificial insemination, livestock research and extension, and other market services such as credit, livestock insurance, and delivery of market information, output marketing and milk collection. Good support services are critical for enhancing livestock productivity and for enabling the poor to gain access to expanding markets (Ahuja & Redmond, 2001). Lack of access to such services entails great burdens for poor households who can least afford the loss of their animals (Dold & Cocks, 2001).

### 4.11 Access to production inputs

A large number of poor households undertake own food production as one of their livelihood strategies (Monde, 2003). However, without productive inputs there will be no agricultural production process. Rural households' inputs are generally low, except perhaps for labour, but a shortage of labour is often cited as a constraint to the cultivation of existing plots (May, 2000). Rural households with limited access to resources or with access to poor quality resources have fewer options and often fail to provide enough food for their families through own production (Monde, 2003).

### 4.12 Purchasing power

In spite of the need to focus on increasing input purchases, rural households usually, lack purchasing power (Abdoulaye & Sanders, 2005). According to Mohr, *et al*. (2008), purchasing power is the value of a currency expressed in terms of the amount of goods or services that one unit of money can buy. Inflation tends to decrease the amount of goods or services that can be purchased. Rural households tend to respond by trying to produce without or with very little inorganic fertilization. In this way, they incur lower expenses. In addition, household agriculture is characterised by intensive use of labour provided by family

members (Pote, 2008). This is because rural household farmers are resource-poor (Dold & Cocks, 2001) and cannot afford external farm inputs (Pote, 2008). Poverty in the rural areas is also due to agricultural policies that have persistently marginalized small-scale black farmers by limiting their access to resources such as land, credit and technical knowledge (Gbetibouo & Ringler, 2009).

### 4.13 Management capacity

There is evidence of mismanagement of resources in some of the rural households, especially in those with lack of knowledge and skills (Mtshali, 1999). This sometimes occurs despite access to abundant unused land of medium or even high potential. This may be explained, among other factors, by limited extension of agricultural production, lack of inputs and shortage of labour. Moreover, the infrastructure and services to support sustainable land use are inadequate (Chaminuka *et al*., 2008). Lack of knowledge about how to work the land appropriately results in land degradation and remains a problem on good and marginal lands. With increasing pressure on agriculture to increase output per unit of land, the challenge is to ensure that it does not take place at the expense of the natural resource base. There is also a lack of management problem in terms of appropriate food storage to minimise food losses (Mtshali, 1999).

### 4.14 Wealth

Wealth is defined as consisting of assets that have been accumulated over time. It can take many forms, such as fixed property and shares. In this study, wealth is measured by the ownership of assets as well as the number of livestock owned. Assets help to buffer households against adverse circumstances. Assets such as houses, land and movable goods can be sold and converted into cash to meet household consumption needs during difficult times (Gbetibouo & Ringler, 2009). Livestock may serve as collateral, as provision for retirement, as a means of rural saving and for emergency cash purposes (May, 2000). The more assets a household owns and the larger its flock or herd, the wealthier it is and the better able it is to deal with unforeseen shocks.

#### 4.14.1 Number of livestock owned

Keeping livestock is a major component of southern African rural agriculture (Schwalbach *et al*., 2001). Stock numbers vary in part because of weather conditions. Stockbreeders

concentrate on such breeds as are well adapted to diverse weather and environmental conditions (SA Yearbook, 2010). Cattle are dominantly held in the eastern parts of the country where the rangelands have a higher carrying capacity, while sheep are favoured in the drier west and in the southeast. Mostly these are Dohne Merino, bred mainly for wool production, and the Dorper for meat production. Goats are more widely distributed, the main breeds being the Boer goat and the Angora, while ostriches are used in the southern parts of the country where they feed on natural vegetation, supplemented by fodder and concentrates (Palmer & Ainslie, 2006).

To keep livestock is the norm in the communal areas of South Africa (Mngomezulu, 2010) and it serves as collateral, for retirement, as a means of saving, as draught power and a source of food and fertilizer (May, 2000). Owners generally use livestock to maximise the yield of consumable products and services for the household investment portfolio and for savings, security and emergency cash purposes (May, 2000). Livestock can also generate income through sales and the renting of animals for traction (Aliber & Hart, 2009).

### 4.14.2 Ownership of assets

Assets such as land and housing entail direct and indirect benefits for individuals and households. Benefits come in the form of a secure place to live and livelihood protection during emergencies. Assets are important to reduce poverty, to cushion against risk and vulnerability from natural disasters, illness or financial crises (Doss *et al*., 2008). Ownership of assets has a positive impact on market access. When households possess assets such as farm machinery and equipment such as tractors, motor vehicles, and storage facilities, access to the market becomes easier to obtain (Pote, 2008).

## 4.15 Farm income

In South Africa today income is the principal determinant of household food security (Kirsten *et al*., 2003). While farming plays a dominant role in poverty alleviation and food security, it does not generate sufficient household income regardless of farm size (Machethe *et al*., 2004). Ellis (1998) argues that farming on its own is increasingly unable to provide a sufficient means of survival in rural areas. In subsistence production, crops are usually not produced for sale but for home consumption. Sales do occur but these are incidental, not the main purpose. Hence, the livelihoods of the rural poor tend to depend on remittances and government grants (Adey, 2007). This dependence can also be attributed to labour shortages

at critical times, unavailable or expensive inputs, limited access to traction for ploughing, uncontrolled grazing by livestock which threatens crops, easy saturation of local markets, inability of households to compete with commercial farmers and the pervasiveness of diseases and weather risks (Hendriks & Lyne, 2003). Accordingly, most subsistence farmers in South Africa tend to diversify their income and livelihood sources to spread and manage risk and reduce poverty (Aliber & Hart, 2009).

### 4.16 Farm organizations

Farm organizations are formed by groups of farmers who meet voluntarily to fulfil mutual economic and social needs by operating a collectively controlled enterprise such that the benefits achieved are greater than the benefits that would have been achieved individually (Chibanda, 2009). Some studies argue that farm organizations have significant potential for reducing poverty, enhancing empowerment and creating employment by reducing costs, enhancing incomes and improving the viability of business activities (Chibanda, 2009). It is further argued that people form farm organizations to exploit new market and economic opportunities through self-help to provide themselves with services that would not have otherwise been available if provided individually, to strengthen bargaining power, to maintain access to competitive markets, to acquire needed products and services on a competitive basis, to reduce costs, and to manage risk (Chibanda, 2009).

### 4.17 Diversification of livelihood strategies

By definition diversification in agriculture is the strategy of shifting from less profitable to more profitable farming enterprises, increasing exports and competitiveness in both domestic and international markets, protecting the environment, and making conditions favourable for combining agriculture, fishery, forestry and livestock activities (Dharmasiri, 2007). It is a resilience mechanism pursued by farmers in different regions (Sharma *et al*., 1996). It does not apply only in agriculture as it also means one can diversify sources of income. It enables people to meet the cash needs of the family and to combat risk (such as uncertainties in crops yields and livestock productivity due to climatic and biological vagaries or loss of jobs due to economic recession and loss of income earners in a family due to death) associated with single livelihood strategies employed by households (Malik & Singh, 2002). Other benefits include food and nutrition security, income growth, poverty alleviation, employment generation, judicious use of land and water resources, sustainable agricultural development

and environmental improvement (Sharma *et al*., 1996). However, efforts to diversify in the case of farming households are mostly constrained by resources such as land holding size, soil suitability, quality of irrigation infrastructure and availability and cost of labour (De & Chattopadhyay, 2010).

### 4.18 Concluding remarks

In the previous chapter (Chapter 3) a conceptual framework was presented for the assessment of rural households' vulnerability to climate change. As part of that chapter, a number of possible determinants of vulnerability to climate change were identified. This chapter (Chapter 4) has provided more details of those indicator variables, based on available literature. From the material presented in this chapter, it is clear that rural households are disadvantaged in respect of most of these characteristics and therefore, they can be expected to have a low adaptive capacity. The next chapter describes the research methodology used in this research project.

## Chapter 5: Research methodology

### 5.0 Introduction

This chapter reviews the research methods used to collect and analyse data concerning the households in the study villages. The chapter explains the sampling procedure and how data were collected and analysed. It begins by describing the study area.

### 5.1 Description of the study area

The description of a study area familiarizes one with the locus of research (Jari, 2009). A description of the three typical villages (an inland, a village near the river and a coastal village) includes issues of geographical location, topography and climate, socioeconomic factors, livelihoods and agricultural potential. Very little research has been carried out in the Ingquza Hill Local Municipality and so there is very little in the literature to describe these villages specifically.

#### 5.1.1 Location of the study area

The study villages are located in the Ingquza Hill Local Municipality[1] which is one of seven local municipalities which fall within the jurisdiction of the OR Tambo District Municipality of the Eastern Cape Province (SA Yellow.com, 2011), the second largest Province of South Africa (Pote, 2008; Jari, 2009). The municipality is located in the north west of the OR Tambo district. It was established through the amalgamation of the former Lusikisiki and Flagstaff (its two major urban centres) Transitional Local Councils and the surrounding rural areas, which fell under the transitional representative councils. It was named after Ingquza, a place where innocent people were gunned down by the apartheid regime (IHLM, 2011a). The seat of the municipality is in Flagstaff and the municipal area is divided into 27 wards (SA Yellow.com, 2011). Figure 5.1 below shows the exact location of the three study villages within the municipality.

[1] In the remainder of this dissertation the term "municipality" refers to the Ingquza Hill Local Municipality, where the three villages under study are located.

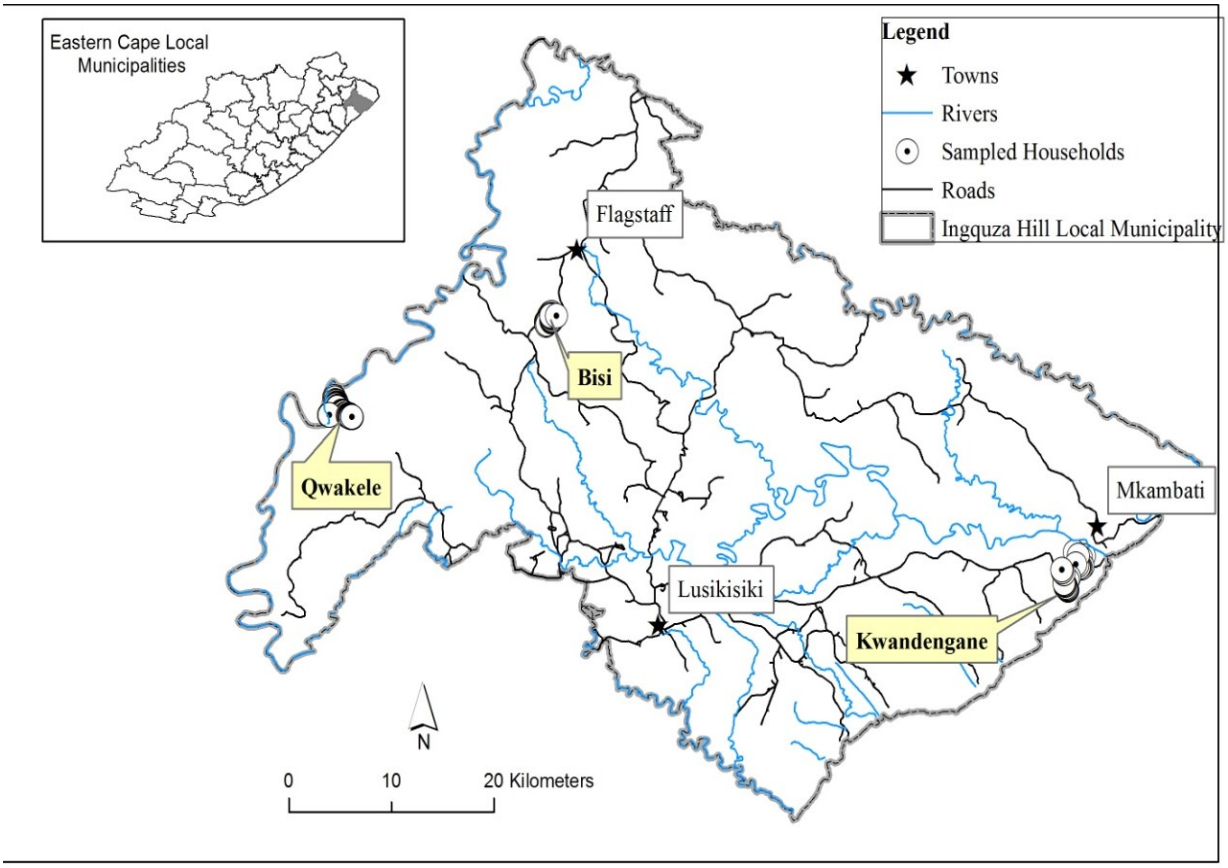



**Figure 5.1: The Ingquza Hill Local Municipality, its major towns and the study villages.**

### 5.1.2 Topography and climate

According to the IHLM (2011b), the municipal jurisdiction is characterised by summer rainfall, with a small amount falling in winter. The mean Annual precipitation ranges between 700 – 1100 mm. Frost is infrequent, but may occur where cold air becomes trapped in the valleys. The mean daily maximum temperature in February rarely falls below 26 °C and often exceeds 32 °C. In winter (July) the temperatures rarely rise to more than 20 °C.

The municipality lies within the northern section of the Wild Coast and is characterized by many hills, dongas, rivers, and streams that are flanked by wild forests. In most cases, the topography is such that tillage is restricted due to the steep slopes and escarpments. Moreover, in some cases, the presence of dongas makes some of the land unusable. The rugged plateau of the Msikaba sandstone formation is the most prominent geographical and topographical feature. The formation is characterised by shallow, highly leached acidic, sandy soils of low production potential but which are for the most part good for grazing (in the summer months only). The sandstone formation comes to a clear-cut termination at the Egoso fault, which lies just north of Mbotyi and extends 18 km inland from the coast. The

Karoo super group (comprising shale, mudstones and sandstones with dolomite intrusions) features beyond this point southwards (IHLM, 2011b).

### 5.1.3 Socioeconomic factors and livelihoods

The municipality is predominantly rural and comprises an area of 2476 square kilometers with a population of approximately 279 795 people in total (IHLM, 2011a). It is low in racial diversity and more than 99% of the inhabitants are African and the remaining 1% is comprised of Coloured, White and Indian racial groups (Van Zyl, *et al*, 2010). Like most South African rural communities, the majority of the Eastern Cape's rural communities face problems of food insecurity due to the high unemployment rate and aggravated by lack of inputs for land cultivation. In most cases, lack of economic opportunities combined with the marked seasonality of rain fed agriculture leads to labour shortages during the critical phases of the cropping season, with under-employment for the rest of the year. This has resulted in a common tendency to abandon arable land by those who have the rights to utilize it (Kwaru & Gogela, 2002). The unemployment rate at Lusikisiki and Flagstaff is at an average of 66% (IHLM, 2011a). The labour market is highly concentrated in the community services sector followed by the household and agriculture sector. These dominant sectors do not guarantee job security and the associated wage rate is generally below the poverty line (IHLM, 2011a).

Other sectors that are considered to be primary growth sectors which should ideally be the highest contributors to economic development, such as manufacturing, transport, trade and financial services make relatively small contributions towards job creation. The result is that the municipality is characterised by a narrow economic base that contributes to the high levels of unemployment and poverty (IHLM, 2011a), while poverty has deepened in rural households that have to manage without the remittance income they formerly received from migrant family members (IFAD, 2008). The lack of job opportunities in the labour market as well as loss of jobs has led to a fall in remittances from migrant labour consequently pushing many rural households deeper into poverty.

In addition, the situation in terms of youth unemployment is similar to that indicated in Yu's (2013) study where he was deriving the comparable youth labour market trends since 2000. Youth unemployment has long been one of the most pressing socioeconomic problems of South Africa due to lack of sufficient networks to obtain information on job opportunities, as well as financial resources and mobility to seek work (Yu, 2013). Other causes of youth unemployment include lack of communication skills, personal presentation and emotional

maturity. Some of the youth are not well-educated and dropped out from school (due to poverty and inability to cope with studies), while some of the matriculants completed their post-matric qualifications at institutions not recognised by employers (Yu, 2013). As a result of unemployment, household income levels in the municipal area are generally very low with less than 1.4% of households earning above R76 000 per annum, while more than 97% of households have to live on an income of less than R800 per month (IHLM, 2011b).

In South Africa as a whole, infrastructural development is one of the main challenges that the government faces (Makhura & Wasike, 2003). While the cities and sophisticated industrial areas of the Eastern Cape are well served by infrastructure, its rural areas still battle with huge backlogs left by apartheid (ECDC, 2004). In spite of the fact that service infrastructure, including electricity, plays a crucial role in the development of the economy of the municipal area as well as the maintenance of environmental and health standards, service delivery is one of the challenges in the municipal area. The reality is that areas with huge infrastructural backlogs tend to do poorly in attracting investment. Whilst it has favourable geographical conditions, this municipality has been unable to attract established industries to come and invest in its area. Only 77% of the households have access to RDP standards of electricity. As a result, extensive use is still made of other sources of energy possibly for reasons of affordability. Wood remains the most commonly used source of energy for cooking purposes that can have serious environmental consequences. Paraffin is also commonly used as fuel for both heating and cooking purposes. Candles are still used extensively for lighting purposes (IHLM, 2011b).

The municipality is predominantly rural, and, as in many rural areas of South Africa, poor roads, lack of means of transport, lack of market information and inadequate markets manifest themselves as the main constraints to market access. The means of transport used mostly are walking, head-loading and draught power. Head loading is done by women by virtue of their dual responsibility for social reproduction and economic production (Kleih, 1999), while men use draught power and horses rather than to walk. Access to assets, services and economic opportunities is unequal across the population. Larger households are more likely to be poor, particularly those with many children. Access to education, a major driver of relative wealth (Zezza *et al*., 2007) is highly inequitable as well. Many elders did not even start primary school. Secondary and higher education was not easy to obtain owing mainly to the required enrolment fees. Elders usually claim that they were forced by their fathers to

look after livestock and they were forbidden to go to school. Some had to go to urban areas in search for jobs in their junior secondary schooling age.

Attempts to escape rural poverty are frustrated by the recurrence of shocks that include weather-related events such as crop failures and increases in the price of food, illness and death of family members, frequently due to HIV/AIDS. The poorest of the poor households have to adopt costly coping strategies such as the selling of assets, withdrawing children from school and reducing food consumption (Lahiff, 2002). In addition to social grants, most of the rural households live on what they can produce from cultivating, on average, less than 1.5 ha of land (the fields), or from herding livestock on grazing land that is increasingly and severely degraded, or on occasional income from other sources such as casual labour or remittances. Those who live in the rugged mountain areas are significantly poorer than others are. Yields tend to be low because of severe land degradation, reliance on rain fed agricultural production methods and poor crop cultivation methods. Literature makes it clear that the exploitation of the potential of agricultural production is hindered by the unfavourable climate that is worsening because of climate change. This suggests that rural households are the most vulnerable to climate change impacts. As pointed out by Machete (2004), the lack of investment in agriculture, the decline in agricultural production, the lack of income-generating activities and degradation of natural resources are among the principal causes of rural poverty.

### 5.1.4 Agricultural potential

The municipal area falls within the Savanna Biome and the vegetation of the area is described as Ngongoni veld. The landscape is dominated by dense, tall grassland, consisting of primarily unpalatable, wiry Ngongoni grass (Aristida Junciformis). This dominance results in low vegetative species diversity (IHLM, 2011b). Subsistence agriculture is the predominant form of land use in the municipal area and most of the land is communal. Merryweather (2008) noted that the decline in level of production is a tendency that began long ago, following the independence of the Transkei. This has progressed to the extent that Transkei now imports most of its food requirements and this may be attributed in part to the changed approach to the provision of goods and services to farmers and in part to agriculture being labelled as an uneconomic or non-economic activity by the youth.

## 5.2 Sampling procedure

A sample is a subset of the whole population which is being investigated and whose characteristics will be generalized to the entire population (Bless *et al*., 2006). In other words, the sample must have properties that make it representative of the whole population. Sampling is a process of selecting units from a population of interest, so that by studying the sample, the results obtained may be generalized to the population from which the sample was chosen (Jari, 2009). Hence, the purpose of sampling is to reduce the cost of collecting data about a population by gathering information from a subset instead of the entire population (Magnani, 1997).

The population of interest in this study is the households of the three typical villages, an inland, a coastal and a village near the river. The sample size was 120 (n = 120) drawn from households from three villages which include Qwakele, Kwandengane and Bisi. Forty households were selected from each village. The researcher chose a sample size of 120 because sample size of 40 households in each village is greater than the minimum statistical sample size required, which is 30 ($n \geq 30$). The sample size of 120 was drawn from the total of 425 households in the three villages. The three villages were randomly selected. Six focus groups sessions, two from each village, were conducted. Table 4.1 below shows a tabular representation of the sampling of the study.

**Table 5.1: Sampling procedure**

| Village | No. of households | Sample size (FG)* | Percentage |
|---|---|---|---|
| Qwakele | 97 | 40 (2) | 41.23% |
| Kwandengane | 108 | 40 (2) | 37.04% |
| Bisi | 220 | 40 (2) | 18.18% |

*FG: Focus groups (numbers in parentheses)

Qwakele is in the Mzintlava river catchment that joins Umzimvubu River to the sea in Port St Johns. It is a small village comprising of a population of 487 people in 97 households (Van Zyl *et al*., 2010). It is a village with huge developmental backlogs. The village is located far from both urban centres in the municipality and more than 50 km away from the R61. It is one of the sub-villages of Mantlaneni village. Even though ruled by one chief, each sub-village has its own headman. It is located where the big rivers called Mzintlava and Mzimvubu meet. The landscape is mostly unfavourable for cropping and the village is

flanked by natural forests. An unsurfaced road that ends at the beginning of this sub village is the only developmental infrastructure that the village has. The schools, clinic and police station are about 8 km from the village.

Kwandengane comprises a population of 548 people in 108 households (Van Zyl *et al*., 2010). It is situated along the coast. It is located about 50 km away from Lusikisiki. Like many rural areas, it is characterised by a backlog in road infrastructure. The road between Kwandengane and Lusikisiki is unsurfaced. Kwandengane is right along the coast and is one of the most underdeveloped villages. An unsurfaced road is the only developmental infrastructure that the village has. The landscape is fine and suitable for both cropping and livestock.

Bisi is inland. It is a small village with a population of 1 106 people, 220 households and an average household size of 5 (Van Zyl *et al*., 2010). It is located along the R61 and is just less than 10 km away from Flagstaff, the other urban centre of the municipality. The nearest clinic is in Flagstaff. There is one Junior Secondary School known as Bisi Junior Secondary School in the village. This village is making development progress. It receives water, electricity and housing from government, although, electricity has not covered the whole village yet. The landscape is suitable for both cropping and livestock.

Simple random sampling was used to select 120 households. One of the reasons for choosing simple random sampling is that the number of households (i.e. sampling frame) is known. Therefore, 120 households were selected randomly from a total of 425 households. Simple random sampling ensures that each unit has an equal chance of being chosen (Cassim, 2011).

In addition to the sample survey of households in the three villages, the researcher decided to use focus groups to discover the feelings of the majority about some critical factors that affect their livelihoods. These factors included both institutional and socioeconomic factors as well as some environmental factors.

### 5.3 Data collection

Two questionnaires were designed as a tool for data collection. The first questionnaire, which was administered to individual respondents through face-to-face interviews conducted by the researcher, was designed to capture data on the demographic characteristics, livelihoods and socio-economic characteristics of sampled households. The second questionnaire, which was administered to focus groups, was designed to capture respondents' view of noticeable

climatic variations, their impact on agricultural productivity and livelihoods as well as adaptation measures taken.

According to Bless *et al*. (2006), an interviewer-administered questionnaire is an important tool of data collection because it reduces omission of difficult questions by respondents. In addition, it reduces the problem of word or question misinterpretation by respondents and can be administered to participants that can neither read nor write. In addition, the presence of the interviewer increases the quality of the responses since the interviewer can probe for answers that are more specific. The use of interviewer-administered questions ensures minimal loss of data when compared to the other methods.

### 5.4 Data analysis

This section discusses how the data was analysed. In line with the objective of the study, descriptive statistics were used to analyse demographic characteristics. The main descriptive indicators that were used include percentages, charts (columns and pie charts) and Tables.

Three indicators of vulnerability (Reliability of income, reliability of water resources and diversification of agricultural production) were selected, based on the argument raised by Adger *et al* (2004) that the methods and frameworks for assessing vulnerability must address determinants of adaptive capacity in order to examine the potential responses of a system to climate change and variability. Each of these three indicators was then subjected to a statistical procedure that involved relating a large number of variables to the element of vulnerability in question in order to identify the factors that are statistically significant. A multiple regression model was used to predict the relationship between each vulnerability indicator and a large number of socioeconomic and institutional characteristics that shape how rural households respond, cope and adapt to the effects of climate change. The multiple regression fitted this form:

$$Y = f(X_1, X_2, \ldots, X_n)$$

Where: Y is the dependent variable representing some measure of vulnerability for a particular village, while the Xs are the explanatory variables. Following convention, the model can be specified as:

$$Y_{income} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots \beta_n X_n + U_i$$

$$Y_{water} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots \beta_n X_n + U_i$$

$$Y_{diversification} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots \beta_n X_n + U_i$$

Where:

$\beta_0$ = the intercept or constant term

$\beta_1, \beta_2, \beta_3 \ldots\ldots\ldots \beta_n$ = slope or regression coefficient

$X_1, X_2, X_3 \ldots\ldots\ldots X_n$ = explanatory or independent variables

$U_i$ = error term

Socioeconomic and institutional characteristics that shape how rural households respond, cope and adapt to the effects of climate change were analysed. Table 5.2 presents a summary of these variables, their units of measurements and types. Since there are three indicators of vulnerability that were assessed and compared, the hypothesized relationships are specified in Chapter 7.

**Table 5.2: Model variables applied in the analysis**

| Variables | Unit | Type of variable |
|---|---|---|
| Age | Actual in years | Continuous |
| Gender | Male or Female | Categorical |
| Marital status | Single or otherwise | Categorical |
| Education | No education or otherwise | Categorical |
| Income class | Intervals | Categorical |
| Household size | Actual number | Continuous |
| Individuals bringing income | Actual number | Continuous |
| Household average income | Actual amount | Continuous |
| Garden size | Estimated size | Continuous |
| Reasons for growing crops in a garden | Selling or otherwise | Categorical |
| Field size | Estimated size | Continuous |
| Source of water for crops | Rain or irrigation | Categorical |
| Government support | Have access or not | Categorical |
| Organizations | Participate or not | Categorical |
| Distance to water resources | Estimated time in minutes | Continuous |
| Adequate/unreliable (water resources) | Adequate or unreliable | Categorical |
| Number of assets | Actual number | Categorical |
| Number of livestock | Actual number | Categorical |
| Infrastructure | Have access or not | Categorical |
| Sources of water | River or other | Categorical |

The vulnerability model used as framework to identify explanatory variables is given, algebraically, as Y = f(X). The more accurate representation of the model is Y = f (exposure, sensitivity and adaptive capacity)

Further simplified as $Y = f(X_1, X_2, X_3, \ldots\ldots X_n)$

Where Y is vulnerability and $X_1, \ldots, X_n$ are the different factors or variables that are used to indicate or measure vulnerability. The dots and the term $X_n$ indicate that vulnerability is a result not only of $X_1$, $X_2$ and $X_3$, but also of other factors or variables of which $X_n$ is the last.

Table 5.3 below presents the determinants of vulnerability, component indicators, description of indicators, and hypothesized functional relationship between variables and data sources.

**Table 5.3: Vulnerability indicators, variables and data sources**

| **Determinants of vulnerability** | **Component indicators (Variables)** | **Description of the indicator** | **Hypothesized functional relationship between indicator and vulnerability** | **Data source** |
|---|---|---|---|---|
| **Exposure** | Extreme events (drought & flood) | Frequency of droughts & floods | The higher the frequency, the higher the vulnerability | Secondary data |
| | Precipitation & temperature changing patterns | Expected changes in temperature & precipitation | The greater the changes from present climate normal, the higher the vulnerability | Secondary data |
| | Rising sea levels | Expected changes in sea level | The greater the change from present sea levels, the higher the vulnerability | Secondary data |
| **Sensitivity** | Irrigation rate | Percentage of irrigated land | The greater the land under irrigation, the lower the vulnerability | Primary data |
| | Land quality | Land degradation | The higher the land degradation, the higher the vulnerability | Secondary data |
| | Crop diversification | % area of x crops/Number of crops | The higher the crop diversification, the lower the vulnerability | Primary data |

| | | | | |
|---|---|---|---|---|
| **Adaptive capacity** | Wealth | No. of livestock & assets owned | The greater the wealth, the lower the vulnerability | Primary data |
| | Technology | Adoption of new technologies | The higher the adoption of new technologies, the lower the vulnerability | Primary data |
| | Availability of infrastructure | Infrastructural development | The more developed the infrastructure, the lower the vulnerability | Primary data |
| | Potential for irrigation | Availability & affordability of irrigation infrastructure and water resources | The greater the potential for irrigation the lower the vulnerability | Primary data |
| | Literacy rate | Proportion of respondents who completed at least Grade 8 | The higher the literacy rate, the lower the vulnerability | Primary data |
| | Farm organization | Share of households members of farmer organization | The higher the share of participating households, the lower the vulnerability | Primary data |
| | Farm income | Net farm income | The higher the farm income, the lower the vulnerability | Primary data |
| | Farm holding size | Average farm holding size | The larger the size of land, the lower the vulnerability | Primary data |
| | Farm assets | Number of farm assets | The higher the farm assets, the lower the vulnerability | Primary data |
| | Access to credit | Amount of credit received | The higher access to credit, the lower the vulnerability | Primary data |

# Chapter 6: Socioeconomic and institutional characteristics of rural households in the study areas

## 6.0 Introduction

This chapter discusses and analyses the results of the field survey. It begins with descriptions of demographic characteristics of sampled households. It goes on to discuss institutional and socioeconomic chracteristics of households, giving special attention to aspects related to agricultural production.

## 6.1 Demographic characteristics of sample households

In this section, descriptive statistics such as mean, maximum and minimum values, percent and standard deviation were used. Since this is an assessment and comparison of vulnerability indicators, the analysis and discussion of demographics was done first for the villages combined, whereafter the same aspects were looked at again for each village. Demographic aspects included household head characteristics such as age, gender, marital status, education, employment status, level of income and sources of income. Sources of income pertained not just to the household head, but to the household as a whole. Makhura *et al*. (1999) indicated that information pertaining to the household head is important because the main household activities are coordinated by the household head. Makhura *et al*. (2009) further indicated that the head's decisions are most likely to be influenced by such demographic characteristics as age, gender, marital status, level of education as well as employment status and level of income.

### 6.1.1 Demographic characteristics: all villages combined

This section discusses and analyses demographic characteristics of household heads for all the study villages combined.

#### 6.1.1.1 Actual age distribution of the household head

Studies have indicated that older people, often taken as most vulnerable of demographic groups, are most experienced (Adger *et al*., 2004). Older people may have lived through many things and may have developed coping mechanisms that give them more resilience than other age groups. Jari (2009) also noted that age determines the experience one has in a certain type of farming. Table 6.1 presents the average age in the study villages.

**Table 6.1: Actual age (n = 120)**

| Variable | n | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Actual age | 120 | 21 | 90 | 56.07 | 16.940 |

Table 6.1 above shows the actual age distribution of the sampled households in the studied villages. The results show that the agricultural producers in the study villages are relatively experienced. This is confirmed by the average age of 56 years, while the standard deviation shows that the ages were widely spread.

#### 6.1.1.2 Gender distribution of the household head

Gender is crucial when it comes to familial decision making, particularly for rural households of the former Transkei. Muzamil & Shubeena (2008) indicated that women play a crucial role in the economic welfare of the family. They perform different tasks depending on their socioeconomic structure, number of people in the family, the nature of the profession they are involved in and many other things.

In addition, the idea of measuring gender distribution in this study was based on the paper by Posel & Rogan (2012) that indicated that poverty remains a gendered phenomenon in post-apartheid period in South Africa. The paper analysed income data from regularly collected household surveys to investigate gendered trends in poverty over the post-apartheid period and the female-headed households were over-represented among poor households. Moreover, the reduction in poverty was found to have favoured males and male-headed households because the results show that for each of measures of income, the extent of depth of poverty are considerably higher for females and female-headed households (Posel & Rogan, 2012). The relevence and soundness of the forgoing analysis in this study is that the datasets included information on earned income and social grants income at the individual level.

The results for this study are presented in Figure 6.1 below. In the context of this study females were classified as household heads when they were single, divorced or widowed.

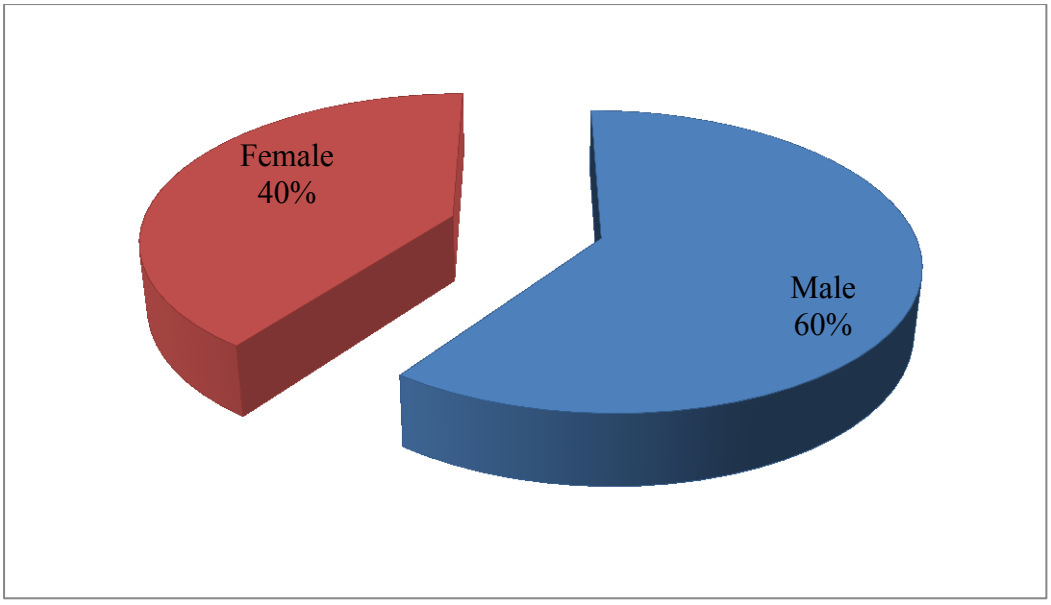



**Figure 6.1: Gender distribution of the household head, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that sample households comprise a majority of male-headed households indicating that decision-making powers are rested more in male family than female family members. Based on Posel and Rogan's (2012) analysis above one can predict that the results further show that the proportion of poor households was relatively smaller across the study villages.

### 6.1.1.3 Marital status of the household head

Muzamil & Shubeena (2008) and FAO (2010b) indicated that the issue of marital status is of equal importance to that of gender because the authoritarian character of a traditional joint family entails decision making powers concentrated in the position of males, in the case of a married couple, or otherwise in the eldest male member. Women are traditionally less involved in decision making at all levels unless they are single, widowed or divorced. Figure 6.2 presents the survey results.

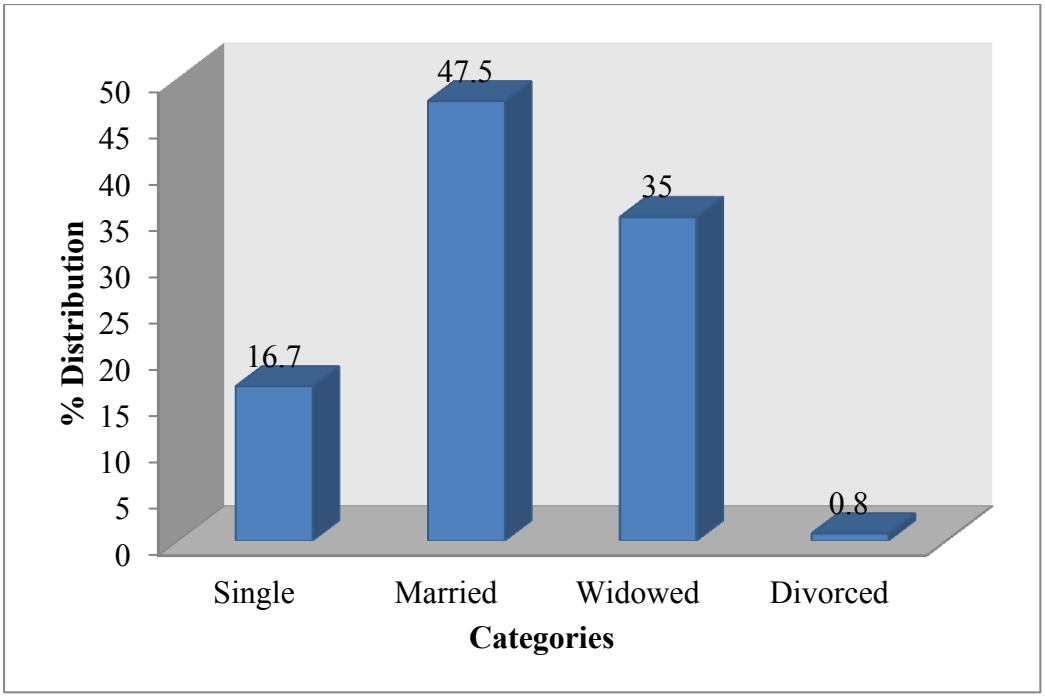



**Figure 6.2: Marital status of the household head, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that the majority of respondents were married. This implies that the authoritarian character of decision-making powers is in hands of males, rather than women for married couples.

### 6.1.1.4 Education level of the household head

Education is one of the key components of human capital and provides a quality dimension to the simple availability of labour. It is also a key input determining household ability to access higher return activities whether in agriculture or not to escape poverty (Zezza *et al*., 2007). Jari (2009) emphasised the importance of education in enabling people to interpret information. The study indicated that people with higher educational levels are more able to interpret information than those who have less education or no education at all. Figure 6.3 presents the educational levels of the sampled households.

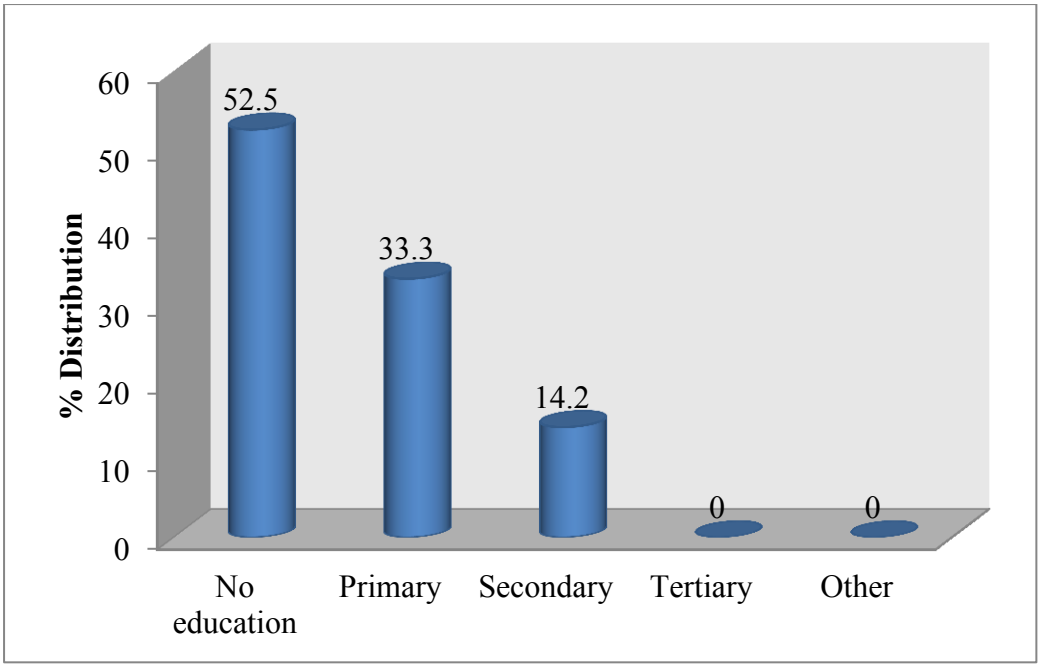



**Figure 6.3: Education level of the household head, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The levels of education were grouped into five categories. The results show that the study villages are characterized by low levels of education that indicates lack of human capital and of a quality dimension to the available labour.

### 6.1.1.5 Employment status of the household head

Studies have shown substantial increases in dependence on market purchases on the part of rural households (Monde, 2003; Machethe, 2004; Sotsha & Bester, 2012). As a result, food expenditure may be as much as 60-80% of the total income of low-income households. Here, employment status and type of employment can serve as measures of income expenditure on food. These characteristics are presented in Figure 6.4 and 6.5 below.

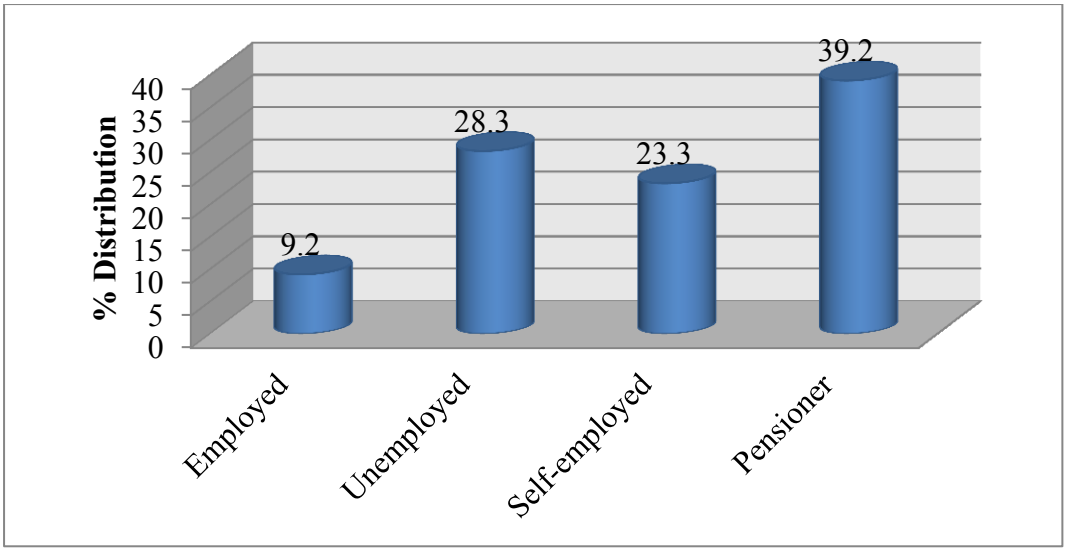



**Figure 6.4: Employment status of the household head, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that there is a high level of unemployment (28.3%) among the households. As a result, there is a heavy dependence on social grants (39.2%). This is no surprise given that South Africa has been experiencing one of the highest reported unemployment rates in the world (Klasen & Woolard, 2008). The results are consistent with the findings of Klasen & Woolard (2008) in the study where they were examining how unemployment can persist without access to unemployment compensation by analysing household surveys from 1993-2006. Klasen & Woolard (2008) used two definitions of unemployment; i) a narrow definition that includes only those who are willing to work and actively searching, and ii) a broad definition that includes those who are willing to work but are not searching. The results given based on these definitions indicated that based on the narrow definition, unemployment stood at 28% in 2004 while it was 41% based on a broader definition (Klasen & Woolard, 2008). Given this state of unemployment one could argue that social grants directly impacts on levels of poverty by reducing both the incidence and the severity of poverty (Neves, *et al*, 2009).

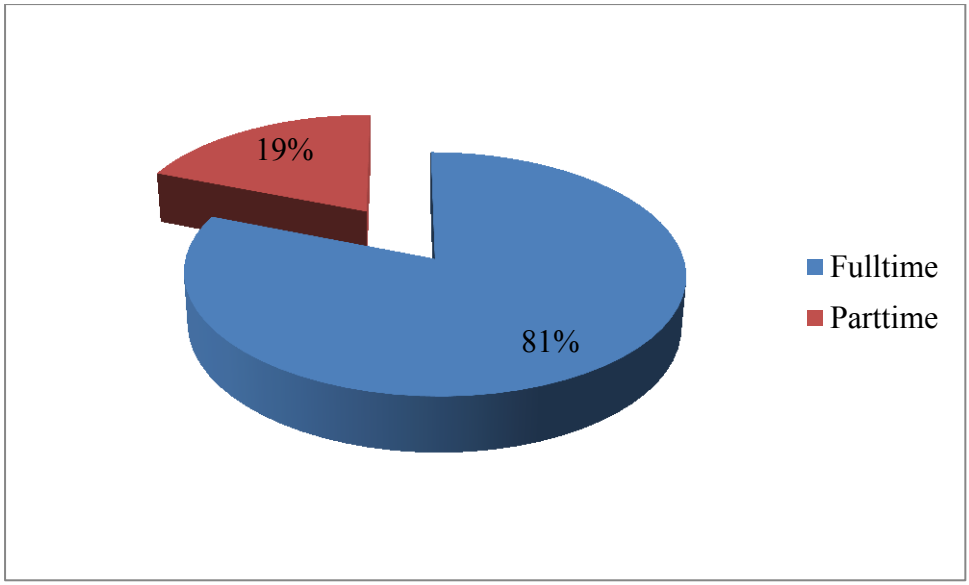



**Figure 6.5: Employment status of the household head (full-time or part-time), Qwakele, Kwandengane, Bisi, 2012 (n = 120).**

Figure 6.5 shows that a larger proportion of respondents were full-time (81%), while the rest were part-time (19%). However, 81% might not be a true reflection of the full-time employed respondents as it includes pensioners who, almost all received social grants.

### 6.1.1.6 Level of income of the household head

Actual income was recorded, there were no categories in which respondents could be grouped. Table 6.2 below presents the results for the level of income of the household head using mean, standard deviation, minimum and maximum values.

**Table 6.2: Level of income in rands per month of the household head, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| Variable | n | Min | Max | Mean | Std. Deviation. |
|---|---|---|---|---|---|
| Income class | 120 | 100 | 10 000 | 1447.32 | 1561.275 |

The results show that income levels were widely dispersed, as shown by a large standard deviation. The mean income was R1 447.32 and the income range was R900, as shown by a minimum of R100 and a maximum of R10 000.

### 6.1.1.7 Sources of income

According to Van Averbeke & Khosa (2009), most rural households are highly dependent on social grants and wage incomes in addition to own food production. Sources of income for sample households were grouped into six categories but each category was asked seperately to avoid a multiple responses factor. The results are presented in Figure 6.6.

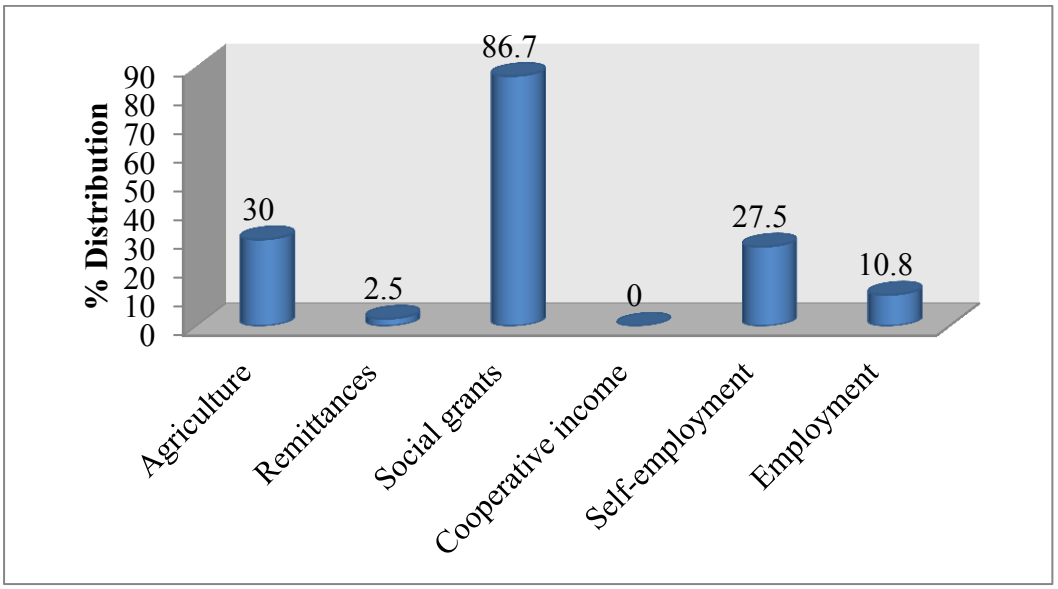



**Figure 6.6: Sources of income, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that, in terms of frequency, social grants form the major source of income for the respondents, as 86.7% houselholds receive grants. Agriculture (30%) is the second most frequent source of income in the form of crop and livestock sales. The contribution of self-employment (27.5%) is larger than that of employment (10.8%) (see also Figure 6.4). Remmittances (2.5%) is the smallest source while cooperative activity (e.g income from community vegetable gardens) (0%) does not contribute at all to household income of the sample households. These results show that household poverty would be more widespread in the absence of social grants.

### 6.1.2 Comparative analysis of demographic characteristics

Section 6.1 (6.1.1.1 to 6.1.1.7) presented the demographic characteristics of the sample households for all three study villages combined; in this section the demographic characteristics are presented for the three villages separately, in order to explore differences between them.

### 6.1.2.1 Analysis by age of the household head

The sample's households were asked to provide the age of the household head. The actual age was recorded. Table 6.3 below shows the results of an analysis by age of the household heads in each of the study villages.

**Table 6.3: Actual Age, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| Village | N | Mean Age | Maximum | Minimum | Std. Deviation |
|---|---|---|---|---|---|
| Qwakele | 40 | 56.77 | 90 | 21 | 20.394 |
| Kwandengane | 40 | 52.47 | 79 | 25 | 15.167 |
| Bisi | 40 | 58.95 | 87 | 26 | 14.399 |

The results show that all the studied villages were characterised by, on average, 56 years old household heads, meaning that the decision-making powers were concentrated in the experienced members of the families.

### 6.1.2.2 Analysis by gender, marital status, education and employment status

Table 6.4 presents a comparison between villages of gender distribution, marital status, education level, and employment status of the household head. These are important aspects of demographic information of the household head, as they tend to influence the head's decisions in the process of coordinating household activities.

**Table 6.4: Gender, marital status, education and employment status, Qwakele, Kwandengane, Bisi, 2012 (n = 120).**

| | Qwakele (%) | Kwandengane (%) | Bisi (%) |
|---|---|---|---|
| **Gender** | | | |
| Male | 50.0 | 55.0 | 75.0 |
| Female | 50.0 | 45.0 | 25.0 |
| **Marital status** | | | |
| Single | 32.5 | 17.5 | 0.0 |
| Married | 30.0 | 50.0 | 62.5 |
| Widowed | 35.0 | 32.5 | 37.5 |
| Divorced | 2.5 | 0.0 | 0.0 |
| **Education** | | | |
| No education | 55.0 | 60.0 | 42.5 |
| Primary | 32.5 | 20.0 | 47.5 |
| Secondary | 12.5 | 20.0 | 10.0 |
| Tertiary | 0.0 | 0.0 | 0.0 |
| Other | 0.0 | 0.0 | 0.0 |
| **Employment status** | | | |
| Emplyment | 0.0 | 12.5 | 15.0 |
| Unemployed | 30.0 | 32.5 | 22.5 |
| Self-employed | 27.5 | 25.0 | 17.5 |
| Pensioner | 42.5 | 30.0 | 45.0 |

The results show that gender was equally distributed for the Qwakele village, while other villages were characterised by many male headed households. A higher proportion of respondents was married in Kwandengane and Bisi villages, while only 30% of respondents were married in Qwakele village. Education level is very low and many sample respondents have no education. There was not a single respondent who went to a tertiary or other level such as ABET.

### 6.1.2.3 Analysis by level of income

As argued by Ziervogel *et al*. (2006), a household having better or good income will also be able to purchase agricultural inputs so that a household can grow or produce its own crop and keep livestock with the purpose of getting food for the family. When a household is in a good financial position, it can even hire people for agricultural production processes. Table 6.5 below shows the level of income of household head.

**Table 6.5: Level of income in rands per month, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| Village | Mean | Max | Min | Std Dev |
|---|---|---|---|---|
| Qwakele | 1016.79 | 1800.00 | 100.00 | 355.643 |
| Kwandengane | 1385.19 | 8000.00 | 300.00 | 1423.891 |
| Bisi | 1890.32 | 10000.00 | 400.00 | 2157.831 |

The results show that the average income of respondents was R1 430.77. Bisi village has the highest income earner (R10 000) and also the highest average income (R1 890.32) while Qwakele had the lowest income earner (R100) and also the lowest average income (R1 016.79). The standard deviation was lower for Qwakele village indicating that income values were not as widely dispersed as in the other two villages.

### 6.1.2.4 Analysis by source of income

As argued in the literature, South African rural households depend on other sources of income more than they do on agricultural production. These sources include claims against the state, wage earnings, and remittances by kin who live and work elsewhere for monetary income. Employment levels tend to influence poverty trends and hence food insecurity. The less the employment, the lower is the household income. This is because even those who are employed earn too little to sustain them and their families (Bonti-Ankomah, 2001). Figure 6.7, below, presents income sources categorised into six groups.

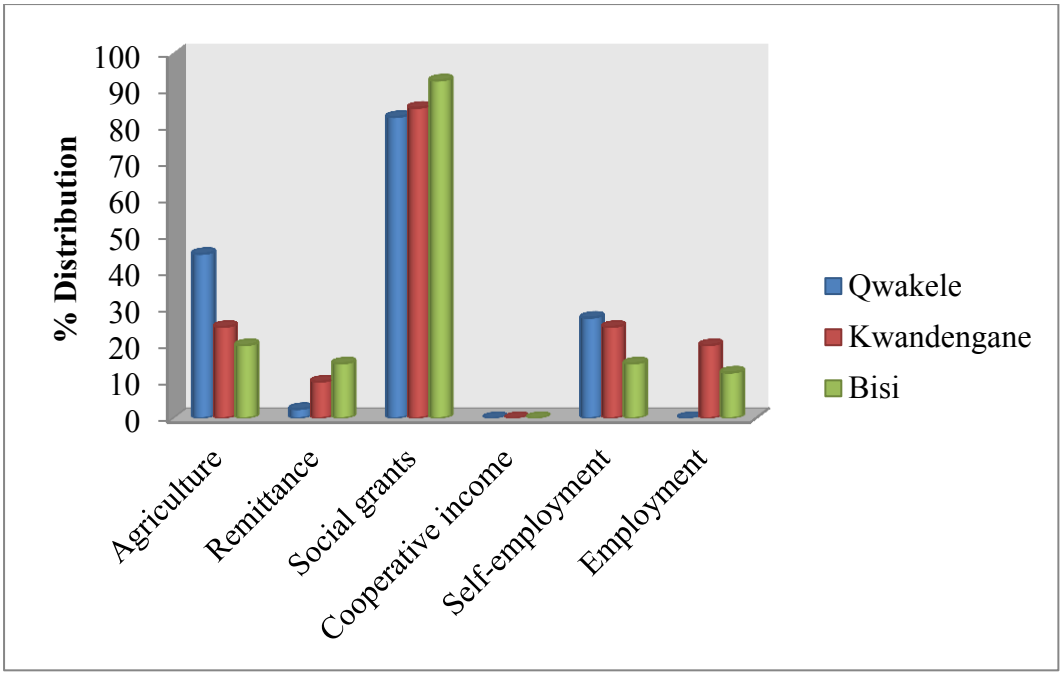



**Figure 6.7: Comaprison of sources of income, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that social grants are the most prevalent source of household income, followed by agriculture (livestock and crop sales) and self-employment for each of the three villages. Remittances and employment are the least prevalent sources in Qwakele because most of respondents in this village were unemployed and had no family members engaged in employment elsewhere. Cooperative income does not contribute at all in any of the studied villages because there were no cooperative activities taking place during the course of the study.

### 6.1.2.5 Analysis by household size, individuals bringing income, household average income

Normally, there is a positive relationship between household size and agricultural production when the essential family labour is available during the planting times. Moreover, when a household has sufficient finance, it can even hire people for agricultural production processes. Table 6.6 below gives a brief explanation on household size, number of individuals bringing income and household average income, in Rands per month.

**Table 6.6: Household size, individuals bringing income, household average income per month, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| Villages | N | Mean | Max | Min | Std Dev. |
|---|---|---|---|---|---|
| **Household size** | | | | | |
| Qwakele | 40 | 5.50 | 15 | 1 | 3.693 |
| Kwandengane | 40 | 7.00 | 18 | 1 | 4.243 |
| Bisi | 40 | 9.28 | 17 | 1 | 9.275 |
| **Individuals bringing income** | | | | | |
| Qwakele | 40 | 2.60 | 7 | 1 | 1.582 |
| Kwandengane | 40 | 3.80 | 12 | 1 | 2.614 |
| Bisi | 40 | 4.58 | 10 | 1 | 2.286 |
| **Household average income** | | | | | |
| Qwakele | 40 | 1425.00 | 3420.00 | 100 | 771.226 |
| Kwandengane | 40 | 2152.00 | 10300.00 | 540 | 2189.498 |
| Bisi | 40 | 2662.75 | 10000.00 | 600 | 1944.032 |

Table 6.6 shows that household sizes are relatively large. The results further show that the larger the household size the greater the number of individuals bringing income. Household average income was R2 079.92.

Tables 6.7 and 6.8 below present the importance of social grants for South African households as well as the impact of large household sizes given that social grants are the main source of income. The tables were adapted from Lloyd-Sherlock *et al*. (2012)'s paper that was based on a survey conducted in 2002. The paper seeked to review and interpret selected findings from a comparative study of older people, pensions and wellbeing in South Africa and Brazil.

**Table 6.7: Pension sharing, 2001**

| **How much of your pension and your own money can you keep for yourself?** | **Response (%)** |
|---|---|
| None | 65.2 |
| A little | 15.9 |
| Some | 7.7 |
| A reasonable amount | 2.5 |
| All | 8.7 |

Source: Lloyd-Sherlock *et al*., 2012: 247

Table 6.7 is based on old-age grant and shows that the majority of respondents do not save, with only 8.7% of respondents who can save all their pension. This implies that the majority of pensioners shared all, or most of their benefits with their households.

**Table 6.8: Self-reported financial situation of households, 2002**

| **Situation** | **No pension (%)** |
|---|---|
| Very bad | 23.1 |
| Bad | 32.9 |
| Average | 36.6 |
| Good | 7.1 |
| Very good | 0 |

Source: Lloyed-Sherlock *et al*., 2012: 247

Table 6.8 shows that for the majority of respondents the situation of the household ranges from average to very bad. Only 7.1% respondents indicated that their situation was good and none indicated that it was very good.

### 6.2 Household asset ownership

Ownership and control of assets such as land and housing provide direct and indirect benefits to individuals and households. These benefits come in the form of a secure place to live, a means of livelihood, or protection during emergencies. Clearly, assets are important for reducing poverty and cushioning against risk and vulnerability to natural disasters, illness or financial crises (Doss *et al*., 2008). Ownership of assets has a positive impact on market access. Barriers to markets are reduced when households possess assets such as farm machinery and equipment such as tractors, motor vehicles, storage facilities, etc. (Pote, 2008).

#### 6.2.1 Land

Land is obviously a critical resource in agriculture and it has a great influence on income distribution (Stockbridge, 2007). Hendricks & Fraser (2003) argued that, in South Africa's former Bantustan areas, land is an obstacle to agricultural development.

#### 6.2.1.1 Access to arable land

Access to arable productive land in Africa has declined due to population growth and land degradation because of climate change (FAO, 2010a). During the apartheid era, the former homelands constituted 13% of the land of which only a small proportion was suitable for agricultural production, and only a miniscule area under irrigation (Lahiff & Cousins, 2005). The survey shows that all of the sample's households had access to arable land. However, in most cases only a small proportion of the land is suitable for agricultural production.

#### 6.2.1.2 Size of arable plots

Makhura (2001) argued that insufficient land is one of the most limiting factors for rural households in South Africa, particularly where households own small plots of land. During the apartheid era, blacks had access to only 13% of the total of the country's surface land area to constitute the former homelands. Much of it was overcrowded and not suitable for agricultural production (Lahiff & Cousins, 2005). Table 6.9 below presents the results on size of arable plots owned by the sampled households.

**Table 6.9: Garden and field size, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| | N | Mean | Max | Min | Std Dev |
|---|---|---|---|---|---|
| **Garden size (in hectares)** | | | | | |
| Qwakele | 40 | 0.580 | 1.20 | 0.30 | 0.2509 |
| Kwandengane | 40 | 0.859 | 3.00 | 0.20 | 0.6190 |
| Bisi | 40 | 0.458 | 1.20 | 0.10 | 0.2286 |
| **Field size (in hectares)** | | | | | |
| Qwakele | 40 | 1.05 | 1.80 | 0.60 | 0.3086 |
| Kwandengane | 40 | 1.13 | 5.00 | 0.40 | 0.8844 |
| Bisi | 40 | 2.17 | 5.00 | 1.00 | 0.9977 |

The results show that, even though there is 100% access to land, the mean size of land allocated to each household is significantly small. These results are similar to the real situation in the African context. Jayne & Muyanga (2013) indicated that half or more of Africa's smallholder farms are below 1.5 ha in size with limited or no potential for area expansion.

#### 6.2.1.3 Type of land ownership

Land is allocated through customary land allocation procedures in the study villages and these procedures do not allow households to acquire more land even in areas where a

significant portion of land appears to be unutilized. In addition, some young men and women start their families without inheriting any land from their parents. This situation is similar to that of African smallholder farmers, as indicated by Jayne & Muyinga (2013).

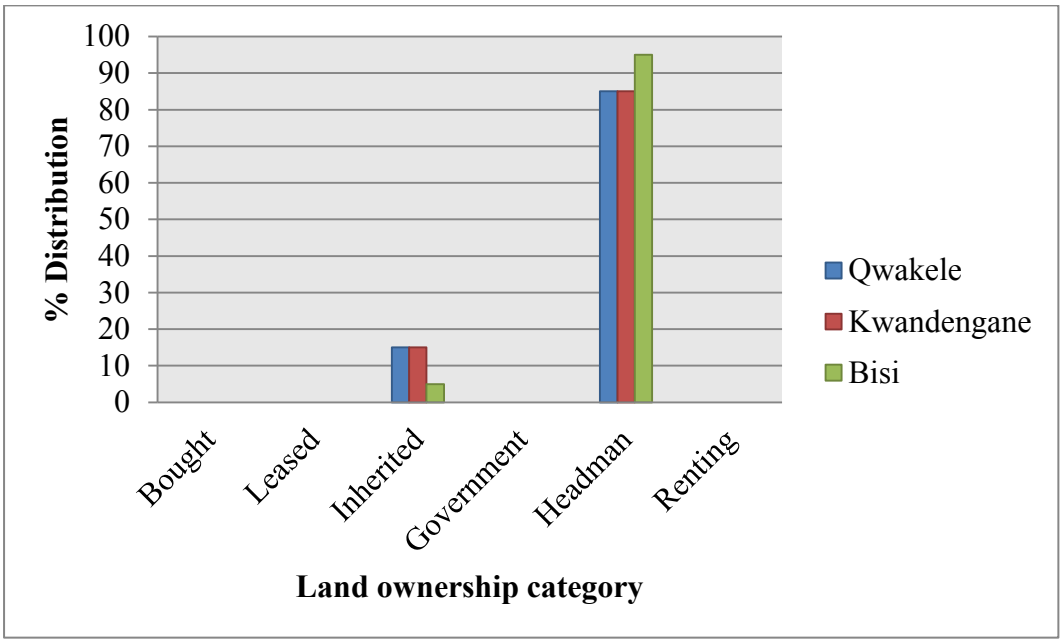



**Figure 6.8: Type of land ownership, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that more than 80% of the sampled households were allocated land by headman while the rest (less than 20%) inherited their land.

### 6.2.1.4 Access to grazing land

Livestock production is a major component of Southern African agriculture and it remains prevalent with wide variations between households and regions as argued by Schwalbach *et al*. (2001). About 80% of South African agricultural land is suitable for extensive livestock farming. In many areas, livestock is kept in combination with other farming enterprises and livestock numbers vary according to weather conditions because stockbreeders concentrate on developing breeds that are well adapted to diverse weather and environmental conditions (SA Yearbook, 2010). The sample's households were assessed in terms of access to grazing land. All the households had access to grazing land. However, other studies carried out in other rural areas indicate that rural households face a problem of scarcity of land since the land to which they have access is overcrowded (Lahiff & Cousins, 2005). Makhura (2001) argues that insufficient land is one of the most limiting resources for rural households in South Africa, particularly where households own small plots of land.

### 6.2.2 Cultivation implements

Pote (2008) argues that the type of farming carried out by households is an important factor in determining the extent to which farm equipment can be constraining in the rural household environment. Ownership of cultivation implements including ploughs, planters, hoes, etc. was assessed and the results are presented in Figure 6.9 below.

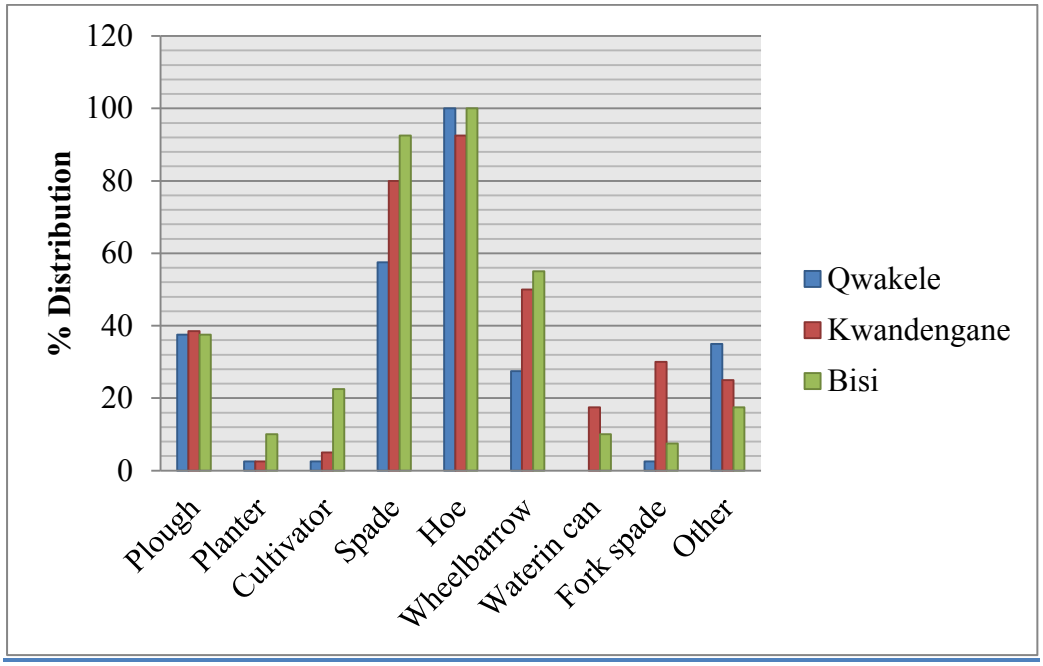



**Figure 6.9: Ownership of cultivation implements, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results reflect ownership of a wide range of implements. However, not many households own all of them, especially not in Qwakele village. Percentage distribution of ownership is higher for Bisi for most of implements than the other two villages. Hoes, spades, wheelbarrows and ploughs are owned more often than other implements.

### 6.2.3 Livestock ownership

Livestock contributes to the livelihoods of at least 70% of the world's poor (Moloi, 2008). Moloi further indicated that livestock plays a great role as a means to earn higher income, particularly for rural households. Livestock ownership was assessed and the results are presented below.

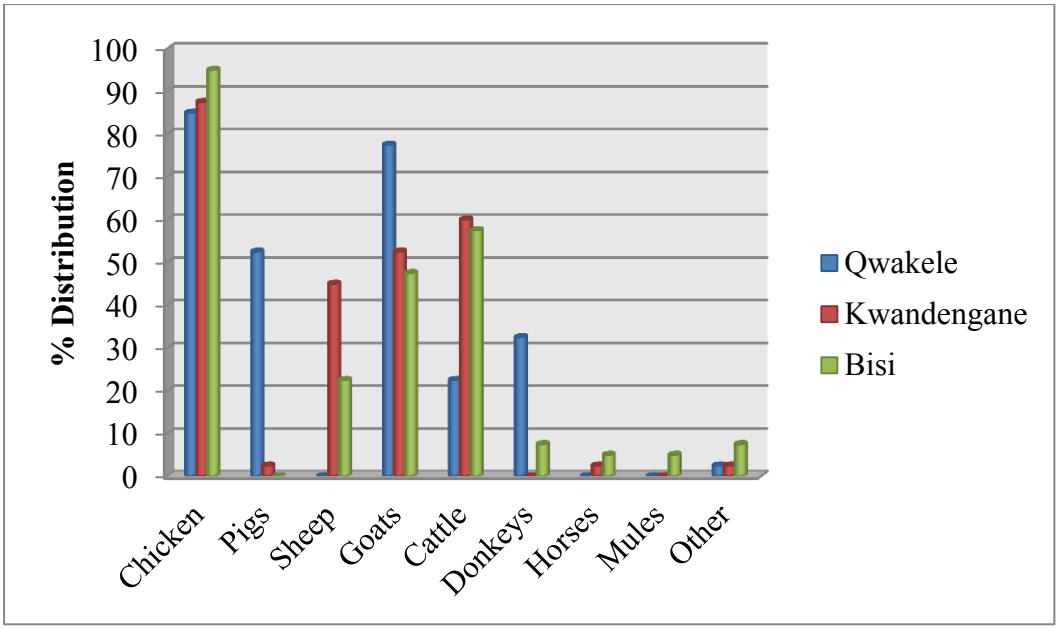



**Figure 6.10: Livestock ownership, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that most households owned chickens, goats and cattle. The results further indicate that cattle are the preferred enterprise for draught power rather than donkeys, horses and mules.

### 6.2.4 Other assets

Other assets noted included household structures, implements and machinery and equipment such as tractors, motor vehicles, generators and refrigerators. The results are presented in Figure 6.11 below.

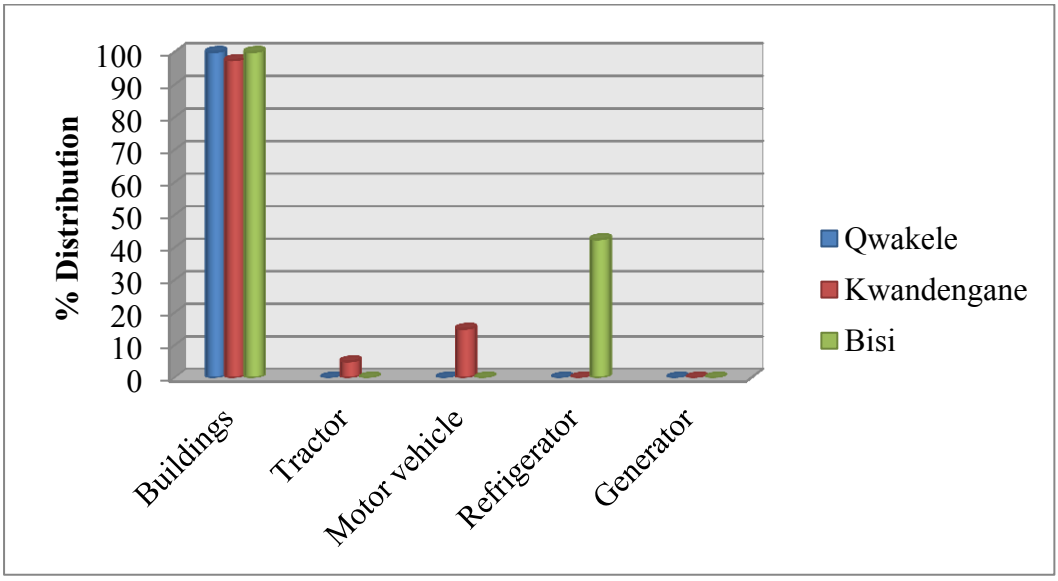



**Figure 6.11: Ownership of other assets, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that 100% of sample households in Qwakele and Bisi own buildings, compared to 97.5% in Kwandengane. There is very little ownership of other valuable assets. Anderson (2012) argued that asset stocks are more informative since they implicitly contain additional information on the future livelihood prospects of the economically disadvantaged. Asset endowments provide a cushion against income shocks and are a general store of value for future income and consumption (Anderson, 2012).

### 6.3 Household socioeconomic and institutional characteristics

The literature indicates that sensitivity and adaptive capacity of rural households to climate change is shaped by both socioeconomic and institutional characteristics.

#### 6.3.1 Source of capital

The availability of capital may determine the level of investment in agricultural production. The households from each study village were asked to indicate where they source money to invest in agricultural production. Options included borrowing from banks; borrowing from friends, own savings, state aid, or other.

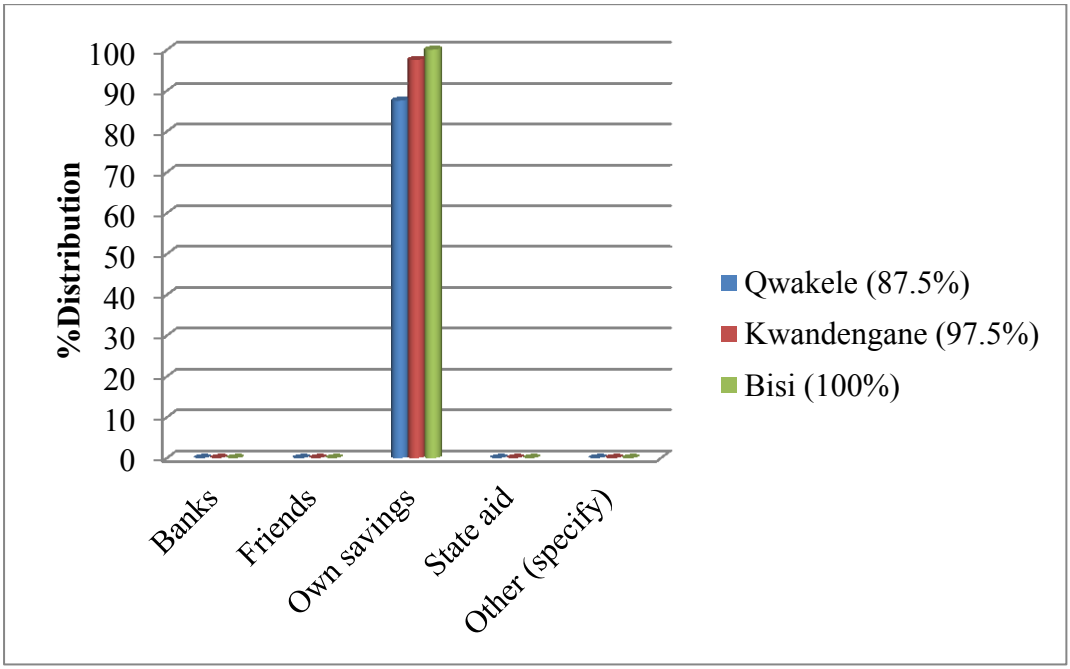



**Figure 6.12: Sources of capital, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that own savings is the only source of money used to invest in agricultural production. This may be due to absence of ownership of valuable assets usually used as collateral (Figure 6.12).

### 6.3.2 Source of labour

The availability of labour tends to determine the level of production. The more labour is available to perform agricultural practices the more a household is likely to produce more. In addition, the sources of labour will co-determine the level of spending on agricultural production. Where there is limited family labour, households will respond by cutting down on production or they will hire labour. A previous study by Sotsha & Bester (2012) attempted to determine the role of agricultural production in the livelihoods of the rural households of Lubala village in Pondoland, Eastern Cape. A multiple regression model was used to test the relationship between reliance on agriculture for livelihoods and household characteristics. The results confirmed that the households of Lubala depend, in order of importance, on social grants, remittances and agricultural production for livelihoods. They obtain food from urban markets and from own food production. Agricultural production plays a vital role in the food security of the households of Lubala. Using multiple regression analysis, the results showed that a statistically significant variable is household size such that an adjustment in household size has a significant influence on agricultural output.

The sample households were asked to indicate their sources of labour and were given options to choose from. The options were categorised into family, exchange, hired, family + exchange, family + hired, exchange + hired, and all. Exchange labour refers to the labour traded between two or more households for the use of animals for drought power. It is common when one household has animals for drought power but has limited labour, while the other has more labour but no animals.

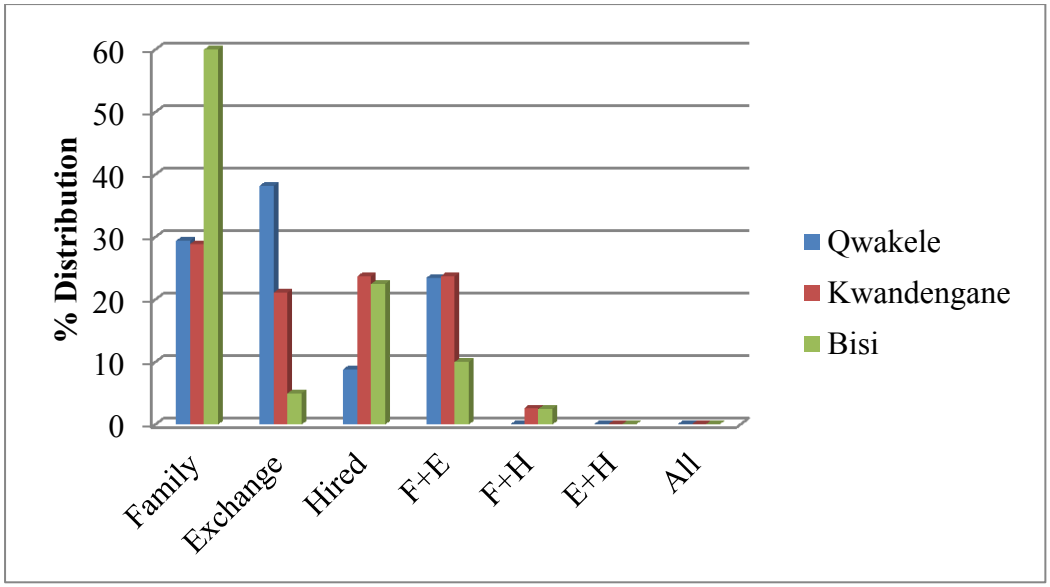



**Figure 6.13: Sources of labour, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that family labour is the predominant source of labour in all three villages, followed by exchange, hired, and family + exchange labour. Other combinations are not part of the sources of labour here. These results confirm the previous findings by Sotsha & Bester (2012) that there is a positive relationship between household size and labour employed in agricultural production processes.

### 6.3.3 Method of cultivation

The sampled households were asked to indicate their method of cultivation and options were provided. To a certain extent, the method of cultivation indicates the state of technological development. Rural households used to apply the old methods of animal traction and hand ploughing before the introduction of tractors that came as a result of technological development.

**Table 6.10: Methods of cultivation, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| | Own (%) | Borrowed (%) | Hired (%) |
|---|---|---|---|
| **Qwakele** | | | |
| Tractor | 0 | 0 | 0 |
| Animal traction | 20 | 50 | 5 |
| Hand | 10 | 0 | 0 |
| **Kwandengane** | | | |
| Tractor | 0 | 0 | 0 |
| Animal traction | 27 | 37.5 | 17.5 |
| Hand | 10 | 5 | 0 |
| **Bisi** | | | |
| Tractor | 0 | 0 | 12.5 |
| Animal traction | 30 | 12.5 | 12.5 |
| Hand | 30 | 2.5 | 2.5 |

The results show that there is still a heavy dependence on own and borrowed animal draught and hand ploughing. The use of animal traction is still prevalent and that influences the transition towards adoption of newer technologies, such as the tractor.

### 6.3.4 How soil fertility is improved

Rural households use a combination of organic and inorganic fertilizers with which to treat land. However, the most commonly used type of fertilizer is organic (kraal manure) because it is cheaper to use (no direct or cash transport costs involved). Organic fertilizers can be exchanged or traded between households and can be taken to arable fields by animal draught power or in a wheelbarrow depending on the distance to the destination. Figure 6.14 presents the responses of sampled households.

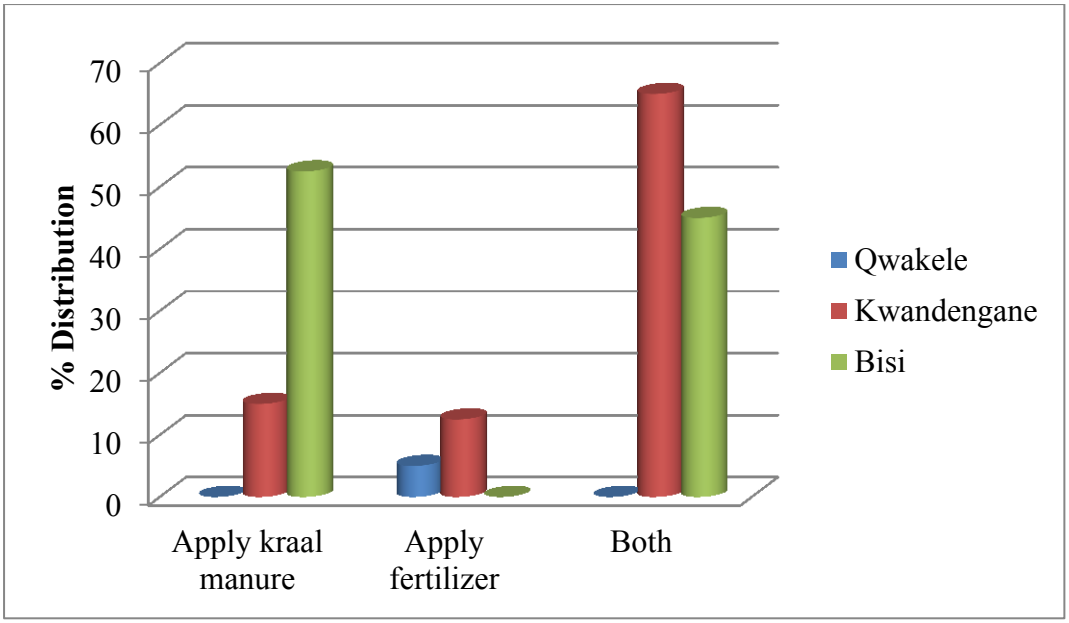



**Figure 6.14: How soil fertility is improved, Qwakele, Kwandengane, Bisi (n = 120)**

The results show that the sampled households apply organic fertilizers rather than inorganic ones. This justifies the importance of livestock production in providing the means of livelihood.

### 6.3.5 Factors influencing choice of crops

The households were also assessed in terms of factors that influence their choice of crops and they were given options from which to choose. This was based on the supposition that agricultural production plays a crucial role in enhancing rural incomes and in reducing poverty (Pote, 2008). It has the potential to become a major source of employment and political stability and to improve food security by increasing the food supply and reducing dependence on purchase of food in a context of high food price inflation (Baiphethi & Jacobs, 2009). The results are presented in Figure 6.15 below.

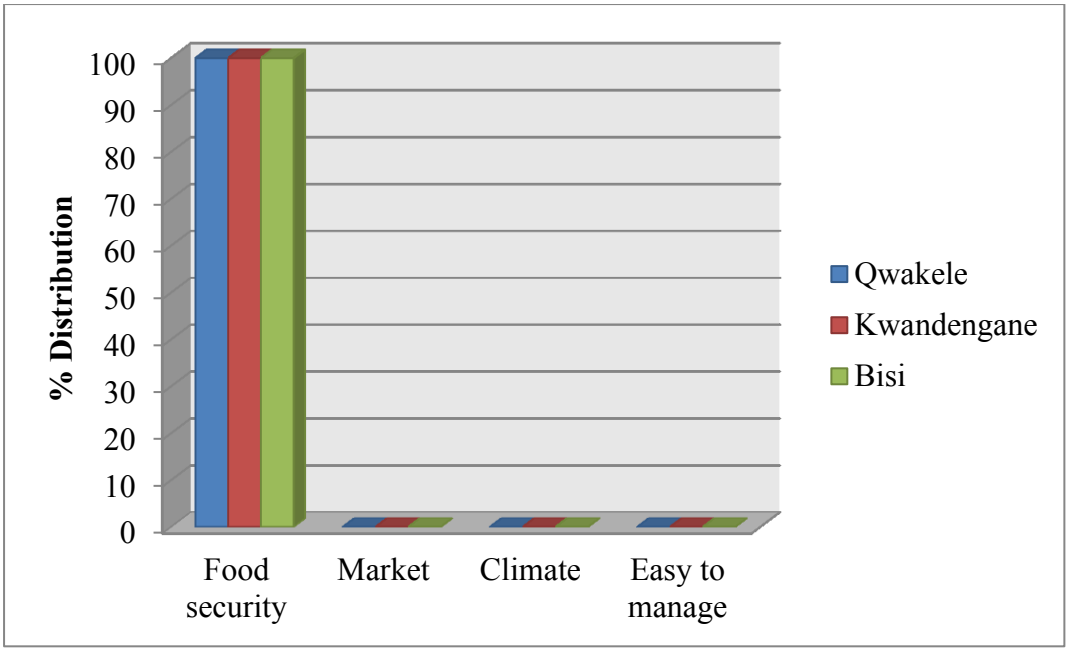



**Figure 6.15: Factors influencing choice of crops, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

Figure 6.15 show that the households produce their own food to improve food security. If the share in total consumption representing the total production was known one would argue that, the results, to some extent, contradict the findings of Baiphethi & Jacobs (2009). Baiphethi & Jacobs (2009) indicated that poor households access their food from the market, subsistence production and transfers from public programmes or other households, whereas in the past rural households produced most of their own food.

### 6.3.6 Utilization of produce

The literature suggests that rural households produce staple foods to meet household demand for food. However, it is expected that they might produce a surplus and it is well to determine what is done with the surplus. Hence, sample households were asked how they used their produce and the results are presented in Figure 6.16 below.

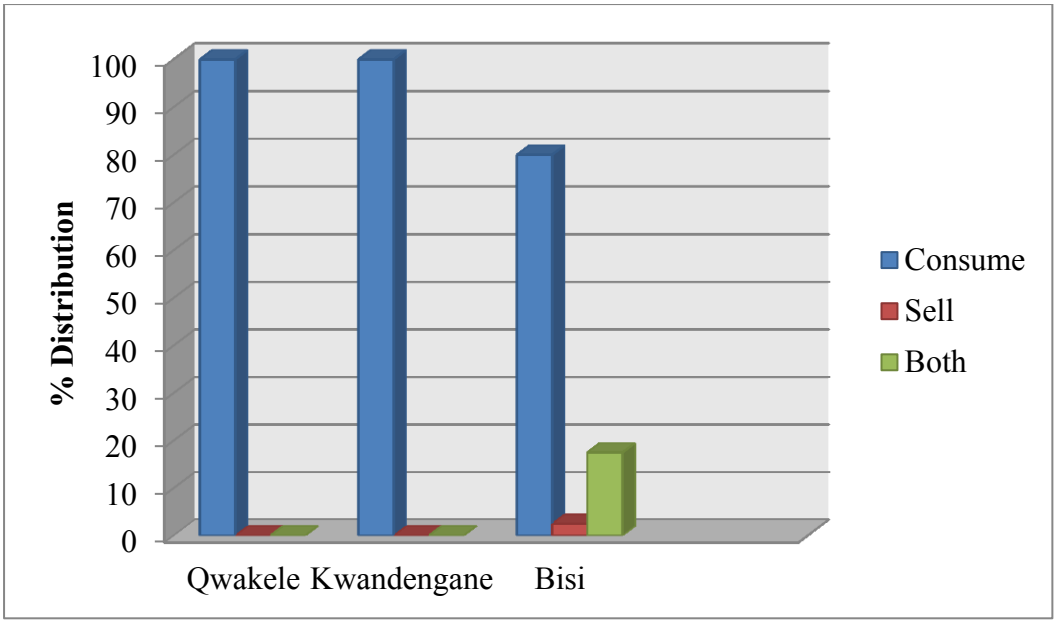



**Figure 6.16: Utilization of produce, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that the largest proportion of sampled households produces for home consumption. This is in line with the results given in Figure 6.16 above. Bisi is the only village (comprising of 2.5% sell and 17.5% both) with households also selling their produce.

### 6.3.7 Access to water resources

It is common cause that one of the challenges in South Africa is lack of service delivery, and that affects rural households the most. Some of the rural households in South Africa still do not have access to clean drinking water. They fetch water from rivers and springs for cooking, drinking, washing and feeding their chickens.

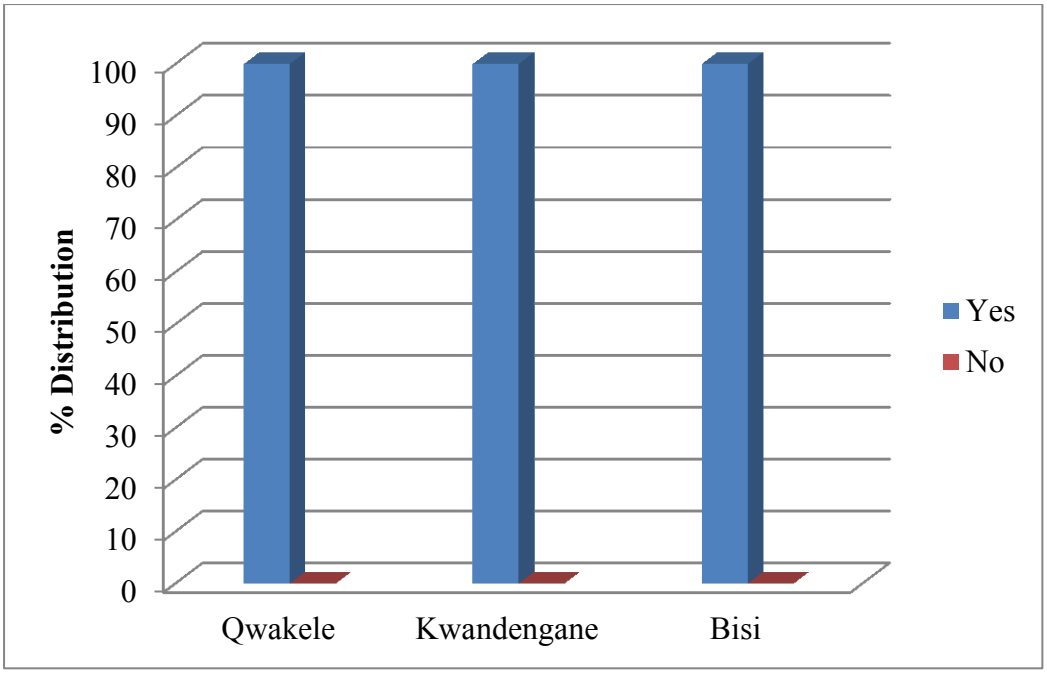



**Figure 6.17: Access to water resources, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

Figure 6.17 shows that all the households in the study villages had access to water resources but these resources were rivers. Therefore, the results do not obviate the need for development of infrastructure, since access to clean and safe water is a most basic need for livelihoods.

### 6.3.8 Sources of water for household use

It is generally understood that most rural households still get their water from rivers and springs without other water delivery services.

**Table 6.11: Sources of water for household use, Qwakele, kwandengane, Bisi, 2012 (n = 120)**

| Source | Qwakele (%) | Kwandengane (%) | Bisi (%) |
|---|---|---|---|
| Spring | 2.5 | 0.0 | 0.0 |
| River/stream | 97.5 | 92.5 | 0.0 |
| Rain water tank | 0.0 | 7.5 | 0.0 |
| Communal taps | 0.0 | 0.0 | 100 |
| **Total percent** | **100** | **100** | **100** |

The results show that Qwakele and Kwandengane villages rely heavily on river and streams, somewhat on rain water tanks (7.5%), while Bisi's water is all from the communal tap (100%). This shows the need for delivery of development infrastructure.

### 6.3.9 Average distance from the water sources

Rivers being main sources of water, individuals in some places have to walk more than 10 minutes to fetch water. Individuals from poor households transport buckets of water on their heads.

**Table 6.12: Average distance from sources of water, Qwakele, Kwandengane, Bisis, 2012 (n = 120)**

| Village | Average distance (minutes) | Standard Deviation |
|---|---|---|
| Qwakele | 16.33 | 4.411 |
| Kwandengane | 8.25 | 3.543 |
| Bisi | 5.05 | 2.050 |

The results show that the sample households depending on rivers and streams for water have to travel over 15 minutes to fetch water while those that rely on communal taps take less than 5 minutes to get to their sources of water.

### 6.3.10 Reliability of water resources

Some of the sources of water, including rivers and streams, dry out when there is not enough rainfall, and get so dirty during heavy rains that they cannot be used.

**Table 6.13: Reliability of water resources, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| Reliability | Qwakele | Kwandengane | Bisi |
|---|---|---|---|
| Reliable | 39 | 28 | 40 |
| Unreliable | 1 | 12 | 0 |
| **Total (frequency)** | **40** | **40** | **40** |

Sources of water for household use are reliable as shown by Table 6.13 above. However 12 of the 40 Kwandengane households indicated that their sources of water for household use are not reliable.

### 6.3.11 Major source of water for crops

There is a general perception that most rural household agricultural production relies on rain fed agriculture. The sampled households were asked about major sources of water for crops and the results are presented in Figure 6.18 below.

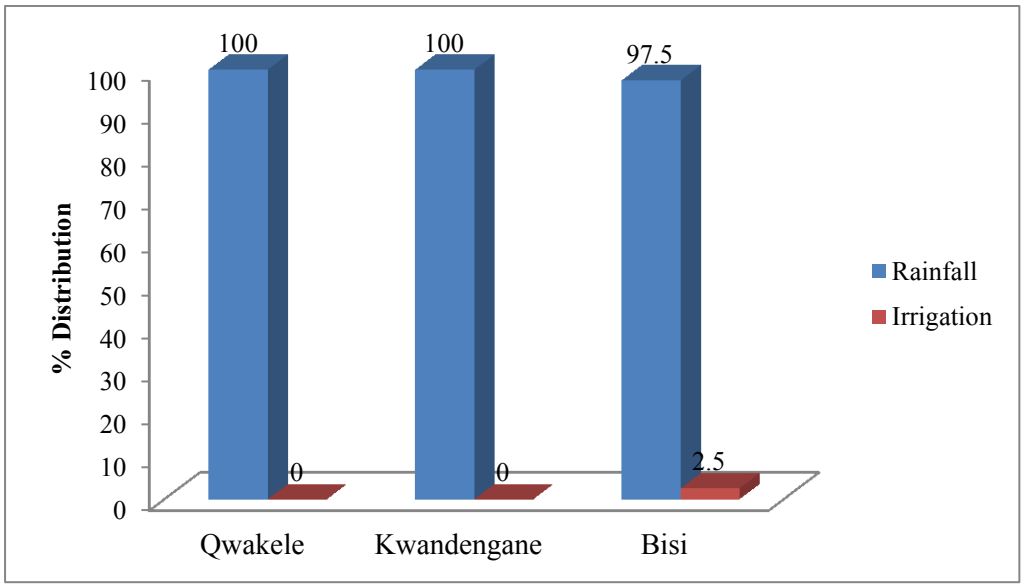



**Figure 6.18: Major source of water for crops, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that most sampled households practise rainfed crop production.

### 6.3.12 Major reasons for not irrigating

The households were asked why they did not irrigate in both their backyard gardens and in arable fields. Meyer *et al*. (2009) indicated that major constraints to new irrigation development in South Africa are limited water resources and high cost of irrigation schemes. Figure 6.19 below presents the reasons why sample households do not irrigate.

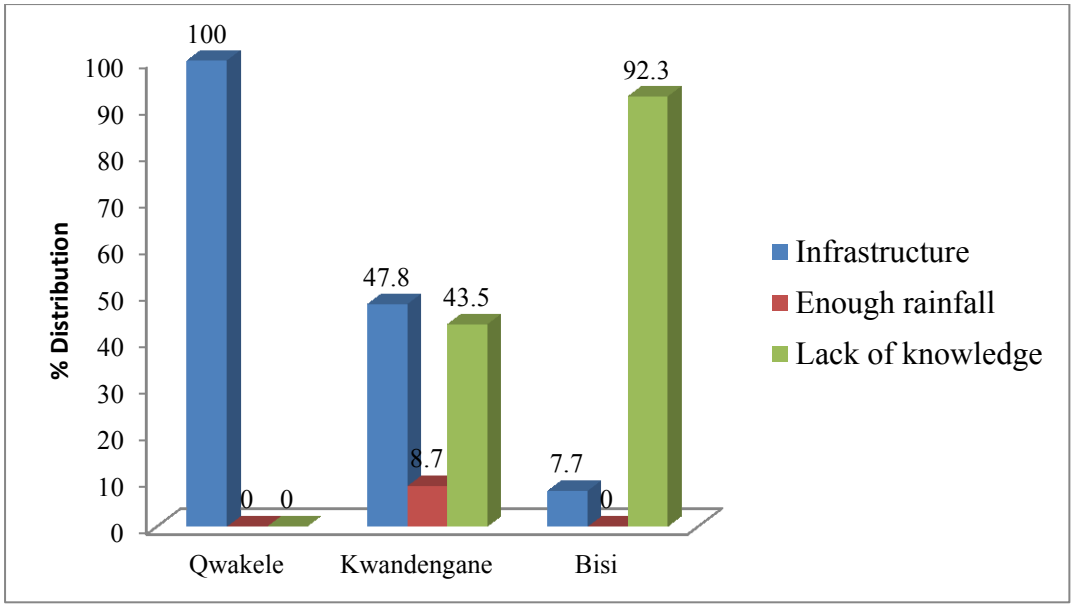



**Figure 6.19: Major reasons for not irrigating, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that respondents in Qwakele did not irrigate mainly because of the lack of irrigation infrastructure and while respondents in Bisi did not irrigate because of inheritance (application of old methods of cultivation by great grandfathers and mothers that involved no irrigation in maize fields).

### 6.3.13 Challenges hindering crop and livestock production

As suggested by the literature, rural households depend on own food production as a buffer and a cushion, particularly for the poorest. In addition to the challenges that rural households face in agricultural production that are technical and institutional, there are also natural challenges including pests and diseases, inadequate rainfall, poor soils and grazing pastures. Such indicators were provided as dummy variables (yes = 0, no = 1). Table 6.14 below shows the responses about natural challenges hindering crop and livestock production, respectively. The values outside brackets represent the percentage of respondents agreeing that a given variable hinders crop or livestock production, while the values in brackets represent the percentage of respondents who think otherwise.

**Table 6.14: Challenges hindering crop and livestock production, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| CHALLENGES HINDERING CROP PRODUCTION (%) | | | |
|---|---|---|---|
| | **Qwakele** | **Kwandengane** | **Bisi** |
| Pests and insects | 0 (100) | 81.6 (18.4) | 27.5 (72.5) |
| Inadequate rainfall | 100 (0) | 23.7 (76.3) | 77.5 (22.5) |
| Poor soils | 100 (0) | 18.4 (81.6) | 2.5 (97.5) |
| Other | 0 (100) | 0 (100) | 2.5 (97.5) |
| **CHALLENGES HINDERING LIVESTOCK PRODUCTION (%)** | | | |
| Diseases | 20 (80) | 70 (30) | 39.5 (60.5) |
| Inadequate rainfall | 80 (20) | 0 (100) | 7.9 (92.1) |
| Poor grazing pastures | 5 (95) | 0 (100) | 10.5 (89.5) |
| Other | 0 (100) | 5 (95) | 0 (100) |

NB: 0 (100) represents Yes (No)

The results show that climatic and environmental effects differ between the villages. For example, poor soils (100%) and inadequate rainfall (100%) are major challenges for crop production in Qwakele village, while pests and insects (81.6%) were a major challenge in Kwandengane village. Bisi village experienced the same two challenges as Kwandengane village, except that inadequate rainfall (77.5%) comes first in Bisi, followed by pests and insects (27%). Table 6.14 further shows that inadequate rainfall (80%) and diseases (20%) are the major challenges for livestock production in Qwakele. In Kwandengane, a larger proportion of respondents (70%) indicated that diseases are a major challenge followed by other (5%), including snake bites. A combination of many factors hinder livestock production in Bisi village, including diseases (39.5%), poor grazing pastures (10.5%) and inadequate rainfall (7.9%).

### 6.3.14 Government support services

Government support includes credit, market information, workshops, extension and veterinary services. Such services do to some extent determine the role of agricultural production for rural households who depend on own food production as a livelihood strategy, as was suggested by the literature.

**Table 6.15: Use of Government support services, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| USE OF GOVERNMENT SUPPORT SERVICES (%) | | | |
|---|---|---|---|
| | **Qwakele** | **Kwandengane** | **Bisi** |
| Credit | 0 (100) | 0 (100) | 0 (100) |
| Market information | 0 (100) | 0 (100) | 0 (100) |
| Workshops | 0 (100) | 0 (100) | 0 (100) |
| Extension service | 2.5 (97.5) | 5 (95) | 10 (90) |
| Veterinary service | 0 (100) | 7.5 (92.5) | 7.5 (92.5) |

NB: 0 (100) represents Yes (No)

The results in Table 6.15 show that extension and veterinary services were the only government support services used in the study villages but no more than 10% of the respondents indicated that they received such services. Extension services appear in all the study villages, while veterinary service appears only in Kwandengane and Bisi.

### 6.3.15 Collective action among sample households

Sample households were asked if they participated in rural organizations of any type. The results are presented in Figure 6.20 below.

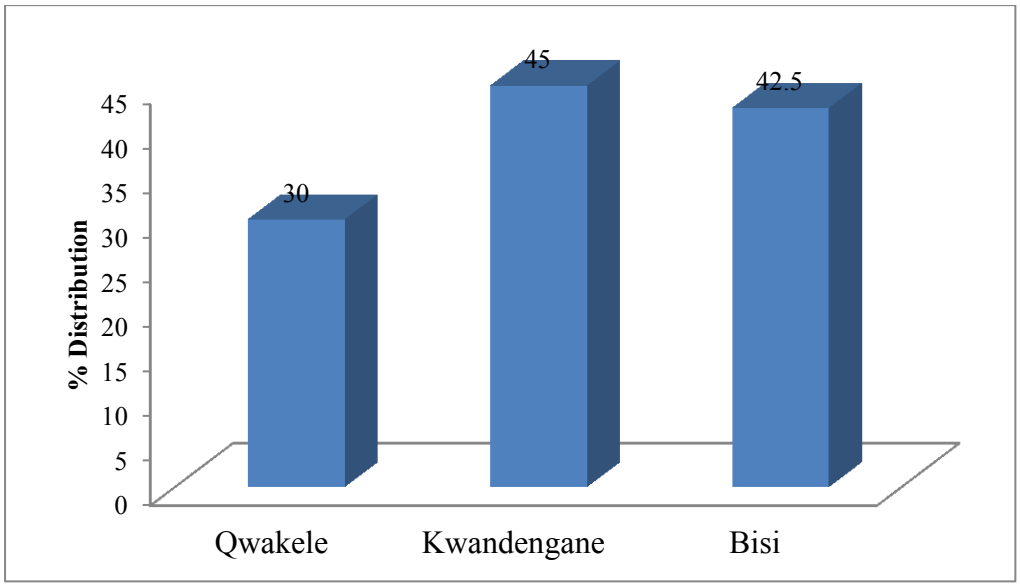



**Figure 6.20: Participation in collective action, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that less than 50% of respondents in each village participated in collective action.

### 6.3.16 Awareness of the role of collective action

One of the possible reasons for households not to participate in rural organizations could be lack of knowledge or awareness of the role played by organizations in the welfare of individuals. Hence, the households were asked if they were aware of the role played by organizations in rural household welfare and the results are presented in Figure 6.21 below.

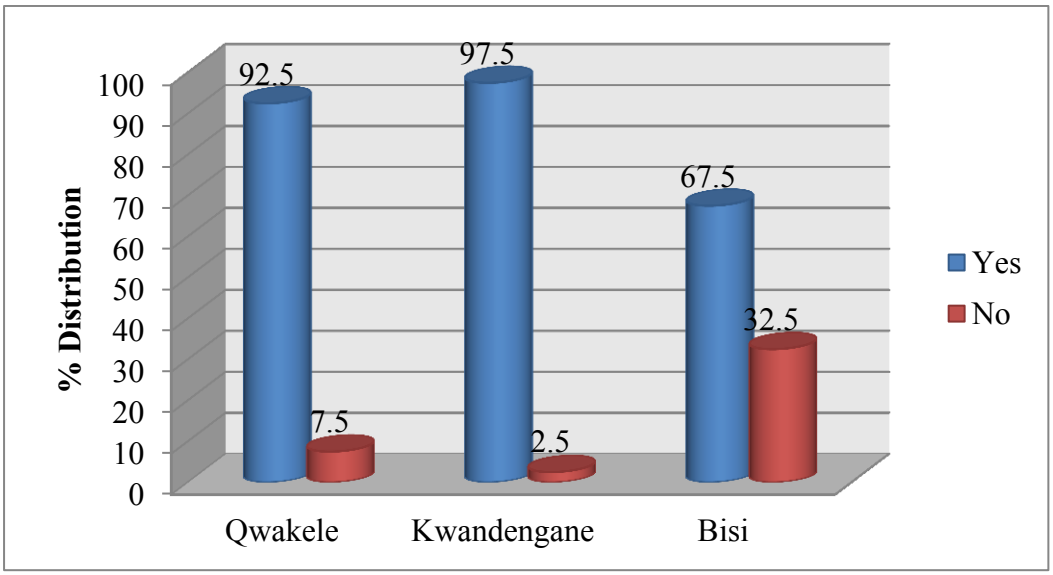



**Figure 6.21: Awareness of the role of collective action, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that most respondents by far in all study villages were aware of the role played by team work.

### 6.3.17 Reasons for not participating in collective action

After having asked sample households about their participation in collective action and their awareness of the role of collective action it was thought useful to see why they did not participate. The responses fell into the categories of not interested, low income, age and politics as reasons for avoiding collective action, as shown in Table 6.16 below.

**Table 6.16: Reasons for not participating in collective action, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| REASONS FOR NOT PARTICIPATING IN COLLECTIVE ACTION (%) | | | |
|---|---|---|---|
| | **Qwakele** | **Kwandengane** | **Bisi** |
| Not interested | 60.7 | 38.1 | 56.5 |
| Unstable income | 3.6 | 0 | 0 |
| Low income | 32.1 | 61.9 | 30.4 |
| Age | 3.6 | 0 | 0 |
| Politics | 0 | 0 | 13 |
| **Total percent** | **100** | **100** | **100** |

Table 6.16 shows that a majority of respondents from Qwakele (60.7%) and Bisi (56.5%) were not interested in teaming up with other households, while a majority in Kwandengane (61.9%) indicated that low income was the reason for them. Politics involved in collective action had, to some extent, an influence on decisions of households to participate in collective action in Bisi.

### 6.3.18 Market for crops and livestock

Households have a high potential to derive livelihoods from market-oriented agriculture (Magingxa & Kamara, 2003). However, households are faced with a number of barriers which include physical access to markets (distances and costs); structure of the markets (asymmetry of relations between farmers, market intermediaries and consumers); and producers' lack of skills, information and organisation (understanding of the market, prices, bargaining etc.) (IFAD, 2003). Figures 6.22 and 6.23 below show the types of market to which sample households have access for crops and livestock, respectively.

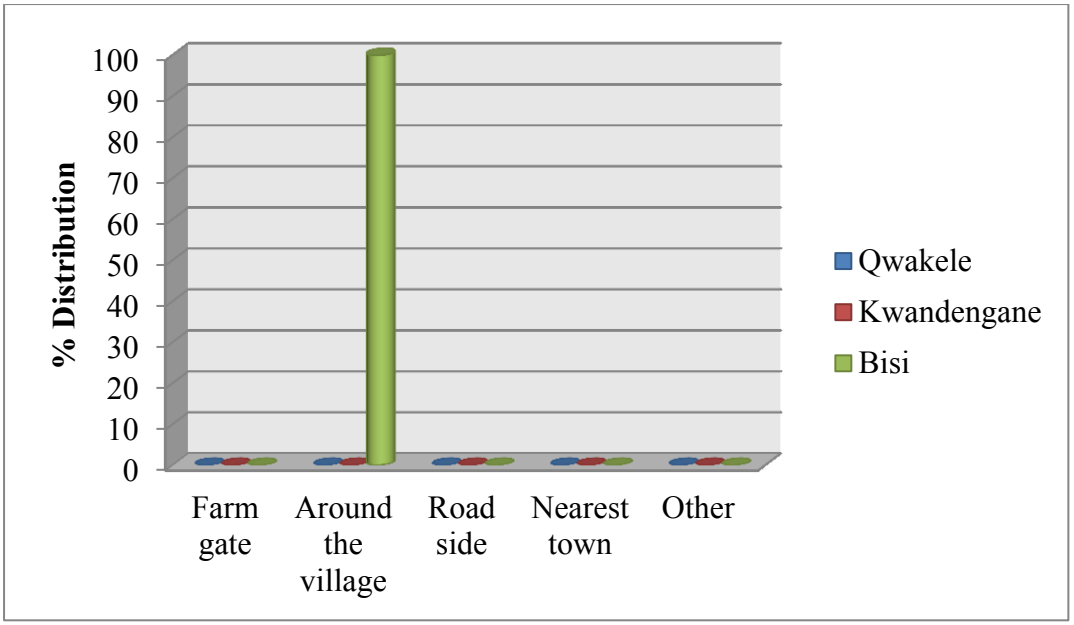



**Figure 6.22: Market for crops, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show that 100% of sample households in Bisi sell their produce, but only to local households.

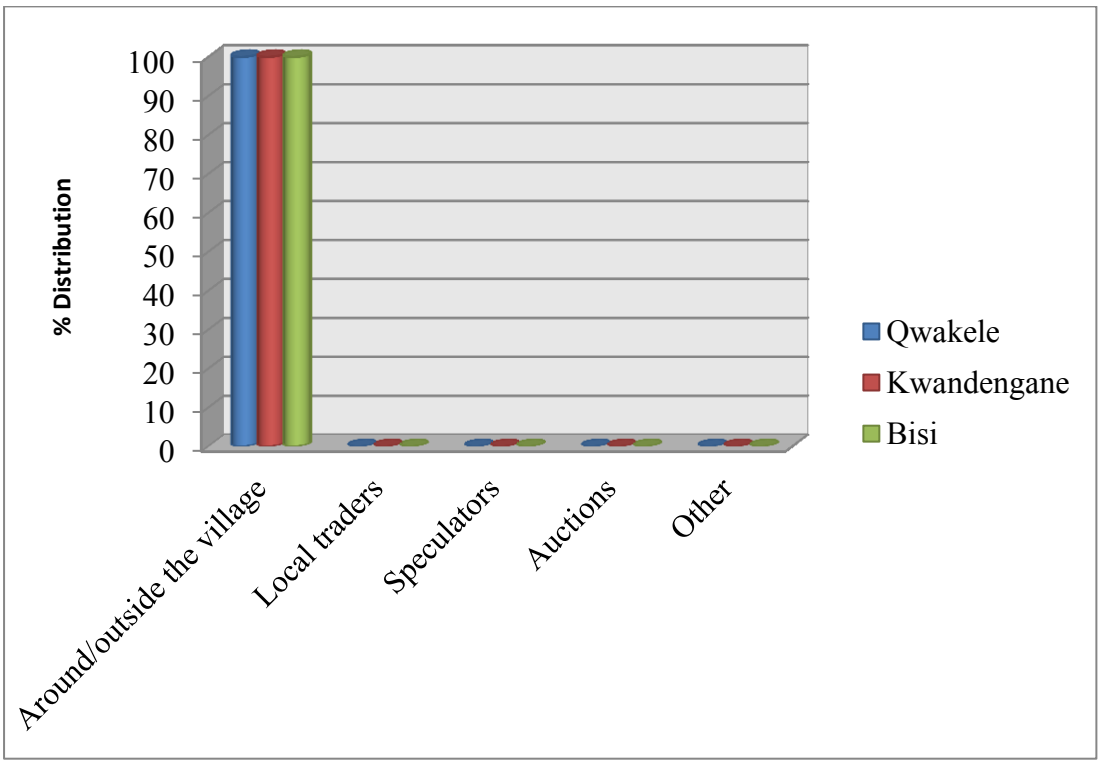



**Figure 6.23: Market for livestock, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

The results show in each of the villages livestock was sold around or outside the village, to other rural households.

## 6.4 Concluding remarks

This chapter has presented the descriptive analysis and interpretation of the demographic characteristics of the three villages studied. Given the results relating to the vulnerability of rural households' agricultural production – which is one of their livelihood strategies - it appears that rural households in the areas studied are vulnerable to the effects of climate change that are already being felt. Other studies highlighting vulnerability at a household level focus explicitly on those demographic and socioeconomic characteristics that increase the impact of events or hazards on local populations and the degree to which they can be harmed (Cutter *et al*., 2009). Understanding this relationship and its drivers can inform future planning for resource management.

The results have shown that the sample households are headed by experienced people as indicated by their average age of 56 years. However, a number of demographic characteristics could complement each other to build resilience among the people. The survey results show that the study villages are characterised by a low level of education, which means that there is a lack of human capital and of a quality dimension in the available labour that limits the ability to access higher return activities in agricultural production to escape poverty and build resilience to climate hazards. Also, there is little ownership of valuable assets that can be used as collateral. Access to clean and safe water and lack of irrigation infrastructure are also key factors adding vulnerability stress on the already vulnerable rural households. In general, the results clearly show that the studied villages are vulnerable to the effects of climate change. They further show that vulnerability is greatest for the village near the river and least for the inland village. The next chapter focuses on an econometric analysis of the results and assess and compares vulnerability indicators.

## Chapter 7: Econometric analysis of variables through a multiple regression model

### 7.0 Introduction

This chapter focuses on the main objective of the study, which was to provide indicators of households' vulnerability to climate change. Indicators of vulnerability to climate change were selected and subjected to statistical analysis. These indicator variables include stability of income, reliability of sources of water, and diversification of agricultural production. The selected indicators of vulnerability were subjected to a statistical procedure that involves relating a large number of explanatory variables to vulnerability in order to identify the factors that are statistically significant. This approach was applied using a multiple regression model that predicts the scores of one variable (dependent variable) based on scores of several other variables (independent variables). For this purpose, a multiple regression model was used to test how these variables relate to one another. The idea behind the model was to obtain the beta values ($\beta_1$, $\beta_2$ .$\beta$n) as these measures show how strongly each independent variable ($X_1$, $X_2$,...., $X_n$) influences the dependent variable (Y). A multiple regression model was also used to obtain the significance levels of the relationship between the independent variable and dependent variables. The independent variables were tested for their significance and this enabled the selection of good indicators of vulnerability to climate change.

### 7.1 Specification of the model

The model is given as:

$$Y_{income} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots \beta_n X_n + U_i$$

$$Y_{water} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots \beta_n X_n + U_i$$

$$Y_{diversification} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots \beta_n X_n + U_i$$

This model explains the relationship between the reliability of income, reliability of water resources and diversification (measured by Simpson indices) and socioeconomic and institutional characteristics influencing such vulnerability dependents. These dependent variables provide information on the condition of internal and external monetary resources, the sources of water and diversification of agricultural production. In the above equations, the reliability of income and water resource and diversification are dependent variables that were regressed against twenty independent variables. The independent variables were selected from a vulnerability model used in several studies including Gbetibouo & Ringler (2009); Deressa *et al*. (2008) and Gbetibouo *et al*. (2010). Of the 20 selected independent variables,

nineteen, sixteen and sixteen independent variables were included in the regression against income, sources of water and the Simpson index, respectively. When a number of explanatory variables were related to vulnerability indicators to choose significant statistical relationships using a statistical approach, some explanatory variables were excluded under certain vulnerability indicators. Table 7.1 below shows the independent variables that were related to vulnerability indicators; those that were excluded are marked by a cross (X).

**Table 7.1: Included and excluded explanatory variables used in the model, Qwakele, Kwandengane, Bisi, 2012 (n = 120)**

| **Independent variables** | **Reliability of income** | **Reliability of sources of water** | **Simpson index** |
|---|---|---|---|
| Age | ✓ | ✓ | ✓ |
| Gender | ✓ | ✓ | ✓ |
| Marital status | ✓ | ✓ | ✓ |
| Education | ✓ | ✓ | ✓ |
| Income class | ✓ | X | X |
| Household size | ✓ | ✓ | ✓ |
| IndividualsY | ✓ | ✓ | ✓ |
| HHAveY | ✓ | ✓ | ✓ |
| Garden size | ✓ | ✓ | ✓ |
| RFRGRWCRPGADN | ✓ | ✓ | ✓ |
| Field size | ✓ | ✓ | ✓ |
| SOWTERFRCROPS | ✓ | ✓ | ✓ |
| GovSupport | ✓ | ✓ | ✓ |
| Organization | ✓ | X | X |
| Distance | ✓ | ✓ | ✓ |
| Adequate/Unreliable | ✓ | - | ✓ |
| Assets | ✓ | ✓ | ✓ |
| NMBEROFLIVSTKOWND | ✓ | ✓ | ✓ |
| Infrastructure | ✓ | X | X |
| Source of water | X | X | ✓ |

**Source: Survey data, 2012**

## 7.2 Empirical results and significant variables

The results were obtained using a multiple regression model. Regression analysis is a technique designed to characterise the relationship between a set of independent variables (Xs) and a dependent variable (Y). Data was pooled for all villages, a stepwise regression analysis was applied and the regression was run. The initial intention was to do regression analysis separately on the three villages but the results did not make any sense, particularly for the Qwakele and Kwandengane villages. Therefore, at the end, the regression was run for the three villages together.

The three indicators of vulnerability to climate change include the reliability of income, reliability of water sources, and the Simpson index and they were regressed against a large number of demographic characteristics that shape the response of and the ability of households to adapt to the effect of climate change. All three of the depended variables were used as dummy variables. For example, reliability of income (Yes=1, No=2), reliability of sources of water (Yes=1, No=2). The respondents were asked to indicate if their sources of income and sources of water were reliable or not. The Simpson index is a measure of diversification that ranges between 0 (infinite diversity) and 1 (absolute specialization). The indices were calculated and those that were less than 0.5 were equated to one while those that were greater than one were equated to two, i.e., Simpson index (0.5 < =1, 0.5 > =2)

This section presents the results of the multiple regression model and discusses the significant variables that determine the vulnerability of rural households to climate change. The analysis was conducted for eight dependent variables (Ys) separately against the same independent variables (Xs). The results presented in Table 7.2 below include only the variables that were statistical significant for each dependent variable.

**Table 7.2: Regression analysis**

| | Reliability of income | | Reliability of water sources | | Simpson index | |
|---|---|---|---|---|---|---|
| | Estimated coefficient | Significance | Estimated coefficient | Significance | Estimated coefficient | Significance |
| Constant | | 00.2* | | 0.064*** | | 0.296 |
| Age | | | 0.009 | 0.034** | | |
| Gender | - 0.326 | 0.085*** | | | | |
| Education | - 0.147 | 0.090*** | 0.139 | 0.089*** | | |
| Individuals bringing income | 0.078 | 0.051*** | | | | |
| Household average income | 0.000 | 0.064*** | | | | |
| Garden size | 0.777 | 0.027** | | | 0.325 | 0.042** |
| Extension & Veterinary services | - 0.367 | 0.007* | | | | |
| Distance to sources of water | - 0.038 | 0.060*** | - 0.023 | 0.053** | | |
| Household size | | | 0.077 | 0.000* | | |
| Reasons for growing crops in gardens | | | - 0.106 | 0.085*** | | |
| Sources of water | | | 0.205 | 0.001* | | |
| **Model summary** | $R^2$ 0.988 | | $R^2$ 0.825 | | $R^2$ 0.648 | |
| **ANOVA** | F-value 13.349, Sig. 0.027 | | F-value 4.708, Sig. 0.002 | | F-value 1.628, Sig. 0.250 | |

Source: Survey data, 2012

*1% significance level, **5% significance level, ***10% significance level

As indicated by Table 7.2 above, some predictor variables influence vulnerability dependents significantly. The results show that eight: gender, education, number of individuals bringing income, household average income, distance to sources of water, garden size, government support, including a constant were statistically significant at 10%, 5% and 1% levels for reliability of income. The significance values imply that there is enough evidence to support the hypothesis that an increase/improvement in each of these variables will increase reliability of income. Furthermore, in all but three cases, the signs of the estimated coefficients were consistent with the expectations. Unexpected negative signs were noted between education, government support and distance to the source of water and reliability of income. Possible explanations for this relationship are that:

- The municipal are show very low level of education, high unemployment and heavy dependence on social grants, therefore education (which could enable households to exploit other improved or better sources of income) has a small, if any contribution to household income. Farm income was very low, and there was very little government support resulting in low contribution of farm income to household income. Furthermore, it is generally expected that farm income would be unstable where there are less support services and where production is under dry land conditions, given uncertainties in weather variability.

A statistically significant variable that had a large marginal impact on income was garden size. Furthermore, the mean numbers were different for the study villages and the difference was statistically significant, as shown by the F and significant values of the ANOVA. $R^2$ value of 0.988 points to the fact that at least 99% of the variation in income is explained by the variation of the independent variables given that the closer $R^2$ value is to 1, the better is the fit of the estimated regression line.

Seven: age, education, household size, reasons for growing crops in garden, sources of water, distance to sources of water, including a constant, variables were statistically significant at 10%, 5% and 1% levels for reliability of water sources. The significance values imply that there is enough evidence to support the notion that an increase/improvement in each of these variables will increase the reliability of sources of water. It was only in two cases that the signs of the estimated coefficients were not consistent with the expectations. An unexpected negative sign was noted between reasons for growing crops in gardens and distance to sources of water and reliability of sources of water. A possible explanation for this

relationship is that there is actually no direct relationship between these variables and that the predictor variables tend to influence the perceptions of individuals regarding the dependent variable. For example, if a household grows vegetables in the garden for consumption, that household might not make much of inadequate sources of water given that there is a poor or total lack of irrigation infrastructure as is the case for most households. Household average income had a largest marginal impact on reliability of sources of water.

It was found to be more likely that at least one of the populations has a mean different from others as shown by a large F-value. This hypothesis was statistically significant as shown by a significance value of the ANOVA. The goodness-of-fit test, shown by $R^2$ value, for a multiple regression model measures the suitability of the model to a given data set. The results for the goodness-of-fit test shown by the model summary indicate that a multiple regression model is well suited to predict the influence of the independent variable on the dependent variable.

Based on a deductive and statistical procedures adapted from Adger, *et al*. (2004), the results show that income and water are good indicators of household vulnerability to climate change. The Simpson index has only one significant explanatory variable, garden size that was significant at 5%, implying that an increase in garden size increases diversification. As indicated by Table 7.2 a unit increase in garden size results in a 33 unit increment in diversification, other things being equal. Unexpected negative signs were noted for age, household size, individuals bringing income and distance to sources of water, however, this was not statistically significant. Household average income was the only predictor variable that had a large marginal impact on diversification but was not statistically significant.

The F-value indicates that the mean values were not different, the study villages showed equal mean values. This is supported by a significance value of 0.174 that indicates that there is no statistically significant difference between the means. Based on $R^2$ value of 0.648, it may be concluded that 65% of variation in diversification as measured by a Simpson index is explained by the variation of the independent variables. This value of $R^2$ is closer to 1, implying that the multiple regression model was well suited to predict the influence of the independent variables on the dependent variable.

### 7.3 Empirical results of other indices

There were five more Simpson indices; including dominance, reciprocal, alternative Simpson, alternative dominance and alternative reciprocal indices that were used in regression analysis with the purpose of measuring validity and consistence of the Simpson index in measuring diversification. Like the Simpson index, these other indices had one significant variable (garden size) that was significant at 5%. However, the reciprocal and alternative reciprocal indices did not have even one significant variable. Table 7.3 below presents the results of the ANOVA and model summaries of the other Simpson indices.

**Table 7.3: Comparison of the ANOVA and model summary between Simpson indices**

| ANOVA | | | | | | MODEL SUMMARY | | |
|---|---|---|---|---|---|---|---|---|
| **Index** | **Sum of squares** | **df** | **Mean square** | **F** | **Sig.** | **R** | **$R^2$** | **Adjusted $R^2$** |
| **Dominance** | 0.750 | 17 | 0.044 | 1.628 | 0.174 | 0.805 | 0.648 | 0.250 |
| **Reciprocal** | 42.627 | 17 | 2.507 | 1.876 | 0.114 | 0.825 | 0.680 | 0.317 |
| **Alt Simpson** | 0.738 | 17 | 0.043 | 1.642 | 0.170 | 0.807 | 0.650 | 0.254 |
| **Alt Dominance** | 0.738 | 17 | 0.043 | 1.642 | 0.170 | 0.807 | 0.650 | 0.254 |
| **Alt Reciprocal** | 39.655 | 17 | 2.333 | 1.992 | 0.093*** | 0.832 | 0.693 | 0.345 |

**Source: Survey data, 2012** ** Significant at 5% level

The results indicate that Simpson indices are consistent. This is shown by the F-values that indicate no difference between the mean values. This was the case with the results of the Simpson index presented in Table 7.3 above. Furthermore, a multiple regression model proved to be well suited to predict the influence of independent variables on the dependent variable as shown by the values of $R^2$ which were greater than 0.5.

### 7.4 Concluding remarks

This chapter has presented a detailed discussion and interpretation of the empirical results. Table 7.2 was used to make the results easy to understand. The chapter began with a description of the included and excluded independent variables as well as their expected

marginal impact on dependent variables. This was followed by the assessment of the impact of independent variables as well as the statistical significance of that impact. The assessment was done using a multiple regression model. ANOVA and a goodness of-fit-test ($R^2$) were used to determine if the means are statistically different or not and if the model was suitable for measuring/assessing the impact of independent variables on a dependent variable. The next chapter presents a discussion of conclusions based on the descriptive and analytical results.

## Chapter 8: Conclusions and recommendations

### 8.0 Introduction

This chapter provides the conclusions and recommendations drawn from the data analysed in the assessment and comparison of vulnerability indicators in three typical villages, a village near the river, an inland village and a coastal village. The conclusions concern the main objective of the study that was achieved by answering the research questions. The main objective of this study was to provide indicators of vulnerability to climate change, specifically for rural households involved in agricultural production. The idea behind this objective was that the information gathered could inform the adaptive capacity of resource-dependent rural households. The results are expected to provide a platform for rural development to help rural households plan to adapt to and overcome the effects of climate change, thereby uplifting the living standards of these households. To do so, the research questions needed to be answered. It had to be known how particular localities are affected by climate change given Wongbusarakum & Loper's (2011) argument that armed with good knowledge about the nature of the linkages and the implications of different management options, natural resource managers and policy makers have the best chance of identifying strategies that will enhance household resilience without worsening the vulnerability of the already vulnerable households. The next section summarizes the whole study.

### 8.1 Summary

The literature reviewed indicates that resources such as water, one of the most valuable resources in growing food for the increasing population, are already under stress in South Africa. Other resources such as land are degraded due to overuse and poor management. The majority of the poor households are located in rural areas and depend largely on social grants, agricultural production and, to a lesser extent, on remittances for their livelihoods. The reason for the dependence on these livelihood strategies is the high unemployment rate among the rural population. Insufficient public spending on rural infrastructure and services also characterizes the country.

The literature further indicates that climate change is unavoidable. It poses a great threat to food and water security, public health and natural resources. Poor countries relying on agricultural production are expected to be the most vulnerable due to their low adaptive capacity.

The foregoing implies that for livelihoods to be sustainable, households have to be able to cope with and recover from stresses and shocks, without further damage to the resource base. However, it transpires that in order to build the adaptive capacity or resilience of rural households to the effects of climate change, policy makers and resource managers must know the livelihood strategies employed, the response mechanisms that are already employed, and the extent to which agricultural production is likely to be affected. Hence, this study was carried out.

The methodology employed enabled the study to achieve its main objective and answer the research questions, thereby helping to bridge the gap between what is known about the likely effects of climate change and what is not known about the possible coping strategies of affected rural households. In bridging this gap, the study first described the demographic and socio-economic characteristics of the households of the study villages; it then explored the indicators of vulnerability to climate change and the main strategies that might improve adaptive capacity. The next section presents the conclusions of the study.

## 8.2 Conclusions

This section presents the conclusions drawn from the data analysed. It begins by discussing descriptive results and goes on to discuss the results of the analysis of vulnerability.

### 8.2.1 Descriptive results - conclusion

This section relates to the second and third objectives of the study. Based on the results of descriptive statistics, households in the studied villages are characterized by being poor and less developed; as a result, these households largely depend on social grants and agricultural production for their livelihoods. Agricultural production is characterized by low labour productivity, low levels of purchased inputs and production technology, low usage of credit, but high inputs in terms of time. Agricultural production is mainly for home consumption.

In addition, due to high unemployment rates, the unemployed are dispersed widely among households. The unemployed sustain themselves by being attached to households with adequate means of survival. The unemployed youth and younger adults postpone leaving the home of parents or other relatives; a phenomenon that is very common amongst the poor households. Those who have secured employment move out and form families of their own, leaving the unemployed behind. While this, to some extent, ensures some resource access, the

private safety net does not cover everyone due to involuntarily increased household size. This drags many of the households supporting unemployed people further into poverty, with negative consequences for the welfare of beneficiaries of social grants, particularly, children and elders who are not of working age.

As a result, it is likely that poor rural households live below the poverty line; some report no cash income whatsoever. Some individuals are turning to forms of self-employment to make ends meet. This socioeconomic context is further aggravated by job losses, high and increasing cost of living, a lack of means to fully exploit the potential of arable land, and increasing vulnerability to changes in climate. This implies that in the absence of agricultural production in these areas, the experience of hunger would be much worse; hence efforts should be made to enhance poor rural households' agricultural production.

### 8.2.2 Analysis of vulnerability - conclusion

This section relates to the main specific objective of the study, which was to assess the main indicators of vulnerability of rural households to climate change. The stability of income, reliability of sources of water and diversification of agricultural production measured by the Simpson indices were selected as dependent variables. Using a deductive approach the explanatory variables that shape the sensitivity and adaptive capacity of rural households to the effects of climate change were selected and regressed against the indicator variables using a statistical approach. The first indicator was the reliability of income from any source. In line with the descriptive results, the number of individuals receiving income, household average income and garden size play a significant role in livelihoods. The second indicator was reliability of water resources. Household size, source of water and distance to water resources were significant and the results are in line with the real situation. Due to poor service delivery, some of the poor rural households still fetch water from rivers and streams and incur opportunity cost in terms of time. In the case of the last indicator variable, diversification of agricultural production, garden size was the only significant variable. This implies that households would be able to diversify production if resources such as land allow it.

## 8.3 Recommendations

Clearly, the studied rural households are vulnerable to climate change due to a combination of a number of indicators. However, the level of exposure to and the ability to cope with

climate change varies, and this study has confirmed that poor rural households will be particularly vulnerable. It has also shown that agricultural production, even though it is for subsistence purposes rather than commercial, forms a basis of resilience for poor rural households. Therefore, every effort should be made to support and enhance agricultural production by poor rural households.

The regression results were consistent with the available literature. They both show that there is a need for support of rural households' subsistence agricultural production in terms of capital for infrastructure (particularly, the irrigation and road infrastructure), extension services, access to formal markets, and easy access to credit facilities. Furthermore, the studied households are located in rural areas where services delivery is still lagging. Therefore, speeding up of service by government could build resilience to climate change. For example, improved access roads would improve households' access to the major centres of the municipality, where health facilities, inputs markets and formal output markets are situated. In addition, access to sufficient and reliable water resources combined with irrigation infrastructure could improve crop production.

Based on focus groups, government must ensure strict and well-enforced interaction between extension officers and farming rural households. Lack of extension support is vital because, among other factors, rural households in the study villages show very low level of education and knowledge about climate change and variability as well as coping strategies.

Another most important issue, that was not really part of this study, is that of a high birth rate, particularly at a household level. Population growth contributes to high competition for already scarce resources that, to some extent, exacerbates the impact of climate change. There is a need for awareness programmes about the control of birth rate to reach remote rural areas.

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**Annexure 1: Household survey questionnaire**

**University of Fort Hare**

**Department of Agricultural Economics and Extension**

**Household survey questionnaire for the Ingquza Hill Local Municipality**

## A. GENERAL INFORMATION

Enumerator's name……. Village……

Date of the interview…… Questionnaire reference number……

GPS Coordinates

North……. South…….

GPS Altitude……..

## B. DEMOGRAPHIC INFORMATION STARTING WITH HOUSEHOLD HEAD

Fill in the relevant information and where possible mark with an X.

| **B1 Age** | **B2 Gender** | | **B3 Marital status** | | | | **B4 Education** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. M | 2. F | 1. S | 2. M | 3. W | 4. D | 1. N | 2. P | 3. S | 4. T | 5. O |
| | | | | | | | | | | | |

Gender: 1.Male, 2.Female; Marital status: 1.Single, 2.Married, 3.Widowed, 4.Divorced

Education: 1.No education, 2.Primary, 3.Secondary, 3.Teriary, 4.Other

**B5 Employment status**

| **Occupation** | **Full-time/Part-time** | **Income class (R/month)** | **Time at home** |
|---|---|---|---|
| | | | |

**NB:** Occupation could also stand for: 1. Unemployed, 2. Self employed or 3. Pensioner

**B6 Household size & contribution to household income**

| | | |
|---|---|---|
| Number of adults (Age ≥ 21) | | |
| Number of children (Age < 21) | | |
| Number of individuals bringing in income | | |
| Household's average monthly income ® | | |
| Is it stable throughout the year? (Yes/No) | | |

## C. LIVELIHOODS

**C1. What are the sources of income? Indicate the number of individuals deriving income from each source.**

| **Source** | **Number of individuals** |
|---|---|
| Agriculture (e.g selling crops or livestock) | |
| Remittances | |
| Social grants | |
| Cooperative income | |
| Self employment (e.g building houses, plumbing, etc.) | |
| Business (e.g Spaza shop, hawking, taxi business, etc.) | |

## D. LAND AND AGRICULTURE

**D1. Do you have a garden in your residential site? Indicate its size.**

| **Garden** | **Yes** | **No** |
|---|---|---|
| **Size (ha)** | | |

**D2. If you grow crops in your garden, please indicate the kind of crops, amount of land allocated to each crop, yield and reasons for growing them**

| Crop | Amount of land (ha) | Yield for the previous season | Reasons for growing |
|---|---|---|---|
| Maize | | | |
| Dry beans | | | |
| Dry peas | | | |
| Pumpkins | | | |
| Butternut | | | |
| Potatoes | | | |
| Cabbages | | | |
| Carrots | | | |
| Tomatoes | | | |
| Spinach | | | |
| Onions | | | |
| Other (specify) | | | |

**D3. Do you have one or more arable fields? How many are they? Indicate the size of each field**

| Field | Yes | No |
|---|---|---|
| **How many?** | | |
| **Size (ha)** | | |

**D4. How did you obtain access to each of the fields?**

| | |
|---|---|
| Bought (title deed) | **1** |
| Leased | **2** |
| Inherited | **3** |
| Given by government | **4** |
| Allocated by headman | **5** |
| Renting and/or share cropping | **6** |
| Other (Specify)…….. | **7** |

| **D5. Are you satisfied with the size of land that you have?** | **Yes** | **No** |
|---|---|---|
| **Why…….** | | |
| **D6. Do you really feel secure with land that you have in terms of ownership?** | **Yes** | **No** |
| **Why…….** | | |

**D7. If you grow crops in your fields, please indicate the kind of crops, amount of land allocated to each crop, yield and which ones do you sell**

| Crop | Amount of land (ha) | Yield for the previous season | Reasons for growing |
|---|---|---|---|
| Maize | | | |
| Sorghum | | | |
| Dry beans | | | |
| Dry peas | | | |
| Pumpkins | | | |
| Butternut | | | |
| Potatoes | | | |
| Other (Specify) | | | |

**D8. Where do you sell your produce?**

| Place | Mark with X | Reason |
|---|---|---|
| Farm gate | | |
| Around the village | | |
| Road side | | |
| Nearest town | | |
| Other (Specify) | | |

**D9. Where do you get money to invest in agricultural production?**

| Source | |
|---|---|
| Borrowing from banks | **1** |
| Borrowing from friends | **2** |
| Your own savings | **3** |
| State aid | **4** |
| Other (specify)……. | **5** |

**D10. Where do you get the production inputs that you use?**

| List of inputs | Place you get it | Reason for using this place |
|---|---|---|
| Seeds | | |
| Fertilizer | | |
| Pesticides | | |
| Insecticides | | |
| Other (Specify)…… | | |

**D11. How do you cultivate your land?**

| **Method of cultivation** | **Own** | **Borrowed** | **Hired** |
|---|---|---|---|
| Tractor | | | |
| Animal traction | | | |
| Hand | | | |
| Other (Specify)……. | | | |

**D12. Which factors influence your choice of crops in any growing season?**

| Climate | Food security | Market | Easy to manage | Other (Specify)…… |
|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** |

**D13. Please indicate the sources of labour**

| | |
|---|---|
| Family | |
| Exchange | |
| Hired | |
| Family + exchange | |
| Family + hired | |
| Exchange + hired | |
| All | |

**D14. Are you satisfied with the number and quality of labour that you employ? Explain**

**…….**

**…….**

**D15. If you do improve the fertility of the soil, please indicate how**

| Apply kraal manure | Apply fertilizer | Both | Other (Specify) |
|---|---|---|---|
| **1** | **2** | **3** | **4** |

**D16. Please indicate the source of water for your crops**

| | |
|---|---|
| **Rainfall** | **1** |
| **Irrigation** | **2** |
| **Both** | **3** |

**D17. If irrigation is not included, please explain why**

……
……

**D18. Which of the following animals do you keep? Indicate numbers owned and reasons for keeping them.**

| TYPE | Number owned | Reason for keeping |
|---|---|---|
| Chicken | | |
| Pigs | | |
| sheep | | |
| Goats | | |
| Cattle | | |
| Donkeys | | |
| Horses | | |
| Mules | | |
| Other (specify)…… | | |

**Reasons:** 1. Household consumption, 2.Ritual slaughter, 3.Sales, 4.Savings, 5.Draught power, 6.Traditional reasons (e.g lobola), 7.Other

**D19. If you sell livestock, who do you sell to?**

| | Mark with X | Reason |
|---|---|---|
| Friends/neighbours | | |
| Local traders (e.g local butcheries, local shops, etc.) | | |
| Speculators | | |
| Auctions | | |
| Other (Specify)…… | | |

**D20. What are the challenges hindering livestock productivity?**

| Diseases (Specify) | Inadequate rainfall | Poor grazing pastures | Other (specify) |
|---|---|---|---|
| **1** | **2** | **3** | **4** |

**D21. What are the challenges hindering crop productivity?**

| Pests and insects | Inadequate rainfall | Poor/not fertile enough soils | Other (Specify) |
|---|---|---|---|
| **1** | **2** | **3** | **4** |

## E. SUPPORT SERVICES, RESOURCES, ASSETS AND INFRASTRUCTURE

**E1. Indicate the type of support services you have access to**

| | **Mark with X** | **How often (e.g once a year)** |
|---|---|---|
| Credit | | |
| Market information | | |
| Workshops | | |
| Extension services | | |
| Veterinary services | | |

| | | |
|---|---|---|
| **E2. Are you a member of any organization?** | **Yes** | **No** |
| **E3. Are you aware of the role played by organizations in farming?** | **Yes** | **No** |
| **E4. Reasons for not joining…….** | | |

| | | |
|---|---|---|
| **E5. Do you have access to water resources?** | **Yes** | **No** |
| **E6. Are you satisfied with water resources you have access to?** | **Yes** | **No** |
| **E7. Why……..** | | |

**E8. Where do you get water for household use? Indicate water the sources that are adequate?**

| ***Source*** | ***Distance*** | ***State whether adequate/unreliable*** |
|---|---|---|
| Dam | | |
| Borehole | | |
| Spring | | |
| Communal Well | | |
| Own well | | |
| Communal tape | | |
| Own tape | | |
| Rainwater tank | | |
| River/stream (Name the river) | | |

**E9. What are the sources of drinking water for your livestock?**

| | Dam | Borehole | River | Well | Spring | Other (Specify) |
|---|---|---|---|---|---|---|
| Cattle | | | | | | |
| Sheep | | | | | | |
| Goats | | | | | | |
| Pigs | | | | | | |
| Donkeys | | | | | | |
| Horses | | | | | | |

| | | |
|---|---|---|
| **E10. Do you have access to grazing land?** | **Yes** | **No** |
| **E11. Are you satisfied with the grazing land you have access to?** | **Yes** | **No** |
| **E12. Why……** | | |

**E13. Indicate the type of assets you have access to**

| | |
|---|---|
| Buildings | **1** |
| Machinery: Tractor | **2** |
| Motor vehicle | **3** |
| Storages facilities | **4** |
| Other (Specify) | **5** |
| Equipment: Plough | **6** |
| Planter | **7** |
| Cultivator | **8** |
| Spade | **9** |
| Hoe | **10** |
| Wheelbarrow | **11** |
| Other (Specify) | **12** |

**E14. Indicate the type of infrastructure you have access to**

| **Infrastructure** | | **Condition** | | |
|---|---|---|---|---|
| | | **1. Bad** | **2. Fine** | **3. Good** |
| Telephone | | | | |
| Electricity | | | | |
| Water | | | | |
| Roads | | | | |
| Storage facilities | Modern | | | |
| | Old | | | |
| Other (specify)…… | | | | |

**Thank you very much for your cooperation!**

**Annexure 2: Focus group questionnaire**

**University of Fort Hare**

**Department of Agricultural Economics and Extension**

**Focus group questionnaire for the Ingquza Hill Local Municipality**

## A. GENERAL INFORMATION

Enumerator's name……. Village……

Date of the interview…… Questionnaire reference number……

## B. SOCIOECONOMIC, INSTITUTIONAL AND ENVIRONMENTAL FACTORS

**Indicate the type of support services you have access to**

| | **Mark with X** | **How often (e.g once a year)** |
|---|---|---|
| Credit | | |
| Market information | | |
| Workshops | | |
| Extension services | | |
| Veterinary services | | |

**Have you noticed any changes in the planting season?**

……
……
……

**If yes, how long have you noticed change?**

……
……
……

**What do you think are the causes for the change?**

……
……
……

**How do you adapt to these changes?**

……
……
……

**Do your sources of water provide water throughout the year?**

……
……
……

**If no, for those which dry up for how long do they dry up?**

……
……
……

**How do you cope with water stress?**

……
……
……

**Have you noticed any changes in the river systems?**

……
……
……

**If yes, for how long have noticed change?**

……
……
……....

**What do you think is the cause of these changes?**

……
……...

**How do you adapt to these changes?**

……
……
……

**Do you think the soil is fertile enough for crop production?**

……
……
……

**How do you think government is doing in terms of improving rural livelihoods, for example, by looking at roads, electricity, housing, water sanitation, schools, clinics, etc. in your village?**

……
……
……
……
……
……

**Thank you very much for your cooperation!**